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The Techno-Agrarian Renaissance - Introducing "The Rain Forest Model of International Economic Development" and other New Metrics for the Economy (a Work in Progress - November 2012)

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HEALTH COMES FIRST!!!, USA

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I. Embracing Health Economics in the US

Introduction

The idea of systems-based government gained popularity in the United States under the Clinton Administration but did not flourish under President William Jefferson Clinton or President George Walker Bush. This article challenges the Obama Administration and its supporters to re-examine measurement and valuation in the government and the economy in order to:

1) Promote economic policies that place human health first;
2) Allow simultaneous advancements in renewable energy and healthcare cost containment.
3) Value traditional and renewable energy sources based on their impact to human health or climate change.
4) Consider and capture benefits to future generations while simultaneously considering and capturing benefits for the current generation.

Work in these four areas is loosely called "health economics" and may be applied at the national economy level or the international economy level.

Old Linear Based Measures Are Still Used in Measuring the US Economy's Performance

To date, green policies in the US are often perceived by business as added constraints to current operations rather than as a source of exciting and profitable new financial directions. This perception is largely due to the fact that old, linear-based measures are still used to evaluate economic success in the US.

Consider the benefits of two new systems-based measurements in the US economy: 1) "cousin industry analysis" and 2) "intergenerational equity" valuations of energy. To date, industry players tend to analyze market opportunities that exist either within the linear bounds of their particular industry and/or according to old-school ideas of creating "value." Consider if industries could come together and analyze costs and benefits across a family of industries in the "Food-Energy-Health Nexus."

"Cousin Industry Analysis" – Bringing together US Food, Energy and Health Markets

Consider bringing together these US industries: Food and Beverage, Healthcare and Biofuels. These industries may be considered "cousin industries" in that prior to the present they have not been analyzed together.

Consider data from studies that correlate the use of high fructose corn syrup and increased body fat. Princeton University has evaluated this connection and found that fat content per the same caloric intake is higher when rats consume high fructose corn syrup rather than sugar.[1] Consider that corn is a critical input to biofuels with particular regard to biodiesel. Consider that the National Biodiesel Board (NBB) together with other biodiesel experts has advocated in the past that the use of pure biodiesel (B100) provides a 93.6% reduction in cancer risk as compared to petroleum diesel use.[2] The NBB and its affiliates also estimate a 96% reduction in hazardous waste generation in the production of biodiesel as compared with that of petroleum

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[1] http://www.sciencedaily.com/releases/2010/03/100322121115.htm (hereafter cited as "*Princeton HFCS Study*").

[2] *Biodiesel Educational Workshop*, sponsored by the Iowa Soybean Promotion Board, National Biodiesel Board, National Renewable Energy Laboratory, United Soybean Board, USDOE, September 1999. Section L, P.10. Hereafter cited as *Biodiesel Workshop*.

diesel.[3] These figures are mitigated by the fact that new retrofits on biodiesel vehicles sharply reduces their illness risk profile, however, one can assume still assume a positive impact on cancer risk reduction associated with biodiesel manufacture and use. This impact remains to be measured to date.

When "Food-Energy-Health Nexus" industries are evaluated traditionally, we might find that Coca-Cola and other US Food and Beverage players experience huge losses as information surrounding corn syrup and health issues proliferates. On the other hand, when "cousin industry analysis" is used to evaluate impacts and advances common to all three markets (food, energy and health), we might find these results:

1) Health risk of diabetes and/or weight gain may be reduced as HFCS is eliminated and raw sugar or other sweeteners are reintroduced into food products[4];
2) Health risk of high blood pressure may be reduced as HFCS is eliminated and raw sugar or other sweeteners are reintroduced into food products[5];
3) Health risk of cancer risk may be reduced as biodiesel replaces or leads production over regular diesel[6];
4) Health tax credits may be issued to Food and Beverage players such as Coke for:
    - Diabetes risk reduction
    - Weight gain reduction
    - High blood pressure risk reduction
    - Cancer risk reduction.

In addition to these health risk reduction scenarios, additional market advances may include:

1) New markets developments for renewable energy, specifically biodiesel;
2) Minority ownership development in biofuels.

Food and Beverage players may actually serve as investors in new energy models.

"Intergenerational Equity" as a Concept

"Intergenerational equity" refers to the idea that we want to preserve "the public good" for our children and their children. If fossil fuels are harvested and used at the current rate, we may find that their supply is not guaranteed for future generations. Additionally, the use of fossil fuels in the present generation may be associated with environmentally induced illnesses and/or climate concerns. The goal of "intergenerational equity" policies is to ensure that: 1) energy sources remain available to future generations; and 2) the healthiest production/use of energy sources is pursued within each generation.

What Happens When "Value" Is Attached to Renewable Inputs? Perhaps most crucial to consider in adopting systems-based measures for the economy is new economic valuation of energy sources, including both renewable energy and traditional energy sources. To date, energy market players can claim "value" in their production processes as raw energy sources such as fossil fuels are processed into petroleum and/or related fuels or by-products. Currently, renewable resources like sunlight, wind, biomass, geothermal as well as traditional energy resources like oil and coal are measured as they are converted into power at some intermediary level.

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[3] *Biodiesel Workshop*, Section N, p.25.
[4] *Princeton HFCS Study re weight gain. Diabetes risk is not included in the Princeton HFCS study but is extrapolated here.*
[5] http://www.drweil.com/drw/u/WBL02172/High-Fructose-Corn-Syrup-and-Your-Blood-Pressure.html (hereafter cited as "*Dr. Weil HFCS*").
[6] *Biodiesel Workshop.*

Consider what would happen on the books of traditional and alternative energy players if all the sudden we were to "value" the existence of renewable energy sources such as sunlight, wind, biomass and geothermal. Consider if we were to value the mere presence of these alternative sources into perpetuity or as long as the earth is in orbit with the sun. Rather than just "valuing" energy as it is produced, we could attach "value" to the mere existence of energy sources. *Virtually overnight, solar, wind, biomass and geothermal are captured on the books into perpetuity. Rather than giving ourselves credit for using up our traditional energy sources, we would actually provide ourselves credit for developing and preserving energy in the healthiest manner possible.*

Under these new rules, oil or coal reserves, when valued on the books as a future resource, may prove to be more valuable as future equity than as a current harvest. Instead of encouraging us to process the most oil or coal possible, new measures would place value on saving oil or coal until a time when their processing would be cleaner or healthier.

Finance and Nature in Harmony, Intergenerational Equity Success - Recognizing sunlight, wind, biomass, and geothermal as renewable energy resources and thereby sources of present and future equity means we are honoring "intergenerational equity" in our energy markets. The timeframe we use to value our natural resources moves from the-present-time to a timeframe that includes future generations. *All of a sudden, economic value is based on the existence and continuation of natural resources rather than their depletion. Energy assets may move from x to infinity times x. Finance and natural resources are in perfect harmony.*

Who are the Techno-Agrarian Producers?

This allegiance between finance and nature creates a new opportunity for our financial systems to evolve and honor the successes of our agricultural and energy farmers. Farmers here includes agricultural workers engaged in food security (along the community-sustained agriculture / CSA model[7]) as well as those farmers engaged in alternative energy production. It may be that farms can be utilized for both food and renewable energy production simultaneously. Under this model, we may advance food production simultaneously to the production of solar, wind, geothermal or biomass. Farms, termed "Nouvelle Fermes," seek to correlate advances in food and energy security by adapting valuable farmland for multiple uses. The emergence of a farm-first model is at the core of the "Food-Energy-Health Nexus." It is also a key requirement of a "Techno-Agrarian Renaissance."

If "Nouvelles Fermes" were to advance in the US, it might be easiest to see how such farms would develop around energy hog cities such as New York, Los Angeles or Atlanta. "Nouvelles Fermes" would exist in "Satellite Settlements" around the circumference of these major US cities and would be tasked with providing 51% or more of the food and energy needs of their sister cities. "Satellite Settlements" would be organized in such a way as to minimize transport costs of food and energy as well as energy inefficiencies associated with long commutes over the grid.

[7] "Assessing Sustainability Claims: Key Factors in Case Studies," by Jo Margaret Mano, SUNY New Paltz, presented at the Society for Values in Higher Education Annual Conference July 2010 in Portland, OR.

Summary: the "Techno-Agrarian Renaissance"

In sum, the United States is blessed with a wealth of natural renewable resources. By simply measuring renewable resources in the United States differently, we can make pronounced progress in the fields of health economics and alternative energy market development. By valuing both renewable and traditional energy sources differently, we progress the economy by correlating what is good for the environment and what is good for human health.

By applying lessons learned from technological advances regarding energy processing from the 1970's forward, we foster the development of a "Techno-Agrarian Renaissance." This "Techno-Agrarian Renaissance" may be pursued at the national level in the US and/or abroad. Instead of food and energy farmers being forced to fit into an antiquated Wall Street model, the concerns of food and energy farmers are brought to the forefront. Financial measures in this light work with farmers' concerns in a "Techno-Agrarian Renaissance."

II. Health Economics at the International Economy Level

Introduction

It is probably true that as long as the nation-state measures its economic success under old school financial silo models, the international economy will continue to evaluate its success along the same lines. Until systems-based measures can be evolved nationally, health concerns will continue to be presented as by-products or externalities with little room for economic recovery into "the public good." In addition, farmers (of food and renewable energy) will operate largely as sub-players rather than as strategic players.

That said, there is ample room for the worldwide economy to evolve a similarly robust set of measures as nation-states simultaneously evolve their measures. Concepts presented as relevant for the international economy include:

1) "Cousin industry analysis;"
2) "Intergenerational equity" and new valuation strategies;
3) "Nouvelles Fermes" organized in "Satellite Settlements"

In addition to these concepts, "The Rain Forest Model of International Development" is presented as an important model for taking health economics to the worldwide economy. "The Rain Forest Model" is backward compatible with health economics and human capital concerns at the national economy level.

"Cousin Industry Analysis" - International Economy Example

Consider the surpluses, shortages and by-products in food, energy and health when evaluating US and African concerns. In general, American populations have a surplus of inexpensive food particularly of cheap beef, pork and chicken while African nations have a shortage of these and other foods. In addition in the US, "leveling the burn" associated with a wide variety of biomass inputs may present challenges to the agrarian food and energy "Nouvelle Fermiers." While at the same time in Africa, biomass players may be isolating the existence of an "African Aloe" very adept at "leveling the burn" associated with most waste-to-energy inputs.

Under an international "cousin industry analysis" framework, when food, energy and health entities are analyzed together, we might find:

1) Cheap food surpluses in the US may be needed in Africa;
2) African aloe may be needed in the US and other developed nations;
3) Biomass inputs including sugar cane waste and other agricultural waste products may be diverted to the home nation (Africa) or affiliate nation (USA) biomass production.
4) Illness-impacted animal carcasses as well as animal waste in the home nation (Africa) or affiliate nation (USA) are disposed of safely via a biorefiney model.

In this way, food, energy and health considerations in Africa and the USA may be analyzed together. Considering African and US concerns under the same umbrella is loosely called here "spheres of influence." In addition to African-US concerns, "spheres of influence" at the international economy level may also include developments in these additional spheres:

- India and the UK;
- Indo-China and France;
- Latin America and Spain/Portugal.

At a minimum, these "spheres of influence" establish partnering opportunities for technology transfer from more developed nations to less developed nations. In addition, rain forest and other natural resources in less developed countries may be more strategically managed as nations begin to partner around long-term as well as shorter-term economic goals.

"Spheres of Influence" and "Intergenerational Equity" in International Markets

Under a "spheres of influence" model, advanced economy players are expected to be engaged in these "intergenerational equity" type concerns:

- Provide a leadership role for example in sustainable harvesting of natural resources from rain forests or other such natural blessings or wonders.
- Play a leadership role in reforestation of whatever natural resources are being harvested such that these resources remain available for future generations.
- Provide resources and/or communications around ensuring the coordination of legal considerations at the tribal, town/city, state/county/province, nation-state, international levels.

Under a "spheres of influence" model, underdeveloped or developing nations are expected to be engaged in these "intergenerational equity" type concerns:

- Collaborate regarding sustainable harvesting of natural resources from rain forests and other natural areas.
- Collaborate regarding reforestation goals of natural resources being harvested.
- Seek to develop laws that integrate concerns at the tribal level on up to the nation-state and international level.

When nations are grouped by "spheres of influence," it may be that trade developments and natural resources harvesting are more likely to occur in a manner which is sustainable.

The Rain Forest Model of International Economic Development

The Rain Forest Model of International Economic Development ("The Rain Forest Model") is explored in full to help illustrate how governing entities at the nation-state and international levels can work together to measure and promote change. This change is primary in new health economics measures.

III: The Rain Forest Model of International Economic Development

Health Economics at the International Level

"The Rain Forest Model" serves to provide a working model for worldwide economic development with the following characteristics. The model:

1) places "health economics" at the forefront of national and international concerns;
2) advances energy and food markets in a way that optimizes health;
3) grows the overall worldwide economic "pie;"
4) employs the expertise of seasoned political leaders to foster economically and environmentally safe and viable fiscal activity.

The Rain Forest Model has four discreet components that work together in a common system. These components are:

- The Canopy Layer;
- The Emergent Layer;
- The Understory Layer; and
- The Ground Layer.

In addition to these four layers, nation-state based Commissions or Commissioners exist at the Ground Layer to incent safe migration from a static Canopy / static economic state to a more dynamic international marketplace.

Current Multinational Economy as Canopy Layer

Consider the multinational economy and its activity as the Canopy Layer. Observe that there has been little emergent behavior since World War II save perhaps the rise of the "dot coms" in the 1990s and/or the rise of the pharmaceutical industry in the 1980s. In the existent model, this Canopy Layer has been allowed to dominate so long that there is little visible Emergent Layer behavior.

Consider as a prime example energy market developments since 1950. In the 1970s, the United States was virtually ready for the Canopy Layer to give way to new alternative energy technologies in the Emergent Layer. However, financial and political leadership did not promote these developments. Instead, leadership over the last 60-70 years has sponsored either actively or passively an extension of traditional energy players' dominance in the Canopy Layer. This extension of traditional energy players' dominance may be associated with such concerns as global climate change and other environmental or human health hazards.

Movement in the Canopy Layer Allows for Emergent Layer Developments

The static nature of the Canopy Layer over the last 60 to 70 years further can be seen as a sign that the overall forest or the overall economy may be poised for an overarching negative event if change is not adopted. Climate Change experts may see this overarching event as the advent of increased natural disasters such as tsunamis and floods and/or increased risk of animal-to-human borne illnesses. Human Capital experts may see this overarching event as the persistence of famine and disease in underdeveloped nations. When considering the economy as a dynamic system, observers may characterize the current Canopy as static. In this climate of economic stasis, fiscal advances become more and more likely to rely on black markets, monopolistic forces and/or other aberrations of a malfunctioning economy.

To be truly growth-oriented, the Canopy must allow for the transition of less-performing Canopy Layer players to new growth in the upcoming Emergent Layer. To provide for new growth in the Emergent Layer, some old Canopy players must fall. These felled trees allow sunlight to reach into the forest and attract new Emergent growth and Understory advancement. Simultaneously, important advances in human health and environmental protection may be promoted as the Canopy transitions its make-up.

Canopy Layer Movement Also Allows for Understory and Ground Layer Developments

In a developing forest, it is understood that Canopy players have a set lifespan; they are not intended to exist at a dominant level into infinity. If long-standing dominance is preserved for the few, the overall forest ceases to grow and/or becomes threatened by overarching disease or natural catastrophe. When political advances extend the life of Canopy players unnaturally, the overall economy becomes at risk. In a healthy rain forest, Canopy players fall from time to time.

As a Canopy tree falls to the ground, several important things happen:

- Sunlight reaches the Understory Layer and the Ground Layer and encourages new and healthy growth;
- Emergent Layer players have an opening through which to advance equal to or greater than the old Canopy;
- With biodegradation of the fallen tree, the Ground Layer is replenished with important "nutrients" (or in this case research and information) for the growth of all trees at all levels.

These "nutrients" may be considered as important information for advancing "cousin industries" nationally or internationally. As an old Canopy player falls, data surrounding that industry or that company sifts down to the Ground Layer and provides fodder for new, more progressive economic growth at all levels.

Emergent Layer Distinctions and Example

An important distinction should be made when characterizing the Emergent Layer. Emergent Layer players are not considered to be those trees or companies that are bigger than the Canopy. Instead, new Emergent Layer players are considered as those companies that are smarter or more agile than the existing Canopy players. Instead of relying on old linear based models of economic success, Emergent Layer players engage in new cross-industry economic analysis or "cousin industry analysis." This Emergent Layer is informed by such concerns as climate change, civil society, energy security and food security to name a few. Emergent Layer players actually create value out of unwanted by-products such as illness or climate impacts and create new markets by combining analysis of here-to-fore unrelated industries.

Consider again the advancement of the biomass industry where corn inputs for biomass have been recovered from inputs to food and beverage production as an example of Emergent Layer behavior. The swap (from corn as a sweetener to a biofuel input) promotes the development of alternative energy markets while simultaneously lowering the overall population risks for various illnesses including cancer, diabetes, weight gain and high blood pressure.

Another important distinction of Emerging Layer players is that they may be local, national or international in scope. Again, it is not their size that characterizes them as above the Canopy. It is their information-rich, waste-wise behavior in the marketplace. In other words, these players are excellent systems-based performers. They may advance by making simultaneous inroads for example in human health and/or in protection of the natural environment including climate.

Old Canopy Players May Evolve into Emergent and/or Understory Players

In the current evolution from old growth Canopy, it may be that old growth Canopy players reorganize themselves in a variety of ways. As old Canopy players learn to develop markets with systems-based approaches, they may be candidates of or sponsors for Emergent Growth. At the same time, Canopy players may also find that certain markets previously pursued at the Canopy level may be better pursued at the Understory Level. The Understory Level in this new model is where those industries with a national or local economy reach (not an international reach) are poised.

As an example, consider the case of Chevron, geothermal and traditional oil markets. Chevron is currently an old Canopy Layer player. Should Chevron make a dedicated advancement into geothermal and partner with several other non-Canopy players to make this happen, Chevron could move from the Canopy Layer to both the Emergent and Understory Layers. As Chevron embraces geothermal and new systems-based approaches and partners with new market players, Chevron becomes an Emergent Layer player. As Chevron dedicates its traditional oil production to fuel inputs for developing biorefineries in US markets, Chevron's oil markets may fall back to the Understory Layer. As Chevron finds local markets for its oil production for fueling biorefineries, it may retain oil market participation but at the national Understory Layer instead of the old Canopy Layer.

Critical Nature of the Understory and Ground Layers

The Understory and Ground Layers are crucial for securing growth in the overall forest or economy. The Understory Layer serves to prime players for new, Emergent growth as a Canopy player falls and provides room for industry advancement. The Ground Layer serves to inform players at the Understory Layer which are ready to advance past the Canopy to the Emergent Layer. The Ground Layer further seeks to regulate Emergent layer behavior such that Canopy fells are controlled (rather than pursued across the entire Canopy at one time).

The Ground Layer in the new model is considered a pre-incubator zone. It is ultra-information-rich and seeks to promote the advancement of market players at every level who are ethically inclined and oriented to furthering the growth of the overall economic pie. The Ground Layer is not so much "the bottom" as it is the location of nutrient-rich soils or information-rich analysis for the development of the most healthy trees in the forest. In our budding economic model, this Ground Layer is made up of nation-state governments, international government agencies, policy organizations, NGOs and all those vested in fostering economic activity that honors human capital, human health, environmental protection and other non-linear or systems-based advances.

Advent of Rain Forest Commissioners by Nation-State to Govern the Forest Growth

This article promotes the adoption of Rain Forest Commissioners to govern at the Ground Layer. These Commissioners:

1) oversee the development of Emergent Layer players;
2) monitor the extent to which Canopy players fall or recede and thereby create Emergent opportunity;
3) ensure that vital information at the Ground Layer is circulated as Lessons Learned throughout the forest ecosystem / international economy;
4) link political and economic agents to address global concerns such as climate change.

Commissions from all participating nation-states are recommended as Ground Layer organizations. In this model, Commissioners would work closely with World Bank and other leadership to ensure that Canopy layer developments are regulated.

Commissioners serve to promote economic activity in the Emergent layer that promotes the interests of national as well as state and/or tribal leadership. Commissioners work to develop laws that promote human rights and other advancements at the local, tribal, state, national and federal levels. For the purposes of this article, US Commissioners might include former Presidents Bill Clinton and George W. Bush. The vast political experience of these leaders as well as other similar leaders around the globe would help to ensure a functioning matrix between international politics and international finance.

Success of The Rain Forest Model Is Its Systems-Approach

The success of The Rain Forest Model is not found in the development of any one layer but in the fact that the various layers work together in an ecosystem or system. At all times, the failures and successes of market players at all levels are reviewed and evaluated by nation-state based Commissioners at the Ground Layer such that

Lessons Learned inform newer, more robust market activity. This robust activity is characterized by the recovered value of waste products such as negative impacts on human health or on climate considerations. It is associated with human health/human capital advancements, and win-win economic developments for tribal and non-tribal peoples in each nation-state and/or federation.

IV. Closure/ Summary

The "Techno-Agrarian Renaissance" at Home and Abroad

With new measurement systems, multinationals and their smaller competitors are challenged to grow smarter and/or more sustainably. They are also challenged to evolve in ways that limit unwanted health and other by-products such as climate impacts. In this light, systems-based measures such as "health economics" are considered vital and not just a "nice to have" option.

The starting point for developing these systems-based measures and health economics is the "Food-Energy-Health Nexus." By adopting such practices as "cousin industry analysis," "intergenerational equity" analysis and metrics from "The Rain Forest Model," we create and deliver the "Techno-Agrarian Renaissance."

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Solar Water Heating: The Case of Mauritius

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Abstract

A small-island developing state with a fragile eco-system, dependent largely on tourism and vulnerable to climate change, Mauritius is in search of a sustainable future. In spite of an average daily insolation of 7 kWh/m2 per day with at least 11 hours of sunlight throughout the year, Mauritius remains depend at 80% on imported coal and oil for its needs. Liquid Petroleum Gas (LPG) is subsidized and as much as 50 000 tonnes are used annually for domestic water-heating purposes. Electricity derived from fossil fuel is also used for the latter purpose.

The Government has launched a programme to promote solar-water heaters instead, providing a subsidy of USD 300 per household to some 40 000 beneficiaries. This paper analyses the Energy, Engineering, Economic, Environmental and Ethical (E5) dimensions of this initiative from a multidisciplinary perspective.

The potential to reach 160 000 remaining households is also assessed. The compliance of the programme in terms of sustainability criteria as well as Life-Cycle Analysis studies are conducted to encompass its holistic impacts and outcomes.

The feasibility of replicating the programme in other small-island economies is also analysed. Comparison is also made with similar projects elsewhere. Finally, an Energy Management programme is proposed to ensure the long term sustainability of the initiative taking into account its constraints, limitations and specific strengths. The scope of this programme in terms of North-South and South-South cooperation in the post-Kyoto era is also considered.

Keywords: Solar, Water-heaters, Mauritius, Renewable, Energy, Environment.

Background

Figure 1 shows schematically the operation of a typical solar-water heating system.

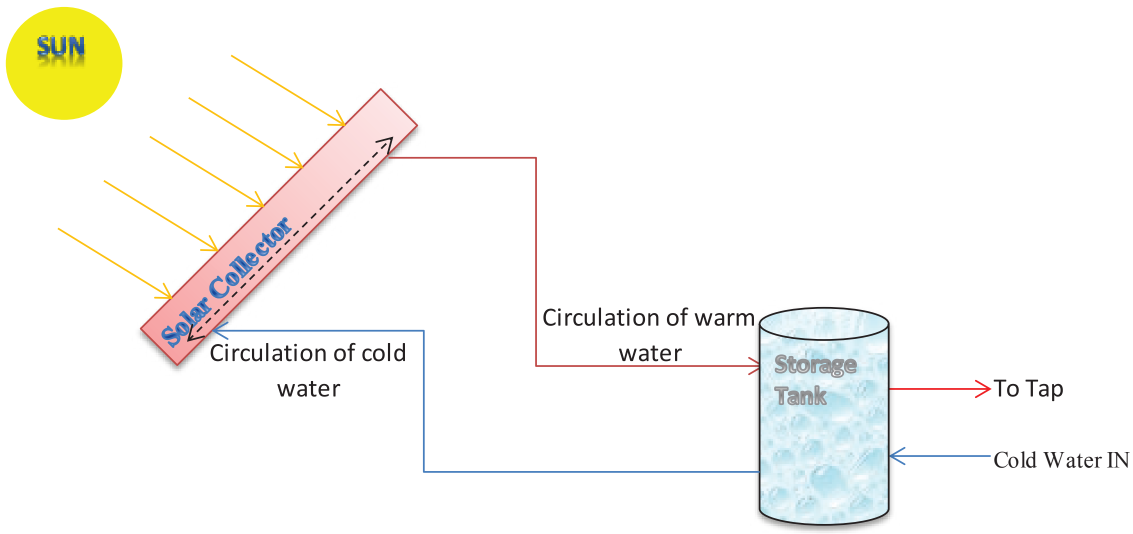

Figure 1: Solar water heater system

The characteristics of a solar water heater are determined by the thermal performance, transmittance, absorption and conduction of solar energy and the conductivity of the working fluid (Jaisankar et al., 2009a; Jaisankar et al., 2009b). The performance of a solar water heater is influenced by the product configuration and the local meteorological conditions as fully discussed by Budihardjo and Morrison, 2009. Solar water heaters can operate as a solar pre-heater in series with a boost tank or instantaneous gas heater or as a single-tank system with a boost element incorporated in the solar tank. The collector is usually mounted at a standard roof inclination, but can also be adjusted to optimise the performance during winter months when the hot water demand is the highest (Budihardjo and Morrison, 2009; Budihardjo et al., 2007).

Engineering

Solar energy collectors are special kind of heat exchangers that transform solar radiation energy to internal energy of the transport medium. A comprehensive list is shown in Table 1.

Motion of fluid	Collector type	Absorber type	Concentration ratio	Indicative temperature range (^{0}C)	Available in Mauritius
Stationary	Flat plate collector (FPC)	Flat	1	30-80	yes
	Evacuated tube collector (ETC)	Flat	1	50-200	yes
	Compound parabolic collector (CPC)	Tubular	1-5	60-240	yes
Single-axis tracking					
	Linear Fresnel reflector (LFR)	Tubular	10-40	60-250	no
	Parabolic trough collector (PTC)	Tubular	15-45	60-300	no
	Cylindrical trough collector (CTC)	Tubular	10-50	60-300	no
Two-axes tracking	Parabolic dish reflector (PDR)	Point	100-1000	100-500	no
	Heliostat field collector (HFC)	Point	100-1500	150-2000	no

[adapted from Kalogirou, 2004; Kalogirou, 2009]

Table 1: Types of solar thermal collectors

A high-efficiency collector will be best suited in climates with relatively low solar radiation with low ambient temperatures or where large volumes of water at temperatures in excess of 60°C (140°F) are required whereas a low-efficiency collector may be used in high-irradiation climates, milder ambient temperatures or for low-temperature applications.

A high-performance collector stays reasonably efficient even at large temperature differences between the collector and the ambient whereas a low-performance collector loses heat rapidly at high temperature differences. The overall thermal performance of solar collector depends on its efficiency and loss factor.

Survey

This section describes the analysis of the survey carried out in Mauritius in November and December 2012 among a random sample of 100 respondents defined as households from the local population. The sample size is stratified as follows (Table 2):

Districts	Number of households*	Estimated size	Percentage (%)	Required sample size
Port-Louis	32723	33000	9.82	10
Pamplemousses	36150	37000	11.01	11
Rivière du Rempart	29373	30000	8.93	9
Flacq	36625	37000	11.01	11
Grand-Port	30360	31000	9.23	9
Savanne	18992	19000	5.65	6
Plaines Wilhems	103921	104000	30.95	31
Moka	22122	23000	6.85	7
Black River	21025	22000	6.55	6
Total	331291	336000	100.00	100

Table 2: Population sampling

* Official value from Central Statistics Office (CSO, 2011)

The stratified random sampling technique is a probability sampling technique that uses a two-step process to partition the population into subsequent subpopulations, or strata. Elements are selected from each stratum by a random procedure.

Moreover a pilot testing was carried out after the questionnaire was designed whereby five respondents selected. Response was received from the pilot respondents, hence further changes had to be brought forward. Some questions had to be rephrased and simplified and the sequence of some questions was changed. Some questions had to be eliminated as well some technical jargons were clarified to enhance participant's comprehension. Questions structures were adjusted by increasing options and more elaboration was needed in order to facilitate the respondent in answering the questions. This has helped in making the study realistic and meaningful.

As shown in Figure 2, 60% of the respondents have at least one water heater at home, 22% have two water heaters, and 9% have three water heaters. Only 9% have no water heater.

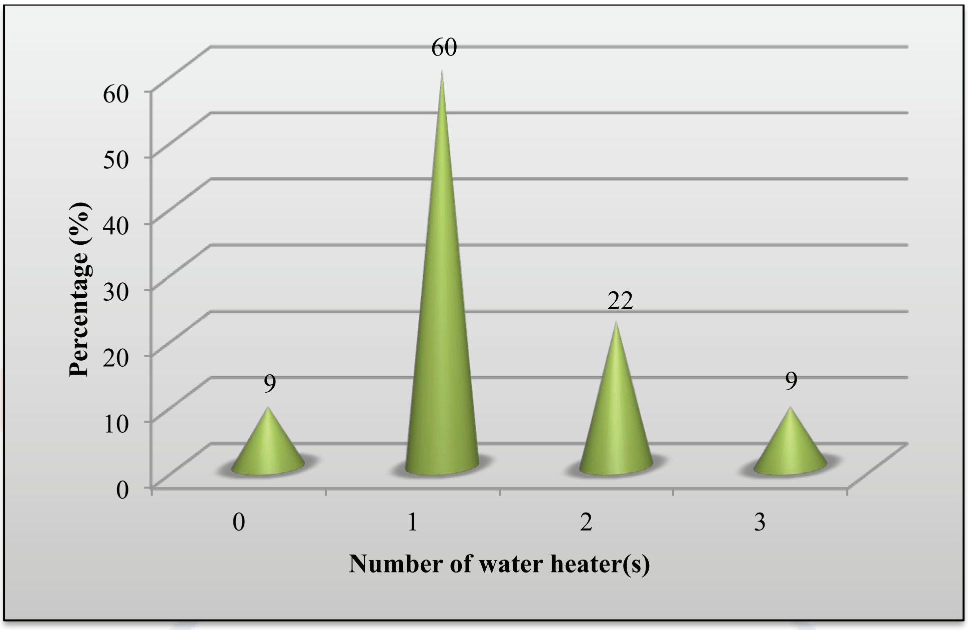

Figure 2: Number of water heater per household

45% of the respondents have solar water heater compared to 31% having electric water heater. Gas water heater represents 15% and 9% of respondents have no water heater. This shows a significant bias compared to data provided from Central Statistics Office (CSO, 2011). This factor is taken into account later in the further analysis. Focusing on solar-water heaters, the following findings were made:

- 49% have a tank capacity of 200 L, 18% for 150 L and 33% in total for 100 L, 250 L and 300 L as given in Figure 3.

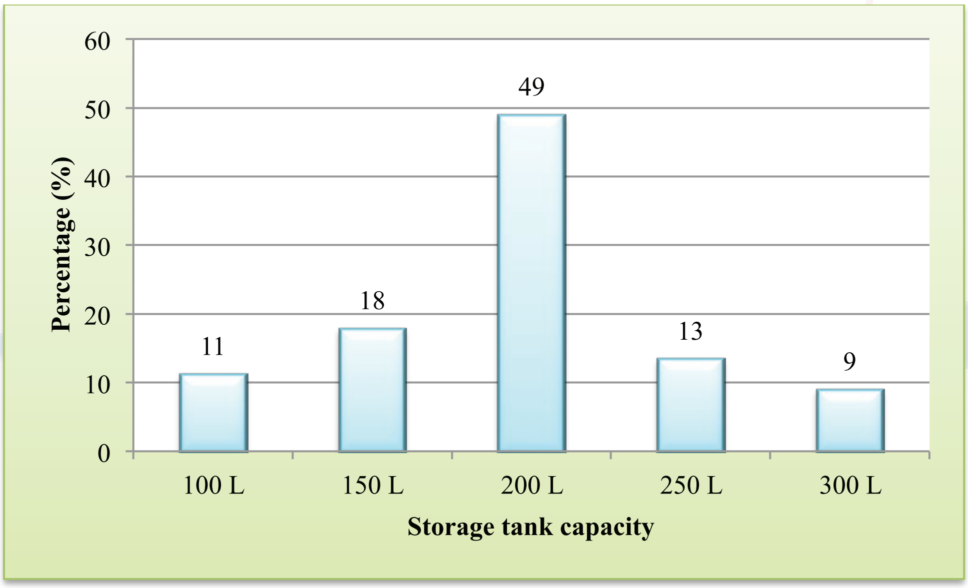

Figure 3: Storage tank capacity

- 87% of those who have solar water heater use evacuated tube solar collector compared to flat plate collector (13%) as shown in Figure 4.

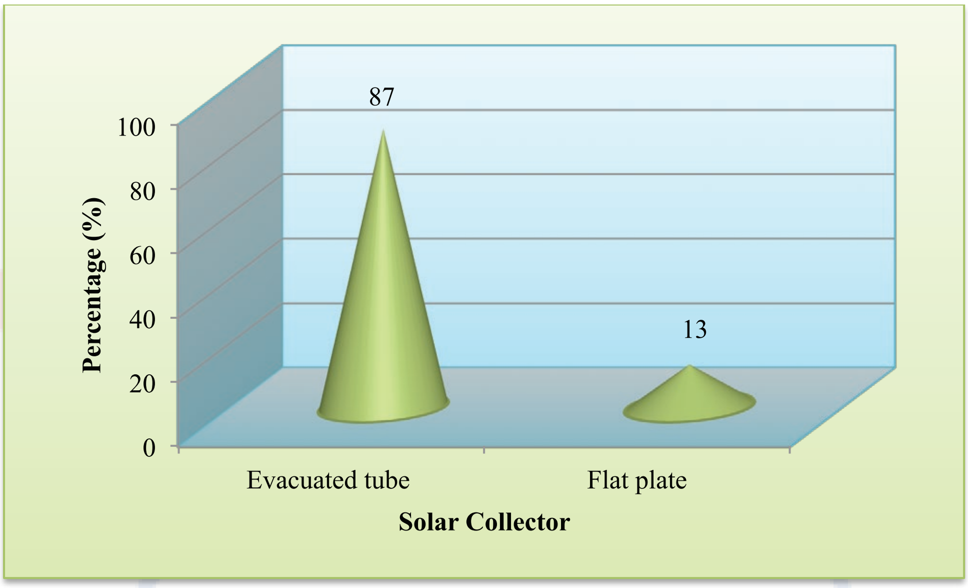

Figure 4: Solar collector

It was noted that:

- 80% of those having solar water heater have low-pressure solar water heater and 20% have high-pressure solar water heater (11% coil type and 9% heat pipe). No respondent has split unit water heater.
- 84% of solar water heater users stated its quality is excellent with only 7% moderate and 9% poor.
- On average, the cost of a low-pressure solar water heater is Rs 15,000 (USD 500) and for high-pressure solar water heater is Rs 25,000 (USD 830) irrespective of the tank capacity. The prices vary depending on the suppliers and from where it is imported and/or manufactured.
- 78% of solar water heater users did not encounter any problems with their solar water heater whereas 22% states they encountered problems.
- Problems frequently encountered on solar water heater are overflow, poor water heating in warm conditions and algae deposition.
- Majority of the respondents stated that they perform their own maintenance such as cleaning the glazing or vacuum tube with detergent to remove fungus deposition.
- 83% of the solar water heater respondents have bought their solar water heater from the Government-sponsored Development Bank of Mauritius (DBM) scheme only and 13% from their own means only. Only 4% have bought both from their money and the DBM scheme.
- 96% of the respondents agree that the DBM project on solar water heater is a success as they say it helps the reduction of emission of pollutant gases emitted to the atmosphere, provides awareness to most people about the importance of having solar water heater, and helps people to reduce electricity consumption which leads to lower monthly expenses.
- 4% of the respondents stated that it requires further improvements such as providing standard and quality solar water heaters, trained personnel, and implementing solar water heater in apartments, industries, commercials and hotels.

- 98% of the interviewees stated that the Central Electricity Board (CEB) bill has decreased after they have installed solar water heater. Of the 98%, 71% have "seen'' their CEB bill decrease less than Rs 500, 13% in the range Rs 500 – Rs 1,000, 11% in the range Rs 1,000 – Rs 1,500, and 2% greater than Rs 1,500. Some 2% who did not notice a reduction in their CEB bill stated that the presence of gas water heater had kept their CEB bill stagnant. This is shown in Figure 5. It is to be noted that there is no indication or record as to whether electricity was the only source of energy for heating before the purchase of a solar-water heater. The estimate on savings is based on the respondents' perception.

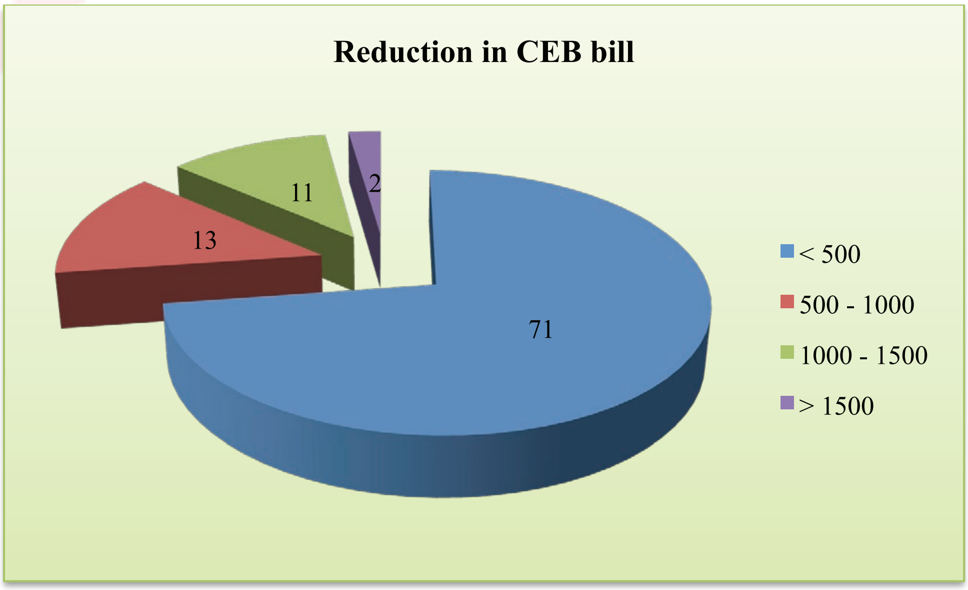

Figure 5: Reduction in CEB bill

- 65% of all the respondents use hot water for bathing, 22% for washing, 10% for cooking and 3% for cleaning (Figure 6). This shows that solar water heater is almost a necessity for bathing during warm condition.

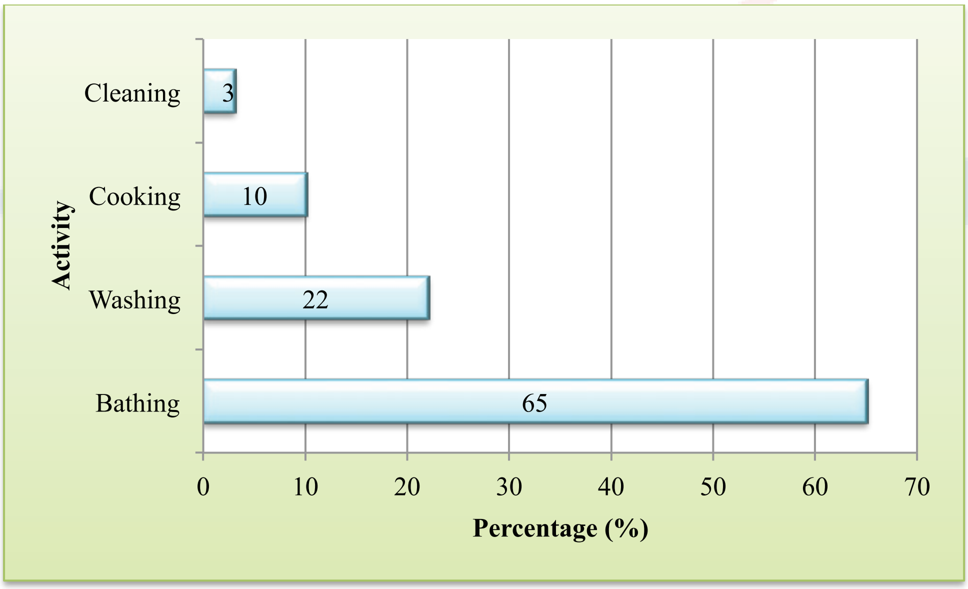

Figure 6: Hot water activity

Life-Cycle Analysis

According to ISO 14040 and ISO 14044, Life Cycle Cost (LCC) is usually carried out in four steps:

1. Define a goal, scope and functional unit
2. Inventory costs
3. Aggregate costs by cost categories
4. Interpret results

STEP 1: Define a goal, scope and functional unit

The goal of the life cycle cost was to compare, for solar, electric, and gas water heater, the LCC results of the three versions. In LCC, the geographical coverage was Mauritius. In terms of time-related coverage, only cost data in year 2012 were used. The LCCs were calculated for the whole assuming a length of Life Cycle Cost (LCC) of 19 years for all the three water heaters (solar, electric and gas) with no income tax applicable which served as the functional unit for the three versions.

STEP 2: Inventory costs

The relevant cost elements considered for the LCC of the three water heaters were:

i. Cost of solar, electric and gas water heater (including installation)
ii. Electricity consumption
iii. Maintenance cost
iv. Replacement cost for electric and gas water heater
v. Total Net Present Value

An inflation rate of 4% as from December 2012 and a discount rate of 10% were taken for all three water heaters.

STEP 3: Aggregate costs by cost categories

Table 3 gives the assumption taken into consideration when calculating the LCC.

	Units	
Number of family sizes	-	4
Litres of hot water per person per day	L	30.00
Total litres of hot water needed per day	L	120.00
Estimated family electricity used for water heating	kWh/yr	2239.92
Inflation rate	%	4
Discount rate	%	10
Residential electricity utility rate (including fuel adjustment)	Rs/ for 1st 25 kWh	3.16
Residential non-utility ("bottled") gas/propane cost	Rs/12 kg	330.00

Table 3: Assumptions taken into consideration when calculating LCC of water heaters

Figure 7 gives the results of the LCC of the three water heaters in Mauritius.

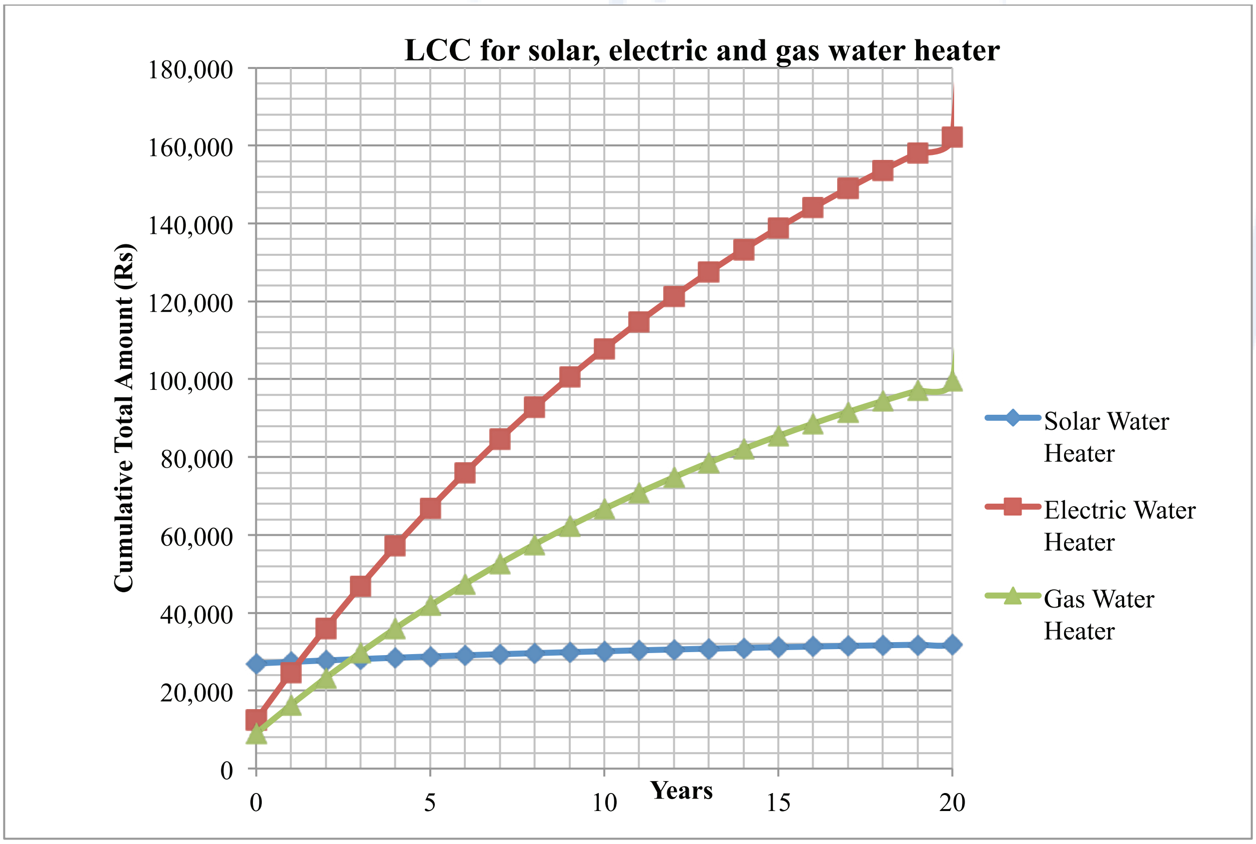

Figure 7: LCC for solar, electric and gas water heater without replacement cost

STEP 4: Interpretation

The economic analysis above based on marginal costs and current financial parameters shows the obvious benefit of solar-water heaters. Furthermore, the electricity rate is assumed at a minimal value in the analysis. The LCC for the latter is likely to be much more than the calculated value. Environmental and social costs are also not quantified in the above analysis. It is proposed that other dimensions are also included to the Energy, Engineering and Economic aspects already addressed above. A holistic analysis must also include the following non-quantitative benefits and costs.

Environmental and ethical (or social) aspects

Appendix I show a detailed analysis of the CO_2 emission related to use of electricity and LPG instead of solar energy for heating. About 250 000 tonnes/year of CO_2 are thus to be avoided if solar water heating substitutes the former, including about 150 000 tonnes/year related to LPG alone. The latter is subsidized for domestic use to the tune of about 40%.

Some 60% of the total households in Mauritius use LPG as the principal source of fuel to heat water for bathing (CSO, 2011). However, most of the residents are not "fully" aware of the dangers that may cause by LPG cylinder. Gas water heater requires the availability of butane LPG cylinders, which is heavy to carry by elderly or handicap people and provides risks of explosion if no proper care is taken into consideration. The transport costs to and from the households, alone, may effectively increase the cost of LPG by at least 10%.

In the past, people have died due to accumulation of carbon monoxide (CO) in poorly ventilated areas in private dwelling such as bathroom. High concentration of CO may kill a person within few minutes as it is absorbed more readily into the blood stream than oxygen (O_2). When haemoglobin, or red blood cells become saturated with CO, no oxygen can be absorbed which will result in blood poisoning.

In almost all cases, proper inspections by registered engineers were not performed after a gas water heater had been installed to check whether the installation had been done accordingly to standards such as BS 5482-1:2005. Depending on the frequency of usage of gas water heater, a person has to spend between Rs 300 to Rs 700 monthly to buy LPG cylinder(s), which is considered as an additional cost compare to solar water heater.

The main hazards associated with gas water heater are:

i. impact from the blast of a gas cylinder explosion or rapid release of compressed gas;
ii. impact from parts of gas cylinders or valves that fail, or any flying debris;
iii. impact from falling cylinders;
iv. contact with the released gas or fluid (such as chlorine);
v. manual handling injuries;
vi. fire resulting from the escape of flammable gases or fluids (such as LPG);

When carrying LPG, the cylinders must be stowed and secured upright, with the valves uppermost. Open back vehicles are considered when transporting LPG cylinders, however small LPG quantity may be transported in closed vans. But currently the legislation in the country does not allow for the latter. In spite of this, most people do it.

Electric water heater provides the risk of electrical shock when exposed to water or high humidity. Also, users might not be able to use electric water heater during midday due to frequent cut of main water supply as pressure is needed to trigger the heater.

The power input of the electric water heater is around 1.5 kW, which makes it one of the highest rated electrical appliances for the home. With the need to reduce the peak power consumption to lighten the need to install further power stations, the use of electric heaters can be a source of problem for the CEB as most people normally take shower around the same time in the morning and evening, contributing to considerable peak power on the grid. This leads to the need of urgent investment in extra generation capacity at a high economic, social and environmental cost.

From the survey carried out in December 2012, most respondents stated that their existing electric water heater contribute an increase in the CEB bill. They would take the opportunity to buy a solar water heater in the future.

Solar water heaters are much safer in operation, with no risk of gas leakage and electric shock. Furthermore, with the thermal storage it has, there is better availability of hot water, even at night and the likelihood of not having hot water is less than for electric and gas water heaters, which are based on instantaneous heating as opposed to heating over a whole day for the solar water heater. Despite its initial high cost, solar water heater has proved to be a budget saving compared to electric and gas water heater as solar energy is free and abundant to use. Solar water heater has proved to be beneficial for washing purposes as well as providing warm water in winter.

Since the introduction of Solar Water Heater Scheme by the Government in July 2008, there has been an increase in the number of suppliers and wide range of solar water heaters being imported with different prices and standard. This in turn has created a number of job opportunities for new and existing applicants. As at December 2012, there are about 31 registered solar water heaters suppliers. Together with other suppliers not registered with DBM, they provide a job opportunity for 200 to 300 people. The workers would be given an estimated salary of about Rs 10,000 to Rs 20,000 depending on their jobs they perform.

Conclusion

Mauritian population is becoming aware of the importance and advantage of installing a solar water heater as it can be seen that the demand for a solar water heater is increasing. Solar water heater has the advantage over electric and gas water heater as it does not make use of LPG cylinder or electricity and hot water may be available on a sunny day, thereby saving energy from the usage of electricity and gas water heater. The intervention of the Government in subsidizing its introduction has created an increase in job opportunities for sales executives, maintenance manager and technicians. More importantly, a new mindset has emerged such that the solar-water heater is becoming part of our lifestyle.

Future work related to replicating and adapting the programme in other small-island developing states will be reported in a later version of this paper to be uploaded on the website of the Conference. Comparison with the cases of Reunion, Malta, Israel and other countries will be pertinent. Besides, the Third Solar-Water Heater Scheme sponsored by the Government has to be integrated in the analysis. The latter scheme is now in its early phase of implementation. Consequently the final version of this paper, to be uploaded and published in September 2013 after the Conference, will include recommendations and findings related to a holistic Energy Management programme for solar-water heaters in Mauritius. The sister-islands of Rodrigues and Agalega can also be included. Discussions during the Conference as well as references to other papers presented during the event will hopefully identify avenues of North-South and South-South cooperation in the context of mitigating climate change in the post-Kyoto era. This will serve promote sustainability.

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APPENDIX I

Energy Impact of Solar, Electric and Gas water heater per household

To restrict the possibility of the growth of Legionella bacteria, a minimum storage temperature of 60 °C should be attained, with a minimum secondary return (if provided) temperature of 50 °C [1].

Assumption:

- Number of family size = 4
- Number of litres of water a person uses per day = 30 L
- Total liters of water needed per day = 120 L
- Average temperature for bathing = (60 – 20) = 40 °C
- Maintenance cost (assume to be the same for all three water heaters) = Rs 400
- Cost of a 12 kg LPG bottle = Rs 330
- Length of Life Cycle Cost = 19 years (2012-2030)
- Operating cost of solar = Rs 0
- 1 kWh = 3.6 MJ
- Energy factor of gas water heater = 0.50 – 0.70 [2]
- Energy factor of electric water heater = 0.75 – 0.95 [2]

Calculation:

Energy required to heat water = $m\ c\ \Delta T = 120 * 4200 * 40 = 20.16$ MJ

Where m = mass of water (kg)

c = Specific heat capacity of water (J/kgK)

ΔT = Average temperature for bathing (°C)

The energy required to heat water is the same for solar, electric and gas water heater.

ELECTRIC WATER HEATER

Assume an energy factor for an electric water heater = 0.9

$$\text{Energy for electric heater} = \frac{\text{Energy required to heat water}}{\text{Energy factor for an electric heater}} = \frac{20.16}{0.9}$$

$$= 22.4 \text{ MJ}$$

= 6.222 kWh/day

= 186.66 kWh/month

= 2239.92 kWh/year

Cost of monthly electricity bill for 186.66 kWh => CEB BILL TARIFF 110

	CEB Tariff (Rs)	Cost (Rs)
1st 25 kWh	3.16	79.00
Next 25 kWh	4.38	109.50
Next 25 kWh	4.74	118.50
Next 25 kWh	5.45	136.25
Next 86.66 kWh	6.15	532.96
Total cost (Rs) / month		976.21
Total cost (Rs) / year		11,714.51

GAS WATER HEATER

Assume an energy factor for a gas water heater = 0.66

$$\text{Energy for gas heater} = \frac{\text{Energy required to heat water}}{\text{Energy factor for a gas water heater}} = \frac{20.16}{0.66}$$

$$= 30.5 \text{ MJ}$$

Calorific value of LPG = 45.6 MJ/kg (from Total, Mauritius) [3]

Mass of gas needed per day = (30.5/45.6) = 0.669 kg/day

Mass of gas needed per year = 244.13 kg

Number of LPG bottles = (244.13/12) = 20.34

Number of LPG bottles = approximately 21

Annual Energy Cost = (330 * 21) = Rs 6930

SCENARIO 1: Consider the situation where all households in Mauritius have an electric water heater

Average unit used by a household consist of 4 people = 2,239.92 kWh/year

Number of households in Mauritius = 331,291 (CSO, 2011)

From CEB: CO_2 emission = 1 tonne/MWh

1 MWh = 1000 kg

1 kWh = 1 kg of CO_2 emitted

Number of kg of CO_2 emitted = (Average unit used by a household * Number of households in Mauritius * 1)

= (2,239.92 * 331,291 * 1)

= 742, 065.34 tonnes

SCENARIO 2: Consider the situation where all households in Mauritius have a gas water heater

The combustion equation for LPG is: $2C_4H_{10} + 13O_2 \longrightarrow 8CO_2 + 10H_2O$

$2C_4H_{10} \longrightarrow 8CO_2$

58 g $\longrightarrow$ 176 g

1 g $\longrightarrow$ 3.03g

For each gram (g) of gas burnt, 3.03 g of CO_2 is emitted. Therefore, the ratio is 1:3.03.

Average mass of gas needed per year for a household consist of 4 people = 244.13 kg

For each household, the amount of CO_2 emitted per year is = 244.13 * 3.03 = 739.71 kg

331,291 households, the amount of CO_2 emitted per year is = 331,291 * 739.71

= 245,060.56 tonnes

SCENARIO 3: Carbon dioxide emission of electric and gas water heater according to CSO 2011

According to CSO 2011, the number of households that uses principal fuel for heating water for bathing is:

Principal fuel	No. of household	%
LPG	200,723.00	60.59
Electricity	40,925.00	12.35
Solar	40,973.00	12.37
Other	6,586.00	1.99
None	41,538.00	12.54
Not stated	546.00	0.16
Total	331,291.00	100

- *Electric water heater:*

Average unit used by a household consist of 4 people = 2,239.92 kWh/year

Number of households in Mauritius that have electric water heater = 40,925 (CSO, 2011)

From CEB: CO_2 emission = 1 tonne/MWh

1 MWh = 1000 kg

1 kWh = 1 kg of CO_2 emitted

Number of kg of CO_2 emitted = (Average unit used by a household * Number of households in Mauritius * 1)

= (2,239.92 * 40,925 * 1)

= 91,668.73 tonnes

- *Gas water heater:*

For each gram (g) of gas burnt, 3.03 g of CO_2 is emitted. Therefore, the ratio is 1:3.03.

Average mass of gas needed per year for a household consist of 4 people = 244.13 kg

For each household, the amount of CO_2 emitted per year is = 244.13 * 3.03 = 739.71 kg

200,723 households, the amount of CO_2 emitted per year is = 200,723 * 739.71

= 148,476.81 tonnes

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Responses of multiple biomarkers to chloroaniline coexposure in Carassius auratus

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Abstract

2,4,6-Trichloroaniline (2,4,6-TCA) and 2,4-dichloroaniline (2,4-DCA) are widespread environmental pollutants and represent a considerable long-term threat to aquatic and human life. In this study, the in vivo effects of 2,4,6-trichloroaniline and 2,4-dichloroaniline on a set of biomarkers, ethoxyresorufin-O-deethylase (EROD), glutathione-S-transferase (GST), glutathione peroxidase (GPx) and Na+/K+-ATPase, in crucian carp (Carassius auratus) were investigated. Liver EROD and GST activities were significantly increased by 2,4,6-TCA and 2,4-DCA (alone and in combination) after 1, 2, 4, and 7 days of exposure, and obvious dose-response and time-response relationships were observed. Liver GPx and gill Na+/K+-ATP activities were significantly inhibited by the two chemicals (single compounds and in combination) and dose dependence was apparent. The integrated biomarker response (IBR) was calculated by combining multiple biomarkers to single value and used to quantitatively evaluate the toxicological effects of different chemicals. In general, 2,4,6-TCA showed higher IBR values than 2,4-DCA. The joint action of mixture was influenced remarkably by exposure dosages.

Keywords: Chloroanilines; Multiple biomarkers; Carassius auratus; IBR

1. Introduction

The aromatic amines are commonly used in the chemical manufacture of dyes, rubber and textiles and can also originate from gasoline and coal combustion (Palmiotto et al. 2001). Many of these compounds are harmful to the environment and to human health. In which, 2,4-dichloroaniline and 2,4,6-trichloroaniline are widespread environmental pollutants, particularly in wastewater (Kilemade and Mothersill 2000). They represent a considerable long-term threat to aquatic and, ultimately, human life because of their low water solubility and high toxicity (Chen et al. 2007; Lu et al. 2009). Aquatic organisms are typically not exposed to single substances but rather simultaneously to multiple mixtures of chemicals. Assessing the cumulative toxicity of complex chemical mixtures has therefore been an enduring challenge in environmental health research for the past few decades (Monosson 2005).

In the aquatic environment, the exposure of living organisms to xenobiotics leads to interactions between these chemicals and biological systems, and may give rise to biochemical disturbances or/and adaptive responses (Masfaraud et al. 1992). Biochemical biomarkers are increasingly used in ecological risk assessment to identify the incidence of exposure to and effects caused by xenobiotics (Otitoju and Onwurah, 2007). However, most studies evaluated individual biomarker responses without an integrated assessment. The use of a set of biomarkers may be useful to evaluate the various responses to mixtures of pollutants in organisms under stress (Aarab et al. 2004).

The crucian carp (*Carassius auratus*) is distributed widely in freshwaters throughout China and was demonstrated to be a very sensitive species in the study of biotransformation and oxidative stress responses (Lu et al. 2010). This study aims to investigate possible biochemical responses to 2,4,6-TCA, 2,4-DCA and their mixtures, measured as biotransformation phase I enzyme ethoxyresorufin-O-deethylase (EROD) and phase II enzymes glutathione-S-transferase (GST), antioxidant defense enzyme glutathione peroxidase (GPx) and membrane-bound enzyme Na^+/K^+-ATPase in the crucian carp, to study their dose-response and time-response relationships during a 7-day exposure period, and to evaluate integrative toxicological effects of chloroanilines.

2. Materials and methods

Chemicals

2,4,6-Trichloroaniline (98.5% purity) and 2,4-dichloroaniline (98% purity) were obtained from Acros (NJ, USA). Nicotinamide adenine dinucleotide phosphate (NADPH), 3,3’-methylenebis-(4-hydroxycoumarin), 1-chloro-2,4-dinitrobenzene (CDNB), resorufin, ethoxyresorufin and glutathione (GSH) were purchased from Sigma Chemical Company (St. Louis, MO, USA) and the stated purities were >99.9%. Bovine serum albumin was purchased from Shanghai Huixing Biochemistry Reagent Co., Ltd. (Shanghai, China) and the purity was >98%. Coomassie brilliant blue G-250 (Ultra Pure Grade) was purchased from Sinopharm Chemical Reagent Co., Ltd.

(Shanghai, China). All other chemicals were of analytical grade and were obtained from Nanjing Sunshine Biotechnology Co., Ltd. (Nanjing, China).

Animals

Juvenile crucian carp weighing 50.6±3.4 g were obtained from Shengliwei Aquatic Farm in Nanjing. The fish were acclimatized for two weeks in dechlorinated municipal water prior to experimentation. Fish were fed with OSI freshwater aquarium pellet food (6% of body weight/day). Feces and uneaten food were removed every day by suction. Fish were not fed for 24 h prior to the experiments and no food was provided during the test period.

Exposure Test

Five treatments were delivered via intraperitoneal injection at dosages from 0.1 to 20 or 100 mg kg^{-1} chloroanilines dissolved in dimethyl sulphoxide (DMSO). Control animals received DMSO only. Several dosages of 2,4,6-TCA/2,4-DCA mixture were also tested according to an equiconcentration ratio of 1:1. A blank control and a solvent control (DMSO) were included in the experimental design. Dose range was based on range finding experiments (no lethal effect at the highest exposure dosage). Fish were weighed before injection to determine the volume of dosage per kilogram body mass of each fish. Masses and dosages were recorded. Fish were kept in groups of twelve in 30-l glass tanks containing dechlorinated municipal water under constant aeration. A 50% water change was performed every other day. Water temperatures ranged from 20 to 22°C with pH 7.0±0.2, and dissolved oxygen of 5.8±0.2 mg l^{-1} during the period of exposure.

Enzyme Assays

Three fish were collected for each treatment and control after 1, 2, 4, and 7 days of exposure. Fish were killed by cervical transection and liver and gill tissues were collected. Tissues were carefully dissected, washed in 0.15 M of cold KCl, weighed, immediately frozen in liquid nitrogen, and stored at –80°C.

Tissue samples were homogenized in nine volumes of cold buffer and centrifuged for 20 min (9,000×g) at 4°C. The supernatants were used as the extract for enzymatic activity determination. EROD activity in liver was quantified at 572 nm using a microplate reader (Lu et al. 2009). The reaction mixture consisted of 140 µl buffer (0.1 M Tris, 0.15 M KCl, pH 8.0), 10 µl of 2 µM 7-ethoxyresorufin and 10 µl extracts. The reaction was initiated at 25°C by the addition of 40 µl of 2.1 mg ml^{-1} nicotinamide adenine dinucleotide phosphate (NADPH). GST activity in liver was determined at 340 nm by the method of Habig and Jakoby (1981) adapted to a microplate reader as described in Frasco and Guilhermino (2002), using 0.03 ml of homogenate and 0.15 ml of the reaction solution (100 µl of 0.1 mM potassium phosphate, 10 µl of 1.0 mM 1-chloro-2,4-dinitrobenzene, 10 µl of 1.0 mM GSH, and 880 µl H_2O). GPx activity in liver was determined by measuring the decrease in absorbance (340 nm) due to the decline in NADPH at 23–25°C (Berntssen et al. 2003).

Na^+/K^+-ATPase activity, expressed as μmol PO_4^{3-} liberated per mg of protein in a gill homogenate, was measured by liberating PO_4^{3-} from a hydrolysis reaction with ATPase, as described previously (Levesque et al. 2003). Each enzymatic activity was determined in triplicate and expressed as units (U) per mg of protein. A U is a picomole (for EROD), nanomole (for GST and GPx) or micromole (for Na^+/K^+-ATPase) of substrate hydrolyzed per minute. Protein concentrations were determined with the Coomassie Protein Assay Kit (Bradford, 1976), with bovine serum albumin as the standard. The measurements were done on a microplate reader at 595 nm.

Calculation of the IBR

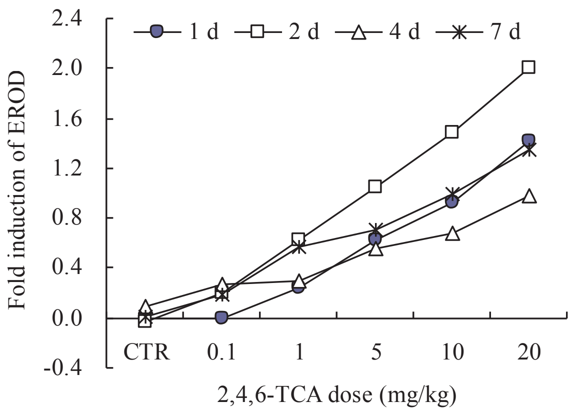
A method for integrating all the measured biomarker responses into one general "stress index", termed "Integrated Biomarker Response" (IBR; Beliaeff and Burgeot 2002), was applied to evaluate an integrated impact of toxicants. The procedure of IBR calculation is: (1) Calculation of mean and standard deviation (SD) for each biomarker; (2) Standardization of data: $F_i'=(F_i - \text{mean}F)/\text{S}$, where F_i' is the standardized value of the biomarker, F_i is the value of each biomarker responses, mean$F$ is the mean value of the biomarker, and S is the standard deviation of the biomarker; (3) Using standardized data, Z was computed as $+F_i'$ in the case of activation and $-F_i'$ in the case of an inhibition, and then the minimum value for each biomarker was obtained and added to Z. Finally the score B was computed as $B=Z + |\text{min}|$, where $B\geq 0$ and $|\text{min}|$ is the absolute value. The corresponding IBR value is: $\{[(B_1\times B_2)/2]+[(B_2\times B_3)/2]+\cdots[(B_{n-1}\times B_n)/2]+[(B_n\times B_1)/2]\}$.

Statistical analysis

For each biomarker, the data were expressed as mean ± SD. All data from different treatments were checked for normality. Data from different treatments were compared by a one-way analysis of variance (ANOVA) and statistically different treatments were identified by Dunnett's *t* test. All differences were considered significant at $p<0.05$. Statistical analyses were performed using the SPSS statistical package (ver. 11.5, SPSS Co., Chicago, USA).

3. Results

No mortality occurred during the experiments. In crucian carp exposed to DMSO in the solvent controls, liver EROD, GST, GPx and gill Na^+/K^+-ATPase activities did not differ significantly from those in the water controls. Therefore, enzymatic activities of chemical-exposed fish were compared with those of solvent controls. The in vivo effects of 2,4,6-TCA and 2,4-DCA on EROD are presented in Fig. 1. Lower dosages of 2,4,6-TCA and 2,4-DCA (0.1 mg kg^{-1}) did not induce obvious effects on EROD. EROD activity was significantly increased by exposure to higher dosages tested ($p<0.05$) and the increasing level of EROD activity matches the dosage increase. However, the highest 2,4-DCA dosage (100 mg kg^{-1}) resulted in a significant decrease of EROD induction as compared with that the exposure of 20 mg kg^{-1} ($p<0.05$). Regarding time response, most significant EROD increases occurred at 2 d for 2,4,6-TCA and 4 d for 2,4-DCA for most exposure dosages.



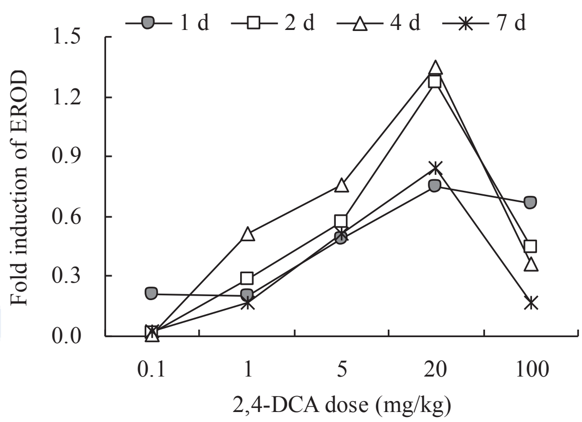


Fig. 1 EROD responses in goldfish exposed to individual compounds (CTR=solvent control)

The responses of GST activity exposed to 2,4,6-TCA and 2,4-DCA are shown in Fig. 2. It was similar to EROD response pattern, GST activity was significantly induced by all tested dosages of 2,4,6-TCA and 2,4-DCA with the exception of 0.1 mg kg^{-1} and the fold induction declined at the highest exposure dosage (20 or 100 mg kg^{-1}). Furthermore, most significant induction of GST activity was found after 1 or 2 d exposure to 2,4,6-TCA, after 2 or 7 d to 2,4-DCA.

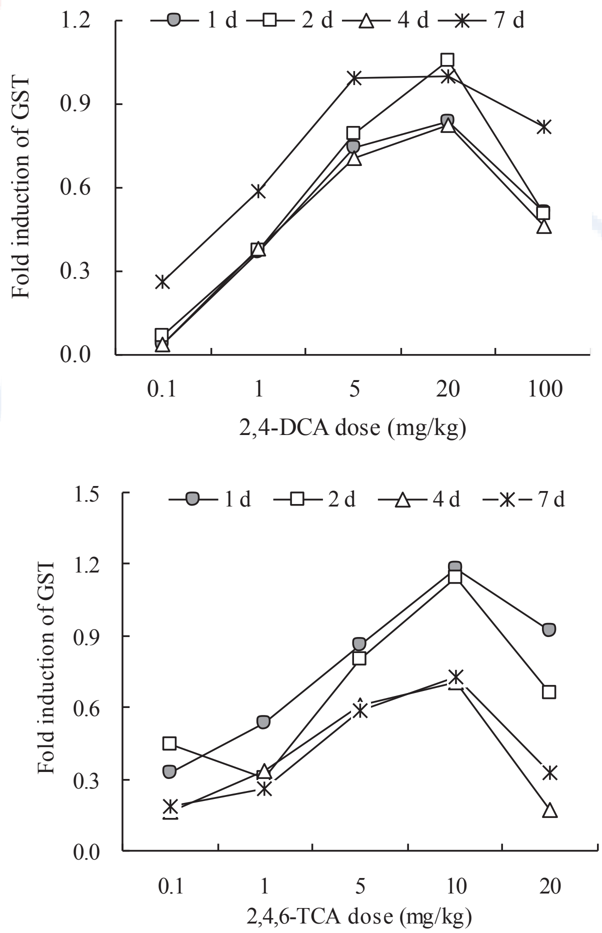


Fig. 2 Liver GST responses in goldfish exposed to individual compounds

Inhibition rates of 2,4,6-TCA and 2,4-DCA on GPx activity during all periods exposure (1, 2, 4 and 7 d) are presented in Fig. 3. 2,4,6-TCA significantly inhibited liver GPx activity at dosages equal to or higher than 1.0 mg kg^{-1} (p<0.05). 2,4-DCA significantly inhibited GPx activity at all test dosages (p<0.05), and dosage dependence was apparent. For both compounds, the most significant GPx inhibition was observed at 20 mg kg^{-1}, however, time dependence was not apparent.

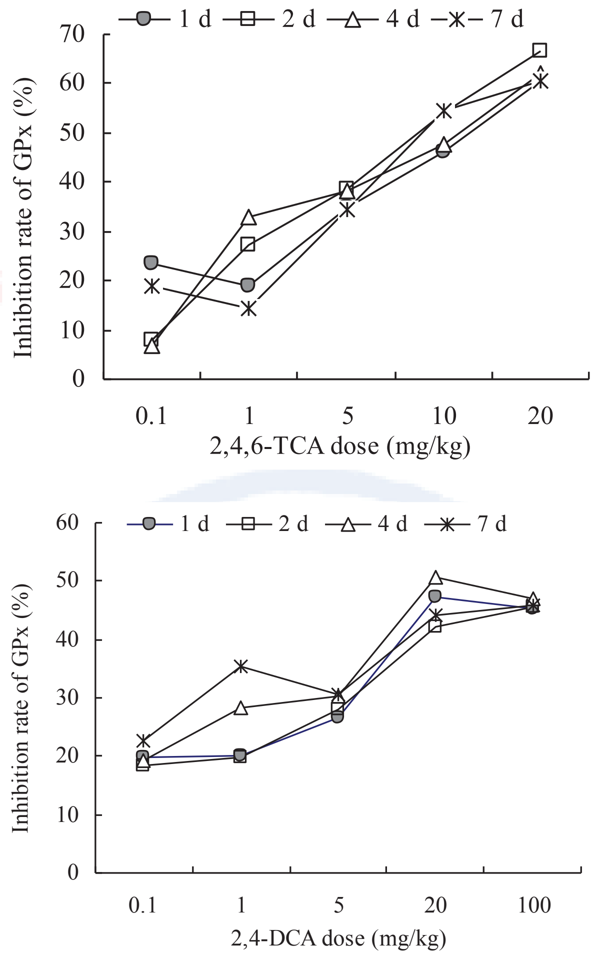


Fig. 3 Liver GPx responses in goldfish exposed to individual compounds

Inhibition rates of 2,4,6-TCA and 2,4-DCA on gill Na^+/K^+-ATP activity during all periods of exposure are presented in Fig. 4. 2,4,6-TCA significantly inhibited Na^+/K^+-ATP activity in all cases (p<0.05) and dosage dependence was apparent. In addition, most significant Na^+/K^+-ATP inhibition occurred at 1 d for all dosages with the exception of the lowest dosage. Low dosages of 2,4-DCA (0.1 and 1.0 mg kg^{-1}) did not significantly inhibit Na^+/K^+-ATP activity after 1 d and 2 d of exposure. However, Na^+/K^+-ATP activity was significantly inhibited by exposure to higher dosages of 2,4-DCA at the four exposure periods (p<0.05). Regarding time response, most significant Na^+/K^+-ATPase inhibition occurred at 2 d for higher dosages of 2,4-DCA exposure (≥5 mg kg^{-1}) and at 4 or 7 d for lower dosages (0.1 and 1.0 mg kg^{-1}).

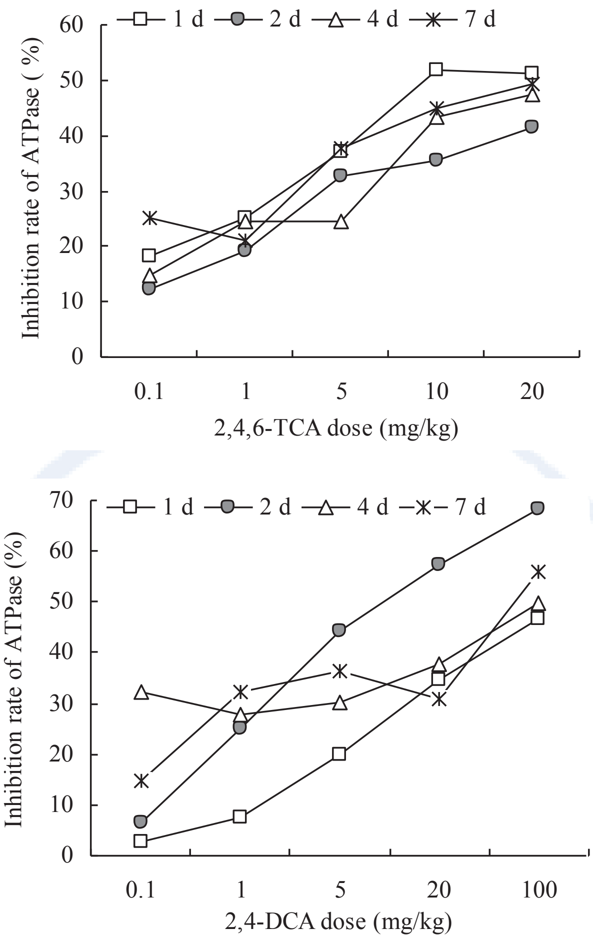


Fig. 4 Gill Na^+/K^+-ATP responses in goldfish exposed to individual compounds

The changes of enzymatic activities after 2 d of exposure to 2,4,6-TCA/2,4-DCA mixture are presented in Fig. 5. The mixture significantly changed the activities of the four enzymes at all test dosages except at 0.1 mg kg^{-1} on EROD activity (p<0.05). Induction of EROD activity was elevated with increased mixture dosages, with the exception of slight reduction at 5 mg kg^{-1}. The dose–response curve of the mixture on GST was similar to those of individual chemicals, GST induction increased continuously corresponding to the dosages, and the fold induction declined significantly at the highest exposure dosage. Percentage inhibition of GPx activity increased continuously corresponding to the exposure dosages and exhibited a good dose–response relationship. Na^+/K^+-ATP activity was significantly decreased by all the dosages of mixture, however, dose dependence was not as apparent as that of individual chemicals.

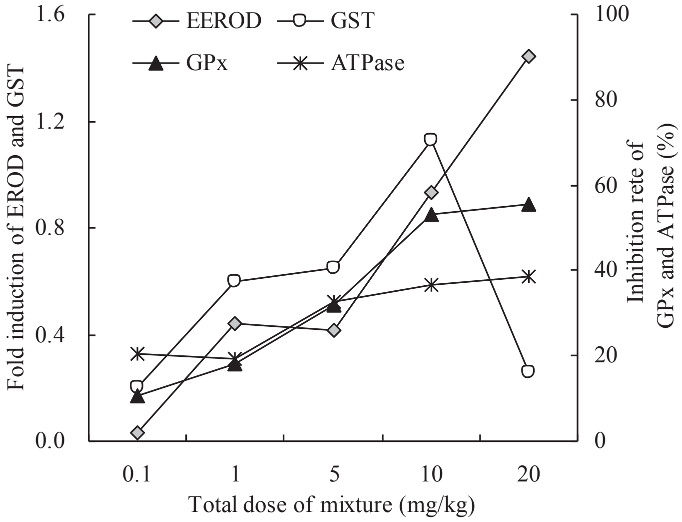


Fig. 5 Biomarker responses in goldfish exposed to 2,4,6-TCA/2,4-DCA mixture

Standardization was carried out on EROD, GST, GPx and Na^+/K^+-ATP activities obtained from each chemical and their mixture. The integrated biomarker response (IBR) values were computed and given in Fig. 6. As the exposure dosages of both chemicals and their mixture increased, the IBR values tended to increase. IBR values of 2,4,6-TCA were always higher than those of 2,4-DCA. However, IBR displayed different manners of joint action dependent to mixture dosages, and it seemed to be synergistic effect at 1 mg kg^{-1}, additive effect at 5 mg kg^{-1} and antagonistic effect at 20 mg kg^{-1}.

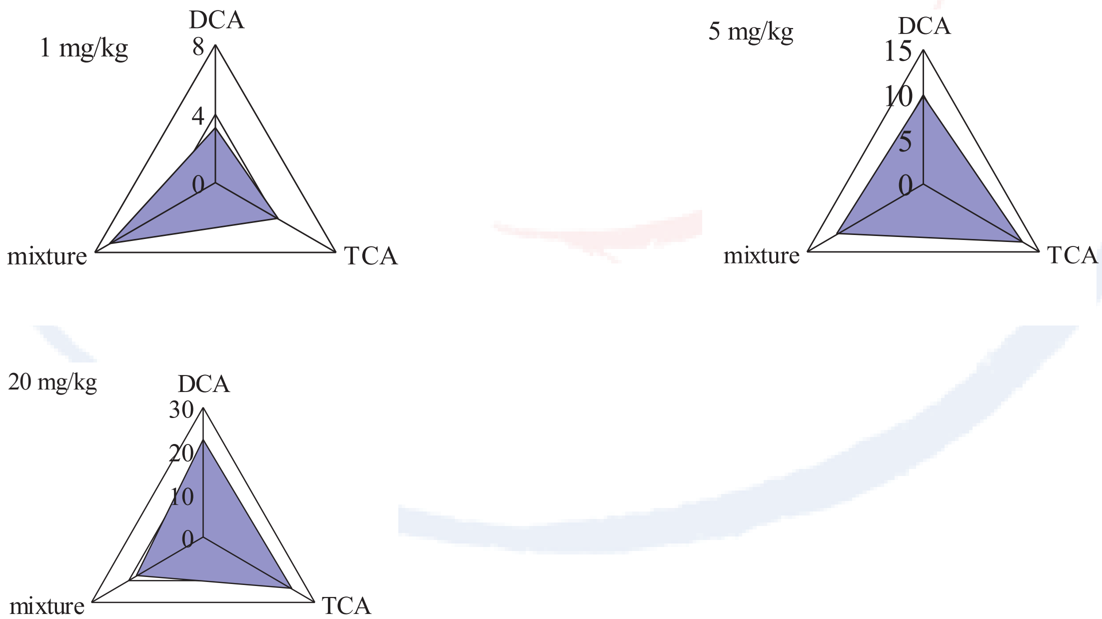


Fig. 6 IBR values of chloroanilines at different exposure dosages at 2 d

4. Discussion

P450 induction is primarily due to the transcriptional activation of the gene, but can also be caused by post-transcriptional regulation or post-translational regulation (Werlinder et al. 2001; Sadar and Andersson 2001). The mechanism by which cells recognize inducers and transmit information to genes is well understood in the case of the members of subfamily CYP1A, which are induced by polycyclic aromatic hydrocarbons (PAHs) and their halogenated forms (Tuvikene 1995). CYP1A induction potency of a chemical has been related to its binding affinity to the Ah receptor (Mekenyan et al. 1996). The CYP1A induction measured either by immunodetection or through its catalytic activity is probably the best-studied biomarker (Bucheli and Font 1995). Hence, EROD activity has been widely used as a biomarker for fish exposure to substances that bind to the aryl hydrocarbon (Ah) receptor (Teles et al. 2005). EROD and GST are considered related biomarkers. The metabolites formed by phase I biotransformation activity are conjugated via phase II enzymes (e.g., GST) before excretion. GST may play an important role in detoxifying strong electrophiles with toxic, mutagenic and carcinogenic properties. It can catalyze the conjugation of the tripeptide glutathione with the xenobiotic in phase II of the biotransformation process and promote its elimination from the organism (Richardson et al. 2008).

The results in this study demonstrate that both chemicals (alone and in combination) resulted in a significant increase in hepatic EROD and GST activities in crucian carp. This is consistent with previous findings in same or different species of fish treated by various aromatic compounds. For example, both naphthalene (NAP) and β-naphthoflavone (BNF) revealed to be strong biotransformation (phase I) inducers (Pacheco and Santos 2002). Hepatic GST activity in *Carassius auratus* was slightly elevated by 2,4-dichlorophenol exposure at 0.01 and 0.05 mg l^{-1} (Zhang et al. 2004). Benzo(a)pyrene displayed strong hepatic EROD and GST induction potency in *Sparus aurata* (Banni et al. 2008). Phenanthrene was found to induce a concentration-dependant formation of the enzyme EROD in the tilapia, *Oreochromis mossambicus* (Shailaja and Classy 2003).

The induction effects of the mixture on EROD and GST activities were consistent with those of the corresponding individual exposures, suggesting that the two chemicals when in mixture induce an additive effect on fish toxicity. In addition, EROD induced by 2,4-DCA and GST induced by 2,4,6-TCA and 2,4-DCA (alone and in combination) exhibited bell shaped dose-response curves. Bell-shaped curves have been reported on EROD and GST induction for in vivo or in vitro systems after exposure to PAHs (Bosveld et al. 2002; Lu et al. 2009). Although the mechanism that results in decreased EROD or GST induction has not been completely defined, it is likely that high concentrations of the inducer inhibit or inactivate the induced enzyme (Voorman and Aust 1987).

GPx catalyzes the reduction of both hydrogen peroxide and lipid peroxides, and a reduced GPx activity could indicate that its antioxidant capacity was surpassed by the amount of hydroperoxide products of lipid peroxidation (Monteiro et al. 2006). GPx catalyzes the reduction of both hydrogen peroxide and lipid peroxides and is considered an efficient protective enzyme against lipid peroxidation (Winston and Di Giulio 1991). GPx activity may be increased due to increased production and enzyme-inducing effect of H_2O_2 derived from O_2^-. Low activity of GP_X in different tissues of exposed fish demonstrates inefficiency of these organs in neutralizing the impact of peroxides (Fatima et al. 2000). The dose–response curve of the mixture on GPx inhibition was similar to those of individual chemicals and an additive effect appeared to exist.

ATPases play important roles in intracellular functions and in all types of physiological activity. Gill Na^+/K^+-ATP is a membrane-bound enzyme that catalyzes the active Na^+ and K^+ transport into the animal, providing a driving force in the gill epithelium (de la Torre et al. 2007). Although ATPase activity is used as a sensitive indicator of heavy-metal toxicity, there is evidence that organic pollutants can inhibit ATPase activity in concentration-based experiments (Reddy et al. 1992; Dutraa et al., 2008). The Na^+/K^+-ATP activity appeared to be noticeably inhibited exposed to 2,4,6-TCA and 2,4-DCA (alone and in combination) which would suggest the animals most likely suffered disruption, as regards ion regulation. It is possible that the toxic organic compounds reacted with the membrane bound ATPases and brought about an alteration in the active transport mechanism (Lakshmi et al. 1990). The inhibition level of the mixture on Na^+/K^+-ATP activity was lower than that observed in individual exposures on the whole. It is suggested that a slight antagonistic effect existed between 2,4,6-TCA and 2,4-DCA with regard to Na^+/K^+-ATP activity inhibition.

IBR index was calculated by combining different biomarkers to single value, which can be used to describe the toxically-induced stress level of populations in different areas. This method has been previously used as a useful tool for environmental risk assessment (Damiens et al. 2007; Lu et al. 2010; Pereira et al. 2010). Recently, IBR was also used to identify the toxicological effects of organic pollutants toward fish including perfluorinated organic compounds (Kim et al. 2010), fungicide (Li et al. 2011a) and verapamil (Li et al. 2011b). Given that the IBR is an indicator of environmental stress, 2,4,6-TCA appeared to be more stressful than 2,4-DCA toward the crucian carp on the whole in this study. The results demonstrated that the IBR might be a useful tool for quantification of various biomarker responses induced by toxic chemicals toward fish.

5. Conclusions

The present study investigated the biological effects of two chloroanilines on crucian carp. 2,4,6-TCA and 2,4-DCA (alone and in combination) significantly induced liver EROD and GST activities and inhibited liver GPx and gill Na^+/K^+-ATP activities, and both dose dependence and time dependence were apparent. The results suggest that those biomarkers should be addressed in ecological risk assessments of chloroanilines in fish. In addition, IBR method was found to be useful for quantitative assessment of the toxicological effects of chlorinated anilines.

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Passive House to Improve the Environment

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Abstract

Buildings consume large amount of energy in order to achieve user's thermal comfort because building design doesn't take enough into account to the considerations of energy-saving, especially with regard to geometrical shape and orientation. The Passive House was originally developed in Germany and offers a realistic option for cost-efficient building that provides a high level of living comfort using very little energy for heating and cooling. It is necessary protect the environment and the best way is reducing the unnecessary consumption without decrease the quality of life. This makes the Passive House an attractive option. This paper evaluates the different elements of Passive House to reduce the energy consumption to protect the environment.

Keywords: Environment, Insulation, Orientation, Passive House

1. INTRODUCTION

The residential complexes take different patterns and their streets take different orientations without paying attention to the climatic factors, especially to the solar radiation. These situations would increase the energy consumption for heating and cooling in buildings affecting comfort and efficiency.
The solution is called Passive House that combines high-level comfort with very low energy consumption. They take into account elements as thermal windows, insulation, orientation or shape to keep the comfort of the user with the less consumption possible.

This kind of buildings is no different from conventional buildings, but the main difference is that uses less energy for heating. As can see on the image below German passive houses need no more than 15 kWh per year to heat a square meter. This means a saving of more than 75 % in relation to the average consumption in existing building. So each Passive House is an active contribution to climate protection.

	Heating demand		Cooling Demand	
	Standard	*Passivhaus*	Standard	*Passivhaus*
	[kWh/m2 yr]	[kWh/m2 yr]	[kWh/m2 yr]	[kWh/m2 yr]
Germany	90	15	0	0
Italy	111	10.5	4.63	3
France	69.6	17.4	n/a	5
Spain	59	8.7	23.1	7.9
Portugal	73.5	5.8	32	3.7
UK	59	15	0	0

Fig. 1. Heating and cooling energy demand [1]

To explain with sufficient detail the main needs to be a Passive House, the information of this paper has been divided into separate points.

2. ORIENTATION

How the buildings are situated and how they are oriented provide important opportunities to reduce overall environmental impacts—including both direct and indirect impacts relating to energy consumption by the building[2].

Solar energy is friend and a foe of low-energy building design. The next figure illustrates the amount of daily solar energy availability relative to orientation for each month of the year at 40° latitude.

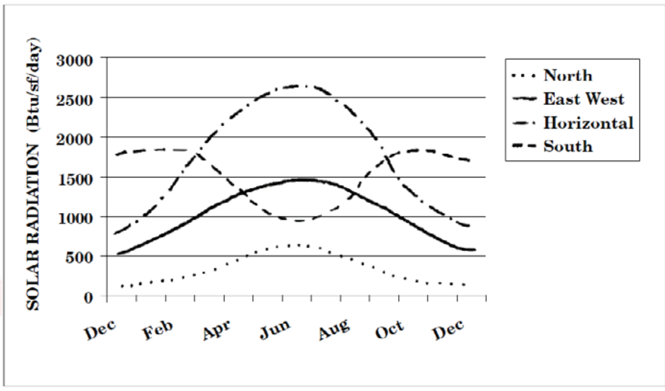

Fig. 3. Solar Radiation [3]

As can be seen on the image above, south-facing walls achieve a higher solar gain in the winter than in the summer. East and west vertical orientations and horizontal orientation (skylights), all result in more heat in the summer than winter. The optimal orientation depends of the application. Some examples of applications depending of the orientation of the house are:

- South-facing glass: Is recommended when we trying to use solar energy during the winter for passive solar heating. This kind of orientation is relative easy to shade with an overhang or awning during the summer to minimize solar heat gain.

- North-facing glass: This kind of buildings receives good daylight but relatively little direct insolation, so heat gain is less of a concern.

- East- and west-facing glazing: Is the most difficult to control (because of low sun angles) and the greatest contributors to unwanted heat gain.

Daylighting can be achieved with almost any orientation, but control of natural light is critical and will depend on the glazing area, the types of glazing used, daylighting design strategies, and other key issues.

3. SHAPES

The building's shape, spacing and configuration in its neighborhood affect both the solar and wind factors. They play a large role in determining the amount of solar radiation received by the building's surface and the airflow around it [4].

Furthermore, the building form can affect the thermal performance as it determines the size and the orientation of the exterior envelope exposed to the outdoor environment. Also, cost and aesthetics are affected by the building form. Selecting the optimum shape, orientation, and envelope configuration could reduce the energy consumption by about 40%. [5].

The following figure shows the energy consumption for different shape of buildings on heating and cooling:

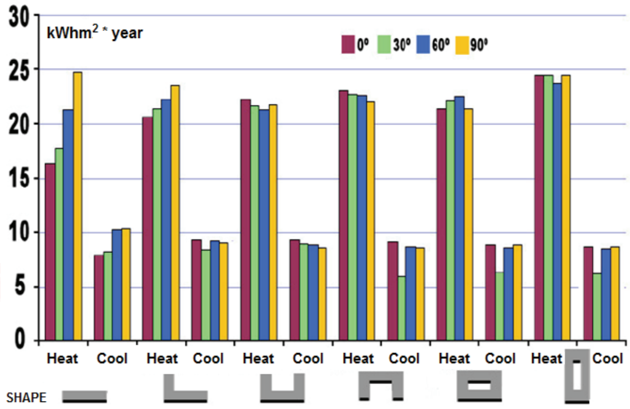

Fig. 2. Energy requirements in buildings by shape and orientation (similar envelope configuration, South top glazing) [6]

Consequently, the building's shape plays a large role in determining the amount of solar radiation received by the building’s surface and the airflow around it.

4. INSULATION

A key feature of a passive house is that they incorporate very high standards of insulation. This reduces the amount of heat lost through the building fabric.

The heat loss through an external wall, a floor to the basement or a slab on ground, a ceiling or a roof is characterized by the thermal heat loss coefficient or U-value. This value shows how much heat (in Watts) is lost per m^2 at a standard temperature difference of 1 degree Kelvin. The international unit of the U-value therefore is “W/(m²K)”. To calculate the heat loss of a wall you multiply the U-value by the external wall area and the temperature difference.

The following chart presents the typical heat losses for different external walls based on a typical European single family house with an external wall area of 100 m². Winter temperatures of -12 °C outside and 21 °C at the inside are used as they are typical of Central Europe [7].

U-value (W/m^2K)	heat loss load (W)	annual heat loss $kWh/(m^2a)$
1	3300	78
0,8	2640	62
0,6	1980	47
0,4	1320	31
0,2	660	16
0,15	495	12
0,1	330	8

Table. 1. Typical heat losses for different external walls

5. WINDOWS

High-quality windows are essential components for Passive House. The stringent thermal protection requirement for the fitted window is determined by the demands for thermal comfort in living spaces. The window frame plays a particularly important role, because for typical windows sizes, the frame accounts for between 30 and 40 % of the total window area.

Heat losses from conventional window frame (U-value 1.5-2 W/m^2*K) are twice as great as the heat losses through an insulated frame with a U-value of 0.8 W/m^2*K.

Fig. 1 Difference on thermal comfort between standard house and passive house

Passive House Institute.

6. SHADING DEVICE

Shading is an essential parameter in all climates especially in Mediterranean climates to avoid overheating at midday on sunny days. The critical period for the Mediterranean summer season is the afternoon when the sun is still hot, yet low in the sky.

Shading must be provided to the west walls by trees, evergreen vegetation, trellises or overhanging roofs. It is advisable integrate the shading with insulation on west walls. Exterior shading devices should be provided on west windows with some air flow between the glass and the protection device, in order to maximize the benefit from internal shading systems.
The shadowed portion of the glazed area should be as large as possible in summer and as low as possible in winter.

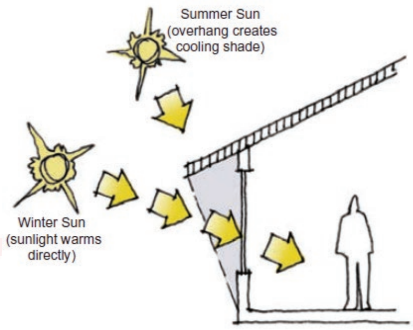

Fig. 4. Overhang [8]

7. LANDSCAPING

For the proximity of trees to buildings should take into account the growth rate, life span, and ultimate canopy shape. Planting's decision about trees requires a careful balance between the desirable qualities of shade with the loss of future solar access.

The evergreen trees may provide shade and block cold winter winds, but on the south side deciduous trees are preferred because they lose their leaves and admit more sun in winter. When existing tree plantings are too dense, selective thinning and lifting the canopy may improve air movement, enhance ground-level vistas, and allow remaining trees better growth potential. Special care should be used in construction near trees.

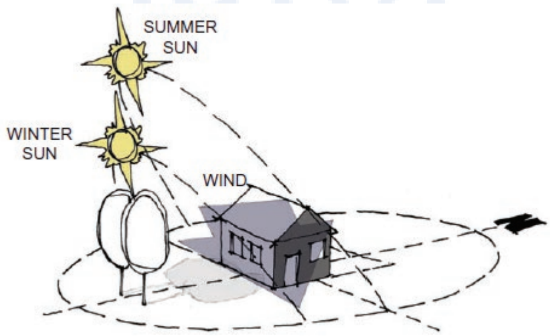

Fig. 2 -Landscaping [8]

8. INTERIOR LAYOUTS

A good interior layout will facilitate many of the passive strategies recommended in this paper. Following is shown the ideal location for the different rooms of the houses.

- Kitchens should ideally be located within the building in such a way as to avoid over-heating, either the kitchen itself or the rest of the building. One way to ensure this is to avoid placing kitchens on the western elevation. In most instances, this will cause overheating in the warm summer months, so an ideal location for a kitchen is on the eastern side of the building. This catches the morning sun but not the warmer, late afternoon sun.

- Rooms that are occupied predominantly in the evening should be located on the western side of the building, in order to take advantage of the evening sun.

- Frequently used rooms, should be located on the southern side where they can be warmed but sunlight throughout the day.

- Bedrooms generally require less heat. Decisions for the location of bedrooms can largely be based on aesthetics and occupant or designer preferences in addition to thermal comfort considerations.

The following image shows an example of good interior layout:

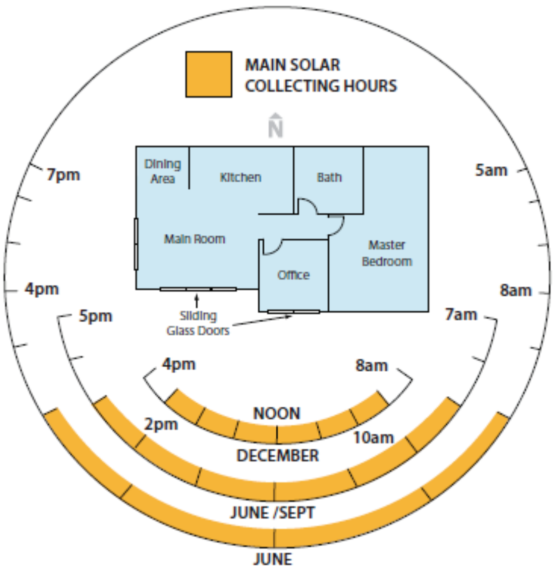

Fig. 5. Interior layout [8]

9. CONCLUSIONS

All elements of a building affect consumption, this paper has highlighted some advice order to influence designers to reduce energy consumption.

The following picture shows the main ideas of this study and how all the elements are related to energy consumption where the axes represent the compactness percent glass and the z axis represents the demand total energy for the three services: lighting, heating and cooling

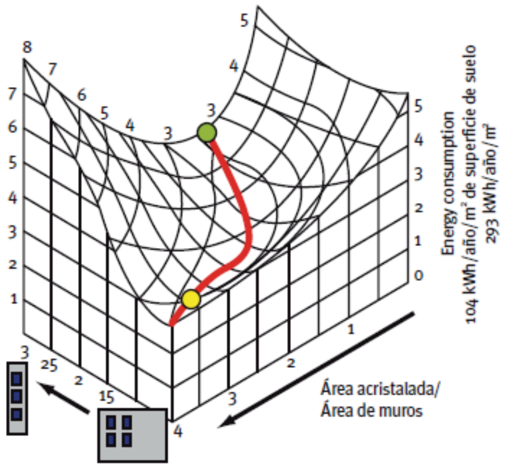

Fig 6. Energy consumption [9]

Anyway we think that it is necessary to introduce a new standard to improve the engagement of the builders with propose to reduce the effect in the environment.

10. References

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Acute and Chronic Effects of Metal Nanoparticles on Daphnia Magna

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Abstract

With the increasing use of nanomaterials, their release into the environment is inevitable, which has resulted in an increasing concern regarding their potential environmental risks. In the present study, the acute and chronic effects of copper nanoparticle (nCu), chromium nanoparticle (nCr) and their mixtures on *Daphnia magna* were investigated. The median lethal concentrations were 0.63 mg/L for nCu and 1.57 mg/L for nCr after 48 h of exposure. The endpoints "days to first pregnancy", "days to first brood", "number of offspring per female in the first brood", "number of offspring per brood per female" and "intrinsic rate of natural increase" were measured during the 21 d testing period. nCu (≥0.002 mg/L), nCr (≥0.01 mg/L) and their mixtures (≥0.002 mg/L) significantly suppressed the growth and reproduction of D. magna and reduced their feeding rates, and obvious concentration-response relationships were observed. The results showed nCu was more toxic than nCr, and nCu combined with nCr may induce synergistic effects in D. *magna.*

Keywords: metal nanoparticles, acute toxicity, chronic toxicity, *Daphnia magna*

1 Introduction

Nanoparticles (NPs) are widely applied in many commercial industrial and consumer products such as semiconductors, cosmetics, textiles, and pigments (Gottschalk *et al.* 2009). Given these materials broad use, it is inevitable for the increasing quantities of NPs to be released directly or through discharges of municipal wastewater into the aquatic environment (Nowack & Bucheli 2007). At the same time, there is an increasing concern regarding the risks of nanoparticles to human and ecosystem health (Colvin 2003; Nel *et al.* 2006; Wiesner *et al.* 2006).

Until recently, most of the studies on the potential toxicity of nanoparticles have focused on metal oxide NPs such as $nTiO_2$, nZnO, nCuO, $nCeO_2$, nAl_2O_3 (Alok & Vyom 2010; Blinova *et al.* 2010; Heinlaan *et al.* 2008), carbon NPs (Cheng *et al.* 2009; Kang *et al.* 2009; Lovern & Klaper 2006; Murray *et al.* 2009) and quantum dots (Kloepfer *et al.* 2005). In comparison, studies on the ecotoxicity of metal NPs are limited to a few reports on gold NPs and silver NPs (Bar-Ilan *et al.* 2009; Farkas *et al.* 2010; Griffitt *et al.* 2012). Information is lacking on the toxicity of nanoscale copper (nCu) and chromium (nCr) in water, especially their joint effects on aquatic orgamisms.

However, the environmental effects of copper NPs and chromium NPs are still poorly known. Yoon et al. (2007) reported that Cu NPs can inhibit the activities of bacteria, including *Escherichia coli* and *Bacillus subtilis*. In fact, except for the mortality, the effects of oxidative stress, gill injury, heart rate, hatching rate, edema and malformations were also addressed as bio-endpoints (Gomes et al. 2012; Griffitt et al. 2008; Griffitt et al. 2009; Susana et al. 2012). Since contaminated aquatic ecosystems are often polluted with not only a kind of pollutant (Lu *et al.* 2007; Su *et al.* 2008), mixtures of chemicals to ecotoxicology constitute a prevalent issue.

Daphnia magna as a common zooplankton found in freshwater lakes and ponds, is one of the most sensitive organisms used in toxicity tests. So we investigated the toxicity effects of nCu, nCr and their mixtures on *D. magna* by a 48-h acute toxicity test as well as a 21-d reproductive and growth test. The objectives of the present study were threefold: (1) to find out acute toxicity of nCu and nCr on *D. magna* by observing immobilization and mortality; (2) to detect chronic cumulative effects through observing the growth and reproduction of *D. magna* such as the days to first pregnancy, the body length and the intrinsic rate of population growth; (3) to explore whether high bioaccumulation of nCu and nCr could interfere with food intake and ultimately cause toxicity on *D. magna.*

2 Materials and Methods

2.1 Nanoparticles: Preparation and Characterization

The aqueous dispersion of nCu (grain size 50 nm, surface area 80 m^2/g) and nCr (grain size 800 nm, surface area 10 m^2/g) were purchased from Beijing Nachen S&T Ltd. (Beijing, China), which the degree of purity is 20% (W/W). The stock solution was prepared by dispersing the NPs in ultrapure water (Millipore, Billerica, MA, USA) with ultrasonication (50-60 kHz) 30 min before dosing each day. The test solution were prepared immediately prior to use by diluting the stock solution with daphnia culture medium (consisting of 64.75 mg/L $NaHCO_3$, 5.75 mg/L KCl, 123.25 mg/L $MgSO{\cdot}7H_2O$, and 294 mg/L $CaCl_2{\cdot}2H_2O$) reconstituted according to standard OECD guideline (OECD, 2004). The pH of the culture medium is 7.8±0.2. For this experiment, the aqueous suspensions of nCu and nCr (both 80 mg/L) have been characterized by transmission electron microscopy (TEM) in ultrapure water (Fig. 1). Particle size distributions of the studied metal oxides (at 80 mg/L) in *D. magna* test medium were determined by Malvern Mastersizer 2000 and the pH of the aqueous suspensions is 7.7.

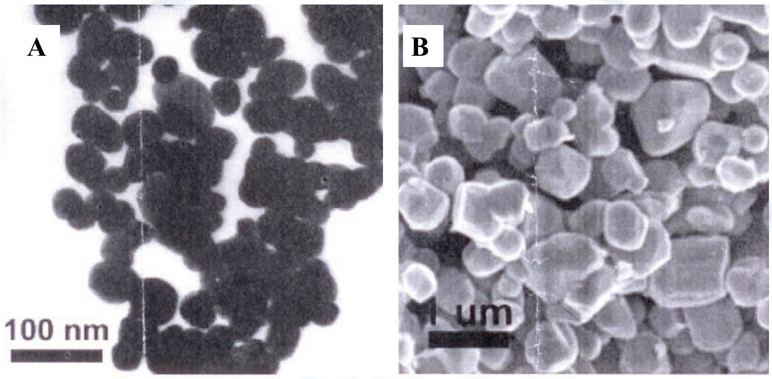


Fig. 1 TEM images of nCu (A) and nCr (B)

2.2 Test Organism

Daphnia Magna were obtained from Chinese Center for Disease Control and Prevention (Beijing, China). They were maintained in laboratory culture under controlled conditions, *e.g.* photoperiod 16h:8h light:dark and a constant temperature of 20±1°C. The culture medium was renewed two times a week and the daphnids were fed daily with the green algae *Scenedesmus obliquus*, which was supplied by Wuhan Institute of Hydrobiology, Chinese Academy of Science (Wuhan, China).

2.3 Acute Toxicity Test

The 48-h acute toxicity tests of nCu and nCr were conducted using the modified OECD standard procedure (OECD, 2004). *D. Magna* were exposed to seven concentrations (0.01, 0.05, 0.1, 0.5, 1.0, 5.0 and 10 mg/L of nCu and 0.05, 0.1, 0.5, 1.0, 5.0, 10 and 25 mg/L of nCr) plus a blank control. Ten neonates (6-24 h old) from a designated brood were exposed in a 50 mL glass beaker containing 35 mL test solution with three replicates per each concentration and control. The test solution was renewed daily to maintain the same concentration of exposure. *D. magna* were not fed during the testing period. At test end, the immobilization and mortality for the individuals in each container were recorded. The animals that are unable to swim within 15 sec of gentle agitation of the test container are considered immobile. Those animals whose heartbeats have stopped are considered dead. The heartbeats were watched under a stereoscopic microscope (4×magnification). The dissolved oxygen content and pH of the test media were measured at the beginning and at the end of the test.

2.4 Chronic Toxicity Test

The chronic bioassay was conducted under static daily renewal condition for 21 days following a procedure adapted from OECD (1998). Based on the results of acute toxicity, neonates (6-24 h old) were exposed 21d to a series concentrations of nCu (0, 0.0004, 0.002, 0.01, 0.05 and 0.1 mg/L) and nCr (0, 0.002, 0.01, 0.05, 0.25 and 0.5 mg/L). Binary mixtures were also tested according to an equiconcentration (W/V) ratio of 1:1 and the total exposure concentrations were 0.0004, 0.002, 0.01, 0.05 and 0.1 mg/L. One single neonate was placed in a 100 mL glass beaker containing 50 mL test suspension. Twenty replicatess were completed for each concentration and control group. Danhnids were fed daily with algae at a concentration of 1×10^6 cells mL^{-1}. Each offspring (if present) was carefully separated from beaker and the test solutions were renewed every day. The criteria used to evaluate the reproduction of *D. magna* included days to the first pregnancy, days to the first brood, number of first brood per female and average offspring in each brood. At the endpoint the survival of adults in each treatment was documented to measure the body length under a stereoscopic microscope.

The intrinsic rate of natural increase r value was calculated using the formula of Lotka (Lotka et al. 1913), $\sum l_x m_x e^{-rx}=1$, where l_x is the proportion of individuals surviving to age x, m_x is the age-specific fecundity (number of neonates produced per surviving female at age x), and x in days. As r calculated in *D. magna* organisms after 21 days is indistinguishable from r estimated for the entire lifespan, due to the great importance of early reproduction (Leeuwen et al. 1985), all calculations were based on 21 d experiments.

2.5 Feeding Experiment

Filtration and ingestion rates were used as measures of the feeding behavior (Villarroel et al. 2003). The feeding experiment was run according to a method described by Zhu et al. (2010), and the exposure concentrations were the same as the chronic experiments. Each treatment consisted of three replicates. Ten neonates (6-24 h old) were placed in a 100 mL glass beaker containing 50 mL test solution. The tests were conducted at 20±1°C with a dark photoperiod for 5 h. During the exposed period the organisms were fed with 1×10^6 cell mL^{-1} of algae. Then final food concentration was measured using a hemocytometer under an electron microscope (400×magnification).

Filtration rate (F) is defined as the volume of medium swept clear by an animal per unit of time and the ingestion rate (I) as the number of cells consumed by an animal during a specific time interval. To calculate the average F (μL/(ind·h)) and I (cells/(ind·h)) the equations (1)-(3) were used (Gauld et al. 1951) :

$$F = \frac{V}{n} \times \frac{\ln C_0 - \ln C_t}{t} - A \tag{1}$$

$$A = \frac{\ln C_0 - \ln C_t'}{t} \tag{2}$$

$$I = F \times \sqrt{C_0 \cdot C_t} \tag{3}$$

Where C_0 and C_t are initial and final food concentrations (cell/μL), t is time (duration of the experiment in hours), and n is the number of daphnias in volume V (μL); and A is a correction factor for changes in the control with final concentration $C_t^{'}$ after time t.

The expression $\sqrt{C_0 \cdot C_t}$ represents the geometric mean of food concentration during time t.

2.6 Statistical Analysis

Data were expressed as the mean with standard deviation (SD). Data from acute tests, chronic tests and feeding experiments were analyzed using an analysis of variance (ANOVA) to detect significant differences between different treated groups and control (p<0.05). All statistical analyses were performed using SPSS 17.0 (SPSS Co., Chicago, IL, USA).

3 Results and Discussion

In the acute test, the observation of exposure duration showed a concentration-response feature, and no mortality occurred in the control groups. In the groups exposed to 0.01 mg/L of nCu and 0.05 mg/L of nCr, the movement of *D. magna* was fast and smart, just like the daphnids in control groups. However, the increased concentrations of the metal NPs caused immobility and death of daphnids. The concentration-response curves of the NPs tested on *D. magna* are presented in Fig. 2. Through one variable linear regression analyses of the negative logarithm of NP concentrations and the immobilization or mortality rates as the relative toxic potency, the median effective concentration (EC_{50}) on immobilization and the median lethal concentration (LC_{50}) on *D. magna* were otained, which were 0.34 mg/L and 0.63 mg/L for nCu, and 0.96 mg/L and 1.57 mg/L for nCr, respectively. These results were consistent with those of previous studies. Griffitt et al. (2007) examined the acute toxicity of 80 nm copper nanoparticle suspensions on zebrafish, which demonstrated that nCu was acutely toxic to zebrafish, with a 48 h LC_{50} value of 1.5 mg/L. Zhen et al. (2006) assessed the *in vivo* toxicity of nCu to mice, and the median lethal dose (LD_{50}) via oral gavage was 413 mg/kg body weight. However, no acute toxicity data were provided for nCr up to now.

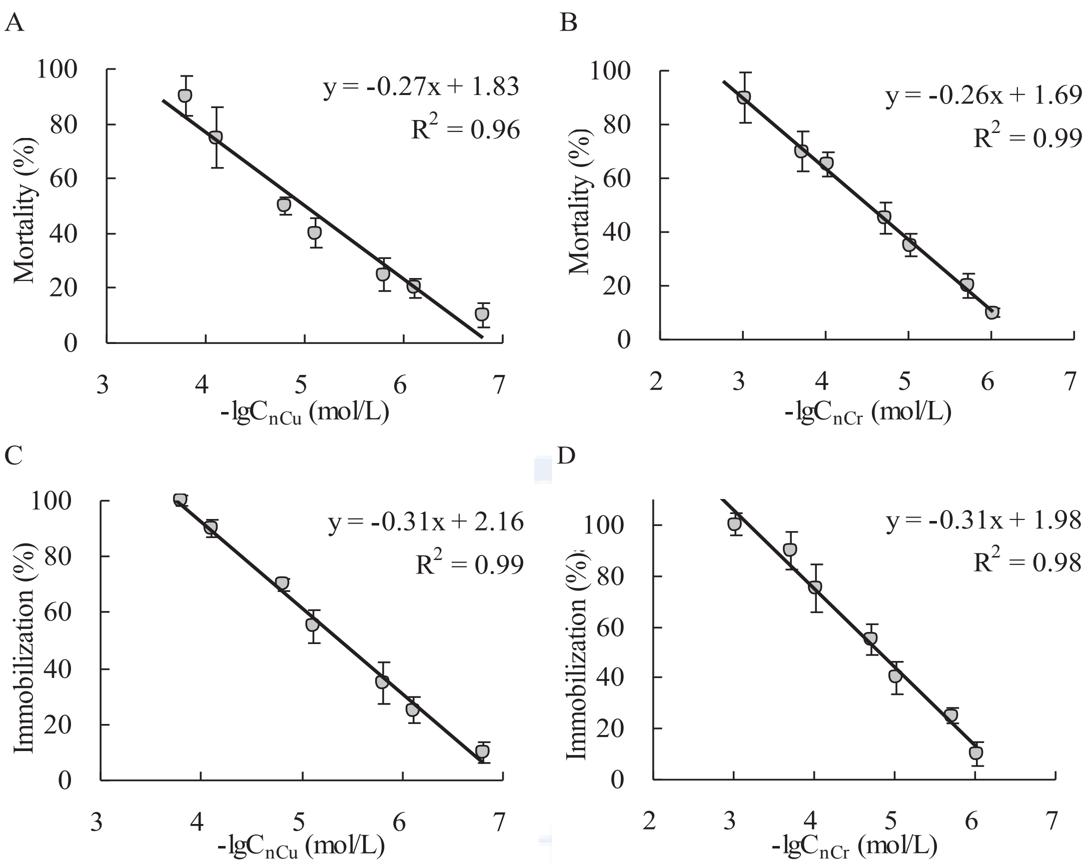
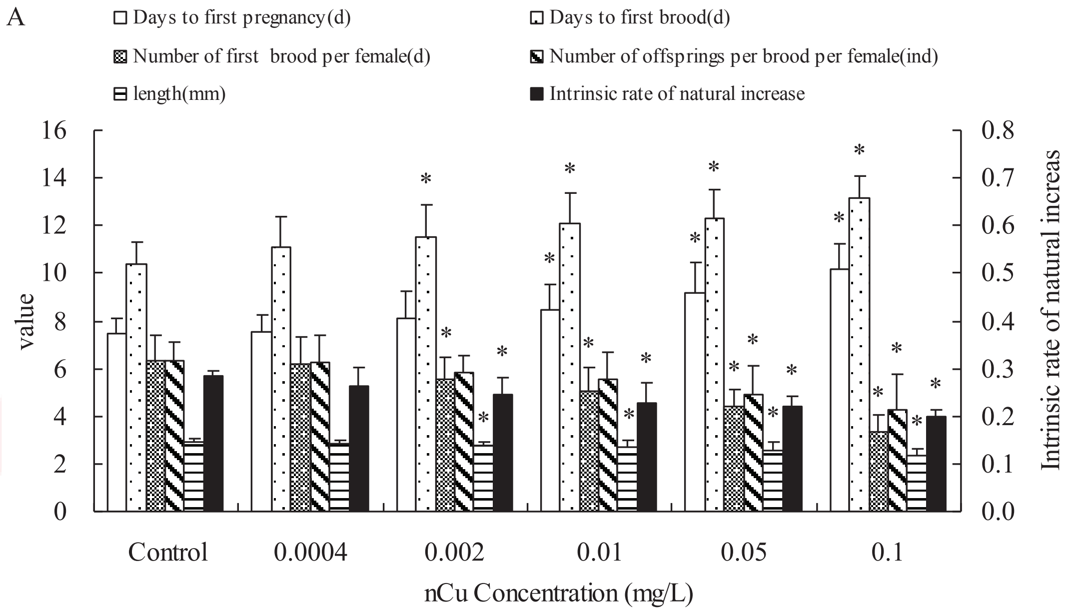
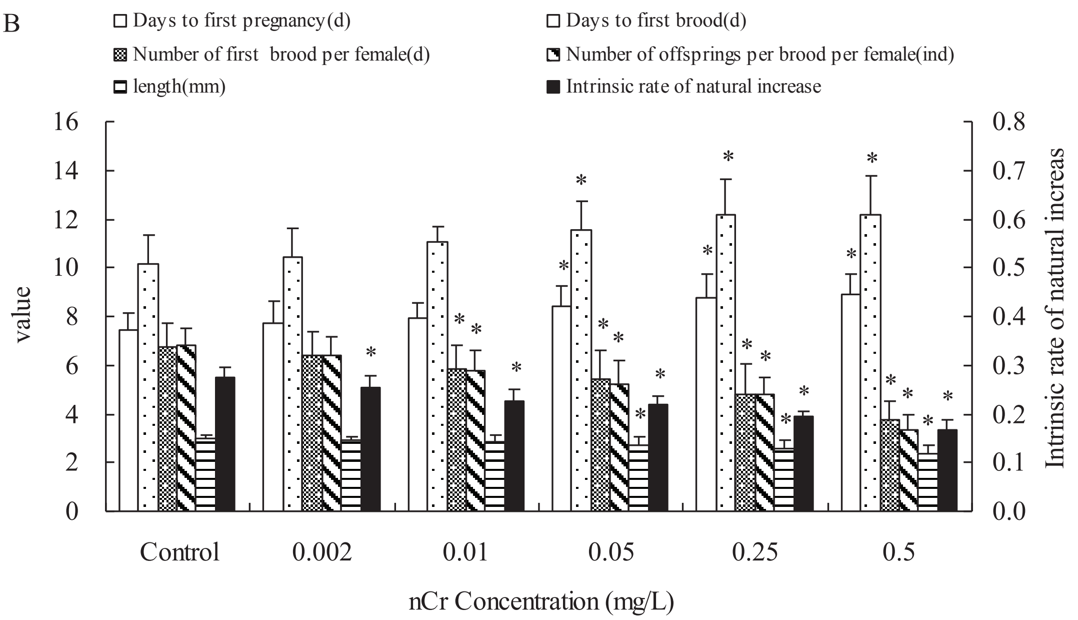


Fig. 2 The concentration-response curves of nCu (A, C) and nCr (B, D) to *D. magna*.

The traditional 48 h acute toxicity test may not be sufficient for the toxicity assessment of NPs due to their low environmental concentrations. More attention should be paid to chronic or long-term exposure (Yi et al. 2010; Dao et al. 2010), which is a part of an integrated environmental monitoring and assessment strategy (Mendonça et al. 2011). This point was further substantiated by the 21 d chronic toxicity tests for daphnia reproduction in the present study, as reported by Wienh et al. (2009). We assessed the survival, reproduction, body length and population parameters of *D. magna* after 21 d of exposure and the results are shown in Fig.3. It showed that 0.002 mg/L of nCu and 0.01 mg/L of nCr could inhibit the reproduction of *D. magna* and even affected the population of *D. magna*. Moreover, the growth inhibition and mortality of *D. magna* were also observed at the concentration 0.002 mg/L of nCu and nCr mixture. Obvious concentration-response relationships were obtained for both individual and combined exposure. The parameters “days to first brood”, “number of offspring per female in the first brood” and “intrinsic rate of natural increase” were more sensitive to indicate the toxicity of metal NPs compared with the other endpoints. The inhibitory effects of binary mixtures on the growth and reproduction of *D. magna* were higher than that of the corresponding individual exposures, suggesting that nCu combined with nCr may play a synergistic effect.

In our privious study, nCuO and nZnO (alone and on combination) were also found to significantly inhibit the growth and reproduction of *D. magna*, and the highest concentration of mixtures (0.25 mg/L) caused the death of *D. magna* **(**Zhao et al. 2012**)**.


A
Days to first pregnancy(d)
Days to first brood(d)
Number of first brood per female(d)
Number of offsprings per brood per female(ind)
length(mm)
Intrinsic rate of natural increase
value
Intrinsic rate of natural increas
Control
0.0004
0.002
0.01
0.05
0.1
nCu Concentration (mg/L)


B
Days to first pregnancy(d)
Days to first brood(d)
Number of first brood per female(d)
Number of offsprings per brood per female(ind)
length(mm)
Intrinsic rate of natural increase
value
Intrinsic rate of natural increas
Control
0.002
0.01
0.05
0.25
0.5
nCr Concentration (mg/L)

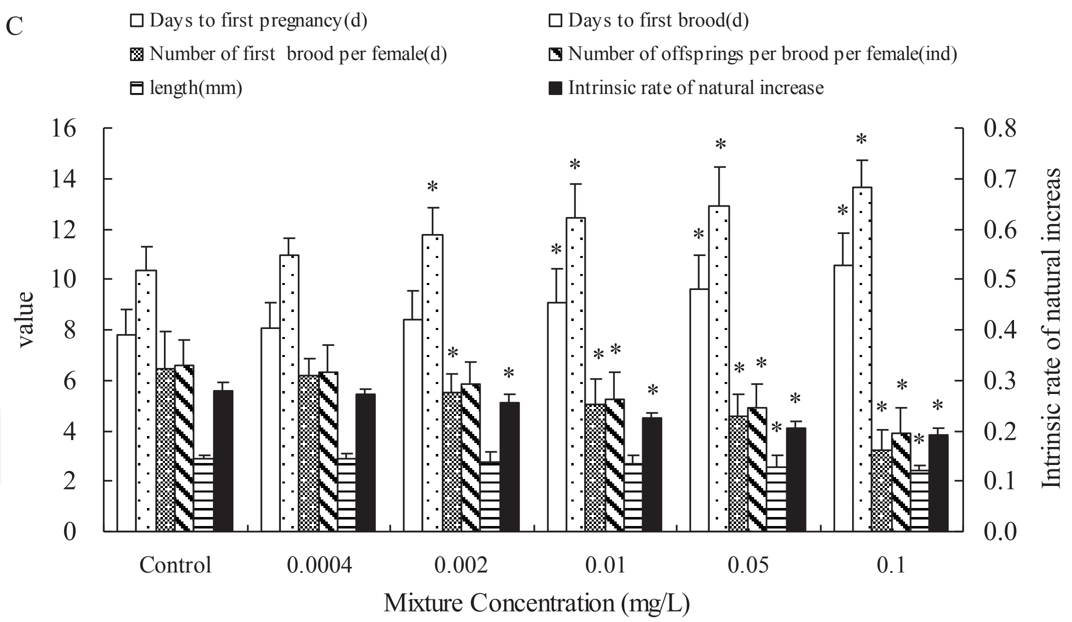


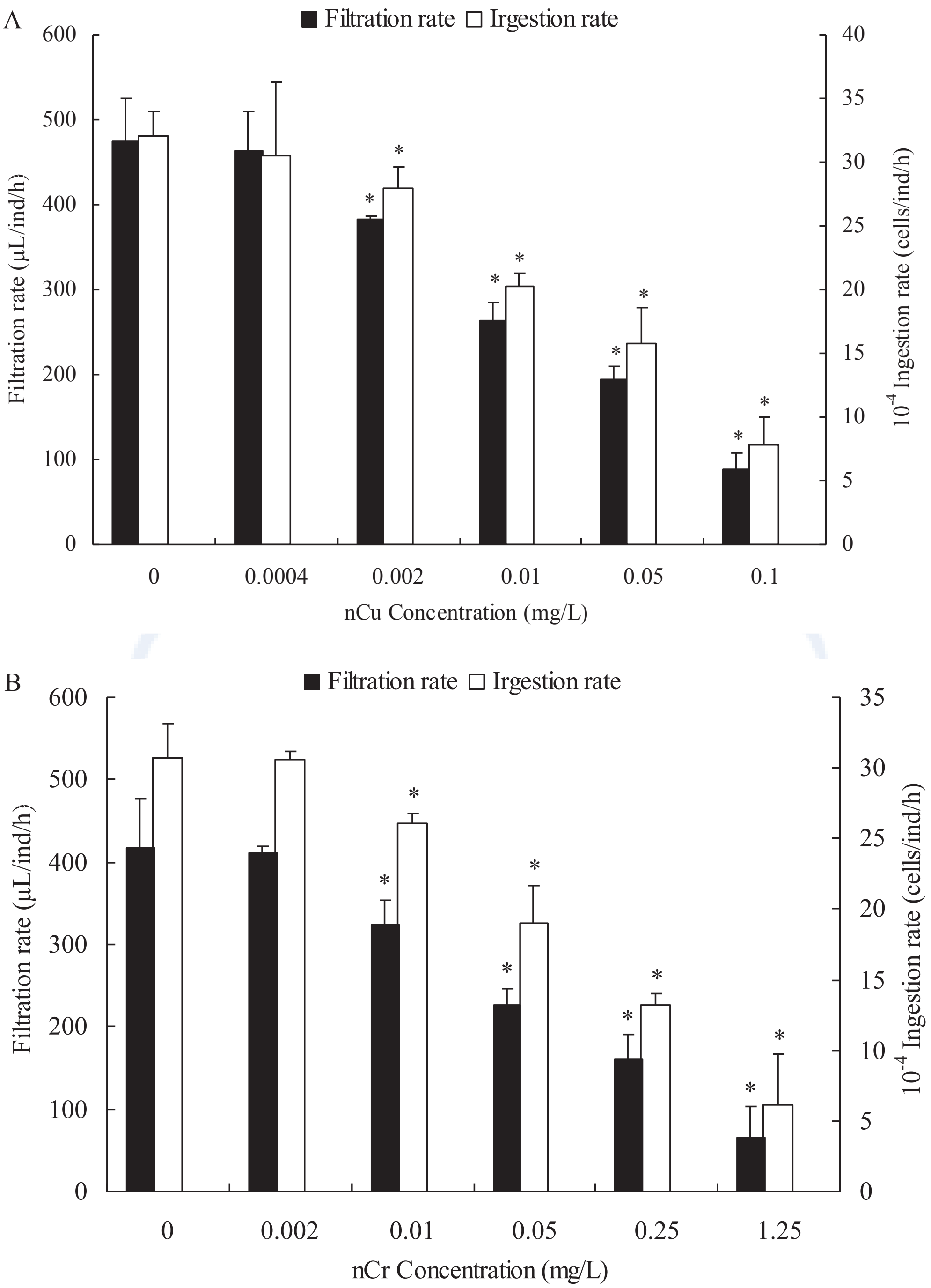
Fig. 3 Size, survival and fecundity of *D. magna* exposed to several concentrations of nCu(A), nCr(B) and the mixtures(C) in a 21 d life study

The intrinsic rate *r* was used to estimate chronic effects in *D. magna* and which has becoming a critical component of population level to evaluate ecological risk including cladocerans (Tanaka 2003). The toxicants which cause a decrease in the number of the first few broods of daphnias could cause *r* values to decrease significantly, while the later broods of daphnias have little effect on *r* values (Villarroel et al. 2003). Therefore, the lowest observed effect concentration (LOEC) and no observed effect concentration (NOEC) were estimated based on intrinsic rate data in the present study. The maximum acceptable toxicant concentration (MATC) was represented as the geometric mean of NOEC and LOEC. The NOEC, LOEC and MATC values of nCu, nCr and their mixtures to *D. magna* were shown in Table 1. The results showed that nCu was more toxic than nCr, and the mixtures exhibited the toxicity similar to nCu, but higher than nCr.

Table 1 NOEC, LOEC and MATC values of NPs to *D. magna*

NPs	NOEC (mg/L)	LOEC (mg/L)	MATC (mg/L)
nCu	0.0004	0.002	0.0009
nCr	0.002	0.001	0.0014
nCu/nCr	0.0004	0.002	0.0009

The effects of nCu, nCr and their mixtures on the feeding behavior of *D. magna* are shown in Fig. 4. *F* and *I* values significantly decreased in all treatments (alone and in combination) at all tested concentrations except for the lowest concentration, and concentration dependence was apparent. The maximal inhibition rates for filtration exceeded 80% at the highest exposure concentrations. Since NPs may accumulate in the *D. magna*, the poor food intake and malnutrition may further cause observed chronic toxicity (Mendonça et al. 2011).


A
Filtration rate
Irgestion rate
Filtration rate (μL/ind/h)
10^{-4} Ingestion rate (cells/ind/h)
nCu Concentration (mg/L)
0
0.0004
0.002
0.01
0.05
0.1
B
Filtration rate
Irgestion rate
Filtration rate (μL/ind/h)
10^{-4} Ingestion rate (cells/ind/h)
nCr Concentration (mg/L)
0
0.002
0.01
0.05
0.25
1.25

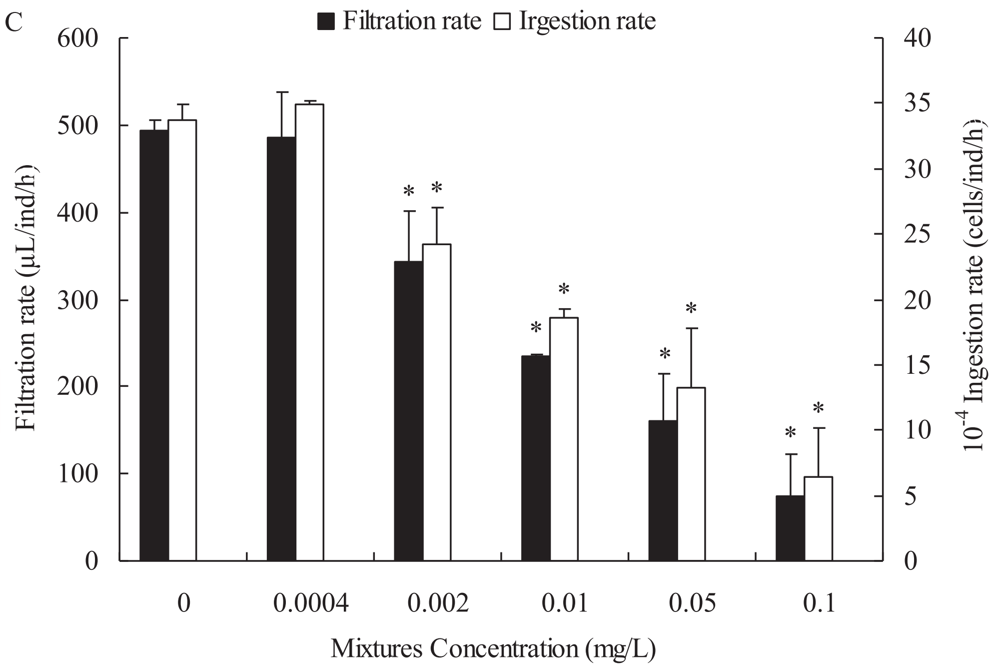


Fig. 4 Ingestion and filtration rates of *D. magna* after exposure to nCu (A), nCr (B) and the Mixtures (C) for 5 h.

4 Conclusions

This study demonstrated the acute and chronic effects of two metal NPs (alone and in combination) on *D. magna*, and concentration dependence was apparent in all cases. nCu was more toxic than nCr, and nCu combined with nCr may play synergistic effects on *D. magna*. The intrinsic rate of natural increase *r* is confirmed to be a sensitive parameter to NPs exposure. Our results also suggested that coexistent metal NPs might cause more adverse effects on aquatic ecosystem health when they were simultaneously or successively released into the aquatic environment.

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Urban Agriculture's Synergies with Ecological and Social Sustainability: Food, Nature, and Community

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Abstract

The practice of urban agriculture (UA) is a flourishing topic in environmental discourse based on its promise for increasing sustainable food production in a world increasingly urbanized at the same time food security is threatened by climate change. Research indicates UA has potential for a substantial contribution to food sustainability in the global South where extensive poverty and large populations with traditional agricultural knowledge provide the material and social bases for growing an already appreciable level of production. However, UA may have a low ceiling in the global North due to the high value of land and the lack of unpolluted soil (a legacy of industrial production). It has been argued that UA in the global North can overcome this lack of affordable arable land by constructing vertical farms and expanding the production of current venues: allotments, kitchen gardens, community gardens, and peri-urban farming. This paper considers these arguments based on a case study of a community garden in New York City, supplemented by data from other studies. The conclusion is that the potential for UA in the global North will likely remain low. Still, it merits policy support on other grounds: its synergies with ecological and social sustainability. While UA may offer somewhat greater capacity to enhance ecological sustainability than other green spaces, its synergies with social sustainability are more substantial—generating social capital for community development, promoting environmental education, and advancing environmental justice. These synergies warrant increased attention in urban sustainability research.

"The garden is the smallest parcel of the world and then it is the totality of the world."
Michel Foucault (1986:26)

Introduction: Parsing the potential of urban agriculture

My basis for parsing the potential of urban agriculture in this paper this is experiential as well as empirical: The experience comes from over a decade of participation in a community garden in New York as well as occasional workdays on friends' allotments here in the UK. Much earlier on, I grew up in a semi-rural environment in Kentucky.

My local community garden in Manhattan, the WSCG occupies 17,500 square feet (0.16 hectare) of rising land between two parallel streets. It is dominated by two features. At one end lies a large vegetable garden divided into 80-odd raised plots that are six feet by five feet in size. Six plots are reserved for school children. The small size of the plots considerably limits the scale of food production. Gardeners reported that produce served as occasional supplements to their tables. At the other end of the Garden is an amphitheater which is used for a series of cultural productions throughout the summer season.

The Garden's 300-odd members and thousands of users were found to represent a cross-section of the neighborhood's population—with two major exceptions: Age and gender. Older women are disproportionately represented. Studies of other urban gardens have shown similar findings (Garnett 2001: 484; Sokolovsky 2009).

The Garden is now decades old, having been developed by neighborhood activists on a rubble-filled vacant lot. Although quite successful, it requires large amounts of labor to operate. The labor includes physical work like turning compost and administrative work like fund-raising.
This labor falls to a small cadre of gardeners—as one told me, "our problem is that only a core does everything--a dozen or so people." This is a common problem for community gardens, and the small core of active persons is not always sustained. A national survey of US community gardens found that "the primary reason given for loss of [hundreds of] garden sites is lack of interest by gardeners" (ACGA 1998:3).

Urban Agriculture: Back to the future?

It was the development of agriculture some 10,000 years ago that made cities possible and it has sustained their growth over the millennia. This sustenance is becoming problematic in an era when a majority of humans are for the first time residing in urban areas—at the same time as the species is dealing with global climate change. The principal threat to the human species from this climate change is to agriculture. The UN (2009; 2011) projects a global population in 2050 of 9 billion, 70 percent of whom will live in cities. This population will require about 70 percent more food that the 2009 population. Meanwhile, expanding cities coupled with the floods and droughts expected from global climate change will reduce the store of arable land. The upshot of these changes is that our species must enhance its food production on a large scale, and do so in a sustainable fashion.

Gardening in urban areas has led to a full-blown movement which has acquired its own categorical identity—Urban Agriculture (UA). Thus, McClintock (2010: 191) argues,

> As we find ourselves once again in the throes of a crisis of capitalism, the popularity of UA in the Global North has surged and the discourse surrounding it has shifted from one of recreation and leisure to one of urban sustainability and economic resilience. Even the terms used to describe it have shifted in the Global North; "urban agriculture" is replacing "community gardening" in everyday parlance' placing it (despite its much smaller scale) in the same category as UA in the Global South . . . .

Of course, urban agriculture is as old as cities but what is the future of its revival? The potential of UA can be analyzed using three vectors of sustainability—food (or agricultural); ecological (or environmental); and social (or community).

Food Sustainability

The primary focus in UA is on cities of the global South, and with good reason—it is far more widely practiced there. The results of one comparative research project (Zezza and Tasciotti 2010) found that in cities in 11 of 15 countries (in Africa, Asia, Eastern Europe, and Latin America), the share of households participating in food production was over 30 percent. Participation was concentrated in the poorest strata of populations, with over 50 percent of the poorest quintile participating in 8 of the 15 nations. UA's contributions to total agricultural production ranged from a high above 20 percent in Madagascar and Nicaragua, to a low of 3 percent in Malawi. In only 4 nations was more a one-third of agricultural production marketed. A significant additional finding of this research was that urban agriculture was associated with indicators of dietary adequacy and diversity in a majority of the nations.

As to the potential of UA in the global South, the researchers concluded:

> On the one hand, the potential for urban agriculture to play a substantial role in urban poverty and food insecurity reduction should not be overemphasized, as its share in income and overall agricultural production is often quite limited. On the other hand, though, its role should also not be too easily dismissed, particularly in much of Africa and in all those countries in which agriculture provides a substantial share of income for the urban poor, and for those groups of households to which it constitutes an important source of livelihoods (Zezza and Tasciotti 2010: 255).

Thus, at present UA has a reasonable potential to be a significant food producer for the poorest people living in the poorest cities of the world, and it is receiving enhanced attention from climate change analysts. For example, at Rio+20, Altieri (2012) made a case for a considerable scaling-up of urban agroecology in the South.

What about the potential role of urban agriculture in producing food in cities of the global North?

Summaries of four pieces of research from two countries show the following:

> --London could produce 18 percent of the fruit and vegetables eaten by its residents (Garnett 2001)

--Oxford could produce one-half of its fruit and vegetables (*FoodPrinting Oxford* 2012)
--Cleveland, Ohio, 11 percent of food and beverage consumption by weight and 4.5 percent by expenditure could be produced (Grewal and Grewal 2012)
--Oakland, California has a potential for vegetable production of 5 percent of current vegetable consumption (McClintock *et al.* 2013)

These percentages are much higher than present production in these cities—Cleveland, for example, has the potential to produce more than 100 times its current level of food and beverage consumption. However, the percentages for potential production remain low and do not approach food sustainability. Thus, in Oxford, the potential of producing 50 percent of fruit and vegetables would represent only 2 percent of the city's overall requirement for land to feed itself. Moreover, these maximum potential figures are even less impressive if the following is considered:

--We are looking only at fruit and vegetable production which is a minority share of the human diet
--Even when that share is upgraded, as in the UK Eatwell Plate (FSA 2010), to one-third of a recommended sustainable dietary allowance, the result would be that London has a maximum potential of producing only about 6 percent of its total food needs

Additionally, there are major obstacles to reaching the potential production levels. The first is that an unknown portion of the land that would be converted to agriculture is too contaminated to sustain food production for humans. For example:

--Nearly 60 percent of London's vacant industrial land is contaminated and that even many allotments, domestic gardens, and other small pockets of land are too polluted for safe food production
--A study that assessed the lead contamination of soil in 12 vacant sites in Oakland, California, found a high level of site variability that must be taken into consideration when planning for urban farming; significantly, sites with contamination significantly higher than the Federal screening level were in predominantly low-income and African American neighborhoods, indicating a major environmental justice concern (McClintock 2012)

The other obstacle to greater urban food production is the land squeeze. Food production is land intensive and urban land has high commercial value and economic competition for its use. Thus, they feature skyscraper buildings. For example, two-thirds of the original lot rehabilitated by the WSCG was eventually taken by residential apartment buildings. The negotiation of conflicting land stakeholder interests is quite intense in many cities of the North, New York and London being prime examples.

Meanwhile, these cities struggle even to maintain their current levels of green space. For example, in London, the domestic gardens which comprise 25 percent of the land upon which fruit and vegetables could be grown, are declining. A recent study (Smith 2010) found that between 1998 and 2008, their area had declined by 12 percent. It is primarily being lost to paving for parking cars.

Vertical farming?—One idea to overcome the lack of arable land in cities of the North which is gaining traction is vertical farming, or high-rise structures devoted to food production (see Despommier 2009). These urban farms would use new, sustainable greenhouse technologies in order to mass produce food, including fish and perhaps even poultry. Although not a new idea, such a skyscraper has yet to be built.

Chicago is an example. There, a "mega" indoor vertical farm is being converted from an abandoned warehouse. *FarmedHere* as it is called is located in the suburbs and has 90,000 square feet in which to produce a million pounds a year of organic greens. The plant proposes to integrate aquaponics by using tanks of fish to clean water and provide fertilizer for the soil-less crops. It is a business that started with loan from the massive US organic food store chain, Whole Foods (FCRN 2013). Though large in floor space, this structure is only two stories tall. The goal of building a skyscraper for food production has yet to be met.

There are two major obstacles to achieving this goal. One obstacle is economic; *i.e.*, the high costs of skyscrapers. Currently, their costs are borne by corporations and governments for their offices, and by middle-to-upper class residents for their homes, or state-subsidized housing for lower-income citizens. The costs are for land, for construction (or conversion), for maintenance, and for taxes. Then there are the energy and labor costs of growing food. It appears quite problematic that a successful business model for skyscraper food production would include very high costs for its output.

In addition to economic obstacles, there are major presumptive questions about the sustainability of vertical farms. Energy will be required to get adequate artificial light to plants that are not at windows on all the floors of high structures in order to replace sunlight. The proponents of vertical farming recognize this sustainability issue. Dickson Despommier, its best-known advocate, has been quoted as saying that "powering farms is still the biggest hurdle for the industry" (*Chicago Impact* 2013: 2). The consensus of technology experts at an international meeting on vertical farming at the University of Maryland in 2012 was that there is a bottleneck in the development of more efficient LED lighting, which is now about one-half of what it needs to be to make such farming economically feasible (*The Vertical Farm* 2013).

At least in the near and mid-term, vertical farming appears to have low potential for making a major contribution to sustainable urban food production.

Scaling-up present urban farming?--Even if its food sustainability production prospects low, UA can still make a material contribution to the lives of some sub-groups in some cities of the global North—for example, for low-income immigrants with access to land, as the work of Mares and Pena (2010) indicate for community gardens in Los Angeles and Seattle. In both cases, the gardens were large ones (14 and 4 acres) and the immigrants came from agricultural backgrounds.

A best-case scenario for growing the scale of urban farming has been developed for Detroit, a distressed city which today has sizeable acreage of the vacant, publicly-owned land that would be required for the purpose (Colasanti *et al.* 2010). The scenario is based on the following assumptions:

--Soil would be non-contaminated or de-contaminated
--Field harvest could be stored as well as consumed immediately
--The growing season would be extended by using “hoop houses” (passive-solar greenhouses made with plastic sheeting stretched over metal frameworks)

In this scenario, it would be possible to supply a significant portion of the fruit and vegetables consumed locally—about 75 percent of vegetables and nearly 50 percent of fruits.

However, there are caveats to this scenario:

--If Detroiters increased their fruit and vegetable consumption to government-recommended and sustainable dietary allowances, three times as many acres would be required
--The significantly scaled-up gardening would require substantially more human labor, the source of which is unknown

That is the story at the moment for sustainable food production in cities of the North. What about the ecological and social sustainability vectors of UA?

Ecological Sustainability

All urban green spaces, including gardens, enhance natural environments is a number of significant ways (see Bousse 2009; RHS 2011):

--Contributing to biodiversity through sustaining a variety in flora and fauna
--Contributing to species preservation by providing food and habitat
--Reducing soil erosion and retarding flooding
--Mitigating the urban heat island effect

While community gardens likely are no better than other urban green spaces in providing these contributions to ecological sustainability, they are more likely to provide opportunities to link ecological and social sustainability; for example in environmental justice projects.

Thus, Palamar’s (2010) case study of New York’s Green Guerrillas illustrates the possibilities of for integrating ecological restoration and environmental justice within an urban setting. Additionally, in a study of community gardens in the San Francisco Bay area, Ferris *et al*. (2001: 567) concluded that “community gardens can be very positively linked to the implementation of Local Agenda 21 and sustainability policies and at the same time used to promote environmental equity.”

Social Sustainability

As to social sustainability, UA offers a range of contributions--in health, education, and community development (see Relf 1992). With regard to health, gardens provide locally-accessible and free opportunities for both physical and mental well-being. Gardening is by nature a physical pursuit. Its physicality ranges from the fine motor involvement of cutting flower stems to the aerobic gross motor tasks of turning a compost pile (Brown and Jameton 2000: 28, citing Mattson 1992). While gardening has positive consequences for physical health, it also "has been observed to be a way to relax and release stress" (Brown and Jameton 2000: 28). Thus, in addition to promoting physical health, gardens can support mental health—for their users as well as their gardeners. They provide a small plot of nature for people living in large and dense cities, access to which can be a form of therapy allowing for solitude, escape, serenity, and reflection. Such access has been found to be related to mental health by mitigating a psychological "nature deficit disorder" (Louv 2008).

It is with regard to education that community gardens may make their most significant contributions. The educational programs they provide for school children can be a vehicle through which coming generations are provided a structured opportunity to learn-by-doing some of the basic principles of ecological sustainability. Thus, in the WSCG, classes from nearby schools engage over the course of a term in sustainable agricultural practices such as working compost bins and growing organic vegetables. These classes have led to the creation of a small garden at the primary school across the street.

It is in community development that community gardens have received the most attention. They have been found to "contribute to neighborhood satisfaction, sense of community belonging, and social contacts" (Comstock *et al*. 2010, citing Clayton 2007; Kearney 2009). They have also been found to enhance community pride and serve as an impetus for broader community improvement by improving relationships among people (Comstock *et al*. 2010, citing Wakefield *et al*. 2001).

One study of an urban multi-ethnic area concluded that the social benefits of any public open space are to "provide relief from daily routines, sustenance for people's sense of community, opportunities for sustaining bonding or making bridges, and influence tolerance and raise people's spirits" (Cattell *et al*. 2008: 544). Finally, UA has been found to create opportunities for leadership development and community organizing and in this way contributes to neighborhood social capital (Brown and Jameton 2000: 29).

The social capital manifested in urban gardens is mobilized through political activity and they have become meaningful arenas for political action. Community gardens are increasingly landscapes that support and connect three vital spheres of political mobilization: Environment, food, and space. For example, a study of community gardens in Toronto by Baker (2004: 306) argues that: "By digging into their small plot of land, gardeners are challenging conventional ideas of urban planning and design, working on community-development projects, engaging with place-based social movements, and creating alternative food systems."

In Canada, an emergent community food-security movement aims to cultivate democratic food practices by raising awareness of where food comes from and by promoting locally grown food. This practice has as a model, "Food Citizens," who not only are consumers but also who are engaged in their communities and have an intimate connection to their food (Baker 2004:306; Welsh and MacRae 1998). Another framing of the new connections between urban space and food is that of "civic ecology" (Tidball and Krasny 2007: 158), a term that embraces the management of nature, public education, and community development within urban settings.

Conclusion: Maximizing the Food, Ecological, and Social Sustainability of Urban Agriculture

While there is potential for increasing UA, it is probable that this will occur in the global South. There, widespread and deep poverty creates a material need and social basis for enhancing the already appreciable level of urban food production. Also, Altieri (2012: 17) noted also that "the reason why the potential resides in the South and not in the North is because in developing countries still resides a large peasant-indigenous population, with a rich traditional agricultural knowledge and a broad genetic diversity which conforms the basis of resilient diversified agroecosystems."

In the global North, UA has the potential to increase but its ceiling appears low due to the commercial value of real estate, a lack of safe land for growing food, the sheer amount of land needed to produce food, and questions about its energy sustainability. At least in the foreseeable future, the best prospects for any vertical farming lie in turning the spaces on the rooftops of urban buildings into gardens. This would require no new land and no energy for artificial light.

One model of the city for expanding food production is the regional or ecosystem approach. The ecological region focuses on the natural sustainability of urban agglomerations through the preservation of ecologically significant land such as wetlands, and the redevelopment of a regional agriculture (Luccarelli 1995). A schematic for a zonal scaling of agriculture in urban agglomerations might look like the following:

1. Core or inner city: Some fruit and vegetables. Continue to develop community gardens but direct the focus to social sustainability.
2. Suburbs: Even more fruit and vegetables, possibly with some poultry (meeting both public health and sustainability concerns). Expand allotment systems.
3. Exurbs: Small farms producing fruit, vegetables, and poultry that are taken to farmer's markets in the inner city.
4. Periphery: Small and medium size farms producing fruit, vegetables, poultry, pork, and dairy, the produce of which is marketed through retail outlets across the urban agglomeration.

Even assuming such a zonal scaling and a considerable increase in food production, UA will not be able to produce at least two groups of food, one that is a necessity—that is the food that requires large-scale land use, including all grains—and one that is discretionary—that is the exotic components of modern urban diets; for example, bananas and citrus in cities like London and New York.
In conclusion, the potential of the contemporary upsurge in urban agriculture is assessed as follows:

1. Agricultural (food): Limited potential and concentrated in the provision of fruit and vegetables, and in the South

2. Ecological (environmental): Meaningful potential but no more so than other urban green spaces except for synergies with social sustainability
3. Social (community): Substantial potential, especially in the mobilization needed for furthering education for sustainability and environmental justice

These considerations are by nature preliminary. We have a lot of questions about urban food production and a dearth of information. This means that UA can be the basis of a rich research agenda. In terms of knowledge we are probably at the end of the beginning of this research agenda.

Finally, whatever their agricultural, ecological, and social assessments, it needs to be said that urban gardens are also important resources for the personal lives of city dwellers.

Like all urban gardens, the WSCG is only a very small piece of nature in a very large city, but like all of nature it “has unusually potent power to heal broken human landscapes and to humanize and reinvigorate distressed cities and built environments . . . to restore community and hope at the same time that urban ecosystems are repaired” (Beatley 2011: 9).

The garden is indeed a “totality” for urbanites—providing for community solidarity, for a direct connection to nature, and for **some** food.

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Economic Impact and Water Use Trade-Offs and Synergies: A Case Study of the Cyprus Tourism Sector

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Abstract

Water issues have been gaining importance on the global political agenda in recent years. Nevertheless, water scarcity issues are inherently local. The impact of tourism activities on local water resources remains an understudied issue. Tourism is highly heterogeneous and offers a plethora of different products which cater for different tastes and budgets at different times of the year. Tourism products differ in terms of their economic impact but also in terms of their demand for water and other resources. Direct use of water by the tourism industry, which includes water used in hotels, golf courses, water parks and other tourism establishments, is relatively well understood. In addition to this volume of water, substantially more is required indirectly to produce food and other products which cater for tourism demand. Quantifying both the direct and indirect components is essential to understanding total water demand and productivity in the tourism sector.

The common perception in Cyprus and other tourism economies is that high-spending tourists represent the most desirable market segment. However, this assertion is rarely based on economic yield assessments and ignores environmental impacts. The present research uses Environmental Input-Output (EIO) analysis along with detailed tourism expenditure data in order to quantify economic and water use synergies and trade-offs, for different tourism markets in Cyprus. The results suggest that different market segments vary significantly in terms of their economic return in relation to total water use. Consequently, there are important sustainability implications for policymakers and destination managers in water scarce destinations.

1. Introduction

All economic activity requires the input of environmental resources, either directly or indirectly. Water is one such input, and a scarce resource that has been receiving increasing academic, political, and press attention in recent years – largely because there are already parts of the globe where water has become or is fast-becoming (UN-Water, 2006; Vorosmarty, Green, Salisbury, & Lammers, 2000) a limiting factor for human life and economic development. As water remains a vital input in the production of goods and services, it is essential that focus shifts towards increasing water efficiency and water productivity (Gleick, 2003). Each use of water must be able to generate the maximum amount of utility using the least quantity.

Tourism is not an economic activity that has traditionally been associated with pressure on water resources (Gössling, 2005). This is mainly because, on a global level, direct water use from tourism only represents a very small percentage of water use (Gössling et al., 2012) compared to other users such as agriculture, industry and household sectors (FAO, 2011). The tourism industry's focus on minimising carbon emissions from travel and accommodation has also perhaps detracted attention away from tourism's use of other resources, including water (Hadjikakou, Chenoweth, & Miller, 2013). Nevertheless, due to its seasonal and spatial concentration, tourism can significantly impact water resources in certain places (De Stefano, 2004; Kent, Newnham, & Essex, 2002). The Mediterranean is a prime example, as it is an area where most tourists arrive in the summer, when precipitation and natural flows tend to be at a minimum. Furthermore, as a service sector with a very large supply chain and interlinkages, tourism draws water through its supply chain, thus exponentially increasing its total demand for water (Hadjikakou, Miller, & Chenoweth, 2012). Tourism tends to be a highly 'extravagant' form of consumption, as a holiday often represents a well-earned break (Miller et al. 2010), with destinations commonly encouraging spending and consumption in order to maximise revenue.

It is well understood that tourist facilities such as golf course and swimming pools directly use large amounts of water (Hof & Schmitt, 2011; Tortella & Tirado, 2011). Increasingly, there has also been acknowledgement and understanding of the indirect water use component of tourism (Gössling et al., 2012; Hadjikakou et al., 2012; Lundie, Dwyer, & Forsyth, 2007), even though this is still to be comprehensively or consistently quantified. The concepts of virtual water (Allan, 1996) and the water footprint (Hoekstra, 2003) have succeeded in raising awareness of the fact that the majority of water consumption takes place in the agricultural and industrial stages of production (i.e in the supply chain). Approximately one-third of all tourist expenditure is used to buy food (Gössling et al. 2010), which suggests that tourism may have a much more substantial impact on water consumption, particularly in agriculture, than previously thought.

It is becoming clear that it is in the long term interests of not only the environment but also the tourism industry itself to be able to accomplish more with less. However, important questions remain with respect to the trade-offs between water use and economic impact of different kinds of tourists. Tourism is highly heterogeneous and offers a plethora of different products which cater for different tastes and budgets at different times of the year. This implies that there is no 'one-size-fits-all' management approach for reducing water use impacts and that different groups should be targeted in specific ways to ensure that economic yield is maximised and water use minimised. This is the issue that this paper seeks to address, by firstly developing a suitable methodology to estimate the total economic and water use impact of tourism on the island of Cyprus, and then breaking this down into more relevant tourism sub-sectors whose relative performance can, subsequently, be compared.

The paper is structured as follows. The next section sets the scene by briefly discussing tourism and water scarcity issues in Cyprus – the case study for the present paper. A subsequent section provides a general overview of the methodology, along with a brief description of the environmental input-output (EIO) model and the datasets used to perform the analysis. The ensuing results and discussion sections present the key findings of the modelling exercise, such as total water use as well as water productivity for different kinds of tourists, with a concluding section which discusses some of the key implications for water scarce destinations and tourism management.

2. Tourism and water scarcity in Cyprus

Cyprus is an island nation in the eastern Mediterranean region (Fig. 1). Similarly to other islands in the Mediterranean, a favourable climate, natural beauty and rich history have made the island an attractive tourism destination. The island first became a tourism destination in the 1960s. Since then, the development of tourism has been a remarkable success story, with the establishment of tourism as the dominant economic sector since the early 1980s (Sharpley, 2001). In 2012, according to the Cyprus Statistical Service (CyStat), the tourism sector made a total contribution of 19.4% to GDP and supported 20.8% of total employment (CyStat 2013). Cyprus belongs to a group of countries known as Small Island Tourist Economies (SITEs), owing to its small size, its nature as an island and its economic dependence on tourism (Shareef, Hoti, & McAleer, 2008).

Cyprus has a climate typical to the region, characterised by mild rainy winters and long, hot and dry summers (Hadjinicolaou et al., 2010). With an annual average precipitation of around 460mm, the climate regime is classified as semi-arid – making Cyprus one of the EU member states experiencing the highest levels of water shortage (Cyprus WDD, 2009). The water scarcity problem is further compounded by the extremely unequal spatial distribution of water resources as well as the fact that around two-thirds of the annual rainfall total typically falls during the winter months (Kampanellas et al. 2003). As in other Mediterranean islands, water demand can often surpass natural water availability during the summer months (Gikas & Angelakis, 2009). As a result, the island has become highly reliant on reservoirs and desalination.

Desalination plants presently supply around 50% of the water used in the residential sector, which includes tourism establishments (Kaimaki, 2010).

Tourism is directly responsible for around 16.9% of domestic water use in Cyprus, which corresponds to 5% of the total annual water use (Kaimaki, 2010). As the most prominent environmental issue on the island is water scarcity, it is commonly accepted that tourism has exacerbated the problem (Sharpley, 2003). This is especially the case during the summer months where peak tourism demand coincides with full irrigation requirements in agriculture (Iacovides, 2011). In recent years, attempts have been made by the government and the tourism sector alike to diversify the tourism product in order to attract higher-spending clientele (Adamou & Clerides, 2009; Clerides & Pashourtidou, 2007). With the current economic downturn in the EU and the recent collapse of Cyprus as an offshore banking centre, tourism is likely to become an even more important main source of national revenue (Hadjikakou et al., in press). Nevertheless, even though diversifying the existing tourism product represents a proven way to increase the economic yield of the sector, it is likely to increase water demand. Evidence from other mature destinations in the Mediterranean suggests that water resources tend to become increasingly stressed from diversification and upgrading of the tourism product, especially at a time when the challenges posed by climate change are becoming apparent (Hof & Schmitt, 2011; Tortella & Tirado, 2011).

Figure 1. Map of the eastern Mediterranean region showing the location of Cyprus (source: drawn by author using freely available GIS shapefiles available at http://www.diva-gis.org/Data).

Future water availability on the island is expected to be severely affected by climate change. The eastern Mediterranean region is considered to be an extremely sensitive 'hotspot' for climate change (Giorgi, 2006; Giorgi & Lionello, 2008; Ludwig et al., 2011). Projections show that the area is likely to face an increase in annual mean temperature of well above the average global temperature increase, whereas annual precipitation is very likely to decrease. Specifically for Cyprus, recent studies using regional climate models suggest that, by mid-century, average temperature is likely to increase in the range of 1.3°C to 1.9°C (Giannakopoulos et al., 2010) and precipitation will decrease by 20% (Chenoweth et al., 2011).

The present study therefore represents a timely attempt to comprehensively quantify and compare the total (direct and indirect) water demand and water productivity of the tourism sector, in addition to performing a necessary comparison of different tourism types currently present on the island.

3. Methods

Overview of methodology

Fig. 3 below provides an overview of the methodology. Subsequent sub-sections describe each of the three stages in more detail.

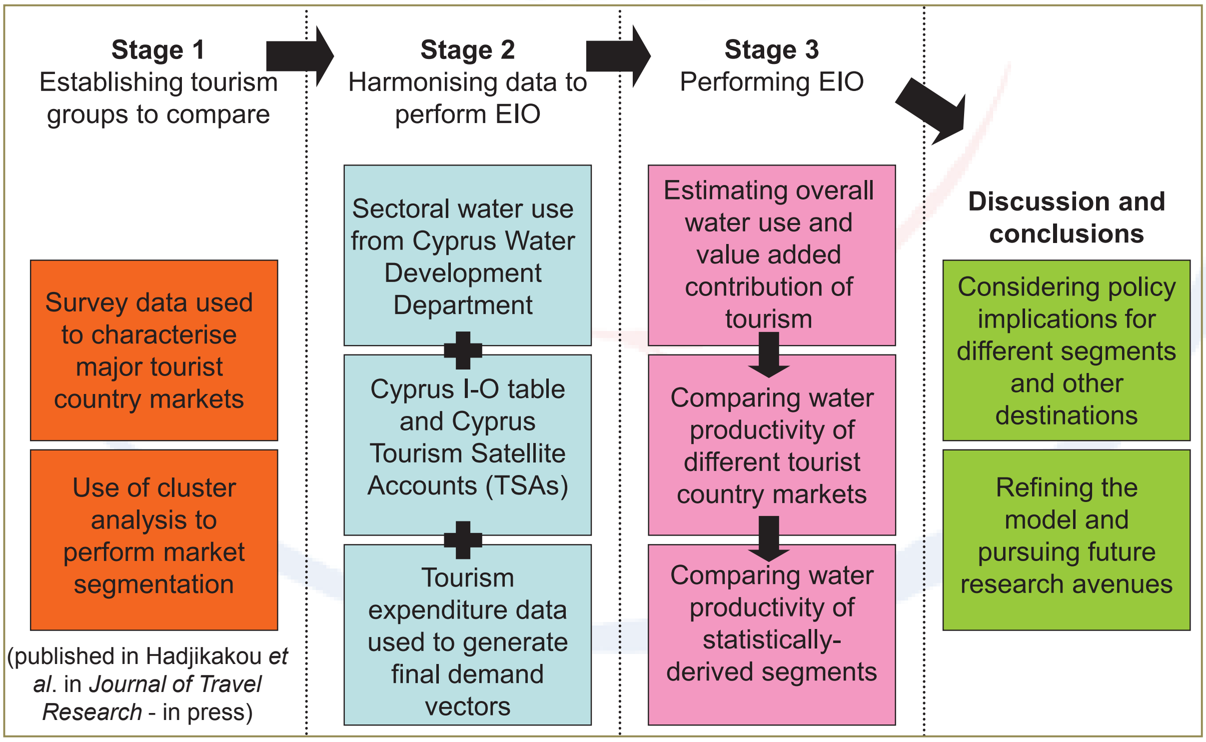

Figure 2. Brief outline of the three-stage methodology followed in the current study.

Stage 1 (establishing tourism groups to compare)

The first necessary objective of the study was to determine what kinds of tourist groups are currently present on the island. As an established mature tourism destination, Cyprus offers a plethora of holiday choices which are likely to have different economic impacts as well as exert different amounts of water use pressure. The Cyprus Tourism Organisation (CTO) distinguishes tourists based on their country of origin (COO), which traditionally serves as the basis for collecting and interpreting tourism data (Andriotis, Agiomirgianakis, & Mihiotis, 2008; Reid & Reid, 1997). Nevertheless, Hadjikakou et al. (in press) argue that existing COO segmentation needs to be supplemented with tourist typologies based on other tourist characteristics and consumption patterns besides nationality. In the aforementioned study we employed cluster analysis to segment the largest COO market in Cyprus (tourists from the United Kingdom), and showed that spending behaviour can vary enormously between tourists belonging to the same COO segment.

Stage 2 (EIO and data harmonisation)

EIO analysis is a top-down economic technique that allows the association of economic accounts with environmental accounts of resource use or pollution. It is based on the input-output (IO) model, an analytical framework developed by Leontief in the 1930s that makes use of sectoral monetary transactions to account for interdependencies between industries in modern economies (Munksgaard et al. 2005). The fundamental starting point in performing an IO analysis is having information on the flows of products from each economic sector to each of the other sectors (R. E. Miller & Blair, 2009). This is typically available in the form of an input-output table (IOT) of the economy (see Table 1). Today, most statistical agencies worldwide regularly produce IOTs as part of their National Account framework. In the inter-sectoral transactions matrix (shaded area in Table 1), rows represent the distribution of a producer's output throughout the economy whereas columns describe the composition of inputs required by a particular industry.

Table 1. Basic input-output table for a hypothetical two-sector economy.

	Sector 1	Sector 2	**Final demand (y)**	**Total output (x)**
Sector 1	z_{11}	z_{12}	y_1	x_1
Sector 2	z_{21}	z_{22}	y_2	x_2
Imports	m_1	m_2		
Value added	VA_1	VA_2		
Total inputs	x_1	x_2		

The next step in the Leontief input-output model is to replace the inter-sectoral sale terms (denoted by *z*) with technical coefficients (R. E. Miller & Blair, 2009), interpreted as the monetary input value per one monetary unit of output for each sector, described using the ratio:

$$a_{ij} = \frac{z_{ij}}{x_j} \tag{1}$$

The basic Leontief model is then based on the principle that total output is equal to intermediate demand plus final demand, given by:

$$Ax + y = x \tag{2}$$

where A is the 'direct requirements matrix' whose elements are all the technical coefficients (a in equation 1) for a given economy, y is the vector of sectoral final demand (as shown in column 3 of Table 1 – y can correspond to final demand from any chosen group of consumers such as households, exports or, as performed in the present study, tourists) and x is the vector of sectoral total outputs (as shown in column 4 of Table 1). Equation (2) can be rearranged in terms of x to give the Leontief equation:

$$(I - A)^{-1}y = x \tag{3}$$

where I is an identity matrix (a matrix with the same dimensions as A with ones on the main diagonal and zeros elsewhere). $(I - A)^{-1}$ is the 'Leontief inverse' matrix. It captures the total sum of an infinite series of round-by-round effects, thus representing the total production generated by each economic sector in order to satisfy final demand in the economy (Velazquez, 2006).

The extension of the IO model to include links between economic and environmental data was first undertaken in the late 1960s by Leontief himself, who developed a method to incorporate environmental externalities such as pollution into the conventional IO structure (Leontief, 1970). Environmental input-output (EIO) makes use of the Leontief matrix that contains monetary inter-sectoral transactions, allowing both direct and indirect environmental pressures (resource use or pollution) for any given consumption pattern to be estimated. This is based on the premise that all monetary flows in the supply chain of a product or service are correlated with the use of resources. Common applications of EIO in the literature include carbon emissions (Druckman & Jackson, 2008; Druckman & Jackson, 2009; Druckman & Jackson, 2010; Minx et al., 2009; Munksgaard et al., 2005; Weber & Matthews, 2008), ecological footprint considerations (Turner, et al. 2007; Wiedmann et al. 2006) and water use/water footprinting (I. Cazcarro, Duarte, & Sánchez-Chóliz, 2012; Duarte, Sanchez-Choliz, & Bielsa, 2002; Wang, Xiao, & Lu, 2009; Zhang et al. 2011; Zhao et al. & Qin, 2010). Tourism-related EIO studies (Collins, Munday, & Roberts, 2012; Jones & Munday, 2007; Lundie et al., 2007; Munday, Turner, & Jones, 2013) are also prominent in the literature. The model setup used in this study is akin to Munday et al. (2013).

The generalised EIO approach involves the calculation of direct impact coefficients (denoted by the vector w_i for water use in this case). This is a vector of resource use per unit of currency of output for each sector within the IO framework, calculated as:

$$w_i = \frac{e_i}{x_i} \tag{4}$$

where e_i is a vector of water use by each economic sector or commodity and x_i is the previously defined vector of total sector output. The generalised expression for calculating the total water use for any given final demand vector is given by:

$$W_T = w_i(I - A)^{-1}y + W_d \tag{5}$$

where W_T stands for total water use, and W_d corresponds to direct onsite water use (in the case of tourism, this refers to water use at hotels or other accommodation) which needs to be added separately since it cannot be included in the IO model. Although EIO is an approach that belongs to the family of life cycle assessment (LCA) methodologies, unlike conventional process-based LCA, it does not require micro-scaled production details and also captures entire supply chains (Murray, Wood, & Lenzen, 2010). Through the addition of imports into the IOT (see m_1 and m_2 in Table 1), EIO can also distinguish between water that originates from domestic sources and that which is imported from abroad.

As shown in Fig.2, the study uses three main kinds of data to perform EIO: (a) water use data supplied by the Cyprus Water Development Department (WDD), (b) economic data in the form of an IOT for Cyprus along with Tourism Satellite Accounts (TSAs) provided by CyStat, and (c) tourism expenditure data which originated from the survey data previously used in Stage 1, also supplied by Cystat. The data are for the year 2007, which corresponds to the latest edition of the Cyprus TSAs. Even though the 2007 data is slightly dated now, this ensures that all data are from the same year. Below is a brief description of the datasets.

(a) Water use data

The WDD (Cyprus WDD, 2011) and the Cyprus Statistical Abstract (CYSTAT, 2011a) provide the most reliable information on annual water withdrawals and estimated water demand for different sectors of the economy for any given year. This provides the vector *e* which then allows the calculation of *w*, as seen in equation (4). Furthermore, the WDD provides information on domestic water use, taken as W_d in equation (5), for households and tourists, respectively. The figures used in this study are 217 litres per capita per day for the local population (l/c/d) and 450 l/c/d for the average tourist (with adjustments made across different tourist groups in relation to accommodation types).

(b) Economic data

As CyStat does not currently release IOTs, the study uses IOTs for Cyprus from the World Input-Output Database (WIOD). Funded by the European Commission's 7th Framework Programme (EC, 2012) , the WIOD was developed in order to help in the analysis of the impacts of globalisation on trade patterns, environmental pressures and socio-economic development (Timmer et al., 2012). THE WIOD IOTs are used to estimate $(I - A)^{-1}$, the 'Leontief inverse' matrix, as shown in equation (5). In addition, TSAs were obtained from CyStat. TSAs are satellite accounts of the core national accounts compiled from visitor expenditure data, industry data, and supply and use relationships in the System of National Accounts (Dwyer, Forsyth, & Dwyer, 2010). They essentially provide an estimate of tourism-specific expenditure, thus complementing information on inter-sectoral transactions contained in the IOTs.

(c) Tourism expenditure data

Passenger survey data that includes expenditure is typically collected through exit surveys in which tourists are asked to provide an estimate of total and detailed expenditure during their visit (Wilton & Nickerson, 2006). The expenditure data used in this study were obtained from exit surveys administered through questionnaires at the island's two major airports during 2007 (CYSTAT, 2011b). The data is used in conjunction with TSAs in order to estimate final demand from tourism, which corresponds to y in equation (5).

Stage 2 involved considerable pre-processing and aggregation or disaggregation of data in order to ensure that all data were in the same sectoral classification, as required in order to perform EIO.

Stage 3 (Comparisons between tourist groups)

Stage 3 involved the estimation of total water use by tourism in Cyprus, subsequently converted into per capita averages, which then allows a comparison to that of residents. The comparison proceeded by producing final demand vectors for the major nationalities of tourist on the island, as well as the clusters belonging to the UK country market. The objective of this stage was to produce a wealth of comparison data that allows an understanding of water use differences and subsequently water productivity and trade-offs between different tourist groups.

4. Results and analysis

Total water use

Fig. 3 displays total daily water use for the main country markets in comparison to the average tourist and the average resident (households). The figure also shows what percentage of the water use is direct or indirect and further divides supply-chain water use into domestic water and imported water, thus accounting for trade in food and other commodities.

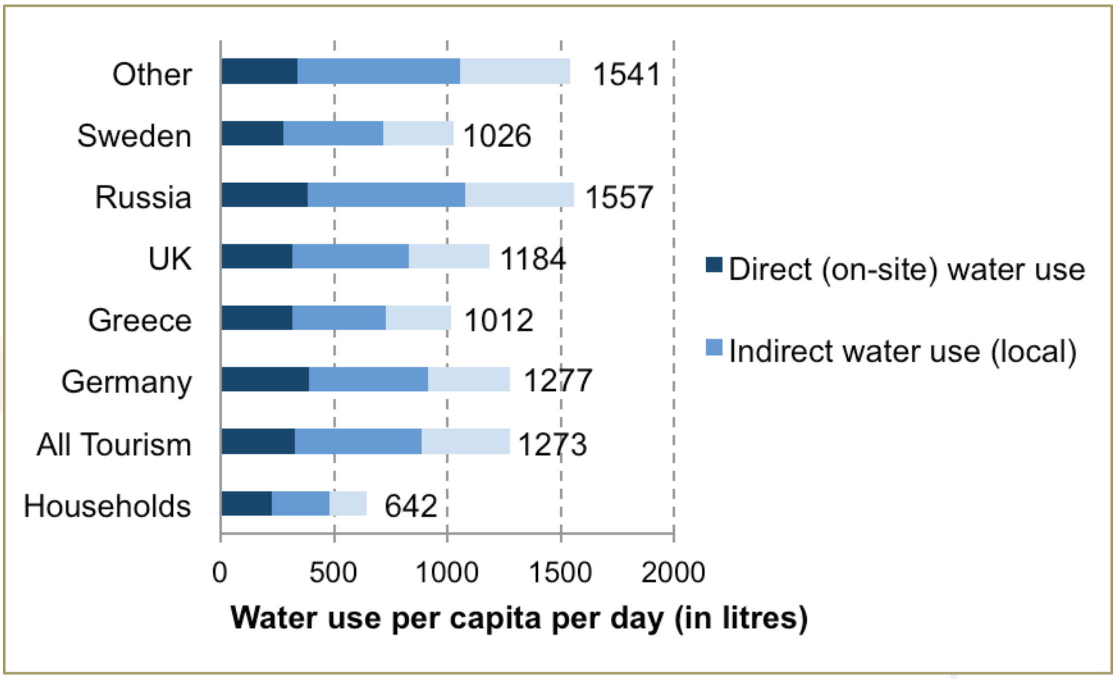

Figure 3. Daily direct and indirect water for the main country markets, the average tourist and households.

The results (Fig. 3) show a considerable range in daily total water use between tourists and households, with the average tourist using almost twice as much water (1273 l) as the average Cypriot (642 l), with some tourists groups (Russia and Other) using considerably more. This supports the findings from previous studies which show that tourists tend to use significantly more water than residents (Essex, Kent, & Newnham, 2004); (Gössling, 2005); (Emmanuel & Spence, 2009). In this instance, the ratio of direct to indirect water does not appear to vary significantly between different nationalities, which suggests that the average spending behaviour within large tourist groups of the same nationality is fairly homogeneous.

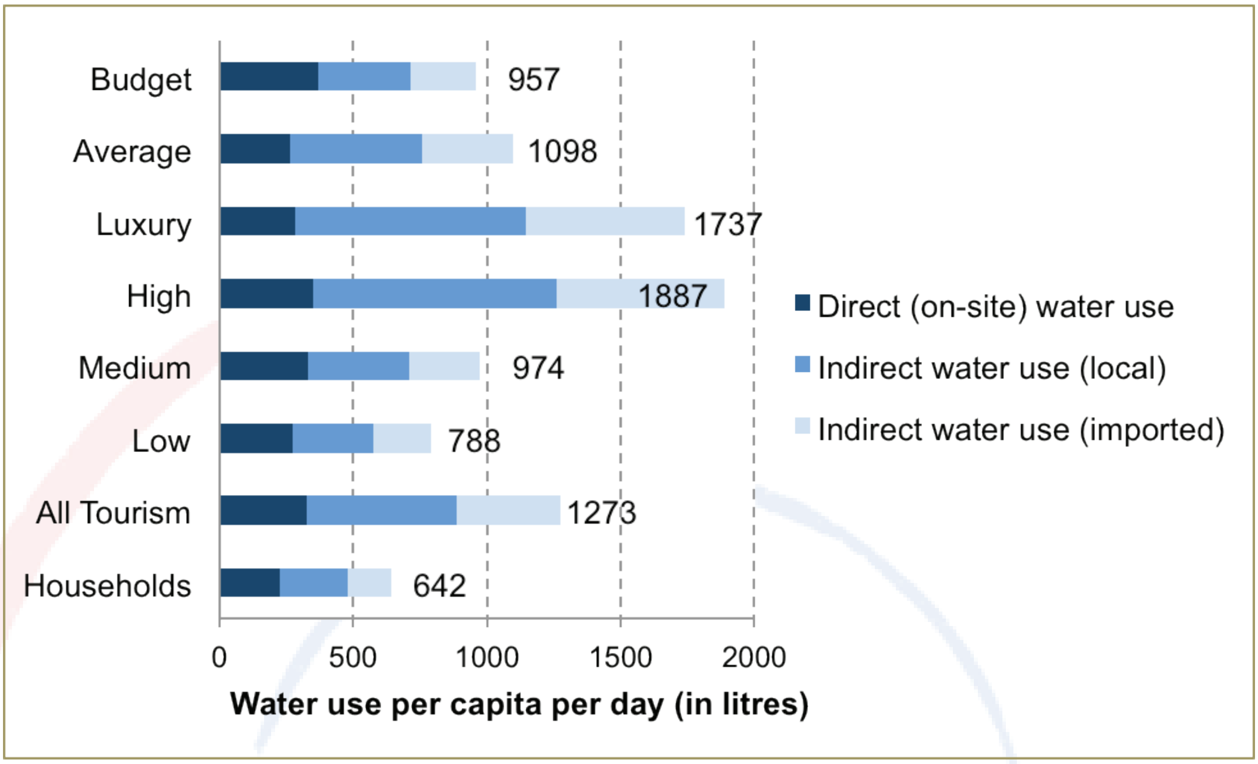

Figure 4. Daily direct and indirect water for different segments of the UK market.

Fig. 4 shows that, within the UK tourism segment, there is considerably more range in daily per capita water use than between the different country segments. This highlights the argument made elsewhere (Hadjikakou et al. in press) that there is actually considerable heterogeneity within different country segments that has to be explored further using statistical techniques. Again, it appears that those segments that spend the most money ('luxury' and 'high') are the ones associated with the highest overall water use, with both of these segments consuming around three times as much water as an average Cypriot. Fig. 5 shows that there is indeed a strong linear correlation (with an R^2 value of 0.95) between expenditure and water use.

Nevertheless, the percentages of direct and indirect (local or imported) in Fig.4 show considerably more variation than in Fig. 3. A comparison between the two extremes within the UK market exemplifies this observation very well. In the 'high-spending' segment, 81% of total water use comes from the supply chain (48% of which is local and 33% of which is imported), with only 19% of the total water use being directly used on-site. In contrast, in the 'budget' segment, only 61% of total water use comes from the supply chain (36% of which is local and 25% of which is imported), with 38% of the total water use taking place on-site. Therefore, even though on-site water use in absolute terms does not differ widely between the two segments, overall water use is almost around double in the 'high-spending' segment, owing largely to higher spending to buy food and other goods which require significant inputs of water in their production.

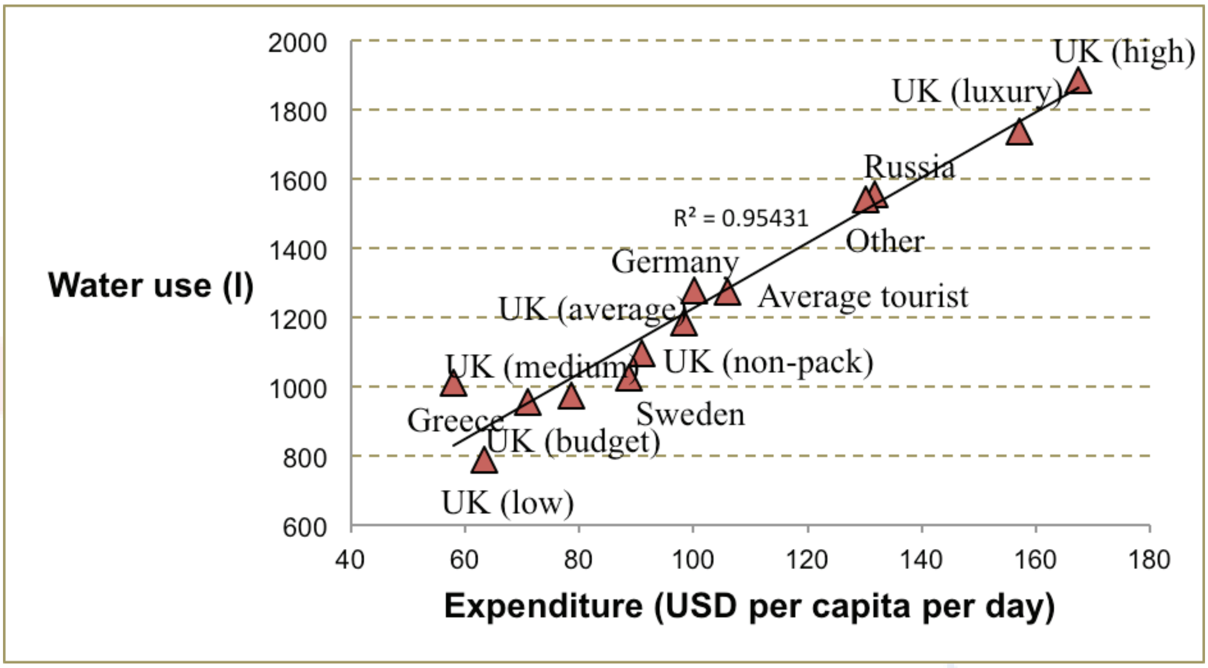

Figure 5. Linear correlation between expenditure and water use.

The above figures already point to potentially important trade-offs or synergies that should be taken into account in water demand assessments of the tourism sector. For the more budget end of the market, it appears that on-site water use can represent almost 40% of the total water use associated with a tourist's consumption activities. This implies that ensuring water-efficient accommodation facilities becomes an important priority for budget hotels and other accommodation, as it may ensure higher water productivity for the lower-spending tourist segments. On the other hand, in the higher-spending end of the market, indirect water use typically accounts for around 80% of total water use, emphasising the need to consider where agricultural products used in hotels and restaurants originate from and how much water was required to produce them. Even though this issue is important for all types of tourist, it is particularly so for the higher-spending segments, who are typically interested in consuming local delicacies and generally consume more food products.

Water productivity

Fig. 6 considers water productivity, using a simple indicator of water use divided by value added (VA), in an attempt to relate water use impacts to economic benefits. According to the overall results, an average tourist uses 10.6 litres for every USD VA contributed. This is significantly less than the average Cypriot resident that requires 17 litres in order to generate one USD of VA. This appears to suggest that, even though tourists use significantly more water than local residents, they do contribute considerably more to the economy. It therefore becomes more important to explore the range of values for different tourist types. Once again, taking two extremes as an example, the 'budget' segment requires 12.1 litres (14% more than the average tourist) for every USD VA generated whereas the 'luxury' segment requires only 9.7 litres (8% less than the average tourist) for every USD VA. It is evident that the higher-spending tourism segments tend to compensate for their higher water use by generating more VA and hence contributing more to GDP. It should be noted, however, that VA is only one indicator of economic contribution: it is likely that other indicators of economic contribution such as employee numbers or labour compensation may result in a different ranking of the segments (Dwyer & Forsyth, 2008). For this reason, the results presented here should only be considered as one of many possible measures of water productivity indicators.

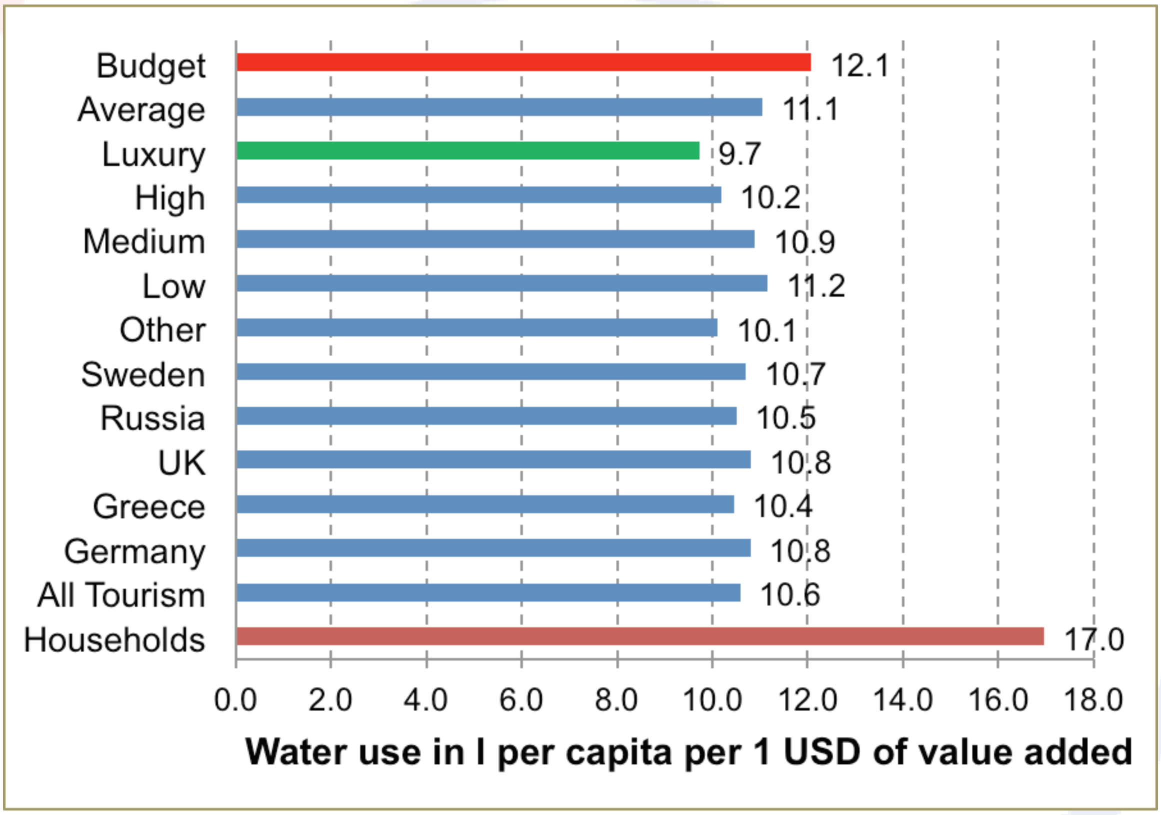

Figure 6. Water productivity shown for all tourist segments considered in the study.

5. Discussion and conclusions

Implications and limitations

The results suggest that indirect water use dominates over direct water use for all kinds of tourism consumption. Expenditure on food is the category that accounts for most of the water use associated with each tourist segment. This suggests that whereas traditionally tourism and agriculture are seen as competing water users (Holden, 2008; Iglesias et al. 2007), they may in fact be correlated in the sense that more tourism spending also results in more food production and hence more agricultural water use.

Even though reference of this phenomenon, known as a ‘water demand multiplier effect’, can be found in previous literature (Emmanuel & Spence, 2009), it is only in the past few years that researchers are beginning to explore the water use associated with the tourism supply chain (Cazcarro, Hoekstra, & Sánchez-Chóliz, 2014; Gössling et al., 2012; Hadjikakou et al., 2013). The results of the present study reinforce the need for more rigorous quantification of the indirect water use component of tourism consumption, as well as for comparisons between different tourist types. One of the key implications is that there is substantial variation in water use needs between different tourist types. Whereas the benefits of saving water used directly in hotels and accommodation are well understood (Bohdanowicz & Martinac, 2007; Deng & Burnett, 2002) and relatively straightforward to address, indirect water use is likely to prove a much more complex issue.

It is important to acknowledge that the approach outlined in this paper is only a brief demonstration of the potential uses of EIO for establishing water use needs for different tourism types. The approach outlined here requires further refinement in order to provide meaningful management advice and policy guidelines. Firstly, there is need to use more disaggregated data (IOTs, tourism expenditure and water use) in order to explore the role of different dietary preferences. As indirect water use is clearly associated with food consumption, and especially animal products which have considerably higher water footprints (Hoekstra & Mekonnen, 2012; Vanham, Mekonnen, & Hoekstra, 2013), it is imperative that the analysis is carried out at a level of disaggregation that allows capturing the impact of different food choices. This could then allow more specific recommendations to be drawn for hotel buffets or restaurant menus in order to maximise water productivity for different kinds of tourist consumption. A second research priority is to add a seasonal component to the model, which can provide information on how direct and indirect water is used throughout the year by different tourist types, and the associated water demand pressures which arise.

Another important research avenue is to obtain a more qualitative understanding of tourist behaviour. Through the use of in-depth surveys, working closely with tourists and hotel and restaurant managers, research needs to explore why different tourist types have different preferences – and what are the factors that tend to promote consumption patterns associated with higher water use intensity. Ultimately, studies will also need to be conducted in order to test the impact of different water-saving measures as well as their likely effects on tourist satisfaction. Ensuring adequate revenues, high tourist satisfaction and sustainable water use is a highly challenging proposition, but the methodological framework described here has the potential to contribute towards achieving this.

Concluding remarks

For regions already suffering from some form of water scarcity, the additional consumption of water from tourism development can lead to severe water stress.

However, the extent of this stress is rarely apparent from official water use statistics, because they generally only consider direct water use in tourist accommodation. The use of LCA-type methodologies, such as EIO, ensures that impacts throughout the supply chain of tourism are captured, otherwise the picture remains incomplete. Maximising the economic impact of tourism is certainly desirable, but this must not be pursued at the expense of environmental resources. The present research has used the island of Cyprus as a case study – however, the proposed framework is potentially relevant for any tourism destination where water is scarce, such as many islands and most countries of the Mediterranean. It is envisaged that further data collection and modelling refinements should allow a multi-indicator approach that can handle water alongside other environmental pressures such as carbon emissions, land use and threats to biodiversity. This would provide a more complete appreciation of trade-offs and synergies between different kinds of consumption, and help to maximise policy interventions.

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Architecture Culture in the Mediterranean Region. Specific Tactics of Passive Conditioning in Our Architectural Heritage

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Abstract

The purpose of this paper is to explain how human interaction with the environment has emerged an architectural culture deeply rooted in the territory in the Mediterranean Eurasian region. The importance of this work lies in the consideration of architecture as a basic result of an evolutionary process since ancient times shows this interaction elemental. It is therefore in our historical and artistic heritage that we must seek the architectural achievements made in terms of sustainability.

An effective way to present this goal is by exposing specific tactics of passive conditioning, without mechanical means, revealed by the buildings of our architectural heritage. The most decisive reason of a successful research has been the consideration of domestic architecture as a repository of these tactics of passive conditioning. Tactics are technical solutions that have endured over the spontaneous consciousness of the people ensuring their survival.

Therefore, this paper shows some of the achievements of domestic architecture that resides on the spontaneous consciousness of the Mediterranean peoples in relation to sustainability, energy and the environment. These achievements justify its firmness by historical traceability and its validity by bioclimatic behavior. At the same time legitimizing the greatness of their constructive and artistic expression, with the use of local materials, has reached insuperable heights.

The results allow conclusions about the desirability of protecting, catalog and preserve the specific tactics of passive conditioning residing in the Mediterranean architectural heritage for possible consideration as a first step towards zero energy cost architecture.

Keywords: Architecture, bioclimatic, domestic, environment, heritage, Mediterranean, strategy, tactics.

Introduction

The energy crisis and climate change have led to a growing concern evidenced by the profusion of lines of research in all fields of scientific knowledge. We are seeking solutions for research lines opposite essence, in the field of architectural knowledge: one that proposes new methods and architectural models and another that explores the architectural heritage.

In the last century a new architectural movement emerged breaking with traditional construction principles and focusing on new energy-efficient models, looking for an architecture that can be implanted in any territory. A world leader of those who defended this counterculture movement is Victor Olgyay that, in 1962, proposed a new architecture known as "bioclimatic architecture". Alongside this cultural current, a concern to preserve the good work of vernacular architecture tied to a specific territory or entity biogeography is consolidated all over Europe. It is worth noting the work of Javier Neila González, relating to environmental conditioning architectural techniques, which presents the invariants revealed by vernacular architecture as references for a good architectural design in each territory. These invariants vernacular architecture are reference passive design can be completed with actions proposed by the new bioclimatic architecture.

If we consider, according to Charles Redman, that culture is a tool that acts as an intermediary between human group and the environment, so that humans use tools or cultural systems to adapt to the environment, we can observe architecture as a cultural system that develops adaptation tools, showing crucial environmental information and tactics that have led man to successful adaptation to their environment.

The first step before starting the observation of these coping mechanisms is to find a large homogeneous territory but adjusted to the desired level of knowledge. Large tracts of homogeneous territory allow general solutions and small areas we provide detailed knowledge. The area of this study is the Eurasian Mediterranean ecosystem that goes far beyond the Mediterranean sea basin in the east to reach Afghanistan. Mediterranean ecosystems of the world are limited to five relatively small areas are in the southern and southwestern Australia, in central and southern California, reaching in the Mexican state of Baja California, in the center of Chile, in the coastal province of Western Cape in South Africa and in the surroundings of the Mediterranean Sea that extends from the east to the plateau of Iran.

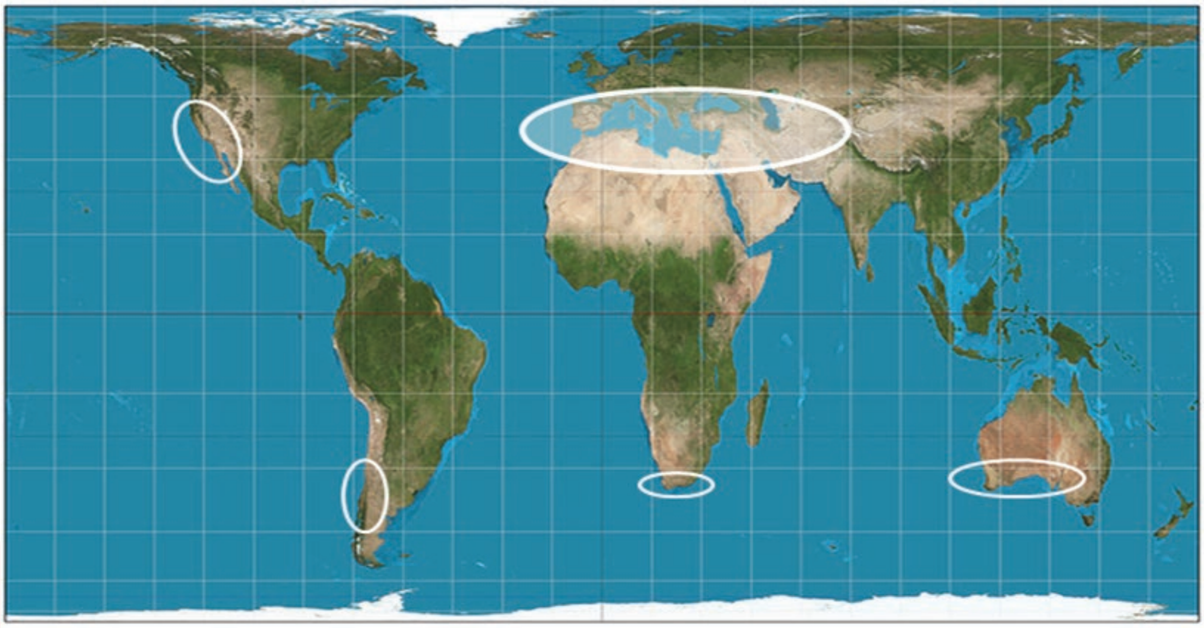


Figure 1 Mediterranean ecosystems. Source: Own elaboration map based on satellite image projection Peter.

They have a common climate, latitudinal situation around 35 ° N and S and a position in the west of the continents bordering their desert areas. These regions have similar landscapes but have been subjected to various processes of humanization. The Eurasian Mediterranean ecosystem is the cradle of Western civilization for millennia that welcomes human activities, while other regions have been populated only a few centuries ago showing a lower population density. Of the five Mediterranean ecosystems in the world, it offers the best documented set of cultural systems developed by the process of humanization, with more and diverse data, and has a large architectural heritage that presents new opportunities to study.

Figure 2 Mediterranean (red) and Temperate macrobioclimate (green). Source: own elaboration map.

The territorial area can be delimited by references or references bioclimatic biogeographic, however, the criteria for both disciplines were needed to define homogeneous areas of different widths that allow different levels of observation. Therefore, we have identified three biogeographic subregions macrobioclima included in the Mediterranean: the Irano-Turanic, dominated the cold deserts and steppes, the Saharian-Arabian, where are the hot deserts and the Mediterranean basin, the territory of the sclerophyllous.

Tetsurō Watsuji emphasizes the importance of environmental conditioning of human existence and teaches us to understand human existence and cultural history from the knowledge of the types of climate and landscape that are both paradigms of forms of history and culture.

Watsuji emphasizes the importance of environmental conditioning of human existence and teaches us to understand human existence and cultural history from the knowledge of the types of climate and landscape that are both paradigms of forms of history and culture. Watsuji think that the Mediterranean climate has a friendly nature compared to the nature of the Japanese climate, referring to the scarcity of torrential rain, the dry environment, weak wind and places in Italy the real cradle of European. he maintains that the separation between the humidity and heat shows the face of a happy nature, rational and submissive, where the Greeks learned to look to a nature nothing hidden, found it rational rule and fused with it; therefore the climate was manifested in the Greek spirit and Hellenistic culture emerged.

Figure 3 Warm desert area (red), the steppes and cold deserts area (brown) and sclerophyllous area (green). Source: own elaboration map

The last guideline to adjust the field of observation refers to the archaeological and built architectural heritage preserved. The contents of this paper are based on the observation of those who are part of domestic architectural culture lies in the spontaneous consciousness of the people, which remains selective knowledge of materials, basic construction techniques and associated lifestyles. The study of the heritage in an homogeneous environmental context helps us to understand the rationale and the origin of adaptive tools that have been developed through the history of the region.

The interaction between man and environment is a process that begins with the emergence of cultural systems, if we understand architecture as one of those systems that made possible the permanence of man in each territory, we can find information on adaptive tools that emerged despite and because of environmental limitations. These tools are specific actions or tactics facing towards environmental conditioning.

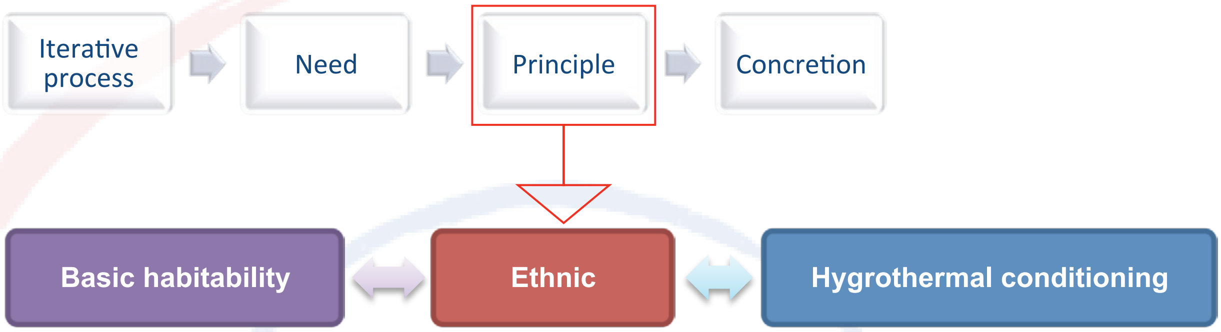
Environmental tactics of passive conditioning

The tactic is a specific action, a system or method that executes within an overall plan or strategy devised by man for a purpose.

The tactic helps tidy up resources and reduces the margin of error minimizing spontaneous actions. An environmental tactic is the concretion of an idea or method integrated into a bioclimatic strategy which aims to achieve wellness in buildings. Environmental tactics emerge to operate facing to bioclimatic aspects (the action of climatic factors and the availability of natural resources), to meet cultural aspects resulting from the way of life in each country, and even to improve indoor comfort in the buildings.

Environmental tactics and bioclimatic strategies present in domestic architecture are part of a spontaneous conceptual project, synthesis of Mediterranean culture and environment. We are facing an iterative process that begins when a need arise from an environmental constraint or a cultural aspect linked to a particular lifestyle. This need stimulated an idea or a principle that takes shape in a habit, a constructive system or an architectural element. The first achievements arise from basic habitability needs, once man has sedentary. Later, with the progress of civilizations emerge the need to adapt the spaces to societies organized in each territory, we can find information

The Mediterranean region was providing to the first architectural types that constitute the seed of all posterior architecture. Based on architecture that is already habitable and ethnic, hygrothermal conditioning systems are developed that contribute to greater interior comfort.



The basic habitability needs are those who seek to healthy living conditions inside the home, are the first to appear in the historical sequence. They materialize in tactics to protect against climate factors, to preserve or renew the indoor environments, for water supply and indoor natural light.

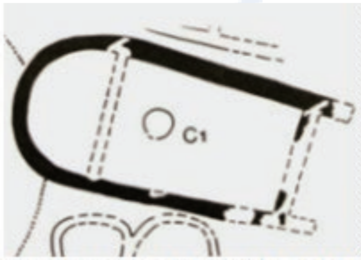
The ethnic needs are inherent in a human community or people with affinities in their way of life, social organization, in their family relationship in trade relations, in the technical capacity to manage natural resources, ... The ethnic tactics arise after the lifestyles had left their mark on the architectural culture and the human groups enjoyed dwellings with basic habitability and started to organize themselves into societies for historical significance. The dwellings are organized according to complex schemes, are zoned according to orientation, are related to form spontaneous or planned urban fabric and are used according to the comfort in the rooms. New specialized architectural types were born: palaces, forts, markets…

The hygrothermal conditioning needs are the last to show up in the historical sequence, the most complex, and its goal is improved the basic habitability. They are based on physical principles for heat transfer, so it requires complex technical and scientific knowledge. They arise into advanced civilizations that have developed systems of thought (mathematical, philosophical, physical) and scientific methods. The heat transfer processes are not isolated so they must be involved a combination of conduction and convection with radiation. The main goals are: to cool overheated indoor environments, to accumulate masses of fresh air and to heat in the coldest periods.

Below are the objectives or needs of hygrothermal conditioning, the idea or principle governing the concretion of this need and the description of specific tactics. Shows the evidence its historical and current presence.

HYGROTHERMAL CONDITIONING

GOAL Principle	TACTIC	Circunmediterranean area, sclerophyllous and hot deserts HISTORIC ATTACHMENT / CURRENT PRESENCE	Asian area, deserts and steppes domain HISTORIC ATTACHMENT / CURRENT PRESENCE
HEAT Convection	**Hearth**	The hearth or stove is a heat source, fixed or mobile, which can tempering a room housing. In the Asian area, the archaeological remain more antique is the hearth with smoke ventilation in bathrooms. in the Circunmediterránea area, the archaeological remain more antique is the opened hearth in the center of the meeting rooms.	
HEAT Solar radiation	**Mass built**	Solar radiation is a heat source known since ancient times. Building mass protects the solar radiation and the glass transforms into heat, tempering the space by the greenhouse effect. Although Mediterranean dwellings are facing courtyard and they close their facades to the street to protect, in the yards we see different levels of exposure to solar radiation. In many areas, courtyard facades are built with wood and glass lattice that capture solar radiation in winter benefit the greenhouse effect, and are protected in the summer by curtains, porches or iwans	



Fixed central hearth, 6500 BC, Lerna, Greece.

Fixed hearth, Fez. Morocco

Bathroom with hearth, s. XVIII BC; Tell Hariri, Syria. (Andre Parrot, 1958)

Stove, Iran. (Horne)

Tunisia

Isfahan

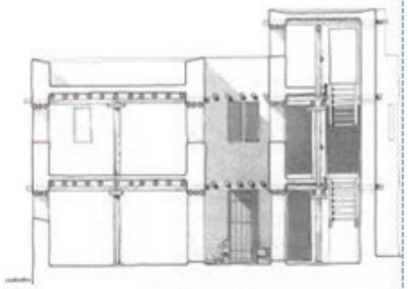
Shiraz

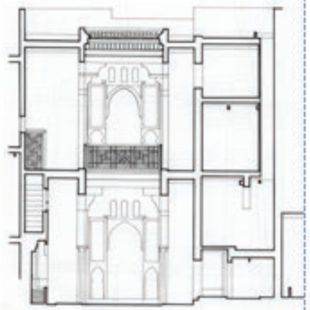
STORE ENERGY

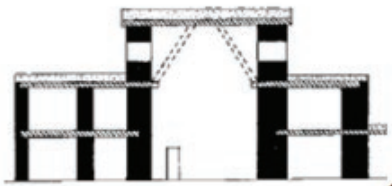
In mass

Mass built

The dwelling protects the external environment when charging its mass with the energy received from the environment, the sun and the ground, until the building mass exhausts its thermal capacity, from this moment it becomes energy emitter to the environment. The proper arrangement of thermal mass in the house, where it is necessary to accumulate cold or heat, is a sophisticated and complex system of passive conditioning of Mediterranean house. Sections of traditional dwelling shown how along history and in each area change the arrangement of the thermal mass. Overall, Mediterranean dwelling accumulates energy in the basement and ground floor walls, built of brick, adobe or stone. The upper floors and the courtyard facades have little thermal mass to accumulate energy, either by building materials, the facade design or the protection systems against solar radiation.


House, s. XIII BC, Ugarit, Syria. Hypothetical recreation

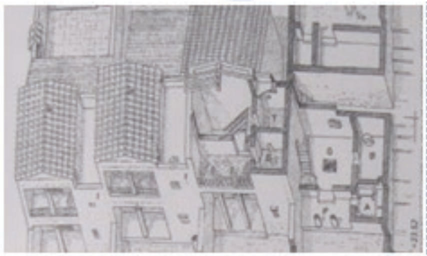

House, s XVII AC, Fez, Morocco


Hypothetical recreation of the palace of Mari, s. XVIII BC, Tell Hariri, Syria

Traditional house, Baghdad, Iraq.

Roof

The roof has little thermal mass and in some cases is ineffective to accumulate. The flat roof constructed with wood beam, mats and mud, and the sloping roof constructed with wood beam, air chamber, wood planks and tiles are resistant elements with little ability to store energy. By contrast, the domes and vaults built with adobe and stone provide mass to accumulate energy but due to its small thickness, are rapidly converted into heat emitters at night.


Greek house, s. V BC, Priene, Turkey.


Arizon house, s XIX AC, Cadiz, Spain.


Megaron elevation, s. X BC, Gordion, Turkey


House in Akcakent, Kırsehir, Turkey. Author: Birol

STORE ENERGY **Roof**
In mass


Roof plain, site of Cnossos, s XVII BC, Crete, Greece


Restoration work in Riad Laroussa roof, Fez, Morocco


Roof, 6700 BC, Catal Hüyük, Turkey


roof plain, Iran.


Alberobello, Italy


Harran, Syria


Compund Herat, Afghanistan

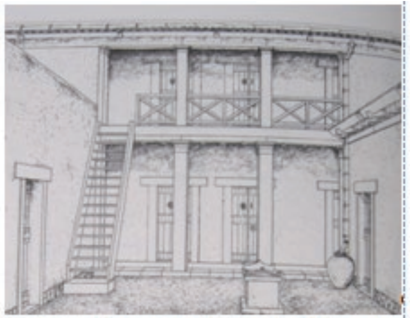

First vault radial. XII BC, site of Tell el Rimah, Iraq.


Tunisia


Nasiriya, Iraq


Seh Qaleh, Iran

STORE ENERGY In air	Courtyard	It is an uncovered indoor space where accumulate cool air. At night the building masses lose temperature by heat emission to the sky, the courtyard atmosphere is keeping cool during the day until the masses are reloaded by solar radiation and begin again to release heat to the environment. Environmental conditions vary depending on the size of the yard, the intended end use (domestic, industrial, social) and containing elements (vegetation, water, stoves).


Greece house, s V BC, Olinto.

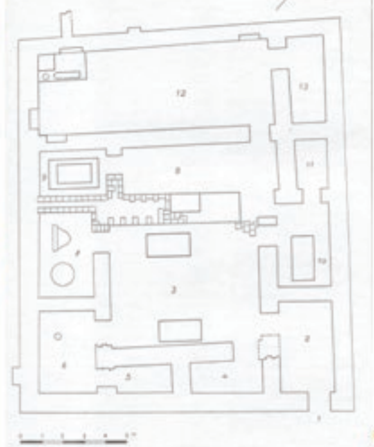

Roman house, Pompey , Italy

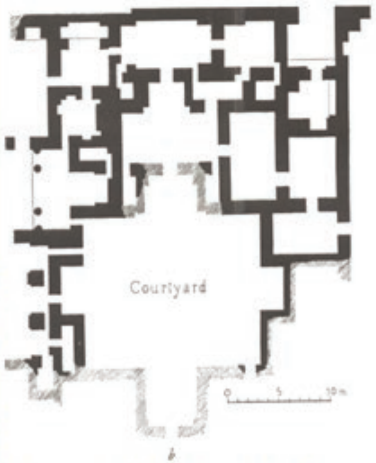

Roman house, Emporia, Spain.


House in Granada, Spain.


Riad in Fez, Morocco


House in Murcia, Spain


House, 3000 AC, Tello, Iraq.



House, s VI AC., Ctesiphon.


House in Iran


House in Isfahan, Iran


House in Nain, Iran

STORE ENERGY
In air

Basement Basements accumulate air mass to ground temperature. Most of the ground floor and the courtyard floor of the Persians houses are below street level. The underground floors are used in summer and higher floors in winter. The man makes internal migration by the house searching the best comfort conditions.

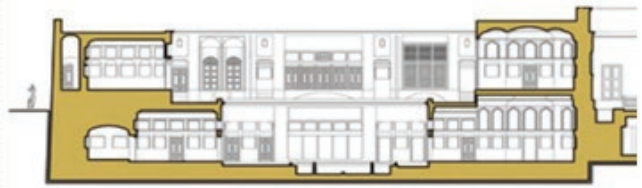

Roman house in Bulla Regia, Tunisia.

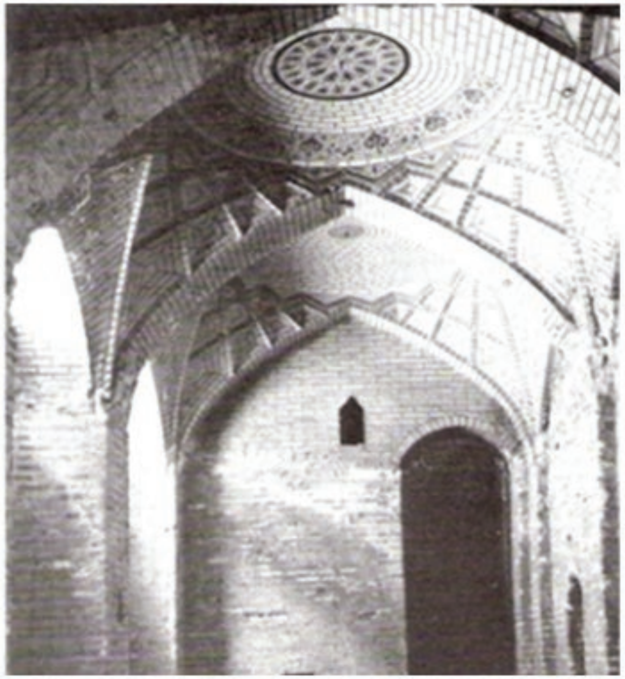

Secrets room, La Alhambra, Granada


Diocleciano palace, Split, Albani


House in Ghardaia, Alegria.


Arizon house, Cadiz, Spain.


Persian house Rasodian, Yazd, Iran. Source: Stamatina Th Rassia, Sustainable Environmental Design in Architecture: Impacts on Health


House in Bagdad, Iraq.

STORE ENERGY
In water

Reservoir

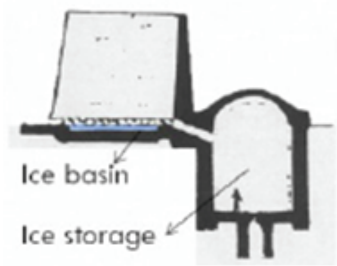
Ice is collected in winter taking advantage of the cold temperatures and it accumulates in underground reservoirs where it is kept for consumption in the summer season.

In Rome, in the third century AD, snow was imported from the mountains, stored in straw-covered pits, and sold from the snow shops.

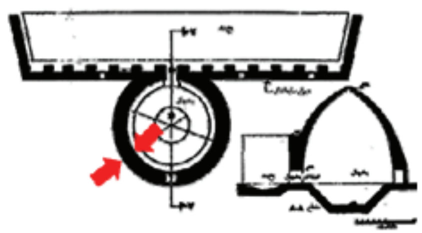
Underground icehouse, Malaga, Spain. Source: web sierranieves

Tradicional reservoir in Boboli gardens, Firenza, Italy. Source: M. Zandieh, I. Khaleghi, R. Rahgoshay

An inscription from 1700 BC in the northwest of Iran records the construction of icehouse



Source: M. Zandieh, I. Khaleghi, R. Rahgoshay



Icehouse Pākdasht, Iran

COOL
Radiation

Mass built

The built mass is filled with energy during the day by solar radiation and evening it begins to emit into the environment, they lose energy to reach room temperature. As a consequence of suffocating effect exerted by the emission of heat to the indoor environment at rooms, in the Eurasian area is customary to spend the summer nights outside on the deck or patio.

The vaulted roofs and domes are built with adobe or stone in areas with limited or no wood, it accumulates less heat during the day due to be less exposed and have more surface area for nocturnal radiation, this makes them more effective at cooling. The flat roof is constructed with wood and mats that form the support on which lies a layer of compacted clay, although they are more exposed to the sun, by its nature it accumulates little heat preferably acting as resistant elements to the heat transfer.

COOL Evaporation	**Water and ventilate**	There is an ancient natural conditioning system that catch the dry air in the roof of the building and leads it to a humid area (source, reservoir, well) for cooling, from there is flowing through the house until go out on roof or courtyard.
		 The Partal in La Alhambra, Granada, Spain  Windcatchers in Ghardaia, Algeria.  Courtyard house, Kashan, Iran  Rervoir with 6 win Shahdad, Iran,
COOL Convection	**Air from cool areas**	By the underground canals for water supply from natural sources to population, the fresh air also flows from the mountains and the highlands. This air keeps the temperature through the evaporation of water from the canal and arrives fresh to the supply points provided, dwellings or urban spaces. The ventilation system of the dwellings is connected to the water canal, where they get fresh air to cool the indoor environment.
	Night air	The cool night air cools the atmosphere, but this effect is hardly noticeable inside homes or in their surroundings, because the building mass is sending out heat. Flat roofs, courtyard and gardens are favorite spots for night rest.
	Air from reservoir	The fresh air that form in water reservoirs or icehouse can flow through underground canals to dwellings and urban spaces.
COOL Conduction	**Basement**	The basements are architectural elements in direct contact with the ground, which transmitted to ground ambient heat constantly, day and night, therefore constitute the most effective heat drain of buildings. The cool air mass that forms in the basement housing circulates by cross elements as the patio and stairs. Therefore, the ground provides environmental stability in the basement and in the whole house. In arid areas, the basement is used in the summer during the hottest hours of the day. Basements spontaneously arise in buildings built on slopes and in the empty space left by remove the construction material of the land where the home is located.

The courtyard is an original element of the Mediterranean architectural culture where we find relevant information on the interaction between man and his environment. It is both the manifestation artistic stand and environmental mechanism, therefore it is a cultural reservoir that reaches excellence by the presence of environmental tactics. Each courtyard has its own atmosphere, different and somewhat isolated from the outside, conditioned by its formal and material characteristics, the items it contains and the use to which it applies. These circumstances that operating in the atmosphere of the courtyard, properly managed, are tactics of passive conditioning which still endures thanks to its presence in spontaneous awareness of the Mediterranean peoples

The shape, size, proportion and treatment of the facades of the courtyard (gap-mass relationship, materials, size and shape of the gaps) are decisive for indoor environmental conditions and environmentally the most significant items are the protection devices, mobile or fixed, vegetation and water.

The Persian tradition shows a tendency to large courtyards of horizontal ratio, sunny, well ventilated, where is usually the presence of vegetation and ponds with fountains. It is a recreational space whose main function is to illuminate and ventilate the dwelling. The courtyard atmosphere varies during the day due to solar heating and night cooling. The courtyard facades oriented north-northwest are usually opaque and massive, with few and narrow gaps, resistant to heat transfer. The facades oriented south-southeast tend to be porous and light, less resistant to heat transfer, constructed with lattice of wood and glass that close rooms warm by the greenhouse effect, protected by porticoes or iwans that are very sunny indoor spaces in winter. The courtyard elements permit conditioning its environment and controlling its relation to indoor environments, therefore constitute tactics of passive conditioning.

As example, show a typology of Persian house located in the city of Shiraz, southwest Iran, to 1,486 m above sea level on a plateau at the foot of the Zagros Mountains. The earliest reference to the city dates from 550 BC, was an administrative center in Sassanid period, was occupied by the Arabs in 641 AC and now is the economic center of southern Iran

Figure 4, Figure 5. The courtyard facades of a house in Shiraz.

Figure 6, Figure 7. The courtyard facades of a house in Shiraz.

The Moroccan tradition shows a tendency to small courtyards of vertical ratio, rather shadowy, less ventilated, it has usually water source in a wall and lacks of vegetation. The courtyard is the main room, the heart of the house, a estancial, family and social space, around which is organized the other rooms of the house and cross the internal circulations. It is by far, the largest room, better lit and ventilated the house. The other rooms of the house are illuminated through the courtyard but, due to its pronounced verticality, its small area and low solar radiation received, are shadowy. The courtyard facades are usually opaque, often protected by porticoes or galleries of circulation, with a door and a small gap over it than just illuminate and ventilate the room.

Overall the courtyard surfaces remain protected of solar radiation especially in winter when they accumulate little heat at day and cool down faster at night, the courtyard atmosphere is cold and you need to set fireplaces or stoves in some rooms. During the summer, although the courtyard is sunnier, its atmosphere is kept cool during the day and the rooms are dark. The ability to intervene in the courtyard atmosphere is limited and also the possibility to adapt indoor environments to seasonal weather conditions.

As example shows two traditional courtyards Fez, located in the neighborhood of the Qayrawanies. The city of Fez was founded in 789 AD, in an area with plenty of water and forest resources, occupying a strategic position at the crossroads of major land routes. Their culture is marked by the arrival, in 818 AD, of migrants from the southern suburb of Cordoba (Spain) and from Kairouan (Tunisia) that formed two populations with different traditions in walled neighborhoods and separated by a stream. The Art of Al Andalus confronts with that which comes from the Fatimid East. The neighborhood of Qayrawanies will become the heart of the medina and relegated to the background to the Andalusia city. The unification of the two cities, by the first Almoravid emir made it the s. XII in a large metropolis.

Figure 8, 9, 10 Riad Dar Bensouda, s. XVII AD, Fez, Morocco

Figure 11, 12, 13 Riad Dar Bouanania, Fez, Morocco

Both cities were born and prospered under the political action of the Arab caliphates, but in a background of different populations, Berber origin in Fez and Persian origin in Shiraz. Both have dwellings with the Mesopotamian cultural imprint, where is born the house around courtyard as basic type of domestic architecture. The Achaemenid Persian tribes contacted Mesopotamian civilization in the 9th century B.C., when they were settled in northern Iran near Lake Urmia and tributary to the Assyrians. In Fez, the Berbers learned about a Eastern civilization with the arrival of migrants from Fatimids in the 9th century A.C.

The environment of both cities is homogenized by xeric Mediterranean bioclimate, semi-arid with a ombrotype similar but different continentality index which means an annual amplitude of temperature higher in Shiraz (28,6ºC a 6,1ºC) than in Fez (26ºC a 10ºC). The absolute values of temperatures have substantial differences, in Fez it exceeds in summer 40 º C and in Shiraz it falls in winter below 0 ° C. The Fez environment is warmer than Shiraz.

Both houses are the basic type of courtyard house of Mesopotamian origin; in their courtyards look different artistic traditions and environmental knowledge. Both courtyards accumulate heat by the solar radiation and they cool at night but the atmosphere quality of the courtyard is different in each case. The Persian courtyard atmosphere varies throughout the day and throughout the year; its design integrates mechanisms or tactics that allow us to intervene in their environment and in their relationship with the indoor environment of the rooms. By contrast, the courtyard atmosphere of the house of Fez is more stable, integrated tactics on it allow us limited participation in its atmosphere and the relationship with the indoor atmosphere of the rooms. Overall it is a cool and shady house throughout the year and fireplaces or stoves are used to heat the rooms in the coldest periods.

Conclusions

The tactics along with environmental strategies present in the Mediterranean domestic architecture are part of a cultural heritage resulting from the interaction between man and the Mediterranean environment. TThe presence of specific tactics hygrothermal conditioning on the architectural heritage is documented since ancient times and have endured for millennia in some territories. Both conditions, longevity and permanence, give them firmness and sufficient validity be considered the basis for a sustainable and efficient cultural system. Despite the fact that the same tactics have spread throughout the region, for reasons of culture, or by the bioclimate, have been consolidated into various environmental strategies that maintain comparable levels of welfare.

Heat the built space is easy with the implementation of fireplaces and stoves, but advantage of greenhouse warming requires precise technical and environmental knowledge. The large rooms with wooden latticework and glass are very efficient in winter thanks to the sun radiation but must be used correctly in the Mediterranean summer season. Store energy has been possible through the use of the building mass, the confined air in spaces built and the water reservoir; basements and courtyard are the specific tactics that take an essential role in achieving this goal. But the use and effective management of this energy also require precise technical and environmental knowledge. To cool indoor environments there are simple tactics that act by controlling sources of cold, variations in humidity and wind catchment, and other more complex that lead the masses of fresh air from natural sources to the cities. Its proper use requires knowledge of the principles of natural cooling.

The architectural culture of the Mediterranean region has an unique set of specific tactics for heating, energy accumulation and hygrothermal conditioning with high efficiency and sustainable for its minimal environmental impact. But it is important that this culture is present in the consciousness of the peoples inhabiting the region, since the use of architectural tactics requires technical knowledge or habit behavioral at the inhabitant of the house. The lack of knowledge about the environment and architectural tactics prevents man from appreciate the integrated environmental strategies in buildings. The disuse of the tactics in areas where long ago was appreciated, not due to a functional or environmental reason, but rather to a loss of cultural and technical knowledge during periods of devastation, caused by internal and external conflicts that have devastated the Mediterranean region. This lack of architectural culture becomes an inability of disadvantaged groups in the region to meet the needs of natural conditioning in the dwelling.

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Optimization of Ca-Based Sorbents for Acidic Gases Removal Produced by Municipal Solid Waste Combustion

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Abstract

Acidic gases (mainly hydrochloric acid, HCl; and sulphur dioxide, SO2) are the common pollutants released from the incineration of municipal solid waste (MSW). To meet the stiffening emission limits on incineration process, the dry scrubbing process is now widely accepted as one of the preferred methods for treating acidic gases.
This work focuses on the optimization of a Ca-based sorbent (Ca(OH)2) for acidic gases. The effects of the pellet size, the concentration of acidic gases as well as the addition of fly ash were studied. Sorbents before and after reaction were characterized by using the X-ray diffraction (XRD) to identify the solid species.
Together with different particle sizes (100 up to 425 mm), it was found that only internal kinetic phenomena are of importance. External transport processes can be considered as infinitely fast.
It was observed that the behavior of HCl and SO2 is completely different. While SO2 removal can really be described by a shrinking core model, the reaction of HCl is much more complex, and influences the diffusivity of the SO2. This was observed by adapting the HCl/SO2 ratios.
Furthermore, fly ash was investigated as sorbent or additive for acidic gases removal. Fly ash itself showed very low activity for HCl and SO2 removal. However, when it was added as additive to Ca(OH)2, the removal efficiencies of Ca(OH)2 for HCl and SO2 were enhanced dramatically. More experiments will be carried out to further investigate this improvement.
The systematic experimental study in this work helps us to better understand the reaction network between the Ca(OH)2 sorbent and the acid gases in flue gas cleaning process. A mathematical model for the combined removal is under development, both for the industrial entrained flow reactor as for the lab packed bed set up.

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Introduction

The increasing amount of municipal solid waste (MSW) is a global environmental problem. Incineration of MSW (MSWI) is a common technique to treat waste because it takes up less space in comparison to landfill and can also generate electricity. It does pollute the environment due to the formation of pollutants such as acidic gases, particulates, heavy metals, dioxins etc. Acidic gases (mainly hydrochloric acid, HCl; and sulphur dioxide, SO_2) are the harmful gases released from MSWI. To meet the high demands on the emission limits of the incineration process, various emission control technologies have been developed, such as wet scrubbing, semi-wet scrubbing and dry scrubbing. The dry scrubbing process is widely used for removing acidic gases from incineration/combustion processes because there is no discharge of wastewater and a high acid gas removal rate (Golesworthy, 1997C; Stein et al., 2002).

Fly ash, generated during the incineration of municipal solid waste, is an industrial by-product which is also recognized as an environmental pollutant. In recent years, the recycling and reuse of MSWI fly ash has become a main issue because of the limited availability of landfill space. MSWI fly ash still contains high levels of alkali chlorides (mainly NaCl, KCl and $CaCl_2$), heavy metals, dioxins, and soluble metal salts (Ahmaruzzaman, 2010). Therefore, MSWI fly ash needs to be treated before recycling. The main usage of fly ash after treatment is for the production of construction materials, but this has a very low reuse rate. In the present work, fly ash samples generated from MSWI process were tested to investigate the possible improvement of the removal efficiency for acid gases by using fly ash either as sorbent or as additive to $Ca(OH)_2$ sorbent.

This paper presents the results obtained from a lab scale set-up using $Ca(OH)_2$ as the sorbent for the removal of the harmful acidic gases. The effects of the pellet size, the concentration of acidic gases as well as the addition of fly ash to $Ca(OH)_2$ were studied. Sorbents before and after reaction were characterized by using the XRD to identify the solid species.

Experimental

Material

$Ca(OH)_2$ is a dry powder obtained by treating quicklime with sufficient water to satisfy its chemical affinity for water, thereby converting the oxides to hydroxides. In the present work, two $Ca(OH)_2$ sorbents (provided by Sigma-Aldrich, CAS 1305-62-0 and Lhoist) were used to compare their acidic gases removal efficiency. The reagent grade lime supplied by Sigma-Aldrich was used in the early stage for checking and adapting the homemade lab setup performance. A comparison between the results obtained from the two sorbents showed similar removal activities. In order to compare with the industrial plant tests, the Lhoist industrial $Ca(OH)_2$ was used to perform the extensive lab tests to investigate the influence of variables on the sorbent removal capacity. Table 1 lists the chemical and physical properties of the Lhoist industrial $Ca(OH)_2$.

Table 1: Chemical and physical properties of Lhoist industrial $Ca(OH)_2$.

Chemical characterisitics of $Ca(OH)_2$ sorbent	
Chemical compositions	Weight (%)
$Ca(OH)_2$	96.0
$CaCO_3$	1.82
SiO_2	0.95
MgO	0.42
Al_2O_3	0.18
Fe_2O_3	0.12

Physical characterisitics of $Ca(OH)_2$ sorbent	
Density (g/cm³ at 25°C)	2.24
Mean particle size (µm)	2-3
Specific surface area (m²/g)	16-18.5

The surface area and reactivity of this material were gradually decreased by exposure to air. Therefore, the fresh hydrated lime was stored in a nitrogen glove box to avoid any contact with air and retain reactivity.

Lab scale setup
A flow diagram is given below (see Figure 1) showing all components of the lab scale setup which are numbered accordingly.

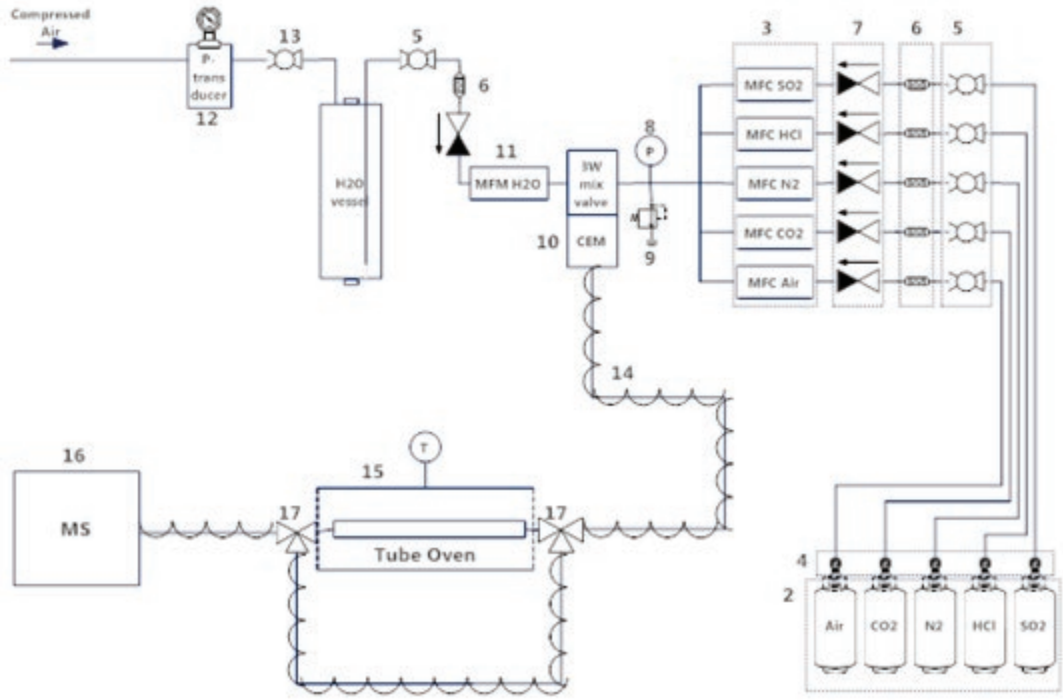

Figure 1: Flow diagram of the experimental lab setup.

In order to simulate the real fuel gas composition, different gas bottles[2] (N_2, CO_2, Air or O_2, 1% SO_2 in N_2 and 1% HCl in N_2) are supplied from Air Product NV. These bottles are then connected to five mass flow controllers[3] (MFCs, Bronkhorst Hi-Tec) preceded by a pressure transducer[4] (on top of the gas bottle), a ball valve[5], a filter[6] and a non-return-valve[7]. The outlets of the MFCs are guided into single tube with the use of T-connectors, after which the gas mixture passes a 4-way connector equipped with both a pressure transmitter[8] and a pressure relief valve[9]. The mixture passes the gas inlet of the three-way mixing control valve (TMCV) on top of the "controlled evaporation mixer"[10] (CEM) where the gas will be moistened with water controlled by a mass flow meter[11] (MFM) for liquid. The water is supplied to the TMCV on top of the CEM by using a house made pressurized water vessel, which is set at the desired pressure using compressed air and a pressure transducer[12] equipped with a ball valve[13]. In the CEM, the temperature is elevated to 134°C to assure water is evaporated. Afterwards, the moistened gas stream passes through heated stainless steel tubing (by means of a heating ribbon[14]) to avoid condensation of the water and to pre-heat the gas mixture, into the quartz tube with the prepared lime sample in the furnace[15] or into the bypass (depending on the position of the 3-way valve[17]). Once past the second 3-way valve, the gas stream enters the mass spectrometer[16] where its composition is analyzed.

The lab scale setup can be basically divided into three sections: a gas mixing system, a tubular furnace containing the quartz reactor tube, and a quadrupole mass spectrometer (MS) for gas analysis. The gas mixing system is composed of MFCs for N_2, CO_2, Air or O_2, SO_2/N_2 and HCl/N_2). Beside this, water can be added up to 18 vol%, using the CEM. The simulated inlet gas contains a HCl concentration of 200 ppm to 1000 ppm, a SO_2 concentration of 100 ppm to 1000 ppm, 8% CO_2 8% O_2, a H_2O content of 0 to 16% and N_2 balance.

In lab scale, a packed bed reactor is used in order to test the removal of acid gases out of a flue gas mixture with $Ca(OH)_2$ as sorbent (Figure 2, lower picture). This reactor is made up of a quartz tube (high purity SiO_2), with a certain amount of $Ca(OH)_2$ pressed between 2 pieces of quartz wool to avoid potential displacement of $Ca(OH)_2$ due to the pressure of the flue gas mixture through reactor tube. The tube is placed inside a cylindrical furnace (Figure 2, upper picture) as to have a homogeneous distribution of the temperature.

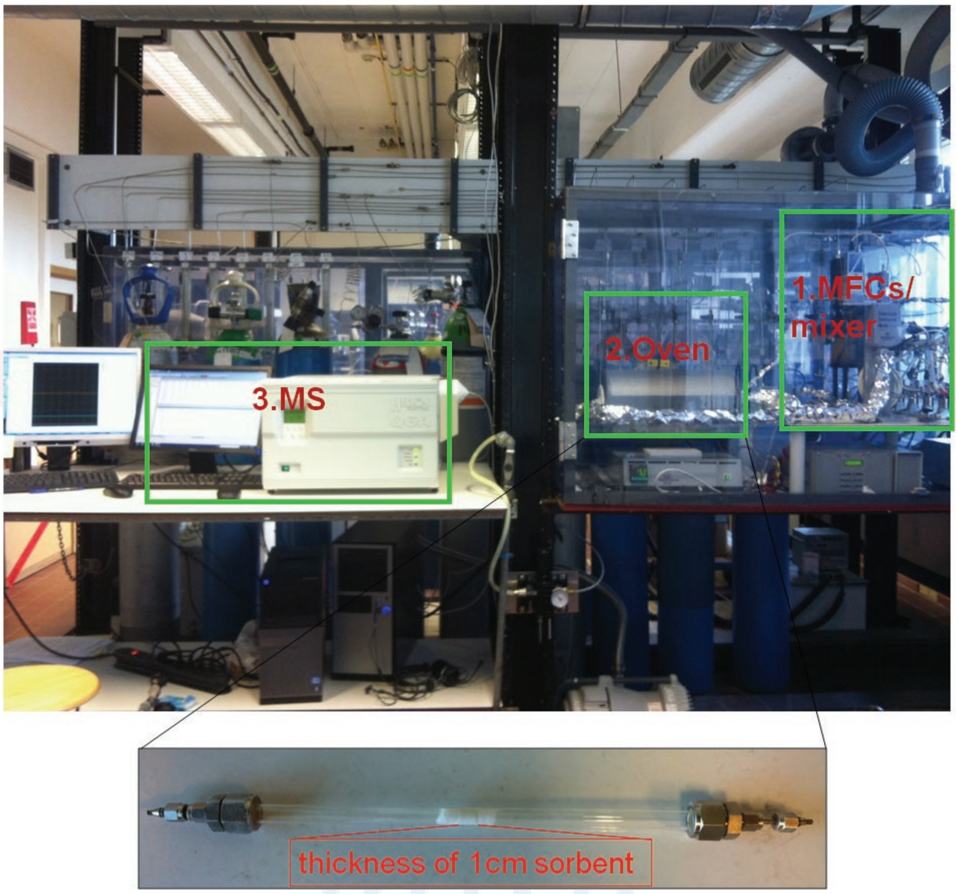

Figure 2: Lab scale setup and a close-up of the packed bed reactor.

Operation parameters
Extensive lab scale experiments were carried out with similar gas conditions as derived from the MSWI process. Table 2 shows the typical flue gas compositions during lab experiments.

Table 2: Simulated gas conditions during lab experiments.

Simulated flue gas compositions during lab experiments	
N_2 (Nml/min)	balance
O_2 (Nml/min)	4
CO_2 (Nml/min)	4
HCl concentration (ppm)	0-1000
SO_2 concentration (ppm)	0-1000
Humidity (%)	0-16
Total (Nml/min)	50

In this work, operating parameters were varied depending on the different research purposes.
The varying parameters are:
- Pellet size (100-160μm and 250-400μm);
- HCl and SO_2 concentrations;
- Fly ash as additive (0.1g, 0;3g and 0.9g).

MS analysis
The mass spectrometer (MS) (Hiden Analytical's QGA Bench-top Gas Analysis System) (see Figure 2 (upper), point 3), equipped with Hiden Analytical's MASsoft 7 PC software provides an instant view on the variation of the concentrations of all components in the simulated flue gas on a ppm level. MASsoft 7 can provide accurate quantitative analysis by automated calibration routines and automatic subtraction of spectral overlaps. The MS-constant is slightly adjusted to account for temperature, pressure and systematic errors on a daily basis in order to keep the detected gas mixture concentration with the desired concentration. A 2 meter sampling heated capillary inlet was connected to exit of gas stream from the lab scale setup. The MS can analysis up to 200 amu mass with fast data acquisition. It is possible to immediately export the data to a Microsoft Excel file to plot the recorded data.

X-ray diffraction
The crystalline minerals present in the solid residues were identified by X-ray powder diffraction (XRD) using a nickel-filtered Cu-Kα radiation (λ = 1.5406 Å) in a Siemens D5000 apparatus (Brüker), and the computer programs Diffrac Plus and Topaz V2.0. The XRD data were recorded in the 2θ-range 10-60° at a scan speed of 0.08° min^{-1}. Lattice parameters were refined using a least-squares technique.

Breakthrough curve
When running an experiment, a certain phenomenon occurs, which is characterized by three (to four) different areas: (the initial rate of absorption[1]), the change in rate of absorption[2], the breakthrough[3] and the saturation of the sorbent[4] (Figure 3).

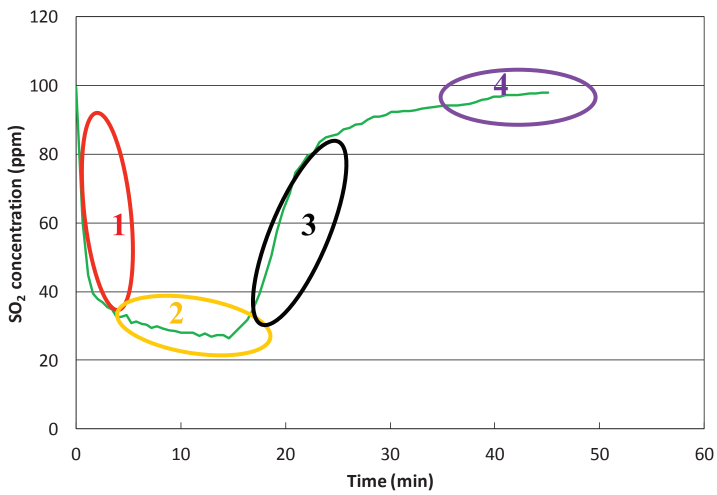

Figure 3: Example of breakthrough curve.

Results
Pellet size
Some researchers demonstrated that lime with smaller particle diameters and higher surface areas were found to be more reactive for acidic gases removal (Davini et al., 1996; Yan et al., 2003; Lee et al., 2005).

In order to elucidate the role of pellet size in HCl and SO_2 capture in the present work, sorbents with different pellet sizes were sieved from Lhiost fresh hydrated lime, in the ranges of 100-160µm and 250-400µm. The typical operation conditions are 8 vol%

CO_2, 8 vol% O_2, 500ppm HCl, 100ppm SO_2 and N_2 as balance at a flow rate of 50Nml/min and a temperature of 150°C with 0.1g $Ca(OH)_2$ sorbent.

Figure 4 and 5 show the desulfurization and dechlorination activity as a function of the pellet size of the $Ca(OH)_2$ sorbent in the absence and the presence of 12% H_2O. In the absence of H_2O, it is obvious that the smaller the pellet size, the better the sorbent removal efficiencies. In the presence of 12% H_2O, the influence of pellet size on HCl removal is more significant than on SO_2 removal. Hence, it demonstrated that pellet size can drastically influence the sorbent removal efficiency for HCl and SO_2. So with different pellet sizes (100 up to 400 mm), it was found that only internal kinetic phenomena are of importance, external transport processes can be considered as infinite fast.

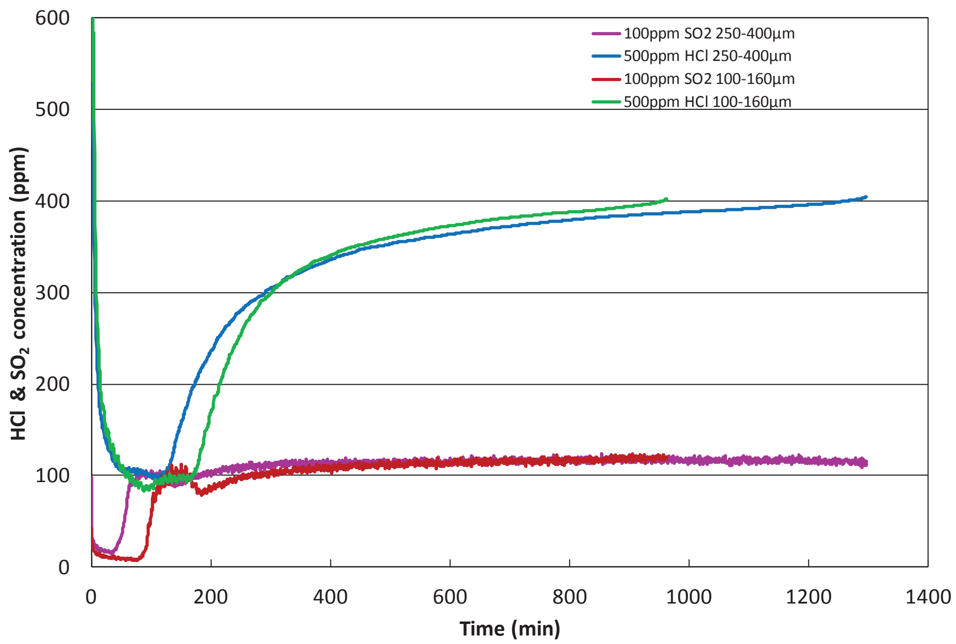

Figure 4: Effect of pellet sizes on the desulfurization and dechlorination activity of $Ca(OH)_2$. Operation conditions: 0.1g $Ca(OH)_2$, 150°C, 100ppm SO_2, 500ppm HCl, 8% O_2, 8% CO_2, 0% H_2O, flow rate of 50Nml/min.

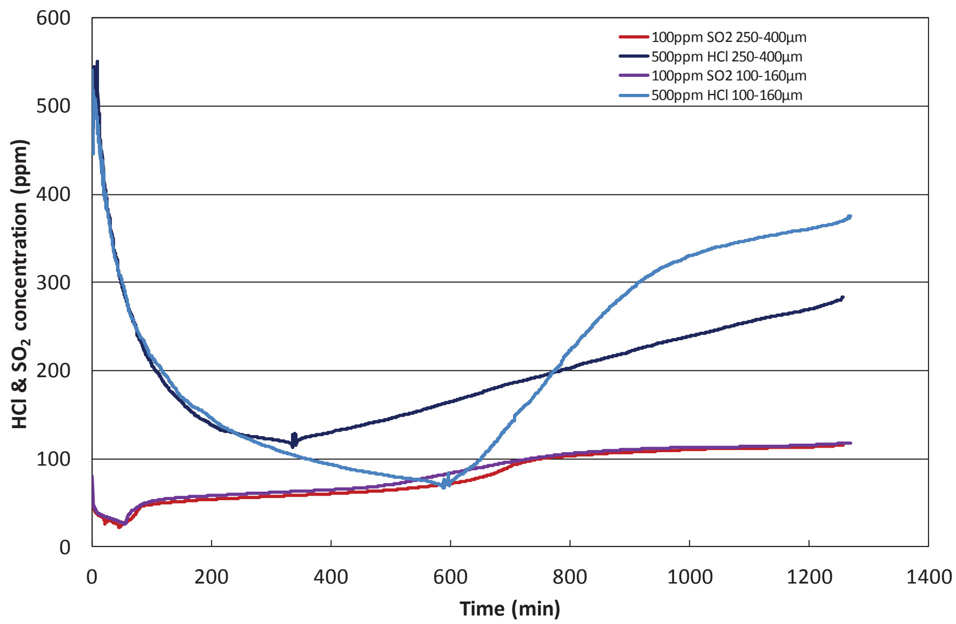

Figure 5: Effect of pellet sizes on the desulfurization and dechlorination activity of $Ca(OH)_2$. Operation conditions: 0.1g $Ca(OH)_2$, 150°C, 100ppm SO_2, 500ppm HCl, 8% O_2, 8% CO_2, 12% H_2O.

HCl and SO_2 concentrations

<u>500ppm HCl as constant</u>

A series of experiments were carried out at typical conditions (8% CO_2, 8% O_2, 200ppm SO_2, 12% H_2O at 150°C, 0.1g $Ca(OH)_2$). The HCl concentration was kept constant at 500ppm, and the SO_2 concentration was changed from 100ppm to 1000ppm.

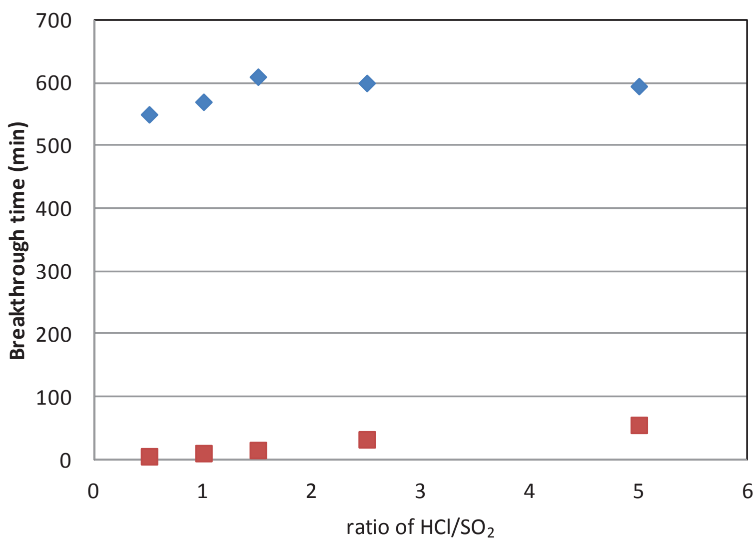

Figure 6: Effect of HCl/SO_2 ratio on the breakthrough times of HCl (◊) and SO_2 (■). Operation conditions: 0.1g $Ca(OH)_2$, 150°C, 100ppm-1000ppm SO_2, 500ppm HCl, 8% O_2, 8% CO_2, 0% H_2O, flow rate of 50Nml/min.

Figure 6 indicates that with the increase of SO_2 concentration from 100ppm to 1000ppm (ratio from 5 down to 0.5), the breakthrough time of HCl is not affected accordingly. This leads to conclude that there is sufficient sorbent available for HCl removal, even when the amount of SO_2 to be simultaneously removed is very high. At higher HCl/SO_2 ratio (1.5, 2.5 and 5), the HCl breakthrough times are also quite similar. Only in the case of extremely high SO_2 content (500ppm or 1000ppm), a slight competition between HCl and SO_2 to react with sorbent can be witnessed.

200ppm SO_2 as constant

A set of temperature tests is carried out at typical conditions (8% CO_2, 8% O_2, 200ppm SO_2, 12% H_2O at 150°C, 0.1g $Ca(OH)_2$). The SO_2 concentration was kept constant at 200ppm, and the HCl concentration was changed from 200ppm to 800ppm.

There is no clear effect of HCl/SO_2 ratio on SO_2 breakthrough time because it is only surface reaction between SO_2 and $Ca(OH)_2$ sorbent, which is fast (in a range of 20-30mins). The effect of HCl/SO_2 ratio on HCl breakthrough time is obvious, Figure 7 shows the higher the HCl/SO_2 ratio is, the shorter the breakthrough time.

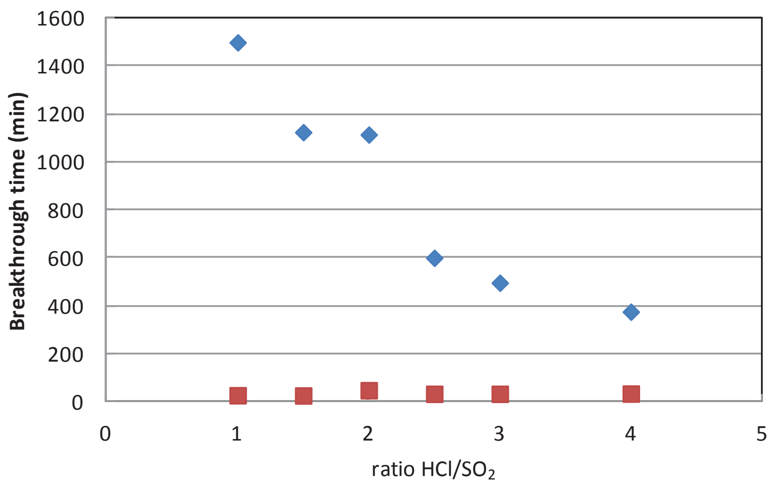

Figure 7: Effect HCl/SO_2 ratio on the breakthrough times of HCl (◊) and SO_2 (). Operation conditions: 0.1g $Ca(OH)_2$, 150°C, 200ppm SO_2, 200-800ppm HCl, 8% O_2, 8% CO_2, 12% H_2O, flow rate of 50Nml/min.

Fly Ash

Three tests were carried out at typical conditions (8% CO_2, 8% O_2, 12%H_2O, 500ppm HCl, 100ppm SO_2 and N_2 as balance at a flow rate of 50Nml/min and at 150°C). Different sorbents (0.1g $Ca(OH)_2$, 0.9g fly ash, 0.1g $Ca(OH)_2$/0.9g fly ash) were used to demonstrate the role of fly ash in sorbent. Figure 8 shows that fly ash has low intrinsic activity to meet the stiffen emission limits for acid gases. It can also be seen from Figure 8 that when adding fly ash as additive, the activity of fly ash promoted $Ca(OH)_2$ sorbent is enhanced drastically. For example, when 0.9 g fly ash is used as additive to 0.1g $Ca(OH)_2$, the HCl and SO_2 breakthrough times are 3000mins and 2600mins, respectively. In comparison with $Ca(OH)_2$ activity, it is obvious that the addition of fly ash can dramatically improve the $Ca(OH)_2$ removal efficiencies for HCl and SO_2. Hence, this might be a new approach to increase the fly ash reuse rate in the MSWI process.

Table 3: Different sorbents (0.9g fly ash, 0.1g $Ca(OH)_2$, 0.1g $Ca(OH)_2$/0.9g fly ash) activities for HCl and SO_2 removal. Operation conditions: 150°C, 100ppm SO_2, 500ppm HCl, 8% O_2, 8% CO_2, 12% H_2O, flow rate of 50Nml/min.

Sample	HCl breakthrough time (min)	SO_2 breakthrough time (min)	HCl conversion (%)	SO_2 conversion (%)
0.9g fly ash	195	145	42	76
0.1g $Ca(OH)_2$	595	50	70	76
0.1g $Ca(OH)_2$/ 0.9g fly ash	3015	2560	95	97

XRD results

Prior to reaction, a fresh fly ash sample was measured by XRD. The tested fly ash sample (0.9g) was under typical conditions: 500ppm HCl, 100ppm SO_2, 8% CO_2 8% O_2, 12% H_2O and N_2 balance, at 150°C and at a flow rate of 50Nml/min. It is found that fresh fly ash is a very complex mixture. It contains 41.24% NaCl, 20.62% KCl, 9.86% aluminate of calcium, 9.22% $(K, Na)_3Na(SO4)_2$, and other trace compounds (Table 4). After reaction, it is clear that the major changes of fly ash compositions are KCl and NaCl.

Table 4: Fly ash compositions.

Component	fresh fly ash (%)	tested fly ash (%)
C3A Na orthorhombic	9.86	9.12
Calcite	2.79	5.04
Halite (NaCl)	41.24	39.42
Portlandite	0.05	0.35
Sylvite (KCl)	20.62	17.92
Anhydrite	7.96	6.85
Periclase	0.65	0.54
Aphthitalite	9.22	11.93
Bassanite	6.76	6.58

The composition of the fly ash might lead to the improvement of hydrated lime sorbent activity when fly ash is added. A further test in industrial plant is needed to investigate the stability of fly ash promoted hydrated lime.

Conclusion

In this work, the effects of pellet size, acid gas concentration and addition of fly ash have been investigated extensively. When the pellet size is decreased, the removal efficiency is increased for both HCl and SO_2. It is found that only internal kinetic phenomena are of importance, external transport processes can be considered as infinite fast.

It was observed that the behavior of HCl and SO_2 is completely different. While SO_2 removal can really be described by a shrinking core model, the reaction of HCl is much more complex, and influences the diffusivity of the SO_2. This was observed by adapting the HCl/SO_2 ratios.

Fly ash itself has a low intrinsic activity for HCl and SO_2 removal. When fly ash was added as sorbent additive, the acid gases removal efficiency can be improved extensively. This opens up possibilities for an increased fly ash reuse.

The XRD results showed that fly ash is a very complex mixture, with NaCl and KCl making up the largest part. The presence of NaCl and KCl in fly ash may be the explanation of why fly ash enhances $Ca(OH)_2$ activity so dramatically.

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Energy Retrofitting in Architectural Heritage, Possible Risks Due to the Missing of a Specific Legislative and Methodological Protocol

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1. Introduction

After the first EPBD entered into force, administrations have shown an increased interest in interventions aimed to obtain energy saving in existing buildings: Energy Retrofit (ER). Within an ER in architectural heritage is necessary to undertake completely different operations in some aspects from the same interventions carried out in contemporary existing buildings.
However the current interventions often include criteria that is totally inapplicable on historic buildings, even when being fully compliant to the energy saving aims. This is because the regulations concerning preservation of architectural heritage and rational use of energy are not linked to each other, and because within European standards a protocol for ER and the definition of its feasibility within historical and heritage buildings is still missing.
Moreover, the scientific and legislative heterogeneities are leading to increase differences in awareness and in historical building protection across the EU Countries. Far from the concept of European Architectural Heritage developed during the Granada conference.
This paper discusses the rise of critical issues due to the absence of a systematic methodology for energy retrofits in historical buildings

2. Architectural heritage sustainable development before the EPBD

Although the minimum energy requirements for new and existing buildings were formally introduced by CE.91.2002 in 2002, the environmental improvement of European existing and heritage buildings stock was already discussed before that time. From 1985 until 2001 five conferences of ministers for heritage preservation and management were held with the aim of rethinking the European heritage in a sustainable perspective.
The first conference of Ministers for heritage and monuments in Brussels (1969) has to be considered the starting point for the matter. In this conference, the concept of cooperation at legislative level in order to allow a BH[1] sustainable development was widely debated by Ministers. Unanimously the importance in integrating the preservation policies within "*the framework of a general policy for town and country planning, in particular by means of permanent co-operation at all levels between the authorities responsible for the protection of the cultural heritage of monuments and sites, on the one hand, and for town and country planning, on the other"* was highlighted [1].
Previously the issue of integrating building protection in town planning policies had already been debated during the conference of Amsterdam [2] in 1975 and later on in Granada during the Convention for protection of the architectural heritage of Europe (1985) [3]; In Granada the cooperation between town planners, developers and conservationists[2] was seen as a fundamental factor towards the economic and sustainable development. In order to achieve combined preservation for architectural heritage and environment, during the Helsinki conference in 1996, a "*joint protection in the context of an international ecological approach to spatial management"*[3] was

[1] BH, Building Heritage
[2] Resolution 2. B, on the promotion of the cultural heritage in socio-cultural life and as a factor in the quality of life, pp 31-32; Second European Conference of Ministers responsible for the Architecture Heritage; Granada 1985
[3] Final decision D, *The cultural heritage in the process of sustainable development*; pp 45; Fourth European Conference of Ministers responsible for the Cultural Heritage, Helsinki 1996

strongly solicited as well as "co-ordinate policies for heritage conservation and spatial planning".
According to the Helsinki convention, the establishment of an European strategy for heritage management in the frame of sustainable development, had to be based on public-private practices aimed not only at architectonic preservation[4], but at a whole "*building stock life cycles to assess the environmental impact of rehabilitation of old buildings compared to buildings constructed according to modern production methods".*[5] This approach, during the Hanover conference (2000), was introduced in a more complex urban ecosystem management based on optimizing water, energy and waste [6] [4].
The novelties in these conferences and specifically in Granada were strongly related to the heritage significance itself. The meaning formulated in 1982 during the World Conference on Cultural Policies in Mexico City [5], was extended not only to the single monuments, but to groups of building and sites when peculiarly interesting. Furthermore the fittings and fixtures embedded into the buildings themselves had to be protected, at transnational level, as part of a unique European heritage[7].
Since across the European countries, the heritage buildings inventory process is (still now) different or ongoing [6], the Granada Convention has prudently extended the level of building protection also to "not yet" protected buildings.
The conferences held from 1969 through to 2001, raised awareness in considering a sustainable perspective for heritage buildings.
But the above described developed insights, weren't effectively translated within the first EPBD[8] CE.91.2002. The technical problems related to the energy retrofitting feasibility within a historic context were almost neglected or generally derogated[9].
In 2005, during the Faro convention solutions to overcome this detachment were proposed [7], and once again in 2010 when the CE.31.2010 was published, the initial weak points regarding the matter had still not been updated.
After eleven years from the first European directive on energy and after seventeen years from the pioneering conference in Helsinki, technical standards or specifications to clarify the heritage buildings' position on their potential sustainable development have not yet been published by European Commission.

3. Risks for energy retrofit in historical buildings; eventual lack of building protection

After the EPBD publication, several discussions about how a historical building might be considered energetically performing and eventually how to intervene on it, have developed [8].
Despite derogations for officially protected buildings quoted in art 4 CE.91.2002 and in its recast, these interventions, are also rising in regards to historical fabrics. According to a recent study made by Building Performance Institute of Europe,

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[4] Since"not only conservation of the past is at stake"; in Enhancing and protecting natural resource and natural heritage; Principles of planning policies for sustainable development in Europe; pp 9-10; Guiding principles for sustainable development of the European continent; Cemat 2000
5 Resolution 2, on the cultural heritage as a factor of sustainable development, pp 48-49; Fourth European Conference of Ministers responsible for the Cultural Heritage, Helsinki 1996
[6] Spatial development measures for different type of European regions-Urban areas, pp 12- 13; in Guiding Principles for sustainable spatial development on the European continent, Hanover 2000
[7] Art 1, Definition of Architectural Heritage, pp 2; ETS 121, Convention for the protection of the architectural heritage of Europe, Granada 1985
[8] EPBD, Energy Performance Building Directives
[9] Art 4.3; CE.91.2002; Art 4.2.a; CE.31.2010

"minor and moderate interventions might be performed also in case of heritage buildings"[10] in order to achieve Energy and CO_2 reduction by 2050 [9]. If on one hand the energy retrofitting in existing buildings is considered challenging because of the significant opportunities for reducing primary energy consumptions, then on the other hand the problem in linking energy improvement to building protection arises when the intervention is carried out in historical buildings [10] [11] [12].
The abovementioned art 4 states that the EU members might avoid interventions for: "*buildings officially protected as part of a designated environment (1) or because of their special architectural or historical merit, in so far as compliance with certain minimum energy performance requirements would unacceptably alter their character or appearance (2)".* Two specific discussion points of this article are discussed.

3.1 Officially protected buildings (1)

The first discussion point refers to the potential risk of threats for historical buildings when those are not already officially protected.
This point was already discussed during the Granada conference. In the recommendations, the building protection was extended also to buildings for which: "*the protection procedures have been instituted*"[11] when proposals for their altering have been planned. Therefore not only officially protected buildings might be exonerated from alterations. This preventive approach was in compliance with the assumption for which it is not allowable, in a given historic building, a certain alteration if its potential heritage is still not agreed upon.
This fundamental concept has been neglected within both the EPB directives which allow derogation only for already listed buildings[12]. The risk in implementing this policy is high, not for monuments themselves, but for minor Architecture [13], for those historical buildings, not yet protected, that make up a large part of European historical centers.
This discussion point becomes even more alarming by considering the heritage inventory in a continuing process as it was discussed during the Council of Europe in the conference "Architecture Heritage: Inventory and documentation methods in Europe" (Nantes 1992).
"*The process of collecting is never finished since a collection is never finished, therefore we should endeavor in the compilation of inventories to ensure the perpetuity of knowledge of the heritage along with the perpetuity of the heritage itself*" [13] [14]. In the fourth article, another critical point might be further discussed.

3.2 Unacceptable alteration (2)

The other discussion point is related to the expression quoted in the article as *unacceptable alteration.* Which kind of materials or interventions might be considered detrimental for the building itself? Who and which instruments are capable

[10] "*these buildings (Heritage) are not excluded (from the energy renovations) because there will always be some energy efficiency measures that can be applied, even if it is not a total renovation. Minor and moderate measures may often be feasible in the case of heritage buildings*"; in Determining the practical limit for the renovation of the EU building stock; pp 106; Building Performance Institute of Europe, Europe' s buildings under the microscope; 2011
[11] Art 4.2.a; Statutory protection buildings, pp 3; ETS 121, Convention for the protection of the architectural heritage of Europe, Granada 1985
12 A part from derogations regarding the building function: worship and religious activities; Art 4.2.b CE.31.2010
[13] Paragraph 7.1, Coherence of the Inventory, pp 45; The inventory as a continuing process; in Guidance on Inventory and documentation of the cultural heritage; 2010

of defending the unacceptable alteration due to the energy retrofits interventions in historical buildings?

Despite the big amount of CEN standards aimed at providing methodologies for energy performance calculation in new and existing buildings [15], no standards or methodologies have been delivered in order to clarify the allowable retrofitting methodologies for historical buildings or to define the intervention boundaries (allowed materials, allowed techniques) [16].

Although there is a wide range of available technologies for energy retrofit in existing buildings, [17] a large part of these solutions cannot be applied if preservation issues have to be considered [18] [19] [20] [10].

During the years, several efforts have been made to provide common buildings classification systems. The Core data Index[14] [14] for historical buildings assessment and PTA[15] (Preliminary Technical Assessment) [21] for presenting methodological guidelines for technical activities were developed to ensure approach standardization across the European countries; But often, the approach to the building analysis or to the intervention evaluation, is delegated to local protocols.

This condition gives incentive to the deep consciousness of the local *patrimonium* by the local Bodies on one hand, but it might lead to a different elasticity in the intervention evaluation on the other hand. If no shared EU methodologies aimed at evaluating the level of tolerance are provided, we can run the risk of judging differently each retrofit strategy: more acceptable in one country as opposed to another.

Image 3.2.1 Building in Antwerp 2013

14 In Nantes the - Core data index - for European historic buildings inventorying was proposed in order to provide a common and upgradable tool for building listing. It was proposed at art 14 of Granada conference. The recommendation on the co-ordination of documentation method and systems related to historic buildings and monuments of architectural heritage was adopted by the Committee of Ministers of the Council of Europe on 11 January 1995; Appendix 1

15 PTA, Preliminary Technical Assessment was developed within the frame of the EU joint program on the integrated rehabilitation project plan/survey on the architectural and archeological heritage; IRPP/SAAH 2010

4 Indoor thermal quality: energy consumption and preservation issues

Since energy consumption is directly affected by indoor thermal conditions, in EN 15251 is discussed the fundamentality in assessing the ITQ[16] as part of the building energy classification and labelling: "*An energy declaration without a declaration related to the indoor environment makes no sense*"[17]. [22] Indoor thermal conditions and users' satisfaction have a direct implication on energy demand [23].
It is well known that traditional buildings were designed on a basis of an eco-systemic interaction between indoor and outdoor environments in order to adjust, mostly by passive solutions, internal thermal conditions [18] [24]. Because of their permeable system, the strong relation out-indoor is rather unavoidable even though the building has been equipped with HVAC system. [25] Therefore, during the design process, the ITQ and people satisfaction should be evaluated on the basis of a adaptive approach. [26][27]
The aforementioned out-indoor interaction is much higher in historical buildings than it is in contemporary ones, indeed a correlation up to 60% was found between internal and external physical indexes in historical buildings compared to 10% of correlation in modern ones. [28]
Historical buildings often include fixtures, fittings and works of art such as frescoes, plasters or paintings. Within the Granada Convention, the level of protection was extended also to them as being part of a unique architectural heritage, according to Art 1.1[18].
Hence, since the indoor conditions affect directly the human [29] and works of art well-being [25], when energy retrofits are planned for historical buildings, it becomes essential to take into account energy performance against their indoor climate. Human discomfort and art crafts physical deterioration are correlated to indoor climate.

4.1 In situ monitoring as multi objective assessment

By performing onsite monitoring campaigns in historical buildings, it is possible to acquire information capable of describing more accurately the building thermodynamic behavior and the state of materials conservation, evidencing possible relations between occurred deteriorations and unsuitable thermal conditions for building materials or works of art. [30] [31]
Short or long term assessments[19] might be helpful for building modeling and simulations but also for strategies selection. Furthermore it is possible to analyze:

- preliminary retrofitting scenarios based on their real technical feasibility
- indoor comfort for users and optimal thermal conditions for preserving works of art (minimum and maximum physical indexes fluctuations)
- building materials deterioration and potential influence on building thermal proprieties (moisture content, discontinuities)

16 ITQ, Indoor Thermal Quality as specific part of Indoor Air Quality (IAQ) and Indoor Environmental Quality IEQ
17 EN 15251; Introduction; the standard refers to the Energy Performance Certificate (EPC) foreseen by the EPBD
18 - For the purpose of this Convention, the expression "architectural heritage" shall be considered to comprise the following, permanent proprieties: 1) monuments: all buildings and structures of conspicuous (historic, architectural…) interest including their fixtures and fittings- ; Definition of Architectural heritage, pp 2; Second European Conference of Ministers responsible for the Architecture Heritage; Granada 1985
19 Depending on to the aims and the technical and economical feasibility of the monitoring campaign

- accurate energy modeling (model calibration)

For an accurate building envelope behavior modeling, the material deterioration should not be neglected. For instance, the thermal transmittance value is strongly correlated to the material water content [32] [33]. Dynamic effect of moisture flow through the material layers are, normally, not taken into account during the calculations[20] [34] even though it might change the overall thermal proprieties of the building component(s). Only by performing instrumental analysis (infrared analysis, sonic analysis etc) on the building envelope it is possible to recognize potential weaknesses and adjust the simulations by considering the measured thermal characteristics. [35]
Furthermore, a higher accuracy on the retrofitting scenarios can be obtained if the baseline simulated model has been calibrated on experimental investigations [36] [37].

5 Materials for energy efficiency in historical buildings: compatibility, reversibility and sustainability.

In the Council of Europe held in February 2011, the need was stressed for reducing primary energy use in order to be on track with the aims of 20% of primary energy use and CO2 reduction up to 2020 [38]. The challenging aims agreed by the June 2010 European Council, increased the scientific and market interest in working on the existing buildings[21].
Among the energy retrofitting strategies, the building envelope improvement is one of the commonest intervention proposed by professionals also for historical buildings in order to reduce energy demand, improving ITQ for users, minimizes temperature and relative humidity fluctuations allowing optimal conditions for material conservation [36]. But even though the intervention, as a whole, might be considered adequate for its energy saving achievements, in a long term it might reveal harmful due to the used materials.
Each retrofit material is, often, chosen on the basis of its high thermal performance and low cost characteristics.
Is common to find, even in historical buildings, synthetic insulation panels wrapping traditional brick masonries or insulation foams filling the gaps between masonries and internal layers in order to improve thermal and air tightness properties. It's even possible to find new super insulating moldings replacing previous plaster or stone moldings to solve the thermal bridge. (see image 5.1)

[20] Measured U-values might be introduced within the energy simulation to get a more accurate building baseline
[21] Buildings account for 40 % of total energy consumption in the Union; paragraph 3; 2010.31.EU

Image 5. 1, Building envelope insulation; Details; Building in Antwerp 2013

Since studies aimed to assess the risks on traditional materials due to this implementation of the strategies are still missing, several technical guidelines suggest to use natural insulation materials to allow moisture transpiration and absorption. [10] [39] [18]
In historical buildings the material selection based on ensuring mechanical, physical and chemical compatibility between original and retrofitting materials should be preferred.

5.1 Reversibility and Sustainability

The energy retrofit growth in Europe has preceded the growth of a theory aimed at clarifying the potentials of the intervention itself. A big deal for researchers and professionals is to provide a methodology while the interventions across the EU countries are increasing.
One of the most stringent questions is related to the intervention in its long term evaluation. How the intervention should be considered in the entire building life span? Should it be seen as a temporary or a definitive solution?
Once again the building typology evaluation is fundamental. If in existing buildings the intervention might be designed for a complete building renovation, in historical buildings minor or moderate interventions should be preferred [9].
Furthermore the intervention strategies should be weighted also on their potential reversibility since "*our ability to judge the long term impact of change on the*

significance of a place is limited. Interventions may not perform as expected. It is therefore desirable that changes, for example those to improve the energy efficiency in historic buildings are capable of being reversed"[22]. [10]

By following the above mentioned strategy, the historical buildings retrofit has to be designed on the basis of a sustainable development perspective not only on a "energy saving" approach. This means that the retrofit strategies themselves have to be considered under their entire environmental cost (LCA) taking into account the life cycle energy use.

6 Conclusions

The Energy efficiency in historic buildings is an extremely sensitive issue. However in the current state of art it is possible to highlight the lack of a specific protocol aimed at providing *well balanced* solutions for the energy efficiency improvement in historical buildings. The detachment between building preservation and energy improvement may be found even in some EPC showed in historical public buildings. Window replacement, roof or wall insulation, are often suggested in the documents without taking into account the architectural limitations.

When historical or heritage buildings are involved, the energy saving has to be seen as one of the several parameters to take into account for a conscious environmental improvement. The indoor comfort ameliorating needs to be weighted on the optimal climate conditions for materials conservation; the retrofit materials choice has to be considered on its physical, chemical and mechanical compatibility with existing materials; the retrofitting technologies have to be weighted on their reversibility or less invasiveness, considering the whole environmental impact of each solution.

Furthermore the entire building retrofit should be weighted on the basis of a multi criteria approach, considering the meaning of sustainable development as it was seen by the Brundtland Commission in 1987[23] [40]: "meeting the needs of present generations without jeopardizing the ability of future generations to meet their own needs". Threaten our architectural heritage just to save few Kwh/m² y makes no sense.

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The Earth And Ice-pits Sustainable Architecture In Iran

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Abstract

Many architects hold the view that Iranian traditional architecture has proved to be successful in creating innovative and sustainable architecture especially in hot-arid parts of the country. Among those architectures, an ice-pit or Yakh-chal is a clear-cut example. An ice-house (or *a Yakh-chal* literally meaning "ice-pit", *Yakh* meaning ice and *Chal* meaning pit) is a reservoir to store and preserve ice. To preserve ice for a long period of time, the earth as a good thermal insulation has been chosen. On the other hand, recent researchers have identified earth-sheltered or underground architecture as an innovative design for reducing and saving energy. The paper goes through the many benefits of earth which encourage us to build such buildings in special places. The way the earth works with the surrounding environment to fulfill our needs is another issue discussed in this paper. The paper aims at evaluating Ice-pits' sustainability, regarding all the factors which are influential in its sustainability, and suggests using their features in modern architecture and in proportion to today's technology. This research includes literature review, observation and site visits to achieve a practical solution.

The study shows that during the whole process of making and preserving ice, there was no need to consume any kind of energy but manpower. Thus from technical point of view, they were quite beneficial. They were made of mud bricks which are a good material for saving energy in deserts. Ice-pits actually addressed people's expectations, and can be considered as a source of inspiration for the next generation of architects.

Keywords: Ice-pits, sustainable architecture, earth, energy, saving

1. Introduction

More than one-third of the earth's land surface (about 36%) is considered arid or semi-arid and is found mainly between 15° and 35° north and south of the equator[3]. In general, the hot-arid zone is where the greatest amount of solar radiation is encountered. The climate is stressful with extremely high temperatures, dust-laden winds, and intense radiation together with ground reflection. The diurnal range of air temperature is large and can be as high as 17 ◦C or more [3]. Among the many types of desert climate, there is one where the use of earth-sheltered construction is thought to be most suitable; the very hot and dry climate found in some parts of Iran. Indeed, Iranian architects did find earth-sheltered construction very convenient in hot-arid parts of Iran, providing comfort for the users. Among those constructions, ice-pits (Yakh-chal) have been considered in this paper. In the first place, the basic principles of earth as a sustainable source have been discussed in order to find out it's features. In the next stage, Ice-pits are introduced as an earth-sheltered construction, using the earth's features. Finally sustainability is considered in ice-pits according to the existing sustainability factors. The paper aims at introducing the earth as a sustainable source and ice-pits as a traditional sustainable architecture.

2. Earth-sheltered or underground structures

Recent research has identified earth-sheltered or underground structures as one type of innovative design as an alternative to conventional aboveground buildings for reducing total energy requirements as well as peak load demands[3]. This new but in a way very ancient type of architecture requires no new technology. No scientific breakthroughs are necessary to enjoy the advantages that exist in subterranean structures [3].

1.2. Basic principles for energy-saving through earth sheltering

Here are some basic principles for energy-saving through earth sheltering. These energy-saving principles are incorporated in most energy-conserving earth-sheltered buildings including ice-pits. Although earth is a poor insulating material, it can insulate effectively because it is massive enough. The fact that heat loss must flow vast distances makes earth a suitable blanket in which to wrap a building [2]. In fact, the soil enclosing an underground building reduces the heat transfer from its surroundings [3]. Earth sheltered buildings are mostly protected from the direct solar radiation [1] which is very crucial in hot-arid parts of Iran. The temperature of the earth just a few meters below the surface is stable in the 5-15°C range all year long [2] and is subjected to smaller temperature fluctuations than surface building. Even at very shallow depths, the ground temperature seldom reaches the outdoor air temperatures in the heat of a summer day [3]. In fact, when the weather is extremely hot, the earth provides a source of cooling. In essence, the earth moderates the environment in which the building is located [2]. Earth sheltering also reduces the infiltrated outside air. With the earth covering most of the envelope of a building, the building can be made more airtight [2]. In surface structures, up to 35% of heat loss can often be attributed to air infiltration. An earth-sheltered building offers greater opportunity to control the rate of outside air supply to the interior of a building [2]. All these principles have been adopted by Ice-pits.

2.2. Earth-sheltered structures in Iran

To provide cold water in hot-arid parts of Iran, two kinds of buildings were constructed but with the same approach, Ab-anbar (water reservoir) and Yakh-chal (Ice-pits) which both rely on earth to a large extent. An ab-anbar is a traditional reservoir of drinking water and its storage was built under ground to withstand the pressure the water exerts on the containers of the storage tank [4]. But the most important reason for which Ab-anbar was built underground has been overlooked and it is the power of earth. Since much research has been done on ab-anbar, we preferred to study Yakh-chal or Ice-pits.

3. Ice-pits in Iran

1.3. Definition

An ice-house (or *a Yakh-chal* in Persian literally meaning “ice-pit”, *Yakh* meaning ice and *Chal* meaning pit) is a reservoir to store and preserve ice [5]. Ice repositories in Iran were public and free charge, so all people could use ice in hot-arid parts of Iran. Architectural elements are discussed in the following:

2.3. Architectural elements

TABLE 1. shows the architectural elements of Ice-pits

The Shading Wall	The Provision Pool	The Ice Reservoir
The shading wall was a long mud wall standing to the south of the ice-making channel, casting shadow on the shallow ice making channel and stretches from the east to the west. The height of this wall might be up to nearly 10 m. The Wall prevented the sun's radiation from shining on the frozen water in the front pond [5]. The shading wall was beneficial because the temperature difference between the sun-lit and the shaded area in these areas is about 15-20 degrees.	This pool was located north of the wall and its water was provided from the rivers (streams) and subterranean. Square in shape, the channel was approximately 100m.x10 m with a depth of about 40-50 cm [5]. This pool was used for preparing ice during cold winter nights. At nights, the temperature is low and water can freeze more quickly. Coldness of winter takes the heat of water away at night and consequently the ice is formed. When they were completely frozen, they were broken [6] and transferred to the main structure which was the southern pitfall.	These reservoirs were usually located behind the shading wall. The Ice was preserved in an underground well. Three kinds of Ice-pits were prevalent in Iran that will be described in the following [5].

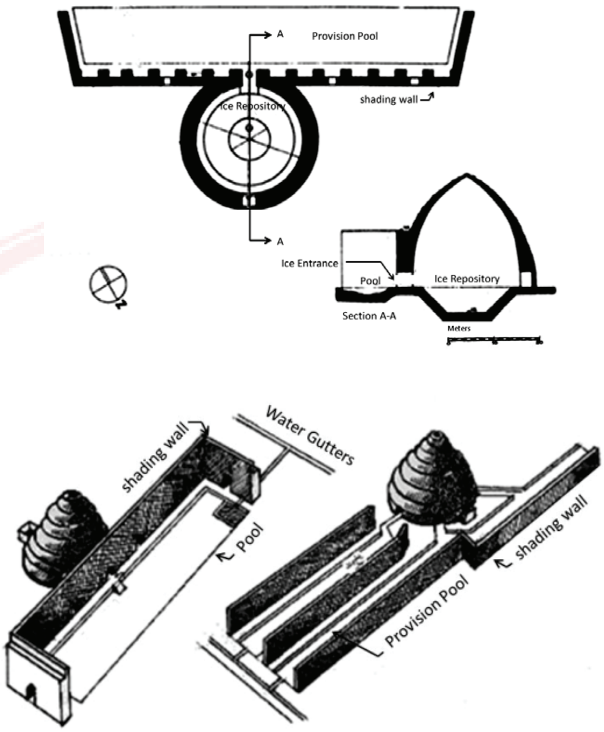

Fig 1. Left, Meibod Ice-pit in Yazd, this structure with a height of 15m is one of the tallest ice-pits in the city. Right, shading walls in the examples from Yazd [5].

Fig 2. Domed Ice-pits in Meibod and Abarku, Yazd, http://graphic.ir, http://dadaryha.com, [5]

Fig 3. An ice-pit in Kashan, Dome, hatch and ice reservoir are shown, photos by Korsavi.

3.3. Different kinds of Ice-pits

TABLE 2. shows different kinds of Ice-pits

Domed Ice-pit	**An underground Ice-pit**	**Roofless Ice-pits**
In north-eastern regions and the central desert, there was a big brick dome above an almost great pit. The pit was surrounded by a dome whose thickness diminishes from beneath to the top to provide more endurance and stability [5]. This also reduced the construction costs as less material and labor forces were employed.	Another type of ice-pit was made in north central parts of Iran and It worked like domed ice-pit, but its shape was different. A large part of this ice-pit was under the ground and its thick walls were made of cements and stone[6].	The third kind of Ice-pit called "Roofless Yakhchal", was without roof. It consisted of just two main parts, the shading wall and the pools in front of it. The provision pools were regarded as the storage for the ice in these ice-pits [5].

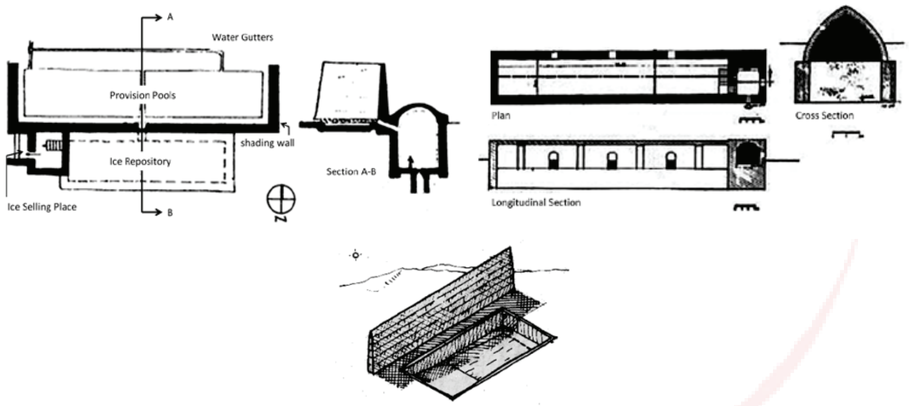

Fig 4. Left and middle show underground ice-pits. Right shows a kind of roofless ice-pit[5].

4.3. How do Ice-pits work

Generally all the principles mentioned for saving energy through earth sheltering could be adopted by Ice-pits. These principles are effective insulation, heat transfer reduction, solar radiation protection, temperature stability, smaller temperature fluctuations, moderating the environment, reduction of infiltrated outside air. Moreover, rather cold and fresh air could enter through the hatch that was placed by the shading wall. Indeed, the air came from a shaded area which was at least 10-15 degrees colder than sun-lit area so the exhausted air went up and existed from a hole on the top of the dome. Actually, cold air replaced warm air and ventilation could took place more efficiently when domes were exposed to sun radiations. Fig 5 clearly shows different parts of a domed ice-pit and their function.

1. The area in which the Ice is prepared, consisting the ponds and the shading walls[5].

2. The ice reservoir where pieces of wood and straw are used between layers of ice to prevent them from sticking to each other.

3. A well at the bottom of the reservoir is placed to vacate the melted ice.

4. The exhausted air exists through the hole.

5. Thick Masonry dome with its external thatched envelope plays an important role to prevent thermal conductivity[5].

6. According to the principles mentioned, the container has winter's temperature during hot seasons.

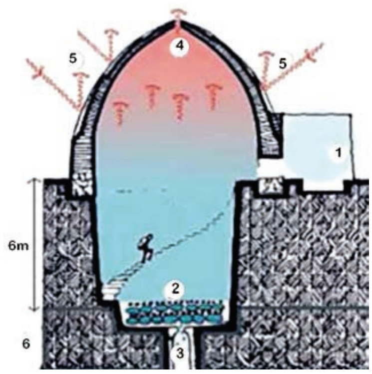

Fig 5. shows general section of the reservoir of a domed ice-pit, [5].

4. Discussion

This paper examines Iranian traditional ice-pits which coexisted with the nature. This kind of architecture was mostly derived from climatic conditions. These buildings provided the context for more comfort in harsh and severe climatic conditions. These buildings were quite advantageous to all of the people therefore during ice making period, most of the people collaborated to make ice, suggesting a common alliance in community thanks to such an architecture. Ice-pits have not only addressed the environmental aspects of sustainability, but also the social and economic aspects. To illustrate, Table 3 is presented.

TABLE 3. considers ice-pits in terms of sustainability factors

Sustainability factors		**Sustainability in ice- pits**	**Reference**
Environmental	Regional Priority	They were exactly in proportion to the regional and climatic features.	LEED Factors
	Innovation in Design	Their form, structure and the way the they used the power of earth all indicate that they were innovative designs.	
	Materials & Resources	The ice-pits' materials were local and had endurance and stability. In fact, Masonry dome with a large thickness and its external thatched envelope prevented thermal conductivity.	
Economic	Energy& Atmosphere	Cooling Ice-pits consumed no energy and its construction was economic thanks to local materials and people's collaboration.	LEED Factors
Social	social justice (equal opportunity and the achievement of all human rights)	Ice-pits were not the exclusive privilege of a special group and every one could use ice.	[7, 9]
	Solidarity (empathy, cooperation, and associational life)	People collaborated to construct ice-pits, break and transfer ice to the pit. They actually formed a society trying for the same reason and every one played a meaningful part. After working continuously for producing ice, people gathered and celebrated their success.	[7]
	participation (opportunities for everyone to play a meaningful part in development)		[7, 9]

5. Suggestions

Industrial refrigerators are the most important reason for which Ice-pits were left unused. Although the application of the Ice-pits may not seem reasonable these days, their benefits should not be overlooked. A lot of merits can be seen in these buildings which are worth considering. The meaningful form, using local materials, using earth features, structural stability, natural ventilation, respecting users and adopting the right strategy toward fulfilling users' needs all can be attributed to a successful architecture. Surely these benefits can be adopted by the next generation of architects in different buildings and constructions. As Hadi Mimiran was inspired by the form of ice-pits and designed a sport complex in Rafsanjan, Iran similar to a domed ice-pit.

Fig 5. shows a sport complex in Rafsanjan by Hadi Mimiran

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Towards a Sustainable Housing in Palestine

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Abstract

There is probably one thing that we can all agree on: the world's known fossil fuel reserves are limited. During the last decades, the extensive use of fossil fuels has had adverse effects on the environment. Problems of global warming, climate change, and pollution are the adverse effects we are facing today. This problem is more pronounced in countries that have limited natural resources and high population density such as Palestine. Thus, it is essential in such countries to promote the concept of sustainability in all aspects of life. One vital sector that needs this promotion is housing, which forms most of the Palestinian built environment. This paper discusses the concept of sustainable housing and its potential in Palestine. This potential has been analysed using SWOT analysis, and considering the comprehensive concept of sustainability. The study concluded that there are great challenges that face the Palestinian housing sectors in terms of sustainability. However, there are several key advantages that create opportunities. In this regard, solar energy is of great importance as it could be effectively used for electricity generation and domestic water heating. In addition, rainwater can also be collected and used to partially fulfil the domestic water demand.

Keywords: Sustainability, housing, solar energy, rainwater collection, green materials, Palestine.

Towards a Sustainable Housing in Palestine

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1. Introduction

The comprehensive concept of sustainability is presented in the well-known Brundtland definition. This definition is adopted by the UN Environment Commission in 1987, and states that sustainable development is "development that meets the needs of the present without compromising the ability of future generation to meet their own needs" (WCED, 1987). There are many concepts related to sustainability in this definition. One of them is the comprehensive perspective of sustainability, which includes socioeconomic, environmental, ecological, and technical aspects. These aspects can be clearly reflected in the construction sector and all of its subsectors.

In this regard, it is estimated that 50% of all resources consumed across the planet are used in construction, making it the least sustainable energy in the world (Battle & McCarthy, 2001). As population of the world increases, dependence on the conventional energy resources is no longer enough. Therefore, there is a real responsibility on architects and engineers to implement the concept of sustainability in construction.

Housing is one of the most important subsectors of construction. Implementing sustainability in housing has two dimensions: the social one and the spatial one. Thus, sustainable housing may be defined as "housing that creates sustainable communities in a resource-efficient manner" (Edwards & Hyett, 2002). This means that sustainable housing can't be presented purely as a low energy design. The efficient use of resources, such as water and energy, should harmonize with the spatial and social requirements needed to create adequate housing environment. This means that residents have to adopt a "sustainable" style of life. They have to promote social accountability and accommodate their life habits to serve the cause of sustainability.

On the other hand, resource efficiency in housing means the wise use of energy, water, land, materials and human labour. This can be achieved through several strategies. This includes the use of passive design techniques and renewable technologies to reduce energy consumption without compromising human comfort, and water management by harvesting rainwater and recycling and reuse of grey water. In addition, the wise use of space is an essential tool in order to reduce building materials and consequently construction cost. These strategies also include waste management by converting waste to bio fuel, and protection of ecology and enhancement of biodiversity.

2. Sustainability in the Palestinian Housing Sector

Palestine, or the Palestinian Territories, is located in the Middle East. It consists of two parts: the northern governorates, known as the West Bank, and the southern ones, known as Gaza Strip. An overall look at the Palestinian construction sector and its subsectors, including housing, shows a great absence of the main concepts and measures of implementing sustainability. This can be related to several reasons including the lack of public awareness, shortage of funds, political instability, and the absence of effective regulatory framework. For example, UNEP (2009) carried out a study to assess the environmental situation in Gaza Strip. The study concluded that "the state of the environment in Gaza Strip is bleak from any perspective." This is reflected in several aspects such as sewage discharge into the sea, over-utilization of natural resources, and pollution of land and groundwater resulting from construction activities.

Thus, the status of sustainability in Palestine in the recent decades has increasingly become critical. In order to specify the internal and external factors that have to be considered in the improvement of sustainability status in the Palestinian built environment, SWOT analysis has been carried out. Table 1 summarizes strengths, weaknesses, opportunities, and threats that have to be considered in this regard.

Considering the housing sector, the following points address the main sustainability challenges:

- Energy: renewable energies are not effectively utilised, with the exception of solar thermal for domestic water heating, CO_2 emissions are not controlled, and the absence of enforced specifications for thermal insulation and energy savings.
- Water: rainwater is not collected and reused due to the lack of a separate rainwater network, in addition to the pollution of the sea and groundwater.
- Building materials: not eco-labelled, environmental impact of materials from cradle to grave is not considered, and the sole dependence on concrete rather than steel.
- Waste: domestic waste is not recycled or efficiently reused.
- Transport: public transport requires improvement, and cycling is not facilitated
- Health and well-being: the absence of well-planned green areas and open spaces, crowding, and the monotonous housing environment
- Land and ecology: recession of agricultural land and the diverse effect on wildlife and biodiversity as a result of horizontal urban sprawl. For example, assuming that every 1,000m^2 of agricultural land covers the need of 13.82 persons means that the required agricultural land area up to 2020 ranges from 156 to 170 km^2. This forms 43 to 47% of Gaza Strip area (MOP, 2010). This requires a careful balance between the requirements of housing and agriculture.
- Economical aspects: housing is generally not affordable due to the great gap between demand and supply. Also, housing design doesn't offer a variety of residential unit sizes that considers family life cycle and future needs.
- Social aspects: the lack of sufficient community services that enhance community living, sustainability is not at the top of people's agenda, and the absence of strategies that promote sustainable style of life.

Table 1: SWOT Analysis of Sustainability Status in Palestine

Strengths	**Weaknesses**
▪ Abundant availability of solar radiation. ▪ Relative availability of other renewable energy sources such as wind. ▪ Rainwater is generally available, and can partially meet the domestic water demand.	▪ Lack of public awareness regarding sustainability concepts. ▪ Absence of governmental intervention and relative legislations. ▪ Inadequate technical capacity. ▪ Unavailability of natural building materials, with the exception of natural stone in the West Bank and

▪ Availability of local industry for some sustainable systems such as solar thermal collectors. ▪ Universities and research institutes are of high potential. ▪ Availability of a diverse engineering sector.	sand in Gaza Strip. ▪ Unavailability of sufficient local funds, and weakness of people's financial capacity.
Opportunities	**Threats**
▪ Availability of international donors. ▪ Implementing sustainability can be promoted by motivating incentives. ▪ The proposed mass housing projects represent an opportunity to implement sustainability concepts.	▪ Political instability. ▪ Lack of unity between Gaza Strip and the West Bank. ▪ Israeli restrictions on basic building materials, namely in Gaza.

In fact, the above-mentioned challenges are of great importance and deserve a comprehensive discussion. They also need to be prioritised within the framework of a national strategy. For example, a recent UN report says that the population of Gaza Strip will increase from 1.6 million people in 2012 to 2.1 million people in 2020, resulting in an increasing challenge in the provision of basic infrastructure, particularly water, sanitation and electricity (United Nations Country Team, 2012). Thus, due to the limitations of this study, the issues of energy, water, and building materials are highlighted in the following subsections. In this regard, the use of solar energy, rainwater collection, and green building material, namely steel, are discussed.

2.1 Solar Energy

There are several renewable energy sources that can be invested worldwide. Solar, wind, wave, hydro, geothermal, and biomass are some of the natural energies that are freely available to use. These sources can be implemented in small or large scale developments. The first type is usually available and easy-to-use in sustainable housing projects.

In Palestine, electricity consumption is rapidly increasing due to the increasing rate of development and population growth. Housing has a main role in this regard, as it forms most of the Palestinian built environment. Percentage of residential buildings reached 72.7% in the West Bank and 75.3% in Gaza Strip (PCBS, 2009a). In Gaza for instance, percentage of domestic electricity subscriptions reached 87% in 2011 (GEDCO, 2012). Under this demographic stress, solar energy represents a practical option in housing considering the sunny and hot climatic conditions of Palestine. There are two common technologies that can utilise solar energy considering the Palestinian climate:

A. Solar Collectors

Solar thermal energy systems involve solar collectors to gather solar radiation. The collected heat is then transferred to a circulating liquid. In general, there are two types of collecting systems: water based and air based. In the domestic use, the main advantage is that solar collectors can be used to heat water without the need of pump or controller. This is because the storage tank is placed above the top of the collectors, which allows water to circulate naturally by convection.

In Palestine, the use of solar collectors for domestic water heating is common. The common solar collector type is the glazed water based one. It operates depending on the thermosyphon principle explained above. It is estimated that 60% of Palestinian households used solar energy for domestic water heating in 2009. This percentage increased to 67% in 2012, which is a good indicator (PCBS, 2013). However, the use of tilt roofs has become common in the newly established housing buildings, especially high-rise ones. In this case, solar collectors are not usually used. Thus, the tilt solar collector systems may be introduced in the market to guard the above-monitored growth of solar collectors use in Palestine.

B. Photovoltaics (PV)

Photovoltaics are devices that directly convert solar energy into electricity. They are made of semiconductors and usually assembled into modules for practical operation. In Palestine, the abundant solar radiation enables solar energy installations to fulfil larger part of energy needs. The annual average global solar radiation in Palestine is 5.4 kwh/m^2/day (Mahmoud & Ibrik, 2006). With this relatively high level of solar radiation, both the West Bank and Gaza Strip are considered ideal places for using PVs. This can be realised when comparing the annual average solar radiation in Palestine to some European cities for instance such as London (2.6 kwh/m^2/day), Paris (3.3 kwh/m^2/day), Hamburg (2.5 kwh/m^2/day), and Rome (4.2 kwh/m^2/day) (Apricus Solar, 2007). However, we can find in these cities much more investment in PV sector.

This resource could be used effectively for the private and public purposes. Private use includes electricity supply for domestic lighting and operation of electrical appliances, while public use includes electricity supply for streets lighting and public services. In this context, the use of PV is more common in the West Bank, where several projects have been implemented to electrify remote villages (see Fig.1). The author found in a previous study (Asfour, 2012) that a simple stand-alone PV system with 5 m^2 PV panels can meet the basic needs of Palestinian households in the cases of emergency or daily power interruption. This system can roughly produce 2.7 kWh per day. Based on the following simple equation, it is possible to estimate the expected PV load if the above-mentioned PV area is increased:

$$\text{PV output} = I * A * \eta \qquad (1)$$

Where: I is solar radiation, A is PV area, and η is PV conversion efficiency (assumed 10%).

Fig. 1: Electrification of villages using stand-alone and grid-connected PV systems has become common in the West Bank, Palestine (ERC, 2012)

2.2 Rainwater Collection

In general, the most pressing need of human is water, even when compared to energy. Water supply in Palestine comes mainly from groundwater. Rainwater is relatively available and helps charging the groundwater reserves. This occurs directly through the vacant lands which function as catchment areas. However, the rapidly increasing urbanism draws a question mark regarding the efficiency of this mechanism in the future. For example, a recent UN report says that Gaza water aquifer may become unusable by 2016 and damage to it irreversible by 2020 due to the intensive and unsustainable use (United Nations Country Team, 2012).

Thus, development of sustainable water supply mechanisms is essential when it comes to sustainable housing. In the optimum situation, sustainable housing must be able to capture, store, and recycle water for its own use. A possible and widely used option in this regard is rainwater collection. On the other hand, rainwater can be injected into the ground to help charging the groundwater again, which requires a separate rainwater network. As mentioned above, rain is generally available in Palestine. However, the annual rainfall is higher in the West Bank compared to Gaza Strip. For example, the total annual rainfall in Nablus city, located in the West Bank, is about 660 mm, compared to 445 mm in Gaza city, Gaza Strip (Palestinian Meteorological Department, 2013). Table 2 presents the monthly average precipitation in these two main cities.

Rainwater collection systems are simple. Rainwater can be collected on site by houses roofs, filtered and treated, and then used for grey water purposes. If the system is intended for purposes such as toilets, then a simple mechanical filter is used to remove fine debris. This requires gutters and down pipes, pre-tank filtering, storage tanks (above ground) or cisterns (below ground), and pump or gravity feeders to pass water through a filter to the user.

Table 2: Monthly precipitation in Gaza and Nablus cities, Palestine (Palestinian Meteorological Department, 2013)

	Monthly Precipitation (mm)					
Month City	**Jan**	**Feb.**	**Mar.**	**Apr.**	**May**	**Jun.**
Gaza	105	88	37	9	1	0
Nablus	141.1	146.9	104	20.2	7.8	0
Month City	**Jul.**	**Aug.**	**Sep.**	**Oct.**	**Nov.**	**Dec.**
Gaza	0	0	0	36	71	99
Nablus	0	0	1.8	20.7	77.1	140.5

Although the advantage of this system is apparent, the need of a large water storage area is a disadvantage that can't be ignored. In order to find out the possibility of using this system, it is essential to determine the supply versus the demand. Supply comes from estimating the collected amount of rainwater, while demand comes from specifying the typical housing unit needs.

To estimate the collected amount of rainwater, W, the following simple equation can be used

$$W = A * R * C \qquad (2)$$

Where: *A* is area of the catchment, *R* is average rainfall, and *C* is the runoff coefficient. Runoff coefficient compensates for the lost or not collected amount of rain. This coefficient is usually assumed 0.5 for flat roofs (Environment Agency, 2009). Based on Table 2, Table 3 shows an example, assuming a roof area of 100 m^2 located in Nablus city, Palestine:

Table 3: Estimated rainwater collection by a 100 m^2 roof located in Nablus city, Palestine

Month	Monthly Rainfall (m)	Collected Amount (m^3)
Oct.	0.02	1.04
Nov.	0.08	3.86
Dec.	0.14	7.03
Jan.	0.14	7.06
Feb.	0.15	7.35
Mar.	0.10	5.20
Apr.	0.02	1.01
May	0.01	0.39
Jun.- Sep.	0.0	0.00
Total	**0.66**	**32.92**

Values presented in Table 3 have to be compared with the expected demand. This can be estimated based on the following assumptions:

- Collected water will be used for toilet flushing as one of the largest domestic water uses.
- Toilets are assumed with a dual flush system that has 3 and 6 litres flushing capacities (Wikipedia, 2013).
- The average Palestinian housing unit has two toilets that serve 6 persons. In total, these toilets are flushed 18 times a day: 12 times for liquid waste and 6 times for solid waste.
- Thus, toilet flushing demand will be 12*3 + 6*6 = 72 litres/day.
- This means a monthly demand of about 72*30 = 2160 litres, i.e. 2.2 m^3.

Comparing this figure to the findings of Table 3 means that the amount of collected rainwater can fully meet the estimated demand from November to March. The surplus amount may be saved for the following months. It also can be used for landscaping or recharged into the ground. Implementing this strategy on a city scale means a significant saving that can benefit other sectors, especially agriculture.

2.3 Green Building Materials

According to the statistics of PCBS (2009b), total number of housing units in Palestine was 691,463 units in 2007. Projected number of required housing units in 2017 has been estimated at 1,124,063 units. This means an increase of about 60%, which requires more than 40,000 housing unit to be annually produced. This in fact puts a great stress on the Palestinian housing sector. This problem is more significant in Gaza Strip. Tens of thousands of housing units are needed today as a result of the Israeli restrictions on basic building materials (United Nations Country Team, 2012). However, this great challenge could be invested to improve the currently implemented housing strategies in a way that rationalize the consumption of our limited resources and save our environment. The role of building materials is essential here.

The most popular building material used in the Palestinian housing sector is reinforced concrete. Raw building materials are not manufactured locally. With the exception of sand in Gaza Strip, main raw building materials (cement, aggregate, and steel bars) are imported. The use of other alternatives such as steel or timber construction is uncommon or even rare. However, urban land scarcity in Palestine makes wooden structures unfeasible option, especially for high-rise buildings. Thus, the remaining options are mainly concrete and steel.

When comparing both options, we find that steel is "greener" than concrete. This is due to several factors such as (Edwards & Hyett, 2002):

- Its reuse and recycling potential at relatively low energy cost. This compensates its high embodied energy compared to concrete (steel is about twenty times higher compared to concrete).
- It requires much less transport energy compared to concrete. A typical steel building weighs about half that of a concrete one.
- It consumes less water than concrete in manufacturing process, as water is held in a closed loop and can be re-used.

Thus, steel can be used in housing production as a green option. It can be used solely or in conjunction with concrete. In both options, "moving construction into the factory" can effectively help meeting the rapidly increasing housing demand over the coming years (Burgan & Sansom, 2006). In this regard, manufacturers can develop steel-framed housing systems and models. This is a practical option that can be constructed quickly compared to site casting of concrete, which is the prevailing method in the Palestinian construction sector. In addition, these steel model houses can be designed in a compact way, which helps reducing the cost further. Fig. 2 shows an example of a steel residential building.

Fig. 2: The use of steel construction in a social housing project, UK (Lawson, 2009)

A wide range of steel technologies may be used in residential buildings (Lawson, 2009). This includes light steel framing used in apartment buildings (3 to 6 storeys), and modular construction used in cellular buildings such as hotels and student residences. The latter technology allows for rapid installation on site, with an average of 6–10 units per day. In addition, two units can be merged together to create larger spaces. A wide variety of building forms and designs can be created too, where steel can be used in several components including walls, flooring, roofs, balconies, and stairs.

Conclusion

In this study, the importance of the adoption of sustainable design strategies in Palestine has been highlighted. This is more important in the field of housing, which witnesses a significant growth and currently exemplifies most of the Palestinian built environment. In order to implement sustainability in housing sector, it is essential to enable the concept of sustainable community, and implement strategies that preserve the limited natural resources. Despite the challenges that the Palestinian housing sector faces, it is characterized by several key advantages that create opportunities. These opportunities can be effectively invested to improve sustainability situation.

As for solar energy, the shortage of non-renewable energy sources in Palatine can be effectively used to encourage investment of the available renewable energy sources. It may be argued that this is not a national priority. However, it seems that it is, considering the social, physical, and mental negative effects of the current persistent shortage of non-renewable energies. One precious source that is in plenty availability in Palestine is solar energy. This can be used for electricity generation and domestic water heating. Statistics and calculations presented showed that there is a great potential for both strategies.

The average solar radiation in Palestine is 5.4 kwh/m^2/day. This can be used to generate electricity that covers the basic needs of a residential unit. In addition, percentage of people using solar energy for domestic water heating is increasing, and is currently about 67%. This can be further promoted by introducing new technologies that are more effective than the currently used systems of solar collectors. Systems that can be installed onto inclined roofs are particularly essential. In addition, the high values of solar radiation in Palestine can be used in other different applications such as water desalination and electrification of remote locations.

Regarding rainwater collection, the presented calculations showed that availability of rain makes this option possible. On a residential unit scale, it is possible to collect sufficient amount of rainwater of about 33 m^3/ year. This can cover the entire amount needed for toilet flushing purpose for five months. As for building materials, the main building material used in the Palestinian housing sector is concrete. However, there is a potential of introducing new building materials that are more environmentally friendly. Steel is a good nominee in this regard due to its environmental advantages. Furthermore, it can help moving housing industry to the factory, which can help meeting the future required housing supply more quickly and effectively. However, this strategy requires great efforts to develop the required infrastructure and technical capacities.

In addition, it is essential to recognise that promoting sustainability in the Palestinian housing sector is a shared responsibility between formal and informal organisations. This requires:

- Organising awareness campaigns to introduce sustainability concepts to the public.
- Organising technical training courses for all concerned stakeholders.
- Developing and enforcing standards and legislations in this field.

- Inclusion of sustainability requirements in the license procedures of buildings.
- Adoption of policies and incentives that encourage people to implement sustainable principles in housing and all other sectors.

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Long Term and Current Urban Atmospheric Variation Changes at Ipoh City, Malaysia

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1. Introduction

Alam sekitar telah jauh berubah dan masyarakat juga telah berubah dengan membawa potensi impak perubahan iklim. Walaupun impak perubahan iklim terus berpanjangan terhadap manusia dan banyak jangkaan dilakukan mengenai kesannya. Skala perubahan iklim dan kesannya terhadap kesihatan manusia, ekosistem kesihatan (*European Journal of Economics, Finance and Administrative Sciences - Issue 31(2011))*, biodiversity, pengeluaran makanan, pertumbuhan ekonomi, pelancongan dan sumber air ((Kovats et al., 2005; Ebi et al., 2006; Arnell 2004).

Keadaan peningkatan gas rumah hijau dari penggunaan bahan api fosil menjadikan pemasanasan yang dialami oleh bumi semakin meningkat sebagai petunjuk perubahan iklim dunia pada masa kini. Menurut IPCC (2007), purata suhu permukaan dunia telah meningkat sebanyak 0.13°C sedekad sejak 1950 dan purata suhu permukaan dunia akan boleh meningkat dari 1.8°C to 4°C pada akhir abad ke 21 bergantung kepada kesan pengeluaran gas rumah hijau pada masa akan datang.

Perubahan iklim adalah salah satu isu penting alam sekitar dalam dunia hari ini. Ini dibuktikan dari perbincangan dalam persidangan, kempen, laporan dan penyelidikan mengenai perubahan iklim dalam 20 tahun lepas (Intergovernmental Panel on Climate Change (IPCC), 2001, Copenhagen, 2009) Lebih seratus tahun lepas suhu global dunia telah meningkat antara 0.3-0.6^{0}C (WMO, 2004). Dalam keadaan yang sama, kepesatan pembandaran menyebabkan pemanasan bandar menjadi masalah yang serius (Oke, 1987; Quattrochi & Ridd, 1994; Nakagawa, 1996; Rizwan et. al., 2008). Rentetan ini banyak kajian telah dilakukan dalam menyelidik menilai perubahan iklim bandar di dunia termasuk menilai trend pemanasan bandar melalui trend perubahan suhu bandar (Chung et al., 2004; Fujibe, 1998a, b; Kato,1996).

Sehubungan itu, manusialah yang mendiami kawasan bandar, merasai apa yang berlaku dan melalui pengalaman yang telah dilalui dengan keadaan perubahan iklim bandar tersebut. Pada masa akan datang lebih dari 60% dari penduduk dunia akan mendiami kawasan bandar.

Pada abad ke-19 hingga abad ke-20 kebanyakan negara-negara Asia telah mengalami pertumbuhan ekonomi yang tinggi disertai oleh pembandaran yang pesat. Pertumbuhan Iklim tropika di Malaysia yang panas dan lembap. Data yang diperoleh dari Jabatan Meteorologi Malaysia (1997) untuk satu jangka masa yang sepuluh tahun rekod menunjukkan suhu luaran yang relatif seragam dengan suhu purata antara 23.7 C º hingga 31.3 C º sepanjang sehari dengan suhu maksimum tertinggi yang dicatatkan iaitu 36.9 C dan yang kelembapan purata relatif sepanjang satu hari antara 67% hingga 95%.

Pada amnya, suhu meningkat di kawasan bandar yang pesat membangun dengan bangunan dan sesak dengan kenderaan berbanding dengan pinggir bandar dan kawasan luar bandar. Kebanyakan penyelidikan kini banyak membincangkan isu-isu alam sekitar berhubung dengan pembangunan pesat bandar dan faktor-faktor industri yang cenderung untuk mengubah corak semula jadi dan trend suhu dalam persekitaran bandar (Shaharuddin Ahmad, Noorazuan Md Hashim & Yaakob M. Jani (2009)

Ini dikaitkan dengan kejadian pulau haba bandar digunakan sebagai tema dikalangan ahli klimatologi dan didokumenkan melibatkan kawasan-kawasan metropolitan di seluruh dunia (Oke 1973; Katsoulis dan Theoharatos 1985; Balling and Cerveny, 1987; Lee 1992; Saitoh et al. 1996;Yamashita 1996; Bohm 1998; Figuerola dan Mazzeo; Klysik and Fortuniak 1999; Kim dan Baik 2002;Wilby 2003). Ini menunjukkan masalah atmosfera bandar atau iklim bandar khususnya pulau haba bandar merupakan masalah besar disebabkan pembandaran dan perindustrian. Ini memerlukan kita peringkat awal mengkaji aktiviti manusia berkaitan pembandaran dan perindustrian yang boleh menyebabkan berlakunya perubahan atmosfera bandar. Kerana kejadian pulau haba bandar ini berlaku di mana-mana kawasan dan keadaan ekstrem juga perlu diteliti di banyak kawasan termasuk di Malaysia. Kajian-kajian sebelum ini banyak bertumpu di Kuala Lumpur dan Lembah Kelang, Bangi, George Town dan Johor Bharu namun amat sedikit kajian dilakukan di Bandaraya Ipoh yang terletak di bahagian utara Perak, Malaysia.

Rentetan ini, Ipoh merupakan bandaraya mengalami proses pembandaran yang pesat di mana berlakunya perubahan persekitaran fizikal habitat bandar kepada kawasan dipenuhi bangunan, permukaan bertar dan aspalth yang dijadikan kawasan perniagaan, industri, komersial dan memberi kesan terhadap persekitaran kehidupan manusia. Ini selari menurut Sham (1982) kebanyakan pencemaran di Malaysia disebabkan pertumbuhan pembandaran yang pesat, peningkatan penduduk dan perluasan perancangan pembangunan ekonomi. Kepesatan pembandaran telah berkembang dari pusat bandar ke pinggir bandar iaitu Ipoh ke Seri Iskandar, Ipoh ke Chemor, Ipoh ke Kampar, Ipoh ke Simpang Pulai. Perubahan ini telah menyebabkan berlakunya perubahan suhu di bandaraya Ipoh . Kegiatan manusia membawa punca berlaku pencemaran udara juga telah dikaitkan dengan faktor penyumbang yang menyebabkan perubahan iklim bandar.

Pembangunan yang meningkat ini turut melanda di Lembah Kinta ketika ini. Pembangunan pesat ini melibatkan aktiviti pembandaran yang rancak merubah lanskap fizikal dalam mengembangkan bandar dan pekan di Lembah Kinta seperti di Kampar, Gopeng, Batu Gajah, Seri iskandar, Ipoh, Chemor, Bercham, Simpang Pulai, Lahat dan Pengkalan, Kanthan serta Tanjong Rambutan. Pembangunan melibatkan aktiviti manusia di kawasan ini dalam merubah alam sekitar semulajadi Lembah Kinta kepada kawasan pembandaran menjadi Metropolitan Lembah Kinta. Aktiviti manusia ini melibatkan perubahan lanskap melalui pembukaan tanah bagi tujuan pembandaran, pertanian, perlombongan dan perindustrian. Perubahan lanskap ini melibatkan perubahan dari sebuah kawasan perlombongan bijih timah yang terkenal menjadi kawasan tinggalan bekas lombong yang ditebus guna oleh manusia menjadi kawasan petempatan, perniagaan dan perindustrian. Kawasan bergunung-ganang di bahagian timur dan utara Lembah Kinta menjadikan sumber aktiviti manusia dalam menjalankan aktiviti kuari dan simen bagi menghasilkan mar-mar dan simen yang bernilai. Kepesatan pembandaran telah berkembang dari pusat Metropolitan Lembah Kinta iaitu Ipoh ke Seri Iskandar, Ipoh ke Chemor, Ipoh ke Kampar, Ipoh ke Cameron Highlands. Perubahan ini telah menyebabkan berlakunya perubahan suhu di bandaraya Ipoh.
Hasil kajian awal mendapati peningkatan suhu berlaku di Ipoh yang telah membantu memahami kesan pembandaran terhadap perubahan suhu di Ipoh (Hizam, 1993; Normazidah, 1990). Perubahan suhu di Ipoh mengalami perubahan yang signifikan sehingga tahun 2000

(Mohd Hairy et al., 2011). . Ini berasaskan aspek kiraan tren min suhu maksimum dan suhu minimum dalam tempoh 1970 – 2000.

2. Data and Methodology

Data iklim melibatkan data sekunder dan data mentah sepenuhnya dari Jabatan Meteorologi Malaysia, Malaysia. Data Meteorologi dari tahun 1970 - 2010 yang didapati dari Ipoh Lapangan Terbang, Stesen Meteorologi. Kawasan Ipoh dari segi lokasi Geografi terletak pada 40 34'U latitud, longitud Timur 1010 5. Bandar Ipoh adalah ke-3 terbesar di Semenanjung Malaysia dan berdasarkan kedua-dua Tebing Sungai Kinta mendarat rata dengan ketinggian 75 meter di atas Paras laut. Topologi kawasan kajian adalah kawasan tanah tamah dan ketinggian kurang daripada 180 meter di atas paras laut. Ipoh mempunyai pelbagai utama sebagai hutan simpan kekal dan kawasan tadahan udara. Sementara itu, Ipoh sekitar dengan Kledang pelbagai di barat daya 600 meter. Di selatan Ipoh,persekitarannya diluti oleh busut kecil batu kapur kira-Kira 160 meter tinggi. (Peta Semenanjung Malaysia, Siri 1307).

Data siri masa suhu maksimum min, min suhu minimum dan min suhu tahunan dari 1968 hingga 2010 (42 tahun) dari data di stesen meteorologi Lapangan Terbang Ipoh yang digunakan untuk mengetahui perubahan dalam suhu bandar dalam tempoh jangka panjang metropolitan Ipoh. Data dianalisis dalam dua bahagian dengan menjalankan Regresi Linear dan mengambil anomali semua tempoh masa; (a) seluruh tempoh dari 1968 – 2010 termasuk monson barat daya, peralihan monson bulan april, monson timur laut dan peralihan monson bulan oktober). Regresi linear digunakan untuk untuk mengetahui perubahan suhu, suhu maksimum, suhu minimum, hujan, kelembapan bandingan dan halaju angin di bandaraya Ipoh, Perak. Suhu digunakan sebagai pembolehubah bersandar manakala tempoh masa digunakan sebagai pembolehubah bebas.

Perubahan suhu tahunan ditunjukkan menggunakan trend suhu tahunan. Trend suhu tahunan ini dianalisis menggunakan regresi linear. Purata suhu minimum dan purata suhu maksimum dalam tempoh 1968-2010 dari Jabatan Meteorologi menunjukkan trend suhu tahunan. Oleh itu, asas model statistik yang digunakan iaitu $Y_t = \mu + \chi_t(\theta) + V_t$, di mana Y adalah suhu pada tahun tersebut μ adalah konstan, $\chi_t(\theta)$ adalah trend variabel dan V_t adalah kesilapan dalam tahun tersebut.

Model ini telah digunakan bagi menerangkan tentang anggaran trend satu-satu parameter yang mudah apabila trend model ini adalah linear (Bloomfield 1992). Formula ini juga telah membolehkan ramalan trend dari model iklim dan bergantung kepada trend parameter dan siri masa yang linear. (Mohamed Elnour 2000).

Analisis ini juga menunjukkan sejauh mana hubungan di antara pembolehubah. Hubungan antara minima dan maksima suhu permukaan dan siri masa tahunan (1968-2010) boleh menganggarkan kekuatan hubungan antara dua pembolehubah boleh didapati dalam Jadual 1. (Alias Baba, 1999). Analisis tren telah dijalankan bagi menunjukkan min suhu dengan masa (dalam tahun). Trend yang diberikan oleh pekali cerun linear garis regresi yang dipasang telah diuji tahap kepentingannya (95 dan 99%).

Kaedah rentasan suhu di lapangan dilakukan mengunakan motosikal melibatkan 62 stesen pencerapan meliputi kawasan pusat bandar hinggalah luar bandar bagi mengukur variasi suhu, kelembapan bandingan dan kelajuan angin dalam menunjukkan variasi keadaan iklim di bandaraya Ipoh. Intensiti haba telah dinilai melalui persamaan pulau haba bandar (Oke, 1987). Pemetaan pola suhu dilakukan dengan menggunakan cara interpolasi dalam sistem maklumat geografi (GIS) dalam menghasilkan peta nilai sesuhu.

3. Keputusan dan Perbincangan

3.1 Perubahan Atmosfera Bandar Jangka Panjang

Keadaan atmosfera bandar turut dipengaruhi oleh topografi kawasan itu tadi. Atmosfera bandar jega dikenali sebagai iklim bandar. Iklim bandaraya Ipoh dikelaskan sebagai iklim tropika lembab dengan kadar suhu yang tinggi sepanjang tahun. Keadaan atmosfera bandar Ipoh iaitu suhu harian siang maksimum 34.0 dan minimum 28.8 dan suhu maksimum malam iaitu 29.5 dan suhu minimum malam 23.3 Min suhu maksimum iaitu 32.8^0C dan min suhu minimum 27.6^0C, purata hujan tahunan 2262.63mm dengan kelembapan 80.7 peratus, hujan pada sepanjang tahun, taburan baik, hujan maksima mac hingga mei dan oktober hingga disember serta hujan minima pada Januari dan September. Mana kala, angin lazim bertiup di bandaraya Ipoh dari arah barat laut dan selatan. Kadar angin rendah $3ms^{-1}$; angin baratlaut dan selatan, angin kuat $15ms^{-1}$ angin monson ogos-disember. Min sinaran matahari tahunan 486 m Hrcm, sinaran matahari tinggi terutama pada musim panas. Min tahunan Awan pula iaitu 6.5 oktas di mana litupan awan maksimum pada bulan mei dan jun, ogos dan november. (Jabatan Meteorologi Malaysia, 2007)

Pembandaran pesat dilakukan oleh manusia dari kawasan pusat bandar, sub-bandar dan pinggir bandar (Mohd Hairy Ibrahim, 2013). Kajian awal mengenai pengaruh pembandaran terhadap suhu di Ipoh telah dilakukan oleh beberapa pengkaji meneliti menilai keadaan suhu ketika itu (Noor Azmi Zakaria, 1981; Normazidah Mohd Mokhtar, 1990; Hizam Mustafa, 1993). Cara ini iaitu melalui penilaian tren suhu yang digunakan dalam banyak kajian adalah cara yang popular telah digunakan bagi menilai perubahan suhu bandar (Prof. Kataoka et al, 2009; Kato, 1996; Fujibe, 1998a, b. Chung et al, 2004). Perubahan antara tahun dan perubahan suhu di Ipoh dengan menganalisis melalui tren linear telah menunjukkan hasil yang ketara. Tren perubahan suhu 1968 hingga 2010 menunjukkan perubahan yang ketara positif, di mana suhu purata tahunan (MAT), min suhu maksimum (MMxT) dan min suhu minimum (MMiT) yang mempunyai perubahan tetapi sedikit penurunan trend dalam tempoh 31 tahun terakhir bagi Ipoh. Secara keseluruhannya, suhu bandar Ipoh 1970 hingga 2000 mempunyai perubahan yang lebih besar walaupun ia mempunyai min suhu perlahan, peningkatan yang maksimum dari 1981-1990 dan sedikit berkurangan dari 1991-2000.

Rajah 5.11 hingga Rajah 5.14 menunjukkan siri masa purata suhu maksimum, purata suhu dan purata suhu minimum bagi Ipoh dan Sitiawan dengan regresi linear. Nilai catatan tertinggi purata suhu maksimum iaitu 33.7^{0}c 2002 di Ipoh dan 32.9^{0}c 2002 di Sitiawan. Dapatan dari Stesen di Ipoh mendapati secara keseluruhannya peningkatan purata suhu 24 jam adalah kecil iaitu 0.018^{0}c setahun. Trend perubahan suhu bagi purata suhu maksimum peningkatan suhu yang agak kecil iaitu 0.007^{0}c setahun dan 0.036^{0}c setahun bagi nilai peningkatan purata suhu minimum di Ipoh.

Jadual 1 : Nilai kekuatan hubungan antara dua pembolehubah

Nilai Koofisien r	Hubungan
0.00 – 0.20	Tiada
0.20 – 0.40	Rendah
0.40 – 0.60	Sederhana
0.60 – 0.80	Tinggi
0.80 – 1.00	Sangah Tinggi

Sumber : Alias Baba, 1999

Hasil trend linear ditunjukkan dengan jadual siri masa MAT, MMxT dan MMiT dibentangkan dalam Jadual 2. Perubahan suhu di Ipoh diwakili dengan 3 tempoh masa yang adalah 1970 hingga 1980, tahun 1981 hingga 1990 dan 1991 hingga 2000. Tambahan lagi, semua tren min suhu bagi seluruh tempoh dari tahun 1970 - 2000 juga menunjukkan meningkat (Jadual 2). MAT 1970-1980 menunjukkan tahap hubungan yang tinggi dengan siri masa daripada MAT 1991-2000. MMxT sebagai siri masa keseluruhan 1970-2000 meningkat dengan tahap yang sederhana. MMxT 1981-1990 dan 1991-2000 meningkat tahap sederhana berbanding MMxT 1981-1990. MMiT 1970-2000 mempunyai peningkatan dalam tahap hubungan yang sangat tinggi. MMiT 1970-1980 telah drastik meningkat daripada MMiT 1981-1990. Perubahan suhu tidak seragam semasa sepanjang tempoh kajian.

Data MMiT menunjukkan min suhu yang tinggi meningkat dari tahun 1970 - 1980. Perubahan suhu minimum banyak terjejas min suhu tahunan di Ipoh (1970 - 2000) yang ditunjukkan dalam jadual. Data MMiT Ipoh secara keseluruhannya menunjukkan meningkat tinggi dalam tahun 1970 - 2000. Bagi tempoh kedua pula menunjukkan bahawa MMiT mempunyai perubahan daripada MMxT tinggi. MMiT adalah tinggi dan semakin meningkat intensiti

Hasil trend linear ditunjukkan dengan jadual siri masa MAT, MMxT dan MMiT dibentangkan dalam Jadual 2. Perubahan suhu di Ipoh diwakili dengan 3 tempoh masa yang adalah 1970 hingga 1980, tahun 1981 hingga 1990 dan 1991 hingga 2000. Tambahan lagi, semua tren min suhu bagi seluruh tempoh dari tahun 1970 - 2000 juga menunjukkan meningkat (Jadual 2). MAT 1970-1980 menunjukkan tahap hubungan yang tinggi dengan siri masa daripada MAT 1991-2000. MMxT sebagai siri masa keseluruhan 1970-2000 meningkat dengan tahap yang sederhana. MMxT 1981-1990 dan 1991-2000 meningkat tahap sederhana berbanding MMxT 1981-1990. MMiT 1970-2000 mempunyai peningkatan dalam tahap hubungan yang sangat tinggi. MMiT 1970-1980 telah drastik meningkat daripada MMiT 1981-1990. Perubahan suhu tidak seragam semasa sepanjang tempoh kajian.

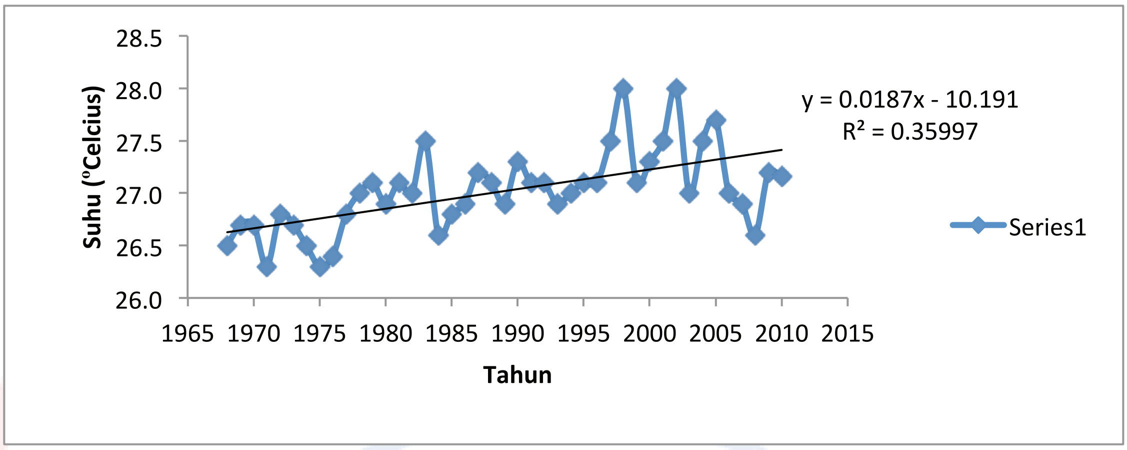
Data MMiT menunjukkan min suhu yang tinggi meningkat dari tahun 1970 - 1980. Perubahan suhu minimum banyak terjejas min suhu tahunan di Ipoh (1970 - 2000) yang ditunjukkan dalam jadual. Data MMiT Ipoh secara keseluruhannya menunjukkan meningkat tinggi dalam tahun 1970 - 2000. Bagi tempoh kedua pula menunjukkan bahawa MMiT mempunyai perubahan daripada MMxT tinggi. MMiT adalah tinggi dan semakin meningkat intensiti daripada MMxT. Keamatan regresi MMxT, MMiT dan MAT menunjukkan tren positif yang signifikan bagi tempoh masa keseluruhan 1970-2000. Secara keseluruhan, min suhu maksimum tahunan dan min suhu minimum tahunan 1970-2000 menunjukkan kesan positif dan signifikan dalam tempoh kedua-duanya.

Jadual 2 : Hasil analisis Regresi antara suhu, kelembapan bandingan, hujan dan kelajuan angin di Ip

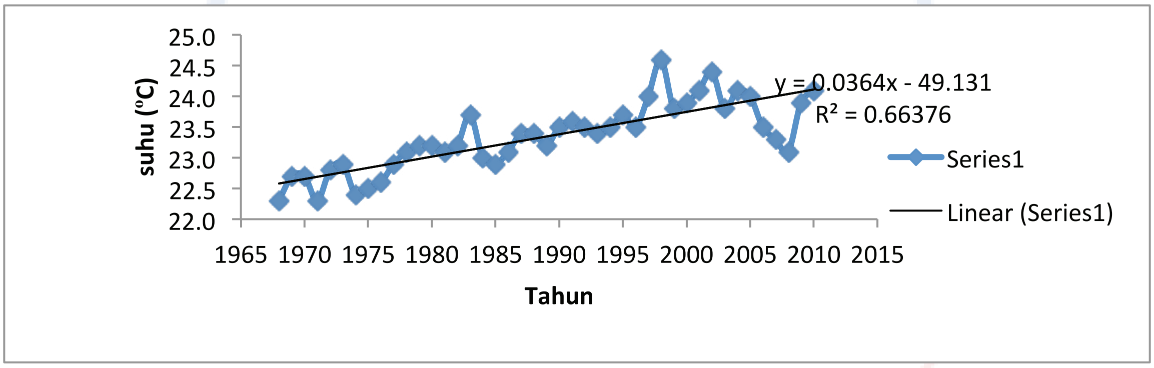
Suhu	**Tempoh**	**Ipoh**	**r^2**	**r**	**Trend**	**Kekuatan**	**Sitiawan**	**r^2**	**r**
Tahunan (MAT)	1968–2010	y = 0.0187x -10,191	0.36	0.6	Meningkat	Sederhana	y = 0.024x -40.64	0.54	0.7
Maksimum (MMxT)	1968–2010	y = 0.007x + 17,815	0.08	0.3	Meningkat	Rendah	y = 0.014x +4,2675	0.21	0.5
Minimum (MMiT)	1968–2010	y = 0.0364x – 49,131	0.66	0.8	Meningkat	Sangat Tinggi	y = 0.0262x +28,883	0.66	0.8
Kelembapan Bandingan	1968–2010	y = 0.015x + 81.27	0.03	0.2	Meningkat	Rendah	y = 0.0588x +28,883	0.49	0.7
Hujan	1968–2010	y = 13.31x + 23.930	0.18	0.4	Meningkat	Sederhana	y = 2.7186x +36236	0.03	0.2
Kelajuan Angin	1968–2010	y = 0.0837x + 18.045	0.52	0.7	Meningkat	Tinggi	y = -0.1196x +256,16	0.22	0.5

* Aras signifikan 0.05: MAT Min Suhu Tahunan; MMxT Min Suhu Maksimum and MMiT Mi

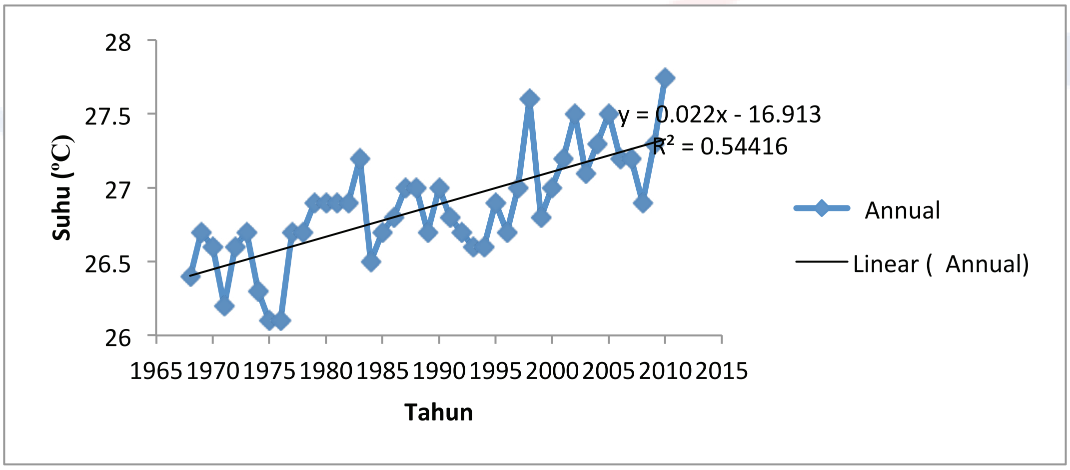
Rajah 1 Trend Perubahan Purata Suhu Tahunan di Ipoh Bagi 1968-2010



Rajah 2 Trend Perubahan Purata Suhu Minimum di Ipoh Bagi 1968-2010

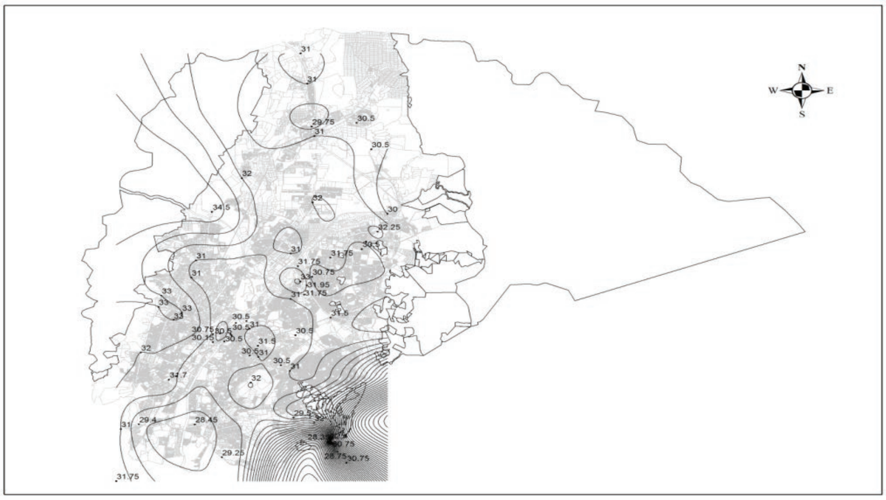


Rajah 3 Trend Perubahan Purata Suhu 24 Jam Tahunan di Sitiawan Bagi 1968-2010

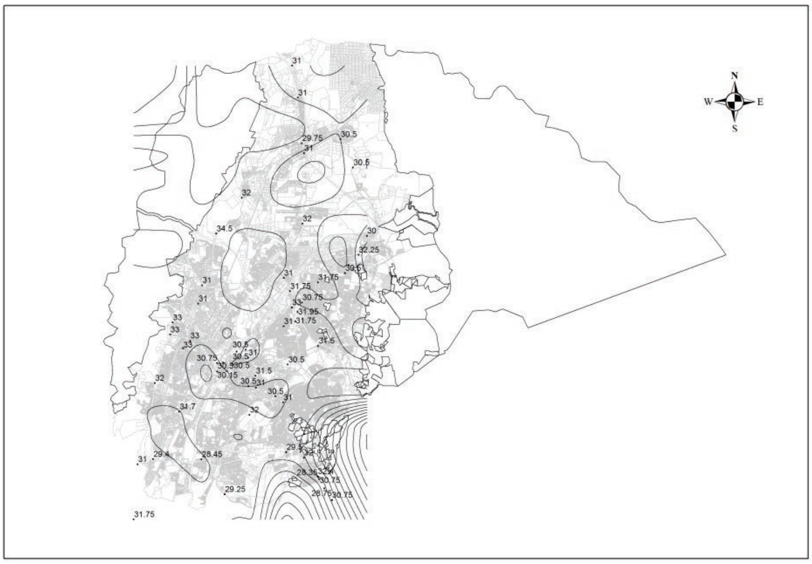


3.2 Keadaan Semasa Perubahan Atmosfera Bandar

Rajah : Taburan Suhu Pada Jam 1400-1500



Rajah : Taburan Suhu Pada Jam 2000-2200, 4 Jun 2011



4. Conclusion

Kesimpulannya, hasil trend analisis yang dijalankan menunjukkan berlakunya perubahan suhu yang positif di Ipoh dalam tempoh masa 1970-2000. Hasil ini diharap dapat menjadi satu tanda perlunya langkah yang mampan dalam memelihara alam sekitar bandar yang lestari agar suhu bandar tidak terus meningkat dan member kesan kepada penghuninya pada masa hadapan. Justeru, perancangan dan pembandaran mampan harus terus dimantapkan dalam memastikan bandar Ipoh menjadi bandar lestari.

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Integration of Renewable Energy Technologies in the Lebanese Electric Power System

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Abstract

The purpose of this paper is to examine the status of Renewable Energy (RE) development in Lebanon and to investigate the policy options that must be adopted in order to accelerate the realization of the Government's commitment to achieve 12% RE penetration out of the total power generation installed capacity by 2020 through the engagement of both public and private sectors. Lebanon represents a unique example in which there is almost a total dependence on diesel generators to compensate for electricity shortage and hence, the development of RE energy will not only contribute to the reduction of GHG but it will also reduce the import of diesel oil as well as the cost of produced energy since, as it will be shown, grid connected PV, wind and micro hydro power plants all produce electricity cheaper than diesel generators.

Keywords: Hybrid systems, off-grid supply, production costing, renewable energy

I. Introduction

The Lebanese Electric Power System (LEPS) has been suffering from technical and financial deficiencies for decades. The Expected Energy Not Supplied (EENS) in 2009 was 3,495 MWh, which is 25% of the energy demanded of 15 TWh and the Loss of Load Probability (LOLP) was 0.9947. These reliability indices suggested that the LEPS was nearing a catastrophic failure in 2009 unless the supply of electrical energy is improved. To respond to these challenges, the Ministry of Energy and Water (MoEW) of Lebanon developed a comprehensive energy policy [1] which calls for conventional and RE capacity additions to meet the load forecast and reserve requirements. The policy calls for public and private sector participation in energy projects.

The generation plan is targeting a total installed capacity of 4,000 MW by 2014 to meet a load forecast of 3,677 MW with around 8% reserve. The forecasted peak for 2014 was estimated from the peak load of 2009 (2450 MW) using an annual growth rate of 7%. The immediate term considers commissioning new plants to rapidly increase the installed capacity by 600 – 700 MW using Combined Cycle Gas Turbine (CCGT) and Reciprocating Engines (200-300 MW: reciprocating engines and 400-500: CCGT). For the medium term, the proposed projects will increase the installed capacity by 1,500 MW in 2014 using the modality of Independent Power Producer (IPP) in collaboration with the private sector. Renewable energy has a significant role in the energy policy; hydraulic power production will have a bigger share through maintenance, rehabilitation and/or replacement of existing hydro plants, in addition to facilitating the implementation of additional hydro capacity on a BOT basis. The private sector will also be encouraged to build wind farms and adopt the technologies of waste to energy [2,3].

The municipalities, which have administrative autonomy, are expected to invest in RE systems because they have already been engaged in developing or supervising the operation of diesel power plants operating within their jurisdictions. The private sector (industrial, commercial and residential) is also expected to invest in RE to reduce its increasing fuel bill for the diesel power plants it already owns [4].

A. Government Initiatives

The Government of Lebanon, through its Ministerial Declaration of 2010 set a target of 12% of total installed capacity to come from renewable energy sources by 2020. It also commits to the preparation and adoption of national programs focusing on demand side management as the basis for saving a minimum of 5% of the total demand [1].

B. International Initiatives

The United Nations Development Program (UNDP) is managing the Country Energy

Efficiency and Renewable Energy Demonstration Project for the Recovery of Lebanon" (CEDRO) [5]. CEDRO has been established with an aim to complement the national power sector reform strategy and to support the greening of Lebanon's recovery reconstruction and reform activities. Its objective is to install approximately 120 energy efficiency and renewable energy applications in public facilities throughout the country, ensure technology transfer or encourage the private sector to invest in various renewable energy sources, and ultimately create an enabling environment to adopt a national sustainable energy policy.

Another initiative is the National Energy Efficiency and Renewable Energy Action Initiative (NEEREA) which is a financing mechanism to support investments in the field of energy efficiency and renewable energy [6]. The NEEREA initiative was officially launched with the issuance of a Circular by the Central Bank of Lebanon in 2010. It offers loans for energy efficiency, renewable energy and green buildings projects with interest rates as low as 0% and repayment period as long as 14 years. The target of NEEREA is to leverage funding for energy efficiency and renewable energy investments amounting to US$100 million during the period ending in 2015.

Paving the Way to the Mediterranean Solar Plan (PWMSP) [7] is an EU-funded regional project assisting Mediterranean Partner Countries to contribute to a significant increase in the deployment of sustainable energy systems based on renewable energy sources. The most relevant lines of activities are the one that supports the Mediterranean Partner Countries to implement sustainable energy policies promoting the use of renewable energy sources in power generation and energy efficiency.

C. Legal Framework

In 2002, the electricity privatization Law #462 was ratified by the Lebanese Government. This law calls for unbundling of the LEPS, retaining full control over the transmission sector while privatizing the distribution and generation sectors. The law envisages selling no more than 40% of the assets to a strategic partner during the first two years following the corporatization of the electric utility. However, the law 462 did not incorporate specific clauses to promote renewable energy technologies particularly the small scale ones. A proposal to amend the electricity privatization Law 462 was recently completed by MoEW to facilitate the introduction of RE producers as small Independent Power Producers (IPPs). There has not been in place a feed-in tariff that can stimulate the market and encourage investments in RE. In addition, there are little incentives developed to promote the implementation of RE systems and products. The companies that provide services in RE are numerous but not all of them are experienced. Equipment Suppliers currently import all kind of products without quality control. Taxes on the imports of RE products and systems have not been waived yet. Financial mechanisms have been introduced for solar water heaters and they can be adopted for promoting other RE systems [1,5,6].

II. Status of Renewable Energy Planning in Lebanon

A. Hydro Power

The installed capacity of all hydro plants is 283 MW but the actual generation capacity is around 190 MW. The energy produced from the 190MW hydro constituted 11.3% from the total production of 2009. The MoEW completed a hydro master plan yielding the following results:

- Rehabilitation & upgrade of existing plants will increase capacity from 190 MW to 282 MW.
- Installation of New Hydro Plants in 32 new sites will provide an additional capacity of 264 MW from run of river schemes and 338 MW from peak schemes.
- Micro Hydro in 13 new sites will increase the capacity by 5 MW.
- Depending on the type of hydro/micro hydro plant and consequently on its CAPEX, the tariff ranges presented in TABLE I have been deduced as guidelines for expected cost of generated energy [8,9].

TABLE I
TARIFF RANGES REQUIRED FOR FEASIBLE INVESTMENTS IN HYDRO POWER

Item	Min selling tariff			Total
	$t < 8.1$¢\$	8.1¢\$ $< t < 12$¢\$	$t > 12$¢\$	
# of sites	13	12	4	29
Power (MW)	139	94	17	250
Capex (M$)	273	287	78	638
Energy (GWh)	713	413	68	1,194
Per unit cost ($/kW)	2.070	3,220	4,310	

B. Wind Power

Lebanon has a reasonable wind potential as reported in the wind atlas, which was finalized in 2011 **Error! Reference source not found.**. Wind power is expected to supply 1% of the energy produced in 2013 increasing slowly thereafter [1]. This energy will represent a generation capacity of 30 MW in 2013, and then 60 MW in 2018 (1.5% of the demand). With the assumed capacity factor of 23%, the contribution of wind energy will be limited to 120 GWh in 2018, or only 0.7% of the total generation. The target of wind power development via the private sector was set at 60 – 100 MW [1].

C. Bioenergy / Biomass

Biomass energy from Municipal Solid Waste (MSW) is an important renewable resource that may contribute to the generation of 301 GWh of electricity, which could result in a total capacity of up to 38 MW. The contribution of forestry is estimated at 930 GWh [7].

D. Photovoltaic (PV)

PV energy has not been sufficiently developed in Lebanon due to the perceived high capital cost, low efficiency and the false belief that PV cannot make a contribution if widely implemented in decentralized mode or in grid-connected mode via net metering. With most of the country connected to the national grid, PV is not economical compared to the grid produced electric energy at the present low tariff. However, the PV produced energy is competitive when compared to private generation that uses diesel oil. At present, 126 kW for schools, municipalities and community centers have been completed through UNDP. It is expected that by end of 2012, the installation of additional 104.4 kW will be realized yielding a total of 230.4 kW. Such a progress is likely to trigger additional penetration of PV into the Lebanese market if supported by other initiatives.

III. VI. Projected Contribution of Renewable Energy Technologies

Starting 2015, Lebanon will witness energy shortages. Since this shortage must be satisfied with the most economical and environmentally friendly technologies, it is envisaged that renewable energy technologies will be implemented in accordance with the set targets in the energy policy except for the PV which was not accounted for and for hydro which was underestimated.

RE can easily compete with private generators using diesel-oil because the average cost of production from private generators is around 30 USC/kWh. TABLE II presents the parameters used for the calculation of the average cost of production from typical 200 kVA high-speed-diesel engines, which are widely used in large buildings, small villages and municipalities where they operate as a substitute to EdL when rotating outages occur.

TABLE II
Parameters Used for the Calculation of the Average Production Cost of a Typical 200 KVA Diesel Generator

Engine Data	Capacity	*kVA*	200
	Active Power	*kW*	170
	Cos φ	-	0.85
	Max. Current	*Amps*	289
	Consumption @ 100% load	*gr/kWh*	202
Energy Analysis	Utilization Factor	*%*	61%
	Load Factor	*%*	90%
	Available Capacity	*kW*	170
	Expected Energy Produced	*kWh*	825,282
Operational Cost	Fuel Cost	*$/Ton*	1,050
	Oil + Filters	*% of*	20%

		Fuel	
	Staff	*$/Year*	14,400
	Miscellaneous	*% of Fuel*	10%
Investment	Engine CAPEX	*$*	35,000
	Cabling	*% of CAPEX*	70%
	Auxiliaries	*% of CAPEX*	20%

TABLES III – VI show the data used for calculating the levelized cost of production from the various renewable energy sources in Lebanon. The levelized costs for wind, PV, hydro run-of- the-river and hydro with storage are shown in Fig. 1 together with the price of private generators and the average tariff currently in-use by EdL.

TABLE III
TECHNICAL AND FINANCIAL DATA OF WIND POWER SYSTEMS

Technical data		**Financial data**	
Item	**Value**	**Item**	**Value**
Installed capacity (kW)	1,000	CAPEX ($/KW)	2,000
Capacity factor (%)	25%	O&M (% of capex)	1%
Availability (%)	95%	Discount rate (%)	10%
		Project life (yrs)	20

TABLE IV
TECHNICAL AND FINANCIAL DATA OF PV SYSTEMS

Technical data			**Financial data**	
Item		**Value**	**Item**	**Value**
Installed capacity (kW)		100	CAPEX ($/KW)	2,500
Capacity factor	hrs/day	7	O&M (% of capex)	1%
	days/yr	365		
DC to AC conversion (%)		85%	Discount rate (%)	10%
Availability (%)		95%	Project life (yrs)	20

TABLE V
TECHNICAL AND FINANCIAL DATA OF RUN OF THE RIVER SYSTEMS

Technical data		**Financial data**	
Item	**Value**	**Item**	**Value**
Installed capacity (kW)	1,000	CAPEX ($/KW)	2,500
Capacity factor (%)	40%	O&M (% of capex)	2%
Availability (%)	100%	Discount rate (%)	10%
		Project life (yrs)	30

TABLE VI
TECHNICAL AND FINANCIAL DATA OF MINI HYDRO SYSTEMS WITH STORAGE

Technical data		**Financial data**	
Item	**Value**	**Item**	**Value**
Installed capacity (kW)	1,000	CAPEX ($/KW)	5,500

Capacity factor (%)	60%	O&M (% of capex)	2%
Availability (%)	100%	Discount rate (%)	10%
		Project life (yrs)	30

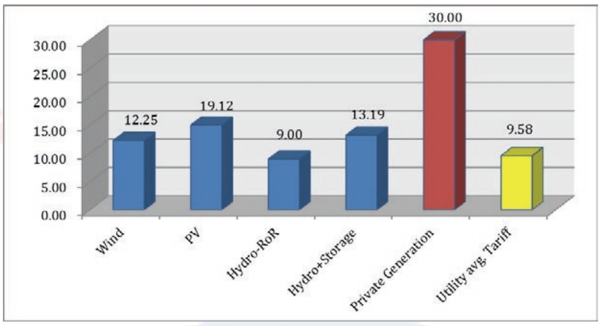

Fig. 1. The levelized costs of various RE resources, private generation, and utility tariff.

The following can be concluded from Fig. 1:

- When the average tariff of the utility is corrected and set at 15 USC/kWh to achieve a break even for the utility, then several RE technologies will become economically viable especially if feed-in tariff with incentives is further adopted for RE suppliers.
- When cost of RE sources is compared to the cost of private generation which is in the range of 30 USC/kWh, it would be more feasible for end users to switch to RE which is economically more viable.

At the national level, the most realistic scenario for incorporating RE technologies in the energy mix is based on the introduction of additional wind turbines, hydro units, PV arrays and waste to energy during the years 2014-2018 as follows:

- Rehabilitation of existing hydro power plants will restore the available 190 MW to the originally installed 283 MW.
- A 77 MW hydro capacity can be added based on the SOGREAH and CEDRO studies [5,8,9].
- A 100 MW Wind capacity can be added based on the recently published wind atlas data [10].
- A 25 MW Waste capacity can be added based on the Ministry's policy paper and the National Bioenergy Strategy for Lebanon [7].
- A 15 MW PV capacity can be added based on the expected market development as a direct result of UNDP and private sector activities in the solar field.

The results of the analysis of the above scenario are given in TABLE VII.

TABLE VII
RESULTS OF THE SIMULATION FOR SELECTED YEARS FROM THE MOST REALISTIC MITIGATION SCENARIO: ALL POSSIBLE RE TECHNOLOGIES

Parameter	2009	2015	2020	2025
Average CO_2 Emissions - only thermal (gr/kWh)	778	454	470	484
Average CO_2 Emissions – including renewables (gr/kWh)	635	397	419	437
CO_2 Emissions – including renewables (Tons CO_2)	7,319,424	8,847,173	11,552,405	13,122,864
CO_2 Emissions – Private Generation (Tons CO_2)	2,164,523	22,803	570,555	1,837,722
Total CO_2 Emissions (Tons CO_2)	9,483,947	8,869,976	12,122,960	14,960,587
% RE of Total MW Generation Mix (%)	11.30%	10.28%	12.01%	12.01%

Although not shown for all years, it can be seen from this table that the CO_2 emissions resulting from private generation are almost eliminated for the period extending from 2014 until 2017 due to the penetration of RE during those years. Starting 2018, the emissions resulting from private generation start to increase as the gap filled by PG increases due to demand increase. It should be noted that the proposed scenario establishes the 12% penetration level of RE as committed by the Government.

The total energy generated from the RE scenario as well as the savings in CO_2 emissions compared with business as usual scenario in which no investment is committed to RE development are 8.77TWh and 4,145,696.59 tons of CO_2 saved. It is clear from these figures that RE can have a significant contribution to the energy mix, meet the national penetration target of 12% and contribute to CO_2 emission reduction at competitive prices. The implementation of the 8.77TWh in practice can be either by private power producers at the level of individual houses, commercial and industrial enterprises and/or by government sponsoring large projects such as developing wind farms, PV plants and other applications. The fact that diesel generators will continue to play a role till the year 2025, is a proof that hybrid schemes based on PV-diesel, Wind-diesel, hydro-diesel and any combination of them will most likely be implemented by private investors to save on diesel operational cost due to price differential in favor of RE.

IV. CURRENT GOVERNMENT POLICY TO FACILITATE THE PENETRATION OF RE AT 12% RATE BY 2020

The new renewable technologies face a range of barriers to achieving wide-scale deployment and maturity of the market. The most common barrier for both types of systems, however, is the cost of the technology. In addition, it is essential that for grid-connected systems, there are grid code and power purchasing arrangements in place. In addition, there is a need to adopt an adequate certification scheme with associated testing standards and enforcement mechanisms, build the capacity of the local supply side and targeted end users so as to prevent early market failure due to bad quality hardware or installation.

Legislation is currently being considered to introduce Feed-in Tariffs (FIT) at EDL, which would go a long way towards removing economic barriers to the use of PV and wind turbines. Allowing the private sector to invest in the energy sector would also require the amending of the privatization Law # 462 as was stated above.

Another clean electricity production incentive tool is Net Metering (NM). Piloted in Lebanon in February 2012, net metering allows consumers to inject generated power at their premises into the grid. By July 2012, the number of participants in NET Metering reached 20 with 2 residential participants and 18 participants from municipalities. Unlike FIT, the consumer will be charged he net balance of electric energy supplied and consumed. Neither FIT nor NM can realize their full potential, however, unless electricity is on the grid 24 hours a day.

Funding of RE projects is expected to be mainly provided by the National Energy Efficiency and Renewable Energy Account (NEEREA) [6], a joint cooperation between the Lebanese central bank, UNDP, the EU, the MoEW, the Lebanese center for energy conservation, Lebanese banks and private investors. So far, the account has received €24 million from the EU and it is expected to raise $100 million locally to be invested in energy efficiency, renewable energy, and green building projects. It is anticipated that many economic sectors and interest groups (SMEs in agriculture, industry and hospitality) will be competing for limited funds.

The Draft Energy Conservation Law approved in early 2012 by the Council of Ministers and currently waiting for the approval of the Parliament provided MoEW a framework for mainstreaming energy efficiency & RE activities in Lebanon, and would institutionalize the Lebanese Center for Energy Conservation as the lead energy entity in the country for the management of EE & RE activities.

V. CONCLUSION

This paper presented an overview of renewable energy planning in Lebanon and it investigated the potential of developing additional power supply using RE sources in order to reduce dependence on private generators and achieve a higher RE share of 12% in 2020. The analysis revealed that despite the Government plans in the immediate term, Lebanon is likely to continue to rely on backup diesel generators, which produce expensive energy and significantly contribute to CO_2 emissions. The paper demonstrated that renewable energy can significantly contribute to the energy supply and hence reduce dependence on diesel generators in the short term and contribute to the establishment of sustainable energy supply sector in the long term. Both municipalities and the private sector can introduce such RE systems easily because of the obvious energy generation cost advantage compared to diesel generators and some thermal power plants. RE can also be introduced at the national level to contribute to the Government plans in the medium and long terms through the development of wind farms, PV power plants, waste to energy power plants and the further increase of micro and hydro power plants.

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An Analysis of Comprehensive Effectiveness of Tokyo's Climate Policies

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Abstract

This paper focuses on two Tokyo climate initiatives which aim to meet climate change mitigation measures, such as carbon reduction targets and energy efficiency measures. The first initiative is the Tokyo Cap and Trade Program, which was launched in April 2010 by Tokyo Metropolitan Government (TMG). This was the world's first cap-and-trade programme that included facilities in the public, commercial, and industrial sectors (TMG, CCS 2007). While the Tokyo Cap and Trade Program focuses on CO2 reduction by restricting energy consumption, the Tokyo Green Building Program focuses on energy efficiency measures that employ environmentally friendly design principles. Both initiatives have a multiplier effect that meets the overall low-carbon and energy efficient objectives established by the city. These initiatives significantly contribute to demand-side management efforts to reduce energy consumption and change human behaviours, thus raising the awareness of a range of stakeholders and users. Alongside the difficult energy issues incurred by the 2011 earthquake and tsunami that hit Japan, energy management and decentralised energy systems employing renewable energy have been strongly emphasised. Even though local climate change policies are limited by the resources and powers of local government, these climate initiatives should be expected not only to promote climate mitigation measures, but also to create fundamental social structural changes including governance and institutional frameworks and even funding mechanisms. Therefore, this paper attempts to explore co-benefits and find the linkage across climate policies, planning policies, and other social factors.

Keywords: Climate Change, Sustainable Development, Energy Efficiency

1. Introduction

Tackling climate change is an inevitable factor in ensuring the world's long-term future. The increasing efforts of global warming can no longer be ignored. Most of governments throughout the world have already made significant efforts to improve energy efficiency, establish and realise carbon reduction targets, and protect energy security for projected increases in demand.

Tokyo is located in the central main island in Japan, has a population of approximately 13 million, and a land area of 2,188 square kilometers.

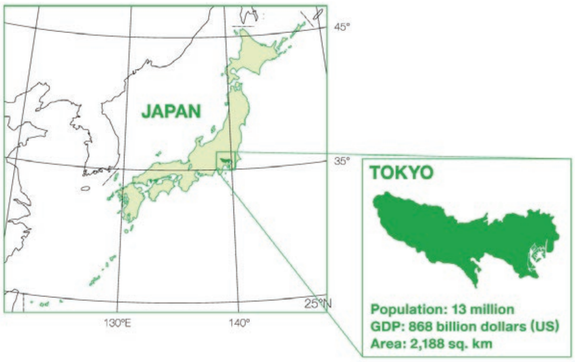

Figure1.1: Tokyo Facts
(Source: Tokyo Metropolitan Government, 2007)

Under a 10-year project started in 2007, Tokyo set a reduction target of 25 per cent for greenhouse gas (GHG) emissions below year 2000 levels by 2020 (TMG CCS 2007). As for per capita emissions, Tokyo is 20–30 per cent lower than London and New York. However, the GHG emissions in the Tokyo region are continuing to increase (TMG CCS 2007). The Tokyo region requires dynamic structural changes to meet reduction targets in each sector.

Tokyo Metropolitan Government (TMG) has implemented a number of mitigation strategies towards long-term climate change strategies. However, the effects of these policies have not been practically monitored. By focusing on two main climate change initiatives established by TMG, effective mechanisms and institutional patterns will be investigated.

In order to achieve target GHG emission mitigation and adaptation objectives, TMG must accelerate energy efficiency and renewable energy initiatives throughout the city. Energy efficiency and renewable energy initiatives on such a scale will require substantial amounts of capital and effective organisational structures. In addition, the linkages between sustainable development and climate change strategies should be considered in an urban context.

This paper aims to observe the good practice of climate change policy measures on a city scale. Governments have little experience in initiating change by using legislation, policies, and regulations (Girardet 1999). As for low-carbon infrastructure development relating to climate change, implementations are tailored to local situations. Thus, it is important to identify what circumstances and what type of stakeholders should be involved in each implementation.

By gathering feedback from a set of stakeholders, the overall effects and practicality will be assessed in a realistic approach to find pragmatic results in the short term. Subsequently, the long-term effectiveness of the measures implemented should be investigated.

2. Research Questions

What policies can succeed in delivering low-carbon and energy-efficient infrastructures in Tokyo?

Investigating two Tokyo city initiatives – the Tokyo Cap and Trade program and the Tokyo Green Building program

2.1 Key Questions

The list of the key questions that will be discussed in the report is shown below.

- What are the current climate policies for the deployment of energy efficiency and renewable energy in the Tokyo region?
- How important is planning for the strategic deployment of renewable energy and promoting energy-efficiency measures to meet climate mitigation targets in a Tokyo context?

3. Literature Review

3.1. Climate Change Strategy, World Overview and Cities

The Stern Review (2006) identified three sets of policy measures that are essential to shift the economy into low-carbon development. First, carbon pricing provides an economic incentive for key players to promote the transformation of the low-carbon market because it encourages players to minimise the impact associated with their investments and production on their economic well-being. Second, tailored technology support that enhances the performance and cost-effectiveness of new carbon-reducing technologies is necessary. In addition, this could create sufficient demand for new technologies. Third, experience regarding energy-efficiency opportunities should be shared more broadly beyond sectors and countries, which will require a shift from current institutional and behavioural patterns. These shifts can be promoted by specific policies and programmes. Therefore, tackling climate change and improving energy-efficiency requires a widespread and broad portfolio of climate-friendly technologies. On the supply-side, increasing quality, efficiency and scale − while reducing costs – is nessesary (Neuhoff 2011).

To achieve this, governments are likely to implement policies to enhance new carbon intensive technologies for achieving targets. These policy frameworks encourage private actors, which accelerate the implementation of new technology at affordable prices to the market. In addition, international cooperation can enhance such a long-term policy framework (Neuhoff 2011). However, while green economy tends to be encouraged in a climate policy context and sustainable development, Constable (2011) warns that there are supporting papers that estimate the transition to renewable energy will cause a significant amount of job loss over the twenty years. It must be noted that a purely market-driven process will not be able to promote the changes that are most needed; therefore, governments at the global, national, and local levels must create relevant policy frameworks to support sustainable social and economic activities. These points may not be able to be ignored when governments plan dramatic fundamental social system changes.

On the other hand, renewable energy resources can significantly minimise the risks of climate change caused by rising GHG, which are emitted in large part by the burning fossil fuels. Renewables can also reduce dependence on imports that might cause economic and political instability (Neuhoff 2004). Renewable technologies can already be cost-competitive provided a renewable plant is located in an area with sufficient resources and low-cost access to the grid (Ueta 2011).

In terms of the potential of decentralised energy systems to contribute to carbon savings and energy efficiency, Girardet (1999) stated the importance of comprehensive strategies for transforming cities; for example, the very density of urban forms offers opportunities for energy efficiency in transport access, home heating, and delivery of services. Local level policies can create much potential for specific urban transformations and social structural changes in local context, and policy implementation must be tailored very closely to local situations (Giradet 1999). Giradet also recommended the transferability of the best urban practices and flexibility of direct access to best practice examples through a dynamic system of decentralised co-operation between cities.

To promote decarbonisation on an urban scale, Rydin (2011) indicated that decentralisation of energy generation is a distinct practice and that a number of high-income countries that have heavily centralised systems tend to shift to decentralised systems. In this process, spatial planning and regulations can contribute to promoting greater decentralisation of energy systems. However, spatial planning and regulation are not enough, on their own, to ensure successful deployment of energy technologies. Energy systems have to be operationalized; thus institutional arrangements are significant as well as delivering reasonably priced energy alongside carbon reductions. Considering these institutional arrangements includes the range of stakeholders within spatial planning governance networks. The important point is that decentralised energy systems need − most importantly − to involve not only energy infrastructure providers, but also organisations to manage the infrastructures, which means communities and local business may be included within decentralised systems. (Rydin 2011).

3.2 Tokyo's Climate Change Strategy

TMG has set a GHG reduction target of 25% from the 2000 level by 2020. As the first step of its climate change mitigation strategy, TMG stated two principles. First, promotes reduced energy consumption by completing implementation of energy conservation programs as well as providing new building regulations. Second, it encourages the use of renewable energy and enhances the new energy market (TMG CCS 2007).

3.3 Current Status

3.3.1 Trends of Green Gas Emissions within Tokyo

Green gas emissions in Tokyo have increased by 3.3 per cent in 2005 compared to the 1990 levels. Carbon Dioxide (CO2) dominated 96.3 per cent of emissions and increased 5.7 per cent from1990.

Greenhouse Gas Emissions in Tokyo (tentative values for fiscal 2005)
(supposing that electricity's CO_2 emission factor is fixed at the fiscal 2001 level of 0.318t-CO_2/MWh)

		Emissions (in Mt-CO_2 equivalent)			Growth from base year		Growth from previous year	
		Base year	FY2004	FY2005	Growth rate (%)	Growth amount (Mt-CO_2)	Growth rate (%)	Growth amount (Mt-CO_2)
Carbon dioxide (CO_2)	Industrial sector	9.9	5.4	5.6	-43.4%	-4.3	3.2%	0.2
	Business sector	15.8	20.2	21.0	33.0%	5.2	3.9%	0.8
	Residential sector	13.0	14.2	15.0	15.3%	2.0	6.2%	0.9
	Transport sector	17.9	20.1	19.3	7.7%	1.4	-4.0%	-0.8
	Other	1.0	1.0	1.0	-0.9%	-0.0	1.3%	0.0
	Total for CO_2	57.6	60.8	61.8	7.4%	4.3	1.7%	1.0
Total for other greenhouse gases than CO_2		3.4	2.3	2.2	-36.4%	-1.3	-5.6%	-0.1
Grand total		61.0	63.1	64.0	5.0%	3.0	1.5%	0.9

Table 3.1: CO2 Emissions in Tokyo (tentative values for fiscal 2005)
(Source: Tokyo Metropolitan Government, 2007)

As for the CO2 by sector, its percentage in the commercial sector has increased by seven per cent from 1990 to 2005 based on the composition ratio. Concerning the trends after 2000, the transportation and industrial sectors tend to decrease, while the commercial sector and household sectors indicate a continuous upward trend. Considering these trends, TMG has decided to take action to reduce CO2, particularly in the commercial and residential sectors (TMG 2008).

3.4.2 GHG emissions and Energy Consumption Trends for Tokyo

Energy-related carbon dioxide (CO2) accounted for around 95 per cent of GHG emissions in Tokyo. CO2 emissions in the city have increased, and energy consumption has also expanded ten per cent over the period. However, comparing FY2006 with FY2000, CO2 emissions in Tokyo decreased by two per cent and energy consumption decreased around four per cent (TMG 2010)

		Energy Consumption (PJ eq)				%		
		1990FY	2000FY	2005FY	2006FY	1990-2006	2000-2006	2005-2006
Energy Consumption (PJ)	Industry sector	129.1	96.5	80.7	76.3	-40.9%	-20.9%	-5.5%
	Commercial sector	182.6	245.2	273.4	266.2	45.8%	8.6%	-2.6%
	Residential sector	171.8	202.1	217.0	207.9	21.0%	2.9%	-4.2%
	Transportation sector	213.0	257.4	218.3	214.2	0.6%	-16.8%	-1.9%
	Total	696.4	801.3	789.4	764.6	9.8%	-4.6%	3.1%

Table 3.2: Energy Consumption by sector in Tokyo
(Source: Tokyo Metropolitan Government, 2010)

By energy type, electricity dominated approximately 50 per cent of CO2 emissions in Tokyo, followed by fuel Oil (28%) and city gas (17%). Since FY1990, the emissions of city gas steeply decreased due to the obvious shift from gas to fuel oil and other factors. CO2 emissions from the use of fuel oil and LPG have decreased by around 20 per cent. However, emissions from electricity use have increased around 15 per cent, along with city gas use (TMG 2010).

	CO_2 Emissions (10,000 t-CO_2eq)					Energy Consumption (PJ eq)				
	FY1990	FY2000	FY2006	1990-2006	2000-2006	FY1990	FY2000	FY2006	1990-2006	2000-2006
Fuel Oil	1,960	1,934	1,547	-21.1%	-20.0%	287	285	228	-20.6%	-20.0%
LPG	206	192	147	-28.6%	-23.4%	34	32	25	-26.5%	-21.9%
Manufactured Gas	680	926	976	43.5%	5.4%	137	187	199	45.3%	6.4%
Electricity	2,460	2,696	2,817	14.5%	4.5%	233	296	313	34.3%	5.7%
Others	132	137	101	-23.5%	-26.3%	4	2	0	-100.0%	-100.0%
Total	5,437	5,885	5,588	2.8%	-5.0%	696	801	765	9.9%	-4.5%

Table 3.3: CO2 Emissions and Energy Consumption by energy type fuel in Tokyo
(Source: Tokyo Metropolitan Government, 2010)

4. Methodology

Public policies should be assessed to identify their effectiveness in achieving their stated objectives. In addition, other possible approaches that might be able to achieve similar goals should be identified. This thesis focuses on two climate initiatives and the renewable strategy set by Tokyo Metropolitan Government. By analysing each policy's driving forces and barriers, the key factors that are likely to realise the policy objectives, or lead to difficulties will be identified.

4.1 Document Analysis

Most of the basic information regarding Tokyo's climate change strategy was collected from the official website of Tokyo Metropolitan Government. This is a first logical step to identify key policies and strategies set by TMG.

The documents that will be analysed are listed below. However, there were no up-to-date documents available on either the website or the office. Therefore, it was difficult to find the latest data, especially data generated after the Great East Earthquake of 2011.

- Tokyo Climate Change Strategy (TMG CCS 2007)
- Tokyo Climate Change Strategy Progress Report (TMG PR 2010)
- Tokyo's Climate Change Measures (TMG CCM 2007)
- On the path to a low carbon city (TMG LCC 2011)
- Tokyo Renewable Energy Strategy (TMG RES 2006)
- Stakeholder meeting report (TMG SMR 2007, 2008)
- Tokyo Metropolitan Environmental Mater Plan (TMG EMP 2008)

4.2 In-depth Interview

In order to collect realistic data, an in-depth interview is necessary. Several hypotheses and detailed questions will be developed, and then interviews will be conducted with several key actors and stakeholders relating to climate change and energy issues in Japan and within the Tokyo Metropolitan Government. This process can help understand real situations and obtain the latest primary information, since policy documents do not always provide detailed, realistic data.

Most interviews lasted for approximately one hour. Climate change and energy issues are currently very sensitive topics in Japan, thus most interviewees were not willing to allow the interview to be recorded. However, most interviewees were willing to provide internal specific documents as well as official information. Also, they permitted the interviewer to take notes. Therefore, a great deal of documents and brochures could significantly support the analysis of the results of these interviews recorded as notes and transcripts.

Actor

Organization	**Interviewee**	**Position/Department**
METI	METI 1	Chief Negotiator of COP15 for Japan
TMG	TMG 1	Planning official, Environmental Dep.
	TMG 2	Energy Efficiency official , Environmental Dep.
	TMG 3	Renewable Energy official, Environmental Dep.
Kyoto University	KYOTO 1	Professor, Chair of FIT committee of METI
Chiyoda-ku	Chiyoda 1	Official, Planning Dep.

Table 4.1: Interviewees' List for Actors (2012)

Stakeholder

Keidanren	Keidanren 1	Official, Environmental Dep.
Japan Business Federation	JBF 1	Official, Environmental Dep.
Tokyo Chamber of Commerce and Industry	TCCI 1	Official, Environmental Dep.
Tokyo Electric Power Company	TEPCO 1	Operator (Public Information)
Japan Council for Renewable Energy	JCRE 1	Official, Environmental Dep.
Tokyo Building Owners and Management Association	TBOMA 1	Official

Table 4.2: Interviewees' List for Stakeholders (2012)

5. Case Background

5.1 Tokyo's Climate Change Strategy Policy Measures

As CO2 emissions trends in the commercial and residential sectors increase, TMG has launched specific policy measures to reduce CO2 emissions in large facilities and office building sectors (TMG 2010). This paper investigates two major initiatives; namely, the Tokyo Cap and Trade Program and the Tokyo Green Building Program.

5.1.1 Tokyo Cap and Trade Program

TMG set a cap at the city level on emissions from large commercial and industrial buildings. This program focuses on mainly demand-side management. Since the implementation, there is high expectation on its effectiveness as a measure set by local government (Nishida and Hua 2011).

This program was planned to target existing buildings that consumes large amounts of energy. Thus the program covers about 1,300 large–scale facilities that emit 40 per cent of all CO2 emissions in the commercial and industrial sectors. The total cap on the targeted sector is six per cent below base-year for the first five years (2010-2014). In the second stage, these facilities will be expected to reduce their emissions 17 per cent below base-year emissions.

The responsibility for emissions reduction falls onto building owners, with whom tenants are required to cooperate with the building owners to achieve reduction targets and report the progress. Building owners who fail to meet the reduction targets are fined as much as US$600 and surcharged a maximum of 1.3 times the cost of unfilled reductions (Nishida and Hua 2011).

This scheme allows business owners to choose the most cost effective methods of reducing emissions, including emission trading. For instance, this program introduced three types of emission offsets such as emission reduction from small and medium size facilities, renewable energy credits, and emission reduction outside of Tokyo (TMG 2007). While CO2 emission mitigation is the main goal of Japan's Cap and Trade Program, it may have a beneficial effect on creating new markets for green products and technologies (Nishida and Hua, 2011).

Another significant feature is that, in TMG's program, the carbon market is organized as semi-closed and is no linked to other global markets. This mechanism can reduce the risk of market-based trading schemes. Also, this program was designed in a simple way that targets only energy-based CO2 emissions with clear data sources that exist for CO2 inventory calculation. Such simplicity helped stakeholders to understand the programme.

In TMG's Cap and Trade Program, consensus building was a significantly important key factor to motivate and engage stakeholders. After announcing the program in 2007, TMG collected opinions from business sectors, NGOs, academics and other main stakeholders (Nishida and Hua, 2011). The key system for building effective consensus consists of expert panels, stakeholder meetings, and forums, seminars, and workshops. In the Japanese policy-making process, these consensus processes featuring a wide range of stakeholders in a public place is rare.

Items	Description
Facilities covered	**1,300 large CO_2-emitting facilities** in the Tokyo area that consume more than 1,500 kiloliters (crude oil equivalent) of energy annually •Individual facilities or buildings are the basic unit of emissions reduction obligations and emissions trading •In principle, responsibility for meeting obligations on facility owners
Gas covered	Energy-related CO_2
Compliance periods	**Two five-year periods (fiscal years)** •First period: 2010 to 2014 •Second period: 2015 to 2019
Emission caps	**6%** reduction below base-year emissions (first compliance period) About **17%** below base-year emissions (second compliance period)
Base-year emissions	Average emissions of three consecutive years between 2002 and 2007
Emission allowance	Base-year emissions × (1-compliance factor*) × 5 years * **6%** for factories, **8%** for office buildings and other facilities
Emission trading	Excess reductions (beyond compliance factor) are tradable after second year
Offsets (credits)	**Three types of offset credits** are currently permitted •Emission reductions from small and midsize facilities in Tokyo •Renewable energy credits •Emission reductions outside Tokyo area
Reporting, verification	Verified reporting is required every year based on TMG guidelines Verification agencies are registered by TMG governor.
Banking, borrowing	Banking to the second commitment period is permitted. Borrowing is not permitted.
Tenant obligations	Tenants are required to cooperate with emission reduction measures taken by building owners. Specified tenants using a large floor area or a large amount of electricity are required to submit their own emission reduction plans to TMG via the building owner, and to implement the plans.
Penalties	Fines, charges (up to 1.3 times the shortfall). Violation will be published.

Table 5.1: Tokyo Cap and Trade Program

(Source: On the Path to a Low Carbon City: Tokyo Metropolitan Government, 2010)

5.1.2 Tokyo Green Building Program

Every new construction a large building (over 5,000 square meters in total floor area) in the Tokyo region is required to employ environmentally friendly design principles. Under this program, more than 1,500 buildings have disclosed their 'Green Specs' since 2002. Through this rating and reporting system, the Tokyo Green Building Program aims to create a greener building market in which energy-efficient and environmental buildings can be more valued than less-green buildings. The most recent revisions to the programme added the requirement of a feasibility study for the use of renewable energy devices on site (TMG PR 2010).

In the Tokyo Green Building Program, environmental performance is evaluated by twelve items in the four categories (see Table 5.2). Each item will be described as part of a three grade rating system (TMG PR 2010). After addressing the Tokyo Green Building Program in 2002, all large-scale buildings have been assessed for environmental performance, then the results are published on the city's website.

Items	Description	
Facilities covered	Newly planed large buildings over 5,000 square meters in total floor area	
Items assessed	Categories	Items
	Energy	Building thermal load (insulation) Renewable energy devices (on-site renewables) Energy-efficiency systems (building equipments) Building energy management systems
	Resources, materials	Use of eco-friendly materials, ban on the use of fluorocarbons, longer building life, water recycling
	Natural environment	Greening, landscaping, bio-diversity, water conservation
	Heat-island effect	Heat emissions, ground surface cover, wind environment
Rating	Each item is rated using three rating grades (1-3)	
Reporting, disclosure	Environmental plan and rating results must be reported before applying for a building permit. Ratings are displayed with charts on TMG website.	

Table 5.2: Tokyo Green Building Program

(Source: On the Path to a Low Carbon City: Tokyo Metropolitan Government, 2010)

6 Finding and Analysis

6.1 Introduction

TMG focuses on two principles for climate change mitigation measures. The one is energy efficiency measures and the other is deployment of renewable energy. To realise these principles, the Tokyo Cap and Trade Program and the Tokyo Green Building Program have had remarkable effects in the Tokyo context (TMG CCS 2010). These policies can create a positive linkage between regulation, planning policy, and the development of market mechanisms. The alliance between CO2 reduction programs and green infrastructure deployment may have a positive multiplier effect. Furthermore, a wide range of stakeholders such as NGOs, industry representatives, experts, and citizens have participated actively and played an important role in the policy-making process and implementation phase (TMG CCS 2007). This may lead to a significant change in institutional patterns and the creation of innovative market mechanisms for deployment of low-carbon and energy efficiency infrastructures in the Tokyo context.

6.2 Analysis of the Tokyo Cap and Trade Program

TMG implemented its cap-and-trade program in 2010. After 2010, affected building owners have legal obligations to reduce their CO2 emissions by a certain amount. Most new, large facilities are energy efficient and are utilising as many green technologies as they can afford. Also, a number of old facilities have been renovated to be energy efficient under this policy (TMG PR 2010).

The strengths, weaknesses, opportunities, and threats (SWOT) relating to this policy will be identified through the use of document analysis and in-depth interview data.

6.2.1 Strengths

In terms of energy efficiency measures, Tokyo's Cap and Trade Program has directly contributed to efforts to reduce CO2 emissions and improve energy efficiency in large office building sectors. This has also succeeded in enhancing building owners' awareness of their need to reduce CO2 emissions. Tokyo Cap and Trade Program targets only energy-based CO2, thus energy efficiency measures were identified as much easier to understand for building owners than CO2 emissions measures because they can track them by checking their energy bills, and energy efficiency measures can directly contribute to cost efficiency itself; thus, building owners are willing to improve energy efficiency measures for their facilities (TMG interviewee 2 2012).

6.2.2 Weaknesses

As for CO2 emissions measures, however, it can be seen that it is still difficult to motivate building owners and tenants to make efforts to reduce CO2 emissions unless they can obtain benefits by reducing CO2 emissions or pay a penalty for not doing so. Thus, Tokyo's Cap and Trade Program can encourage building owners to meet its requirements as a strict obligation. However, there has been enormous discussion relating to the equity issue with this scheme. Specifically, it has been argued that there are no practical common indicators to identify precise energy efficiency measures for different specifications of buildings which were built in different periods and have different functions (Keidanren interviewee 2012, TBOMA interviewee 2012).

6.2.3 OPPORTUNITIES

The program allows building owners to use three types of offset options – buying credits from small and medium size facilities owners, adopting renewable energy, and reducing emissions outside of Tokyo – which brings multiple benefits for green technology deployment by creating new markets (TMG interviewee 1 2012).

The available offset options also lead to positive linkages with the energy efficiency measures achieved by small and medium facilities, as well as the expansion of green technologies. TMG has promoted energy efficiency measures for small and medium office facilities, and the housing sector, not as an obligation but as a voluntary action. Currently TMG has raised awareness heavily in this sector, because approximately 50 per cent of CO2 emissions from the commercial and industrial sector were generated by medium and small facilities (TMG interviewee 2 2012).

6.2.4 THREATS

The threat in Tokyo's Cap and Trade Program is that carbon is not a visible product. Therefore, it might be difficult to control in a limited region, making an international framework essential. However, organising the futures market to include carbon, thus enabling it to be given the same value as other commodities, might threaten the world market trading system. This point was emphasised by most of the interviewed business-sector stakeholders.

6.3 Analysis of Tokyo's Green Building Program

Energy efficiency measure is one of the big pillars of Tokyo climate change strategy. Japan has already proved its high energy efficiency in transport and building sectors comparing to other developed countries. To achieve climate change mitigation target, Tokyo has still much potential to upgrade their assets to be more energy efficient (TMG interviewee 1 2012).

6.3.1 STRENGTHS

The CO2 and energy efficiency reporting system established in the office building and housing sector under the Tokyo Green Building Program has significantly raised people's awareness of energy efficiency measures. The system is a very practical way to show people how much energy they have consumed and how it influences their energy bills. As long as it is impossible to regulate medium and small businesses, promoting behavioural change may significantly reduce the total amount of CO2 emissions and inefficient facilities. TMG interviewee 2 (2012) emphasised it becomes obvious to people that they can change their ordinary behaviours, or at least make an effort to do so, when they recognise their energy bills can be dramatically reduced.

6.3.2 Weaknesses

Little information has been provided to building owners to employ energy-efficiency equipment and latest green technologies for their buildings. Moreover, TMG has not prepared enough subsidies for building owners to upgrade the facilities. (TMG interviewee 1 2012) In addition, CO2 emissions in building scale heavily rely on the energy use of tenants, however, this policy focuses on only building owners, that is not practically effective to reduce overall energy demand in a city (TMG interviewee 2 2012).

6.3.3 Opportunities

After the Great East Japan Earthquake, people had to immediately change their behaviour relating to energy use due to significant energy shortages. It was an unprecedented situation that required strict measures; however, people in affected regions clearly demonstrated that it is possible to significantly reduce one's energy demand by changing one's daily behaviours (TMG interviewee 2 2012). An interviewee with TEPCO stated that there is an effective plan to provide smart meters to every household in the country, which will be subsidised by the central government in the near future. He also explained the importance of demand-side management to reduce the total amount of energy demand and CO2 emissions on the basis of the hard experience gained in the aftermath of the earthquake. This demand-side management, such as human behavioural changes, can significantly influence environmental performance under the Tokyo Green Building Program.

6.3.4 Threats

This policy covers only large-scale buildings over 5,000 square meters, however, 50 per cent of CO2 emissions are still emitted by small and medium size buildings that are very difficult to regulate and control through policy due to the complexity of grasping real facility data that is spread throughout the urban scale, in industrial and commercial sector in Tokyo (TMG interviewee 2 2012).

7. Conclusions

7.1. Introduction

Two key events have highlighted the need for fundamental social structural changes in Japan. Firstly, climate change is one of the greatest concerns on a global scale, including in Japan. A new global and national framework for tacking climate change issues is essential; moreover, cities' action plans can contribute considerably to reducing environmental risks in the short and long term. Tokyo's climate change strategy is one of the progressive examples of how an area can set its own targets for CO2 reductions and energy efficiency measures.

Secondly, the other significant event was the Great East Japan Earthquake in March 2011. After this event, Japan required physical and social mechanism changes due to massive energy issues caused by nuclear power accidents and successive energy security problems. Specifically, Tokyo had sourced most of its energy from nuclear reactors in the Tohoku region that were destroyed in the earthquake. The earthquake showed that megacities that with centralised energy systems that rely on energy supply that comes from outside their cities must reconsider their future energy systems.

7.2 Key Findings across the Two Initiatives

In terms of energy efficiency measures, Tokyo's Cap and Trade Program has significantly contributed to raise citizens' awareness and provided a number of energy efficiency measures for existing large facilities in Tokyo. Upgrading facilities may lead to the creation of an effective green technology market. TMG has attempted to enhance these new market mechanisms to deploy green innovations, thus creating an effective free market. Tokyo's Green Building Program has also succeeded in providing realistic visible data regarding energy efficiency measures by using a rating report system. Both the Tokyo Cap and Trade Program and the Tokyo Green Building Program can encourage renewable energy use for offsetting carbon credits and enhancing energy self-sufficiency.

The expansion of renewable energy production, on the other hand, comes with limitations for installing solar PV on the roofs of buildings, because it is not very cost effective and current solar PV performance has not been proven to produce sufficient energy for megacities such as Tokyo (TMG interviewee 3 2012). However, TMG takes the CO2 credits offset outside Tokyo and renewable energy production into account for creating new social systems to change the existing systems. Specifically, Tokyo's Renewable Energy Strategy requires upgrading the energy network infrastructure on a national scale. This also requires social structural change to realise the shift from the current centralised energy system to a decentralised energy system, including institutional pattern change.

A decentralised energy system might be key to replace the current nuclear and fossil fuel-based energy system with one that is based on renewable energy. However, this change requires enormous contributions from the political system to transform and upgrade existing physical infrastructures. A number of papers; for instance, those listed in the literature review section (3.5), and an interviewees stated that there are few contributions from the planning system to control a practical local master plan; moreover, municipalities have little power to put their own needs into a local master plan. Therefore, significant structural changes to the planning system are also required because renewable energy relies heavily on the local context.

Tokyo' s Cap and Trade Program	Driving Forces	Barriers
Economic Factor	- Semi-closed market (less risky) - Reduce energy related running cost (Energy Bill) - CO2 reporting system with providing subsidies for upgrading facilities.	- Strict obligation for only building owners - Market uncertainty - Lack of effective market for latest green technologies
Political Factor	- Effective consensus buidding (includes expert panel, stakeholders meeting, forums) - Three type of offset options - Raising awareeness	- Equity of setting caps - Lack of gathering feedbacks from stakefolders after implementation - There is possibility for business sectors to escape to outside of Tokyo where not being regulated.
Technical Factor	- Simple coodination as targeting only energy-based CO2 emissions	- There is no practical common indicators to identify precise energy effeiciency measures for differenet specs

Table 7.1: Tokyo Cap and Trade Program Analysis (Driving forces and Barriers)

Tokyo Green Building Program	Driving Forces	Barriers
Economic Factor	- Create greener building market - Energy efficiency is more valued that less greener buildings - Visibility of cost reduction	- Lack of public funds (subsidies) - Lack of effective funding mechanisms with private funds -Lack of effective green market for the latest energy efficiency equipment
Political Factor	- All results are published on the city' s website - Includes new and existing buildings - Raiding awareness - Change human behaviours	- Insufficient political framework which supports centralised energy system - Little contribution of planning policies
Technical Factor	- requirement of feasibility study of renewable energy - Linked to other rating systems (i.e. CASBEE)	- Complexity of grasping real facility data - Inflexibility of energy network infrastructure supporting current centralised energy system

Table 7.2: Tokyo Green Building Program Analysis (Driving forces and Barriers)

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Production of Amino Acid by R. Sulfoviridis Grown on Pineapple Peel Extract at Three pH Values

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Abstract

Organic waste generation in Nigeria is about 68,000tonnes per day. All these are thrown into the environment either untreated or buried in landfills, constituting environmental pollution. Some photosynthetic bacteria can utilize these wastes as source of carbon for growth and Rhodopseudomonas species have been implicated in waste treatment. In an effort to determine if R. sulfoviridis is associated with this hypothesis, 125ml of sodium succinate yeast extract broth supplemented with 0.5mM EDTA was inoculated with 6.25m1 (5%) of stream water collected from Uli town in Anambra State of Nigeria. Cultural characteristics included greenish turbidity in broth culture and branching large greenish colonies on solid agar medium. Motility was positive, Gram stain, negative and sulfide oxidation was sulfate, confirming the isolate to be R. sulfoviridis by Bergey's criteria. Previous studies have shown that R. sulfoviridis grows at pH range of 5.5 to 7.0 therefore ability of R. sulfoviridis to grow in pineapple peel extract without yeast extract and produce amino acid at three pH values, 5.5, 6.8 and 7.0 was monitored using amino acid analyzer, AAI109M002. There was a yield of different quantities of alanine, lysine, glutamic acid, aspartic acid, glycine, leucine, tyrosine, arginine, methionine and cysteine. On day 5, tyrosine was 2.88µg, 2.48µg and 1.38µg at pH 7.0, 6.8 and 5.5 respectively. Pineapple peel and R. sulfoviridis are useful for the actualization of environmental sustainability.

Keywords: Rhodopseudomonas sulfoviridis, Pineapple Peel Extract, Amino acid

Introduction

Most bacteria have the ability to degrade organic carbon compounds either in aerobic or anaerobic conditions with the production of primary metabolites (Agrawal, *et al.,* 2007; Jeong *et al*., 2008; Reungsang *et al.,* 2007) Among these bacteria are the purple non-sulphur photosynthetic bacteria which are metabolically versatile in nature. They can also grow both anaerobically in the light and aerobically in the dark (Kantachote, *et al.,* 2005.) This physiological nature has earned them a wide acceptance for industrial and environmental applications (Madukasi *et al.,*2011; Afsar *et al.,* 2011) Their use for environmental purposes coincides with their industrial importance in the sense that their primary metabolites produced in the process of treating any waste from the environment are usually products of commercial value when purified. Examples of such products which previous studies have shown include hydrogen gas (Jeong *et al.,* 2008; Gadhamshetty *et al*., 2008; Hasson, 2009); volatile fatty acids i.e. acetic, butyric and propionic acids (Sangyoka, *et al.,* 2007; Reungsang *et al.,* 2004) and single cell proteins (Bolliger, *et al.,* 1985). So far, there are no reports on the analysis of the growth culture of photosynthetic bacteria for the presence of such primary metabolites as amino acids, vitamins and nucleotides. It is therefore the aim of this work to investigate the growth culture of *Rhodopseudomonas sulfoviridis* grown in pineapple peel extract at three pH values for the presence of amino acids. The ability of the organism to grow on certain sugars was also investigated, for comparison.

Objectives

1) To isolate the organism, *R. sulfoviridis* by selective enrichment and characterize it by sugar fermentations and sulfate oxidation.
2) To determine the optimum pH for its growth
3) To investigate its ability to grow on pineapple peel extract, acetate, ethanol, fructose, glucose, malate, and succinate.
4) To analyze the culture medium for the presence of amino acids

Materials and Methods

Collection of Samples

The water sample was collected from Ubahudara stream in Uli town, Anambra State, Nigeria. Transparent plastic bottle that was disinfected with 100ppm sodium hypo chloride was used for the collection according to Mahakhan *et al.* (2002). The sampling was done in the dry season and was processed within 24hours of the collection

Isolation of *R. sulfoviridis*

This was done by selective enrichment and also by streaking an agar medium for single colonies. The medium used for this was sodium succinate yeast extract medium according to Lindquist (2000) and modified according to Hougandy *et al.* (2000) by adding 0.5mM EDTA. This according to Kern *et al.* (1992) will strongly inhibit the growth of *Rhodobacter* sp at this concentration. The medium composition is as follows:
This medium composition is in three parts.

1. Basal medium, consisting of KH_2PO_4, 0.33g; $MgSO_4.7H_2O$, 0.33g; $NaCl_2$, 0.33g; NH_4Cl, 0.5g; $CaCl_2.2H_20$, 0.05g; Sodium succinate, 1.0g; and yeast extract, 0.02g.

These were dissolved in 1L of distilled water; pH was 6.8. It was autoclaved at 121°C for 15mins and 15lbs pressure.

2. Trace salts solution consisted of $ZnSO_47H_2O$, 0.01g; $MnCbAH_20$, 0.003g; H_3BO_3, 0.03g; $COCl_2.6H_2O$, 0.02g; $CuCl_2.2H_2O$, 0.01g; $NiCb.6H_20$, 0.002g; and $Na2MoO_4$, 0.003g. These were dissolved in 1L of distilled water; pH was 4.0
3. Sterile solutions added after autoclaving the basal medium above, consisted of 1.0ml of the above mentioned trace salts solution and 0.5ml of 0.02% $FeSO_4.7H_2O$ solution.

Procedure for the Enrichment and Incubation of the culture

The culture bottles used for the enrichment were transparent glass bottles with stopped lids and 125ml in volume. Into each culture bottle, an 80ml volume of enrichment broth was aseptically dispensed and autoclaved at 121°C, 151b pressure for 15mins. Then varying volumes of the water sample (2.5ml, 6.25ml, 8.75ml, 12.5ml and 18.7Sml) representing 2%, 5%, 7%, 10% and 15% respectively, of the 125ml volume of the culture bottle, were dispensed into each culture bottle, containing the broth medium. For each percentage, a triplicate number of bottles were prepared. After this inoculation, each of the culture bottles was filled to the neck of the bottle with the broth medium in order to ensure that air bubbles are not trapped in the culture bottle. Some sterile Vaseline oil was placed on top of the culture medium in the culture bottles before they were covered with both foil paper and paper tape. This was to create anaerobic condition within the culture bottle according to Kantachote *et al.,* (2005). All the culture bottles were properly labeled for ease of identification and then placed on the laboratory bench to incubate at room temperature under illumination by 150W tungsten lamp, placed at a distance of 90cm from the culture bottles.

Streaking for pure isolates

The medium used is the same for the enrichment, but 1.5g agar – agar was added to solidify it for the streaking. The addition of agar - agar altered the pH of the medium which was 6.8 originally. However, it was readjusted by addition of 0.1ml Na0H solution to the required pH of 6.8, as above. The medium was then sterilized by autoclaving at 121°C, 15lb pressure for 15mins. After cooling about 20ml of the medium was dispensed into sterile Petri dishes and allowed to solidify. Sterile Vaseline oil was aseptically poured into the covers of each of the Petri dishes and allowed to solidify before being used to cover the plates. Cultures from the liquid enrichments were used for this streaking and afterwards, the plates were incubated on the laboratory benches at room temperature under illumination by 150W tungsten lamp placed at a distance of 90cm from the plates. The edges of the plates were also sealed with Vaseline oil and paper tapes.

Characterization of the Isolate

Using Manufacturer's instruction , 4.2g of nutrient broth, 2g of the indicator, 10g of each of the sugars and 10g of each salt, were separately dissolved in 100ml of distilled water. Later, they were sterilized by autoclaving at 121° C at 15Ib pressure for 15mins. After cooling, 1ml of each of the sterilized solutions was transferred into the test tubes containing the organism and these tubes were incubated under a light source for 48 – 72 hours at room temperature.

Growth of *R. sulfoviridis* on acetate, ethanol, fructose, glucose, malate, succinate, and pineapple peel extract at pH range 5.5, 6.8, and 7.0

One Gram of each of the carbon sources was measured and separately diluted in 41.4ml of sterile water. 1ml of peptone water and 0.5ml of KH2PO4 were also dispensed into the mixture. Also three drops of phenol red were added into it. This mixture was prepared in three sets each for one pH value being investigated, and for each range, triplicate test tubes were inoculated with the organism for the experiment. Durham tube was placed into each in an inverted position. Then the tubes were covered with cotton wool and incubated at room temperature under tungsten lamp for 14 days and monitored for gas production.

Growth medium for amino acid determination

The medium used to grow R. sulfoviridis for the determination of amino acid production was a modified version of the medium used for investigating its ability to grow. The only carbon source was pineapple peel extract and no yeast extract was added. The incubation condition was the same. At the end of the incubation, the medium was analyzed for amino acid presence using amino acid analyzer with serial number AA1109M002 done by Anima service Consult Nigeria, Ltd, Port Harcourt, Rivers State.

Results

Isolation and Characterization of the *R sulfoviridis.*

The cultural morphology showed that the organism is greenish in color. The Gram stain showed that the organism was Gram negative, the wet mount showed that the organism is motile. Sugar fermentation tests results and the phenotypic characteristics of the organism are presented on Table 1

Table 1 Phenotypic Characterization and Identification

Teats	**Reactions**
Color of culture	Green
Gram staining	-
Wet mount	Motile
Aerobic dark growth	+
Nitrate utilization	+
Sulfate utilization	+
Fermentation tests	
Glucose	-
Malate	+
Succinate	+
Fructose	+
Ethanol	-
Acetate	+

Estimation of optimum pH and sugar of best support for growth by turbidity and pigmentation

Table 2 shows the growth mode of *R. sulfoviridis* on acetate, ethanol, fructose, glucose, malate, succinate, and pineapple peel at pH 5.5. From days 1 to 6, no evidence of growth was observed. The first evidence of growth was recorded on day 7 and the growth ceased on day 14. Except glucose and ethanol which did not support the growth, the effect of the rest of the sugars and pineapple peel was the same.

Table 3 shows the growth mode of *R. sulfoviridis* on acetate, ethanol, fructose, glucose, malate, succinate, and pineapple peel at pH 6.8. From days 1 to 4, no evidence of growth was observed. The first evidence of growth by turbidity was recorded on day 5 while pigmentation was observed on day 6. The growth ceased on day 14. Glucose and ethanol did not support the growth but the rest of the sugars, and pineapple peel supported in equal mode.

Table 4.4 shows the growth mode of *R. sulfoviridis* on acetate, ethanol, fructose, glucose, malate, succinate, and pineapple peel at pH 7.0: from days 1 to 5, no evidence of growth was observed. The first evidence of growth by pigmentation and turbidity was recorded on day 6 and the growth ceased on day 14. Glucose and ethanol did not support the growth but the other sugars and pineapple peel did, in the same pattern.

Table 2: The different Carbon sources at pH 5.5

	Glucose		**Malate**		**Succinate**		**Fructose**		**Ethanol**		**Acetate**		**Pineapple peel**	
Day	**T**	**P**	**T**	**P**	**T**	**P**	**T**	**P**	**T**	**P**	**T**	**P**	**T**	**P**
1	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2	-	-	-	-	-	-	-	-	-	-	-	-	-	-
3	-	-	-	-	-	-	-	-	-	-	-	-	-	-
4	-	-	-	-	-	-	-	-	-	-	-	-	-	-
5	-	-	-	-	-	-	-	-	-	-	-	-	-	-
6	-	-	-	-	-	-	-	-	-	-	-	-	-	-
7	-	-	+	+	+	+	+	+	-	-	+	+	+	+
8	-	-	+	+	+	+	+	+	-	-	+	+	+	+
9	-	-	+	+	+	+	+	+	-	-	+	+	+	+
10	-	-	+	+	+	+	+	+	-	-	+	+	+	+
11	-	-	+	+	+	+	+	+	-	-	+	+	+	+
12	-	-	+	+	+	+	+	+	-	-	+	+	+	+
13	-	-	++	++	++	++	++	++	-	-	++	++	++	++
14	-	-	++	++	++	++	++	++	-	-	++	++	++	++

Turbidity –T
Pigmentation – P
Absence of turbidity and pigmentation –
Presence of turbidity and pigmentation +
Increase in turbidity and pigmentation ++

Table 3: The different Carbon sources at pH 6.8

	Glucose	**Malate**	**Succinate**	**Fructose**	**Ethanol**	**Acetate**	**Pineapple**

													peel	
Day	**T**	**P**	**T**	**P**	**T**	**P**	**T**	**P**	**T**	**P**	**T**	**P**	**T**	**P**
1	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2	-	-	-	-	-	-	-	-	-	-	-	-	-	-
3	-	-	-	-	-	-	-	-	-	-	-	-	-	-
4	-	-	-	-	-	-	-	-	-	-	-	-	-	-
5	-	-	+	-	+	-	+	-	-	-	+	-	+	-
6	-	-	+	+	+	+	+	+	-	-	+	+	+	+
7	-	-	+	+	+	+	+	+	-	-	+	+	+	+
8	-	-	+	+	+	+	+	+	-	-	+	+	+	+
9	-	-	+	+	+	+	+	+	-	-	+	+	+	+
10	-	-	+	+	+	+	+	+	-	-	+	+	+	+
11	-	-	+	+	+	+	+	+	-	-	+	+	+	+
12	-	-	+	+	+	+	+	+	-	-	+	+	+	+
13	-	-	++	++	++	++	++	++	-	-	++	++	++	++
14	-	-	++	++	++	++	++	++	-	-	++	++	++	++

Turbidity –T
Pigmentation – P
Absence of turbidity and pigmentation –
Presence of turbidity and pigmentation +
Increase in turbidity and pigmentation ++

Table 4: The different Carbon sources at pH 7.0

	Glucose		Malate		Succinate		Fructose		Ethanol		Acetate		Pineapple peel	
Day	**T**	**P**	**T**	**P**	**T**	**P**	**T**	**P**	**T**	**P**	**T**	**P**	**T**	**P**
1	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2	-	-	-	-	-	-	-	-	-	-	-	-	-	-
3	-	-	-	-	-	-	-	-	-	-	-	-	-	-
4	-	-	-	-	-	-	-	-	-	-	-	-	-	-
5	-	-	-	-	-	-	-	-	-	-	-	-	-	-
6	-	-	+	+	+	+	+	+	-	-	+	+	+	+
7	-	-	+	+	+	+	+	+	-	-	+	+	+	+
8	-	-	+	+	+	+	+	+	-	-	+	+	+	+
9	-	-	+	+	+	+	+	+	-	-	+	+	+	+
10	-	-	+	+	+	+	+	+	-	-	+	+	+	+
11	-	-	+	+	+	+	+	+	-	-	+	+	+	+
12	-	-	+	+	+	+	+	+	-	-	+	+	+	+
13	-	-	++	++	++	++	++	++	-	-	++	++	++	++
14	-	-	++	++	++	++	++	++	-	-	++	++	++	++

Turbidity –T
Pigmentation – P
Absence of turbidity and pigmentation –
Presence of turbidity and pigmentation +
Increase in turbidity and pigmentation ++

Analysis of the pineapple peel, *R. sulfoviridis* medium for the presence of amino acid.

At pH 5.5, production of amino acids started on day 4 and continued till day 6. The amino acids produced are alanine, arginine, aspartic acid, cysteine, glutamic acid, glycine, leucine, lysine, methionine and tyrosine. On that day 4, the percentage of the individual amino acids are 10%, 2%, 8%, 1%, 8%, 7%, 6%, 9%, 1%, and 4% for alanine, arginine, aspartic acid, cysteine, glutamic acid, glycine, leucine, lysine, methionine, and tyrosine respectively. On day 5, the percentage production for the respective amino acids was 10%, 4%, 8%, 1%, 8%, 7%, 7%, 11%, 3%, and 4%. On day 6, the yield was 10%, 2%, 9%, 2%, 9%, 9%, 7%, 8%, 2% and 4% for the respective amino acid, fig 1.

At pH 6.8, production commenced on day 4 and continued till day 6. Alanine, arginine, aspartic acid, cysteine, glutamic acid, glycine, leucine, lysine, methionine and tyrosine were produced and percentage of each on that day was 10%, 3%, 7%, 1%, 7%, 7%, 6%, 9%, 1% and 3% respectively. On day 5, the amount had increased to 9%, 3%, 11%, 1%, 9%, 7%, 10%, 9%, 2% and 4% for the respective amino acids. On day 6, the record obtained was 11%, 3%, 9%, 2%, 9%, 7%, 10%, 2% and 6% respectively, fig 2.

At pH 7.0, production began on day 4 and stopped on day 6. Alanine, arginine, aspartic acid, cysteine, glutamic acid, glycine, leucine, lysine, methionine and tyrosine were produced and the percentage of each on that day was 12%, 2%, 8%, 1%, 8%, 7%, 6%, 10%, 1% and 3%. On day 5, the amounts obtained were 9%, 5%, 12%, 1%, 10%, 7%, 10%, 7%, 3% and 6% for the respective amino acids. On day 6, yield was 12%, 3%, 10%, 1%, 10%, 8%, 7%, 12%, 3%, and 5% respectively for each of the amino acids, fig 3.

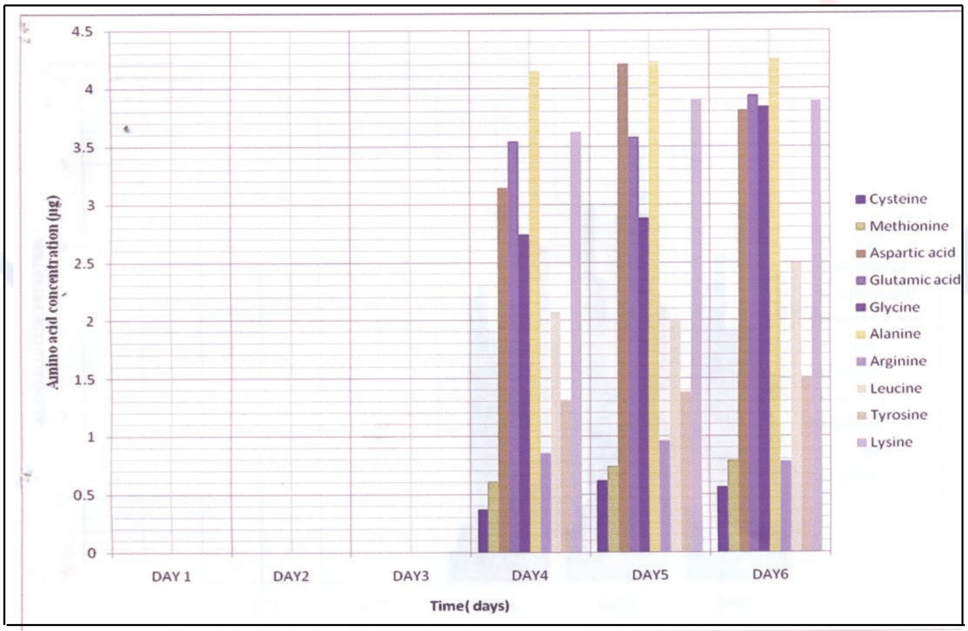

Fig 1: Amino acid production of *Rhodopseudomonas* sp in pineapple peel on bases of time at pH 5.5

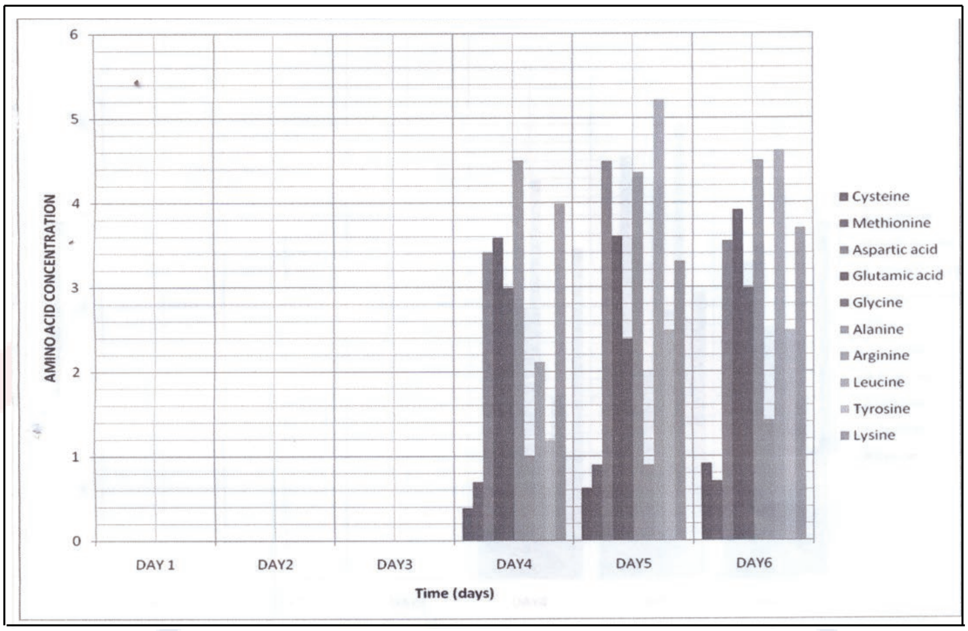

Fig 2: Amino acid production of *Rhodopseudomonas* sp in pineapple peel on bases of time at pH 6.8

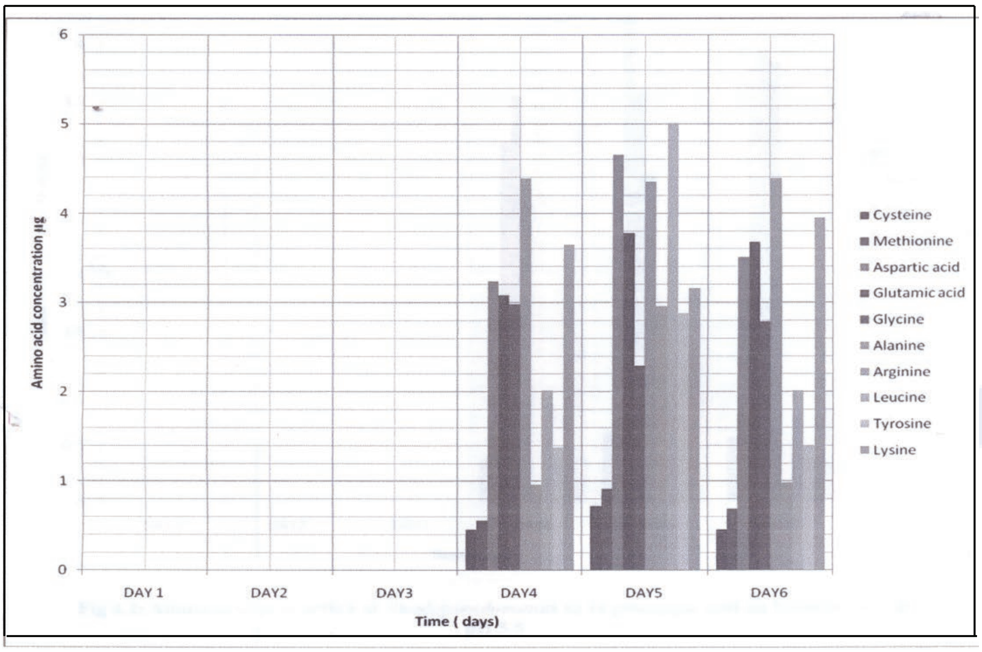

Fig 3: Amino acid production of *Rhodopseudomonas* sp in pineapple peel on bases of time at pH 7.0

Discussion

The form of selective enrichment used for the isolation of *R. sulfoviridis* was very effective according to Lindqunst (2005). The culture obtained was not a mixed culture of organisms, but a pure greenish bloom of spreading colonies whose Gram reaction was Gram negative. The wet mount showed motility and the organism exhibited positive for acetate, fructose, malate and succrunete but negative for ethanol and glucose. Both aerobic dark growth, nitrate and sulfate utilization were positive according to Bergey's manual of determinative bacteriology (1995).

The three pH values investigated supported the growth of *R. sulfoviridis,* Tables 2, 3 and 4. But growth was faster on pH 6.8 with a difference of two days for pH 5.5 and a difference of one day for pH 7.0. However, on pH 6.8, pigmentation was observed later on day 6 while turbidity was observed on day 5. This could be as a result of insufficient light supply since light switches off most often. On both pH 5.5 and 7.0, pigmentation and turbidity were recorded on the same days.

The sugars that supported the growth of the organism were acetate, fructose, malate and succinate. This confirms anaerobic photoheterophy (Kern, 1992). Pineapple peel extract also supported its growth in the same measure that the sugars did. Therefore pineapple is as good as those sugars for the growth of *R. sulfoviridis*. However, further investigations would have to confirm these facts. Pineapple peel is one of the waste substances thrown away into our streets, which constitute environment pollution. Its use for the growth of *R. sulfoviridis* will suggest a solution to that problem. Glucose and ethanol did not support the growth Tables 2, 3, and 4.

The amino acids that were detected in the medium were alanine, arginine, aspartic acid, cysteine, glutanic acid, glycine, leucine, lysine, methionine and tyrosin. Pineapple peel extract was the only source of carbon in this medium and yeast extract was not included in this medium. So, these amino acids detected were completely primary metabolites of *R. sulfoviridis* growing on pineapple extract. The presence of other metabolites was not investigated but our results clearly indicate that these amino acids were present in the culture medium after the incubation. In another unpublished work, nitrogen was detected in the medium in which this organism was grown.

Ammonium chloride NH_4Cl_2 was a component of this medium. Under anaerobic conditions, some bacteria carry out denitrification process, converting ammonium to nitrogen gas. Since this experiment was conducted under anaerobic conditions, we suggest that *R. sulfoviridis* is among the group of bacteria that carry out denitrification. In view of this result, we propose that further investigation on the ability of *R. sulfoviridis* to produce amino acids while growing on pineapple peel extract without yeast extract should be carried out.

Conclusion

This preliminary study proved the relevance of *R. sulfoviridis* to environmental sustainability and industrial importance. This is because it grew in pineapple peel extract in a similar manner that it grew on other sugars studied. The presence of amino acids was also detected in the culture medium to which no yeast extract was added.

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Life Cycle Cost and Assessment Model for Systems and Sources of Lighting in the Middle East

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Abstract

The construction sector in comparison to other sectors has the greatest environmental impact during its whole life cycle because of having the longest life span among other industrial products. This research is concerned with the long-term enhancement of the systems and sources of lighting in the Middle East represented by Egypt. Lighting is at the top of the residential electricity consumption in Egypt with an estimated 34 percent. Internationally, lighting is only second to HVAC in residential electrical consumption.
The research methodology is divided into three parts. Part one is a data collection about the extent of the application of the LCC and LCA in Egypt, the most important costs to be included in an LCC study and the areas of concern (mechanical works, electrical works … etc.) for an LCC study. This part is performed through a questionnaire distributed on 20 Construction Engineers with work experience ranging from 5 to 33 years. Part two is the framework of the LCA study that is adopted in this research. Part Three is the framework of the LCC study that is applied in this research. This methodology is crystallized through the formulation of an optimization model (LCCA-SSL) which integrates both LCC and LCA methods to help construction stakeholders in the decision making for the most sustainable lighting systems and lighting sources.
A case study has been selected to validate the model by comparing two lighting systems, Conventional System and Photovoltaic Solar System, and their corresponding lighting sources; namely, Lighting emitting diodes (LED), high pressure sodium (HPS), and metal halide (MH) within a 10 years period of analysis. The results showed that the best LCC selection is Photovoltaic Solar System using HPS Light Source which has lowest LCC and the best LCA selection is the Photovoltaic Solar System using LED light source which has the lowest carbon footprint. However, the best integrated alternative between both LCC and LCA is Photovoltaic Solar System using HPS Light Source which has the lowest LCC of and the second lowest carbon footprint.
A sensitivity analysis was conducted in order to measure the impact of changing the interest rate, the inflation rate and the period of analysis, where there is uncertainty in their assumption, on the LCC of each of the alternatives.
The model proposed in this study is user friendly and can be used by different construction stakeholders to optimize the use of systems and sources of lighting under environmental and long-term constraints.

Keywords: Life Cycle Costing (LCC), Life Cycle Assessment (LCA), Lighting Systems, Lighting Sources, Sustainability

INTRODUCTION

This research is conducted for enhancing the competitiveness of the construction industry through the application of sustainable measures. The construction sector in comparison to other sectors has the greatest environmental impact during its whole life cycle because of having the longest life span among other industrial products (Sterner, 2002). The building sector is responsible for about 40% of the society's total environmental impact (Paulsen, 2001). During the construction phase it consumes up to 40% of energy consumption, 50% of raw materials (Tupamaki, 2008), 25% of wood and trees expenditure, and 16% of fresh water usage (Paulsen, 2001). Consequently, it causes 40% of waste (Tupamaki, 2008), 35% of the world's CO_2 emissions, and 50% of ozone depletion (Paulsen, 2001).On the other hand, during the operation phase, the environmental impact of the building sector does not come to an end. However, it is still causing environmental impact through heating, ventilation, maintenance, and alteration (Sterner, 2002). The reduction of these environmental impacts has become highly needed. The reduction of the greenhouse gases emissions by about 50% before 2100 and the reduction of the CO_2 emissions by 70% before 2030, in order to avoid the increase in temperature by more than 1°C, are essential (Khasreen et al., 2009).

One of the areas that constitute the main bulk of economic and environmental impacts is selected to be the focus of the study. This area is the electricity utilization in lighting (Khasreen et al., 2009). The methods used in this research for the application of sustainable measures on the different sectors of lighting are Life Cycle Costing (LCC) and Life Cycle Assessment (LCA). This is performed through the formulation of a decision-support model (LCCA-SSL) which integrates both LCC and LCA methods to help construction stakeholders in the decision making for the most sustainable lighting systems and lighting sources.

Sustainability is defined as "***The development that meets the needs of the present without compromising the ability of the future generations to meet their own needs***" (Poveda, 2011). The sustainability concept can be best achieved using a socio-economical approach that applies Life-Cycle-Costing, LCC, and Life-Cycle-Assessment, LCA.

LCC is a ***technique used for the assessment and evaluation of a product/component or a building in general along its whole life in terms of its monetary value*** ("Task Group 4: Life Cycle Costs in Construction", 2003). Accordingly it tackles the economic pillar of sustainable development. LCA is a ***decision making tool used for evaluating and assessing the environmental impacts of a product/component or a building in general along its whole life*** ("Task Group 4: Life Cycle Costs in Construction", 2003). Hence, LCA tackles the environmental pillar of sustainable development.

One of the most important components to be studied because of its large amount of energy consumption which affects its life cycle cost and environmental impact is lighting systems and sources. In a study done to find out the most significant environmental impacts in office building in Finland, "electricity use in lighting, HVAC, and power outlets; heat conduction through the structure; manufacture and maintenance of steel, concrete, and paint; water use and waste water generation; and office waste management" came as priority (Khasreen et al., 2009). On the other hand the residential sector consumes the main bulk of electricity utilization in Egypt (Yassin, n.d).

Consequently, the development of a simplistic model that integrates life cycle costing and life cycle assessment methods and techniques for the optimization of the use of the most feasible and environmental friendly lighting systems and sources will enhance the construction industry competitiveness.

BACKGROUND

In order to apply LCC there has to be a known cost breakdown structure (CBS). According to BS ISO 15686 part 5, the CBS for LCC includes construction costs, operation costs, maintenance cost, end of life costs and finally the environmental cost which is optional.

Initial Investment (Construction) Cost reflects all costs of the asset before occupancy. According to the Life Cycle Costing Manual for the Federal Energy Management Program "*The costs incurred in the planning, design, construction and/or acquisition phase of a project are classified as initial investment costs. They usually occur before the building is occupied or a system is put into service*" (Fuller et al., 1996).**Operation Costs** is defined as *all the costs operating the building except for the maintenance costs; however these costs are not arising from its occupancy but arising from the asset itself* ("Standardised Method of Life Cycle Costing for Construction", n.d). **Maintenance, Replacement and Repair Costs** are either scheduled and anticipated costs or unscheduled and unanticipated future costs ("Life Cycle Cost Analysis Handbook", 1999). **End of Life Costs/ Residual Values** are *those costs which area payable at the end of the analysis period*. It is also referred to as the residual value. The residual value is defined as "the net worth of a building or building system at the end of the LCCA study period ("Life Cycle Cost Analysis Handbook", 1999). **Environmental Costs** is an optional step in the LCC study, which is done when the researcher or the user wants to include the environmental impacts in the LCC study. This is done through integrating LCC with life cycle assessment (LCA) study.

The core process of LCC is shown in Figure 1. Langdon's framework, which is based on this core process, is the one adopted in this paper. **LCC Data Collection** can be divided into five groups; occupancy data, physical data, cost data, performance data, and quality data.

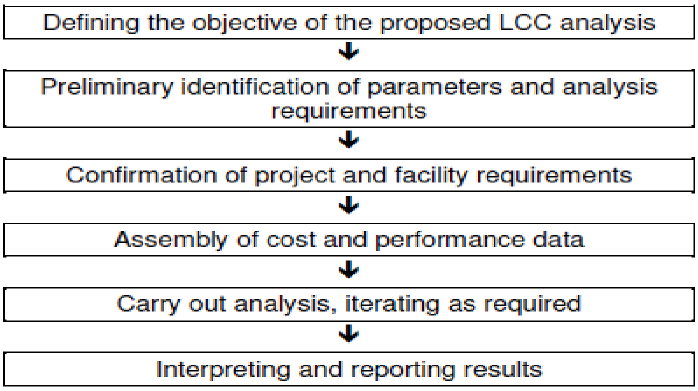

Figure 1– Core Process of LCC – Davis Langdon – "Life cycle costing (LCC) as a contribution to sustainable construction: a common methodology – Final Methodology". 2007

The international standard framework of LCA is based on the ISO 14040, which divides it into four phases as shown in figure 2; namely, goal and scope definition, inventory analysis, impact assessment, and interpretation.

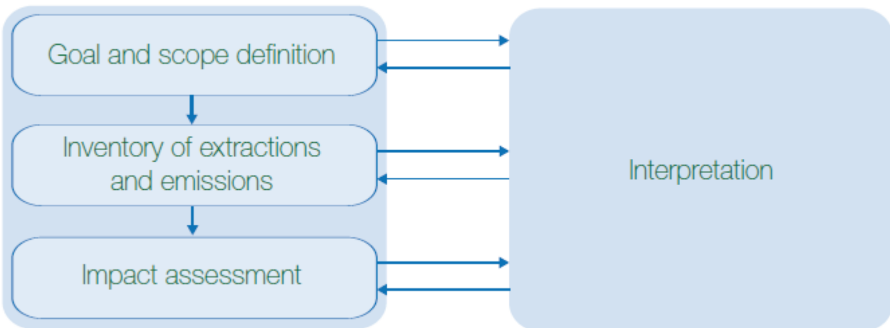

Figure 2 – ISO 14040 LCA Framework – Liu Guoguo – "Integration of LCA and LCC for Decision Making is Sustainable Building Industry". n.d

LIGHTING SYSTEMS AND SOURCES

Energy consumption is mainly distributed among four sectors commercial, residential, industrial and transportation. Electricity has a great impact on energy consumption. Residential sector's electricity utilization encompasses about 38%, commercial sectors about 36% while the industrial sector is about 26% ("Electricity Sector Overview", 2011). Lighting consumes more than one third of the total electricity in residential and commercial sectors in Egypt (Helal, 2008).

The most common types of lighting systems are **electricity, solar energy**, and the new emergent technology which is a hybrid system merging between both. There are four basic types of lighting sources such as incandescent, fluorescent, high intensity discharge (HID), and low pressure sodium (LPS), Figure 3, (Helal, 2008). Each of these is divided into several types with different features and different usage. This in addition to the newly emergent lighting source named Lighting Emitting Diodes (LED).

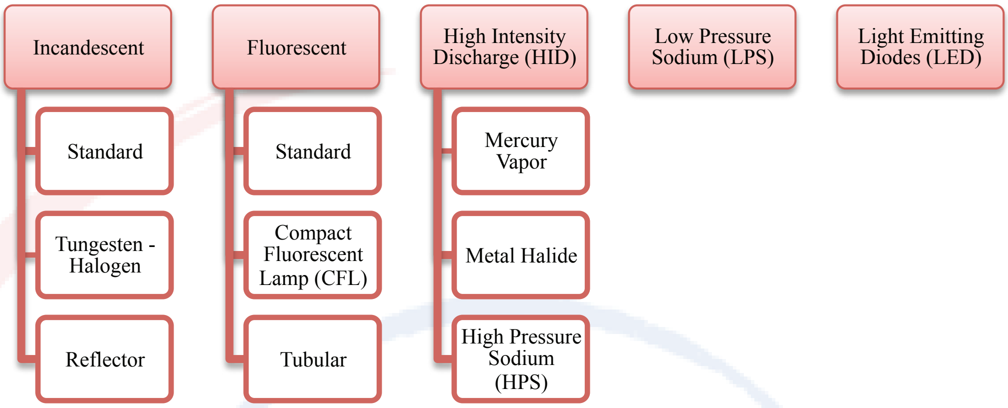

Figure 3– Types of Lighting Sources

According to the European Lamp Companies Federation, lamps are different than all other products as 90% of their environmental impacts are concentrated in the usage phase and most of them are because of their energy consumption as shown in figure 4 (“About Lamps and Lighting”, 2009).

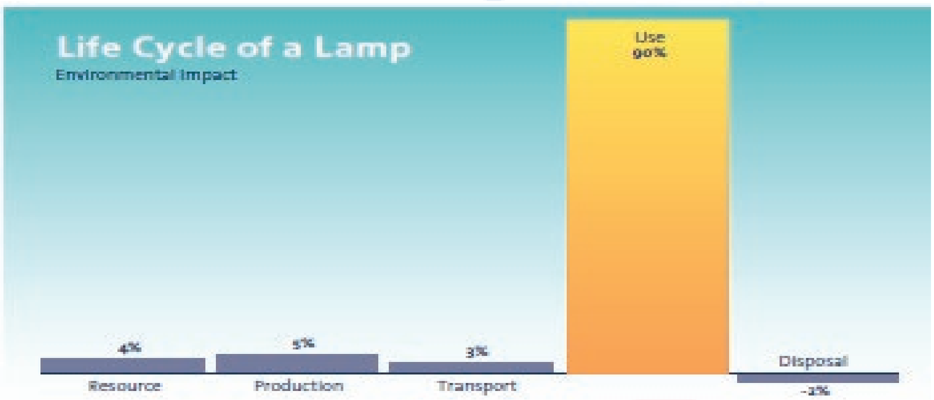

Figure 4 – Lamp Environmental Impacts during Lifecycle – “About Lamps and Lighting”, 2009.

RESEARCH METHODOLOGY

The research methodology is divided into three parts. Part 1 is a data collection about the extent of the application of the LCC and LCA in Egypt, the most important costs to be included in an LCC study and the most area of concern (mechanical works, electrical works … etc.) for an LCC study. This part is performed through a questionnaire distributed on 20 Construction Engineers with work experience ranging from 5 to 33 years. Part 2 is the framework of the LCA study that is adopted in this research. Part 3 is the framework of the LCC study that is applied in this research.

Data Collection –Questionnaire

The questionnaire results showed that the application of LCC is familiar among 68% of the respondents. 58% of the respondents' applied LCC in Egypt. The application of LCA is found to be less common in Egypt as only 47% of respondents claimed that they have worked before in projects applying LCA. The results of the questionnaire's rating questions showed that maintenance and operation costs are the most considerable in an LCC study. As maintenance costs scored a rate of 4.16 out of 5. On the other hand, operation costs took a rate of 3.95. Construction costs/initial investment costs were also one of a great importance with a rating of 3.5. Out of the initial investment costs, Pluming Works, Electrical Works, and Mechanical Works were the most important in the LCC study as they took ratings of 3.72, 3.63, and 3.5 respectively. Consequently, the need of such research was confirmed and indicated the need to formulate a model (LCCA-SSL) that perform LCC and LCA on lighting systems and sources.

Life Cycle Costing

The LCC framework of this research adopted the Langdon's framework, which consists of 15 steps (Langdon, 2007). The first six steps are concerned with the goal and scope of the LCC study, the second seven steps are concerned with the LCC application, and the last two steps are concerned with the results and their presentation.

Life Cycle Assessment

The LCA framework that is utilized in this research follows the ISO 14040 framework which consists of four stages; namely goal and scope definition, inventory of extractions and emissions, impact assessment, and interpretation.

MODEL DEVELOPMENT

The LCCA-SSL is a model developed to facilitate the process of life cycle costing and life cycle assessment calculation. The model consists of two modules. The first module is named "Lighting Design Decision Support", which helps the user to know how many light bulbs he/she may need to light up a specific area as shown in figure 5 (red ovals are inputs and the blue are outputs).

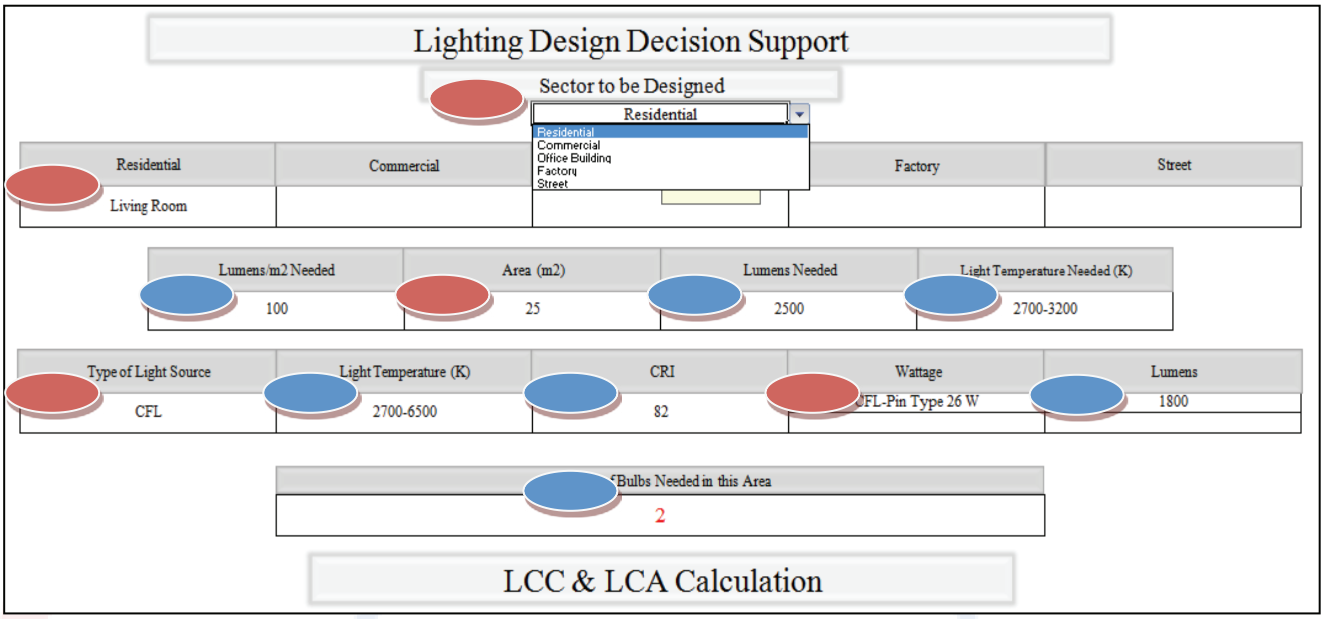

Figure 5 – Lighting Design Decision Support

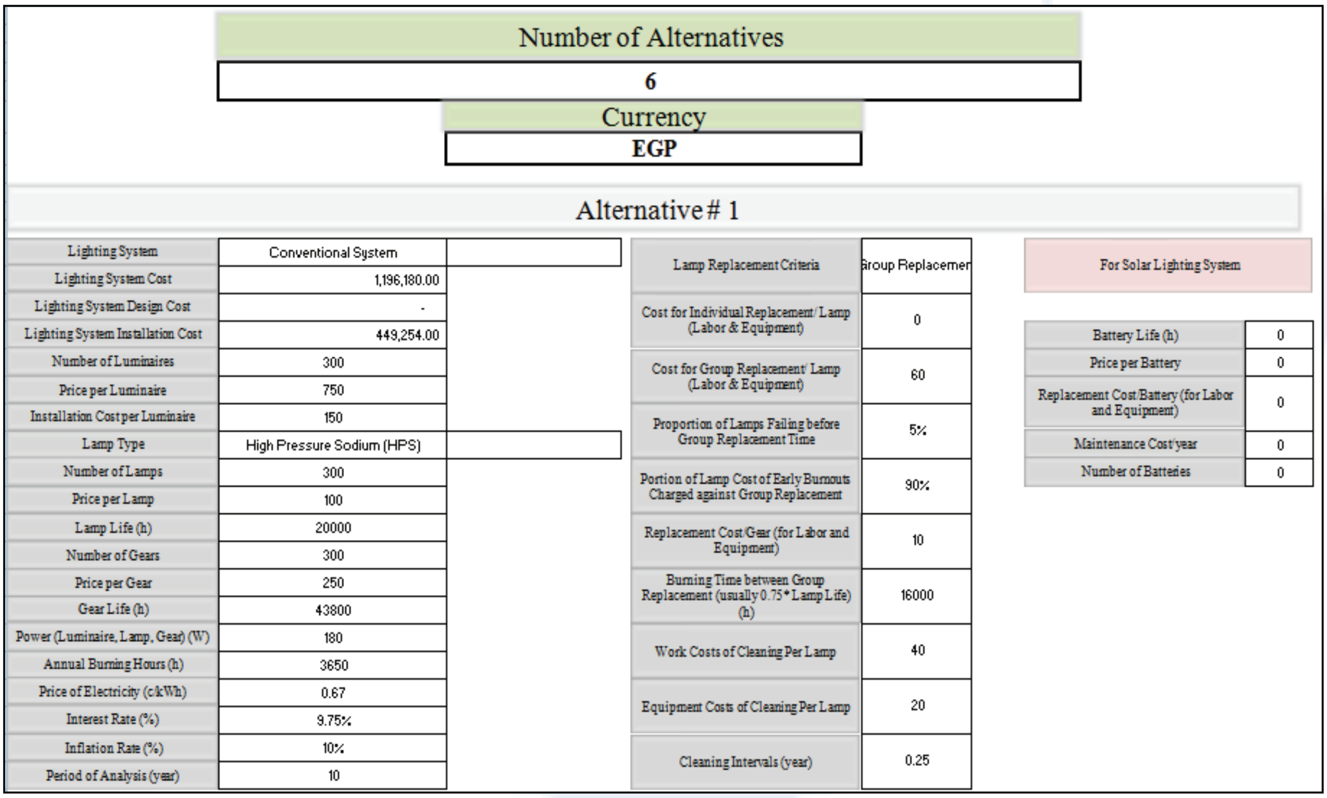

Figure 6 – Input Data for the LCC and LCA Calculation

On the other hand, the second module is named “LCC & LCA Calculation”, which calculates the life cycle costs and assessment based on several inputs given by the user as shown in figure 6. Though, the number of bulbs is one of the inputs which is required to be inserted by the user in the LCC Calculation module, it is not reflected directly from the first module because the lumens/m^2 required to light up a specific area is based on other several factors such as the color of the room, the age of the user who may need more light in a specific area … etc. However, the lumens/m^2 offered by the model is considered as the standard, which based on the user's requirements may increase or decrease.

The output of the model is presented in two charts and two ranking tables; one for LCC and one for LCA as shown in figure 7. The LCC results are presented in two forms; net present value (NPV) and annual equivalent value (AEV). The LCA results are proposed in two forms; energy consumption and CO_2 emissions of the whole period of analysis.

LCC Rank

Rank	Alternative	Present Value	Annual Value
4	Alternative 1	4,183,651.94	213,627.00
5	Alternative 2	4,202,394.15	137,664.66
3	Alternative 3	4,064,549.66	123,355.50
1	Alternative 4	3,504,301.35	147,234.66
6	Alternative 5	4,864,954.74	285,352.50
2	Alternative 6	3,665,570.92	167,604.66

LCA Rank

Rank	Alternative	Total Energy Consumption (KWh)	Total CO_2 Emissions
5	Alternative 1	1,971,000.00	1,913,767.92
1	Alternative 2	766,500.00	39,046.69
4	Alternative 3	766,500.00	744,243.08
2	Alternative 4	1,971,000.00	100,405.79
6	Alternative 5	2,737,500.00	2,658,010.99
3	Alternative 6	2,737,500.00	139,452.48

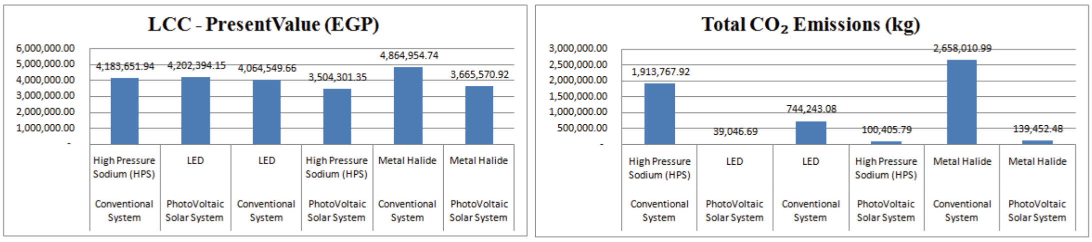

Figure 7 – Model Final Result

CASE STUDY

The model is validated through a real residential/commercial compound project. The study incorporated two alternatives of lighting systems, the conventional lighting system and the photovoltaic solar lighting system and their corresponding lighting sources, LED lamps, high pressure sodium lamps (HPS), and metal halide (MH) lamps. The project requirements were as follows:

- Lighting Intensity: 6000 lumens (150W HPS = 250W MH = 60W LED)

- Operating Hours per day: 10 hours/day
- Number of Lighting Poles: 300 (30m spacing between lighting poles)
- Lighting Pole Length: 6m

The LCC study tackles four main costs for each alternative, initial cost, energy cost, maintenance and replacements costs, and service cost. The period of analysis is 10 years, the inflation rate is 10% and the interest rate is 9.75%. The data were collected from different suppliers such as Hi-Tech Lighting Company (for the conventional lighting system), Foresight Trading and Linuo Solar Thermal Group (for photovoltaic lighting system). The methods used are the annual equivalent value (AEV) and the net present value (NPV) which are calculated with the following equation:

$$NPV = A \times ((1-(1+NDR)^{(-n)})/NDR) \quad \text{(eq. 1)}$$

Where, A is the Equivalent Annual Value
n is the period of analysis
NDR is the Net Inflation Discount Rate, which is calculated as follows:

$$NDR= ((1 + \text{Interest Rate (\%)}) / (1 + \text{Inflation Rate (\%)})) -1 \quad \text{(eq. 2)}$$

The LCA study tackles the carbon footprint of the same alternatives. It is conducted through a Cradle to Grave comparison which is related to the source of power for lighting such as the Conventional Electricity and the Photovoltaic Solar Energy. The other is gate to gate which is concerned with the lighting sources because it is focusing only on the use phase. The study is taking the energy consumption of the end-use only caused by the lighting source it is using. The equivalent CO_2 emissions are assumed to be those converted from the energy consumption by the factor produced by the SimaPro which is 0.050941545 kg/kWh CO_2 equivalent in case of photovoltaic system, and 0.97096292 kg/kWh CO_2 equivalent in case of the conventional system. To calculate the equivalent amount of CO_2 emissions of each electricity generation system using SimaPro, the values used in Spain were taken as an assumption to the nearest amounts of emissions in Egypt.

The results showed that best LCC selection is Photovoltaic Solar System using HPS Light Source which has an NPV LCC of EGP 3,504,301.35, as shown in figure 8, and the best LCA selection is the Photovoltaic Solar System using LED light source which has a carbon footprint of 39,046.69kg, as shown in figure 9. However, the best integrated alternative between both LCC and LCA is Photovoltaic Solar System using HPS Light Source which has the lowest LCC of EGP 3,504,301.35 and the second lowest carbon footprint of 100,405.79kg.

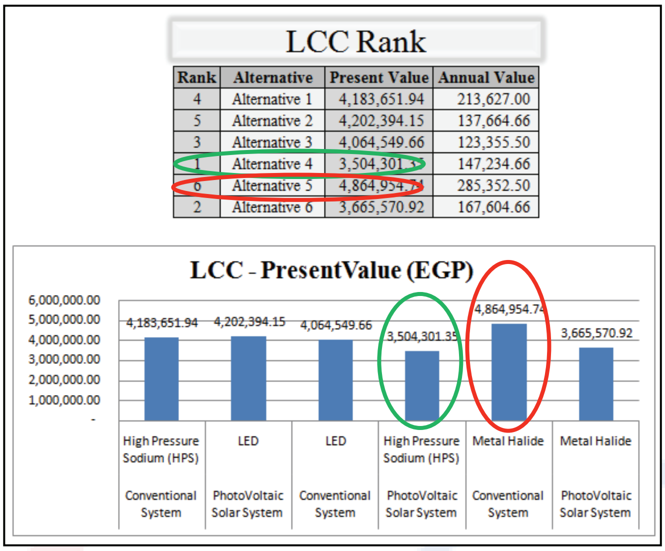

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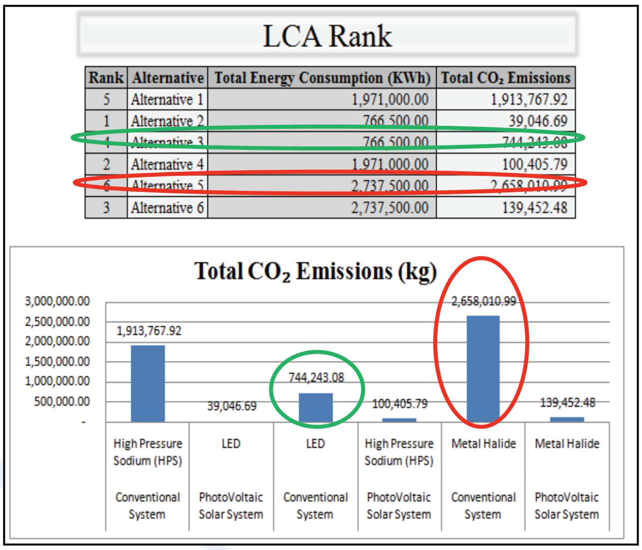
Figure 8– Final LCC Results



LCA Rank

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1	Alternative 2	766,500.00	39,046.69
4	Alternative 3	766,500.00	744,243.08
2	Alternative 4	1,971,000.00	100,405.79
6	Alternative 5	2,737,500.00	2,658,010.99
3	Alternative 6	2,737,500.00	139,452.48

Figure 9 – Final LCA Results

Finally a sensitivity analysis was conducted to measure the significance of changing the period of analysis, inflation rate and interest rate, on the final results. When changing the inflation rate from 5% to 30%, the interest rate from 5% to 40% and the period of analysis from 5 years to 40 years, the Photovoltaic Solar System using the HPS light source proved to have the least LCC among all the other alternatives as shown in figures 10 and 11. However, when the inflation rate reached 35%, the Conventional system using the LED light source proved to have the lowest LCC among the other alternatives as shown in figure 12.

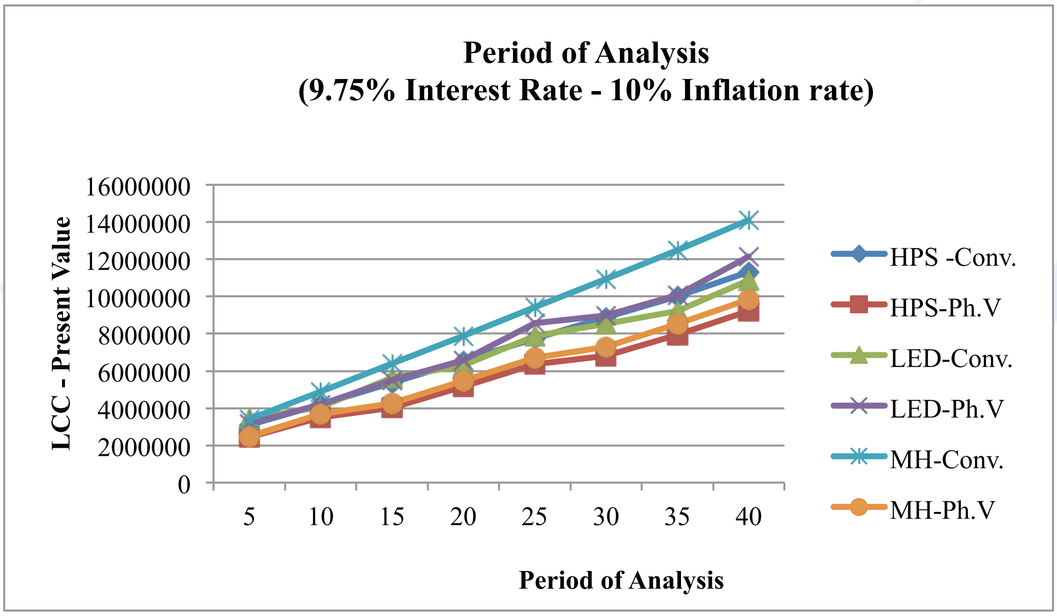

Figure 10 – Sensitivity Analysis on Period of Analysis Variance and LCC - NPV

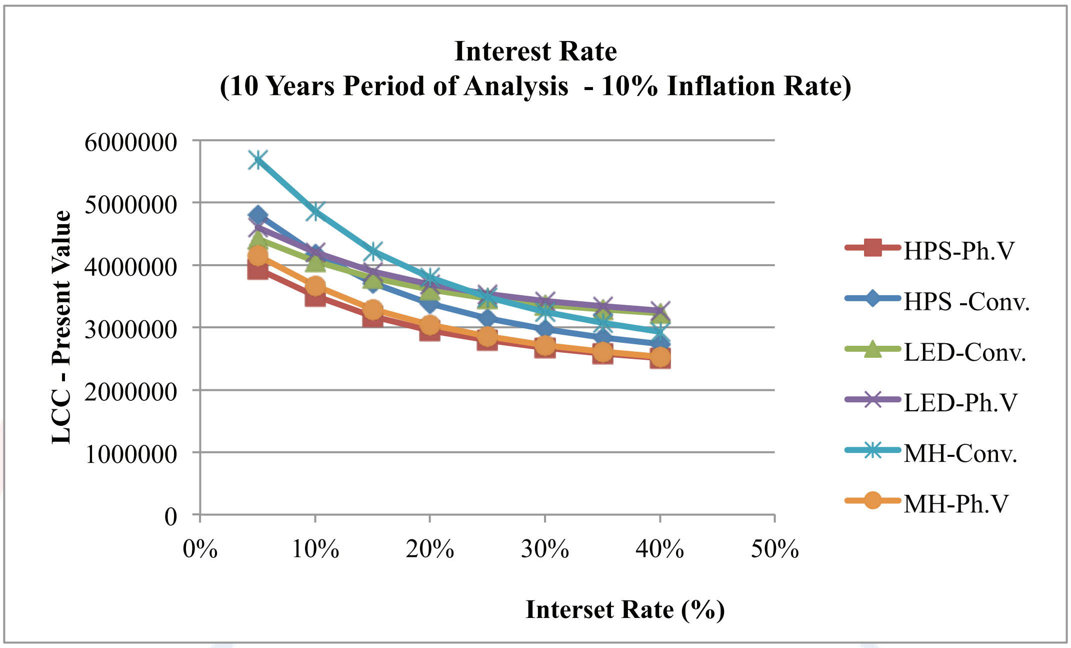

Figure 11 – Sensitivity Analysis on Interest Rate Variance and LCC - NPV

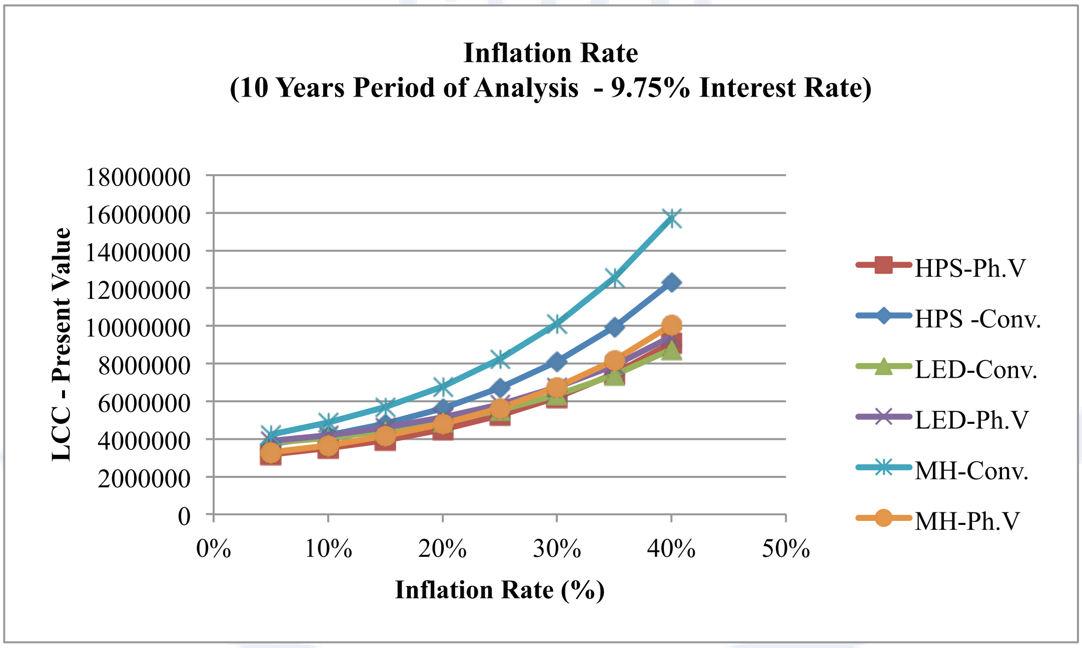

Figure 12 – Sensitivity Analysis on Inflation Rate Variance and LCC - NPV

CONCLUSION

This research was conducted with the purpose of developing a model to facilitate the calculation of LCC and LCA of one of the areas in the construction industry. Accordingly, a questionnaire was conducted to find out which area can be the most area of concern in the LCC study. The questionnaire results showed that electricity was one of the most important areas as it took a rating of 3.63 out of 5. Moreover, it was determined from literature that lighting is at the top of the residential electricity consumption in Egypt with an estimated 34 percent and only second to HVAC in residential electrical consumption, internationally. Consequently, the model focused on the calculation of LCC and LCA of lighting systems and sources. The model was validated with a real project of a street network in a residential/commercial compound for a ten-year period of analysis, 10% inflation rate and 9.75% interest rate. The LCC and LCA study incorporated the comparison between two lighting systems, photovoltaic and conventional system with their corresponding lighting source alternatives, LED, HPS, and MH. The comparison showed that the most economic alternative was the photovoltaic HPS with an LCC of EGP 3,504,301.35. On the other hand, the most sustainable alternative was the photovoltaic LED with a carbon footprint of 39,046.69kg. Finally a sensitivity analysis was performed to measure the impact of changing the assumption of the period of analysis, the inflation rate and the interest rate on the LCC. It showed photovoltaic HPS continued to be the best LCC selection except for the inflation rate above 35%, where the Conventional System using LED started in beating the photovoltaic HPS having the lowest LCC.

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Conference Title: European Conference on Sustainability, Energy and Environment

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Abstract

Sustainable design revolves around the quality, esthetics and service of any design. Historical evolution of any given fashion and design has maintained an identity through ages which becomes the combined personality trait of a culture. Area and culture of the Kalash valley is unique, situated in the Hindu Kush region of Pakistan near Chitral City. It is a small group of believers; their isolated geographical mountainous region is a combination of Birir, Bumburat and Rumbur which differentiate them from the other parts of Pakistan. The traditional cultural fashion dress is a black gown and handspun woolens in winter. A well decorated crown on their head is made up of shells, buttons, black wool and colored feathers. The myths and stories associated with the cultural upbringing of these people shape the mentality of this particular group. The traditional dress keeps the individuality alive. The strength of this culture is their textile, fashion and belief. The visual which this race portrays is the focus of their existence. The use of fabric design and fashion originating from their unique mind set is the main focus of this research. These three elements keep the interest in the cultural and traditional lives of the Kalasha fresh and captivating. The reason that this culture has sustained its fashion and textile design is its isolation and belief system. The globalization has not yet been effective on this particular culture to transform it to a newer form of art. Their design and fashion sustains it individuality and visual strength, while predicts the richer growth of this fascinating culture.

Keywords: Fashion, Design, Kalash, Sustainability, Traditional Culture

Figure 1: Land of Hindu kush Mountains.

1.1 Introduction:

Sustainability of Kalash textile and fashion is a concept that combines the heritage, culture and ideology of its particular region. It represents tradition and its orientation in form of textile practice. The culture of Kalash has been largely neglected in the history though as tradition it provides a strong and distinct individuality. Not many researchers or artists expressed much interest in the possibilities of exploring this unique art. Despite the tribal environment and rather primitive way of living their life is a constant festival. Kalash women dress in headdresses and a black dress which they have been wearing since hundreds of years. All hand woven fine dark woolen yarn which is hand spun.

The present research will highlight the ways in which Kalash textile and fashion has sustained and maintained its presence and individuality. The focus is to explore the Kalash textile and fashion which has embodied the character and essence of the people generation after generation. This study will help to open new perspectives onto the history and theory. Kalash textile surfaces, their qualities such as design, technique and sustainability are an important part of textile language, but have not yet been studied systematically in the local context. Most of the decorative symbols used in Kalash textile have their origin in primary textile design disciplines. Visual studies will validate the place of Kalash design by tracing its history, its individuality and prospective for further implementation.

Figure 2: Tracing textile design historically through old and young generation.

The relationship between textile fashion and design is an embryonic one. The current research is the attempt to investigate the Kalash textile design in considerable depth, by examining the ideas, descriptions, practice and implementation used in it.

1.2 Background:

The Japanese writer for trade magazines, publisher and photo magazines wrote briefly on the significance of Kalash culture and its artistic expression. According to Wada, Kalasha (people of Kalash) are tribal people with very less to go about their daily life yet their lives are a festival through out the year.
"Social and religious activities take place at the level of entire community, or at the level of the clan… because of this orientation toward "collectivism" (clan and community) and rigid long standing traditional socio-religious practices, individual responsibility, independence and individual creativity is almost unknown." (Wada, 2005)
What Wada is expressing in these lines are the closely knitting connection among the community which keeps it close to its origins, her approach is more toward the day to day life of the Kalasha's. This provides an insight into the life of Kalash people which shapes its textiles and fashion.
"Their life is organized around a continuous parade of communal religious celebrations, which are usually mixture of religious rites, dancing singing, wine, food, and general revelry. If it isn't a formal festival, it is a clan event or a special celebration of this or that in the harsh environment the Kalasha life is not easy. However, socially and culturally it is rich and lively life". (Wada, 2005)

Figure 3: A ceremonial gathering of girls dressed in the traditional kalash embellished dresses and headdresses.

Wada has devoted her life to find and define the 'citizens' and she has established Rumbur Development Welfare and Conversation Society with the support of UNDP's Support. Her research provides a broad perspective into the lives of the Kalasha's.
Every culture of the world develops from the values, practices and traditions, ethnicity and beliefs of its people. Through their lifestyle systems are developed of moral codes and norms, which enrich their activities and customs, of, which the textile and fashion has been a very majorly integral component. In case of Kalash textiles, the cultures that have underlined its emergence are not many. This region gives birth to a rich base for the cultivation to a culture, which have been influenced by different settlers of over thousands of years but has not much change and has kept

it identity. A strong sense of design is salient characteristic of Kalash textiles and fashion that can be observed in its all traditional forms.
This culture of traditional clothing has sustained itself through hundred of years.

Figure 4: The traditional follow the old people to the new ones, irrespective of age. The color of the headdresses may vary according to the personal aesthetics.

1.3 Textile - Fashion Needs and Consumption:

An article of clothing becomes textile waste, when it is no longer important for the purpose which it was required for to the consumer. Textile waste stream has increased because of the consumer sending increase on clothing due to the decrease in price of the clothing. This leads to a non-serious and an easy invisible method of replacing and discarding an article of clothing. The Sustainable life of the garment requires a life cycle which sears deep relationship between the wear and the garment, from the point of purchase till its ultimate end.Kalasha textile are pure examples of this their products are embodied to represent the wearer. The use hand spun wool base garment with different colored wool threads for embroidery. They embellished their gowns with geometric motifs which have been in their culture for century. They have closer relationships between the industry and fashion consumer which is their own tribal people. Kalasha's material manufacturing, renovation and reutilizing would be enhanced as the social innovation and technological advances will take place from time to time. They reduce the waste production by reusing their garments and material like buttons, cowrie, threads metal bells etc.

A methodology to sustainable fashion is gradually more conditional on the suitable material choices. The new fabric based on decomposable fibers and ecofriendly materials. As laundering and drying of the clothing is considered to be the most substantial sustainable effect, material has also come in to the mainstream requirement which is facilitating in applications for sustainable fashion. In the fashion industry the potential for new technological environment friendly or cross textile materials has been investigated rarely. A high life cycle for a garment can be achieved by better ecofriendly selection of material and the garment can be manufactured to manipulate fabric maturity and maximize its material presentation. Interchangeable methods and different materials can be utilized to make a garment familiar to its environment, atmosphere and seasons. The Kalasha women have considerably less material and money to invest in a wide range of fabrics which lead to managing resources and controlled use of the material and less washing which leads to much minimized aging of fabric

Figure 5: The traditional dance of the Kalasha women.

Kalash women create stylized floral motifs combined with geometrical lines and shapes to from borders and neckline of the long black gowns in striking colors. The borders comprise of lines, geometric shapes, leaves, flowers etc. The gown is held tight at the waist by a hand woven belt with hanging fringes. The neckline embroidery extends to the shoulder and the top of the gown has a loose baggy look as shown in the figure 5. They wear the headdresses made of bead work and embellished with buttons, cowrie shells, etc. The Kalash textile and fashion demonstrates the convergence between craft and cultural identity. Local materials for garments may involve the innovative local designers to develop options for different garment transformations by using the same material. It may lead to the less consumption of clothing. This tribal set up show that by connecting with the natural resources they are sustaining the clothing culture and can reduce the consumption of clothing.

Before the garment terminates functionally, majority of the fashion users discards it beforehand. So this comes mind that the wearer doesn't have close ties and respect for the garment to be able to use it for a longer time. So the need is to develop that connection and commitment with piece of garment. The requirement here is to be an emotional wearer who sees beyond the physical necessity and takes a leap towards a more emotional bonding with the fabric.

"Sustaining a wearer's interest and engagement with a garment is then the real challenge. However if a designer create a garment that can adapt and transform, and reflect the wearer's invested care, then we can begin to rethink our engagement with our clothes" (Cath, 2011)

Figure 6: A model in the museum of a woman hand weaving a belt or lace for the gown.

So the level of attachment of the wearer and the rate consumption are inversely proportionate to each other and this make the kalasha's ways of clothing sustainable for hundred of years.

1.4 Material:

Material plays an emphatic role in our current understanding of what makes fashion and textiles sustainable. They are, more often than not, our starting point for change and a key commodity for farmers, designer, manufacturing industry, consumer and recycler. Indeed materials have been at the center of both recent waves of interest in sustainable fashion and textiles. In the first, in the early 1990s, natural and recycled fibers dominated trade shows, trend predictions and industry journals. In the second, in the mid part of the 2000s, organic, fair trade and rapidly renewable fibers have led design innovation with many companies basing their collections on choices of 'alternative' materials." (Fletcher, 2008) The fact that materials seem to dominate our ideas about environmental and social responsibility is not really surprising as after all, our industry's product in material 'stuff' fiber, fabric, textile product and garment. The idea of materials in the Kalash valley guide and promote the long term health, resilience and effectiveness of the fashion and textile industry, as well as that of their natural and cultural systems.


Figure 7: Hand woven waist belt fabric for the women's gowns.

The Kalasha's use wool, cowrie shells, buttons, beads, mate belts, feathers and they reuse them to keep their association and attachment to their people and craft alive. They promote their culture through collective textile and fashion design and the material they use keep their social responsibility and cultural roots fresh and revived.

By design around principal's observable in nature, such as efficiency and cooperation the Kalash society is sustainable in the same way that ecosystems are. Just as in natural systems, where interdependence and interconnectedness between species dominate, we would look for these same characteristics in human systems and cultures otherwise as well. We can read nature's lessons literally; and close loops, naturally recycling almost all materials and focus on efficient use of materials as the Kalasha's rightfully do. "We can also interpret nature more metaphorically and pursue textile and fashion designs that promote flexibility, lightness or a sense of wonder, or those that speak of balance, community values or engagement and playfulness." (chapman, 2007)

Sustainability in Kalash culture of fashion and textile is about designing with a range of fibers, majorly wool and cotton avoiding huge manufacturing monocultures, spreading risk, decentralizing production, celebration traditional fibers and giving people creative and productive employment. The simplicity of fabric and fiber range keeps it less expensive and unique but some how this is compromised at time with chemically dyed fibers as well. Designing with a greater number in small volume fiber types encourages farmers to diversify and grow a range of crops. The government needs to support eco friendly systems so that this unique setup remains intact. It offers potential for regional fiber quality which leads to products providing work and respect local environment.

Figure 8:Diversity of material that is used on the crownand dresses of Kalasha women.

The vitality of their tradtional system depends on relationships and on uses and exchanges of energy and resources. We see beauty and greatness that in these kalasha garment which value process, participation and social integration, in pieces that advance relationship between people and enviornment. Friends weaving together is beautiful; compostable garments are beautiful; supporting a disadvantaged kalash community with careful purchasing is beautiful. The kalash textile and fashion ideology protays that relationships can be fostered by designing graments that encourage us to ask question about our sense of placemen in the natural world. Such garments could accomplish this by supporting our desire to jump on a bike instead of taking the car, or by being shareable between friends. Sustainable kalash textile ad fashion is about a strong and nuturing relation ship between consumer and producer and in most cases need based textiles are produced by individual consumers. Its is about making a garment or suface that start a debate, invoke a deep sense of meaning or require the user to 'finish' them with skill, imagination or flair. The Kalash fashion and textiles explode with mystique, exclusivity and prower structure.

Figure 9: A woman hand weaving a belt on a wooden natural stick.

Figure 10: Traditional head dresses with beads and embroidery.

Figure 11: A Kalasha women displaying her dress.

Figure 12: A teacher lecturing about the motifs used in the embroidery of the Kalash traditional fabrics.

Figure 13: Traditional head dress of the Kalasha children with beads.

Figure 14: A woman sewing cloth at home.

1.6 Conclusion:

Kalash textile and fashion's real values come from what they represent together, which is hidden from view. Innovative out comes based on sustainability values and an interconnected approach to design. I will discuss five ways by which we can conclude the value sustainability in Kalash textile and fashion. Firstly Home: what are the roots? The essence of the kalash valley asks the residents to wear it proudly on their backs. It asks them to find the world in their own neighborhood and to know and support what's going on around. These local products inspire and challenge the community while at the same time creating jobs and making use of local resources. The best product is the one with a human and material engagement with place. The indigenous textile and fashion products reflect a mix of concerns, some about local esthetic preferences and others about developing products to sustain cultural community. Secondly Flexibility: fashion and textiles capture a moment in time and are as quickly forgotten. But what if that moment was not one but many moments, a process of transformation? What if that process required you to reach into the sewing kit and update that garment yourself? Kalash culture of textile and fashion is all about that updating. Generations after generations the transformation absorbed in to the network of the Kalash society has led to the presently sustained shape. Thirdly Cleaning: washing, emotional uplifts us and relates to our personal inner satisfaction. So it has exceeded from just basic hygiene control to obsession with it. The energy used to wash our garment throughout our life time is 6 times that is essential to manufacture them. But this is controlled in the tribal culture of Kalash which has a closed local area with limited resource and more managed washing habits.

Fourth in the line is, Recycle: this is typically related to the early culture of Pakistan on the whole. The garments used in the Kalash valley keeping in view the economical state of the residents are transformed and reused according to the needs of the user as they have multiple festivals and celebration they continue wearing their traditional gowns and using them from time to time. They unfold patterns and reuse them in new ones. The cowrie shells, buttons, feather, metal bells, are reused again and again in different headdresses and borders. Lastly the fifth point is about the, Identity: clothes protect our modesty and keep us warm. We also use them to signal who and what we are, to attract or repel others and to be put in a particular frame of mind. Survival, defense, love, indulgent, contribution, formation, regeneration, uniqueness and independence are some common human necessities irrespective of any boundaries. This shows that it not just physical garment properties that we are focusing here but also human psychological needs are being subjected too. This means for example, that many of us relate our individual identity to what and how many materials we consume. Here lies a paradox: psychological needs are not easily satisfied and in some cases are even inhabited, by consuming materials a fact recognized by many religious communities in their guidelines for living materially simple but spiritually rich lives. Which can be identified with the kalasha's who have a close religious circle of polytheist's. And an introvert's culture which retains their textile and fashion needs to a limited simpler and individual image. Yet the pressure to consume materials continues to intensify, pushed onwards by marketing, social competition and the driving forces, innate in humans, of emulation and envy.

With this it is concluded that idea of sustainability of kalash textile and fashion is based on personal social and institutional transformation and from this transformation a unique way of clothing has emerged and sustained itself that speaks individual rhythm and role of textile and fashion. It engages and empowers the user not just covers their bodies but release the potentially self destructive, ever faster pace of change.

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Experimental Validation of a Lumped Parameter Model to Predict the Energy Performance of an Electrical Domestic Oven

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0230

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Abstract

This paper deals with the study of the heat transfer processes occurring during the performance of electric domestic ovens. A model to predict these processes is created by means of SINDA/FLUINT® (a software that applies the thermo-electric analogy to solve the thermal network) by using its non-geometrical graphical interface SINAPS®. The main solid and fluid elements of an electric domestic oven (cavity walls, broil, door, electronic box, room air, cavity air and air flow cooling the electronics and the external and middle glasses of the oven door) are represented in this model. The two heat sources of the oven (i.e., a visible broil element at the upper part of the cavity and a hidden bake element in the bottom of the oven) are driven by a control strategy ensuring that the temperature of the oven reaches and maintains the desired value. The predictions of the model are compared with the experimental results (temperature evolution of the load and the air inside the cavity) of the standard energy classification test of the European Union, EN 50304. In this test, a water wet brick, that simulates a food matrix, is heated inside the oven until it reaches a determined temperature jump. Therefore, the development of this model makes possible to further evaluate different strategies to reduce the energy consumption by enhancing the heat transfer that receives the food load, preserving also the quality of the food.

Keywords: Heat transfer, Simulation, Domestic oven, Experimental validation, Standard energy consumption test.

1. INTRODUCTION

In the GreenKitchen project different strategies are evaluated to reduce the use of energy within the domestic environment and increase the energy efficiency in the home appliance sector (www.iapp-greenkitchenproject.eu). This project is financed by the European Union through the Seventh Framework Programme (via Marie Curie Actions: Industry Academia Partnership and Pathways program—IAPP). In this project three universities—University of Applied Sciences of Southern Switzerland (SUPSI) in Switzerland, Politecnico di Milano in Italy, and Wrocław University of Technology in Poland—and the home appliance company Whirlpool Corporation collaborate together with the aim developing and sharing crucial knowledge in the field of advanced technologies and eco-design strategies needed for drastically improving energy efficiency and resources utilization in the household environment (see Figure 1). In this context, some of the activities of the project are focused to the development of innovative heat transfer models for cooking in ovens (in Figure 1, see Task T5.2 in Work Package 5-called WP5). Several efforts (Ait-taleb et al., 2008; Bottani and Volpi, 2009; Boulet et al., 2010; Capablo et al., 2012-2013; Chhanwal et al., 2010; Goni and Salvadori, 2010; Kuznetsov and Sheremet, 2009; Prasopchingchana, 2011; Rek et al., 2012; Williamson and Wilson, 2009; Xaman et al., 2008) have been dedicated in the last years to investigate the heat transfer phenomena participating in the domestic ovens. However, further efforts are needed to reduce the energy consumption and increase the energy efficiency of these home appliances.

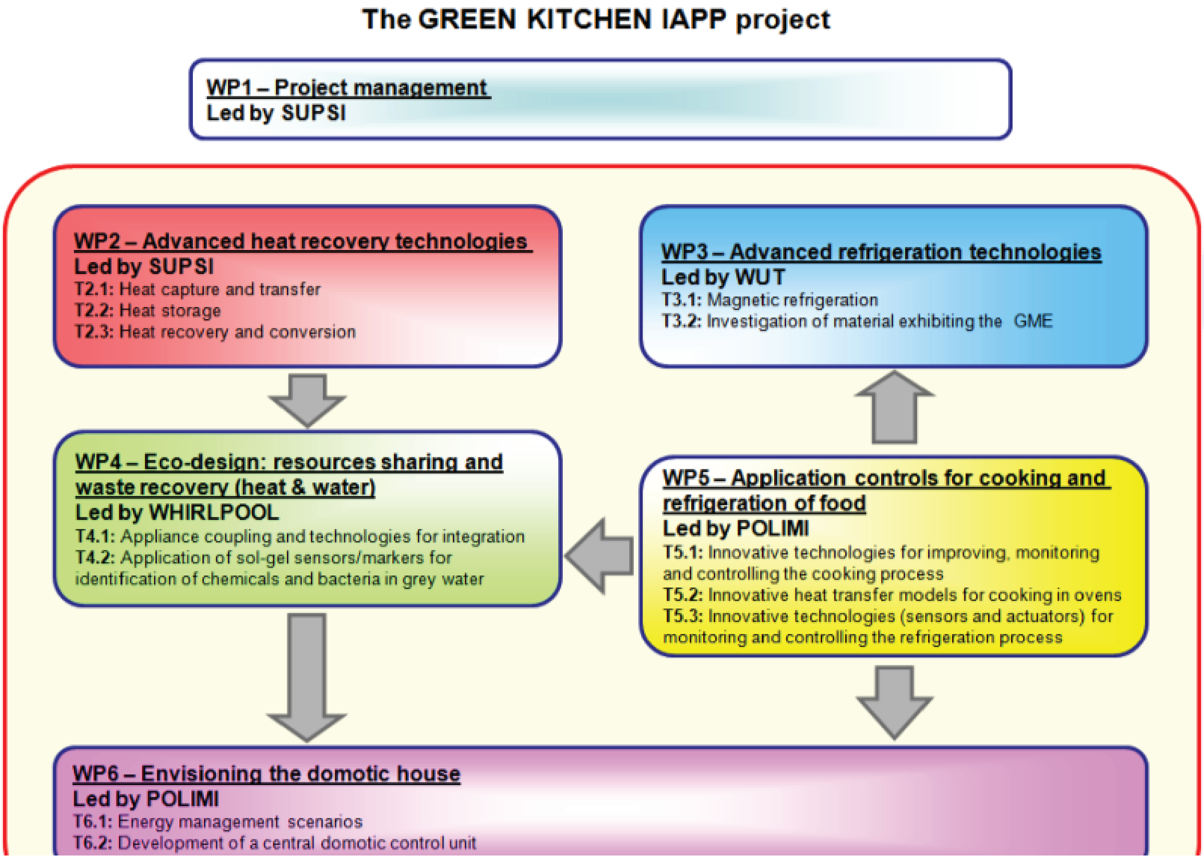

Figure 1: Description of the Green Kitchen IAPP project Activities

The experimental validation represents a fundamental step when developing a theoretical model. In this work, the results obtained in the standard test for energy classification in the European Union, EN 50304 (CELENEC, 1998), are used to validate the predictions of the theoretical model. In this experiment a water wet brick, with similar characteristics to a food load, is heated in the center of an oven until a temperature jump is reached. A NASA-developed software environment called SINDA/FLUINT® (Cullimore et al., 2011) is used to build the model, applying the thermo-electric analogy to solve the thermal network. The final target of the development of the theoretical model is to better understand the heat transfer processes occurring during the oven operation. Then, new advances strategies to increase the energy received by the food load could be analyzed and optimized with this validated model, in order to reduce the oven energy consumption and increase its global energy efficiency.

2. EXPERIMENT

The standard procedures for the Normative Oven Energy Class Test, EN 50304 (CELENEC, 1998), are described in the following lines. The energy consumption of an oven is assessed by means of this test. During the complete test the ambient temperature of a substantially draught-free room should be maintained at 23±2°C. The measurement of the temperature of the ambient should be taken at a point at the same height as the centre of the usable volume of the oven cavity and at a distance of 0.5 m diagonally from one of the front edges of the oven. The supply frequency shall be at nominal 50Hz±1%, and the supply voltage shall be maintained at the main terminal at 230V±1% while the heating elements of the oven are switched on. As a food simulator is used a water wet brick (known as “Hipor”), with physical (e.g. porosity (77%)) and thermal properties (e.g. bulk dry density of 550±40kg/m^3) similar to typical food.

The transient temperature response and weight loss of the wet brick upon heating are similar to those of foods. Therefore, the brick weight loss is assumed to correlate roughly with food quality, high weight loss corresponding to dry, overcooked, or burnt food and low or negligible weight loss to soggy or undercooked food. The dimensions of the brick are 230 mm x 114 mm x 64 mm. Before the test it must first be soaked in chilled water for a minimum of 8h, so that its final temperature reaches 5±2°C. The cold water-saturated brick should be placed in the geometric center of the useful cavity of a room-temperature oven. An electric domestic oven of Whirlpool of 73 liters as cavity volume has been used in the experiments. The most centered position corresponds to the brick set on the center of the rack, placed into the shelf support level of the oven so that the center of the brick comes as close as possible to the center, but not higher than, of the usable oven cavity (see Figure 2).

Figure 2. Position of the brick in the Normative Oven Energy Class Test: EN 50304.

Thermocouples of type J (iron/constantan) are used to monitor the temperature of the brick, the air cavity and the ambient air during the experiment, being collected with a data logger Yokogawa MV100. A power-meter CLM210 is used to measure the energy consumed. The brick temperatures are monitored at two locations near its centre (by drilling two holes 1mm diameter and 32mm deep with a separation of 50mm between them), placed on the upper side. The set point of the oven is defined by selecting a temperature jump of the air of the cavity. In this case the selected “deltaT” is 140±10°C in the static mode.

The measurements must start by turning on the oven within three minutes of brick removal from the refrigerator. The brick is then heated until both temperatures rise by 55K, expressed in Kelvin to stand out that is a temperature difference. Once the brick reaches a deltaT of 55K, it is removed and weighted to determine the amount of water evaporated in grams (after the excess of water has dropped out for about 1 minute), and the oven operation is continued to allow it to reach a steady-state. Time, energy consumption and environment, brick and cavity air temperature are recorded. The final oven temperature is calculated then as the average arithmetic mean between the minimum and maximum temperatures in steady state.

3. NUMERICAL MODEL (SINDA/FLUINT®)

SINDA/FLUINT® (Cullimore et al., 2011) is used to create the theoretical model of the oven. The thermo-fluid network of the studied problem is inserted in its non-geometric graphical interface SINAPS® (Ring et al., 2011). THERMAL-DESKTOP® (Panczak et al., 2012), its CAD-based interface is used to calculate the heat exchange factors between different surfaces (by means of the RADCAD® tool (Panczak and Ring, 1997)) to be inserted in the network of SINAPS®. As shown in Figure 3, the main elements of the oven (walls, door, air cavity, electronics and broil) together with the brick inserted in the center of the cavity are modeled. The two heat sources of the oven (i.e., a visible broil element at the upper part of the cavity and a hidden bake element in the bottom of the oven) are driven by a control strategy ensuring that the temperature of the oven reaches and maintains the desired value.

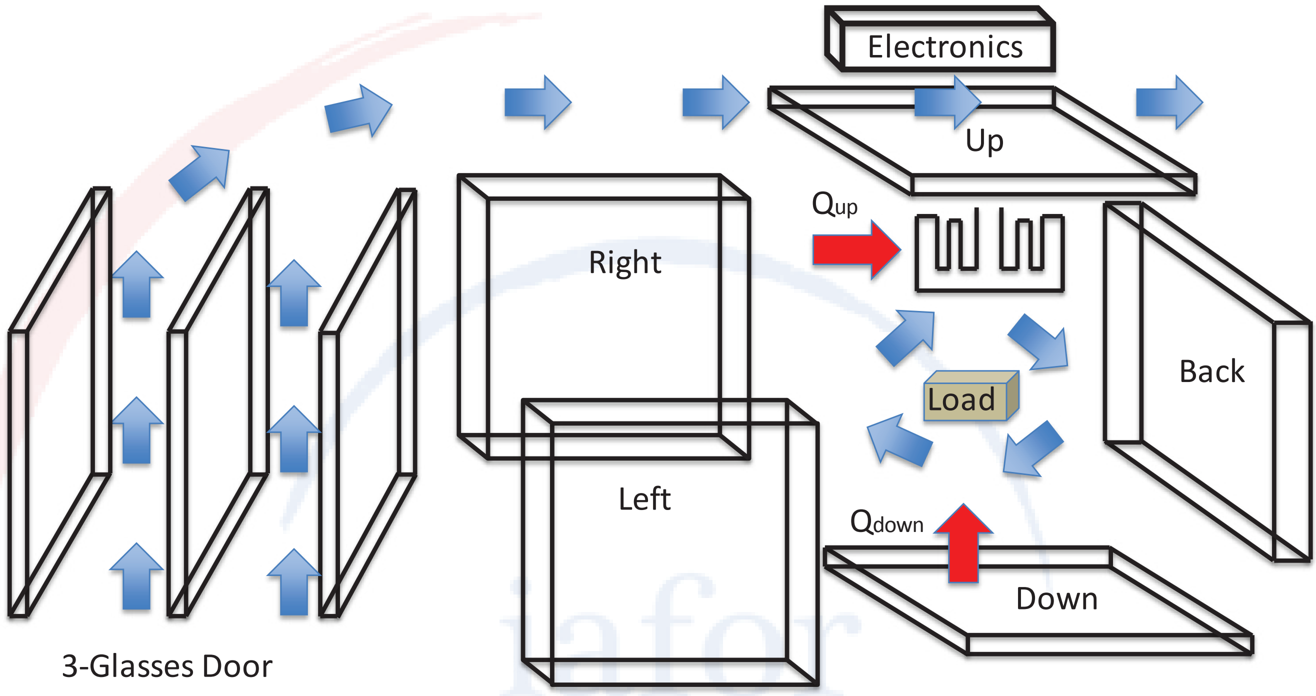

Figure 3: Sketch of the oven to be modeled with SINDA/FLUINT®.

These elements are modeled in SINAPS® by means of nodes and conductors to simulate temperature points and heat flow paths, respectively, and by means of lumps, paths and ties to represent thermodynamic points, fluid flow passages, and heat flow between solid and fluid, in that order (see Figure 4).

The thermo-electric analogy is applied to solve the model of the oven as a 1-dimensional problem. The heat in the oven is considered to be transferred between the elements following the laws of the main three mechanisms of heat exchange: conduction, convection and radiation (Incropera et al., 2007). The heat transferred by conduction is proportional to the temperature difference between the two points considered:

$$q_{12} = \frac{kA}{L}(T_2 - T_1) \quad (1)$$

being k (W/m·K) the material conductivity, A (m^2) the transversal area that the heat traverses and L [m] the length between the temperature points.

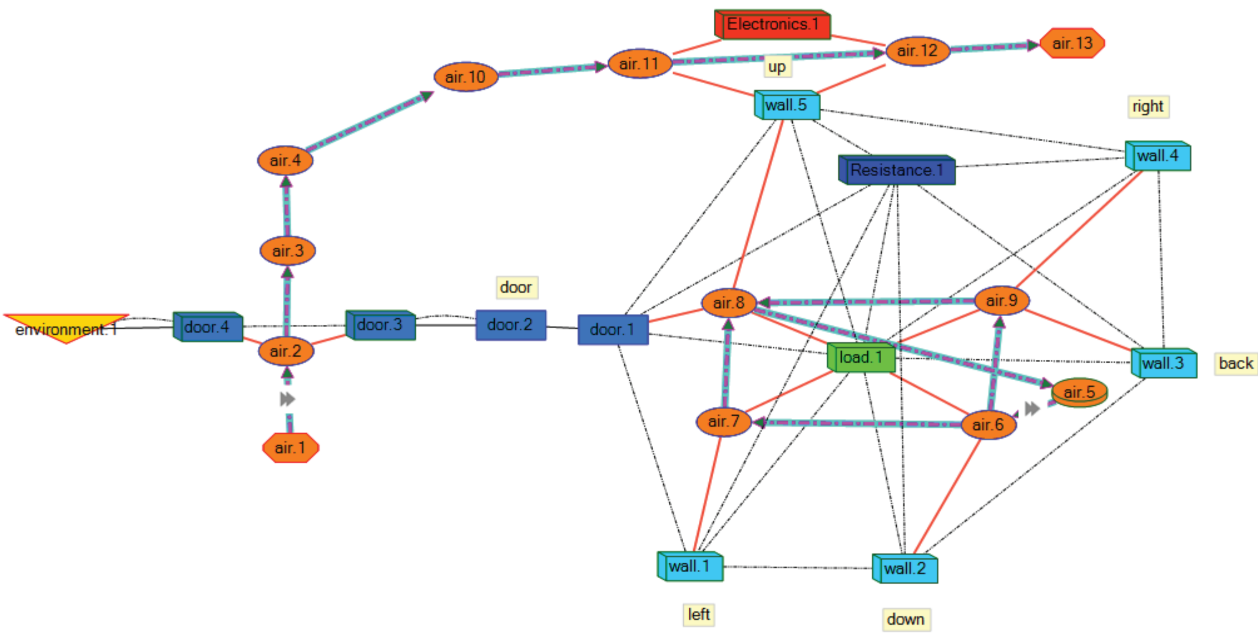

Figure 4: Sketch of the oven model inserted in SINAPS®.

The convection heat is, as in the conduction case, proportional to the difference of temperature between the two considered points:

$$q_{12} = hA(T_2 - T_1) \quad (2)$$

where h (W/m²·K) is the convection coefficient and A (m²) the transversal area that the heat traverses. Natural convection of the air inside the cavity is considered to contribute to the global heat transfer process, whereas forced convection is considered to cool middle and external glasses of the oven door. On the other hand, the heat transferred by radiation is proportional to the difference of absolute temperatures at the fourth power:

$$q_{12} = A_1 \sigma B_{12} \varepsilon_1 (T_2^4 - T_1^4) \quad (3)$$

being ε_1 the emissivity and A_1 (m²) the area of the emitting surface, and $B_{1\text{-}2}$ the amount of energy emitted from surface 1 and absorbed by surface 2 by all possible paths, including reflections. The assumption of large (infinite) parallel planes for diffuse, gray, two-surface enclosure is used to calculate the heat exchange coefficients between the door glasses [19].

$$F_{12} = 1 \quad (4)$$

$$A_1 = A_2 = A \quad (5)$$

$$q_{12} = \frac{A\sigma}{\frac{1}{\varepsilon_1} + \frac{1}{\varepsilon_2} - 1}(T_1^4 - T_2^4) \quad (6)$$

Water evaporation from the brick is also included in the thermal network as a heat sink by inserting a negative value of the heat in the brick element, as being internally absorbed by the load.

4. RESULTS AND DISCUSSION

In this section the SINDA/FLUINT® predictions are compared with the results experimentally obtained in the standard test for energy classification in the European Union. In Figure 5 the evolution of the cavity temperature is pictured together for the predictions of the model and the experimental results. The evolution of the cavity temperature both modeled and experimentally measured has been found to be similar, with a change in the trend of the temperature increase after the first 10-15 minutes, with similar values of temperatures obtained at the end of the experiment. In Figure 6 it can be observed the deviation between the predictions and the experimental results expressed in temperature difference (in Kelvin). A range of difference of ±10K between measured and predicted temperatures is obtained during the considered time.

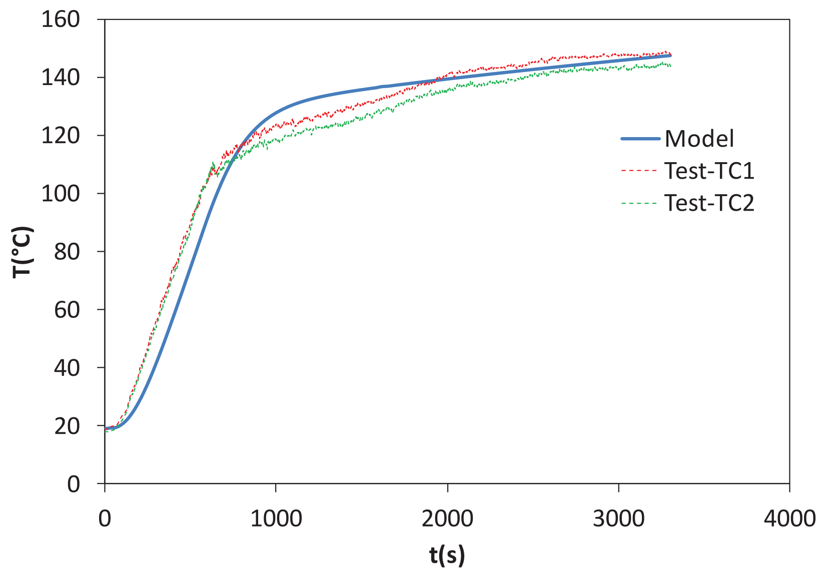

Figure 5. Evolution of the cavity temperature during the standard test EN 50304 (model predictions vs. experimental results).

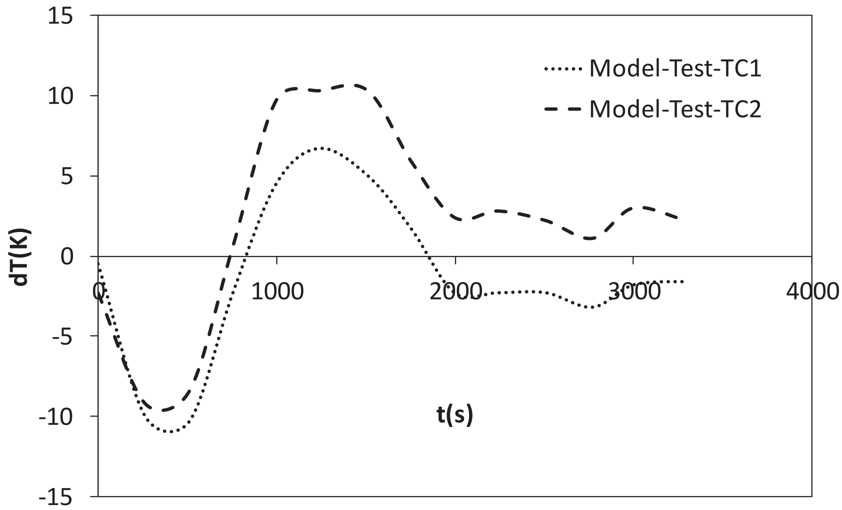

Figure 6. Evolution of the deviation between the model and the test data for the air temperature inside the cavity expressed in temperature difference (K).

The predictions of the evolution of the brick temperature are also compared with the experimental measurements, as shown in Figure 7. A similar trend and a similar final temperature value are found for both predictions and test results, although some deviation between experimental and predicted lines can be observed. The deviation between model and test data is pictured in Figure 8, expressed in temperature difference (in Kelvin). As in the case of the temperature of the air cavity, the difference between the predictions and measurements is always lower than ±10K, following a form similar to a Gaussian bell function. A sub-estimation of the rate of water evaporation can be the explanation of this divergence. A higher evaporation rate implies a decrease of the brick temperature, as the heat absorbed by the brick water is used to generate the vapor (as latent heat) instead of being absorbed as sensible heat by the brick with the consequent increment of the temperature of the brick.

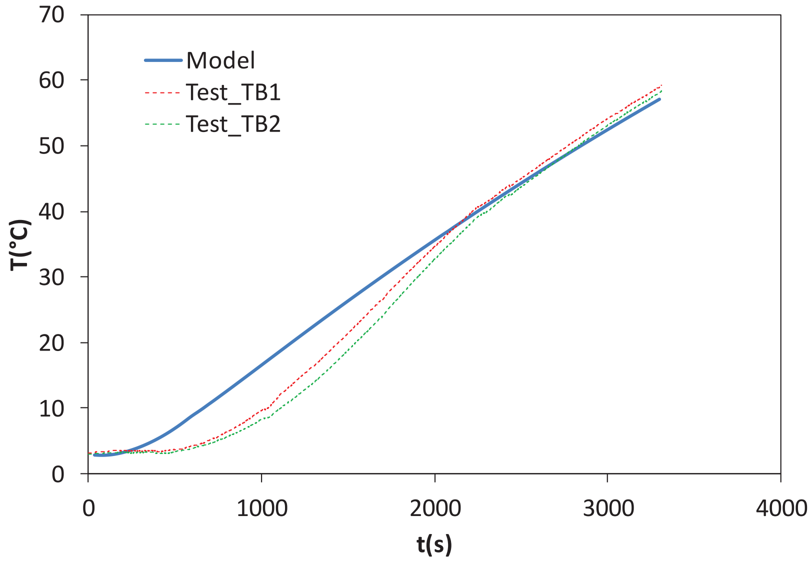

Figure 7. Evolution of the brick temperature during the standard test EN 50304 (model predictions vs. experimental results).

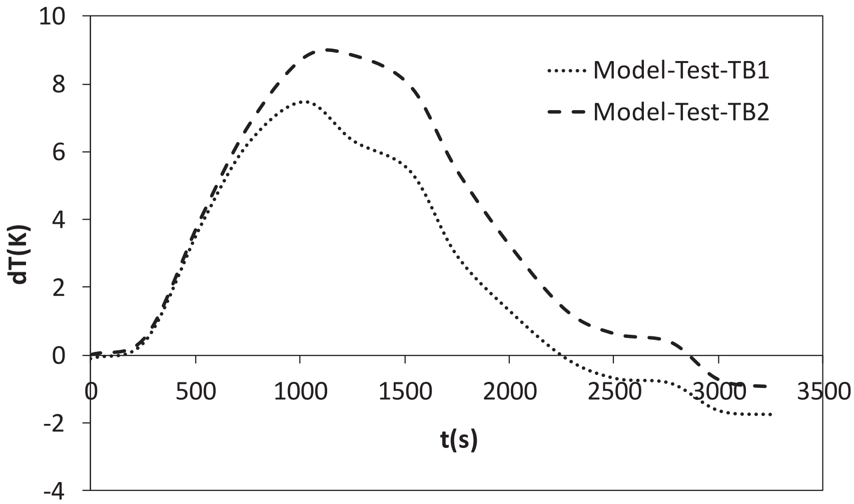

Figure 8. Evolution of the deviation between model and test data for the brick temperature expressed in temperature difference (K).

The low deviation between predictions and measurements and the good accuracy of the final values indicates that the model could be confidently used throughout the next steps in the direction of evaluating the effect of innovative strategies on the oven performance in order to enhance the heat transfer mechanisms to the load and therefore increase the global oven energy efficiency.

5. CONCLUSIONS

A model that simulates the heat transfer in ovens developed in SINDA/FLUINT®, a lumped parameter tool specially focused in heat transfer and fluid flow modeling, has been validated with the experimental results obtained from the standard test in energy classification of the European Union, EN 50304. Its non-geometrical graphical interface SINAPS® is used to built the thermal network of the studied problem. THERMAL DESKTOP®, its CAD-based interface, and its specific module RadCAD®, has been used to calculate the heat exchange factors needed to be inserted in the SINAPS® model to calculate the radiation contributions. The good fit of the theoretical predictions with the experimental data makes possible to use the developed model to perform further optimization of the oven design/configuration. For example, the effect of modifying the value of a determined parameter on the heat transfer paths can be evaluated with this numerical approach. The enhancement of the thermal exchange with the food load by implementing advanced strategies produces an increase of the energy efficiency of all the process. Furthermore, in order to complete the knowledge of the studied system, more temperature points can be included in different brick positions (at the surface and at different depths), in the boundary layer of air around the brick or in the broil element. With this information, a more detailed model with a better description of the heat transfer paths by conduction and convection occurring inside the brick and in the air boundary layer around the load, together with an improved water evaporation representation, can be developed.

ACKNOWLEDGEMENTS

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Removal of malachite green from wastewater using Khulays natural bentonite

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Abstract

The main purpose of this study was to investigate the feasibility of using Khulays natural bentonite for the removal of malachite green (MG) from wastewater. The removal characteristics of MG from wastewater were investigated under various operating variables such as agitation time, initial MG concentration and solution. Batch scale equilibrium adsorption was carried out for a wide range of initial dye concentration. The results showed that the sorption equilibrium of MG on Khulays natural bentonite was achieved after 2 h. The sorption data suggests that solution pH was the most important parameter in controlling MG sorption onto bentonite. They also showed that increasing the initial MG concentration decreased MG green removal percentage due to the saturation of bentonite with MG. The adsorption of MG increased with increase in solution pH. The adsorption isotherm data were well fitted with both the linearized Langmuir and Freundlich models. Furthermore, malachite green adsorption onto Khulays bentonite was well represented by the pseudo-second-order kinetic model. Khulays natural bentonite can be considered as a promising adsorbent for the removal of dyes from wastewater.

Keywords: Malachite green removal, Khulays natural bentonite, bentonite adsorption isotherm, and adsorption kinetic.

Removal of malachite green from wastewater using Khulays natural bentonite.

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1. **Introduction**.

Different industries such as the textile, leather, food, paper, printing, cosmetics, plastic, etc., usually discharge large quantities of wastewater contaminated with dyes. The disposal of effluents from these industries without proper treatment may cause harm to the aquatic environment. [1-5] Malachite green (MG) as a basic dye is used widely in many dye industries. It is highly toxic to mammalian cells and may cause irritation to the respiratory tract if inhaled, irritation to the digestive tract upon ingestion and irritation with redness and pain when contact to skin. [6,7]

Removal of MG using different types of clay has been the subject of several studies. [8-12]. These studies investigated the effect of different factors which affect the adsorption process such as contact time, solution pH, sorbent amount and initial dye concentration. Khulays bentonite which is located 95 km north of Jeddah in the western area of Saudi Arabia is calcium montmorillonite equivalent to a "Texas bentonite" in the USA or Fuller's earth in the UK. It has reserves ranging from 420 thousand tons (proven) to 28.9 million tons (indicated) and 38.9 million tons (possible). [13]

The main **purpose** of this study **was** to investigate the feasibility of using Khulays natural bentonite for the removal of malachite green from wastewater. This material was selected based on its low cost, considering its abundance in Khulays bentonite deposit.

2. Experimental

2.1. Materials and Method

2.1.1 Chemicals and reagents

Malachite green (A.R. Grade, purity > 96%) was purchased from Sigma Aldrich and used as received. The molecular structure of MG is illustrated in Fig.1. The stock solution (1000mg/L) of MG was prepared by dissolving a known amount of MG in distilled water. All working solutions of the desired concentration were obtained by diluting the stock solution with distilled water.

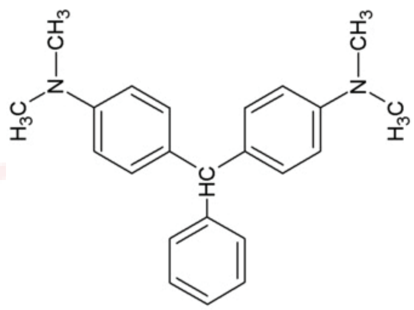

Fig.1. Structure of malachite green: 4-[(4-dimethylaminophenyl)-phenyl-methyl]N,N-dimethylaniline [14].

2.1.2Adsorbent

Khulays Natural bentonite (clay) samples were received as ungrounded rocks. They were undergoing grinding and sieving processes. The natural bentonite has a granular shape with variety of sizes. In this project, only -200 mesh (74μm) was used. The natural bentonite was dried in a convection oven under 105 ^{o}C for 24 hours to insure its dehydration. The dried clay was ground to the size of -200 mesh using a ball mill. The ground bentonite was sieved using -200 mesh sieving tray. All the holdup clay was sent back to the ball mill-grinding machine and the passed bentonite was used in the adsorption process. The chemical composition of bentonite is given in Table 1.

Table 1. The chemical composition of Khulays natural bentonite in wt%. [15].

Compound	**(%)**
Sio_2	52.88
Al_2O_3	17.59
Fe_2O_2	10.15
TiO_2	1.1
MgO	2.30
CaO	1.26
K_2O	0.64
Na_2O	1.26
MnO	0.15
SO_3	<0.05
P_2O_5	0.27
L.O.I.(1000^{o}C)	11.49

2.2.3. Adsorption process.

The adsorption experiments were conducted to investigate the adsorption of MG with Khulays bentonite. A certain amount of bentonite (0.05 g) and 50 ml of MG solution at desired initial concentration were added to100 ml stoppered conical flasks. The flasks were shaken in a horizontal shaker with water bath at 200 rpm. A stock solution of the MG with a concentration of 1000 mg/L was prepared by dissolving an appropriate amount of MG in distilled water. From the stock solution, various concentrations were prepared by dilution. The stock solutions were diluted to required concentrations ranging from 100 mg/L to 3500 mg/L. Solution pH adjustments were carried out using 1N HCl and 1N NaOH. 200 rpm shaking rate and a temperature of 25±2 ◦C was applied to the shaker. Samples with bentonite content were taken from the shaker at regular contact time intervals and separated by filtration. After each run, the filtrate was analyzed for MG concentration using UV-visible spectrophotometer. The effects of several factors such as solution pH, initial MG concentration, and agitation time on MG removal efficiency were examined. The amount of adsorbed malachite green q_e (mg/g) was calculated according to the following equation:

$$q_e = \frac{V(C_o - C_e)}{m} \quad (1)$$

where C_o and C_e (mg/L) are the liquid-phase concentrations of dye initially and at equilibrium, respectively. V is the volume of the solution (L) and m is the mass of dry adsorbent used (g).

3. Results and discussions

3.1 Effect of agitation time

The effect of shaking time on the removal of MG from wastewater was investigated by varying the contact time between the adsorbate and adsorbent in the range 0-210 min. The initial concentration of MG was ranged from 150 to 300 mg/L, while the dose of bentonite sample was 0.05 g/50 ml of MG solution. The pH of the solution was kept unchanged. The adsorption process achieved equilibrium after 120 min. The fast adsorption rate at the initial stage can be explained by an increase in the number of active sites available on the bentonite surface. The results show that shaking the mixture of different initial concentration for 120 minutes was sufficient to reach equilibrium. They also showed that increasing the initial MG concentration decreases MG removal percentage due to the saturation of adsorbent sites with MG. Similar observations for were reported by other investigators [16–18].

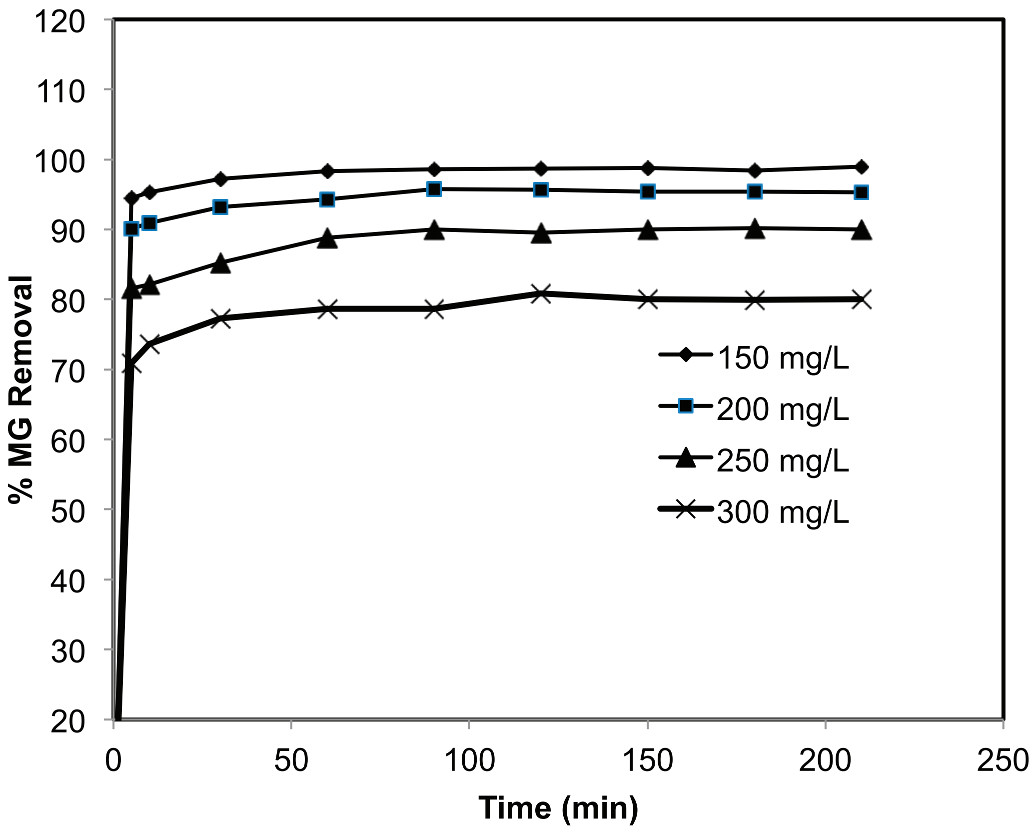

Fig. 2. Effect of agitation time on the removal of MG by Khulays bentonite.

3.2. Effect of solution pH

In dye adsorption, solution pH is considered as the most important parameter due to its effect on the surface charge of the adsorbent and the degree of ionization of the dye molecule [19]. To study the effect of solution pH on the removal of MG using Khulays bentonite, the experiments were conducted using solution pH in the range 3–10 with a constant clay amount of 0.05 g/50 ml of MG solution, a shaking time of 2 h and MG concentration of 300 mg/L. pH adjustments were carried out using 1N HCl and 1N NaOH, 200 rpm stirring rate and temperature of 25±2 ◦C.

Fig. 3 shows MG removal percentage at different solution pH. The lowest MG removal was found at pH 3. The removal percentage of MG by Khulays bentonite was noted to increase gradually with the increase in solution pH up to pH 8 where about 100% of MG was removed. A further increase in dye sorption to pH 10 was insignificant. This behavior may be attributed to two reasons: the surface charge of Khulays bentonite and the presence of excess H^+ ions in the solution. At acidic medium, the number of negatively charged surfaces of Khulays bentonite decreased and the number of positively charged surface increased, which caused the electrostatic repulsion between MG and positively charged surfaces and hinder the removal efficiency [20]. On other hand, this may be explained by the effect of the presence of excess H^+ ions which compete with MG molecules at acidic medium and hinder the removal efficiency MG [21]. Similar observations were made in the literature with other sorbents [20, 7].

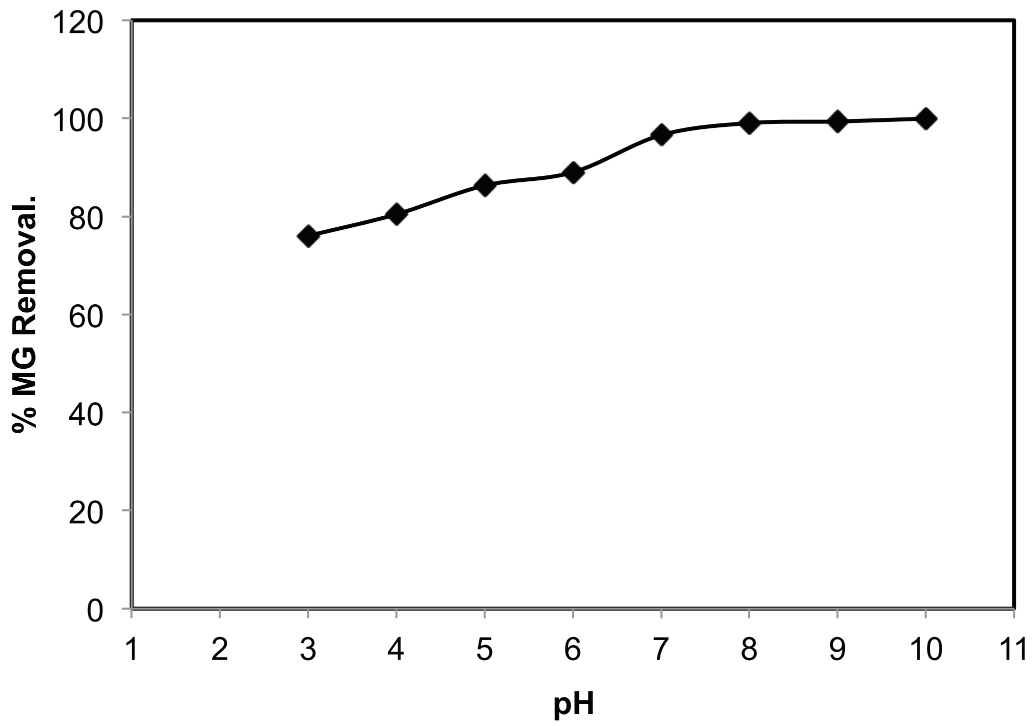

Fig. 3. Effect of pH on the removal of MG by Khulays Bentonite.

3.3 Effect of initial concentration

The effect of different initial dye concentration on the adsorption of MG onto Khulays bentonite is presented in Fig. 4. The study was conducted using MG concentration which varied from 100 to 350 mg/L under operating conditions of 120 min shaking time, 0.05 g of bentonite/50 ml for adsorbate and solution pH was control at 9.

The results showed a gradual decrease of MG removal when MG concentration increased in the solution. The results also showed that about 99% of MG was removed when MG concentration was about 100 mg/L. MG removal percentage decreased with increasing MG concentration to about 70% when MG concentration was 350 mg/L. This decrease was due to the fact that all adsorbents had a limited number of active sites, which became saturated at a certain concentration. [22] Similar results were reported for adsorption of MG from aqueous solution onto clayey soil of Indian origin. [20]

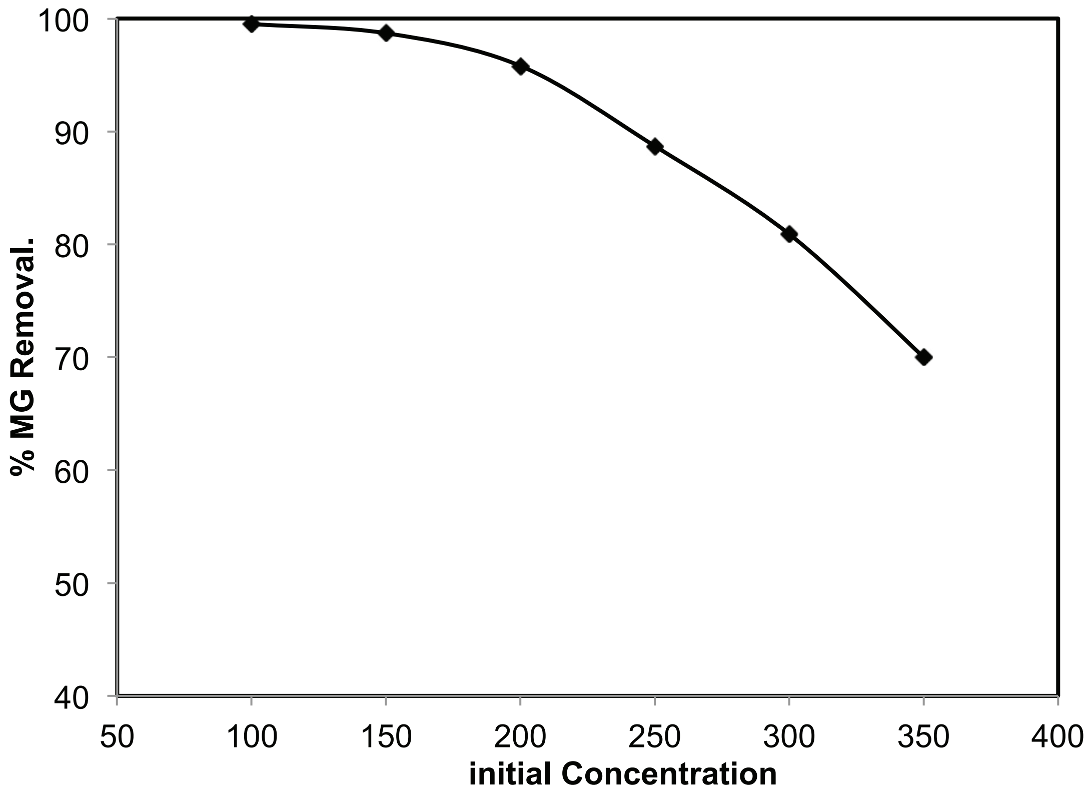

Fig. 4. Effect of initial concentration on the removal of MG by Khulays bentonite.

3.4 Adsorption isotherms

Adsorption isotherms are used to describe the equilibrium characteristics of adsorption process in order to design the adsorption system and evaluate the applicability of the process. Adsorption isotherms of MG on Khulays bentonite was investigated using two different adsorption isotherm models -- the Langmuir [20] and Freundlich isotherm [21] equations.

These two models were used to fit the experimental data and determine the maximal capacity of MG removal using natural Khulays bentonite. The quality of the isotherm fit to the experimental data was typically evaluated based on the magnitude of the correlation coefficient for the regression. The best fit of the experimental data when the isotherm R^2 value was closest to unity. The adsorption isotherms for MG removal were investigated using different initial metal concentrations at adsorbent mass of 0.05 g at room temperature (25^{o}C) and solution pH 9. Afterward, data obtained were fitted to the Langmuir and Freundlich isotherms.

The Langmuir isotherm is based on the assumption that it predicts monolayer coverage of the adsorbate on the outer surface of the adsorbent. [23]

The Langmuir equation, in the linear form is written as:

$$\frac{C_e}{q_e} = \frac{1}{bq_{\max}} + \frac{C_e}{q_{\max}} \qquad (2)$$

where:

C_e equilibrium concentration of MG [mg/L]
q_e amount of MG adsorbed per unit weight of adsorbent [mg/g]
q_{max} amount maximum adsorption capacity [mg/g]
b adsorption equilibrium constant [L /mg].

The data obtained from linear Langmuir isotherm plot for the adsorption of MG onto Khulays bentonite is presented in Table (2) and plotted in Fig. 5.
The maximum adsorption (q_{max}) for MG on Khulays bentonite equals to 250 mg/g.

The Freundlich isotherm is based on multilayer adsorption on heterogeneous surface [24]. Linear form of the Freundlich equation is written as:

$$\log q_e = \log K + \frac{1}{n}\log C_e \qquad (3)$$

where k and n are the constant characteristics of the system.

The best estimated values of all the equation parameters are summarized in Table (2).

Table 2. The Langmuir and Freundlich equation parameters predicted from adsorption isotherm data of MG onto Khulays bentonite .

Isotherm parameters	values
Langmuir	
q_{max} (mg/g)	250
b (l/mg)	0.47
R^2	0.999
Freundlich	
K (mg/g)	85.27
N	4.1
R^2	0.996

The data obtained from linear Freundlich isotherm plot for the adsorption of MG onto Khulays bentonite is presented in Table (2) and plotted in Fig. 6. The value of n between 1 and 10 showed good adsorption which indicates that MG was favorably adsorbed by Khulays bentonite.

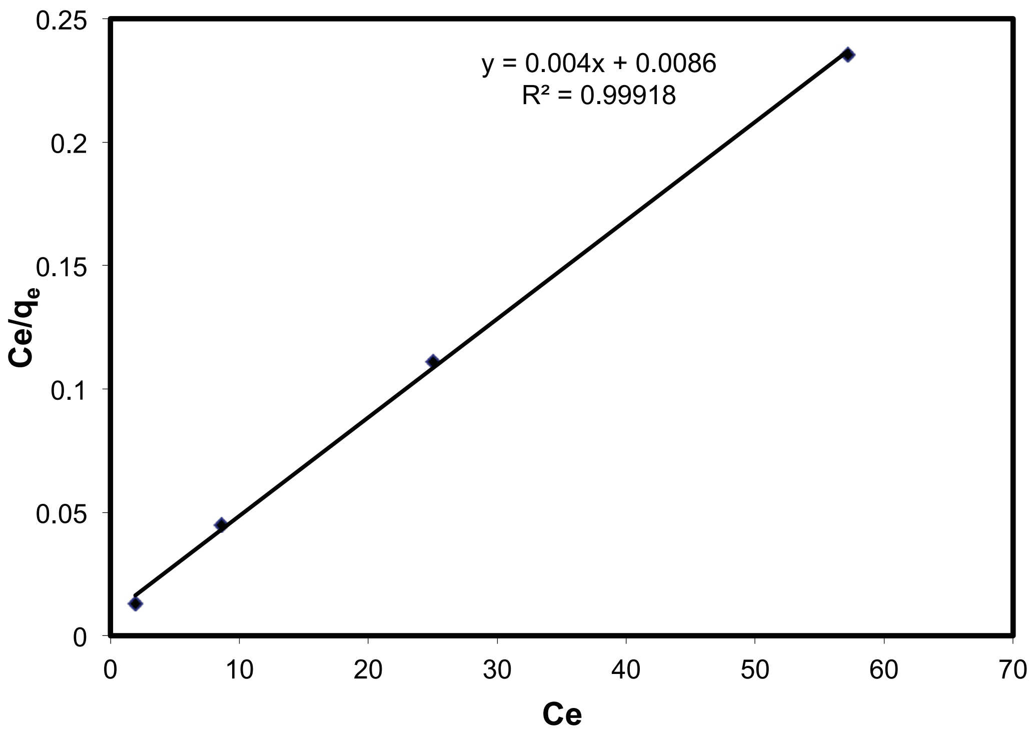

Fig. 5: Langmuir plot for the adsorption of MG on Khulays bentonite.

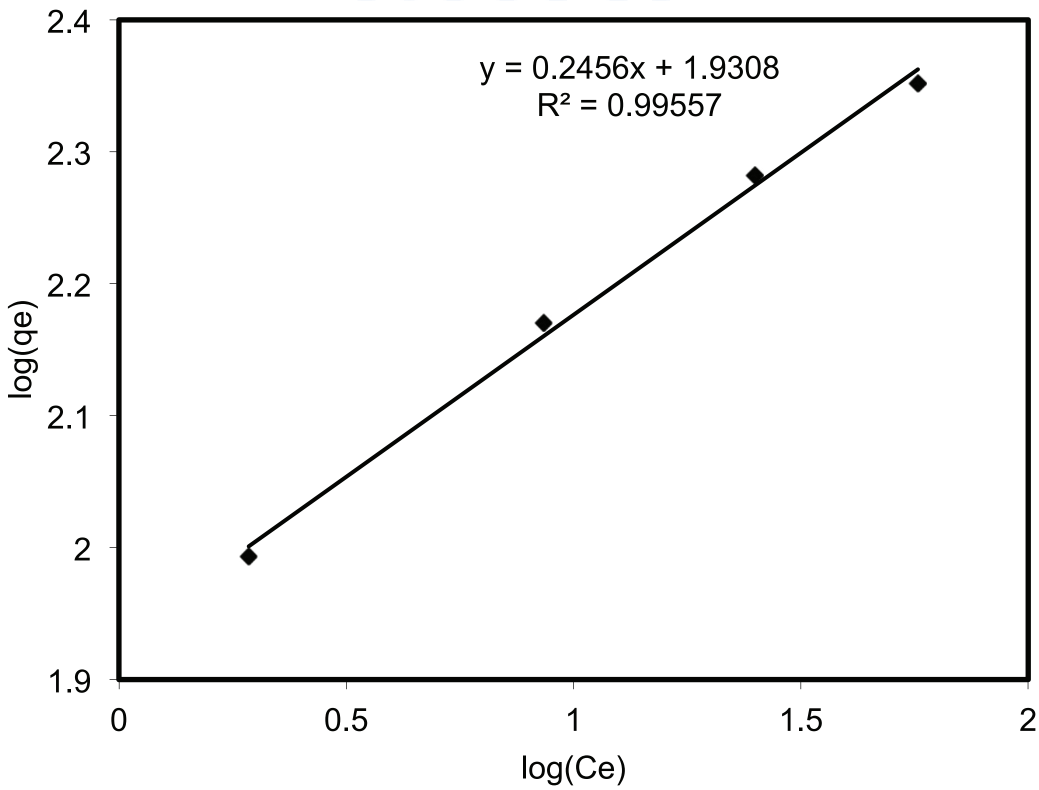

Fig. 6. Freundlich plot for the adsorption of MG Khulays bentonite.

3.5 Adsorption kinetics

In this study, pseudo-first-order equation and pseudo-second-order equation were used to describe the adsorption process of MG onto Khulays bentonite. The kinetic parameters, which are helpful for the prediction of adsorption rate, give important information for designing and modeling the adsorption processes. Thus, the kinetics of sorption describing the solute uptake rate is one of the important characteristics defining the efficiency of sorption. The kinetic parameters for the adsorption process are studied on the batch adsorption at room temperature. The initial concentration of MG was 300 mg/L, while the dose of bentonite sample was 0.05 g/50 ml of MG solution. The data are fitted to the first-order Lagergren equation [25],

$$\log(q_e - q_t) = \log q_e - \frac{k_1}{2.303} t \qquad (4)$$

where:

k_1 first-order rate constant [min^{-1}]
q_e amount of adsorbed metal ions on bentonite at equilibrium [mg/g]
q_t amount of MG adsorbed at time t (min) [mg/g]

The first-order constants can be obtained by plotting log (q_e−q_t) versus time, as shown in Fig. 7.

The experimental adsorption kinetics data are analyzed by applying the pseudo-second-order kinetics model [26], which is expressed as:

$$\frac{t}{q_t} = \frac{1}{k_2 q_e^2} + \frac{1}{q_e} t \qquad (5)$$

where:

k_2 pseudo-second-order kinetics constant[g/(mg /min)]
q_e amount of adsorbed MG on bentonite at equilibrium [mg/g]
q_t amount of MG adsorbed at time t (min) [mg/g]

The fit of this model is checked by each linear plot of (t/q_t) versus t as shown in Fig. 8.

As shown in Fig. 8 and Fig. 9, the value of R^2 was found 0.66 and 1 for pseudo first-order and pseudo second-order model, respectively. By comparing regression coefficients for each model, a good agreement of the experimental data with the second order kinetic model was observed. It can be said that MG adsorption onto Khulays bentonite is governed by second order kinetics.

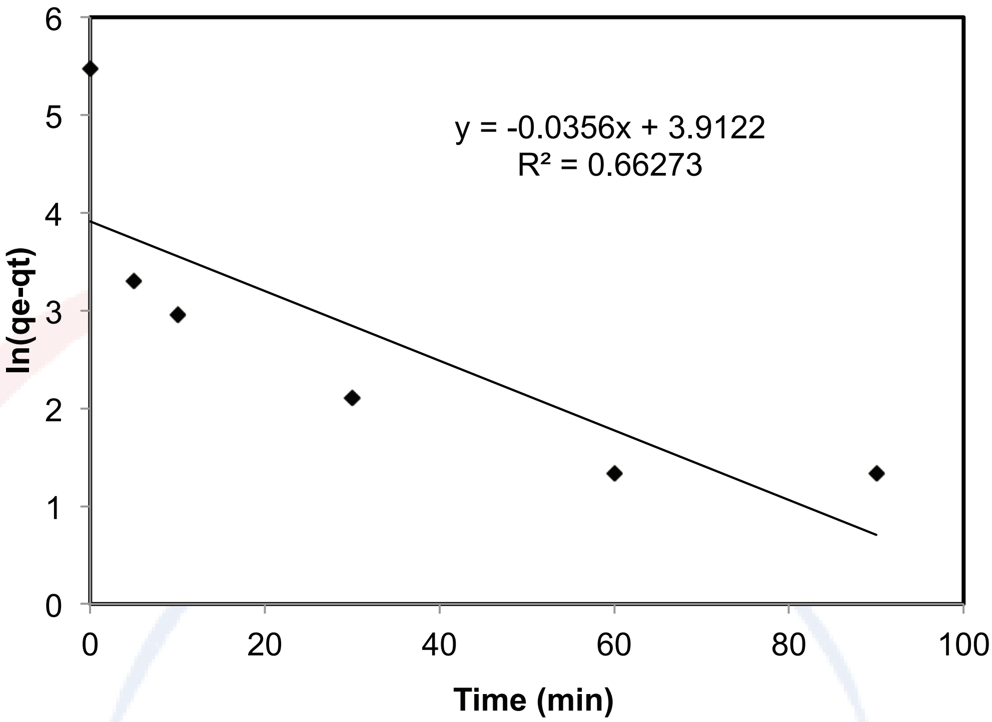

Fig. 7. Plot of first-order model for MG adsorption by Khulays bentonite.

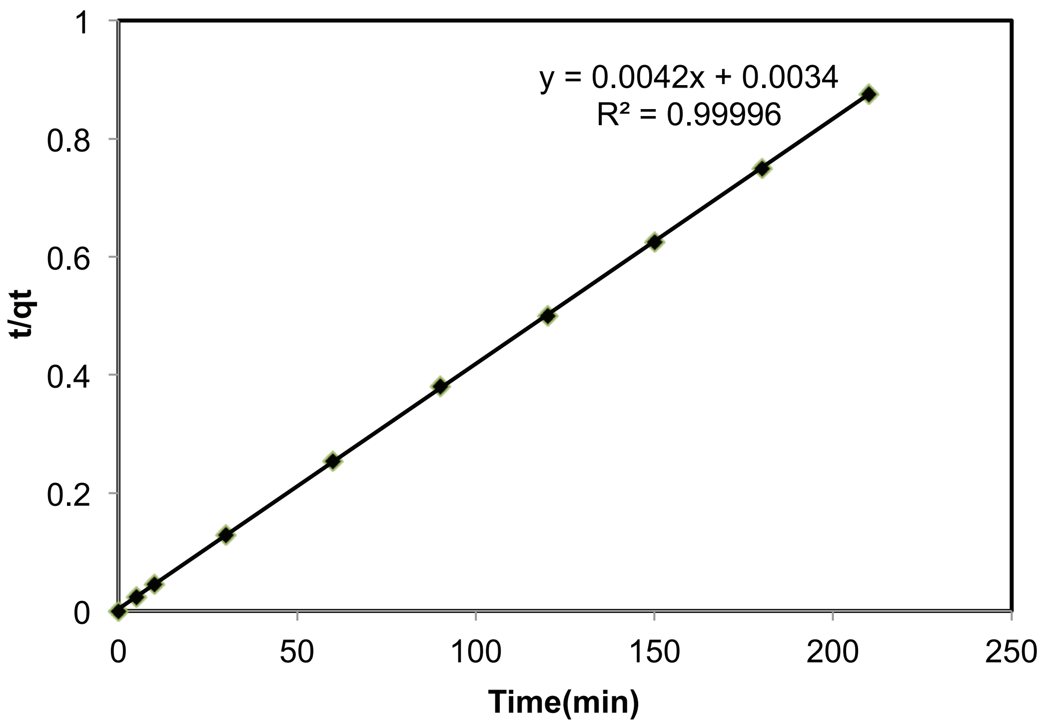

Fig. 8. Plot of second order model for MG adsorption by Khulays bentonite.

4. Conclusion

Removal of MG from wastewater using Khulays bentonite was investigated under various conditions. The results obtained from this study are summarized below.

Khulays natural bentonite was successfully used for the removal of MG from wastewater. The adsorption process was investigated and the equilibrium was reached after 2 h. The results showed that shaking the mixture of different initial concentration for 120 min was sufficient to reach equilibrium. They also showed that increasing the initial MG concentration decreased MG removal percentage due to the saturation of bentonite with MG. MG removal percentage gradually increased with increasing solution pH up to pH 9. This may be attributed to the surface of bentonite which contains large number of active sites.

Further, increase in solution pH MG removal was kept constant in the solution pH range 9-10, where the removal percentage was about 100%. MG removal decreased with increasing MG concentration when MG concentration increased from 150 to 350 mg/L. The removal of MG increased as the amount of Khulays bentonite increased. This was due to increase in the number of adsorbent sites. The adsorption isotherm data were well fitted with both the linearized Langmuir and Freundlich.

A batch adsorption kinetic experiment revealed that MG adsorption onto Khulays bentonite was well represented by the pseudo-second-order kinetic model.

Therefore, Khulays bentonite can be considered as a promising adsorbent for the removal of dyes from wastewater.

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A plane of "Shine" in Search of Synergy

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0233

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Abstract

Applicability of the concept of sustainability is essential to all areas of human society; efficient synergies can be successfully searched if efforts are associated with responsible business practices. An attempt was extended to initiate marketing activities from wide spread network of District Industrial Homes, a nonprofit government organization projected for capacity building of low income class in under developed countries. DIH work with special focus on imparting income generation skills to the destitute, especially women. SHINE (uniforms for government sector schools) was designed for District Industrial Homes in Punjab, Pakistan. This product plan was an organized effort to acquire economic growth and self-sustainability of the institute and the skilled labor trained here, through establishing a marketing line by diversifying the current activities of institute. Internal caliber of the institute was explored to estimate how it could shape a hopeful support for the dependent women getting their earnings from here as well as for institute. Product, place, promotion and price strategies were made after deep considerations. Market offerings were planned observing keenly the company, the aimed market and its positioning ideology. Price structures were considered and prosperity takings were calculated to go well with the qualitative and quantitative objectives located. The plan was formulated to act as a treatment of the present and future that placed a positive value on long term returns both to institute and to skilled destitute females. The overall mission of this market plan was in broad societal terms rather than narrow product terms. SHINE was anticipated to be able to align its growth with that of its workers, communities it operated in, as well as the customers and consumers, hence was able to address common concern: the pursuit of a sustainable societal living.

Keywords: Income generation, economic growth, self-sustainability, District Industrial Home.

A plane Of "Shine" In Search Of Synergy

Applicability of the concept of sustainability is essential to all areas of human society; efficient synergies can be successfully searched if efforts are associated with responsible business practices. An attempt was extended to initiate marketing activities from wide spread network of District Industrial Homes, a nonprofit government organization projected for capacity building of low income class in under developed countries. DIH work with special focus on imparting income generation skills to the destitute, especially women. A market plan of SHINE (female school uniforms for government sector) is planned for the network of District Industrial Home (Sanatzar) in Punjab, Pakistan. The plan is made to explore the viability of District Industrial Home (Sanatzar) for doing business to acquire economic growth leading to self sustainability for institute and of female workers who are trained by the institute and working here.(Gowdy, 2005) This effort is extended to initiate marketing activities from this nonprofit government organization and this will result in uplift of the indulged unprivileged social class.(Information System Unit, SPDC, 2007)

Mission Marketing

The overall mission of this plan is in broad societal terms rather than narrow product terms. This social mission has a clear sense of direction that will serve the best long run interests to the product, the workers and the consumers.(Kottler & Armstrong, 2007) Trained managers and their team, with a passion for the economic growth of poor social class, are dedicated to build a viable, profitable business to fulfill the mission. The plan is formulated to act as a treatment of the present and future that places a positive value on long term returns both qualitatively and quantitatively to both institute and skilled destitute females.

"Any change in a community that enables greater production, increased employment and a better distribution of goods and services is called economic growth."(American Planning Association).Economic growth means making profits which lead to self sustainability ,such a stage of income generation that the needs can be fulfilled internally "Economic growth is never an accident"(New Economics, 2005). This plan is an organized effort to acquire economic growth and stability to the institute and the skilled labor, through establishing a marketing line by diversifying the activities of institute.

1. To open ways for alternative methods of income generation for institute than only relying upon the government funds thus building a framework for self sustainability.
2. Economic and social support to the survivors who are not able to pursue their skills by themselves.
3. Formulize a strategic marketing plan that can be adopted in all institutes of Punjab, Pakistan.

4. Following the principles of societal marketing DIH will provide its customers "desirable product" that will give both the immediate satisfaction and also long run benefits.

SWOT Analysis (Internal and External Environment Influence):

SWOT analysis (Kottler & Armstrong, 2007) (table 1.1 1.4) show that DIH are resourcefully rich with innovative ideas, devoted and expert supervision group functioning under extremely inspired and motivating Social Welfare Department. The institute is already offering its services as skill imparting authority .This new venue of marketing will unfold its hidden capacity building potential.

Table 1.1:

1. **Strengths**
• A well defined net work of DIH all over Punjab • All institutes are controlled centrally • Every DIH has established structure • All DIH have similar courses ,taught to the workers • Each DIH is provided with equipment which is required for manufacture of SHINE. • Every DIH has a list of registered workers who are essentially pass outs of the institute so share same skills • Bulk production will result in lower per piece cost • Many over heads are not included in the cost of product e.g. rent of space utilized for storage of raw material and finished product • DIH are capable of extending customer services such as rapid delivery of made to order and free alteration services for problem sizes.

Table 1.2:

2. **Weaknesses**
• All decisions are to be made centrally by proposed department of Punjab Government.

Table 1.3:

3. **Opportunities**

- New government schools for girls are being opened by Punjab government under Education Reform Programs.
- Existing female government schools are focusing on increasing their enrolment. Thus a broader base of potential customers is produced.
- Increasing trend of use of ready made uniforms is seen which is also supported by school authorities to maintain oneness of colour and style
- Availability of SHINE in side the premises of school.
- All participants of value delivery chain work together for the underlying mission of launch of SHINE.

Table 1.4:

4. **Threats**
• Existing trend of getting school uniforms stitched individually by customers • Threat of new entrants in manufacture • Suppliers do not provide quality raw material at negotiated price • Suppliers fail to supply according to the schedule can result in cardinal failure.

Marketing Objectives:

SHINE will engage a segment of skilled population in productive activity and save them from becoming vulnerable to negative forces of fundamentalism, extremism and terrorism. SHINE will create awareness about the necessity of collective positive action for Pakistan's development.

Quantitative Objectives:

1. To attain 10% sales increase in 1 year time of operation
2. To achieve 15% market share in uniform business
3. To make 40% return on sale
4. To produce 5% return on investment

Qualitative Objectives:

The market planning for SHINE is purely for mission marketing and has 3 fold qualitative objectives

1. To provide lowest cost price, high quality readymade school uniforms to the students of government schools, belonging to the low and middle income groups
2. To provide opportunities for employment generation for workers of DIH.

3. To provide opportunities for economic growth leading to self sustainability to the net work of skill imparting and capacity building DIH (sanatzar) in Punjab

So it will be easier to initiate, implement, maintain and sustain SHINE.

Marketing Strategy:

Alternative Marketing Strategy:

Before reaching the decision of marketing of female government school uniform many other products were also under consideration .There were strong proposals for taking up marketing of one piece lawn kurtas for men, infant garments, preschool girl's frocks and two piece white shalwar kurta for young boys from age 5 to 8.But after deep considerations following marketing strategy was selected.

Selected Marketing Strategy:

The decision about marketing of suggested product line under the brand name of SHINE was made after detailed deliberations in the meetings of the management committees of DIH due to following benefits:

1. The mission associated with marketing of SHINE is its competitive advantage.
2. There is unmet need recognized in the area for which product line is developed.
3. The color and style of female government school uniforms all over Punjab is same, so the purchase of raw material in bulk will result in lesser cost of production.
4. SHINE has broad and consistent customer base in the target market.
5. Creating sale point inside the schools is a competitive edge as both organizations involved in the act of marketing are under the control of government.
6. The product line developed is such that the surplus of one production cycle is easily marketed in next demand time.
7. The design and color of female uniform of government school does not changes quickly

Market Analysis:

Availability of government school uniforms for female is less in almost all districts of Punjab. There are firms doing profitable business in school uniforms for private schools as the profit margins are very high in this sector. There is need felt to offer same products to the government sector schools also.

Market Segmentation:

The potential customers belong to low and middle socio income group. So the mission of this marketing is not only to extend support to the DIH and workers but also to provide customers with quality product at lowest possible price

The Appropriate Targeting Strategy:

Product specialization strategy is adopted which is designed to cater segment needs.

SHINE focuses on the government school uniforms especially for female of high classes. at the beginning stage of this plan because size variation is comparatively low among this age group as compared to lower classes and to keep the operations simple in initial stage. During expansion stage, the segment of smaller sizes of female and segment of male government school uniform of all sizes will be included

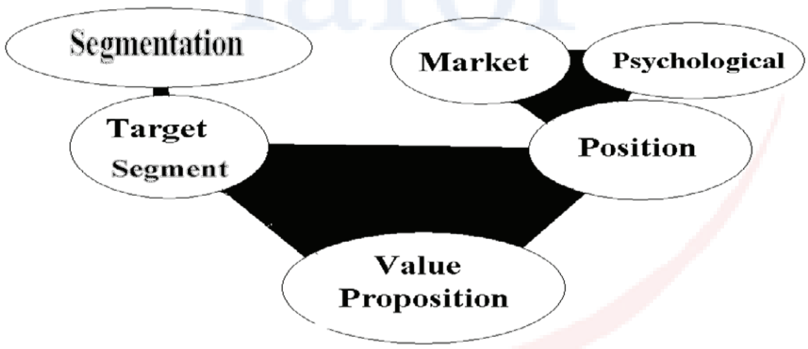
SHINE is adopting a concentrated marketing strategy as it has very few resources, so it has planned to capture bigger share of small niches and it is not trying to have little share from big markets..

Positioning Strategy:

Value Propositions:

The Value Proposition of SHINE contribution that consumers recognize is the respond to the query: What's in it for me?

On the other hand it can be declared as, "Why should I pay what you ask for this offering?"



The value proposition answers the customer's "What's in it form me?" question.

SHINE says: **"Let's join hands to eradicate poverty"**

Key to accomplishment:

The major step for accomplishment is constructing the product positioning as clear as possible. If the objectives of this mission marketing are well delivered to the probable consumers it will be appreciated a lot in the specific segment of people. Unconfirmed reporting of users is important in this fragment. Efforts will be made so that on one instance if consumers are gained, they are never lost. It must always be remembered to sell the SHINE objectives, not the product.

Differentiation:

SHINE will develop its focal point to distinguish itself from local manufacturers and develop the production by satisfying the actual requirement of low as well as middle income group school going children of government sector by providing durable products at lowest possible prices.

Emphasize Service and Support:

SHINE needs to set up its selling contributions as an obvious and feasible option for the aimed market, by providing better, cheap and quick services to satisfy customers.

Emphasize Relationships:

Customers have to understand they are taking on a relationship with SHINE, playing an important role in uplift of destitute buy indulging in the act of purchase. So they are not just buying uniforms but joining hands to eradicate poverty.

Positioning Statement:

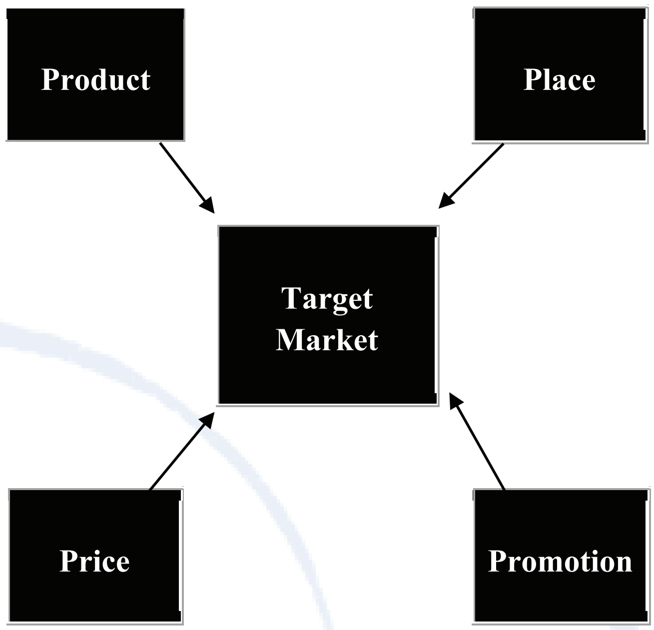
"The SHINE is first of its kind school uniform for government sector among the array of private firms with a unique mission to eradicate poverty both by offering lowest possible price of best possible quality to customers and extending support to workers and institute ,for all those who want the worth of their spending as individual gain and societal improvement"

Point of Parity (POP) =School uniforms for government sector

Point of Difference(POD)=Lowest price ,durability ,availability in the schools, free and quick alterations, customized services for problem sizes without additional charges, mission of the business.

Market Mix:

The SHINE tries to create a constructive response in the aimed segment by joining together these four variables of marketing mix in a most favorable way.



The Marketing Mix
An abstract chart of the selling blend:

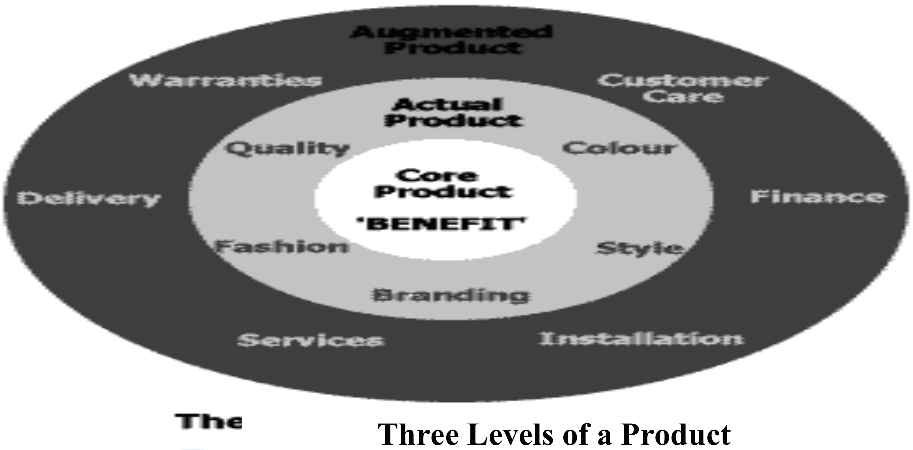
The following chart lists the swift selling blend decisions taken during planning process of SHINE, this chart comprises of some part of each of the 4Ps. (Internet Center For Management and Business Administration 1999)

Summary of Marketing Mix Decisions:

Product.	Price.	Place.	Promotion.
Product Decision Product Market Offering Brand Name Quality Scope Of Product Line Packing	Price Decisions Pricing Objectives Determining Demand Pricing Method	guide partners control stimulus Places Transportation	promotion civic dealings memorandum Media

Product Strategy:

Product Decision:



Three Levels of a Product

The basic mission of SHINE is also the core of the product decisions. The physical product selected is such that it remains in demand, with rare chance of change with respect to colour and style. The demand is higher after the annual examination and after summer vocations. By using quality raw material (purchased centrally), professional patterns of all required sizes and better sewing techniques the SHINE will create better customer value.(Kottler & Armstrong, 2007)

Product Market Offering:

In the initial stage of marketing of SHINE the complete uniform in standard small medium and large sizes according to the recommendations of the Education Department of Punjab with respect to the colour and the style, for the female of high schools of government sector will be prepared.

Brand Name:

It is proposed to give these marketing offerings a brand name. The efforts are made to position the brand in the target customers on bases of strong believes and values.(Kottler & Armstrong, 2007) SHINE is proposed name which not only goes with the use of the product, as children of target social class will shine while receiving education wearing the SHINE but also as the brand sells chances are provided to the workers of unprivileged social class to shine in the society

Quality:

A lot of considerations are given to maintain the quality of all types of raw materials required in manufacture, appropriateness of patterns of standardized sizes for cutting, best assembling and sewing operations to deliver high customer value and maintaining the best quality of product

Scope of Product Line:

For the development of SHINE in near future the product line extension strategy is adopted. SHINE will start manufacturing uniforms for female sizes for junior sections and then it will start to manufacture whole size range of male school uniforms of government sector.

Packing:

The product will be offered to be marketed as one piece priced article. This will give better range of selection among the required articles to the target customers. Customers can choose and make their uniform sets according to their own individual preference. This will also be beneficial for recording the demand for future production of each specific article and for managing back up storage in the DIH.

Price Strategy:

Price Decisions:

Customer oriented pricing decisions will be made involving effective understanding of how much value customers place on the societal benefits they receive from the product .A price is set that captures this value.

Pricing Objectives:

The proposed plan is for mission marketing so no effort is made to achieve high profits."Survival" is the initial objective.(Kottler & Armstrong, 2007)

Determining Demand:

For the target group price sensitivity is high, demand is elastic. A major segment seeks for lowest prices so they might go for alternatives like getting the uniforms made by them selves.

Pricing Method:

Cost based pricing decisions are adopted to acquire a fixed percentage of profit after cost is deducted from price.(Kottler & Armstrong, 2007) As a policy decision 12% profit after the cost is recommended in fixing the price. Major part of the profit will be given to the workers and a smaller part of profit is kept for the self sustainability of institute. Whole process is detailed in the infrastructure of DIH to keep all activities transparent.(Social Welfare Department, 2009)

Break Even Analysis and **Return on Investments** are calculated carefully

Place Decisions (Distribution):

Distribution channels will be managed by DIH own worker force.

Distribution Channel:

Direct selling technique is adopted .Through government policy decision a retail outlet is established inside every government school premises. Out let space is provided, without any overhead cost .It is a contribution from the school management to the mission objectives of SHINE.

Motivating the channel:

At all levels the real objective of the marketing of SHINE is so much felt that all part of value chain willingly contribute to the underlying societal welfare. Objective's challenges are incorporated to go with customer prospect of little charge and elevated worth.

Channel Alternatives:

Selective distribution of the product would be done directly through DIH contact numbers.

Location:

The SHINE products will only be available at the school outlets and at the DIH itself .Customers will be encouraged to visit the DIH to get better insight of the mission.

Logistics:

The premises of DIH will be used for storage of the raw materials which the suppliers will provide .After production the inventory of the SHINE products will also be maintained at the DIH. The supply to the outlets will be made by the official vehicle provided to every DIH.

Promotion Strategy:

Communication Objectives:

1. To establish recognition of SHINE
2. To extend buying objective of prospective consumers

Communication Design:

A mixture of memorandum strategies including attractive label lines has been considered for SHINE.

Advertising:

Leaflets containing appropriate information of the brand its offerings and its mission with the DIH address and contact numbers will be published locally for every DIH and will be made available to the potential customers by being attached with the school circulars and essentially with the result cards. Prominent banners inside the schools to make people aware of presence of SHINE. Print media like local news papers will also be used for advertisement.

Public Relations:

DIH management would visit the potential schools deliver speeches to make consumers aware of the brand. Representatives will be sent periodically for promotional messages. These activities will seek to make its signature as the best low cost solution for school uniforms.

Conclusion:

The following parameters can identify SHINE's success factors and suggest their application to future expansions.

Relevance:

The mission marketing approach, especially in addressing the needs of poor women, has great potential and can and should be replicated. SHINE's marketing plan has been made most relevant to beneficiaries by including them in plan design and implementation, and by conducting thorough market research prior to the formulation of strategies.

Effectiveness:

The plan at its early stages can identify possible weaknesses or issues that can arise in the future, and ensure their mitigation.

Impact:

The mission marketing for the particular product being considered is workable, tried and tested, so that impact is maximized. The preparation and dissemination of case studies through the life of the product plan would be effective in showing impact.

Efficiency:

In future SHINE should maximize cost benefit ratios by communicating with suppliers for lesser rates. The indicators for ensuring that cost benefit analysis takes place during the plan's implementation should be identified

Sustainability:

The plan aims to create sustainability for the workers and the institute itself at the very beginning and follow it closely throughout the action plan, making modifications based upon experience. The plan is designed for eventual sustainability and makes the needed adjustments/interventions a part of the indicators to be monitored through the process.

Gender:

SHINE is developed as working directly for women and shows a solid understanding of their needs.

The plan was formulated to act as a treatment of the present and future that placed a positive value on long term returns both to institute and to skilled destitute females. The overall mission of this market plan was in broad societal terms rather than narrow product terms. SHINE was anticipated to be able to align its growth with that of its workers, communities it operated in, as well as the customers and consumers, hence be able to address common concern: the pursuit of a sustainable societal living.

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A Low-Carbon Tourism Application for Greenhouse Gas Reduction in Penghu, Taiwan

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Abstract

Ministry of Economic Affairs, R.O.C. proposed the Penghu Low-Carbon Island Project to reduce greenhouse gas (GHG) emissions of Penghu Island to 50% of 2005 in 2015. Since Tourism is the major industry in Penghu, promotion of low-carbon tourism is critical in the low-carbon plan. Without proper guidance and a business model, the tourists might not have the intention to adopt low-carbon tourism activities. Although there are numerous applications providing tour information, there is still lack of an application aiming to promote low-carbon tourism. An Android-based low-carbon tourism application is developed to transform tourists' travel habit. The application is designed to increase the awareness of low-carbon tour activities, to encourage ride electric scooters, and to reveal the impact of a trip. Low-carbon tour sites along with normal ones are presented in a geographic information system. Low-carbon tourism activities can be participated more frequently. The information of the ecosystem of green transportation which comprises lease companies, hotels, a vocational school, and battery exchange services for e-scooters has been also included. A carbon footprint calculator has been developed to disclose the GHG emissions of tourists' itinerary. The itinerary can be constructed intuitively with a guidance-based system which simulates real travel stages in Penghu. Tourists can identify the most carbon-intensive activities in their trips. It has been proofed that the low-carbon application and the business model have gradually transformed the tourism style in

Penghu Island. The GHG emissions in tourism sector are expected to drop considerably in the near future.

Keywords: Low-Carbon Tourism; Carbon Inventory; Renewable Energy; Island; Carbon Reduction; Smartphone Application; Carbon Footprint Calculator.

1 Introduction

In recent years, climate change and carbon abatement are the most concerned issues in the global society. Governments around the world are working hard to find ways to reduce greenhouse gas (GHG) emissions On World Environment Day, 2009, The Administrative Yuan of the R.O.C. government approved a set of guidelines named **"Framework of the Sustainable Energy Policy"**, declaring its intention to develop renewable energy and reduce GHG emissions The Administrative Yuan also laid out a comprehensive plan, "**Energy Saving and Carbon Reduction Master Plan,**" in 2010 aiming to reduce the country's GHG emission to 2005 level by 2020.

The Third National Energy Conference was thus held in 2009 to address how to achieve the carbon reduction target, and concluded that the low carbon society should be one of the major approaches. Counties in Taiwan should establish at least two low carbon communities by 2012. Six low carbon cities will be established by 2016. Eventually, four districts of Taiwan, including Northern, Middle, Southern, and Eastern districts, will be transformed into low carbon societies by 2020.

Although there are many low-carbon development plans underway all over the world, such as eco-model cities in Japan (Japan External Trade Organization, 2013) and Jeju Island in Korea (Wikipedia, 2013), there is still lack of a systematic approach for a central government to transform a nation-wide greenhouse gas (GHG) emissions reduction target into a solid implementation plan for a local government to reduce GHG emissions in various sectors. The Ministry of Economic Affairs, Taiwan (ROC), hence, chooses the Penghu Island as a pilot area and proposes the Penghu Low Carbon Island project to demonstrate how to build a low-carbon community in Taiwan. Since tourism is one of the major industries in Penghu, promotion of low-carbon tourism is the key part of the low-carbon development plan. To do so, a low-carbon tourism application has thus been developed to guide tourists how to participate in low-carbon activities based on smartphones.

In the following sections, the master plan of the Penghu Low Carbon Island project is first introduced. The role of the low-carbon tourism application is then addressed, followed by the structure of the system. Finally, the development of carbon footprint calculator integrated in the system is explained.

2 Low Carbon Island, Penghu

The low-carbon transformation plan includes eight major aspects, as illustrated in Figure 1. These aspects are introduced briefly as follows (Li and et al., 2012).

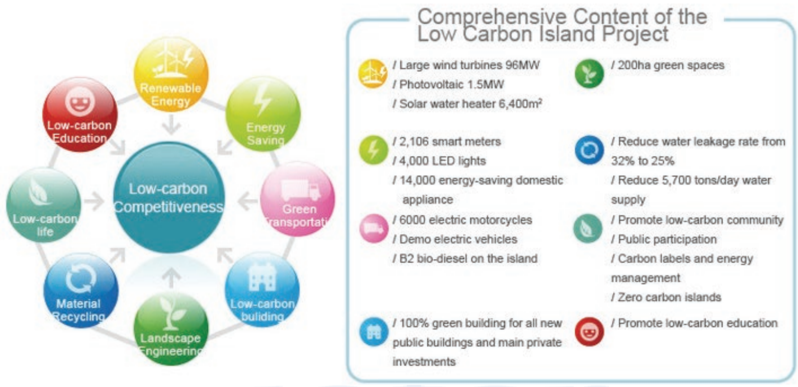

Figure 1 Goals of the low-carbon island project. (MOEABOE, 2013)

1. **Renewable energy:** The project will take advantage of the local natural resources, such as wind and solar energy (Taipei Times, 2011). Total capacity of 96MW wind turbines will be constructed. Iconic photovoltaic structures with 1.5MW capacity have been installed at major attractive sites of Penghu Island. 6,400m^2 solar water heaters will be installed by residents. A Renewable Energy Exhibition Park will be introduced to exhibit various kinds of renewable energy technologies for education and tourism.
2. **Energy saving:** 2,160 smart meters, 4,000 LED street lights, and 14,000 energy-efficient appliances will be installed or introduced to improve energy efficiency.
3. **Green transportation:** 6,000 electric scooters (e-scooters) will be introduced to replace traditional scooters. All fuels for transportation will be supplied by B2 bio-diesel.
4. **Low carbon building:** All newly constructed public structures and all large scale private constructions should attain green building certifications.
5. **Forestation**: Increase 200 Hectare green areas.
6. **Resource recycling**: All recyclable wastes will be reused to reduce the total waste of the island, and a zero-waste facility will be installed to completely eliminate waste export to Taiwan. Water leakage rate will be reduced from

32% in 2010 to 25% by installing DMAs in the water distribution network. Underground water reservoirs will be constructed to increase water resources.

7. **Low carbon life**: Regular promotion activities will be conducted to deliver the importance of low-carbon life style to local residents in hope of increasing public participation in the project. A low-carbon tourism environment will be gradually established by introducing low-carbon facilities and schemes into hotels and restaurants. Four zero-carbon isles will be constructed.
8. **Low carbon education**: Low-carbon related materials will be introduced in schools throughout the communities.

All the above related plans will be carried out in 5 years (from 2011 to 2015) and eventually achieved the goals of the Penghu Low Carbon Island Project.

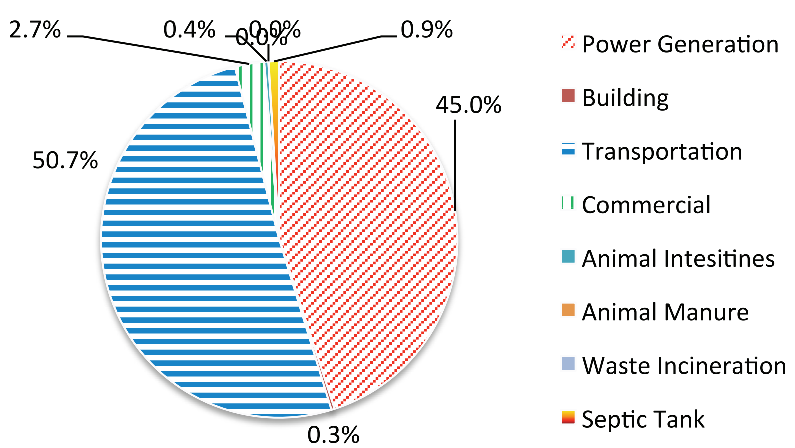

Figure 2 Ratios of GHG emissions from various sources.

According to the GHG inventory of Penghu, as illustrated in Figure 2 (Industrial Technology Research Institute, 2010), the transport sector contributes about half of the GHG emissions in Penghu Island. Therefore, decarbonisation of transport sector is one of critical aspects in GHG reductions for Penghu. Since Penghu is a popular tourism destination, tourist transport accounts for the major part of the GHG emissions in transport sector. Promotion of low-carbon tourism can be an ideal approach to eliminate GHG emissions.

3 Low Carbon Tourism in Penghu

However, very few of 600,000 tourists every year who visit Penghu are aware of the necessity of GHG reductions. Even some of the tourists like to reduce the impact of their visits. There is lack of information for how to transform traditional tourism activities into low-carbon ways.

Nowadays, almost 80% of all mobile phones sold in the market are smartphones (Business Next, 2013). Smartphone is a very popular personal computational platform in modern society. Any information based on a smartphone application can be accessed by any user easily and thus distributed broadly among diverse groups of users. Although there are many applications have been developed for tourism in Penghu, there is still lack of an application aiming to low-carbon tourism. To promote low-carbon tourism in Penghu, a low-carbon tourism guidance application based on Android smartphones has thus been developed.

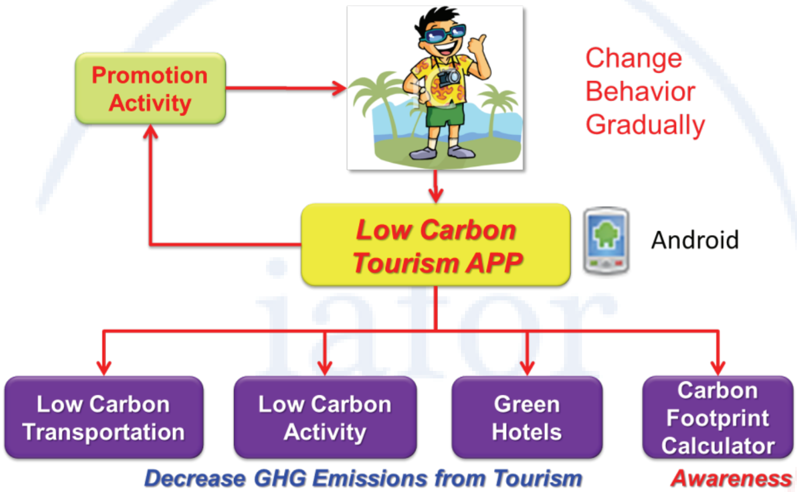

Figure 3 The role of the low-carbon tourism application for Penghu Island.

The major sources of carbon emissions for tourism are from transportation, hotels, and activities. Therefore, the low carbon tourism application integrates essential information of low-carbon tourism, including low carbon transportation, low-carbon pastime activities, green hotel, and a carbon footprint calculator for low carbon tour in Penghu, as shown in Figure 3. Tourists can access the information of these key elements of low-carbon tourism in Penghu from their personal mobile phones, which make the tourists more likely adopt low-carbon tourism activities. The three elements of low-carbon tourism in Penghu are addressed in the following sections.

Most tourists who visit Penghu rent scooter as the major mean of transportation. Therefore, replacing traditional scooters with e-scooters is essential in building green transportation in Penghu. However, the obstacles of promoting e-scooter are twofold: the limit driving range of e-scooter and service of battery exchange. These two factors make ride e-scooter very inconvenient. To transform the way tourists travel in Penghu,

Penghu County established an eco-system of green transportation for local residents and tourists. The eco-system comprises three parts which are tourism industry, e-scooter leasing company, and green job. 550 charging stations have been established at popular tour sites. Every convenient store provides battery exchange service. A tourist can find an e-scooter from the hotel he/she stays or from almost every car leasing companies. Since the number of e-scooter increases dramatically, a local vocational school designs a training course for e-scooter reparation to nurture the local reparation industry and to create greed jobs for local residents.

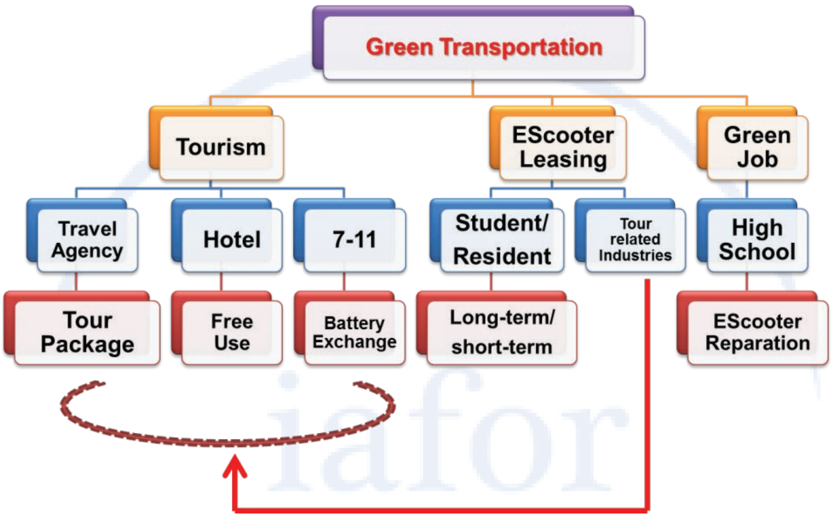

Figure 4 The eco-system of green transportation in Penghu. (EPBPC, 2012)

As indicated in Kuo and Chen (2009), various types of recreation activities lead to different levels of GHG emissions. Motorized water activity (such as sea motorcycle riding) contributes 15,300 g CO2 per tourist. Sightseeing contributes only 417g CO2 per tourist, which is about one fiftieth of the level motorized water activities. Therefore, some creation activities which release less CO2 can be defined as low-carbon recreation activities, such as sight-seeing, historic sites visiting, landscape visiting and nature watching. These low-carbon recreation activities should play the major part of an itinerary in low-carbon tourism.

The different accommodation types also contribute to various levels of GHG emissions. As indicated by Kuo and Chen (2009), bed and breakfast is more low-carbon than hotel. If a tourist can reside in a B&B rather than a hotel, about 3,760 g CO2 can be saved per tourist per night. In low-carbon tourism, a proper choice of accommodation is thus a key element.

However, tourists will not change their travel habits voluntarily unless they can be aware of environment impacts from their activities. Therefore, a carbon footprint calculator is developed and integrated into the system to disclose the GHG emissions of an itinerary. This can increase the low-carbon awareness of tourists who visit Penghu.

4 System Structure

To integrate the information of low-carbon tourism in Penghu efficiently, the structure of the guidance system has been designed to provide various low-carbon tourism information based on the types and locations as illustrated in Figure 5 and Figure 6.

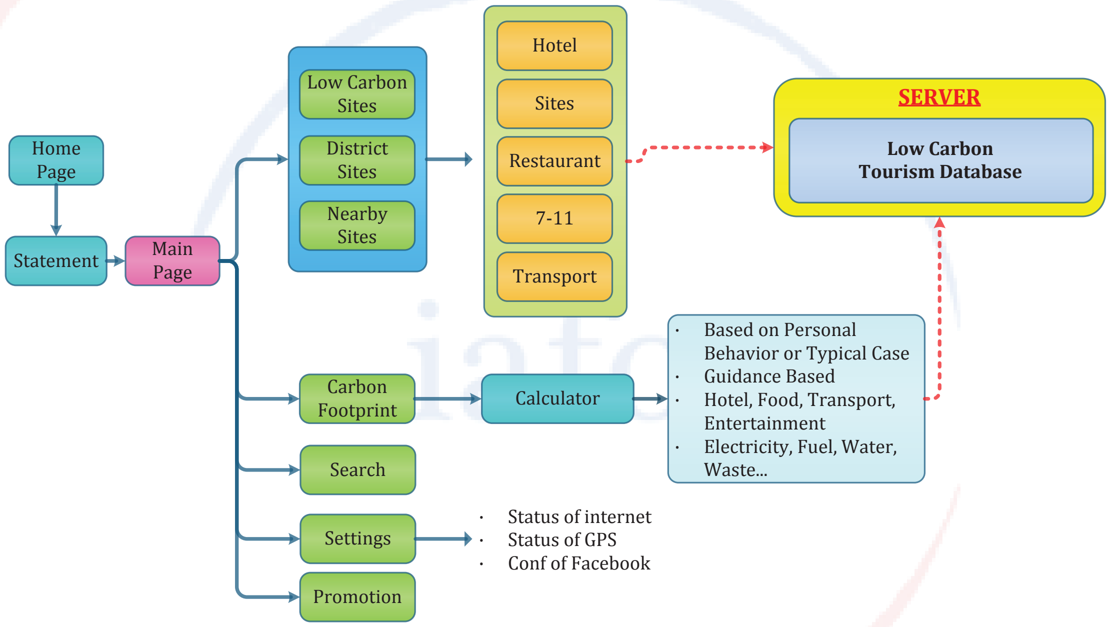

Figure 5 The Structure of the low-carbon tourism guidance system.

As presented in the structure and the screenshots of the system, tourists can find tour sites based on the types of destinations, include the district where the sites locate, the nearby sites of the GPS positioning, and the low-carbon sites in Penghu. The low-carbon sites are aggregated into a single category on the main page of the system which makes these sites more likely to be discovered. These low-carbon sites are the constructions of the Low Carbon Penghu Project, such as PV installation sites, wind farms, and charging stations.

E-scooter is the other category on the main page. All information about e-scooters can be found under this option, include e-scooter leasing companies, charging stations, convenient stores which provide battery exchange service, and the hotels which provide e-scooter for transportation. This category makes it very easy for a tourist to connect to the eco-system of the green transportation in Penghu.

Since all these sites are distributed evenly in Penghu, the system integrates Google Map (Google Inc., 2013) and the routes planning function to guide tourists to the destination.

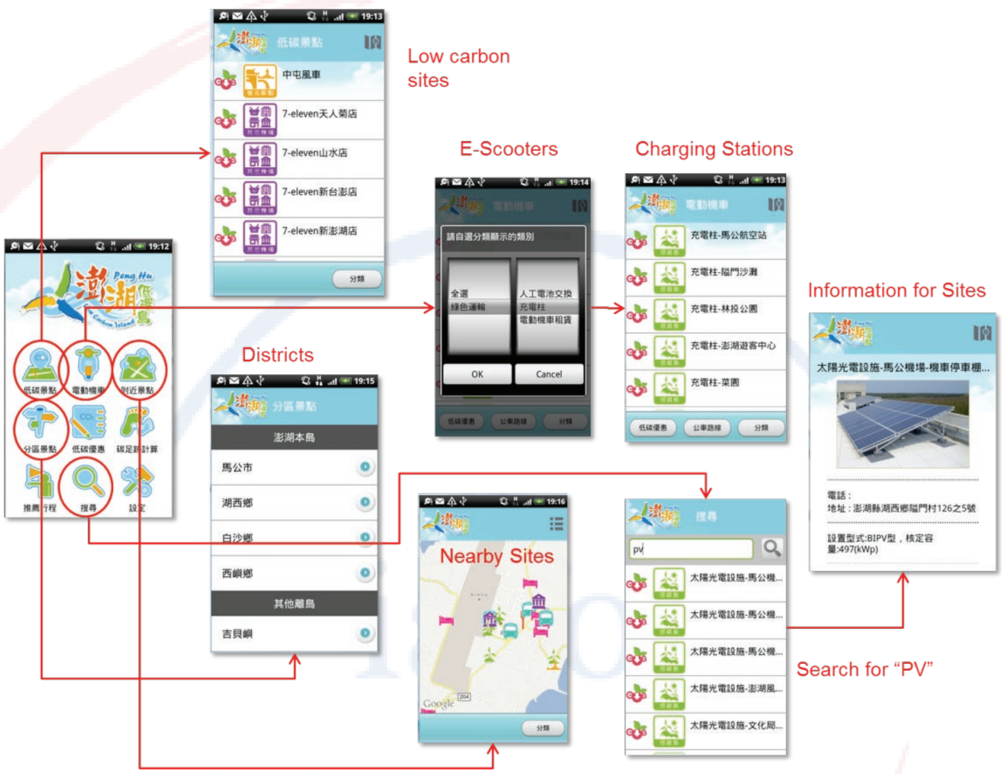

Figure 6 The screenshots of the low-carbon tourism guidance system.

5 Carbon Footprint Calculator

To disclose the environment impact of tourism in Penghu, the GHG emissions of various itineraries should be determined properly. The itinerary of a tourist should be reconstructed on the system for GHG emission estimation. To design the Carbon Footprint Calculator for low-carbon tourism in Penghu, the typical itineraries are collected and analysed. After the preliminary analysis, an itinerary in Penghu can be divided into three major components which are listed as follows.

– Destination
– Transportation
– Activity

The main island of Penghu is comprised by four villages, including Magong, Husi, Baisha, and Xiyu. Some remote isles are also popular tour sites, include Jibei and Chimei. Therefore, the destinations can be represented reasonably by the villages or isles. The tourists should take a way to commute to the destinations. After thorough survey, the transportation means in Penghu include vehicle, van, motorbike, bus, e-scooter, bike, sightseeing bus, ferry, walk, and flight. Commuting between the main island and a remote isle, tourists should take a ferry or flight. Either on the main island or a remote isle, the other methods can be taken to wander around the area. After arriving at the destination, a tourist can take activities according what is available at the destination. Hotels, restaurants, and tour sites can be found in most destinations in Penghu. At a tour site, one of recreation activities can be chosen, such as sightseeing, culture experience, motorized water activities, swimming, and shopping. As illustrated in Figure 7, the conceptual framework of an itinerary has been proposed based on the three major components. Any tourist can reconstruct his or her itinerary following the process of the conceptual framework. After an itinerary is reconstructed, the GHG emission can be estimated based on the tour activities, hotels, and transport tools chosen in one's itinerary.

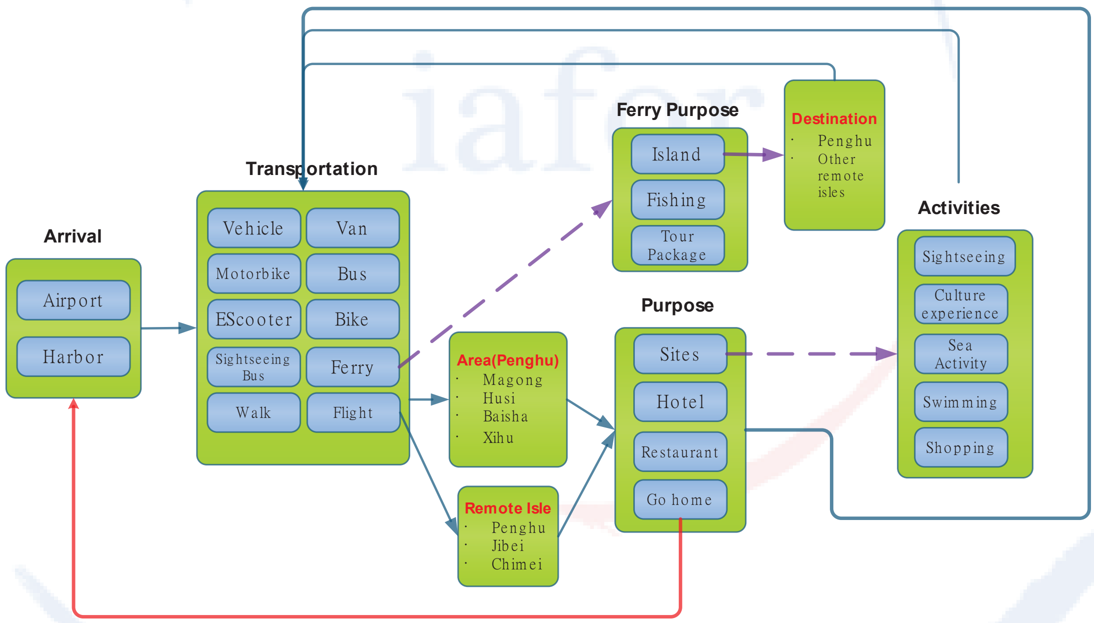

Figure 7 The structure of the carbon footprint calculator for Penghu Island.

As shown in Figure 8, the construction of itinerary is a guidance-based procedure following the structure of the carbon footprint calculator. A tourist can thus implement the carbon footprint calculation intuitively and effortlessly.

Figure 8 The demonstration of carbon footprint calculation.

6 Conclusions

As an international society member, Taiwan government is devoted to reducing GHG emissions in recent years with the target of decreasing GHG emissions back to 2005 by 2020. To achieve the GHG reduction target, various low-carbon technologies and measures should be adopted properly in local areas. Therefore, Penghu Island is chosen as a low-carbon pilot island to demonstrate how to attain the low-carbon future in Taiwan. As a result, the Penghu Low-Carbon Island Project has been proposed to reduce 60% of business-as-usual (BAU) GHG emissions by 2015. The major measure of the project is to install 96MW wind turbines to supply all electricity demands in Penghu Island. Eight aspects of measures are adopted in the plan, including renewable energy, energy-saving, green transportation, low-carbon building, forestation, resource recycling, low-carbon life and low-carbon education.

Since tourism is one of the major industries in Penghu, tourism accounts for major part of GHG emission. Transformation of tourism into low-carbon tourism is thus desirable for the Penghu Low Carbon Island project. A low-carbon tourism guidance application has thus been developed to integrate information of green transportation, green hotels, and low-carbon sites to promote low-carbon tourism in Penghu. After publishing the application on Google Play (Google, Inc., 2013), the total number of downloads has exceeded 6,000 times, as shown in Figure 9. With the completion of infrastructure for e-scooters and the low-carbon tourism application, tourists gradually transform their tour habits, such as ride e-scooter rather than traditional motorbikes. Until now, there are already more than 2,000 e-scooter have been sold in Penghu from 2011. The low-carbon tourism guidance application has been proven as an ideal promotion platform for low-carbon tourism.

However, to reduce GHG emissions from tourism sector in Penghu cannot solely depend on the motivations of tourists. Systematic transformation of tourism related industries is essential in the future. With high market share of e-scooters, green hotels, and low-carbon tour packages, the GHG emissions in Penghu can be expected to be reduced significantly. According to the Penghu Low Carbon Island Project, the number of e-scooter will increase to 6,000, the new buildings will be regulated by green building standards, and many low-carbon sites will be established. Therefore, the Penghu Low Carbon Island Project will be the key approach to implement low-carbon tourism in Penghu in the near future.

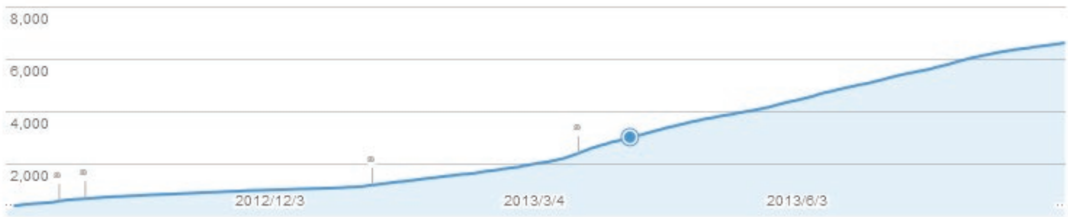

Figure 9 Total number of downloads of the low-carbon tourism application.

7 Acknowledgement

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Local Sustainable Energy Projects as part of Wider System Change; The Story of Local Projects

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0247

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Abstract

Climate change as a result of human activity is widely accepted around the world as one of the key threats of our age; caused by and leading to a number of social, environmental and economic factors. Many national and international laws now oblige the reduction of carbon emissions. Given that just under a quarter of the UK's carbon emissions are from energy use in the residential sector, much attention in the UK has been focused on domestic energy efficiency refurbishment and behaviour change projects. However, energy users are often 'locked-in' to certain energy systems and practices as part of national sociotechnical regimes. Previous studies, however, have not explored what happens in individual, localised projects as part of system transition to sustainable energy use. This research explores this; looking at two Birmingham case studies. Each installed energy efficiency and microgeneration technologies and attempted behaviour change. In both projects a multitude of causative beliefs were found relating to both the problems that each project was trying to solve the solutions to those problems, hence the nature of success. Success was interpreted differently by different organisers, depending on their own priorities in the complex interconnected issues of energy and social sustainability in a diverse and often deprived city. The research demonstrates that in many projects there are positive outcomes, although not always the one originally hoped for. None of these successes are explicitly to do with the transition of the energy sociotechnical regime, and yet the projects do contribute to such a transition. Successful projects are more likely to be built upon, allowing systemic change over a long time. Local projects can act as a 'step' in this process.

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1. Introduction

Anthropogenic climate change is now accepted in the scientific community (IPCC, 2007, Cook, 2013), and governments around the world are increasingly attempting to stall or mitigate its advance. The Kyoto Protocol was the first piece of international legislation in this vein, which in 1997 set legally binding targets for signatory countries to reduce greenhouse gas emissions, by 5% of 1990 levels by 2012. The UK Government has since passed the Climate Change Act in 2008, obliging the UK to cut its greenhouse gas emissions by 80% of 1990 levels by 2050. This has primarily been done so far by focusing on carbon emissions from energy provision and use. The Energy Act followed in order to support this target by making provision for renewable energy, and other legislation introduces innovative ways to fund energy efficiency improvements in the commercial and domestic sectors (GOV.UK, 2013).

Domestic energy use is a key area to target in order to reduce UK carbon emissions, as energy use in this sector is nearly a third of total UK energy use (Swan et al., 2010). In the home, energy use can be cut significantly through behaviour change, Government has explored this in a number of reports . However, it is difficult to change behaviour as people are constrained in important ways by the surrounding technological infrastructure. People cannot turn down their heating beyond a certain level if their home is so energy inefficient that it cannot retain that heat, and the house becomes so cold that the occupants become ill.

This understanding of behaviour comes from the idea that society and technology are intertwined. The literature on sociotechnical systems (for example, Rip and Kemp, 1998, Shove, 2003) describes how society and technology influence each other and co-evolve together. Energy is understood as being provided by a ‘sociotechnical regime’; an interdependent system of technologies, regulations, business models, engineering practices, user behaviours and cultural expectations. As this system is comprised of interdependent components, it is very difficult to change. This is a serious problem, as that system is based on the unsustainable use of fossil fuels. Scholars have been interested in how an understanding of sociotechnical systems can be used to bring about a system ‘transition’ (Geels, 2002, Kemp et al., 1998, Loorbach and Rotmans, 2010). However, little attention has been given to the role of local projects in such a transition, particularly how they play out in practice. This research addresses that gap.

This paper draws on the findings of a wider PhD programme about local projects for sustainable energy, which explores two Birmingham-based local projects for sustainable energy. The first is Birmingham City Council (BCC)’s Birmingham Energy Savers (BES) programme, which installed photovoltaic (PV) panels on a number of households across the city. The second is the community group Sustainable Moseley’s (SusMo) Green Streets project, which installed energy efficiency and micro-regeneration technologies, and worked towards addressing behaviour change. An exploration of these two projects, carried out by in-depth, longitudinal case studies, shows the role that these projects can play in a wider energy system transition.

This paper outlines the literature on sociotechnical systems in section 2, and explains the constraints this places on individual behaviour. In section 3, the case studies will be presented, and the methodology used. The findings are then presented in section 4, and conclusions and implications in section 5.

2. Theoretical Framework – Sociotechnical Systems and Transition Approaches

The theory of sociotechnical systems is important in studying the interaction of society and technology as it pays close attention to the complexity of that interaction. This perspective suggests that the sociotechnical system has an overarching influence on everything within that system. The Multi-Level Perspective (MLP) on system transition is built upon this understanding, and has led to a number of approaches to guide the transition of the current unsustainable energy system to one which is more sustainable. However, there are gaps in our understanding of sociotechnical transition, which will be explored.

Sociotechnical Systems

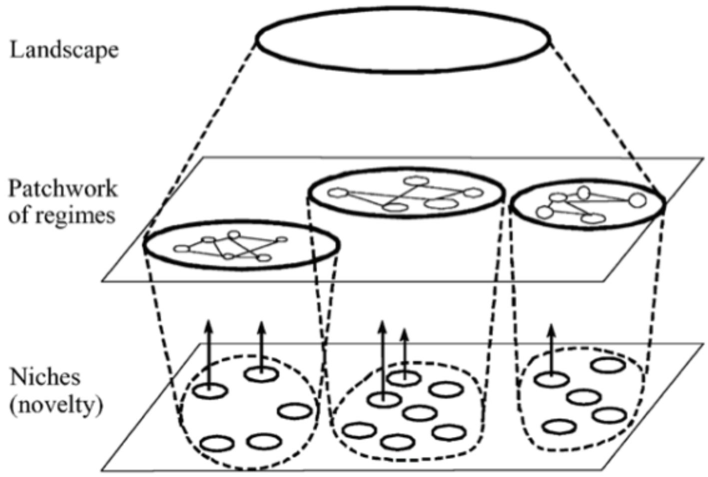
One of the key insights gained from an understanding of sociotechnical systems is that key societal functions, such as transportation, housing, communication, energy and feeding, are provided by systems which are comprised of technologies, supporting infrastructures, natural resources, research priorities, business models, regulations, user behaviours and cultural expectations (Geels, 2002, Hughes, 1987). Hughes (1987) coined the metaphor of a 'seamless web' to describe the way in which all of these components are combined. An example of such a seamless web is given by the UK system of electricity provision. Under the current electricity 'regime', electricity is provided mainly through the burning of fossil fuels at large centralised power stations and carried to the end user via alternating currents in electricity pylons. Electricity is mainly provided by the 'Big Six' energy companies. These companies comprise engineers and other skilled personnel. The education system as a whole provides those personnel with the necessary skills and knowledge to carry out their professions. Further knowledge is provided by R&D departments, universities and other institutions. A National Grid, transporting electricity across the country, is regulated by a number of District Network Operators. Finance is provided by banks with risk averse lending practices. Materials and components are supplied by other companies within the supply chain. The energy market as a whole is regulated by the Office for Gas and Electricity Markets (Ofgem). Electricity users are both commercial and domestic customers with expectations and well-defined practices that imply electricity. The system is similar for heating.

This is referred to as a sociotechnical 'regime' because it is made up of stabilised interdependencies (Rip and Kemp, 1998). As technical components co-evolve with social elements through a process of mutual adaptation and feedback, the components become interdependent, and so the system as a whole becomes stable. Mature sociotechnical systems possess 'momentum' – a tendency towards inertia (Lovell, 2005). Another key feature of mature sociotechnical systems which comes about as a result of this inertia is 'lock-in' – the particular regime of function provision becomes irreversible since the technology is proven and ubiquitous, the infrastructure is set up to support it and no other technology, and users know how to use that technology. The status quo is reinforced (Lovell, 2005, Biggart and Lutzenhiser, 2007, Unruh, 2000).

The Multi-Level Perspective on Sociotechnical Transition

A key insight that comes from the theory of sociotechnical systems is the 'Multi-Level Perspective' (MLP) (Rip and Kemp, 1998, Geels, 2002), which helps to understand how sociotechnical systems change from one regime to another. The MLP describes three levels – a micro, meso and a macro level; respectively the niche, the regime and the landscape.

Figure 1 – The Multi-Level Perspective (taken from Geels 2002, page 1261)



The sociotechnical regime sits at the meso level, and is the site of incremental innovation to improve the 'dominant design of technology' (Nelson, 1995). Here dynamic games are played out within and between firms incumbent in the regime according to their rules and routines; there are user preferences for the regime's technology (and ways of using it); and regulations which suit the peculiarities of the regime. At the macro level is the sociotechnical landscape; a stabilised backdrop which exerts influence, and which it is difficult to change (Geels and Schot, 2007, Geels, 2004). Technology, or the material culture of societies is part of this landscape (for example, the road network), as are shared cultural beliefs, symbols and values. At the micro level there are technological 'niches', which some argue are the site of radical innovations with the potential to change the regime completely (Geels, 2004, Rip and Kemp, 1998, Smith, 2007, van der Laak et al., 2007). They are protected spaces which shield new technologies from the mainstream market selection of the regime. Here heterogeneous actors can learn about the technologies and experiment with them (Geels, 2004). Historical case studies have given examples of such niches going on to replace the incumbent regime; for example the replacement of sailing ships with steam ships (Geels, 2002).

Transition Approaches

Transition approaches build on the insights of the multi-level perspective of sociotechnical transitions and make suggestions for how bring about a transition to a more sustainable system. Three approaches are discussed here; Strategic Niche

Management (SNM), Transition Management (TM) and Technological Innovation Systems (TIS).

SNM (Kemp et al., 1998, Witkamp et al., 2011) starts from the MLP's premise that new technologies arise in niches where the technology does not have to compete with mainstream technologies, which can give new technologies a chance to develop and grow. Niches are important for demonstrating the viability of the technology, to help build a supportive social network behind a technology, and allowing interactive learning and institutional adaptations. Kemp *et al*. (1998) suggest a process of SNM, beginning with a range of possible technologies, followed by selecting an appropriate experiment, striking a balance between protection and selection pressure. The experiment is then scaled up, and finally the protection is broken down again.

Transition management does not focus on fostering a particular innovation. Kemp *et al.* (2006) suggest Transition Management (TM) as a tool to transform society through a gradual reflexive process of variation and selection. TM calls for continuous and iterative deliberation and assessment in a well organised discourse; for cooperation and network management to formulate joint visions; and common goals to help actors coordinate their actions. Once a guiding vision is agreed upon, 'backcasting' is used to identify strategic experiments and set goals. A portfolio of different options is used to avoid locking in to one particular solution which may not be the best in the long term. TM also must find a way to survive short term political changes, since sociotechnical systems take one generation or more to change. This approach has had some success in the Netherlands (Loorbach and Rotmans, 2010).

Technological Innovation System (TIS) (Hekkert et al., 2007, Musiolik et al., 2012) is used to understand how desirable innovations diffuse, and how facilitate that diffusion. The approach recognises that innovation is a collective activity, taking place within the context of a wider innovation system. TIS is concerned with seven functions that are important for well performing innovation systems; entrepreneurial activities, knowledge development, knowledge diffusion through networks, the guidance of the search, market formation, resource mobilisation and the creation of legitimacy. By mapping and analysing all the functions of a particular technological field or system, one can identify weaker functions, and barriers and opportunities (Jacobsson and Johnson, 2000) which can be dealt with or taken advantage of with relevant policy (Hekkert et al., 2007).

Essentially, all of these approaches are about making sure there is a good network of the right people (i.e. with some influence and power) that can work together to think outside the box, and to invent and support new technologies or experiments to begin regime change.

Difficulties with Transition Approaches

There are some difficulties with these theories. Smith et al. (2010) list some of these; exactly how the niche regime and landscape interact is much more complicated than originally thought, the fact that regimes for different societal functions interact with each other is not addressed, and the role of places and spatial scales has not hitherto been an area of concern. This research departs from this last criticism, which asks how local places attempt to transform their mobility, energy, waste and housing systems.

This research looks at the practice of individual city or neighbourhood-level projects as they unfold. What do these projects for change look like? How do they contribute to wider energy system transition? Theory makes us look at these projects in a certain way; as conscious, purposive and directional projects to specifically unlock unsustainable regimes. However, are these projects actually perceived this way in practice?

3. Methodology

A Critical Realism stance is adopted which assumes that reality exists externally to scholarly understanding of it and humanity's knowledge about the world corresponds to that reality, however this knowledge can never be certain, and will always be fallible (Bhaskar, 1978, Bhaskar, 1979). All knowledge is essentially socially constructed, although some knowledge corresponds more closely with external reality than other knowledge. In a critical realist stance a qualitative research approach would be most appropriate for generating insight and knowledge into the social world as it highlights the role of context and the nuanced nature of social reality. Lincoln and Guba (1985) first pointed to the use of case studies as part of this approach, since they allow the generation the necessary rich and complex knowledge that can approach the contradictions of real life, and this now has much support as a research method (for example Flyvbjerg, 2006).

For this research, case studies were used to explore in detail to explore the reality of local projects for energy system change. This research results from a PhD which was originally entitled 'Interventions for Behaviour Change'; and so the projects were originally conceived of as behaviour change projects.

Birmingham City Council's BES project was the first case study. This project installed over 1300 solar PV arrays mainly on social housing throughout Birmingham, from September 2010 until December 2011. The project made use of the Feed in Tariff, introduced in 2010, to recuperate the costs of these panels. The project was intended as a fore-runner to the Green Deal; a piece of legislation allowing householders to have energy efficiency improvements carried out on their homes for no initial cost, and then repay over time using savings made on energy bills. BCC were procuring a partner organisation to help them deliver this programme, and the income from the PV 'phase' was originally intended to pay for that procurement.

The second case study was of SusMo's Green Streets project. SusMo is a voluntary community group based in Moseley, a neighbourhood in South Birmingham, which exists to help Moseley cut carbon emissions. The Green Streets project began early in 2010 after SusMo won £140,000 worth of goods and services from British Gas; one of the UK's 'Big Six' energy providers. From 2010 until the end of 2011, SusMo organised the installation of PV on four community buildings; a church, a mosque, a school and a local allotment building. Solar PV, solar thermal panels and energy efficiency measures were also installed in 17 homes. The resident beneficiaries were also asked to sign up to 'iMeasure'; an online tool which aims to help people become more aware of their energy use.

As part of these case studies, semi structured interviews were carried out with both the organisers of the projects and a sample of those who benefitted from them. This was to gain access to the project participants' own interpretations of the projects, allowing access to the answers to 'why' and 'how' questions. Observations were also made at monthly project meetings, and other documents, such as minutes, project outlines and project evaluations also provided background information.

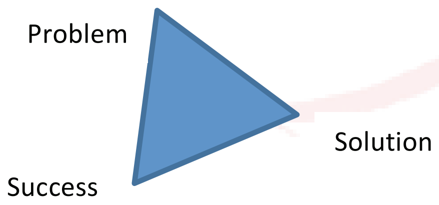
4. Findings and Discussion

'Success' emerged from the data as a key analytical concept. As a meta-concept, 'success' was found to be more important than the concept of 'behaviour change'; it subsumed behaviour change. Therefore, the data was analysed to explore in what way the projects were perceived to be successful. The first key finding was that different people had different conceptions of success. These stemmed from different beliefs about the 'problem'. These beliefs were termed 'causative beliefs', the nature of which is explained below.

Causative Beliefs

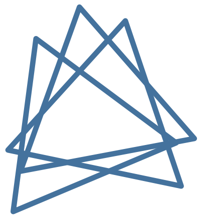
Causative beliefs concern what a person believes the problem to be addressed by a project actually is; what the solution would be and therefore what success is; i.e. the resolution of the problem as they see it. These three elements are three parts of the same mental construct; they are a triplet or triangle. When talking about these projects, participants saw them as successful if they had solved the problem as they had perceived it. If it had not, they viewed the project as a failure. This is presented below as a triangle. The triangle is presented at a slant to avoid the impression that one point of the triangle, being at its apex, is the most important.

Figure 2 – The triangle of causative beliefs



The nature of project is made more complex by the fact that there are a number of different triangles of causative beliefs in each project. Each individual emphasised one particular triangle during interviews; one particular problem their project was trying to solve, and its attendant solution. However this does not mean that they did not see other triangles; other problems and their solutions. Each individual *prioritises* particular triangles of causative beliefs. Within a project, these triangles of causative beliefs are negotiated organisationally and socially, with different triangles being emphasised at different points, according to different circumstances.

Figure 3 – negotiating triangles of causative beliefs



Causative Beliefs: the Problem and 'Success'.

The problems as perceived by the participants of the project, both organisers and beneficiaries, covered a great range. Behaviour change, the original aim of this research, was a necessary part of the solution to a number of problems, but rarely an indication of success in its own right. The main causative beliefs found in this research are given below, with quotes to provide evidence:

Problem 1: Fuel Poverty.

"most of the PV in Birmingham is on social housing, and was done for fuel poverty reasons" (BES organiser)
"I thought we'll have a go and see if it saves any money . . . Every little penny counts these days" (BES beneficiary)

The solution to this problem was to install energy saving measures and change behaviour.

"The PV panels were 'sold' as a mechanism for saving money" (BES organiser)
"The best way of getting people to save money on their fuel bills is to make them change their behaviours that are giving higher electricity bills. For some vulnerable occupiers that is not possible" (BES organiser)

Success under this conception of the problem was therefore reduced bills for project beneficiaries, and their alleviation from fuel poverty.

Problem 2: Too much energy is used, which is either environmentally or economically unsustainable.

"if you've had a terribly inefficient boiler . ..[you're] throwing good fuel after bad"

The solution to this problem was to reduce the energy being used through either physical measures, behaviour change, price changes, or all of these.

"Fuel will be saved by happenchance . . That's what the technology's for, but to get the best out of something you want people to understand it" (SusMo organiser)

Success under this conception of the problem was therefore reduced energy consumption.

Problem 3: Many people have unsustainable lifestyles.

> *"People [need to realise] the importance of not driving cars around for short distances and stop buying everything encased in plastic"* (SusMo organiser)

The solution to this problem was perceived as increasing awareness of environmental sustainability through visible physical measures, information and behaviour change.

> *"They can see the meter go backwards, they're generating, they can see that, why have I got 50watt halogen light bulbs, when I turn two of them on, that takes all the power from my PV. I should get some energy efficient ones"* (BES organiser)

Success under this conception of the problem was viewed as nothing less than a 'conversion' to environmental sustainability and advocacy.

> *"we had also hoped that our core group of people would be greatly enlarged with all these people who had been inspired by everything, and in that we were greatly disappointed"* (SusMo organiser)

Problem 4: Delivering large projects is difficult.

> *"It took a lot of work going round politicians and senior management, again and again, because it doesn't make sense in the first instance"* (BES organiser)

The solution to this problem was to manage anxiety, bring together the right people, include a number of key aims to please different stakeholders, and to create tension to get the best decisions.

> *"So you say it's only five million this time round, then [later] you approve the full business case for the pathfinder programme, that's only this much money – you have to lead them on a journey"* (BES organiser)
> *"When I set up the board for the programme, I set up three champions , a social benefit champion, an environmental champion, and an economic champion. I had a tension"* (BES organiser)

Success under this conception of the problem was therefore the delivery of a large project.

Problem 5: Few jobs and economic deprivation.

> *"We've got the highest levels of unemployment in the country! It's not good for the city!"* (BES organiser)

The solution to this problem was to work towards regenerating the city's economy, in this instance through construction for energy efficiency.

"If we're gonna make it happen, we've got to think big. [That way] we get all the other benefits . . We get the jobs" (BES organiser)

Success under this conception of the problem was therefore simply to achieve more jobs.

Problem 6: Homes need to be kept up to date.

"They have to keep the property up to scratch" (BES beneficiary)

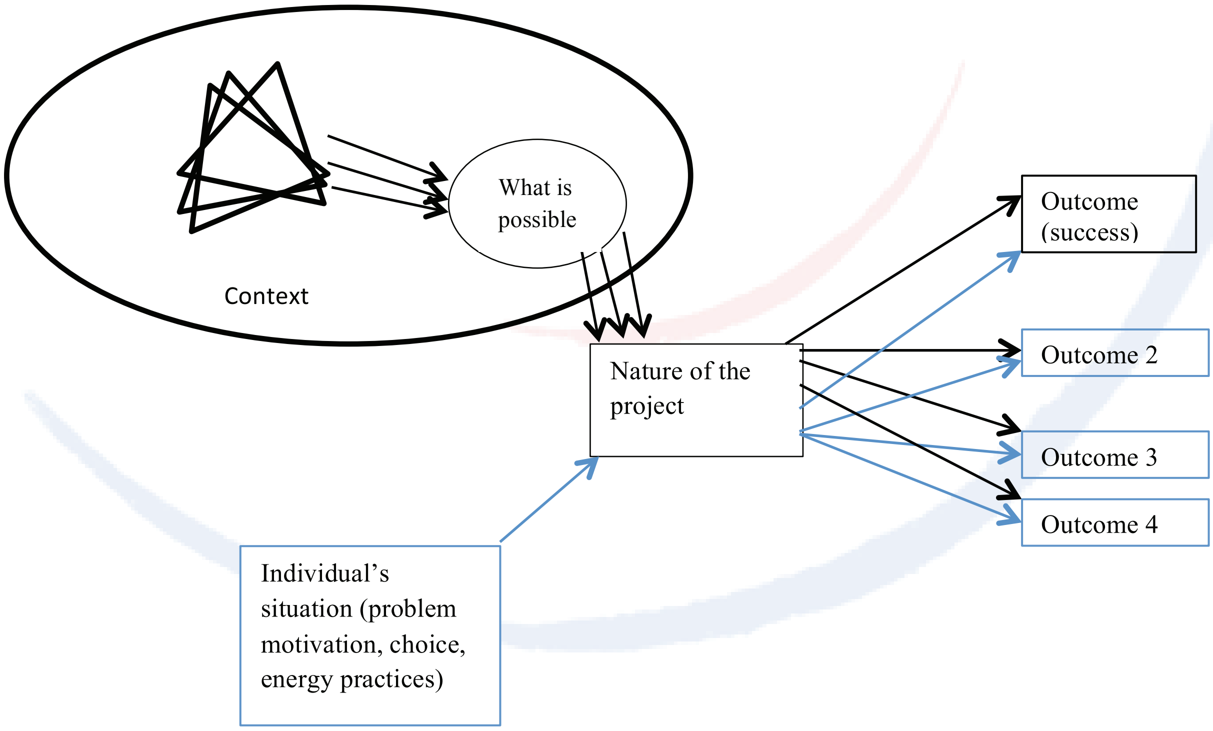
The solution to this problem is therefore refurbishment or new technology.

"so I said well I do rather fancy the idea of having a new boiler for nothing" (SusMo beneficiary)

Success is therefore having new technology installed or refurbishment works carried out.

It can be seen, therefore, that there are a number of different conceptions of the problem held by both organisers and beneficiaries, and therefore a number of different conceptions of success. This is shown in the below diagram.

Figure 4. The multiple 'successes' in a local project for sustainable energy



The wider context influences the nature of the project. This includes the organisation in which the project organisers are working, as well as local and national policy, and cultural expectations and assumptions. These factors, which include resources, capacity and so on, define the sorts of projects that are possible. Context and the causative beliefs both play their part in defining the nature of the project; the mechanisms that are used to bring about change, where the project is carried out, at what scale, for whose benefit, and so on. The intervention is then expected to lead to the outcomes anticipated by those different causative beliefs about what success constitutes. This already complex picture is further complicated by the fact that organiser and beneficiary conceptions of the problem can be very different, and beneficiaries may participate in projects for different reasons than those intended by project organisers.

None of the problems given above specifically state that the 'energy system needs changing', in the language of sociotechnical systems. The two case studies described here were projects for fuel poverty alleviation, for energy behaviour change, for economic regeneration, for environmental awareness. None of them were to contribute to energy system transition in the way described by the transition approaches above. And yet, they can still contribute towards movement in the right direction. They can still change the regime and the landscape in such a way as to make future projects more thinkable, and more possible.

5. Conclusion

In summary, success was interpreted differently by different participants in the case study projects. This depended on each participant's own priorities in the complex interconnected issues of energy and social sustainability in a diverse and deprived city. Success was spoken about in terms of alleviating fuel poverty, raising awareness about energy sustainability, creating jobs and delivering ambitious or difficult projects. These were the problems as seen by the participants of these projects, not the problem of an unsustainable sociotechnical regime. And yet these projects can still make a contribution to unlocking that regime as they change cultural expectations, install new technologies and give project organisers an opportunity to learn.

Essentially, the reality of local projects for wider energy sociotechnical system transition, certainly in the UK is that they do not look like projects for energy sociotechnical system transition. They look like projects which tackle local and immediate problems, and/or general projects for sustainability. However, they can act as a small step in the process towards regime change. 'Success' is key. If a project is perceived to be successful, it is more likely to be built upon. Project following project, just as step following step, can create a trajectory of change over time.

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A Systemic Approach for Preliminary Proposals of Sustainable Retrofit in Historic Settlements. The Case Study of Villages Hit by Earthquake

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Abstract

A proper and innovative restoration and regeneration programme of historic settlements affected by earthquakes can be an opportunity for their most effective use and a more attractive new function. The paper presents the results of two studies that Architettura>Energia Research Centre of the Department of Architecture of Ferrara accomplished for Public Administrations as instrument for sustainable reconstructive interventions in areas with very complex environmental, social, economic and historic aspects.
The two locations considered are Caporciano, a small town within the area around L'Aquila struck by the earthquake in 2009 and now only partially inhabited; and Apice Vecchia, near Benevento, damaged by two earthquakes in 1962 and 1980, which forced the population to settle a new town in the vicinity.
The proposed procedure is structured into two phases. The first consists of a preliminary on-site survey aimed at simplifying the acquisition of a large amount of data, which will facilitate a subsequent in depth survey focused on the energy and environmental characteristics of the towns. Data are analysed after the survey to establish dimensional parameters useful for energy simulation and for setting-up a database of building technologies and materials, used to calculate the energy performance index of the envelope for the current winter heating and summer cooling of the towns. During the second phase of the study, intervention strategies are developed to improve energy and environmental conditions of the urban system, depending on residual performance of technical elements, building's function, historic value and earthquake damage.
The proposed intervention scenarios are contextualized through the application of the strategies to specific buildings used as case studies, which are useful to validate the procedures for retrofitting the building and the hypothesis of restoring historic settlements.

Keywords: Preliminary audit, energy retrofit, environmental quality, historic settlement, seismic damages.

1. Programming tools for supporting local policies

At a time like the present, where the construction sector is hit by a severe crisis, refurbishment and conversion action of existing buildings have a strategic role to promote recovery. To make stable and to implement this trend, it is inevitable that Local Authorities should introduce incentive aimed at regenerating urban centres. This need is even more urgent in the case of territories in which economic and social decay adds to the earthquake's devastating effects, accelerating depopulation and only residential use. The promotion of wide recovery action requires a preliminary feasibility study to provide the data needed to correctly address the programming tools (rules and regulations, calls for encouraging private initiative, guidelines, etc.) and to optimize limited financial resources, often made ineffective by the uncertainty of long and complex processes. Given that, the analysis of the actual energy behaviour, an essential component for a correct evaluation of building's residual performance, must be fast, enough reliable and economically inexpensive in the very first phase of the process.

The results of the research, documented in this paper, wants to answer to these needs through a simplified, but reliable and effective procedure applied to the case studies of 2 small historical villages, located in the South-Italian Apennines, that gave a significant feedback on the methods and tools adopted.

The first case study of Caporciano[1] (2010) fed the second of Apice Vecchia[2] (2012) in a diachronic synergy. Both concern an urban matrix strongly hit by earthquake, respectively:

- in the Navelli plateau in the Abruzzo region, within the crater generated by the 2009 earthquake near L'Aquila where winter conditions are very hard;

[1] Design research by Faculty and Department of Architecture of Ferrara, Architettura>Energia Research Centre with IUAV University of Venice. Coordinator: Prof. P. Davoli. Tutor: Dr. V. Belpoliti, Dr. P. Boarin, Dr. M. Calzolari, Dr. R. Reitano (IUAV). Students: F. Abenante, M. Bortoloni, V. Farinelli, D. Marcucci, L. Nadalin. Design Workshop 'Idee e proposte ecosostenibili per i territori del sisma aquilano", Pescara – Caporciano, 2010. Organization: DiTAC – UNICH and SITdA. Coordination: Prof. M. C. Forlani and Prof. G. Eusani.

[2] "Integrated study for the definition of design strategies aimed at energy and environmental refurbishment, renewable source-fed plants integration and preliminary geological survey in the historic settlement of Apice Vecchia", research commissioned by the Municipality to the Architettura>Energia Research Centre. General Referees: Prof. P. Davoli, Prof. A. Rinaldi, Prof. G. Bizzarri, Prof. R. Caputo. General Coordinator: Dr. P. Boarin. UNIT 1 - Architettura>Energia Research Centre working group. Scientific Referees: Prof. P. Davoli, Prof. A. Rinaldi, Prof. G. Bizzarri. Economic evaluation Referee: Prof. L. Gabrielli. Team: Dr. V. Belpoliti, Dr. P. Boarin, Dr. M. Calzolari, Dr. V. Farinelli. UNIT 2 - Department of Earth Science. Scientific Referee and working group Coordinator: Prof. R. Caputo. Team: Dr. Geol. N. Abu-Zeid, Dr. S. Bignardi.

- in the area near Benevento, within the seismic activities that hit the south of Italy between 1962 and 1980, regions where the summer comfort is very difficult to reach.

Both case studies aim at a sustainable recovery and the seism can be interpreted as an opportunity to enhance energy and environmental conditions of the whole building system.

Both aggregates are typically rural-origined, made with techniques and technologies result of a spontaneous and non-coded practice mainly “pre-industrial”, which uses materials that can be found mostly at the local scale. The on-site survey showed that, as it is common for spontaneous architecture and historical buildings, the building fabric has its own predisposition to passive control of external environmental stresses both at the urban scale and at individual buildings scale. This environmental management skill (which we may call “environmental metabolism”) can be found through a critical reading of the features of the historic town.

2. The town and the earthquake

2.1. Caporciano

The small historical town has started to move away even before the earthquake (which has further exacerbated an already critical situation), because of a declining economy that was no longer able to catalyse the interests of local entrepreneurs. The urban grid is characteristic of an historical aggregate with two or three stories terraced buildings. It is almost entirely a residential village, where just over a third of housing is permanently occupied and the remaining two-thirds are made up of second homes or empty buildings because of the damage caused by the earthquake.

Since the earthquake was a vibrating type, the greatest damage have been reported from the floors and roofing, while the lesions are less evident on the external walls, with the exception of a few cases. The initial embarrassment in proposing solutions for energy efficiency and environmental sustainability within a territory dramatically affected by the disaster and often with very different objectives priority has soon vanished when people understood the extreme need for planning to feed the prospects for revival of these economic and social realities in deep crisis.

The study, called “climate village”, provided the development of strategies for raising the energy performance of the entire urban aggregate, according to the different degrees of intervention possible on individual buildings and the needs of recovery, consolidation and new functions.

Figure 1. Views of the medieval village of Caporciano. The aggregate consists of approximately 300 buildings, with its traditional architecture of rural type, consisting mainly of vertical walls (coinciding with the elevated structure) in local stone, with rustication and gravel of various sizes, which can reach 90-100 cm thick, even with small-recovered brick elements. The village has an outer belt of expansion characterized by newer buildings (from the 50s onwards), with concrete-frame technology and plugging in semi-solid blocks of brick or masonry bearing.

2.2. Apice Vecchia

The country is now completely deserted because of the substantial structural damage caused by strong earthquakes that hit the area generating a high level of critical issues for the safety of citizens, so that the Local Administration decided to move the community, founding a new town a few miles away, on the overlooking hilltop. The strong link with the cultural roots and the desire to enhance the historic building heritage have prompted the City Council of Apice to take the road of recovery and redevelopment of the town with the purpose of hosting new functions that can trigger a new life cycle for the village itself.

Sitting on the top of a hill, the small urban aggregate, plausibly founded by the Romans, but with a significant development during the Middle Ages and during the Norman period as well as in the Renaissance period, has a very compact urban morphology, although slight differences in the building plot which declare a progressive development over the centuries. The village is made up of buildings of small sizes (even one or two cells per unit) with two floors above ground, mainly placed close to the slope. These buildings housed laboratories or small shelters for farm animals in the lower levels. In the Northern part of the village stands the castle, surrounded by the buildings of the wealthiest families, while in the central portion between the two ends stand the building units with the easiest features. Aggregated into arrays with very large blocks that make up for the total development of the village, the buildings are mostly overlooking the front street or, in some cases, towards the inner gardens.

Figure 2. Views of the streets of Apice Vecchia. The reduced ratio between the width of the road and the height of the front allows to have paths and facades heavily shaded; the presence of vegetation in the interior gardens provides greater air oxygenation and humidification, since these characteristics in summer passively contribute to the protection from overheating. The vertical closures are largely made up of dry masonry facings with hewn stone and fill with stones weakly bound with lime and sand, or from mixed masonry of stone and brick, possibly recovered by the demolition of other buildings, also for the variant with brick elements with regular lists.

3. A systemic approach to historic towns refurbishment

In the small towns studied (although many considerations can be easily extended to the whole system of settlements with relevant testimonial value) the need to tackle the knowledge process and the definition of requalification strategies in a systemic and integrated way appeared immediately clear, shifting the focus from the single building to the urban scale. Exceeding the logic, however valid, but no longer sufficient, of enhancing environmental performance of each building, it is possible to support the whole urban performance control and the following effects on the environmental conditions of outdoor public and private spaces for the community. This perspective allows to successfully deal with the issue of high standards, even in historic contexts, as required by European directives on the energy performance of buildings, where the application of the model of 'nearly zero energy building' is suggested, even in case of existing buildings' major renovations when they are «technically, functionally and economically feasible» (Directive 2010/31/EU).

It is clear that this approach should coincide with the need to protect the building and its historical identity, especially when under conservation constraints. To ensure this, the systemic approach adopted in the research allows, through the control of the whole urban virtuosity, to act in a different and compatible way with the single buildings, while significantly reducing overall global energy losses, with the aim of a compensation between buildings with different historic features.

4. Methodology

4.1. Simple procedures for survey and energy audit aimed at understanding the ancient town

Given the preliminary nature of the studies and the high number of buildings to be investigated for each village[3], it was considered appropriate to proceed in both cases with a first phase of "fast" survey to be done in short times (1-2 days with a working group from 4 to 8 units), able to simplify the acquisition of a consistent amount of information. The optimized procedure needed to program in advance all data to be collected in the field that have been chosen from those most able to influence the global energy and environmental behaviour, considering the characteristics of the historic environment, the elements with morphological connotation and documentary value, as well as the role of some elements of passive conditioning and the presence of visible damages caused by the earthquake. This system is able to return the technological and energy characteristics of the surveyed buildings, through a user-friendly tool used directly in the field even by unskilled personnel, through a portable device (smart phone or tablet) with specific applications.

For each surveyed building the following information were gathered:

- the period of construction (in relation to time bands previously encoded and related to the significant moments of technological development);
- the intended use (residential, commercial/industrial, mixed, other);
- the number of habitable floors;
- the presence of elements of historical and artistic value on masonry (mouldings, decorations around doors or windows and other significant elements to be preserved);
- the building type (terraced or semidetached);
- the type of structural system (load bearing walls or pillars);
- the colour of the wall (light, medium or dark);
- the presence of mitigation bioclimatic areas (lower or upper buffers);
- the presence of important thermal bridges (external faces, porches, balconies or loggias, etc.);
- building technologies and materials of the opaque vertical closures;
- transparent vertical closures technologies (vertical window frames), if present;

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[3] For Caporciano 106 out of 286 buildings, equivalent to 37%. For Apice Vecchia 233 out of 313 buildings, equivalent to 74.5%.

- building technologies and materials of top closures, highlighting the presence of ceilings;
- the type of upper closure (pitched or flat);
- the presence of damage caused by the earthquake (low, in case of minor injuries or cracks, medium, in case of small collapses, or high, if in the presence of collapsing floors or roofs);
- the type of winter conditioning, if present;
- additional factors that are important for assessing energy and environment behaviour, like any upper floors or the presence of non-homogeneous material elements in the walls (i.e. the existence of scaffolding holes).

4.2. Parameterization of the surveyed data and definition of benchmarks and calculation of the overall energy performance

Energy analysis on the data carried out after the on-field survey were conducted using a parametric evaluation methodology resulting from the experience of the bottom-up analysis. This method, already used in the analysis of urban aggregates, consist in the acquisition of a certain number of benchmark data resulting from analysis carried out on a sample of buildings representative of the entire built environment. Subsequently, these data are parameterized basing on the characteristics of each building (according to typological, technological and dimensional parameters) to obtain the indicator of the actual energy performance. This method helps to simplify the complex analytical process required to assess the energy performance of buildings, making possible a simplified and fast analysis of entire urban clusters and ensuring a final value of $EP_{i,invol}$[4], $EP_{e,invol}$[5] and/or EP_{gl}[6] of each single building. For the compilation of this data, Caporciano and Apice Vecchia differ in the presence in the first context of the winter heating systems, completely absent in the second due to the depopulation resulting from the earthquake of 1962.

Underlying the process of simplification of the calculation method there is, as already mentioned, the determination of some benchmark data to be extended to all buildings in the village. To obtain such data analysis, a detailed energy assessment was done on some models (basing on UNI TS 11300-1:2008), built to describe the typological, technological and dimensional features of the most common buildings in the village, in reference to the following factors:

- building type: terraced houses, semi-detached houses (terminal of the block of terraced houses). This first factor is a gross index of the outer surface (i.e. the

[4] Energy performance index for envelope in winter conditions.
[5] Energy performance index for envelope in summer conditions.
[6] Energy performance index including envelope and plant system (global performance) in winter conditions.

surface dispersing heat to the outside), less for a row of buildings as they share with the adjacent buildings two walls (adiabatic, where there is heat exchange);

- dimensional characteristic: 1, 2 or 3 floors above ground (relating to buildings occupied/heated). Also in this case the data is index of greater or lesser gross external surface;
- technological feature: masonry exterior light, medium or dark colour (as indicated in UNI TS 11300-1:2008). The external colour of the building influences the thermal storage from solar radiation incident (the darker is the facing, the greater is the solar radiation that catalyses). The solar radiation is transformed into heat gain in winter and overheating in summer[7].

The data thus obtained were attributed to each building to be revised on the basis of the specific characteristics of each building. The database is decomposed with criteria weighted according to the individual value of transmittance and according to the real value of surface dispersion. This is crucial because some components of the external borders have more weight on the global dispersion of the housing: these include a vertical closure and especially the cover. The parts are then incremented, in the case of thermal bridges, or reduced, in case of presence of upper (roof) or lower (basement cellars or underground) buffer elements, and finally added together to obtain the $EP_{i,invol}$ and $EP_{e,invol}$ values representative of the individual building. The rated efficiency of buildings in different scenarios of regeneration was conducted in a similar way as described for the current situation[8].

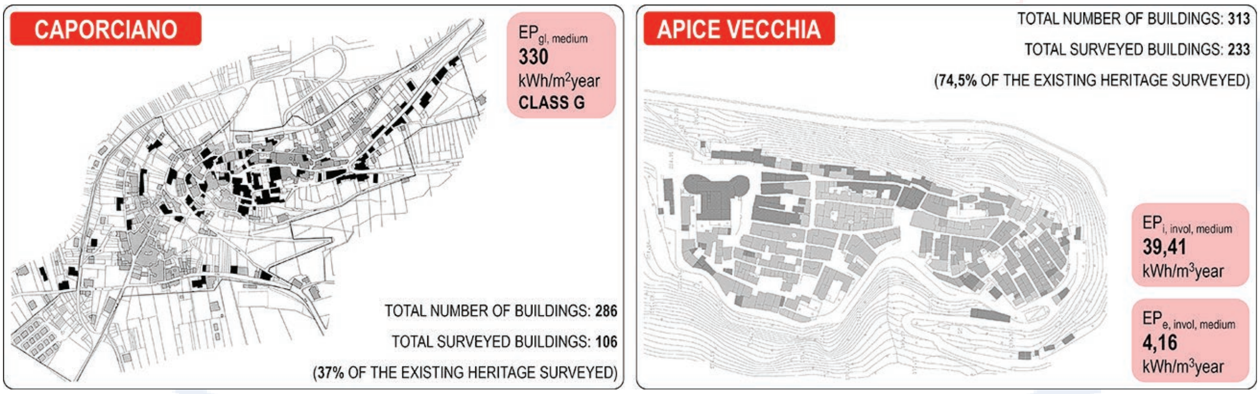

Figure 3. Calculation of the overall energy performance of the villages of Caporciano and Apice Vecchia.

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[7] The calculation of these contributions is relatively complex and even more difficult is its parameterization (different is the case of other technological specifications of the enclosure, such as the thermal transmittance, linked in a linear fashion to the dimensional data of the surface of which is characteristic), for this reason it was decided to include them in the calculation of the benchmark data, avoiding further complications in the application of the method of parametric energy assessment.

[8] For the case of Apice Vecchia was necessary to include the contribution of the plants, absent in the current situation and thus not included in the first evaluation.

4.3. Definition of a database and components analysis

The wide amount of information about Caporciano and Apice Vecchia architecture has been implemented within a database of construction technologies and materials most widely used in the two contexts. Each building element was evaluated in a preliminary way from the technological, thermal and hygrometric point of view in order to identify the residual potential and to advise retrofit guidelines, in particular:

- technological composition: description of subsequent envelopes material layers, with information about thickness and thermal conductivity;
- thermal evaluation: definition of the total thermal transmittance, thermal abatement and phase shift;
- hygrothermal evaluation: definition of critic months for superficial moisture and for interstice moisture (diagrams with temperature and pressure behaviour in January, March, June, September).

C.V.1 MURATURA A SACCO			
C.V.1.1_MURATURA A SACCO + INTONACO ESTERNO			
Strato		Sspessore (cm)	Conduttività (W/mK)
1	intonaco civile calce e gesso	2	0,7
2	pietra da taglio calcarea	25	1,4
3	riempimento di pietrame con malta di calce debole	10	2
4	pietra da taglio calcarea	25	1,4
5	intonaco esterno a base di calce idraulica	2	0,9
TOTALE SPESSORE		64	
VERIFICA TERMICA			
TRASMITTANZA TOTALE (W/m²K)		1,593	
ATTENUAZIONE		0,048	
SFASAMENTO (h)		17,11	
VERIFICA IGROMETRICA			
CONDENSA SUPERFICIALE		Mese critico: Gennaio fRSi Max: 0,653 fRSi: 0,694	
		NESSUNA CONDENSA	
CONDENSA INTERSTIZIALE		Non si verifica condensa interstiziale in nessun mese e nessuna interfaccia	

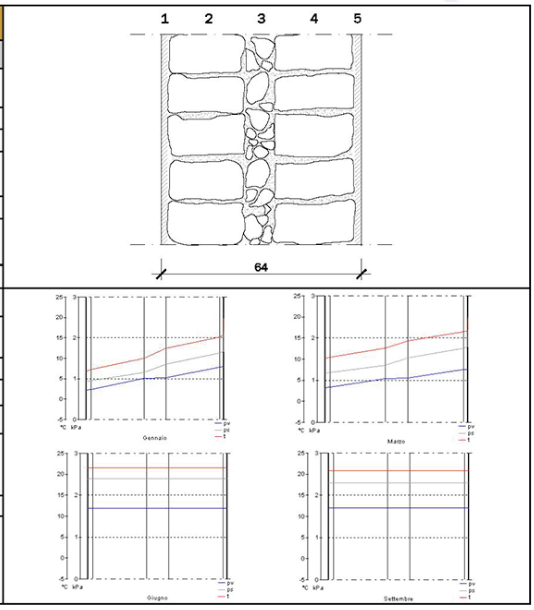

Figure 4. Example of a performance analysis[9] for the definition of a database concerning construction technologies and materials surveyed in the village of Apice

[9] Material's thermal properties have been defined from the indications of the current legislation on energy efficiency, which provides tables of the main building components and materials most commonly used. In particular the following standards: UNI 10351:1994 - *Building materials. Thermal conductivity and vapour permeability*, UNI EN ISO 6946:2008 - *Building components and building elements - Thermal resistance and thermal transmittance - Calculation method*, UNI EN ISO 10456:2008 - *Building materials and products - Hygrothermal properties -Tabulated design values and procedures for determining declared and design thermal values*, UNI 10355:1994 - *Walls and floors. Thermal resistance values and method of calculation*. It was considered appropriate to proceed with the simplification of the energy behaviour of closures in cases of complex technologies, stratigraphic sequences of non-homogeneous materials or in case of lack of references within the existing schedules in the abovementioned regulations.

Vecchia. For each type are indicated: the technological stratification of the material of the closure; the thickness and thermal conductivity; thermal analysis, showing the total thermal transmittance (W/m2K); the attenuation value (dimensionless) and thermal lag (h)[10]; the hygrometric check, indicating the critical month for the formation of surface condensation and graphs relating to condensation formation.

5. Definition of integrated intervention strategies for energy and environmental enhancement of historic buildings

By relating morphological, technology, energy and environmental data and information about protection of historical values and languages, it has been possible to develop different retrofit scenarios to be applied to each building, for an immediate comparison and support to the formulation of an intervention program in line with Public Administrations' priorities and needs.

The main objective of the proposed strategies is the integration of activities to increase envelopes' energy performance, structural interventions aimed at improving the seismic behaviour and adaptions of the plant system for conditioning in summer and winter, fed by renewable energy sources (produced on site or relocated nearby), in accordance with the typical building characteristics and historical value.

Given the colder weather conditions, the strategy adopted for Caporciano is primarily aimed at achieving high global winter performance (EP_{gl}) through the substantial thermal insulation of the building envelope ($EP_{i,invol}$). Some of the proposed solutions are:

- the strong increase/add of insulating material layers in roofs, external walls and lower floors;
- the reduction of thermal bridges due to material discontinuities;
- the improvement of walls insulation between adjacent units;
- the replacement of existing windows with new windows;
- the construction of "energy spots", small cogeneration plants for neighbourhood, fuelled by local wood biomass and placed (with static consolidation function) in some of the buildings in which the high degradation would make any functional recovery unrealistic.

[10] The data analysis of energy and environmental performance of the materials that constitute the external borders of the buildings was carried out according to the calculation methodology described in UNI TS 11300-1:2008 - *Energy performance of buildings - Part 1: Evaluation of energy need for space heating and cooling*, paragraph 11 - *Parameters of Transmission Thermal - Thermal characterization of envelope components*.

THERMAL INSULATION OF BUILDINGS' ENVELOPES	
UPPER ENCLOSURES (ROOFS)	▪ Addition/integration of insulation layers for heat losses reduction. ▪ New definition of the upper old buffers (insulated false ceiling, with high compatibility with historic structures).
	Insulation material's features: - minimum thickness, in order to maintain external alignment and internal rooms' height; - vapor resistance.
VERTICAL ENCLOSURES (WALLS)	▪ Thermal performance enhancement of external walls toward the street and between units, through internal (if in presence of external decorations) or external (if in presence of surface correspondence) insulation layers. ▪ Thermal performance enhancement of walls between units through insulation in both wall's faces. ▪ Thermal bridges reduction through external insulating plasters.
	Insulation material's features: - for internal insulation of external walls: minimum thickness, vapour-resistance; - for external insulation of external walls: insulation plaster made by natural hydraulic binders and light organic insulating materials compliant with historic features and with wall's irregularities; - for internal insulation between units: high thermal mass in order to absorb heat made by the plant system.
LOWER ENCLOSURES (GROUND FLOORS)	▪ Addition/integration of insulation layers in ground floors in case of high shape factor (buildings with only 1 floor above ground). ▪ Insulation enhancement of floors between heated and non-heated spaces in case of high shape factor (buildings with only 1 floor above ground).
	Insulation material's features: - vapor resistance; - compression resistance; - non-hygroscopic.
EXTERNAL WINDOWS	▪ Existing windows replacement with high thermal value windows, preferably with wooden-frame.

Concerning Apice Vecchia, due to the warmer climate, a strategy aimed at achieving a higher performance for the building envelope in summer ($EP_{e,invol}$) was pursued, through the development of thermoregulatory function of the wall masses and the existing underground spaces for exploitation of fresh air reserves. However, even in the case of Apice Vecchia, the need of thermal insulation improvement in winter has made necessary to take actions in order to reduce heat flows through the addition of insulating material on each technical elements (always respecting historical and cultural features), with a strategy close with the one previously used for Caporciano, but acting in an integrated way with the summer needs. Some of the proposed solutions are:

- the strong increase/add of thermal mass, solar reflection and ventilation layer in roofs;
- the exploitation/increase of existing enclosures masses for enclosures toward the streets and for floors directly on the ground and between adjacent units;
- the replacement of existing windows with new windows with sun protection devices;
- the use of electric heat pumps in individual housing units coupled with low temperature radiant systems or mechanical controlled ventilation, powered by renewable energy produced by photovoltaic system located on the roof of some host-buildings (preferably owned by the Municipality).

THERMAL INSULATION OF BUILDINGS' ENVELOPES	
UPPER ENCLOSURES (ROOFS)	▪ Addition/integration of thermal mass in order to enhance phase-shift and attenuation potential of envelopes, strongly hit in the summer period. ▪ Enhancement of external solar reflection, in order to reduce heat accumulation. ▪ Addition/integration of a ventilation layer under roof claddings to increase dissipation.
	Insulation material's features: - minimum thickness, in order to maintain external alignment; - high thermal mass; - high solar reflection.
VERTICAL ENCLOSURES (WALLS)	▪ Exploitation of existing thermal masses in external walls toward the street, to reduce overheating in summer. ▪ Exploitation/integration of existing thermal masses in walls between units, to take away heat from the surroundings and improve thermal comfort.
LOWER ENCLOSURES (GROUND FLOORS)	▪ Exploitation/integration of thermal mass in ground floors, to reduce overheating in summer. ▪ High addition of thermal masses in floors between underground non-heated spaces and heated-spaces.
EXTERNAL WINDOWS	▪ Existing windows replacement with high thermal value windows, preferably with wooden-frame. ▪ Addition of external solar shading/protection devices in case of high windows exposure.

Even if a more specific orientation of the strategies was identified for each settlement, for both villages a hierarchy of intervention levels was provided, in order to ensure high compatibility with different historic levels, which impose different criteria of protection, and thus, performance virtuosity, i.e.:

- basic refurbishment: minimum energy enhancement actions and attention to historic and monumental features identification;

- "energy restoration": environmental original buildings features implementation, with enhancement and recovery of the environmental and energetic self-control capability ("environmental metabolism") of the building itself;
- energy retrofit: systemic energy retrofit action on more recent buildings with lower monumental and historic features.

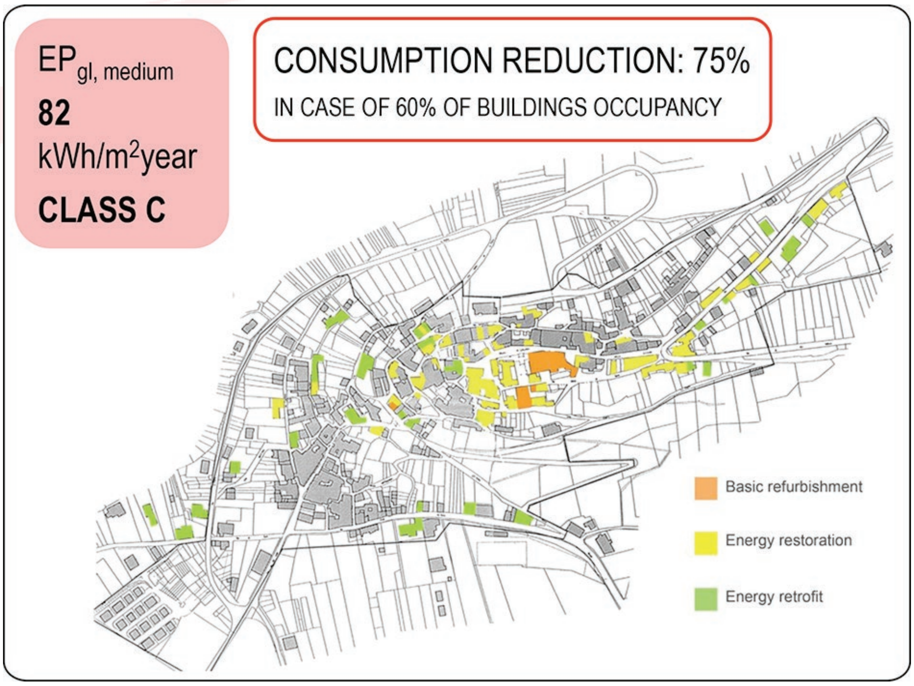

Figure 5. Different levels of performance reached for the different kind of building basing on the historic value and preserving need.

It is also possible to recognize a common denominator for the adopted strategies, i.e. the attention to local and regional peculiarities: in fact, any strategy must fit to the specific climatic, environmental (natural and anthropogenic), technological and cultural requirements and should not be a simple transposition of standardized practice, although effective, used in other contexts[11].

Thus, the adoption of alternative technologies must be strongly related to "short chain" resources, such as forests for wood products, the agricultural system for straw and breeding farm for sheep's wool (Forlani, 2011), can create a perspective of regeneration and/or conversion of the existing productive unskilled factories through a process that will encourage green economy as an engine for economic growth.

[11] Reference to the strategies of hyper-insulated passive house standard of northern Europe that comes strongly into crisis if applied, without appropriate modifications, in contexts characterized by a Mediterranean climate with complex summer-winter and day-night behaviours.

Material \ Performance	Inner side (wall)	Inner side (floor)	Outer side (wall)	Outer side (roof)	Outer side (floor)	Breathability	Tighness	Thermal performance	Performance improvment	Historic building compatibility	Local row promotion
Thermal plaster	●		●			●	●	●	●	●	
Sheep wool	●	●		●		●		●	●	●	●
Wood fiber	○	○	○	○		○		○○	○	○	○
Reflecting multilayer insulation	●		●	●			●●		●●		
Cellular glass	●	●		●	●		●	●	●		
Leca		●			●	●		●	●		

Figure 6. In both cases, the verification of performance improvement solutions provided by enclosures during the design phase was gathered in parallel with the evaluation of insulation materials, chosen in each case basing on performance targets and for an economic regeneration of local productions.

6. Plant integration: from the building scale to the urban one

Thanks to the architectural, technology and energy survey of the villages, it was also possible to define strategies for the integration plant systems for heating and air conditioning.
In the case of Caporciano, in which energy networks are currently present and functioning, some buildings, whose degradation would require substantial consolidation or a scenario of a demolition and reconstruction, have been identified. These buildings, renamed "energy spots", were the subject of an innovative experiment aimed at conversion in CHP neighbourhood plants in which to place a small turbine that can generate heat and electricity by burning wood biomass from the pruning and maintenance of the surrounding forested and agricultural areas. Each building could therefore be served by a network of mini-district heating system that can make particularly efficient the entire village.

For Apice Vecchia, the geological soil features (presence of frequent large cavities in the ground that caused several crashes and made many unstable buildings in post-earthquake) oriented the research towards different proposals related to the integration of systems for summer and winter conditioning: electric heat pumps in individual units coupled to low temperature radiant systems or mechanical ventilation. These devices are powered by renewable energy sources whose production is spread in another place and electricity is then channelled into the local network, already set up and connected to Apice Vecchia. The energy will be produced by a photovoltaic system located on the roof of some host-buildings (preferably owned by the Municipality), so that it is not needed to subtract further ground surface.

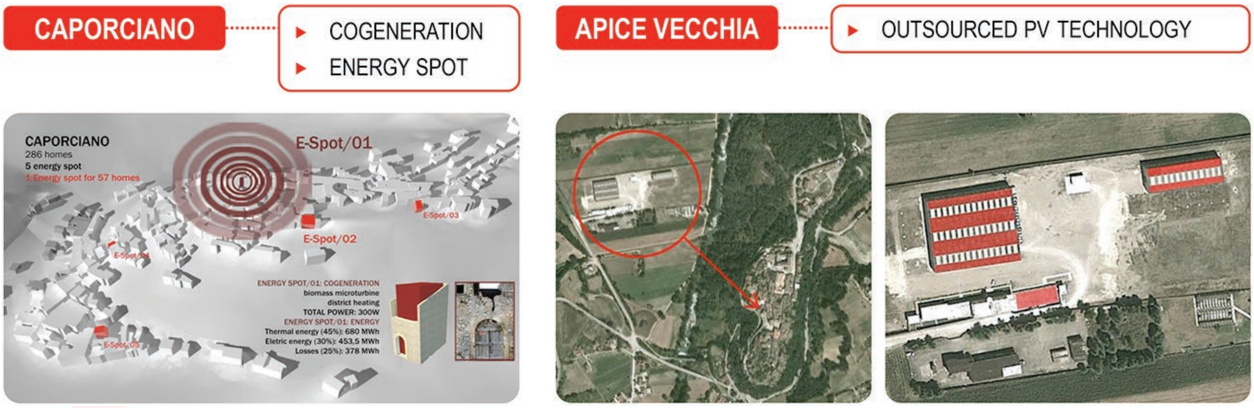

Figure 7. Different approaches for plants integration at urban and building scale in Caporciano and Apice Vecchia, using renewable sources.

7. Integration between energy and seismic aspects

To cite just a few solutions identified by the studies, where it is necessary to consolidate existing wooden floors (inter-storey or roofs) or the substitution of metal slabs or brick and masonry, it is considered advisable to use mainly wooden technologies, made integral to the perimeter walls. Technologies that, in addition to being historically compatible with the building, are particularly light, thereby reducing the weight on the vertical structures. Above the wood support structure, instead of a rigid concrete slab, it is possible to insert a double deck cross (or, better, a double layer of multilayer structural panels, if possible), which generates rigid elements in their plane. The boards must be connected to the perimeter walls (each about 40-60 cm) through metal plates (about 60 cm long), made of wood and screwed on the ground, and, if necessary, to get "collaborating slabs" with the beams, also made integral to the work frames system. The plates are then connected in a punctual and widespread way to the walls system by means of armed seams and perforations made with insertion of steel bars embedded with resin or special mortars and welded to the previous dishes[12]. Another operation that may be necessary to make vertical elevation structures firmly with the horizontal ones or with the flaps is to set up wooden ring beams (especially the coverage level), also connected to the wall in a diffuse way through reinforced perforations.

[12] These plates should also continue every 2-2.5 meters and reach up to the opposite wall to bind better to the whole with pulling effect (both in the case of the floors, both in the case of pitched roofs only, and finally also with shell double-pitched roofs connecting the wood floor to the wall plug or the ridge beam to make roof plans synchronous).

In the case of ring beams and "dry" slabs, the reduced stiffness of the wood and its best performance in reducing the linear thermal bridge induced, compared to jets of reinforced concrete, provide compliant solutions that accompany adequately the fragile historical walls while upgrading building's energy efficiency. Also the diffuse seams system (previously cited) of the slab on the walls, which in many cases can replace the ring beam if the wooden floors are placed further plates on the walls perimeter, is a minimally invasive solution and capable of limiting heat losses (only punctual thermal bridges).

8. Conclusions

Strategies suggested for Caporciano and Apice Vecchia and their intervention scenarios have been formulated to integrate energy and environmental enhancement with settlements' refurbishment and buildings' seismic improvement, which are essential to ensure a new life cycle in conditions of comfort and safety for villages. The most original result is the creation of a 'fast' analysis procedure and proposition of interventions, which takes properly into account buildings' historical memory and identity, operating on the compensation of the whole settlement's performance and not focusing only on the individual building. The attempt to transform the tragic event in new opportunities is mainly based on the natural predisposition to an effective intervention given by the earthquake's effects on buildings and to try to trigger a local chain of "production for reconstruction".

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Analysis for Materials Flows Indicators: Measuring Sustainability in Coastal Tourist Destinations

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Abstract

Sustainable planning of coastal tourist destinations, must guarantee the protection and enhancement of their natural and built heritage. Sustainability in tourism planning in these destinations, where the "sun and sand" model has generated a massive consumption of scarce material resources, requires methodologies including indicators of material flows, to provide information about its management for users and planners. Sustainability indicators for households, those relative to Material Flows, were developed through the analysis and measurement of consumption patterns. This kind of indicators (input-output, describes the flows (energy, materials and water) through a building in its use phase, measuring and calculating the flows into and out of it.
The purpose of this communication is to exhibit the results of the analysis carried out to determine a set of material flow indicators for closed-cycle management (sustainable) and to make easier the control of the planner's decisions for sustainability in the coastal places. The case study to apply it forward is Alcossebre, in Castellón (Valencia).
Updated a group of sustainability goals, those relating to the territory and material resources management were chosen. Structural requirements for the battery of material flow indicators for tourist use households are analysed. Institutional indicators models are studied, the existing indicators systems and the relationship between processes (production, consumption, disposal, regeneration) and flows (energy, water and waste) within a black box system (housing). Given the complete system (territory and resources, flows and processes), the concept for the indicators set falls mainly within the DPSIR (Driving Forces, Pressure, State, Impact, Response) of the EEA Model (European Environmental Agency) considering the Territorial Model.
The result of this analysis is a set of indicators for material flows, as a part of a decision support tool for planners of coastal tourist places.
The main contribution of this analysis is the quality improvement of the material flow indicators since their relationship with the technical processes above the territory, framing the proposed battery within an institutional model and an internationally validated system.

Keywords: Sustainability, Indicators, Material Flows, Frameworks, Coastal Tourist Destinations.

1. Introduction

This paper describes the analysis process carried out to determine the conceptual proposal for a set of material flows indicators, to build a decision support tool for urban development planners in Mediterranean tourist environments. It will be applied in Alcossebre, Castellon. The improvement of the tool "The insediamenti degli turistici compatibilita'ambientale costieri: One instrument di supporto per un approccio decisioni alle sostenibile" (Serafino, 2006), focuses on updating the sustainability objectives and some relevant material flows indicators for resource management in closed cycles.

1.1 Sustainability Objectives

For sustainable development, the tourism values are visitor satisfaction and well-being of the resident population. Therefore, Quality of natural attractiveness and built patrimony are the principal attractions for visitors as well as cultural richness and the best services infrastructure supply.
So, Sustainability Objectives can be grouped into four key thematic areas. For this research, Territory and Resources Management are the principal issues due to the relationship among them and sustainable tourism urban planning.

Territory
Natural attractiveness generates the tourist pressure, so, the first of the SO was stated as:

"To preserve and enhance the natural and built heritage”.

Resources and Waste
Landscape is the outcome of the resources management model which a society adopts (Cuchí, 2011), that is, territory configuration, in this case its tourist appeal, depends on the residents production and consumption patterns for water, energy, materials and waste management.
To ease closing of cycles in technical processes is considered as a principal Sustainability Goal:

"Reducing consumption of resources in open cycles”.

1.2. Sustainability Indicators

To achieve the sustainability goal "Reducing consumption of resources in open cycles”, indicators for material flows are considered. These ones provide necessary information to assess to what extent are shifting the models for resources management to close the materials loops in technical processes.
There are no perfect sustainability indicators, but there are indicators that point to critical sustainability issues in a community or in this case, of a tourist destination. The World Tourism Organisation (UNWOT, 2004), has developed a proposal for key themes and basic sustainability indicators for application in different tourist destinations. The proposal builds on the notion that sustainability is not equivalent to environmental accounting, that all environmental indicators, as well as the ones for material flows should be designed in terms of sustainability, i.e. social participation, environmental impact, considering the cost of repair or replacement of the consumed goods, and institutional policies or programs.

Before adopting core or environmental indicators as sustainability indicators, it is necessary an analysis of conceptual and structural requirements, identifying the moments of the processes to measure and control.

1.3. Evolution of sustainability measurement via indicators.

Since 1972, following the Stockholm Conference, the causes of foregone environmental problems began to be explored, as determined by socioeconomic factors. Traditional development indicators are no longer a unique reference, and emerging new social indicators as the HDI (Human Development Index), but the environmental indicators will achieve greater progress and development.
The fundamental objective of a system of environmental indicators is to provide quantitative information about the environmental performance of a particular socio-economic development in a particular geographic area.
The indicators development is relatively recent and the degree of uniformity and comparability among the operational is still limited. They are generally designed to assess the environmental performance of the global nature of economic and social activity, and less for its partial aspects. The models with greater implementation are those developed by the OECD and the European Environment Agency (EEA).

2. Conceptual frameworks of environmental indicators

The issue of environmental indicators has been addressed by various institutions with different concepts, objectives and scopes. These perspectives have produced confusion, especially in new developers. The information used to build environmental indicators is broad and diverse, and requires a conceptual framework for structuring and facilitating information access and interpretation.

There are several models for organizing sets of indicators. One of the best known is called the Pressure-State-Response (PSR), proposed by Environment Canada (1996) and the OECD (OECD, 1993). Other models are the Guideline Force-Pressure-State-Impact-Response (EEA) and others characterized by its thematic focus (Flow-Quality Model, System Model-Environment or Urban Metabolism or Footprint Indicators and Urban Environmental Quality).
Below is a brief description of the first two, considered as basic for this research and the proposed set.

2.1 Pressure-State-Response Framework (PSR)

The PSR framework is based on logic of causality: human activities exert pressures on the environment and change the quality and quantity of natural resources (state). Also, society responds to these changes through environmental, economic and sectorial polices (answers) (OECD, 1993). This model is based on simple questions:
- What is affecting the environment?
- What's going on with the state of the environment?
- What are we doing about these issues?

It is important to have notice about, although it is a logical in terms of the relationship between pressure, state and actions, the PSR Frame suggests a linear relationship of the interaction between human activities and the environment. This path it is usually not true and hides the complexities of these interactions.

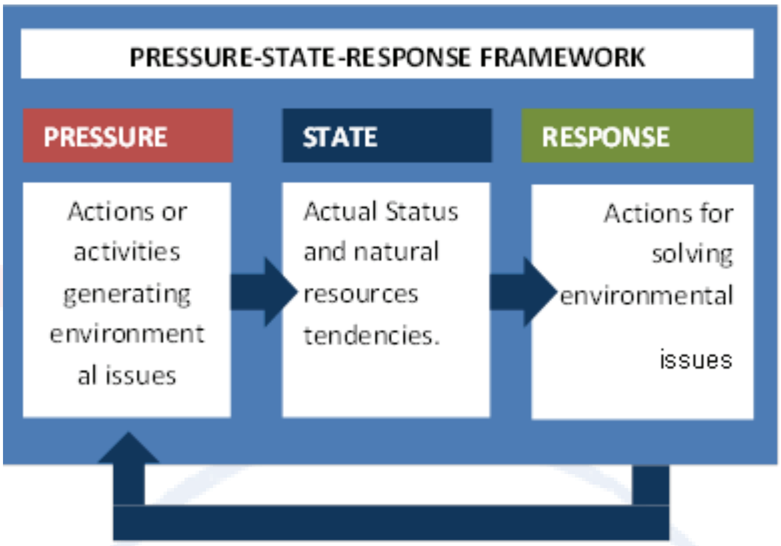


Figure 1: Pressure-State-Response Framework. (OCDE, 1993b)

2.1.1. Pressure indicators

They describe the different human activities pressures on the environment and natural resources. An example of a pressure gauge on air quality is the emissions of polluting gases into the atmosphere.

2.1.2. Status Indicators

Environmental Quality of natural resources and the quantity are referred as status indicators. Information is provided on the situation of the environment and its changes over time, as well as the effects on the population health and ecosystems caused by environmental degradation.

2.1.3. Response indicators

They show the society, institutions and governments efforts aimed at reducing or mitigating environmental degradation. Generally, response actions are oriented toward two objectives: i) pressure agents and ii) the state variables.

2.2 DPSIR Framework (Driving Forces-Pressure-State-Impact-Response)

This scheme, known as DPSIR (Driving Forces-Pressures-State-Impacts-Respond), is a derivation of the Pressure-State-Response model. Adopted by the European Environment Agency (EEA, 1998), incorporates in a linear sequence of logical thinking, the associated impact to the state in which the variable is under evaluation. In theory, this should help in establishing priorities to be addressed with the response taken by the actors involved. The impact is simply the attempt to evaluate the state changes detected in environmentally relevant sectorial trends (driving force), qualitatively or quantitatively.

In this model, the driving force indicators are also related to human activities generating pressures. The status indicators are restricted to environmental resources state and impact indicators show the effects on human health or ecosystems. The interaction between the elements is displayed in the following scheme using the tourist issue from the EEA and Vera & Ivars, by example.

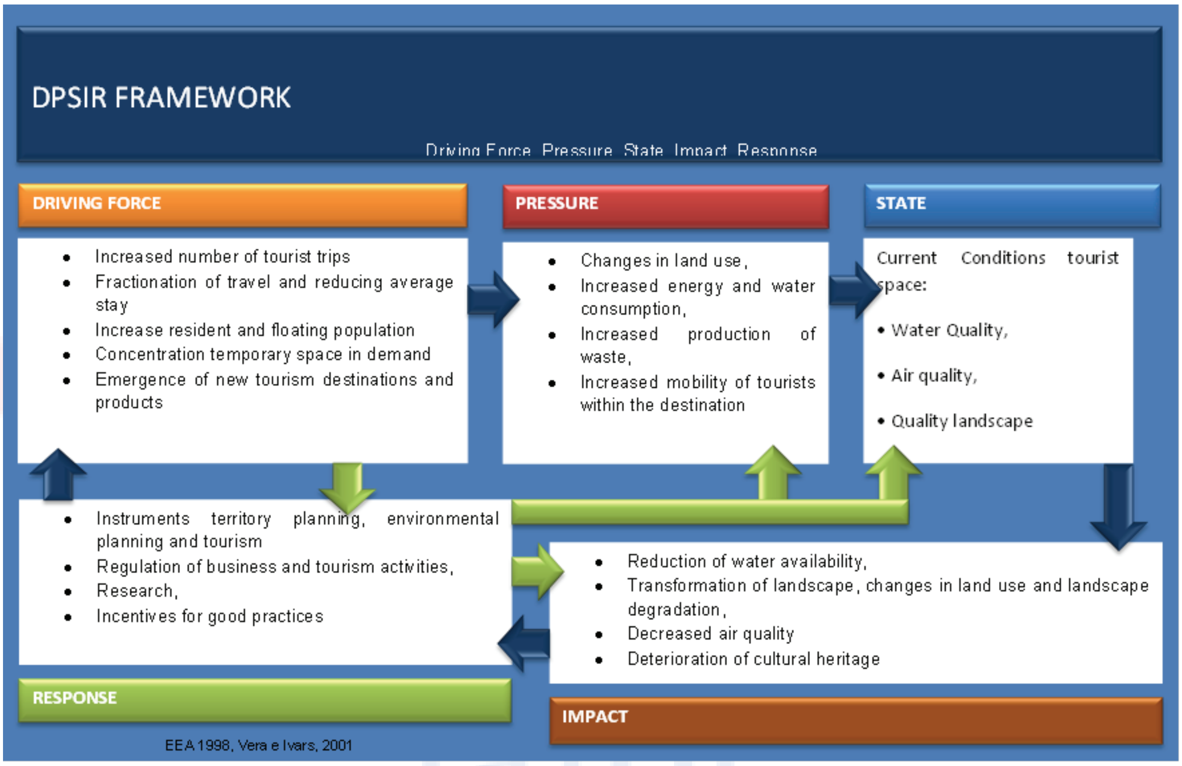


Figure 2: DPSIR Framework for sustainable development by Vera & Ivars (2001).

2.3 Territorial Model-Flow-Quality Framework

This conceptual model proposes a set of municipal environmental indicators organized into three main groups: model indicators, flow indicators and quality indicators.

The model corresponds to those indicators describing processes or multifactorial incidence phenomena and relates directly to the basic model city (based on the procedures established by the green book for European Urban Environment (1990)):

- The compact city
- The diffuse city
- The mixed city

These Model indicators are associated with the characteristics of the urban structure, from the formal point of view and functional.
Flow Indicators. Municipal flows cycles of matter and energy are addressed since the point of view of production, distribution, treatment and reuse.
Municipal Quality indicators can be defined by those relating to the final conditions of the local environment. They report on the environment state and the spatial evolution, i.e., representing basic environmental conditions (Pino, 2001).

An excellent systematization of tourism indicators is offered by Vera and Ivars (Vera & Ivars, 2003)based on the structure of the causal analytical model of the European Environment Agency, the DPSIR model.
Vera and Ivars added policy response indicators according to the characteristics of PSR and DPSIR models to the typology of indicators previously explained (territorial model, flow and quality):

- Land-Environment Model
- Pressure
- State-Quality
- Social and Political Response.

2.4 Framework for the territorial model case study

The chosen case study for this methodological improvement is Alcossebre in Castellón, Spain. It´s a coastal town belonging to the Alcala de Xivert municipality, as well as other closer towns (Cap i Corb and Las Fuentes). Alcossebre has also a small city centre, with Banks, schools and a hospital. In the surroundings there is a wide rural area for agriculture and the "Sierra de Irta" protected natural area. The municipal term has about 7.500 inhabitants.

Figure 3: Alcossebre, Alcalá de Xivert municipality in Castellón, Spanish Mediterranean Coast. Location.

This territorial tourist model, addresses to the MFQR framework, based on DPSIR scheme to be used in the indicators characterization. Because the territory diversification, this coastal town fits in the *mixed city model*. In the next figure, the urban development density is observed.

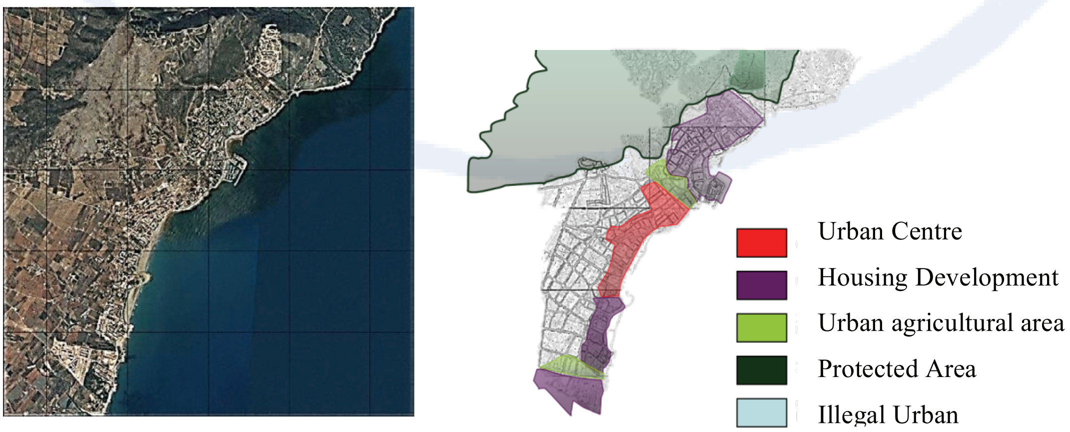


Figure 4: Alcossebre, Alcalá de Xivert municipality in Castellón, Spanish Mediterranean Coast. Territorial characterization...

3. Indicators Systems: Scientific Perspective

The environmental scientific perspective could be predicted to offer most knowledge about ‘the environment’ in a structured way.

This Research task is to analyse two of the existing indicator approaches for providing the knowledge base to understand the differences.

The actual indicators systems address to indicator principles employed, the Life Cycle Assessment (LCA) (Rivela, 2010) and the Material Flows Analysis (MFA) (INE, 2003).

The goal of the scientific approach is to draw an environmental profile of a building as close to a building’s real environmental effects as possible and during its entire life span, including the production of the building materials prior to the building’s erection and the disposal of these materials after the building’s dismantling. Two things are therefore characteristic for the scientific approach:

The focus on emissions and environmental impacts

The life cycle perspective.

3.1 Focus on emissions and environmental impacts

From the scientific point of view it is not justifiable without further scrutiny to use a mere measurement of consumptions (for example of electricity consumption in the use phase) as an environmental indicator for buildings in general without further specification.

> *Instead, the origins of the consumed resources and the emissions related to the production processes need to be taken into account, if the indicators are to express an environmental profile of a building that is close to its real environmental effects. The emissions caused by the production of energy and materials are also just one element in the continuing causal network, as Figure 5 show. (Dammann, 2004)*

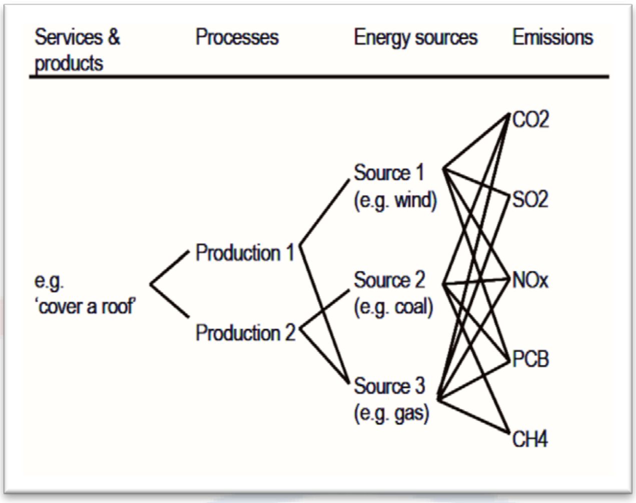


Figure 5: Part of the net of causal relations: the products consumed (for example roof tiles) to provide a service ('to cover a roof') cause multiple emissions, depending on the sources of the energy used in their production. ((Wentzel, et al., 1997)

What ultimately trigger human efforts for environmental improvement are the consequences of human activities. It is, however, not possible to predict the actual effects and consequences of the environmental exchanges in a building's life cycle in an unambiguous, quantitative way. For this reason in LCA, the categories of environmental impact are defined on the basis of emissions and impact potentials and usually not on the basis of consequences.

3.2 The life cycle perspective in environmental management

Society's environmental focus has been shifting: from an 'end of pipe' policy, in the 1970s, focussing on the control and reduction of emissions of industry, automobiles and buildings, towards a consideration also of a product's or a building's environmental impact throughout its entire life cycle, including measures to prevent environmental problems and to use generally cleaner technologies.

The figure below from the book 'Environmental Assessment of Products' (Wentzel, et al., 1997) illustrates the focus of traditional environmental policy for industrial products, where

> *'Efforts have mainly been concentrated on emissions from material production, [from] product manufacturing and disposal.' (Wentzel et al., 1997)*

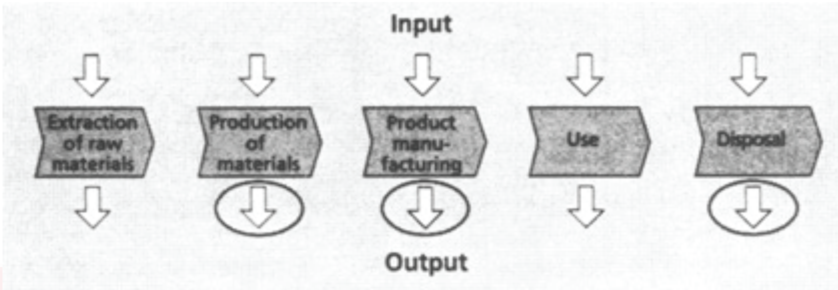


Figure 6: 'Environmental focus in the industrialised world: Efforts have mainly been concentrated on emissions from material production, [from] product manufacturing and disposal.' (Wentzel et al., 1997)

At the same time the material standard of living has risen, neutralising and outweighing many environmental improvements by an increased consumption of resources.
In the building and housing sector the energy crisis of the 1970s set off efforts to reduce energy consumption, focusing primarily on the consumption in the building's use phase. (Dammann, 2004).

This phenomenon of continuing increases in total consumption, that subsequently lead to continuing increases in pressures on the environment in spite of efficiency improvements at the level of single processes has led to the recognition that environmental policy has to broaden its scope so that attention is paid to the total impact from the entire product system. In this broader view, resource streams and emissions that occur during a product's entire life cycle are taken into consideration.

> *'To a large extent, future environmental management will therefore occur at the interface between company and customer, as illustrated in [the below] Figure.' (Wentzel et al., 1997).*

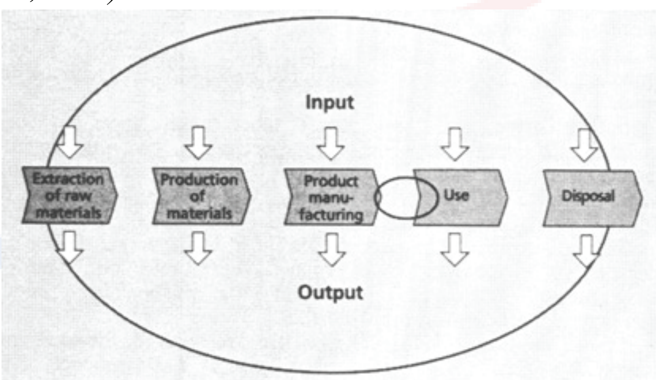
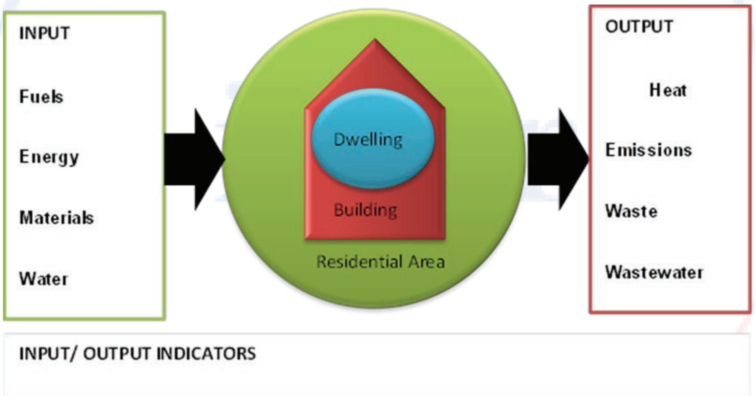


Figure 7: 'Future environmental focus in the industrialised world' (Wentzel et al., 1997)

To propose alternative local development oriented to sustainability, according to a scientific approach must also consider the use of the building phase, impacts and environmental consequences arising from the siting, design, construction and building maintenance (Dammann, 2004).
The Life Cycle Analysis mainly considers the life cycle of all the elements of a product, in this case a home, analysing the exchanges between the environment and the technical system and the flows between the technical systems in all phases of life cycle of buildings.

3.3 The material flows indicators in the use phase of buildings

A key objective for sustainability indicators development for tourism is to facilitate communication of environmental information between planners and everyone involved in making decisions during the life cycle of a destination in order to consider all the development aspects.
Sustainability indicators for buildings, those relating to Material Flows, are developed through the analysis and measurement of consumption patterns. This type of indicators derived from environmental accounting (Jensen, 1999), describes the flows (energy, materials and water) through a building in its use phase, measuring and calculating the flows that enter it (input) and leaving (output), as shown in the figure



below:

Figure 8: Input Output Indicators for the use phase of buildings. (Jensen, 1999).
If the flow should be measured at its input or its output, depends on practical reasons. In some cases it is easier to take the pulse of a flow at its entrance. In other cases, it is easier to measure in its output. For example, the flow of materials during the use phase of a building are regularly measured considering the bill for waste disposal because it is an indicator rather familiar and easy to communicate.

On the other hand, the pragmatic choice of indicators according to the input-output concept is based on the law of conservation of energy and matter, i.e. that, environmental accounts, materials and energy, cannot get out of a system (output) anyway (waste heat, etc.) if before, have not been introduced as materials and energy (input). Nothing is lost in any transformation process.

> *Thus, a residence or residential area is part of the local and global flows of materials and energy (Jensen, 1999).*

Input-Output Indicators focus on the flows entering the building or residential area, as supplies and energy and come out as waste and emissions. They can cover all phases of the building life cycle from extraction and manufacturing of materials to its demolition.

In practice, however, focuses on those streams that are easier to measure, such as water consumption and the volume of waste generated. Environmental accounting systems flows cover only operating during the use and operation of buildings generally, although the calculation of the emissions caused by energy consumption, the concept of input and output indicators deviates slightly the basic concept and becomes part of the stroke (calculation of environmental exchanges), on principle.

4. An individual Analysis about relationships between technical processes and material flows

> *The physical landscape is always the result of the resources management model from the owner society (Cuchí, 2011).*

4.1 Requirements for the conceptual structure of the material flows indicators

To analyse the way the resources management is developed upon the territory and whatever resources are available is determining. It is also important to consider where the waste generated is finally deposited: whether inside or outside the territory.

Proper management guarantees the quality of the tourist attraction, both natural and offer services that visitors expect. This will result in a better quality of life for residents and a better travel experience for visitors.

The main condition for sustainability is the closure of material loops in technical processes. Resources Production, Consumption, Disposal at the end of its useful life and Regeneration, Recovery or Recycling, are the processes in which the available resources are managed to achieve the sustainability goals.

Territory is the "platform" that supports these processes and management of the resources produced or imported to. How many of them are available and are able to have an efficient and sustainable return of their material utility to end of cycle?

The Physical Integrity and Environmental Territory Quality and the Resources and Waste Efficient Management are interrelated by the sustainability objectives: “Preserving and Enhancement of Natural and Built Heritage” and “Changing production and consumption patterns”.

The table below illustrates the processes needed for closing cycles on a relational matrix. The showed relationship between the two fields of scientific competence intervention and Sustainability Goals and the Objectives published by the World Tourism Organisation in 2004 (UNWOT, 2004).

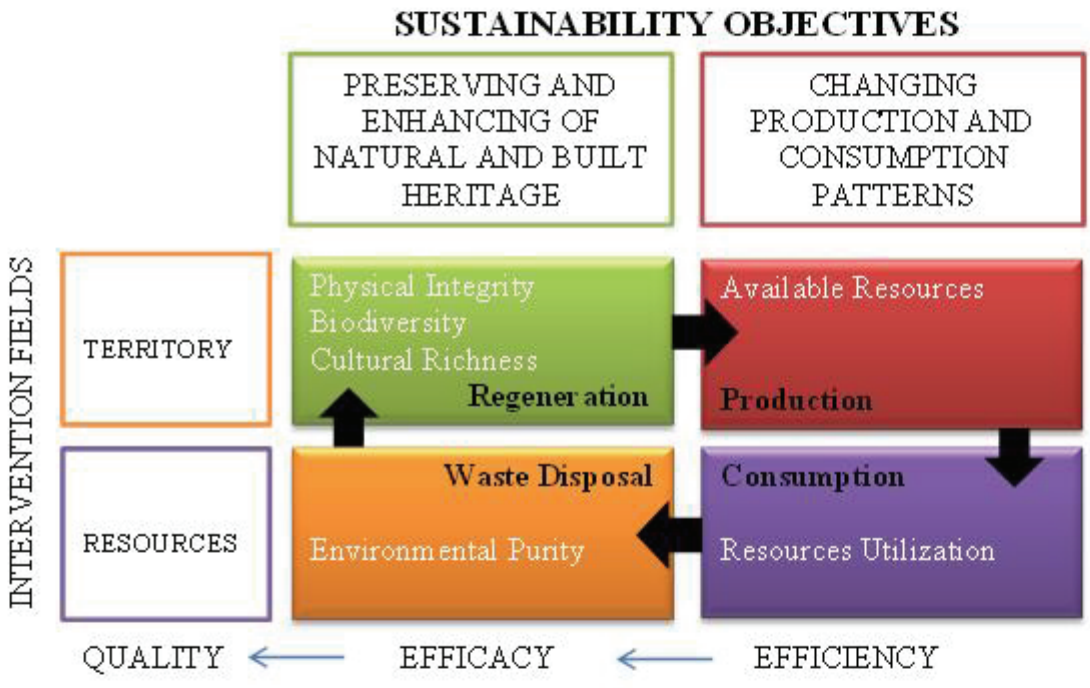


Figure 9: Technical Processes for closing open loops and the related sustainability objectives from UNWOT 2004.

Resource Production - Consumption - Waste Disposal - Regeneration and Recycling

The conceptual framework structure characterizes two environmental systems to analyse:
The Territory (physical landscape) and the material flows in technical processes.

To design the indicators system for assess these criteria; two sets of relationship are identified:
a) Technical Processes happened in the Territory are Production, Availability, Resources Consumption and Regeneration and
b) Material Flows for Resources are Production, Resource disposition, Use Efficiency and Waste Disposal.

This matrix allows designing the indicator system by analysing the degree of relationship of the technical processes in terms of their associated material flows. This exercise addresses the criteria set out above can be more easily measurable, identifying indicators that are most relevant and optimize their quantity and quality to the extent that the local availability of data permits.
Thus, it is possible to distinguish and interrelate the material flows with the technical processes that correspond. This matrix will identify critical points in the system where to place relevant indicators both Sustainability Goals is proposed.

The unit of measurement (X) indicates the degree of interaction, and the maximum represented as XXXX.

SUSTAINABILITY GOALS			PRESERVATING AND ENHANCEMENT OF NATURAL AND BUILT HERITAGE			
CHANGING PRODUCTION AND CONSUMPTION PATTERNS	INDICATORS		MATERIAL FLOWS			
			Landscape/ Territory	Resource disposition	Utilization Efficiency	Waste
	RESOURCES TECHNICAL PROCESSES	Production	XXX	XXXX	XXX	XXX
		Resource Demand/ Availability	XX	XXXX	XXXX	XX
		Consumption	X	XXX	XXXX	XX
		Regeneration	XXXX	XXXX	XXX	XXXX

Figure 10: Relational Matrix for Technical Processes of Resources and Material Flows for Resources. By the author.

The drawings below show the flows into and out of the system. Each process is entering or leaving a "black box" system, where it´s only known about the inputs and outputs. In these models, the material flows are observed and their relationship to the aforementioned technical processes. This step will determine the critical points measured and the indicators may be identified inside an institutional framework.

4.1.1 Water Flows Model

Water flows into and out of the black box system can be observed in this model. Figure 11.

Water resources to sustain life in the territorial model under study can come from within the country or imported to (Input). If removed from the territory itself, one of the impacts (effects on quality of life of the population and the environment) is the resource scarcity in case of not having water reserves such as dams, ponds or rivers. Or, to be in the presence of a particularly dry season.

A simple indicator, which can be useful to establish the degree of attention, required to control the availability and supply of this resource would be in this case, *to observe the days of annual water emergency*, caused by the lack of rain or lowering the level of aquifers. This could be a pressure-impact indicator.

If water is imported to the territorial system, the impact from mining occurs outside the territory and local significance would not hypothetically. There are impacts that affect the local area, which are global but as CO2 pollution due to emissions from its transportation (fuel and energy), could come to affect air quality locally. But this indicator should not be considered for inclusion in the system because it is impossible to know at this scale reliable data and therefore uncontrollable. However it is considered part of the current production model open cycles.

When the water has fulfilled its function within the black box (housing or residential area), is ejected in the form of sewage (Output). So the *volume of water consumed* will be an indicator of consumption patterns, and a pressure-status indicator. The volume of untreated water and poured directly to territory will be another indicator -*the volume of wastewater*-, in this case, an unsustainable resource management. The volume of wastewater discharged outside the territory is not possible to be reliably controlled.

An indicator of a closed-cycle management would be to measure the quality of water being treated to restore its utility value (maximum drinkability possible) as an *index of water quality*. It can be stated as a response indicator, as the *volume of water treated* and the *number of water treatment plants* in the locality.

Another indicator of response might be to implement systems to capture rainwater in tourist residential areas measured by the *annual volume of rainwater* captured in these residences.

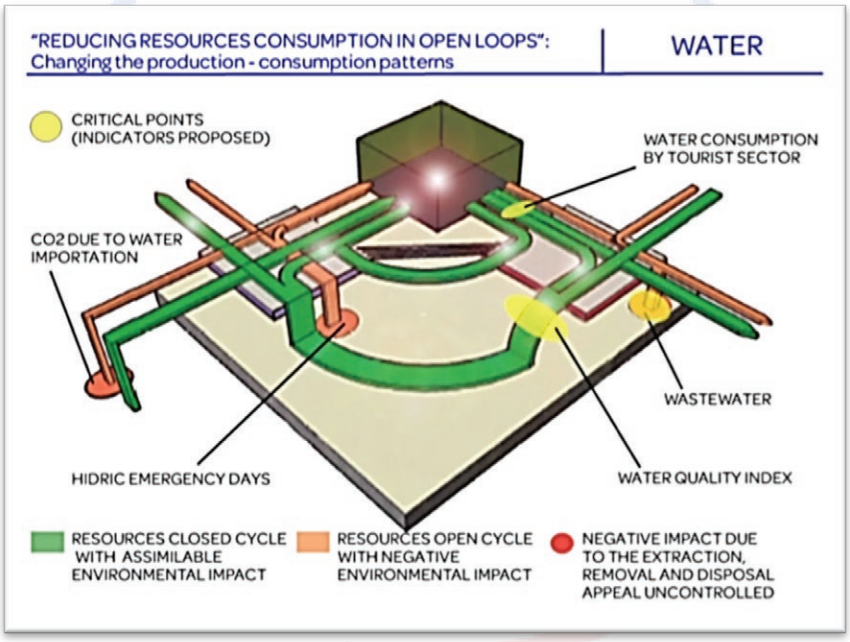


Figure 11: Model for Water Flows. By the author.

4.1.2 Energy Flows Model

The energy flows model, shows the same black box system, which represents the tourist accommodation and the residents dwellings, mainly. Figure 12.

Energy resources necessary to meet the needs of residents and visitors on the site studied, and the water may come from outside the territory or generated within it. Usually, the energy is supplied in the form of electricity and generate over long distances, with infrastructure investments that entails and transmission losses from the plant to the remote location will be consumed.

Energy flows into the black box and coming out of it, as an indicator of material flow on *energy consumption would have per user per year*, which should distinguish between residents and visitors. This would be a pressure-state-impact indicator.
There are several critical points, like the CO2 emissions by generating processes and the CO2 emissions to atmosphere from consumption.
An impact indicator in this case would be *CO2 emissions* (mainly) *to the atmosphere* because of that consumption.
Power generation at the local level is feasible if using the forces of nature (wind, currents, sun, geothermal), biomass) or organic matter, so consider sustainability as an indicator of power generation from renewable sources would be a way to verify the closure of cycles in this technical process, as this pattern of production does not emit CO2. This *energy percentage from renewable sources* would be a response indicator.

Taking into account these exchanges and impacts, planning oriented toward rehabilitation or construction using less industrialized materials and better metabolic performance at the end of their useful life.

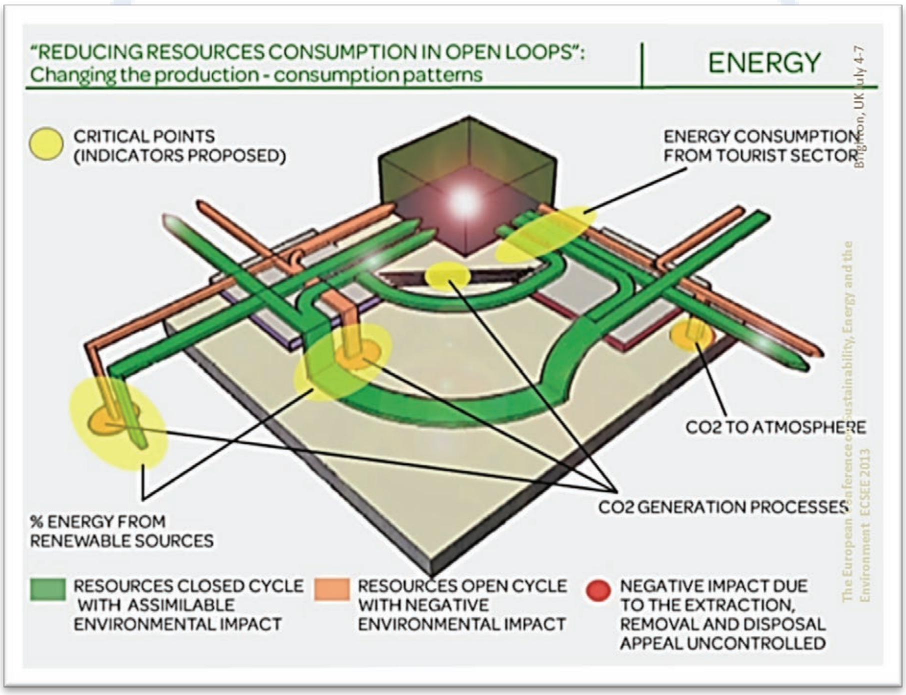


Figure 12: Model for the Energy Flows. By the author.

4.1.3 Materials Flows Model

Figure 13 describes the flows of materials when they enter the territorial system and the black box and its outputs as waste.

The demand for materials or total material requirement is the amount that a country needs to produce goods. Locally, this demand can only be measured by the rate of

garbage that the city administration issues, since it is difficult to measure the amount of material in the form of products that fall within the study area.
This quantity should be the same (hypothetical and ideally) the available material volume. But, in order restore its usefulness in a closed cycles or sustainable production-consumption pattern; materials will require indicators showing the pressures and the status of the system.
So, one of these indicators must be the percentage of waste recovered / reused / recycled or remanufactured. This indicator may be a quality (status) indicator, inside the MFQR Model.
Another one is the waste generated volume, as a flow (pressure-impact) indicator.
The system shows other critical points, like de CO2 emissions to atmosphere due to importation processes, regenerating processes or disposal patterns.

Generally, the generation of waste is a loose of materials and energy. Excessive amounts of waste generated by society resulting from inefficient production processes, the low durability of the products and unsustainable consumption patterns.
The proposed indicators for the sustainable management of materials locally are:

Volume of waste generated by the tourism sector.
Percentage of waste recycled effectively.
CO2 emissions to the atmosphere due to disposal in open cycles (incineration, landfill)
CO2 emissions to the atmosphere due to the energy consumed in the recycling process.

They do not take into account emissions from industrial processes raw material extraction and production of goods, due to be realized outside the territory.

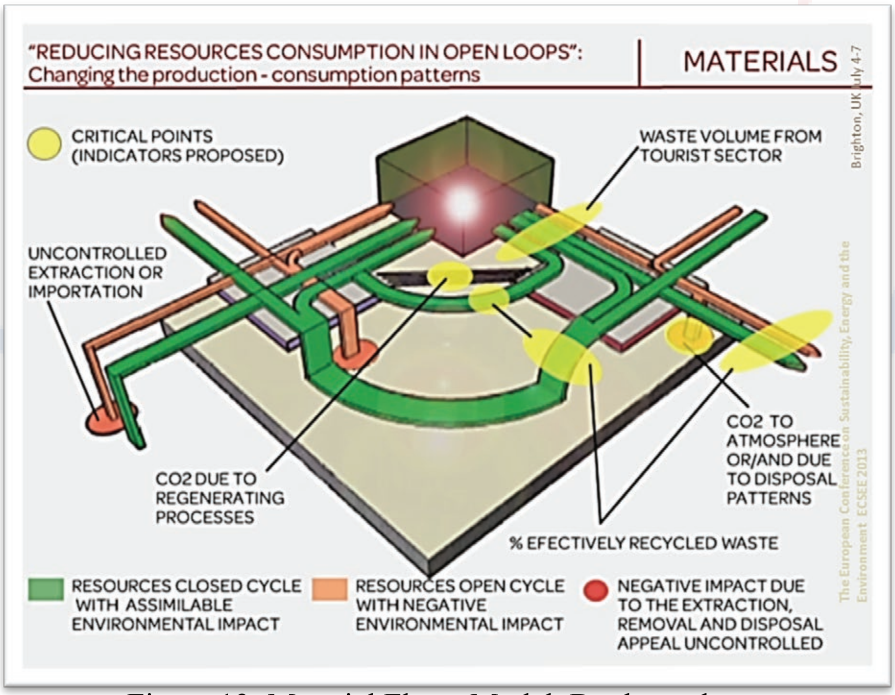


Figure 13: Material Flows Model. By the author.

5. Material Flows Indicators Conceptual Proposal

The Proposal should include pressure-state-quality-impact indicators, to determine the current status of the situation. This diagnosis allows the knowledge of the prevailing production-consumption patterns. Response indicators for guarantee the sustainability of planning decisions and the actions for preserving the natural and built heritage, as it is shown in the next table. Territorial Model characterization permits individual flow calculations for specific planning and management issues. The previous analysis allows organizing them inside the Model-Flow-Quality-Response framework as the figure below shows.

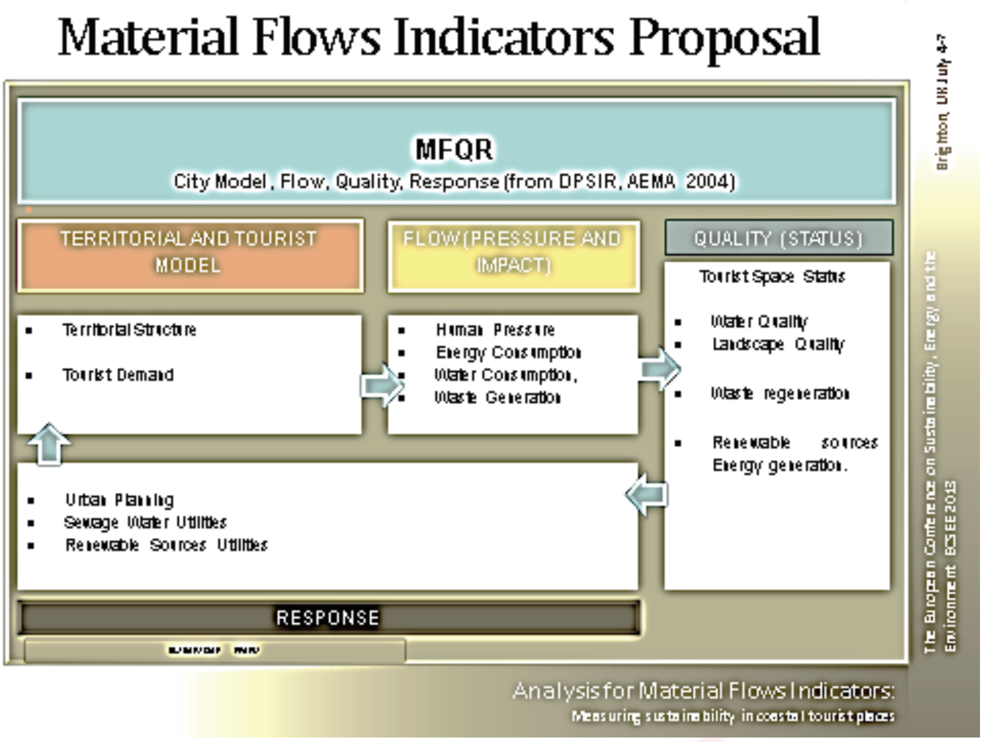


Figure 14: Conceptual Framework for the Proposal. By the author.

According to the previous analysis, a set of sustainability indicators for tourism can not be built with material flow indicators for measuring exclusivelly the input and output flows. That is, in order to the resources demand and their final deposition during the dwelling or residential area use phase.

Impacts of building materials production and its subsequent management, according to the principles of life-cycle analysis of buildings should be considered as the main indicators battery concept. Figure 15.

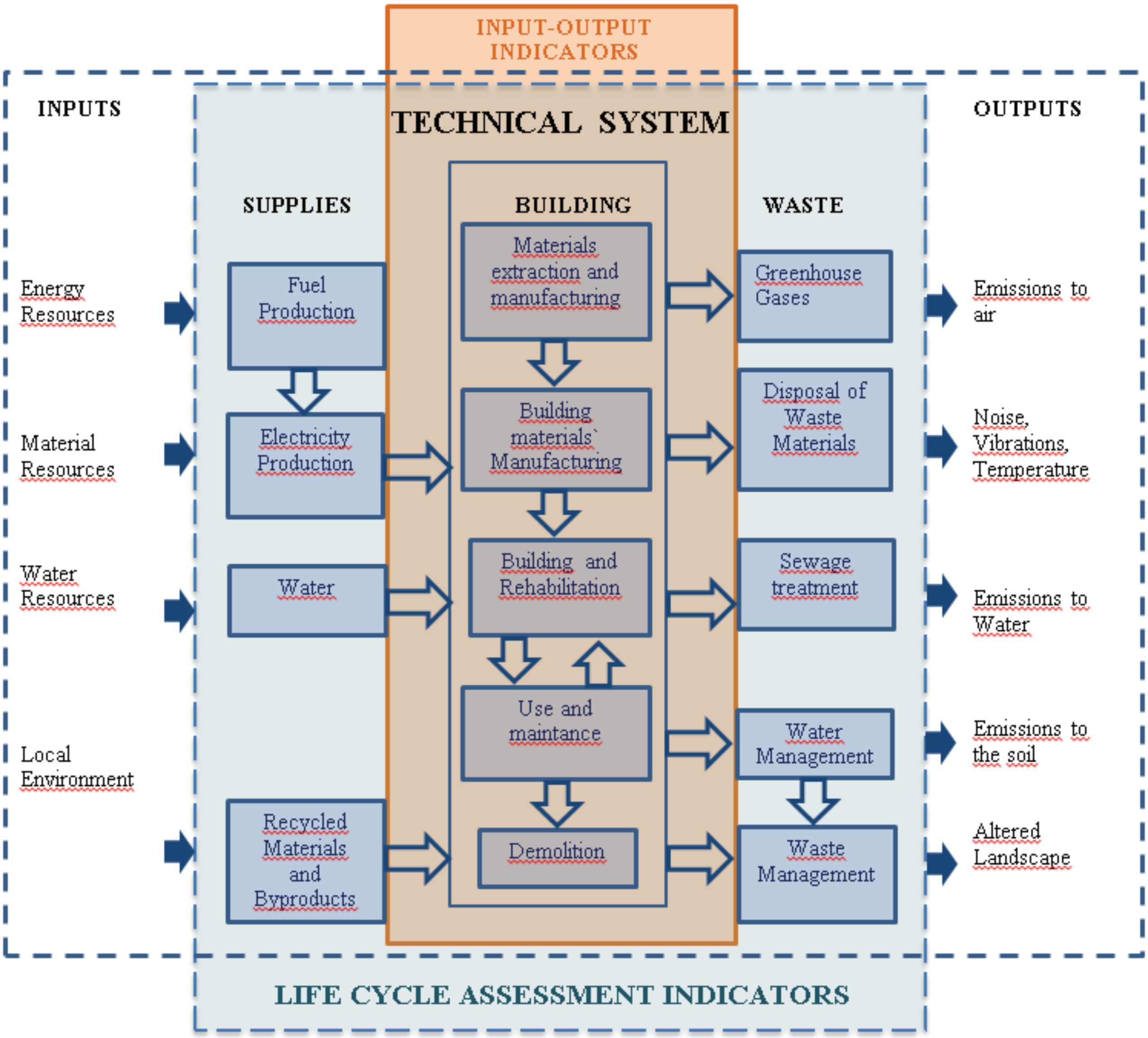


Figure 15: Conceptual System Principles for the Proposal: Input-Output Indicators with a Life Cycle Assessment perspective. The figure shows the system boundaries for the technical system and life-cycle of a building. Applications of environmental data and declarations for building materials (Dammann 2004)

5.1 Material Flows Indicators

RESOURCE: WATER	Tourist Territorial MODEL: Mixed City		DRIVING FORCE Production & Consumption Patterns
THEMATIC AREA	PRESSURE	STATE-QUALITY-IMPACT	RESPONSE
WATER AVAILABILITY	Total municipal population in thousands Sources of drinking water consumed (allochthonous resources, hypogea, etc..).	Water availability per capita in cubic meters per person per year. Hidric Emergency Days Natural water resources per capita. Surface contaminated aquifers.	Percentage of population with access to potable water
	Annual volume allocated for public supply in m3 per capita	Pressure level on water resources in percentage	Wastewater reuse percentage
WATER MANAGEMENT	Consumption of visitors and residents in m3 per capita per year Percentage of losses in the distribution network.		
WATER QUALITY	Population percentage of untreated	Quality urban water supply.	Water generated from Treated wastewater in
	Municipal wastewater discharges in m3 per second.		Number of wastewater treatment plants

Figure 16: Proposal for Water Flows theoretic Indicators framed into the MFQR model based on DPSIR Framework.

RESOURCE ENERGY	Tourist Territorial MODEL: Mixed City		DRIVING FORCE Production and Consumption Patterns
THEMATIC AREA	PRESSURE	STATE-QUALITY-IMPACT	RESPONSE
PRODUCTION/GENERATION	Energy availability	Percentage of non-renewable energy CO2 EMISSIONS due to power generation	Energy from renewable sources in percentage
CONSUMPTION	Energy Demand	Energy consumption per m2 built CO2 EMISSIONS because production processes for construction materials. Residential sector energy consumption in kWh per inhabitant per year. CO2 EMISSIONS residential-tourist consumption	

Figure 17: Proposal for Energy Flows theoretic Indicators framed into the MFQR model based on DPSIR Framework.

RESOURCE: MATERIALS	Tourist Territorial MODEL: Mixed City		DRIVING FORCE Production & Consumption Patterns
THEMATIC AREA	PRESSURE	STATE-QUALITY-IMPACT	RESPONSE
MUNICIPAL SOLID WASTE GENERATION	Total and per capita generation of municipal solid waste in kilograms per day	Disposal of municipal solid waste in percentage Degradation evolucion of Urban and Rural Landscape.	Solid Waste Recycling in thousands of tons. Landfill in number.

Figure 18: Proposal for Materials Flows theoretic Indicators framed into the MFQR model based on DPSIR Framework.

6. Conclusions

The analysis process value is the careful reflection about how are resources flowing or moving (water, energy and materials) throughout a tourist destination urban system.

The methodology used, although quite simple, allows the critical points identification, wherever the system is operating within a traditional management model or within a closed cycle one.

The Proposed set fixes in the Model-Flow-Quality-Response framework derived from DPSIR. The characteristics of the case study territorial model fits due the diverse intensity use of the land. This framing gives validity and reliability to meet specific objectives.

A sustainability indicator should show the current state of the system under study on the one hand, and on the other, the answer that is being given to the problems encountered.

The institutional models analysed and the existing indicators systems have different perspectives of the conceptual structure and characterization for material flows indicators. Life Cycle Assessment and Input-Output Indicators principles provide the scientific approach for this proposal. This condition makes possible using the informatics tools designed for Environmental Impact Evaluation.

So, this proposed set of material flows indicators for a coastal tourist destination permits understanding the state of the development, the critical situations and to have knowledge for urban planning decisions.

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The Effectiveness of Strategic Human Resources Management (HRM) on Developing The Lean – Centric Approach (LCA) towards Integrated Supply Chain Management (ISCM) Sustainability

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0264

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Abstract

The potential for an integrated supply chain to provide an alternate source of differentiation both highlights the importance for organizations of developing a competency in this area, and begs the question as to why it is still the domain of a minority (Power, 2005)

As a rapidly changing supply chain management environment, it requires for open communication, trust and recognition of the interdependence of “individual” elements of the supply chain. Without groundwork of effective supply chain organizational relationships aligned with human resources system in a lean centric organization, any efforts to manage the flow of information, materials or cost flow across the supply chain will be unsuccessful

This lean environment requires HR professionals to develop an effective communication, well trained team management, and constant lifecycle innovation. So configuration and operation of supply chain activities and resources provides significant potential for developing new and alternate sources of sustainable competitive advantage (Power, 2005)

Keywords: lean management, lean, Human Resources Management (HRM), Integrated supply chain, competitive advantage, sustainability

Introduction

The competitive advantage in supply chain management is gained not simply through faster and cheaper communication of data. And, as many managers have come to realize, ready access to transactional data does not automatically lead to better decision-making (Shapiro, 2000).

And Cottrill (1997) The evolution of the concept of integration has moved over time to one in which the supply chain operates as a corporate entity, spans a virtual enterprise without reference to traditional company boundaries, and can be driven directly by customer demand via access to electronic storefronts. He states that this trend will create major changes in many companies, eventually leading to greater use of outsourced services. He also believes that the key to implementation lies in focusing initially on introducing changes within the company, and then extending the process to include suppliers and customers

The integration of supply chain processes through investment in cooperative arrangement and technologies is difficult to separate from, or consider independently of, the strategic positioning of organizations. Effective supply chain integration requires effective implementation, and implementation uninformed by strategy will at best produce little in the way of tangible benefits for the parties involved, and at worst be counter-productive and erode competitive advantage(Power ,2005).

And Assuming that the employees of an organization in some supply chain are individuals with own mental maps and perceptions, own goals and own personalities and as such they cannot be perceived as a whole, HRM holds that the organization should be able to employ both individual and group psychology in order to commit employees to the achievement of organizational goals (Babić, 2009).

Thus, the problem that the logistics professional faces is that managing companywide HR policies to effect coordinated change is often outside his or her management scope. This removes the greatest point of leverage in accomplishing cross-functional integration for those who have such responsibility without commensurate authority. Moreover, it is extremely difficult to tailor coordinated HR policies that span functional departments; many logistics professionals lack knowledge and experience in this complex area (Babić et al., 2009).

Therefore, the importance of human resources has increased significantly due to new places and the role of men in all sectors of society. It is a rational, human being, which runs all the activities, and whose results depend on the knowledge, abilities, skills, motivation, trust, decentralization and distribution of information and knowledge, education, clear roles and responsibilities, freedom of action, feedback and resources necessary for action.

One solution is to transform an organization using “lean.” Lean is not a new concept. According to James Womack and Daniel Jones, (1991) authors of Lean Solutions .Therefore, given the growth of lean thinking among service based organisations across a range of industries and sectors around the world there is a need to examine its

impact on such areas such as HRM as the effective management of human resources and employee outcomes in employing organisations that have adopted such innovations (Stanton et al., 2013).
Body

The integration of supply chains has been described by Clancy (1998) as: attempting to elevate the linkages within each component of the chain, (to facilitate) better decision making [and] to get all the pieces of the chain to interact in a more efficient way [and thus] . . . create supply chain visibility [and] identify bottlenecks. (Clancy, cited in Putzger, 1998,).

Supply chain integration is an integration of core processes across organizational boundaries through improved communication, partnerships, alliances and cooperation. It also includes the application of new technologies to improve information flows and coordinate the flow of physical goods between trading partners (Power, 2005).

The basis of integration can therefore be characterized by cooperation, collaboration, information sharing, trust, partnerships, shared technology, and a fundamental shift away from managing individual functional processes, to managing integrated chains of processes (Akkermans et al., 1999).

It is also apparent that for organizations to develop competence in the management and integration of supply chains, logistics and supply chain management need to be given a higher level of strategic importance (Meade, 1998; Natarajan, 1999; Philip and Pedersen, 1997). Much of the evidence, however, indicates that this is not a common phenomenon. Natarajan states that this is due to three major factors:
(1) Lack of a logistics strategy;
(2) Lack of alignment between logistics strategy, overall business strategy and supply chain strategy; and
(3) Lack of integration with other functional area strategies and proper deployment of the logistics strategy.

But integrating and managing all process links throughout the entire supply chain is likely not appropriate. Since the drivers for integration are different from process link to process link, the levels of integration should vary from link to link, and over time (Lambert and Cooper, 2000). Therefore, Womack (2002) explain that institutionalizing lean principles requires a transformation in corporate culture, practices, processes and management. Many other corporate internal functions have been adopting lean principles beyond the core of manufacturing, including product development and supply chain management and, more recently, accounting. But in many companies, HR remains untouched and unchanged by their company's commitment to lean. And for those who have engaged HR, it often does not contribute as deeply as its potential (Tracey and Flinchbaugh 2006). HR is strategically placed to lead in these areas.

So, whether the process for integration is vertical or virtual, the requirement for integration of supply chains is inherently strategic, and a potential source of competitive advantage for multiple trading partners (Power, 2005). More and more the workforce is being seen as the Human Capital. The human impact of strategic decisions, need to be evaluated. The boardroom is looking for an expert who can support them in creating high performing highly engaged workforces who support the strategic direction of an organization and are looking to the Human Resources (Cultural chemistry, 2012)

. (RippleTraining, 2009). So, they add that The Lean philosophy has changed our attitude and ways of doing things. Employees are much so, more involved in day-to-day activities and as teams they take pride in what they do… Solve their own problem, improved employee relationships, high morale and effective participation

1-The lean perspective:

Every Lean organization needs a broad, continuous, intelligent and self-reinforcing human resource. They are the initiative of the processes, they are the initiative of the business, they see the prospects and the challenges of the future, they are the hands of continuous improvement, they are the eyes of true quality and they are the true face of lean. (Onuh et al., 2010)

What is Lean? ” Lean” is a practice that believes that the use of resources for any goal other than the creation of value for the end customer is wasteful and so should be eliminated(Cultural chemistry ,2012) .Lean has commonly been taken to involve techniques concerned with production, work organization, quality management, logistics, supply chain, customer satisfaction, efficient delivery and continuous improvement methods. In other words, the adoption of lean production implies integration in the use of human resource management (HRM) practices. (Gelade et al., 2010)

Lean is a methodology focusing on what is creating value for the clients or customers, on how operations can run smoothly with the identification of bottlenecks and operations with little value and creating a culture for continuous improvement. Lean implies a bottom-up approach; it requires empowerment and involvement of all employees and a new type of leadership (Norway et al., 2012). And Womack and Jones (1991) define lean as a way to do more with less— less human effort, less equipment, less time and less space—while coming closer to providing customers with exactly what they want.

And according toOnuh et al.,(2010), “Lean” is ‘doing good with less resources’ to others, “Lean” not what organisation need to do, but what organisations should become by effective system design and implementation . Simply put ‘It is not just an act, an action or a reaction but a process’. Gelade et al., (2010) say one thing is for sure there is a consensus that “Lean” is a very efficient and effective management system. Keeping it simple, lean is using less of just anything in order to produce more.

2. Lean culture from HR perspective:

The overall objective of Lean is to create a culture for continuous improvement based on strong involvement of all employees involved. The core idea of Lean is to maximize customer value while minimizing waste. Thus, lean means creating more value for customers with fewer resources, and has a strong focus on the processes for creating the results and the need to be systematic and to measure and report on results of improvement. (Norway et al., 2012).

Organizations who have implemented a Lean culture have encountered business processes aligned to strategy, increased employee engagement and reduced rework and red tape. Working from the perspective of the customer who consumes a product or service, "value" is defined as any action or process that a customer is willing to pay for. By eliminating the waste out of the process, you can do more with less. (Cultural chemistry, 2012)

And they show that awarding people with money for great performance is not effective, but how three other factors can create an engaged workforce. Those factors are autonomy, mastery and purpose.

1-Autonomy is the desire to be self-directed. The Lean culture encourage employees to come up with improvements, make decisions in their own pre-approved areas, without the need of approvals to move forward. When looking Human Resources we see that dependency is a common way of managing HR processes. Managers need many approvals from Human Resources to manage their people. Oftentimes this step is implemented to monitor risk, and assure equal treatment of all employees. Because managers do not understand the role of HR in those decisions, they might move forward without the approval of Human Resources, causing the creation of another processes that eliminates this risk.

In a lean environment, teams need a great deal of autonomy to manage and improve their process, but this is not done in a vacuum.
Teams are still part of the larger organization around them. Providing more autonomy than necessary or prudent can be a big mistake, for with this new authority comes new responsibility—the responsibility to function as a productive team together, and with other teams.
Focusing on the expected behaviors of working with a team can be an effective target of incentives. It has been suggested that "a most significant development in commitment theory has been the recognition that commitment can be directed to targets other than an organization" (Giancola, 2006), where in this case, the team function is the target.

2-Mastery is the urge of getting better at something. In the lean manufacturing you can see that an employee that is being the expert of his piece of the production line and is recognized for his specialize knowledge will try to get better in it, every time. The expert will connect with higher level experts to learn how to become better, oftentimes even when not at work.

3- The last factor is purpose, more and more companies do realize that when the money part of the business is not aligned with the purpose of the business the company will lose at many areas. During an implementation of Lean it is often times implemented with the major focus on eliminating waste. This creates the feel that it is all about the money. When employees go through the process; they realize that the purpose is focusing on what the customer wants. And by that they learn that improving the process, being engaged in the process will create opportunities for them.

3. The lean transformation from the HR point of view :

And Traditionally Human Resource professionals have been managing the organizations workforce rules and regulations. Policies and procedure focus first on preventing increased labor r elated legal and insurance costs (Cultural chemistry ,2012). Human is the greatest asset to a company (NAP),2012. It is important to nurture and develop human which in this case are employees in order to optimize their potential values.

The role Human Resource should play in the Purpose part of the organization, they often times are left out of the decision process. They have to explain decisions and not surprisingly, the persons who were closely involved in the decision process are telling a different story. Needless to say this creates a very weak link between the purpose of the organization and the money, decreasing employee engagement rapidly.

The worker plays a central role. People are viewed as a resource to be developed Trist (1981) and so workers are actually well trained as this is considered a critical element since only knowledgeable workers are able to meet the needs of flexibility and multifunctionality in a 'Lean production system'. So, Human beings are very important in the labor process (Cheng,. and Podolsky 1993) and (Hogg ,1993)

As the ultimate secret to obtain high performance is "people", new ways of managing people and of organizing and supervising them, as well as new ways of obtaining high levels of efficiency and effectiveness (performance) from people should be looked at. Most organisations want their employees to be involved, but employee engagement can range from a simple suggestion system to self-directed work teams. The essential problem is how to structure the involvement process (RippleTraining,2009).

So Lean includes a self managed work team which deals with althea essential aspect on a product such as design, supply chain, manufacturing, quality assurance, customer relations and continuous improvement rather than reporting up a chain of command and waiting for some sort of bureaucratic directives which in itself is wasteful in terms of time and other unseen cost. (Onuhet al.,,2010). And More important, those resources provide effective training in lean's key transformational elements: work cells, kanban, quick changeover, one-piece flow, multi-skilling/job rotation, standard work, down-sized equipment and containers, point-of-use location of feeder equipment and materials, and quality at the source; also, commonly associated with the lean core, 5S and total productive maintenance(Schonberger, 2009) therefore ,It may be appropriate for HR, and its training function, to help guide the firm toward a rational, light-handed approach to managing performance of the lean initiative: infrequent high-level audits of lean's overall progress; continuing, intensive, low-level execution. All the training can be used as a gauge to measure the employee morale indicator. Usually, highly motivated are people who enjoy their work as they know their job.

This will show in the quality of their work, the discipline even the health condition of the employee. Training targets should also involve not only low level staff but also for top management. Jaffar et al.,2012

3.1. Training Target : Lean's Customer-Centered Competitive Benefits:

As with any management initiative, lean must start with training. What is it? What does it do? How does it work? Best answers in terms of what lean does — for the customer: Lean is a set of mostly simple, low-cost practices that deliver quicker, more flexible response to customer demand. Speedier response, in turn, provides early exposure of process defects and likely causes, leading to higher quality service to customers along the value chain. Schonberger,2009 .By default, HR's training function should take on that job. Otherwise lean is likely to remain stuck in a regressive rut. And according to Flinchbaugh and Carlino (2006) Presenting lean in that customer-focused way paves the way to more effective external collaborations in distribution pipelines. HR can, in addition, help redress four issues that impact lean operationally:
1) a trend away from employee engagement in data-based continuous problem-solving;
2) insufficient job rotation to maintain skills in a cross-trained work force;
3) over-control of lean, with stifling effects on its inherent capacity for self-management; and
4) in performance management, failure to capture the full benefits of team-based peer pressure, especially in lean's ideal organizational form, the work cell .

Although it is desirable to model the behavior of a supply chain in order to make informed planning decisions, the issue of dynamic competitive environments makes this an activity that is at best difficult, and at worst perilous(Power ,2005).

3.2.Training Target : Lean-Proficient Employees:

The Human Resources professional doesn't have to spend their time on being a hawk on everything a manager does with its workforce, the manager understand when it is time to call in the experts, and when they can move forward on their own(Cultural chemistry ,2012). Therefore Norway et al.,(2012) mention they will have to play an active role in this improvement process, both in order to be as efficient as possible regarding its own services and in order to support the process in the organization as a whole. And Cultural chemistry (2012) adds when Human Resource professionals explain briefly in easy to understand language to managers the monetary risks, litigation and labor laws, those managers understand why certain processes are in place.
In additions a lean organization, with clear delegation and open communication. Lean is a bottom-approach: this means that those doing the practical work have to be involved in the improvement process and that ideas and actions has to be the ownership of those involved and will have to implement the actions(Norway et al.,2012).

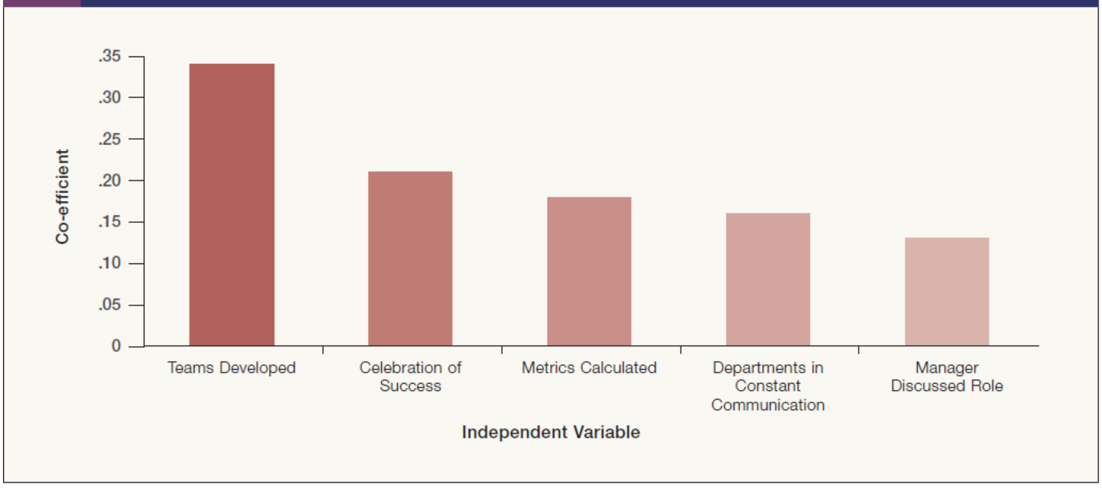
By engaging the direct involved employees in the process improvement discussion and encourage them to come forward with improvements, they automatically feel accountable for making sure that the new process that they have co-developed will work. In other words, when you engage the people, you can eliminate waste out of the process and increase the quality and quantity of that same process(Cultural chemistry ,2012).

Flinchbaugh et al.,(2006)state the following :

1.How responses related to lean implementation. The strongest predictors, in order of significance for employees as mentioned in figure one , were:

- Teams were or will be developed to implement lean
- Success related to the implementation of lean has been or will be celebrated by the organization.
- Departments within the employees' organization stay in constant communication about the implementation and outcomes of lean.
- Metrics are calculated to determine lean implementation success.
- Throughout the implementation of lean, managers talked to the employee about the employee's role in implementing lean.

FIGURE 1 Employee's Perception of Successful Lean Implementation

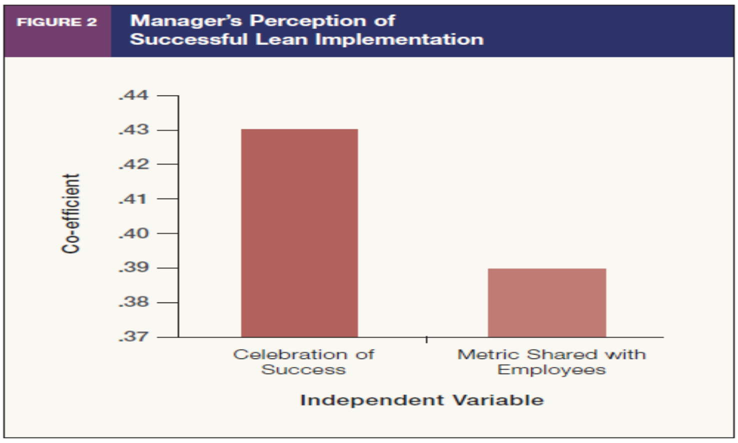


So the employee needs are identified as owning authority empowerment in doing continuous improvement activities, continuous performance target review, objectives of individuals and teams are negotiated, appraised fairly and rewarded with sufficient incentives and financial packages .(Jaffar et al.,2012)

2.The significant predictors of successful lean implementation for managers as mentioned in figure two were:

- Success related to the implementation of lean has been or will be celebrated by the organization.

➢ Metrics are shared with employees. These results suggest that the communication of the measurement to employees and success of lean implementation significantly accounted for managers' perception of a successful lean implementation.



3.Havingsupporting structure team in a lean environment :

A. Formal lean office, often called a Lean Promotion Office, although promotion is hardly the limits of its focus. In a manufacturing environment, these groups are often filled with people who understand lean, whether they came from the management ranks, from process engineering or from the shop floor.

B. Working closely with the HRM , when the organization working on the first step of lean which is the lean steering committee " when employee engagement is a predetermined specific outcome desired by the objective within the organization" . Because the committee often has a diverse representation vertically but is narrowly focused on operations horizontally.

C. And the direct leadership model. This usually involves one person, either the line manager, the CEO or the plant manager. If this person is leading lean, he or she likely has a clear vision of what lean means to him or her. That vision is based on how the organization would work and perform.

D. Each group has a coordinator and a work program, which is updated continuously, setting targets, clarifying responsibilities and resources. The group meets quite regular for sharing of experiences and setting priorities. Group leaders have a joint meeting with head of division every week and should ensure communication between the group and the head of unit (Flinchbaugh et al., ,2006).

E. The whole unit still has a joint meeting about every month. These meetings should focus more on major issues for discussion and exchange of experiences across the groups. Experiences so far are quite promising, even if it takes time to develop a new structure and new routines. Hopefully this new structure should lead to more continuous development of work processes, competence development and thus better use of available resources unit (Flinchbaugh et al., ,2006).

Therefore, Human resources managers' fortransformat the lean they should have a seat in the boardroom, but because of their lack of understanding of business drivers not a voice at the table. By developing a lean culture and in aligning the business acumen and an understanding of their important role toward the top managerial level .

3.3.Training Target : Lean Performance Management :

Lean's essence is simplicity. It thrives on training but is deadened by control; these are performance- management issues, which we consider first at a strategic level, and then with reference to employee- and team level performance. As strategy, lean needs to be audited annually, but not monitored monthly. Industry has been through all this with quality initiatives (Schonberger, 2009).A promising way to melt that opposition is for lean to be presented in terms of its benefits to the customer: flexibly quick response with better quality. Schonberger, 2009 .

The main requisites are understanding and knowledge, it is for everyone and the difference will be the level of the knowledge and skills given are based on the capabilities of each employee.

Besides training, in managing people, is also very important . In this study, the effectiveness of top-down and bottom-up communication is achieved by always keeping in touch with its people through transmitting information to its people either through regular two way meetings, briefings and others(Jaffar et al.,2012).Deming (2000) focused on an organizational system that promotes cooperation and learning for facilitating process management, resulting in the constant improvement of processes, products and services, as well as employee fulfillment and customer satisfaction. By not providing managers with the knowledge they need to understand the human resource process, they are not able to become experts in managing people as they always miss a certain pieceofinformation. Human Resource professionals are traditionally tasked to enforce standards, without understanding how this standard or procedure relates to the bigger picture of the organization(Cultural chemistry ,2012)

This system, then, becomes critical to the survival of organizations (Anderson et al., 1994). Juran (1993) emphasized not only team and project work, participation and recognition, but also highlighted the need to achieve the best return on investment. According to him, the primary responsibility of management is to minimize the total cost of quality and to decide when quality management efforts should be stopped. Deming (2000) also argued that the improvement of the work process reduces cost because of less re-work, fewer mistakes or delays and less waste in manpower and materials, but (in contrast to Juran) prescribed constant improvements.

3.4.Training Target : External Lean — in Outsourcing and Logistics:

Best lean practices are every bit as beneficial in developing economies as in industrialized countries. Yet as massive offshoring to low-wage countries takes place, those best practices
Usually do not get transferred. And Onuh et al.,(2010) inquire ,Is there any hope? Obviously yes. This is because humans are the key to a sustainable lean practice. To make a supposed lean system truly lean, the Structure and Character of the

Organization, Employee Involvement, Managing Employee Commitment and Work practices in the Organization are Proceedings of main management and human aspects that must be focused on.

External consultants have supported the HR Division to understand Lean, to analyze the present situation and to develop some improvement actions as a Starting point:
Who are the users of the services of HR, what are the key issues at present and how to improve? Who are the customers of HR? Obviously the main customers of the HR unit are the top management, the middle management and in principle all employees of the organization. It might also be external customers; potential future employees and users of statistics,(Norway et al.,and 2012)

4.The role of the HR unit in implementing Lean in the organization

Lean's keep-it-simple mandate may suggest omitting the performance from the burden of external performance appraisal, considering it to be non-value-adding, possibly destructive. Instead, monitor the performance as a whole on primary results: quicker, more flexible response with higher quality—and ability to develop good ideas and get them implemented. Schonberger, 2009 . Thus Supporters of lean operating systems maintain that the implementation of lean is more efficient based upon the commitment of people to continuously improve productivity and quality (Carroll 2001).While lean is most often communicated as a set of tools, it is most effectively practiced as a comprehensive operating system including principles or culture, systems and processes, tools and skills, and even evaluation and metrics (Flinchbaugh and Carlino 2006).

• Communication in a lean environment must be vertical, horizontal and two-way. It is not enough for a lean leader to be excellent communicating the vision and direction to the masses of the organization. The lean leader also must convey information about the changes going on at the top. Lean changes the work and the way people think, so employees need to see that the organization's top-ranking individuals are changing the way they think before the remainder of the employees will do the same. In addition, employees needed to be trained in communication and discussion techniques; otherwise they do not understand how to ask questions and how to elicit feedback. Flinchbaugh et al., ,2006

2. Celebrating and raising awareness of the remaining performance gap is a tough balancing act. The organizations should find ways to celebrate success along the journey are more successful at lean. And clearly define milestones, communicate progress toward the milestones and celebrate successes along the journey.(Flinchbaugh et al., ,2006).

3. Providing health, safety, morale and spiritual needs of employees-physical and recreational facilities and other activities such as counseling, self-improvement programs etc. in order to produce employees that are motivated as well as be innovative, creative and perform improvements. Jaffar et al.,2012

4.The organizational structure should be such that the middle managers become more participatory and involved rather than being just enforcers. By being more participatory and involved, they enable the workers by actually putting them through and being there directly Orin-directly for them. They become real mentors that can be looked upon by their decisions and actions towards achieving a lean environment which is waste free. (Onuh et al.,,2010)

5. The Challenges of HR professionals towards developing lean environment :

A major challenge for all organizations is to improve efficiency and to ensure continuous improvement ,maintaining a high level of service for the local customer, while maintaining corporate strategies, standards of excellence, and demonstrable progress towards business objectives (Szary,2012) and power (2005) adds developing more effective and integrated networks is to encourage such a mindset, and use it to promote adoption and implementation of enabling technologies and methods.

Lambert and Cooper (2000), the key to these relationships is the level of management and integration required, with highly strategic inputs requiring the highest levels of management and integration by the focal company. They also make a valid point about the importance of monitoring the relationships suppliers and customers have with competitors ("non-member

5.1.Development of Teams as a Supporting Structure:

Teams are an important element of a lean organization. Development of effective teams extends deep inside and outside of lean transformations. Within lean, teams are important because the whole process must work together to build value for the customer, and if teams cannot work together then the process cannot work for the customer. How teams work is more important than their mere existence (Flinchbaugh et al., ,2006).

5.2. Payment:

The way an organization pays employees can be the first dagger in the cooperation expected in a lean environment. Regardless of the magnitude of the incentives, if they focus on individual behavior or performance, the resulting behaviors will not support a unified team approach (Flinchbaugh et al.,2006). And Zingheim and Schuster (2005) state: "Championing must be continuous, not just at the start of the incentive plan. Incentives are the responsibility of the manager from top to bottom—helping to set goals, coaching employees on how to reach the goals, problem solving with employees, removing barriers to performance, communicating, and helping ensure everyone knows what is required of them. The reason for the incentive is improved results, and the incentive plan serves as a communications vehicle to accomplish this." Incentives require communication and act as a means for communication simultaneously.

It requires creative compensation schemes that reflect the operational changes being adopted by the organization while still providing needed incentives. Performance management will need to be modified to include behaviors as well as accomplishments (Frampton, 2009). Quality of involvement, behavior change and direct performance improvements must be taken into account with role expectations and incentives. However, it is important not to overemphasize the size of contribution, which can lead to frustration, as some individuals are in a position for a greater contribution than others.

5.3. Mistrust and misunderstanding of the incentives and motivations of groups who require cross-boundary collaboration run rampant in many organizations. When a lean transformation begins to take root, cross-boundary collaboration and communication are an absolute must(Flinchbaugh et al., ,2006). Thus , Ballou et al. (2000)define trust in this context as a general expectancy held by a channel member that the word of the other can be relied upon. That is, one party has confidence in an exchange partner's reliability and integrity. They also state that trust can lead directly to cooperation, or indirectly through the development of commitment. They also cite research indicating a high degree of correlation between commitment, trust and cooperation in intercompany relationships (Morgan, R.M. and Hunt, S.D. cited in Ballou et al., 2000, p. 16).

In identifying the importance of trust and commitment for the development of cooperative partnerships .However, Ballou et al. (2000,) also identify the challenge that this reveals: Since cooperation is usually among members that either have different reward systems or are legally separate, members need to realize benefits from cooperation. The most challenging situation occurs when the benefits "pool" with some members at the detriment of others. Balancing these benefits so that all members are better off for their cooperation is the new challenge for supply chain managers.

5.4. Acknowledgement and Celebrations of Successes

Most corporate initiatives have a distinct beginning and a clear, objective outcome, but lean is a never ending journey. If objectives remain clear, employees feel a sense of accomplishment and, if appropriate, the accompanying reward. However, because lean is
An endless journey, employees are unsure when to celebrate accomplishment. Recognizing success in lean first requires that it be understood as a journey. Without implying that ultimate lean has been achieved, leadership must balance recognition of the success achieved with maintaining the tension for future progress. If tension is sustained without recognizing progress, organization wide burnout will follow. Managers should understand that what they choose to recognize as success, and how they choose to recognize it, can either reinforce human progress or retard it (Flinchbaugh et al., ,2006)..

5.5 HR Professional:

For HR executives, managers, professionals or consultants, an organization's move to and through the lean process presents many challenges. How does this professional engage? What levers should HR pull? As a first step, the HR professional should know how the decision-making process for a lean initiative is typically established. There are several options that most companies fall into either because of suitability or popularity(Norway et al.,2012) the immediate chance to add value is to use HR skills, including recruitment and selection, performance assessment, team building, communication processes and training, to assist the group structure itself, grow beyond its initial boundaries and ultimately succeed at a greater rate.

6. Benefits

On the operational front, training can help deal with issues directly affecting work-force capabilities and achievements. The first issue: Over time, front-line engagement in problem-solving has declined, with companies relying excessively on occasional improvement projects dominated by professional staff (Schonberger,2009).

I. Policy optimization:
I. Develop best operating rules, with executives, marketing, and operations on the same lean team, serious collaboration with suppliers and customers to deal with massive channel inventories and long lead times may finally proceed (Schonberger 2009).
II. Encouraging the involvement of staff in decision making, and welcomes input from suppliers to identify areas for potential productivity improvements(Gourley,1998).
III. Understanding the implementation requirements and strategies for getting started(Ripple Training 2009).
IV. Standard and Davis (1999) ,Implementing strategies to increase productivity, quality and performance from personnel and assuring their job satisfaction Organizations implementing lean experienced a 63- percent reduction in customer lead-time, a 61-percent increase in market share, a 24-percent increase in product diversity and a 39-percent time reduction to launch new products

V. Provide staff policy guidelines and strategies(Norway et al.,2012).
VI. adjusting policies to address the lean work place, HR is enabling greater efficiency and adding value throughout the organization,(Frampton, 2009)
VII. Szary,2012 adds ,by rationalizing staffing supply chain , create a proactive, efficient hiring strategy that will dramatically reduce time-to-fill and vacancy rates, improve quality and customer satisfaction, and reduce cost and waste.
Conclusion

The problem that the logistics professional faces is that managing companywide HR policies to effect coordinated change is often outside his or her management scope. This removes the greatest point of leverage in accomplishing cross-functional integration for those who have such responsibility without commensurate authority. Moreover, it is extremely difficult to tailor coordinated HR policies that span functional departments; many logistics professionals lack knowledge and experience in this complex area (Babić et al., 2009).

The lean organization requires leadership and direction from the human resources function in order to provide the most value. The bottom line is this: Every organization wants and needs to lower costs. Removing waste and inefficiencies within Human Resources and adjusting HR policies to help optimize the lean workplace will result in less time spent by employees on each process, and, thereby, lowering costs(Frampton, 2009).

Therefore Effective supply chain management requires simultaneous improvements in both customer service levels and the internal operating efficiencies of the companies in the supply chain (Babić et al.,2009). And an emergency interrelated between the lean environment and the integration process , is not an easy task . So Organizations and its HR professionals that aim to become part of an extended, integrated supply network

Thus The importance of human resources has also increased significantly due to new places and the role of men in all sectors of society. It is a rational, human being, which runs all the activities, and whose results depend on the knowledge, abilities, skills, and motivation in the activity of each enterprise and the necessity of creating the structure of enterprises and caring for organizational culture in line with available human resources of the structure of integrated supply chain networks (Babić et al.,2009).

This illustrates the point that the HR should have a role to play in organisational development in general, including for instance

- change of working methods,
- change in management style and
- Change in organisational culture and according Cultural chemistry ,(2012).

HR is able to change to a Lean Culture, they are able to deliver services that their customers (the workforce and the board room) are asking for. Time will become available to focus on coaching managers and employees and to create a strong connection between business drivers and Human Capital strategy. This will create high engagement at the HR Level

So,HR has a place in the decision-making process, many of the issues and challenges discussed in this paper can get increasingly serious attention. The lean transformation by may be a powerful means to improve businesses, Process Optimization, and Continuous Improvement to your staffing function which will lead to success as organizations transformed their workplace into a lean organization.

However, it was found out that the number of years of company establishment do not affect the openness of the company to adapt new initiatives that can help to improve the effectiveness of the operations. It was also found out the importance of training ,communication with employees and rewards of priority in order to have productive employees that are willing to grow together with a company Jaffar et al.,2012

According to Flinchbaugh et al.,(2006) state that success with lean depends upon how HR changes and adapts its approaches along with the rest of the organization. HR can play a guiding role in lean or be an excuse factor for those pushing the change in creating teams in a lean environment need the following.

1- They need a common language, common principles and common tools.

2- They need a common drive provided by vision, metrics and goals. And according to Cultural chemistry (2012) ,The characteristics of an HR Business Partners is that they know when to uphold the standards and when to treat standards as guidelines while coach in their line managers on how to create an high performing team, while staying compliant.

3- They need to design the work around them visually so that there is high agreement about what work must be done and how it should be done.

4- Problems need to be exposed immediately so that they may be resolved.

When it comes to the link between communication and pay structures, two important variables must be considered. The first is clarity in communication about the impact and expectations regarding incentives and pay. Ambiguity in this matter quickly leads to confusion and a lack of alignment. The second issue is in regard to differences of incentives across the organizational boundaries and how it affects ambiguity. Flinchbaugh et al., ,2006

So how does an organization acknowledge success on a never ending journey? First, the organization must to recognize and communicate progress. Then it must decide how to reward such progress, if at all. Do not overemphasize financial incentives, although those that exist must be aligned to lean efforts (Flinchbaugh et al., 2006)

Finally, without implying that ultimate lean has been achieved, leadership must balance recognition of the success achieved with maintaining the tension for future progress. If tension is sustained without recognizing progress, organization wide burnout will follow.

2- Effective employees

I. Exploring the key requirements for successful employee involvement, Learning how to develop a meaningful employee involvement process in your own organisation, and discovering the organisational structures that support an effective employee involvement process (Ripple Training 2009).

II. Communication to Employees Regarding Their Role Part of management's communication for lean implementation includes clarity of each employee's roles and responsibilities. This communication, however, is a two-person process. Lack of employee commitment was one of the top barriers to implementing continuous improvement (Flinchbaugh et al.,2006).

III. Provide services and expertise in recruitment procedures ,Ensure the proper updating of a staff information system ,Ensure proper wage management (Norway et al.,2012)

3.Developing lean environment :

I. Understanding the Lean path and ways to instill the lean philosophy into people, (Ripple Training, 2009) .In a lean environment, process focus takes priority over functional focus. Successful lean processes have material or information flowing across functional boundaries, so naturally organizations that are successful in lean will also improve communications across functional boundaries in the manner most efficient and effective for the customer , Communication Across Boundaries Organizations that are successful in lean also successfully improve their communications, particularly across boundaries such as departments and functions (Flinchbaugh et al.,2006).
II. Training guide collaborative activities toward lean innovations to eliminate root causes of all that inventory, related demand distortions, and other ills (Flinchbaugh et al.,2006)
III. Understand needs for competence development and provide proper training(Norway et al.,2012)

4. According Flinchbaugh et al.,(2006):Calculation and Communication of Metrics

Metrics "keep score" and determine if progress is being made. In a lean environment, several criteria should be considered when developing metric systems or scoreboards. First, a scoreboard and its relevant metrics must be "owned" by those who own the process, whether it's a cell team on the floor, or an office team such as customer service. Therefore, metric must be easy to update by these process owners. Second, metrics must be as predictive as possible, with only a small fraction of the metrics looking backward. Because these metrics should support daily decision-making, predictive metrics offer much more useful decision support than those that are rearward facing. Third, management must support the metrics, deciding who will review the metrics, when they will do so, what they will look for, and how will they respond to the metrics with action. Fourth, and perhaps most importantly, the metrics must point in a steady and consistent direction toward the ideal state. It is important to understand that any time metrics connects to pay, behavior is influenced. With this in mind, the predictive measures used for empowered decision-making must be linked to those used for incentives. This is a metric design issue and an education of team's issue.

Recommendations

The involvement of an HR unit in lean and continuous improvement should have :
1. enough resources , the right competences to play an active role ,even if there is also a need for continuous improvement, also of the HR function
2. Requires openness, creativity and willingness to change among participants
3. Requires (as usual) good management and follow up
4. The introduction of lean/continuous improvement requires the heavy involvement of the HR unit together with other internal and external experts

Managers and employees, five significant predictors of successful lean implementation were identified:
1. The development of teams as a supporting structure of lean
2. The calculation and communication of metrics
3. Communication among organization members, particularly across organizational barriers
4. Managers explaining to the employees their role in lean implementation
5. The acknowledgement and celebration of successes toward lean implementation.
In addition, the authors discovered conditions to assist HR to support the organizational journey toward lean. Flinchbaugh et al., ,2006

Some of the issues that were identified as drivers of using Lean within the HR unit were:
• The need to improve efficiency of different operations
• The need to improve responsiveness in relation to the needs to the organization
• The need to improve internal and external communication
• The need to develop a more robust management of different tasks - less risk when people are absent(Norway et al.,2012).

(Babić et al.,2009).If logistics professionals are to be consistently effective, they must have:
• Integrative vision - the vision to craft integrative, cross-functional, and cross-company programs that enable product to flow rapidly and responsively through the company and the channel.
• Human resources ability - the ability to harness the power of HR policies to ensure that the programs are implemented effectively throughout the company
• Logistics professionals must learn to harness the power of human resources management to effect sweeping programs of change, not only in their own companies but in other companies in their supply and distribution channels as well (Babić et al.,2009)
• And they add that teams in a lean environment need the following. First, they need a common language, common principles and common tools. Second, they need a common drive provided by vision, metrics and goals. Third, they need to design the work around them visually so that there is high agreement about what work must be done and how it should be done. Problems need to be exposed immediately so that they may be resolved. No surprise so far, but fourth, and perhaps most important,

teams need the capability and the skills to manage themselves(Flinchbaugh et al., ,2006).

Finally ,Roles must change as an organization goes toward lean maturity, so the rate at which an organization reaches maturity partly depends on lean role clarity and integration throughout the journey. Maintaining role clarity as these roles dramatically change appears to be an important criterion of success(Flinchbaugh et al., ,2006)

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