

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 policies (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.

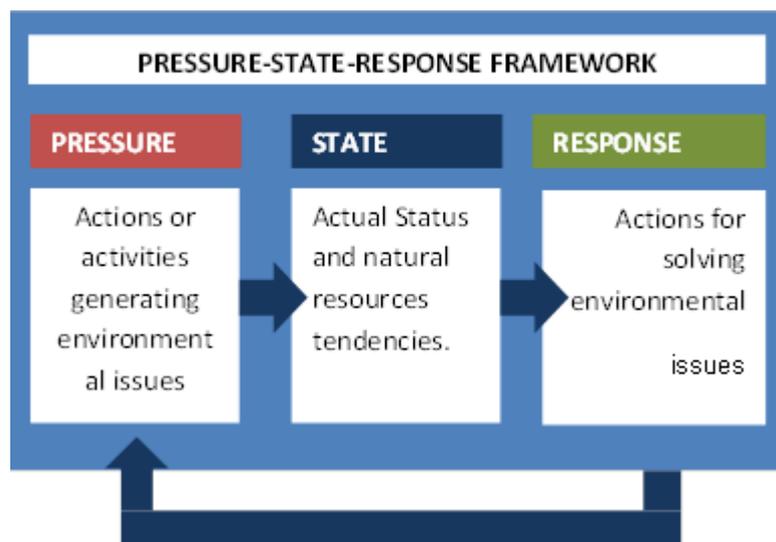


Figure 1: Pressure-State-Response Framework. (OCDE, 1993b)

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.

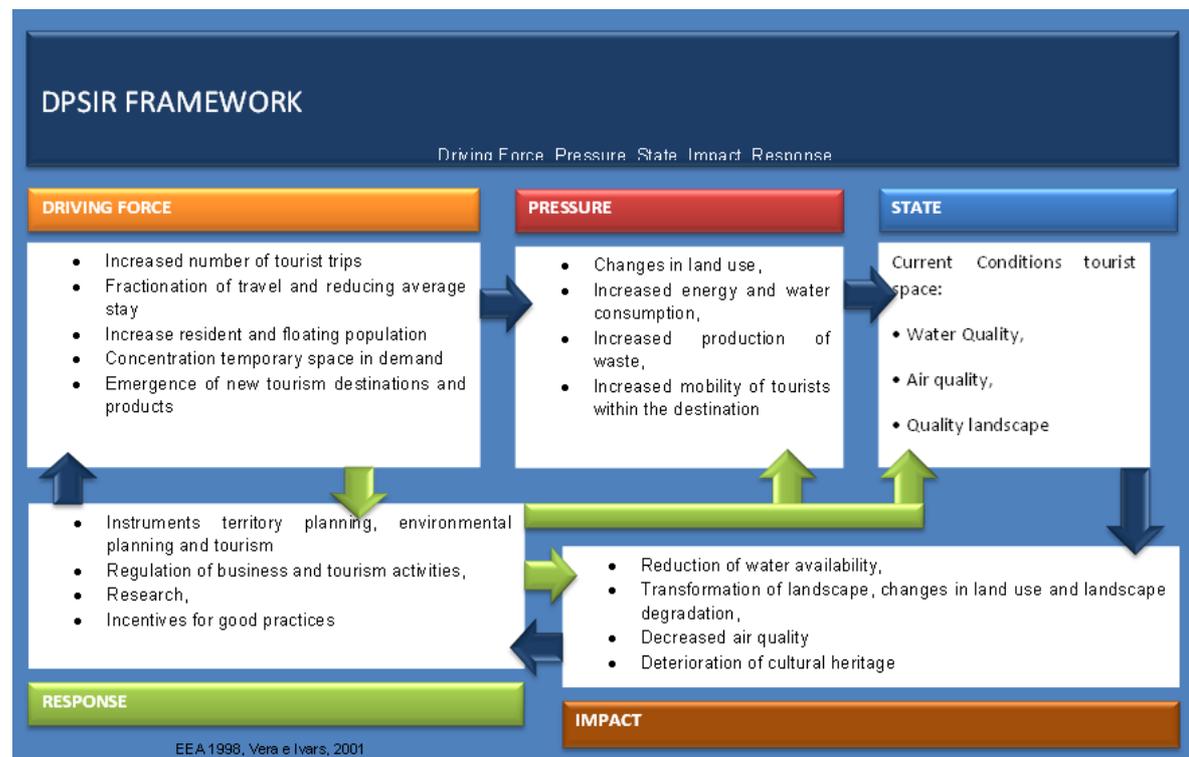


Figure 2: DPSIR Framework for sustainable development by Vera & Ivars (2001).

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 Alcalá 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.

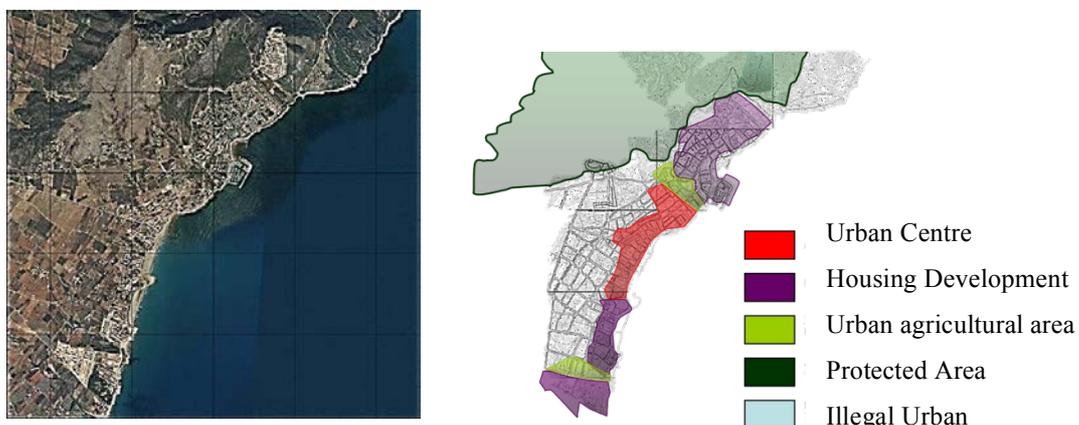


Figure 4: Alcossebre, Alcalá de Xivert municipality in Castellón, Spanish Mediterranean Coast. Territorial characterization...

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)

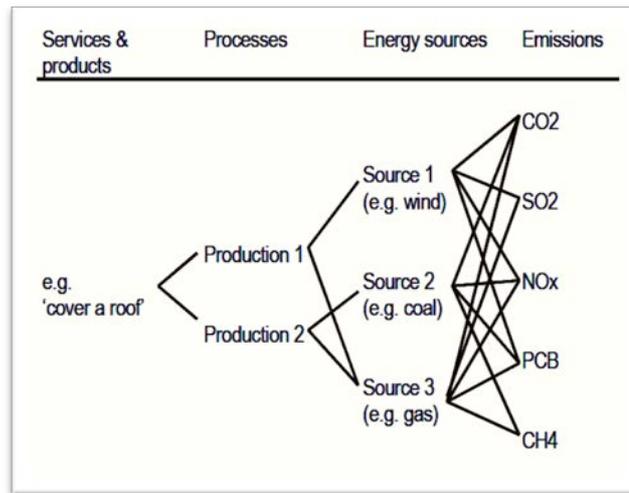


Figure 5: Part of the net of causal relations: the products consumed (for example roof tiles) to provide a service ('to cover a roof') cause multiple emissions, depending on the sources of the energy used in their production. (Wentzel, et al., 1997)

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)

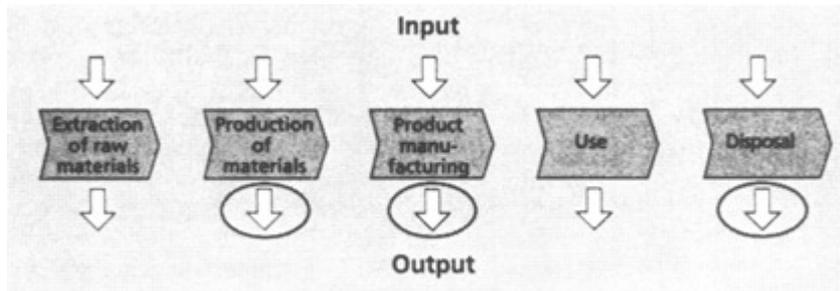


Figure 6: ‘Environmental focus in the industrialised world: Efforts have mainly been concentrated on emissions from material production, [from] product manufacturing and disposal.’ (Wentzel et al., 1997)

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).

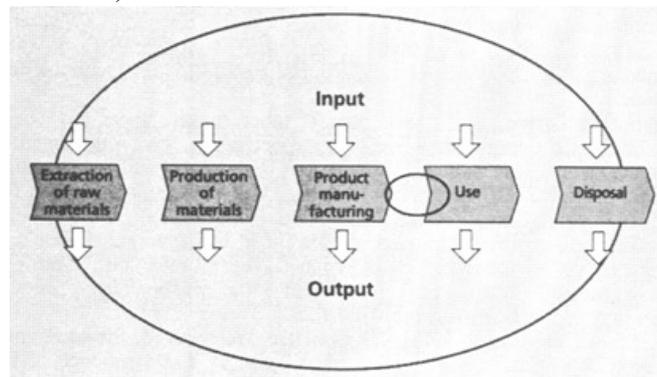


Figure 7: ‘Future environmental focus in the industrialised world’ (Wentzel et al., 1997)

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 (Cuchi, 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).

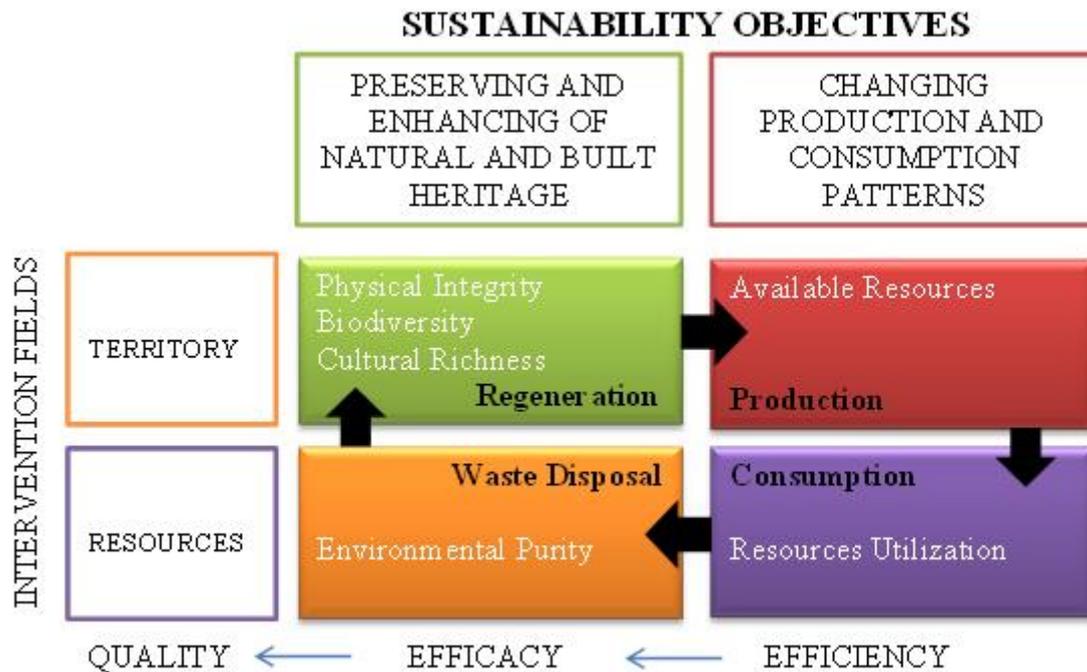


Figure 9: Technical Processes for closing open loops and the related sustainability objectives from UNWOT 2004.

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				
		MATERIAL FLOWS				
CHANGING PRODUCTION AND CONSUMPTION PATTERNS	INDICATORS		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.

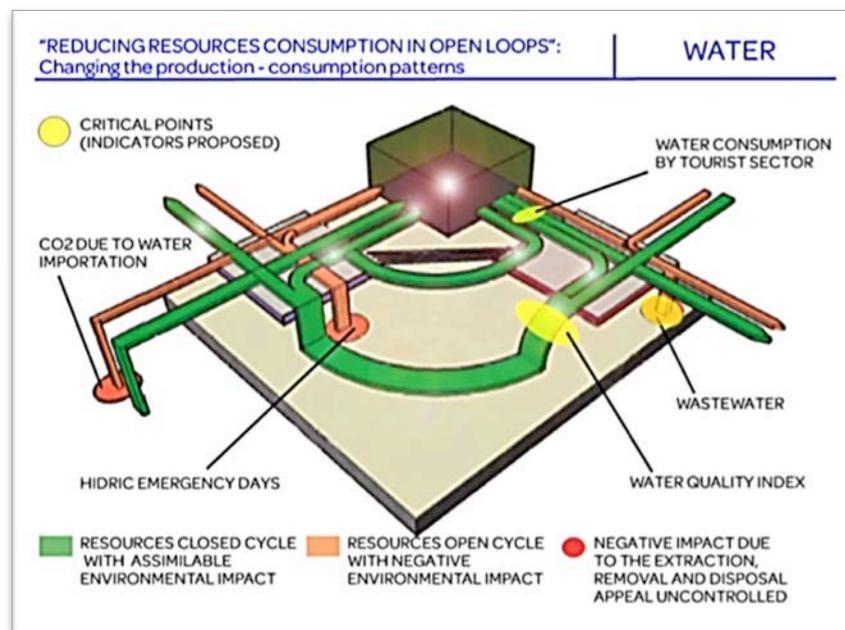


Figure 11: Model for Water Flows. By the author.

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.

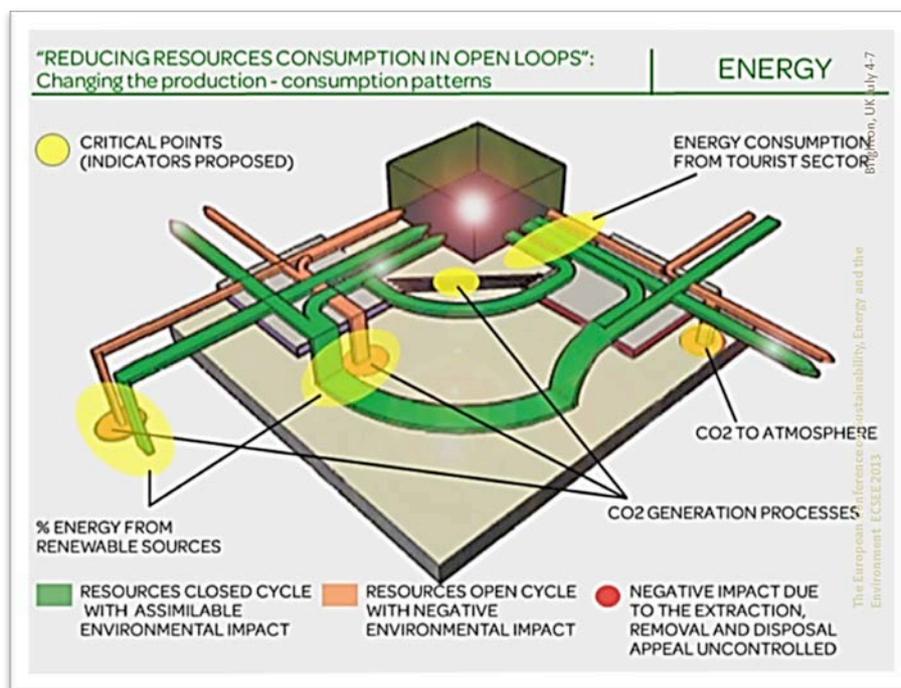


Figure 12: Model for the Energy Flows. By the author.

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.

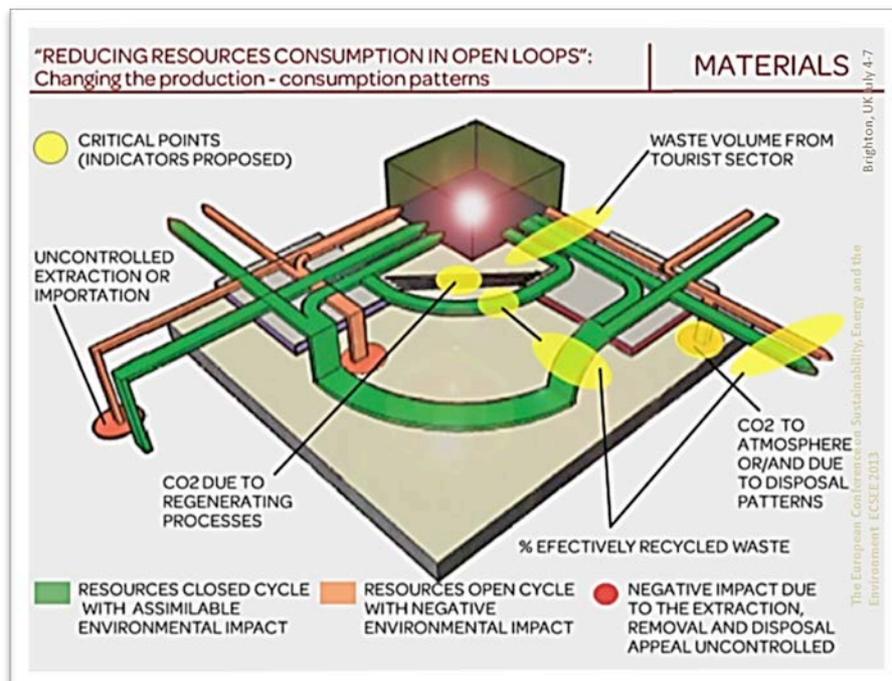


Figure 13: Material Flows Model. By the author.

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.

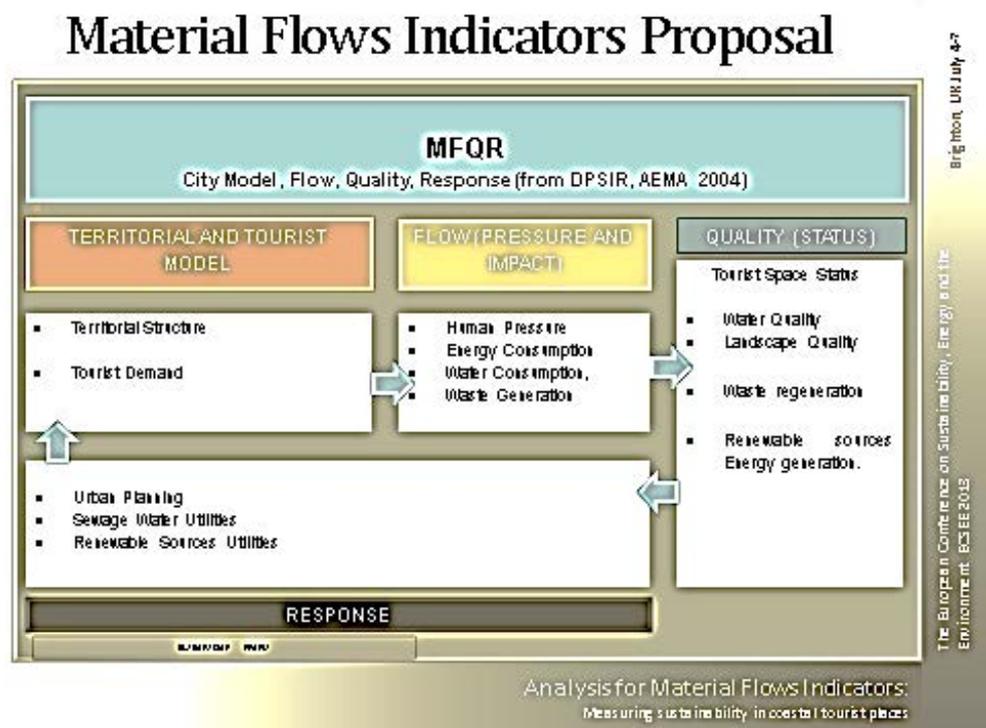


Figure 14: Conceptual Framework for the Proposal. By the author.

According to the previous analysis, a set of sustainability indicators for tourism can not be built with material flow indicators for measuring exclusively 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.

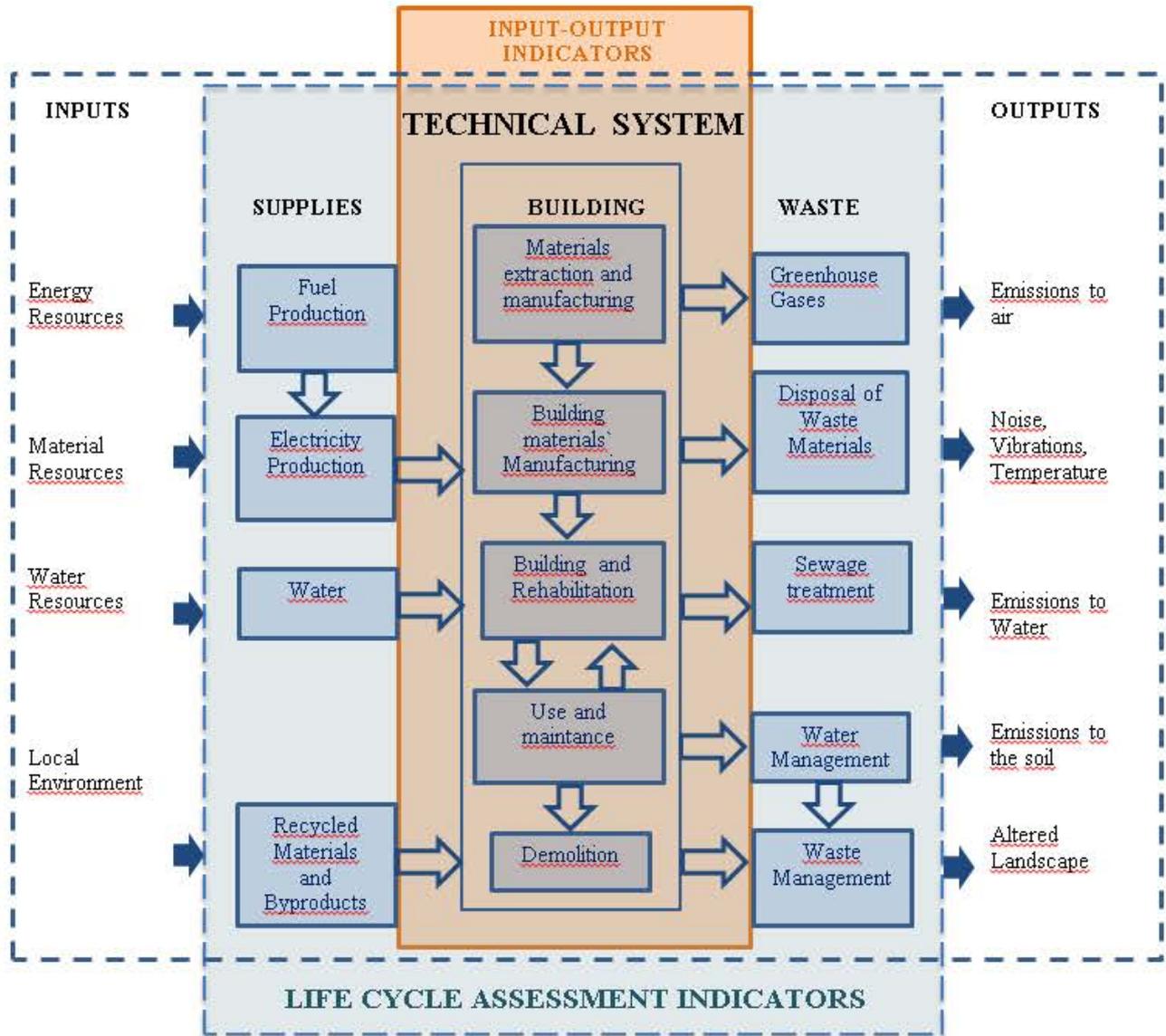


Figure 15: Conceptual System Principles for the Proposal: Input-Output Indicators with a Life Cycle Assessment perspective. The figure shows the system boundaries for the technical system and life-cycle of a building. Applications of environmental data and declarations for building materials (Dammann 2004)

5.1 Material Flows Indicators

RESOURCE:	Tourist Territorial MODEL:		DRIVING FORCE
WATER	Mixed City		Production & Consumption Patterns
INDICATOR AREA	PRESSURE	STATE-QUALITY-IMPACT	RESPONSE
WATER AVAILABILITY	<p>Total municipal population in thousands</p> <p>Sources of drinking water consumed (allochthonous resources, hypogea, etc..).</p>	<p>Water availability per capita in cubic meters per person per year.</p> <p>Hidric Emergency Days</p> <p>Natural water resources per capita.</p> <p>Surface contaminated aquifers.</p>	<p>Percentage of population with access to potable water</p>
	<p>Annual volume allocated for public supply in m3 per capita</p>	<p>Pressure level on water resources in percentage</p>	<p>Wastewater reuse percentage</p>
WATER MANAGEMENT	<p>Consumption of visitors and residents in m3 per capita per year</p> <p>Percentage of losses in the distribution network.</p>		
WATER QUALITY	<p>Population percentage of untreated</p>	<p>Quality urban water supply.</p>	<p>Water generated from Treated wastewater in</p>
	<p>Municipal wastewater discharges in m3 per second.</p>		<p>Number of wastewater treatment plants</p>

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 evolution 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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