NOVEMBER 6–7, 2020 | ONLINE FROM TOKYO, JAPAN

The Asian Conference on Sustainability, Energy & the Environment

ACSEE

Official Conference Proceedings

ISSN: 2186-2311

Organised by The International Academic Forum (IAFOR) in association with the IAFOR Research Centre at Osaka University and IAFOR's Global University Partners

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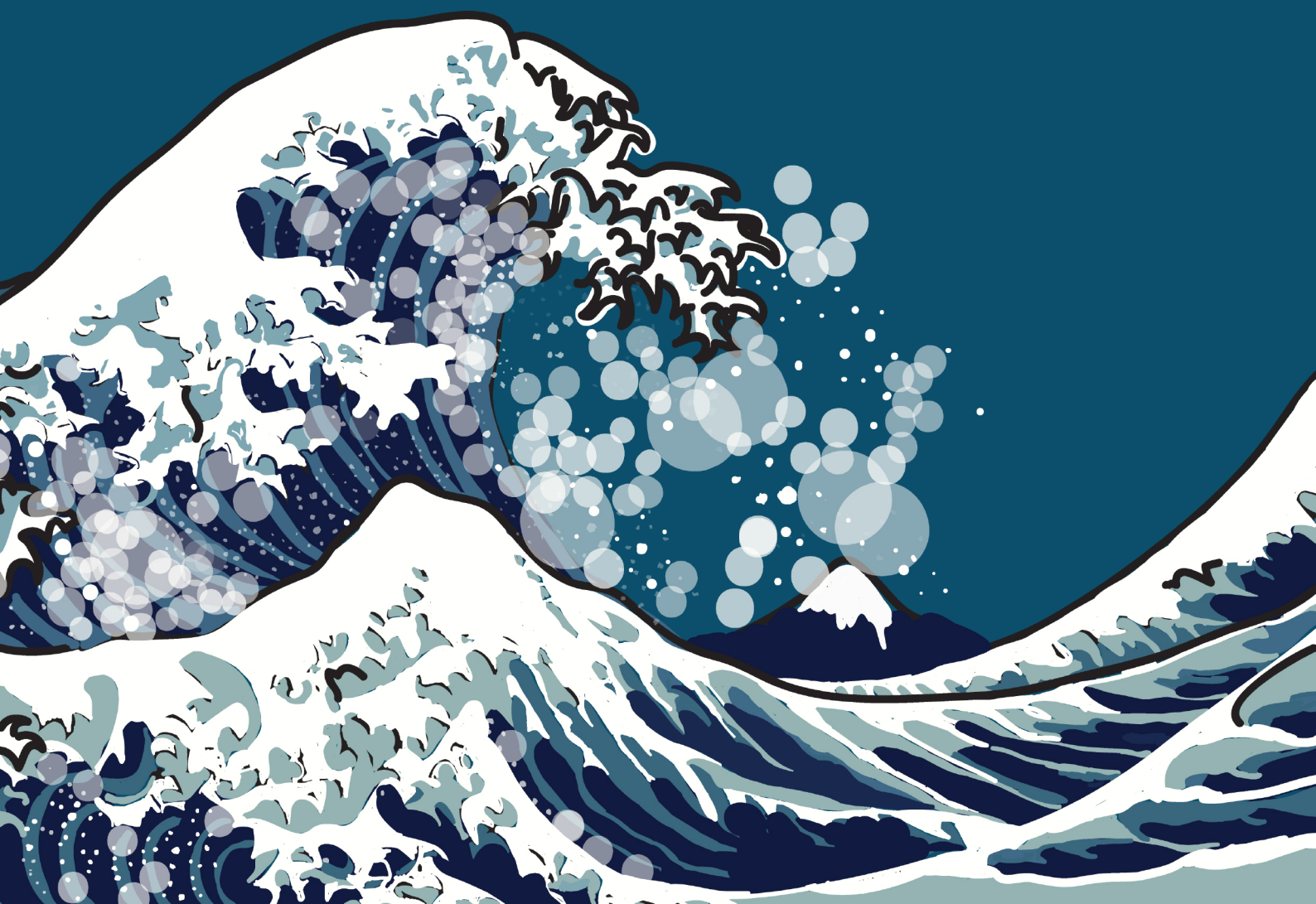

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The Asian Conference on Sustainability, Energy & the Environment 2020

Official Conference Proceedings

ISSN: 2186-2311

The International Academic Forum (IAFOR)
Sakae 1-16-26-201
Naka Ward, Nagoya, Aichi
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ww.iafor.org

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The Guidelines for Development of Agricultural Areas Based on Concepts from Participatory Ecological Agriculture to Solve Environmental Problems

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Abstract
The objectives of this project are to design and develop agricultural areas in accordance with the concept of participatory agriculture ecology to solve poverty and protect the environment by using the study of Landscape ecology and agriculture ecology concepts. In-depth interviews were used to explore the problems and impacts of agriculture affecting the economy Society and Environment of Wapi Pathum District Maha Sarakham Province. The key findings showed that the former agricultural area was all forest areas. The forest area was transformed into the agriculture area. This community has been doing agriculture for more than 50 years and the farmers have been using fertilizer and chemicals for a long time. This results in reduced agricultural production and environmental deterioration. Therefore, these solutions not only must add the concept of "New Theory Agriculture" to introduce to the farmers by focusing on growing a variety of plants for various uses, "Khok Nong Na Model" concept should be implemented to help enhance land and water management for agriculture activities throughout the year also. Moreover “Agroforestry” together with "Organic agriculture" will help rehabilitate the completely degraded forest area and the treatment of soil, water, and air with the ecological plants could potentially help reduce toxins in the environment also. Finally, the Principles of landscape agricultural guidelines will help to create beautiful agricultural areas, sustainable, suitable for learning resources and tourist attractions. Combining these concepts together contributes to a new type of agriculture to help and create a better quality environment.

Keywords: Landscape Ecology, Agricultural Ecology, New Theory Agriculture, Khok Nong Na Model

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Introduction

Agriculture is the top income-generating profession in Thailand. They are an important occupation because it is tied to the way of life of the community. Mahasarakham is one of the provinces where agriculture is the main occupation. However, there is a space limitation because most areas are flat and hilly that called “Khok”. The soil characteristics are sandy and loamy soils that absorb water badly, lack moisture. The area lacks consistent water resources. The seasonal rainfall fluctuations and frequent droughts affect the quantity of agricultural products. This can negatively impact local and regional household income levels (Ministry of Agriculture and Cooperatives). Agriculture in the past was to modify the natural area for growing crops and raising animals that are born into the farming system (Agro-Ecology Systems) (Surachet, 1997). The agricultural area inserted into the natural ecosystem was small. Farmers would remove weeds and small plants, but large trees would remain. Thus they produced hybrid crops such as fruits, herbs, and vegetables for the kitchen garden.

The farming did not have problems for the environment in the past because taking into account the ecosystem, and the dependence of living, and inanimate matter as a form of sustainable agriculture (Claudia Dinep and Kristin Schwab 2010). Presently, agricultural development has expanded considerably; encroaching upon the forest and altering the natural topography through the use of machines to plow waterways and marshes. Modern agriculture focuses on monoculture of economic crops for export such as rice, corn, cassava. The use of agricultural fertilizers and chemicals causes contamination in the soil, water, and air, negatively affecting the environment. King Rama IX saw these agricultural problems and established various royal initiatives to search for solutions. One such initiative was the establishment of a Research and Development Center Khao Hin Son, Chachoengsao Province. This Center aims to collect, study, experiment, and develop strategies to improve agricultural areas as they become agricultural learning centers. Secondly, the Center aims to create environmental & ecological strategies to develop water resources, reforestation, and land development. They are planning for growing crops and livestock in self-reliant ways by using the "New Theory Agriculture" concept. "New Theory Agriculture" uses community wisdom to be adapted for agriculture that focuses on producing enough to eat; farmers build a sustainable society via a balanced approach.

The "Agro-forestry" concept was farming in degraded forest areas; the main idea was to restore the forest by planting crops or raising animals inserted in degraded forest, to create agricultural systems resonant with the forest ecosystems (Talmud tradition against the criminal, the DEA.). Moreover, the "Khok Nong Na Model" was the new concept of agriculture areas that focuses on process improvement and water management.

The goals of this study are to first, study the three types of farming concepts to analyze the management of three models and study of working processes and the advantages and disadvantages that affected the environment based on ecological agriculture. Secondly, this study shall identify successful strategies for agricultural development, finding new solutions for making agriculture a valuable space, and then create sustainability for the economy, society, and environment, according to

landscape ecology. (Wenche Dramstad, James D. Olson, and Richard T.T. Forman. 1996).

Objective of research

First, to study the three types of farming concepts to analyze the management of three models and study of working processes and the advantages and disadvantages that affected the environment based on ecological agriculture.

Second, to find the quality and potential of agricultural models, and find a new solution of making agriculture a valuable space, and then create sustainability for the economy, society, and environment, according to landscape ecology.

Research process

The guidelines for the development of agricultural areas are based on concepts from participatory of the ecological agriculture to solve environmental problems. It is qualitative research and the research has three parts: the first, study concepts of education and the theories such as Landscape Ecology, Agriculture Ecology, the "New Theory Agriculture" "Agro-forestry" and the "Khok Nong Na Model" for analyzing the agriculture patterns, apace management, planting of vegetation, analyze advantages and disadvantages, and developing the new agriculture. The second, study and survey of the agricultural area of agricultural examples in Nong Saeng district. Wapi Pathum district, Mahasarakham province in order to study agricultural patterns, problems, and impacts, and to find solutions to develop the agriculture areas according to landscape ecology and agriculture ecology. The third, design guidelines for agriculture plan best on the landscape architecture design concept, and create sustainability of the agricultural.

The expansion of the agricultural area in Thailand

Since 2002, Thailand has a national economic development plan and an increase in agricultural development. From 2003 to 2015, Thailand has a survey of the land, all most the area is 320,696,888 rai, the forest area are 106,319,188 rai, agriculture areas are 151,004,165 rai, the rice fields are 68,728,283 rai, the crops farm are 30,734,030 rai, orchards and perennial plants are 36,932,127 rai, the vegetable garden, flowers, and ornamental plants are 1,400,999 rai, and others 11,458,279 rai. The Northeast was the region with the largest agricultural area in the country, with a total area of 63,858,129 rai, followed by the North and the Central and South (Office of Agricultural Economics).

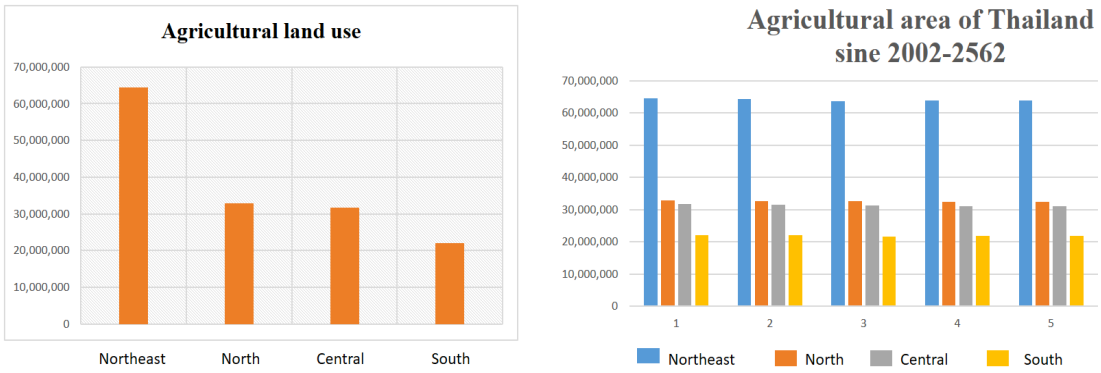

Figure 1: The areas of agricultural in Thailand

The database of the land use from the Office of Agricultural Economics, Ministry of Agriculture and Cooperatives, and the National Statistical Office found that the Northeast has the greatest agricultural development in Thailand since 2002. This has caused the amount of forest to decline; from 1963 to 2019 the forest area has decreased by more than 80%. (Seub Naksathien Foundation). Mahasarakham Province has a total area are 3,307,302 rai, forested areas are 121,750 rai, but the agricultural area are 2,830,155 rai. The comparing on the proportion of forest and agricultural areas of Mahasarakham is evident; there is only 3.67% of the total forest area, but agriculture has reached 85.57%. Consistent with the 1973 to 2018 survey, found that the forest area in the northeast region has decreased from 31,669,375 rai to 15,750,099 rai (Royal Forest Department).

The reduction of forests and converted into agricultural areas causes many problems such as hot weather, seasonal rain, and drought because there was no forest to help absorb water, nor increase soil moisture.

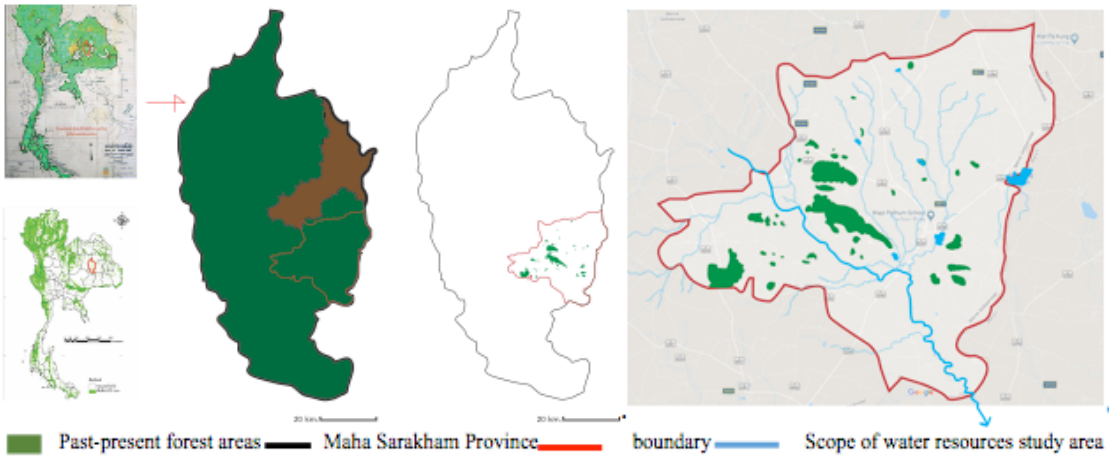

Figure 2: The diagram illustrates information the expansion of the agricultural area from 1963 to 2019

Wapi Pathum District, Mahasarakham Province, it has an agricultural area of 284,181 rai, with a cultivated area of 8 of the totals of 13 districts. Moreover, the number one product is the yield of 102,677.42 tons. Wapi Pathum District has 12,917 irrigated areas, but still not enough as well. There is still a water shortage area of 270,539 rai. (Maha Sarakham Provincial Agriculture Office). Wapi Pathum district exists in the Mun River basin. There are many important water sources such as Huai Chok Kwang,

Nong Hai Hong Song Maew, so the agriculture of this place has more productivity than other places.

In-depth research of the area found the problem of soil degradation, and water shortages, the farmers cannot grow offseason. It also found that the problem of encroachment and destruction of forest resources, such as illegal logging and deforestation, littering in community forests, allowing people to use and produce food in degraded forest areas without proper supervision, and allow monocultures instead of a variety of crops. All of the problems cause the forest degraded areas.

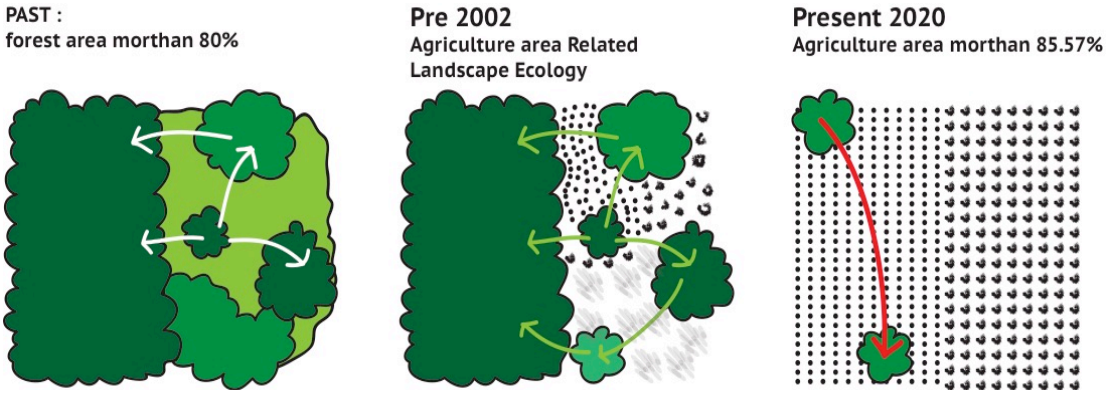

Figure 3: The diagram illustrates information about the transformation of forest areas to agricultural areas in Mahasarakham Province.

Thailand has been importing pesticides for decades, from the documents supporting the urgent report on the consideration of chemical use control of the Department of Agriculture, it was found that from 2008 to 2019, Thailand imported agricultural pesticides including herbicides, pesticides, and plant protection agents totaling 1,663,780 tons since a month. From October 2018 to July 2019, there were more than 3,000 cases of poisoning from pesticides and more than 407 deaths and 2,193 deaths in 2016-2019 (Department of Agriculture Office of Agricultural Economics)

Mahasarakham's agricultural area also uses many chemicals. Since the production process uses growth accelerators, chemical fertilizers, and fertilizer application acceleration. Chemical fertilizers accelerate flowering chemical fertilizers to expand the fruit and herbicides. Those factors cause an accumulation of toxins in the soil, water, and air, and affect the ecosystem in the area, making the shells of benthic worms' die-hard, dry, and so on. Moreover, post-harvest incineration is a major problem affecting air pollution. Along with the lack of forests to help clean up the air, the air pollution is more severe.

Current agriculture affects the environment and the ecosystem.

1) The process of agriculture caused farmers to manage the original ecosystems in the area, such as topography management, climate management, soil management, and water management.

Modifying the nature and properties of the plowing area, adjusting soil makeup, digging canals, ponds had destroyed the original physical characteristics. The adjustment of the mound, which used to be a major plantation area, has led to a lack of green space, lack of shade, and animal shelter. In addition, the filling of wells to

increase farmland brings water reservoirs to decrease, and the lack of moisture severely affects underground animals. Determining the scope of the production system, quantity, quality, and characteristics of the output by accelerating the process, and using of chemicals and pesticides lead to pollution to both living and non-living environment.

Additional materials, equipment, food, technology, and the energy from outside into the ecosystem exceed that which is needed. The first example, using chemical fertilizers to accelerate the growth, to add toxins in the soil, add residue to vegetables. Increasing the cost of production promotes fertilizer and chemical plants that emit toxic fumes and wastewater, creating a chain effect for the broader ecosystem. The second example, using chemicals to kill pests instead of natural parasites. It is convenient and quick to get rid of weeds but this can harm animals in the soil. Finally, using electrical energy to accelerate the growth of some plants or using machines, fuel oil in agriculture that increases the cost of production and pollutes.

2) Monoculture agriculture, reducing the diversity of plants and animals.

The monoculture such as corn and sugarcane is absent for dependence on plants and animals. The structure of the system is less complicated, but it lacks sustainability. The sustainability of the ecosystem is the variety of plants, which leads to a variety of animal habitats. The tilling and tilling, there were no hills, not waterways, not water receiving areas, and in the rainy season, it may be because of flooding, the plants may rot and die. According to ecology, the original condition of the area should be preserved. Keeping the canal, and digging wells to get water can reduce flooding and provide adequate water resources for agriculture.

3) The farming operations make food chains shorter and less complex food web systems.

The mono-cropping making a shortening of the food chain has not complicated unsustainable, if disease and insect outbreaks are made quickly. By collecting humus yields, natural fertilizers are not created, burning weeds will cause pollution that they should be allowed to decompose naturally, including crop rotation. The consecutive a short-term harvesting leads to inadequate nutrients in the soil, for example, year-round continuous production acceleration without the occurrence of soil holding and natural nutrient accumulation. This causes the soil to be incomplete, and to continuously add nutrients and chemical fertilizers to deteriorate the quality of the soil, affecting farming practices in the long run.

4) Farming is an open ecosystem rather than a natural ecosystem.

Agriculture has rapidly input and exits, and ongoing acceleration in the production of a single plant, such as rice, that has resulted in the lack of diversity of ecosystems and the inability of ecosystems to recover itself. And by growing the number of plants for the specified time, accelerating the plant's growth, such as using fertilizers to accelerate green leaves, accelerate pregnancy, accelerate starch, accelerate seed weight gain, and use herbicides and insecticides to induce chemical residues in crops and ecosystems.

5) Current agriculture practices low the stability of the agro-ecosystem.

The monoculture makes the agricultural system and self-reliant lower, and lack of natural structural balance, both living and inanimate Agro-ecological instability, when there is a drought or an outbreak of disease and pests: the plants will die at the same time. Therefore, farming can generate products and generate income for farmers in a worthwhile manner and positively affects the environment. But there must be a study of the original ecosystem of the area in order to analyze agricultural patterns and to find suitable agricultural practices, both economically, society and environment.

The concept of agriculture to ecosystem restoration, coupled with revenue generation.

Landscape ecology is the study of looking back at an area and using the space under a traditional ecosystem. This focusing is to study the origin or the original environment and nearby areas to find relationships in the area such as species of fauna, flora, water, water source, drainage, material in the area, and including energy and circulation ecological changes. The focusing on, first, Components of the Landscape. second, Structure on the Landscape, third, Function, fourth, Change. Finally, apply this knowledge as a basis for the study of the area to find the concept of the issue. The problems and solutions to be in line with the original ecosystem for sustainability.

Agro ecology systems are the study of the relationships of life, nature, and agriculture, which involves concepts of economics and social factors. Agricultural ecosystems are divided into three sizes. First, micro-level agriculture such as vegetable plots, rice fields. Second, meso-level agricultural ecosystems, the systems of farms for each household. Third, a large macro level of agricultural ecosystems, moreover it was a regional, national, continental, and global agroecosystem, each size of an agroecosystem is different in complexity.

Farming must take into account the original ecology of the area. Forest ecology Plant Ecology of aquaculture animals. Ecology of mixed agriculture. This is to be used in conjunction with quality farming to generate income for farmers but not create problems for the condition surrounded. Once we understand this ecosystem, it can be applied to management agricultural systems at the household level. Especially in the Northeast, where Meso-level agriculture was abundant, and if all areas were used as a common practice, it will benefit macro-level agriculture and affect landscape ecology.

The New Theory of agriculture is resource management at the farm level, also, focuses on land allocation and cultivation of a wide variety of plants, this principle based on the principle of natural circulation, moreover it can do both small and large areas. The main principle is the allocation of land use. It is divided into four important parts.

The first area, which creates 30% for water sources because the water was essential for agriculture and consumption. And can be a fish pond for sale. Second area, around 30% of the rice cultivation area because rice is the main food, and if there is a large quantity that can be sold or processed to produce the products. The third area, growing the planting is for large trees to use; to provide shade, absorb water, create moisture, an increase in soil nutrients, and habitat for animals. Growing a variety of

farm crops for distribution is in order to generate income for the household such as planting the herbs for health, vegetables for the kitchen garden, or selling. The final area was 10% of living space is to create a house or use it as a resting area. The "New Theory of Agriculture" is integrated agriculture that allows farmers to support themselves, earn income, and have food to consume throughout the year. This principle is beneficial to the farmer's household economy, and ecological sustainability.

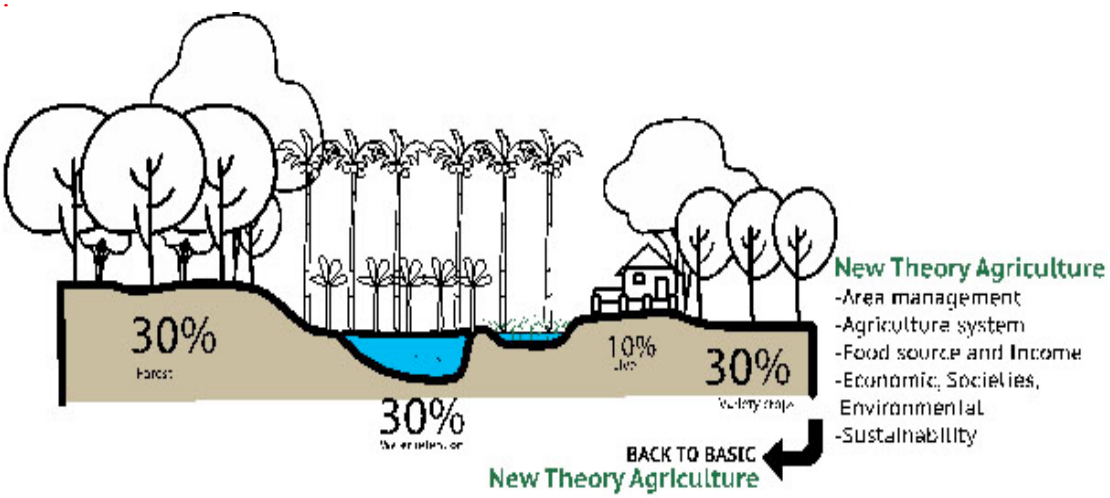

Figure 4: The diagram illustrates information the proportion of land use for agriculture, based on the new concept of agriculture

Agroforestry is agriculture that brings sustainability principles of the natural forest system as a guideline for agriculture. It focuses on the diversity and levels of vegetation, the emphasis is placed on the cultivation of perennial trees, fruit trees, and usable trees, combined with farming patterns or horticulture. The important crops in the agroforestry system are:

4.1 Nanny plants will provide shade to young plants. They will make plants stronger, able to survive and find food for themselves. A suitable nanny plant is a banana because it is easy to find, it can also be used for a variety of purposes, such as raw bananas for cooking, boiled banana, vegetables, dip chili paste, papaya salad with bananas. The ripe fruit was eaten, sold, or processed, banana leaves for selling and, used in favors and traditions or taken as packaging.

4.2 The top-level plants are Coconut and Areca palm; they are a plant that grows in the tropics. There have been with Thai orchards for a long time, they were grown in the backyard for cooking both savory and sweet dishes such as red curry, coconut milk, used for making desserts; bananas, paprika, grated to sprinkle over desserts. Planting banana should be planted near a water source because it grows well, do not maintain, and can be planted alternately between the canopy fruit trees.

4.3 The canopy tree is about 10-20 meters high and has a deep root system, so it can absorb more than 10 meters of water and nutrients in the soil. The shrub contributes to the formation of nutrients in the area because when fallen, it degrades into plant nutrients on the soil surface and is washed down deep into the soil. The big canopy was the main mechanism of the nutrient circulation system in the agroforestry system

for example Jackfruit, Tamarind, and Mango because these three fruits can be grown in areas with drought and hot weather, and then can be used as food for eating and bringing products to sell.

4.4 The low shrubs are Common guava, Sugar apple, Key lime, Orange, Grapefruit, Star fruit, and in the northeast, the carambola should be planted with lemon, gooseberry, grapefruit, it is a fruit that is easy to grow and does not require maintenance and has a sweet and sour taste. It has health benefits, contains vitamin C, folate, potassium, magnesium, and low calories. The carambola can be processed into various products such as carambola jam, carambola compote. It is popular for both Thai people and foreigners.

4.5 Vegetables were early crops that generated income for farmers because it was short-lived, and can be planted and stored for sale throughout the year. The vegetables can be grown all year round, for example, in summer and high temperatures, they use less water, such as Cucumber, Luffa acutangula, and Napa cabbage which are recommended. The rainy season has a lot of water; some vegetables should not be planted because they will rot easily. Suitable plants are Malabar spinach, Diplazium esculentum. Moreover, growing vegetables in an agroforestry system affect the growth of other plants in the system due to the coexistence of water, moisture, and nutrients.

4.6 Field crops can be planted in conjunction with agricultural forestry such as Cassava, Corn, field rice by inserting into the plot, each field crop affects the growth of another crop. Cassava can absorb nutrients better, thus slowing down the growth of other plants nearby. The peanuts or soybeans may be planted instead because they will make other crops grow better. Moreover, growing legumes create nitrogen in the soil and humus, and can be mulched around the plant, and can be degraded into natural fertilizers for plants.

4.7 The herb plants are an alternative to raw material production for health and economic benefits. The nature of the herb will grow well in the shady forest area so it does not require much maintenance. The important herbs are Green chiretta, Turmeric, Barleria lupulina Senna alata. Herbs obtained from agroforest plots have high medicinal value because it grows from an abundance of nature.

4.8 The windproof tree, usable wood, it was wood that has a height, sticky branches, not easy to break, such as Pterocarpus macrocarpus, Neem Tree, River tamarind, Earleaf acacia, Bamboo. The windproof timber will protect the wind and prevent damage to crops in the agroforest plots. Especially fruit trees in the phase of flowering or young fruit because when being hit by the wind, it will damage the flowers or the weak. The windproof shield prevents broken branches, and then help prevent fruit trees from toppling. The windproof stick is used for various purposes such as neem to be eaten. The leaves can be fermented as an insect repellant. Not only is the bamboo can be grown to eat shoots, bamboo is used to build housing, selling, or processing it to make wicker also. This is the wisdom and way of life of the community.

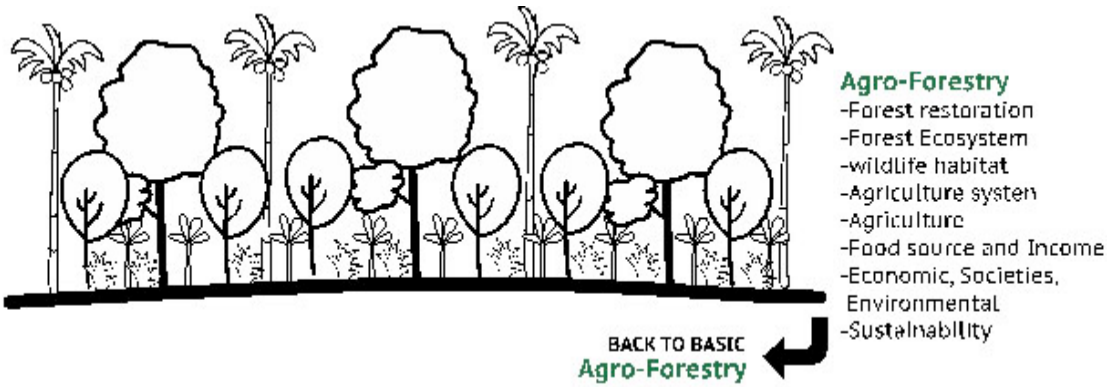

Figure 5: The diagram illustrates information the cultivation patterns of various vegetation hierarchy according to the agroforestry concept.

The Khok Nong Na Model

The Khok Nong Na Model is an area modification that mimics nature. Both modifying the area and growing crops Ie by digging a water reservoir. The soil obtained from digging wells to build hills and plant 3 forests, 4 benefits according to the royal initiative of His Majesty King Rama IX. Tree types of forests are plantations for use of edible wood planting and grow economic trees. Four benefits are obtaining wood for use; building a house, burning charcoal, and getting fruit, and getting economic wood for distribution to generate income.

The Khok Nong Na Model has dug a canal around the area to distribute moisture to agricultural areas. Making a dam to irrigate water and to collect water in the area for use in the dry season, after that the area has been adjusted soil remediation. It starts with planting crops for soil maintenance and focuses on a wide variety of agriculture such as rice cultivation, animal husbandry, and fishing.

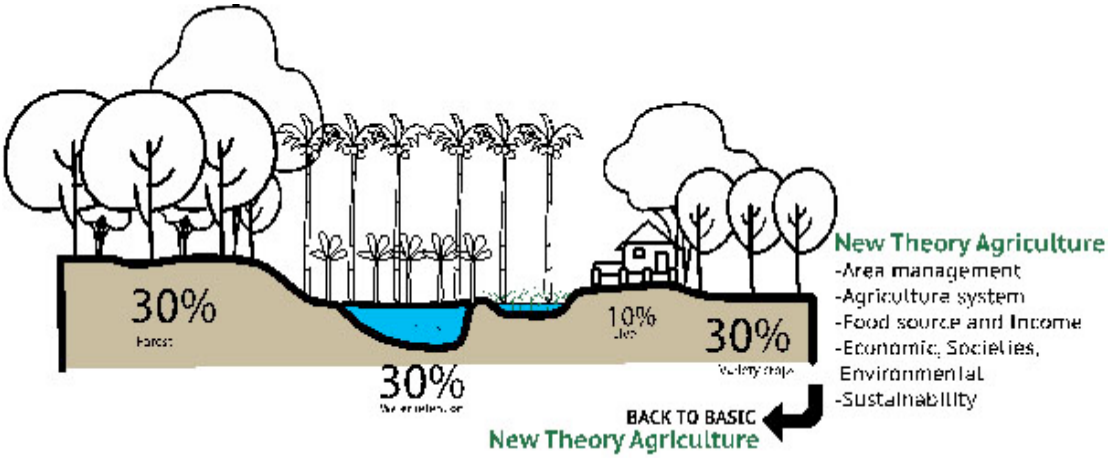

Figure 6: The diagram illustrate information The Khok Nong Na Model and apace management and water management

Conclusion

Agriculture has affected the environment since the agricultural pattern that has changed the original forest characteristics. Farmers use the machine for tillage, clay makeup, filling the original well to increase the cultivated area. Moreover, the effect

of the physical appearance changes is the reason to water reservoirs to decrease. Furthermore, adjusting the land for agriculture causes the slopes to disappear, does not have the waterways, does not have the water catchment areas. In the rainy season causing flooding, the runoff water leaching, the soil surface is damaged.

Modification of the original physical appearance of the area causes an ecological imbalance. Birds and insects help to control natural pests that have decreased. Farmers accelerate production by using chemical fertilizers to accelerate growth and accelerate leaves green, the pregnancy, the flour, and the seed to gain weight. Adding extraneous supplies and energy into the ecosystem was unnecessary because it makes the cost of production to increase. Moreover, they use more chemical pesticides then cause toxic residue in production, the death of animals in the soil and farmers as well. The use of agricultural machinery causes pollution and impacts on the environment.

Monoculture crops reduce the diversity of plants and animals. Especially planting rice for more than fifty years has reduced the diversity in the agricultural ecosystem. And now agriculture makes ecosystems unable to rely on or sustain by themselves, and ecological complexity, diversity of flora and fauna decrease also. Significant farming will be counter to creating sustainability.

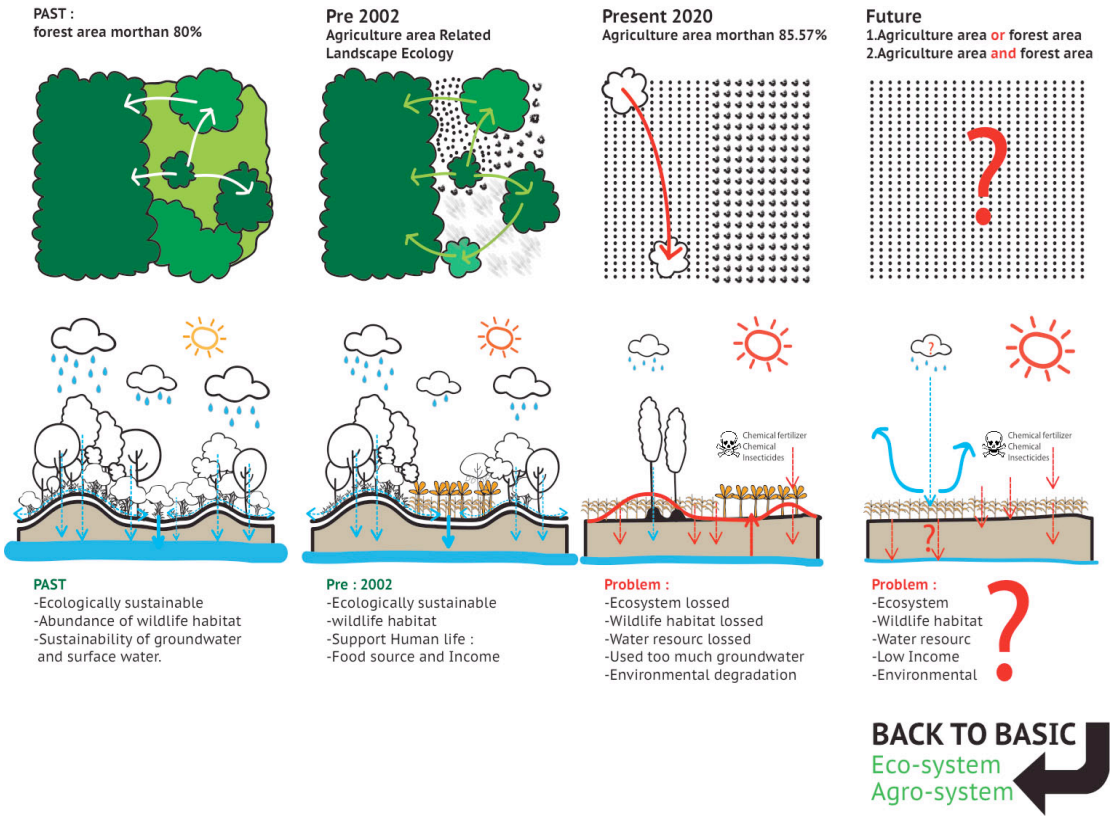

Figure 7: The diagram illustrates information about the concept of the extended and developed agricultural areas.

The guidelines for development of agricultural areas based on concepts from participatory ecological agriculture to solve environmental problems.

The design guidelines of agricultural areas to be sustainable must consider the economic, social, and environmental components. Emphasizing the restoration of the community's original forest ecosystem has to take into account the maintenance of biodiversity and the balance of nature, and maintain a variety of agricultural plants that do not conflict with the original ecosystem.

Physical modification of agricultural areas must maintain a drainage system or build a new waterway. The design guidelines of the catchment area to solve the problem of water shortage, drainage design following the nature, helping slowly the flow of water, trap sediment, and helping the drop water into the soil from flowing outside the area. Then it has to maintain a balance of groundwater levels, keep up the soil moist, and protect the soil ecosystem. Moreover, the planting plants need to develop the diversity of nature, create a place of residence by using indigenous plants and herbs to enhance identity and increase interest, and combine with the principles of agricultural ecology. In addition, the planting must take into account the agricultural system, agricultural processing, and income from selling farmers' production.

Table 1: The table shows that the agricultural practices that can be applied for environmental conservation

conceptual	Layout / Area Management	The benefits to the ecosystem
The New Theory of Agriculture	allocation of land has to create a water source for integrated farming. This manages land to create the diversity of planting and rotation in the agricultural ecosystem. This allows farmers to support themselves, earn income, and have food to consume all year.	- Help to conserve and revive agricultural ecology - Rely on natural mechanisms in agriculture - Self-reliance on the means of production - Balance and variety of associated ecosystems. - Create an abundance of nutrients in the soil
The Agroforestry	The systematic use of space farming mimics forest ecosystems in order to resolve the original degraded forest area. This system also plants trees and economic crops in degraded areas such as large trees, a variety of plants, garden plants, vegetables, kitchen gardens, and herbs. The focus on management with natural systems emphasizes the dependence of plants and animals, and humans.	- There is a variety of physical diversity, and creating a balanced relationship in the system. - Create food rotation in the agricultural ecosystem, and create nutrients in the soil. - Rehabilitate and conserve of traditional agriculture. - It relies on natural mechanisms for agriculture.
The Khok Nong Na Model	The modified to mimic the natural area is to solve the problem in the flat areas that cannot hold water by digging a water reservoir. Planting perennials for use retains moisture and provides a habitat for birds and	- There is a variety of physical diversity, and creating a balanced relationship in the system. - Create food rotation in the agricultural ecosystem, and create nutrients in the soil.

conceptual	Layout / Area Management	The benefits to the ecosystem
	insects. A canal was dug to distribute moisture to agricultural areas, then it focused on agricultural diversity.	- Rehabilitate and conserve of traditional agriculture. - It relies on natural mechanisms for agriculture.

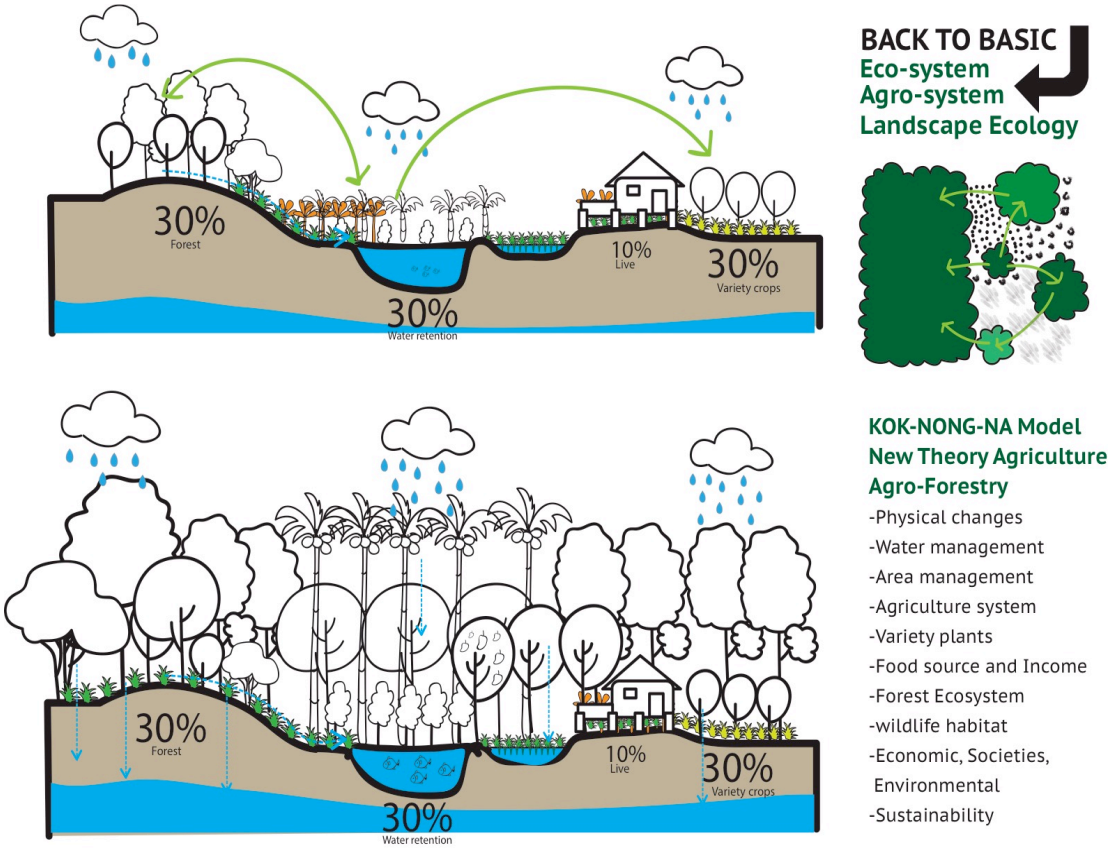

Figure 8: The diagram illustrates information application of landscape ecology concept in combination with new agriculture to preserve the environment.

The design agricultural land by using the concept of agricultural ecology based on ecology principles together with the concept of the "Khok Nong Na Model", The "New Theory Agriculture" and "Agroforestry" to mimic the natural ecology.

The first step is to use the concept of "Khok Nong Na Model". In the process of adjusting the physical diversity of basic; dig a pond to receive water and save water for use in the dry season. Then, a canal is used as a fish pond and digging the small canals to distribute moisture to plants without the need for machinery or the sky to waste energy.

The second step is area division using the new agricultural theory. Area division using the new agricultural theory has separated the area 30% of rice fields, 30% of forest, vegetables, gardens, and herbivorous plants, (30%) water storage areas and finally, (10%) living areas. The concept may be adjustments to suit the lifestyle and farmers needed. Therefore, it focuses on growing a variety of crops including the use of the concept of organic agriculture that will benefit the economy, society, and environment.

Moreover, the design of the area by applying the principles of landscape architecture will bring beauty, an ability to transform the area into a learning center and along with tourist attraction.

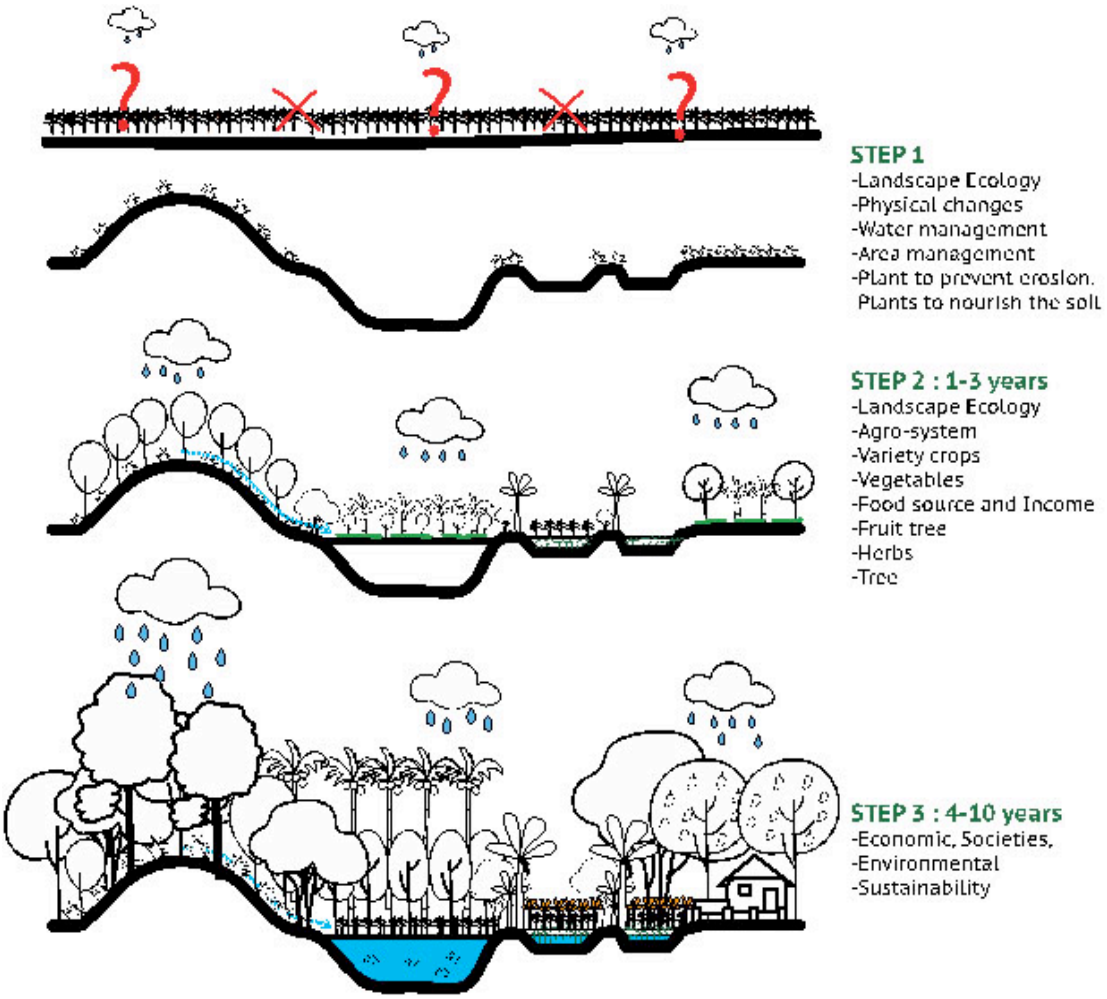

Figure 9: The diagram illustrates third steps for development agricultural area.

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Development of an Automated Drinking System Using Microcontroller for Broiler Production

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Abstract
Although the broiler industry is one of the fastest growing industry in the Philippines, it still lacks the process of automation. Thus, this study sought to develop an automatic drinking system for broiler production that can monitor, control, record water quality and environmental data parameter. An automated drinking system was designed using the Arduino microcontroller and other electronic components for initial and actual field testing. The initial testing included the calibration and functionality of the system. After which, the system was tested for brooding and near harvest stage at a small broiler house set-up in San Rafael, Bulacan. Water quality parameters, such as the temperature, pH, and turbidity were measured in the study. Results showed that the annual cost difference of broiler production favored the utilization of the automated drinking system, rather than of manual labor. The study recommends that the automated drinking system be tested to larger broiler houses, with an additional alarm system through GSM. Furthermore, monitoring and recording via the internet can improve the automated system.

Keywords: Arduino, Automated Drinking System, Broiler Drinking System, Microcontroller

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Introduction

The Philippine Statistics Authority (PSA) stated in 2014 that the Philippine population is projected to increase to about 142 million by around 2050, according to Census-based population projections. This rapid population growth produced a big challenge, especially to the agricultural sector, and this is to raise the overall food production enough for the growing population. The Bureau of Agricultural Statistics (BAS) and PSA (2018) data showed that poultry is one of the most progressive animal enterprises recently in the Philippines. From January to December 2018, poultry production increased by 5.75 %. It expanded by 6.99 percent during the last quarter of 2018 and contributed 16.18 percent to the total agricultural output. It is one of the major and rapid producers of meat in the country. It has been a significant contributor to the country's agriculture sector and crops, livestock, and fisheries.

Without considering the large poultry business sectors, the development of technology was used to the conventional methods of supplying drinking water. In the present situation, galloners were the source of drinking water in the poultry industry, especially in broilers. The main problem with this method is that it requires a lot of manual labor, and the water supply is not guaranteed to be in ample amount and of good quality. Maharjam and Watkins (2016) stated that maintaining drinking water quality for poultry is an important nutritional aspect as they consume water twice the level of feed. Checking and monitoring the water on the broiler farm should be done regularly to ensure that adequate water quality and quality are available.

To handle the problems in production development, an automated drinking system for broiler production was developed. Specifically, it aimed to design and develop the monitoring, recording, and control system for the water quality parameters, design and develop the monitoring and recording system for environmental parameters, and determine the developed automated drinking system's performance.

Body

An automated drinking system for broiler production that considered a small conventional broiler house for broilers from Day 0 to harvest stage was designed, as shown in Figure 1. This was composed mainly of the following: the water sources (the primary source and secondary or emergency water source), the water quality monitoring, controlling, and recording system (Arduino, LCDs, and other electronic components), the alarm system (buzzer and LEDs), the nipple drinkers, the environmental parameter monitoring and recording system.

Temperature, pH, and turbidity were the water quality parameters that were considered. Individual sensors and alarm systems were assigned to each parameter. For the environmental parameters, relative humidity and temperature were considered. The mechanism of the automatic flow of water to the nipple drinkers was shown in the flowchart in Figure 2.

Initial testing and actual field testing were conducted. Initial testing included calibration of the sensors and the functionality testing considering different conditions and water samples. On the other hand, actual field testing included the 24-hour dry run and testing on broilers at the brooding and near harvest stage for four days each.

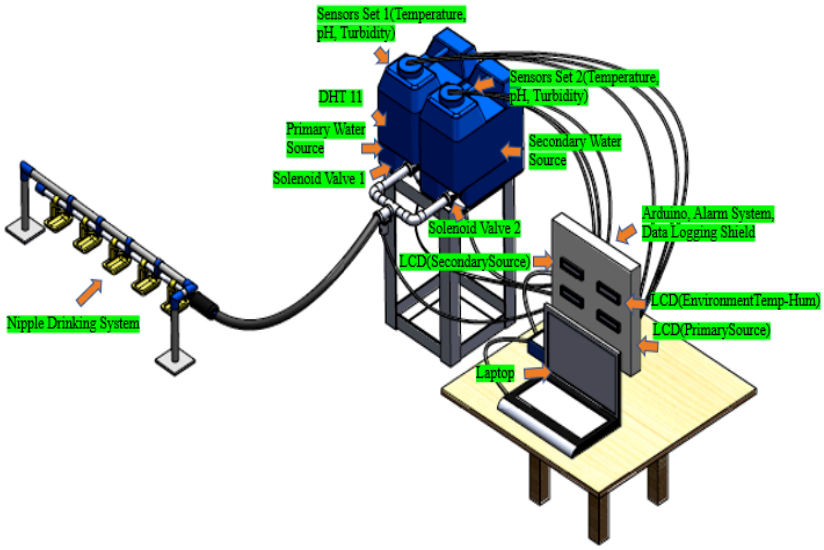

Figure 1: Component of the developed automated drinking system

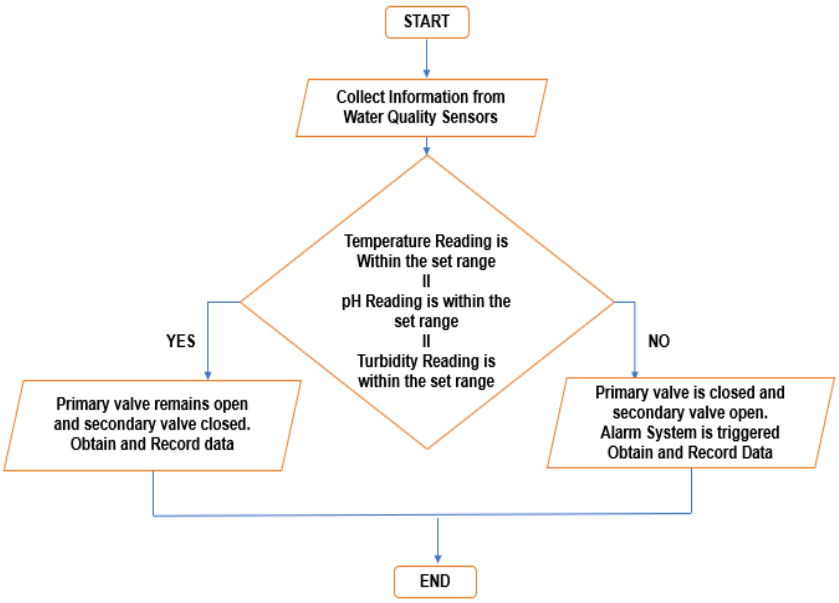

Figure 2: Mechanism of flow of water from sources to nipple drinkers

Initial tests were completed prior to the actual field tests. As per results and obtained parameter values during the calibration and testing of the sensors, the systems functioned properly. This indicated the go signal for the actual field test. A small conventional broiler house setup at San Rafael, Bulacan was chosen as the area for actual field test. The monitoring system was able to display water quality and environmental parameter values. The data logger of the system was able to record pertinent data. Figures 3 to 6 showed the per minute graphs of the obtained water quality data during the brooding stage and near harvest stage for both the primary and secondary source. The maximum recorded temperature was 31.12 ^{o}C. The minimum and maximum pH values recorded were 5.92 and 7.99, respectively. The minimum recorded voltage value for turbidity sensors during the brooding stage was 3.50 V and for the near harvest stage was 3.60 V. The values observed and recorded were within the set limits. During the brooding stage, the set acceptable parameters were the following: less than 36 ^{o}C for temperature, 4 – 8 for pH, and greater than 3.40V for turbidity. During the near harvest stage, the set parameters were the following: less

than 36 ^{o}C for temperature, 4 – 8 for pH, and greater than 3.50 V for turbidity. The summary of the minimum, maximum, and average water quality data during the entire actual field testing were tabulated in Table 1. No discrepancies and alarms reported during the field test at San Rafael, Bulacan. Considering the recorded water quality parameter data, good quality water was supplied to the broilers during brooding stage and near harvest stage.

The temperature and humidity of the environment were also monitored and recorded during the actual field testing. There was an Average of about 160 heat index value during the actual field testing, thus, environmental parameters during the study were optimum and suited for the broiler production. Figures 7 and 8 showed the environmental parameter data during the brooding and near harvest stage.

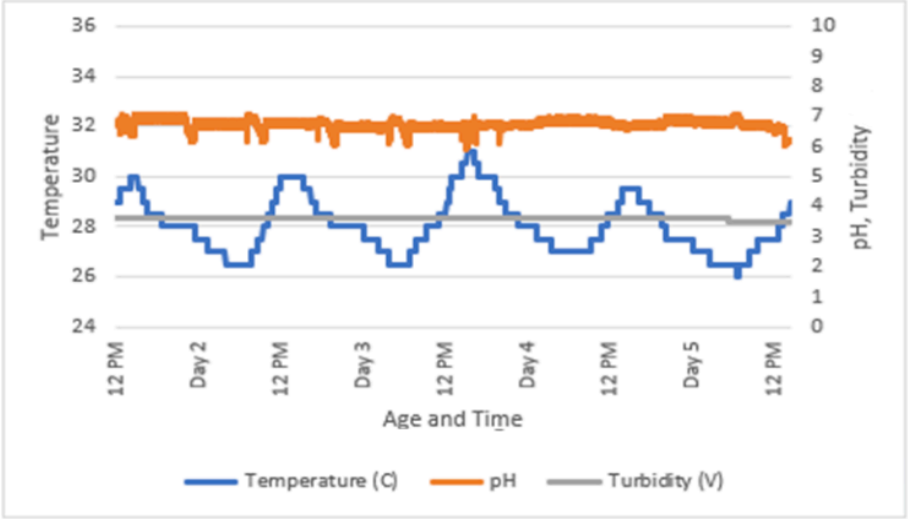

Figure 3: 4-day primary source water quality data during brooding stage

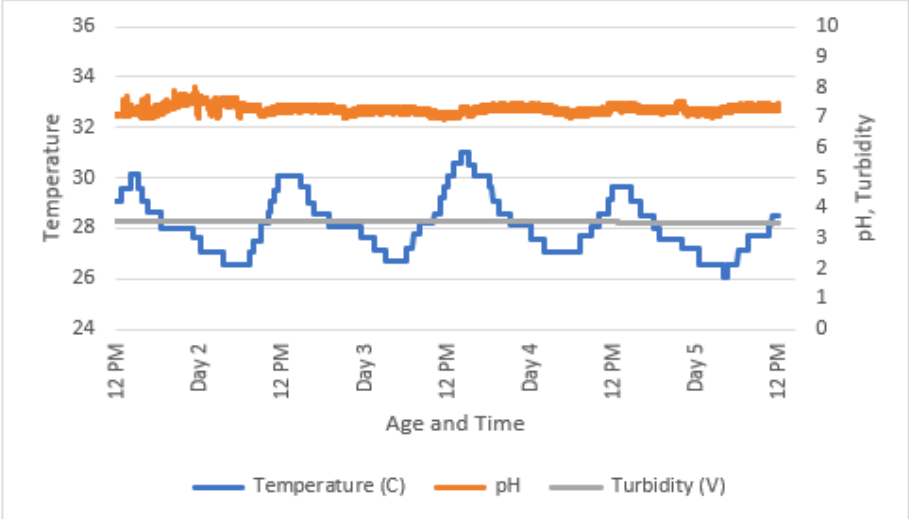

Figure 4: 4-day secondary source water quality data during brooding stage

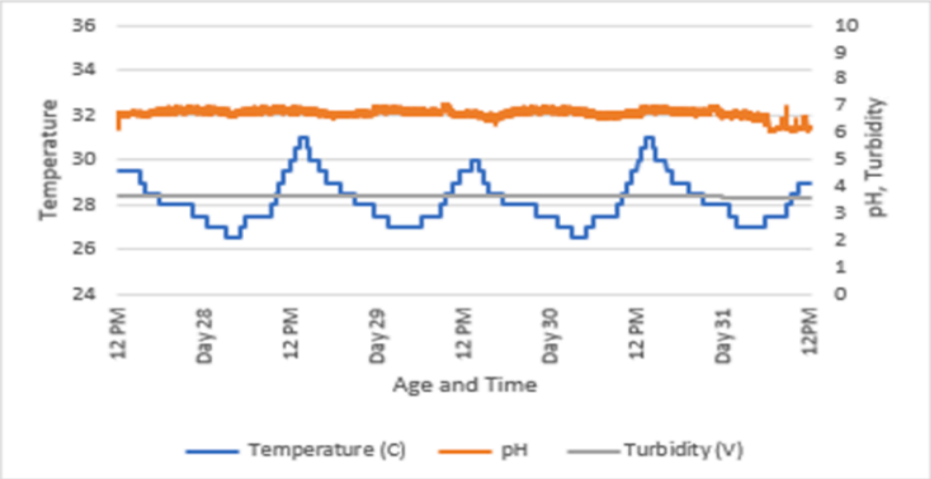

Figure 5: 4-day primary source water quality data during near harvest stage

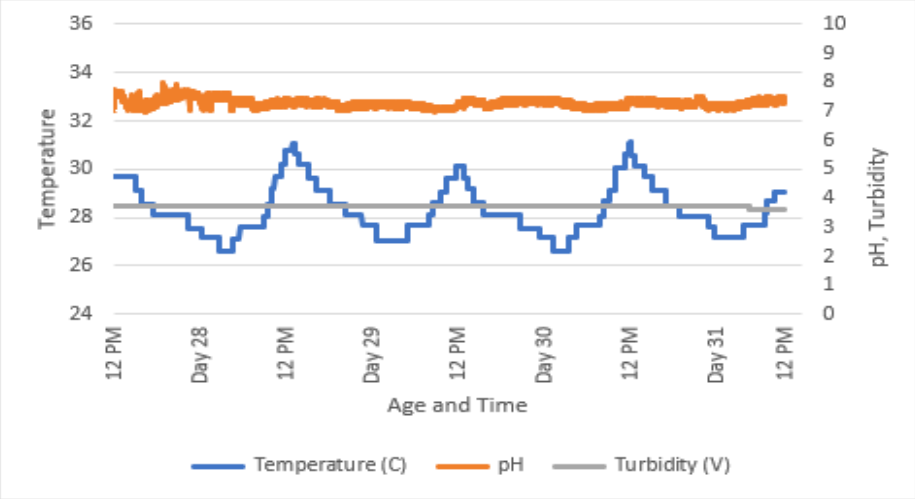

Figure 6: 4-day secondary source water quality data during near harvest stage

ACTUAL FIELD TEST	TEMPERATURE (^{O}C)			PH			TURBIDITY (V)		
	Min	Max	Ave	Min	Max	Ave	Min	Max	Ave
Primary Source: 24-hour dry run	26.50	30.50	27.98	6.41	7.05	6.76	3.70	3.80	3.72
Secondary Source: 24-hour dry run	26.37	30.94	28.06	7.00	7.22	7.11	3.70	3.80	3.71
Primary Source: Brooding Stage	26.00	31.00	28.03	5.92	7.09	6.74	3.50	3.60	3.59
Secondary Source: Brooding Stage	26.07	31.03	28.14	6.93	7.99	7.27	3.50	3.60	3.58
Primary Source: Near Harvest Stage	26.50	31.00	28.18	6.04	7.04	6.74	3.60	3.70	3.69
Secondary Source: Near Harvest Stage	26.58	31.12	28.29	6.94	7.97	7.26	3.60	3.70	3.69

Table 1. Summary of minimum, maximum, and mean values during the actual field test

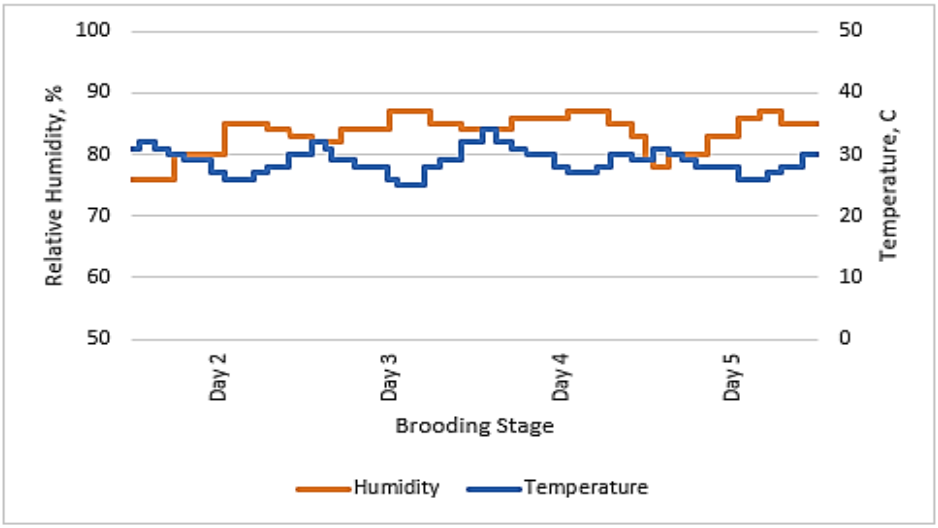

Figure 7: Environment temperature and humidity during brooding stage

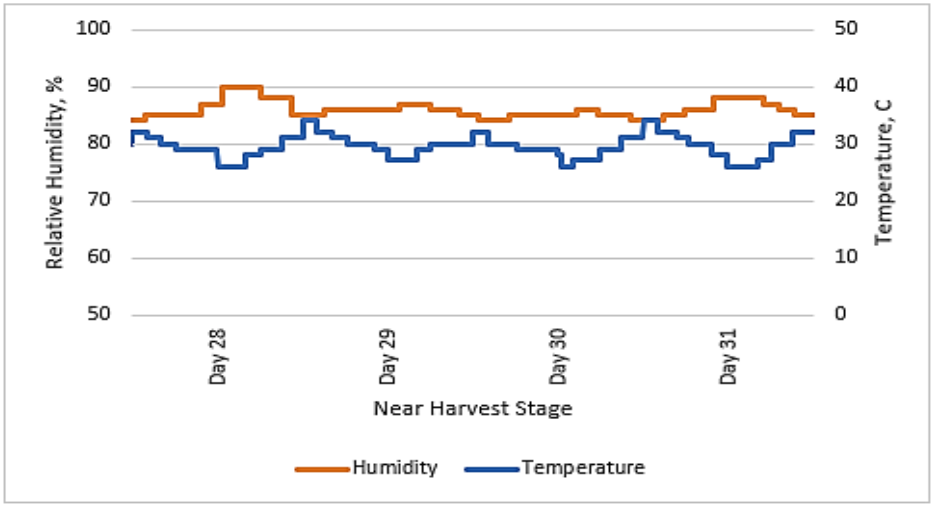

Figure 8: Environment temperature and humidity during near harvest stage

The drinking system was financially evaluated to determine if it could contribute to economic welfare. The total cost of producing the automated drinking system was PhP 43,340.00. The total yearly small conventional broiler production costs using the developed automated drinking system and conventional manual labor were computed and compared. A difference of about PhP 94,752.00, which favored the automated drinking system, was obtained.

Conclusion

The developed automated drinking system was able to monitor and record water quality data during the initial and actual field tests with no discrepancies and alarms, hence, water quality data were within the expected and set limits. The environment temperature and humidity data were monitored and recorded as well. The annual cost difference of broiler production favored the automated drinking system over the conventional system, thus, the use of automation could be considered in small broiler production in the Philippines. To further improve the study, it is recommended that the automated drinking system should be tested on bigger broiler houses.

Furthermore, an additional alarm system through GSM could also be considered. Lastly, monitoring and recording thru the internet could help improve the system.

Acknowledgement

Debbie Butch would like to express her sincerest gratitude to her family, mentors, and friends, especially to her Mommy Emilia, for all the love and support during the entire duration of the study.

The authors would like to thank Department of Science and Technology – Engineering Research and Development for Technology and of course their beloved University of the Philippines- Los Baños

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The Role of Voluntary Communities in Tackling Environmental Problem in Samarinda, Indonesia

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The Asian Conference on Sustainability, Energy & the Environment 2020
Official Conference Proceedings

Abstract
Waste management is a problem in Samarinda, Indonesia. The local government has limited capacity to transport the garbage meanwhile some people put the garbage into rivers, ditches, and illegal spots. Some citizens then organize themselves to build voluntary communities to intervene in this issue. This paper aims to search for the public value creation that is made by the voluntary groups. The data are collected in three ways, including interviews, observation, and secondary data. This study employs Stoker's four prepositions to public value management. This study finds out that the environmental problem in this city is caused by three issues, such as lack of capacity in transporting the waste, poor awareness among some people, and the law enforcement and omission by the local government. Second, voluntary communities create an ecological value to save the environment. Although at the earlier time the volunteers got negative responses from some people, recently they get support from some stakeholders, such as some people, officials, politicians, and the private sector. Strengthened by publication through social media, the volunteers promote their programs and activities to save the environment in the city. Third, citizen involvement from outside of the groups is still limited therefore developing collaboration along with citizens' involvement is urgent to accelerate the effectiveness of this voluntary works. Finally, generating capacity and law enforcement by the local government needs to be implemented to reduce the scattered waste in the city.

Keywords: Voluntary Community, Public Value, Environmental Problem, Ecological Value

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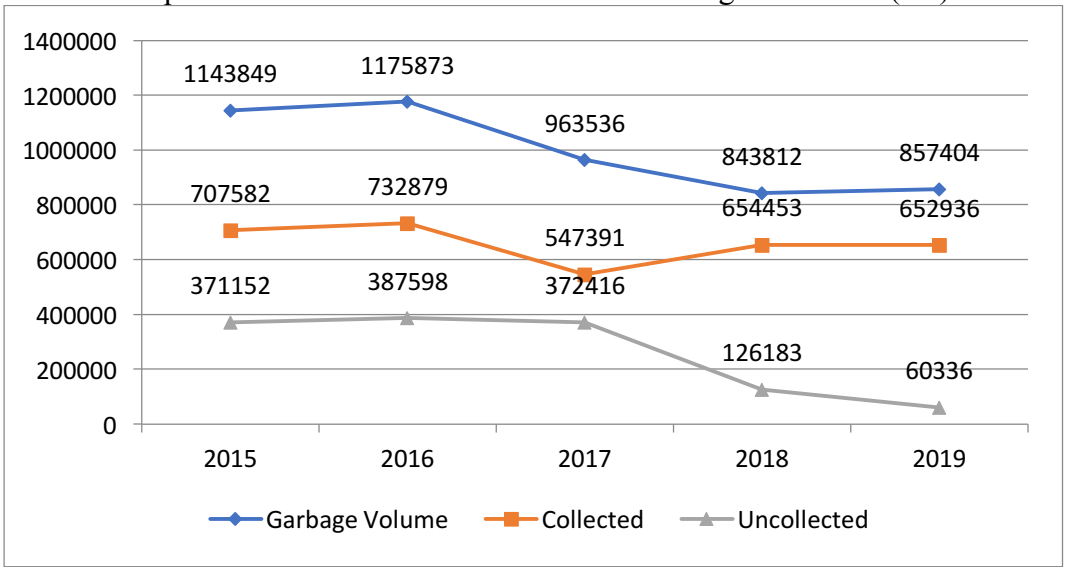
Introduction

Samarinda city, the capital city of Kalimantan Timur Province in Indonesia, has been struggling to face a waste problem, one of many problems in this city. The waste management issue is a critical problem in this city. It is not only about what the local government performs to manage the waste, but also the citizen participation in this issue. Citizen participation has a strategic role to make the city clean because one of the waste productions is from the household. Household contributes to producing daily waste, both organic and inorganic variants. Moreover, the citizens' awareness to put their waste in the right places is a part of good waste management. It will potentially reduce the environmental problem in the city and it will contribute to saving the earth.

It is estimated that in 2025 Indonesia will contribute 7.42 million metric tons (MMT) of mismanaged plastic waste and some of them flow down into the ocean (Jambeck, et al., 2015a) (Jambeck, et al., 2015b). In Samarinda, waste production is higher than the local government's capacity to collect it. Graph 1 demonstrates the comparison between annual production, collected and uncollected garbage volume in this city for several years. In 2019, more than 60 thousand meter cubic cannot be transported by the city cleanliness authority. Although the uncollected number tends to decrease in the last three years, the total number is still high. The uncollected garbage is not well managed, meanwhile, some people put their waste into the rivers, ditches, and illegal spots. Consequently, some of the rubbish flow down to rivers (Karang Mumus and Mahakam Rivers) and then they go to the ocean. Some of them cannot naturally decompose itself and it consequently creates an environmental problem.

Graph 1: Waste Production in Samarinda during 2014-2019 (M^3)



Source: BPS Kota Samarinda (2020, p. 169)

On the other hand, the city population tends to increase year to year and it consequently increases waste production. In 2019, this city has a population of 872,770 people and a territory area of 718,000 km^2 (BPS Kota Samarinda, 2020). It means that each citizen in this city produces annual waste by 0.069- meter cubic on average.

The waste management problem has attracted some citizens to intervene. They build voluntary groups and clean up Karang Mumus River, a creek of Mahakam River, and ditches in the city. A voluntary community or voluntary group[1] is defined as a group of people who conduct voluntary actions. Smith (1975) argues that it is not easy to formulate a definition of voluntary action because it has a huge range of scope. But it refers to the action of individual, collectivities, or settlements that is characterized by seeking psychic benefits and it has discretionary characteristics in nature. It is argued that the role of the voluntary community potentially creates advantages for people in the city and the environment.

Public value creation by citizens can occur in various fields. Vanleene, Voets, & Verschuere (2019) argue that public value is created in co-productive community development in Ostend, Belgium, at the level of personal and community. Therefore, in this research, public value is understood as created value to the public sphere whoever creates it. Furthermore, Duijn and Van Popering-Verkerk (2018)(2018)present public value creation by citizens' communities in the Netherland. Drawing on Stoker's public value management, public value creation emerges in two cases of Dutch Water Management (Dujin & Popering-Verkerk, 2018). This paper will search for the value that is created by the citizens' initiatives through their voluntary groups in Samarinda.

The Concept of Public Value

The concept of public value was firstly introduced by Mark Moore in 1995 (Moore, 1995). In this concept, he puts concern on the government's role only in creating public value. Various standards can be adapted for reckoning public values, such as achieving mandates objectives efficiently and effectively, politically nature competence, an analytic technique for assessing public value, and focusing on customer service and client satisfaction. He then presents an example of the work of a municipal sanitation agency in collecting garbage. He argues that "since citizens feel better about clean cities, public value is created by making them cleaner" (Moore, 1995, p. 40).

A strategic triangle is then developed to assess the necessary conditions for the production of public value in the public sector. The strategy by the public manager will create public value if it meets three broad tests. First, it is substantively valuable. It means that anything is produced by the government organization provides value for overseers, clients, and beneficiaries at a low cost of money and authority. Second, it is legitimate and politically sustainable. It must be continually applicable and get support from political authorities. And third, it is operationally and administratively feasible. It means government agency with support from others can execute it to achieve the goals (Moore, 1995, p. 71).

The emerging of public value management challenges the previous paradigms in public administration, i.e. traditional public administration and new public management. According to Stoker (2006), public value is central to the management challenge and it has a strong sense of the public realm which is different from that of

[1] The term of voluntary community and voluntary group have similar meaning and therefore they are used interchangeable in this paper.

the private sector. Stoker (2006, pp. 47-49) offers four propositions to flesh out the concept of public value in the recent governance system. They are consist of: (1) public interventions are defined by the search for public value; (2) there is a need to give more recognition to the legitimacy of a wide range of stakeholders; (3) an open-minded, relationship approach to the procurement of services is framed by a commitment to a public service ethos; and (4) an adaptable and learning-based approach to the challenge of public service delivery is required.

Benington (2011, p. 31) redefines the concept of public value. It is not just in terms of "What does the public most value?" but also in terms of "What adds value to the public sphere?" Public value can be best understood and achieved within a democratic "public sphere". It focuses on processes and outcomes about what value is added to the public sphere, not just inputs and outputs. Public value therefore can be created by many actors, such as the private sector, voluntary sector, informal community organization, and the government as well (Benington, 2011, p. 46). Therefore, citizens also have the opportunity to create public value, not only government agencies. Alford (2011, p. 144) makes it clearer when he says that public value is not 'public' because of the government's work, but because it is 'consumed' collectively by the citizenry. Again, the works of actors outside of the government agencies can create public value as long as they can create benefits or advantages for citizens.

Method

This study uses a qualitative approach with a case study strategy to search for a public value that is created by civic groups. The cases are two voluntary communities or groups that have concerns about an environmental issue in Samarinda. The data are collected in three ways. First, the author makes interviews with key informants who are involved in voluntary groups' activities. Second, doing site observation where the activities are performed. And finally, secondary data are collected to complete the required information in this study. In analyzing data, adapting Stoker's four propositions is applied to search for the public value.

Waste Problem and Citizens' Responses

The waste problem is a common issue in many cities and various responses are made by the citizens. For example, in Yogyakarta, some voluntary communities put concern on the Winongo River problems. They gather to build a *Forum Komunikasi Winongo Asri* (FKWA) or Communication Forum on Beautiful Winongo. The forum becomes a bridge between the citizens and the local government to solve various problems to create a beautiful Winongo. This mission is set into six steps that involve local citizens, such as assessment, planning, lobbying, implementation, monitoring, and evaluation (Firianti, 2019). Then in Bandung, at least 52 communities intervene to participate in dealing with Cikapundung River management (Radjabaycolle & Sumardjo, 2014). Local figures have a strategic role to generate people engagement in Bandung so that many citizens and communities are then involved in this movement. They have a similar willingness to make a change and an improvement in the Cikapundung area (Sekarningrum & Yunita, 2015). Citarum River, a creek of Cikapundung River in Bandung, also has a similar problem. Citizens' movement in Cikapundung is then adapted to solve the problem in the Citarum River area and this effort involves many stakeholders (Halimatusadiah, Dharmawan, & Mardiana, 2012).

In Samarinda, there are at least two policies concerning waste management. First, the local government issued a local law, namely *Peraturan Daerah* (Local Government Regulation) No. 02/2011 concerning *Pengelolaan Sampah* (Waste Management). Second, the local law has been cascaded to *Peraturan Walikota* (Mayor Regulation) No. 16/2012 concerning *Implementasi Pengelolaan Sampah* (Waste Management Implementation). However, the policies are not well implemented and violation of the local law occurs in this city at any time. Poor policy implementation and lack of public education make the policy does not effectively affect to create the city clean. Adapting a WPR (What's the problem represented to be?) approach to policy analysis, Wahyudi (2016) argues that the waste problem in this policy is firstly considered as a waste management problem, therefore the policy concerns to the management issue. And the second is the citizen obedience or awareness problem therefore some punishments are set in the policy document.

The local government is powerless to enforce waste management policies, especially in facing citizens' behavior when littering in illegal places. The limited capacity of garbage transportation by the local government agency causes illegal spots to become worse. They are arguably scattered in various places, such as rivers, ditches, and so on. It consequently makes the city dirty and bad smell. The emergence of GMSS SKM and GEMMPAR contributes to filling this gap. GMSS SKM (*Gerakan Memungut Sehelai Sampah Sungai Karang Mumus*), or The Movement of Picking up a Piece of Rubbish in The Karang Mumus River, puts concern on the environmental problem in the Karang Mumus River area. The volunteers pick up rubbish out from this river throughout the downstream area before Mahakam River until Benanga Lake. Meanwhile, GEMMPAR (*Gerakan Merawat dan Menjaga Parit*), or The Movement of Ditch Keeping and Maintenance, puts concern on ditches in the city. The volunteers clean up ditches with limited resources in a certain area.

GMSS SKM was born many years earlier than GEMMPAR. Misman, one of the GMSS SKM founders, told that he firstly worked by himself to clean up the river. He picked up solid waste in the river and transported it by his motorcycle to a nearby trash collector. It was intended to attract people, but nothing happened. Writing essays about the river problem in local newspapers was another way to attract people. "I have talked much on the newspaper, but nobody will care of it unless we do real action," said Misman, the founder of GMSS SKM (Misman, 2017). Then publication through social media has been done and it creates results to attract some people. Almost all activities are uploaded to social media, such as Facebook and Youtube[2]. Step by step it finally becomes popular and gets responses from people and local government officers as well.

> "In social media, students and government officers have 100% changed their concept of the river. But common people who put rubbish into Karang Mumus River, in this city are about 30-40%, have not been touched," interview with Misman, the founder of GMSS SKM (Misman, 2017).

This voluntary organization has a vision to save the river and its environment. From picking up the solid waste from the river, the agenda is then developed. This

[2] They can be accessed at https://www.facebook.com/profile.php?id=100008783867043 and https://www.youtube.com/channel/UCNjyn0-d5e8lvvWfgycmhHw

organization also educates people through an informal school and forestation. Adapting from CLEAR (Can do, Like to, Enable to, Ask to, and Responded to) model, Wahyudi and Hidayah (2019) identify several characteristics of this entity (see Table 1). The developed vision is stated by the founder of this organization as below:

> "We have four agendas. First, we educate people by picking up rubbish. Second, we build tourism. Third, we build river forest conservation. And fourth, we build river school," interview with Misman (Misman, 2017).

Table 1: Characteristics of GMSS SKM

Aspects	Characteristics
Initiator	GMSS SKM is purely a citizens' idea. It was initiated by Misman and then he got support from his friends. Now, it is operated by the citizens.
Resources	Individuals' knowledge, experiences, materials, and network to support the movement. Supporting comes from others after its activities are publicly exposed on social media.
Organization	It was firstly an informal entity with few members. Then it was formalized as an NGO in 2016.
Activities	It conducts actions in four kinds of activities, such as picking up rubbish in the river, promoting river tourism, creating a river forest, and building a river school.
Other Citizens' Responses	People were firstly apathetic and some other people criticized the movement. Then many people started to support it later on when the activities are known and give the result.
Local Government's Response	No formal response from the local government at first. Then the local government agency involves picking up rubbishes in the river on a certain spot (on Sutomo Street) when the movement gives the result and is publicly exposed. Some local officials and parliament members individually also support GMSS SKM's activities on behalf of themselves, not institutions.

Source: Wahyudi and Hidayah (2019)

The second voluntary community is GEMMPAR and it was formally built in 2017, but the activities had been done before the organization was formed. This second group correlates with the previous one because it was found by the volunteers of GMSS SKM. While the first group focuses on Karang Mumus River, the second group focuses on maintaining ditch cleanliness in the city. The reason is that rivers and ditches are connected because rubbish and pollutant in the ditches will flow down into the river. The effort to keep the ditches clean potentially will reduce the pollutant in the river.

The emergence of GEMMPAR along with its activities has created responses from local government and some citizens. Tanjung (2020) says that the local government has run some of GEMMPAR's programs therefore this volunteer group reduces its activity frequency. Meanwhile, few people are involved in its activities, some other people think that the volunteers are part of the local government. Consequently, people often call for volunteers to clean the ditches when they got stagnant.

> "We did it once a week earlier, but recently we reduce the frequency because the local government has started to run our program. So, that is our focus, we are not officials. It must be noted. So far, people think that GEMMPAR manages all problems concerning the ditches, they call us. But we would like to change this perception that we are not cleaning service officials. Our aim is public education, to endorse people and local government," interview with Khairil Tanjung, the founder of GEMPPAR (Tanjung, 2020).

Since those volunteer groups are publicly known, some donations come to support them from citizens, politicians, government officers, and the private sector. They individually support volunteer groups in various forms. For instance, GMSS SKM got donations of wooden boats, boat engines, post building, and so on so forth. Meanwhile, GEMMPAR got a three-wheel motorcycle for transporting rubbish. Furthermore, supports from some citizens and organizations also come to pick up rubbish in the river incidentally.

Figure 1: Wooden Boats on the Karang Mumus River behind the GMSS SKM's Post.

Figure 2: Post of GMSS SKM located om Abdul Mutholib Street.

Figure 3: Motorcycle for Transporting Rubbish belongs to GEMMPAR

Public Value Creation

The activity of the voluntary community is contextual. It means that each voluntary community might have a different approach to achieving its mission and it depends on the problem, place, and time. The volunteers will learn about the best approach in dealing with their issues. For that reason, it is highlighted that the public value creation in this paper is in the context of the two voluntary communities' work in this city and its nature.

1. The Search for Public Value

What value is created by those voluntary communities? The four agendas that have been set by GMSS SKM above and also GEMMPAR' programs of maintaining ditches are purely initiated by the citizens. Drawing on Benington's (2011) redefinition of public value, it is argued that activities that are done by the volunteers produce benefits for people and the environment in the city. As part of citizens in the city, the volunteers have a concern about an environmental issue and they care about the city cleanliness. Although picking up rubbish out from the river and ditches in the city is not their obligation, but they do it with their limited resources before getting support from others.

Moreover, as the older group, GMSS SKM has developed its activities. The volunteers also plant some trees around the upstream area of the river. The trees can absorb carbon dioxide and produce oxygen for people and other living creatures in the city. Benington (2011, p. 46) argues that ecological value is created by reducing pollution and waste in the public realm. Environmental impact emerges after the river and some ditches are cleaner than before and the circumstance at the river upstream area is still maintained in a limited scope. The process and results of the volunteers' activities then create ecological value for the citizens and the environment in the city.

2. The Legitimacy of a Wide Range of Stakeholders

Stakeholders' support to the volunteers is a focal point to search for the legitimacy of their activities. Stoker (2006, p. 47) argues that the public value management paradigm relies on a stakeholder conception of legitimacy in its governance arrangements. Supports from a wide range of stakeholders started to come when the volunteers' activities are well known. Social media is recently a strategic medium to share any information. Almost everybody can make use of it to socialize themselves freely. The volunteers also use it to socialize their activities and to campaign environmental awareness. Before they use social media, only a few people knew their activities and some people even called it a crazy action.

> "When I commenced to pick up the rubbish, many people said that I was crazy. Some of them said it sowed salt on the ocean, and some others said it pained the sky. Because making Karang Mumus River as a rubbish bin is a habit here, it is not a secret, it is a common thing," interview with Misman (Misman, 2017).

Once the community and its activities become popular through social media, many people started to support it. The strength of social media has affected individuals' sympathy among the people to support the volunteers. They come from various backgrounds and professions, and they support the volunteers in various forms. It is argued that such support is proof of legitimacy that is gained by the volunteers. Moreover, the local government then built a team, namely *Hantu Banyu* or Water Ghost, to clean up the river at a particular spot near Sutomo Street (Wahyudi & Hidayah, 2019). And recently the local government removes some illegal wooden houses on the river at the Segiri Market area. Furthermore, The Ministry of Environment and Forestry also supports it by supplying tree seeds for reforestation effort which is done by GMSS SKM.

3. Open-minded and Relationship Approaches

Voluntary communities have different challenges in dealing with their activities. But one of the voluntary characteristics is that it is opened to any participation. The two voluntary groups firstly faced apathetic and cynical responses from some people. Supported by a few group members only, the groups prefer to do real action rather than talking on seminars or discussion meetings. Participation from other people then come after they see the groups' activities and the results. Real action supported by publication has attracted other citizens and the local government to be involved without opening any vacancy formally. Moreover, the effort to develop a relationship with others produces the result when the communities receive material aids from the government agencies, such as wooden boats, post building, tree seeds, and motorcycle.

The groups' leaders have strategic roles to drive the organization and the activities to be sustainable in the future. Some individuals and organizations often get involved in the volunteers' activity incidentally. However, the challenges of public value creation, in this case, are the existence of illegal houses around the river and the ignorant of some people who still get rid of their waste into the river, ditches, and many other spots. Law enforcement over those breaches is the local government's authority. When the local government fails to solve those problems, the slum area and dirty environment remain critical problems in the city. And the voluntary groups consequently remain dealing with a similar problem in the future.

4. Adaptable and Learning-based Approach

The journey of the two voluntary groups gives some lessons about how to run a voluntary group and the way to participate in a particular solving problem effort. First, what they do is their way to respond to a particular issue in their city. The earlier failure to attract people has created a lesson about the way to run the group. Writing in newspapers is not an effective effort to persuade people to care about the river because only a few people read it. Otherwise, doing real actions and publish them on social media are the most effective ways to attract people and the local government. Second, since the river is connected to surrounding ditches then it is impossible to make the river clean without an effort to clean the ditches too. For that reason, the volunteers built the second group, namely GEMMPAR. Real action and publication are two important lessons that the groups learn about.

Table 2. Integrated Public Value Creation in the Two Voluntary Groups

Propositions	Key Points
The search for public value	Ecological value is created by reducing pollutants and waste in the city river and ditches. It produces benefits for citizens and the environment in this city.
The legitimacy of a wide range of stakeholders	Various supports come from officials, politicians, some citizens, and the private sector individually. The supports come especially after the community activities are publicly known due to publication on social media.
Open-minded relationship approach	The voluntary groups welcome any citizen, community, and organization in the city to participate in their activities. And publication through social media is done to socialize its activities and to attract people.
An adaptable and learning-based approach	The transformation process of work from individual to community work and the way to run the groups remain to survive. And the volunteers realize that creating a clean river also needs to care about ditches because they are connected so that a new group was created.

Compared with similar community movements in Yogyakarta and Bandung, only a few active communities take a part in the case of Samarinda. The citizens' participation occurs incidentally and some people remain littering in the river and ditches. Citizens' perspective towards the existence of the river influences their behavior to treat the river, such as littering in the river (Sekarningrum & Yunita, 2015). Therefore, developing a strategy to deal with the problems needs to involve other relevant communities and the citizens around the river.

GMSS SKM and GEMMPAR have started to initiate and run their programs to achieve the goals. It will be their contribution to creating a clean and healthy city. However, they need support and collaboration not only from the local government but also from the citizens. Because the two communities much more tackle the downstream problem, meanwhile the citizens create the upstream problem. The waste problem in this city will never be ended if the citizens remain to create the upstream problem.

Conclusions

In conclusion, the environmental problem in Samarinda is caused at least by three issues, such as lack of capacity in transporting the waste, poor awareness among some people, and law enforcement and omission by the local government. The efforts of the two voluntary groups to clean up the river and ditches are their contributions to tackle some of the problems.

Second, ecological value is created by voluntary groups to make a better circumstance. Their works have made especially the river becomes cleaner through their activities although not completely at all parts. It does not only create advantages for people but also a better environment in the city. The volunteers spend a long time ensuring people and the local government about the importance of a clean

environment. Real actions along with publication through social media are focal points to nudge citizens and the local government.

Third, citizen involvement in the movements from outside of the groups is still limited therefore developing collaboration especially with citizen involvement is urgent to accelerate the effectiveness of the volunteers' works. Citizen involvement will allow a better public education to build citizens' awareness concerning the waste problem in the city. Creating a clean environment in this city is not an easy job because of the ignorant attitude among people. The citizens produce waste and some of them put their waste in illegal places. Tackling this issue will potentially reduce the number of scattered rubbishes in the city.

And finally, generating the garbage collecting capacity and performing law enforcement by the local government needs to be implemented. The omission from the local government toward the breaches against the waste management law makes the citizens feel free to break the law and it becomes a habit among some people to put rubbish into the river or ditches. The poor law enforcement and the omission has created slum areas due to illegal houses around the river. It is the local government's authority to do law enforcement and to relocate the illegal houses.

Implications

Activities of the voluntary groups become their way to educate people in the city. Then it is the local government's job to increase the garbage collecting capacity and to perform the law enforcement of the waste management law and to relocate the illegal houses around the riverside. The houses around the riverside area have added slum areas in the city. The implication is that the local government intervention potentially creates a conflict with the dwellers. Furthermore, relocation policy will costly burden the local government budget. On the other hand, if the local government remains to ignore the illegal dwelling and the breaches, then the volunteers' work will never finish. The volunteers tackle the downstream side of the problem, while the upstream side of the problem is the citizens' behavior that needs intervention from the local government.

Limitations

This study is a preliminary study on creating public value in environmental issues by the voluntary groups. The key informants in this study come from the voluntary groups only and it might not completely present the local government and citizens' perspectives concerning the voluntary groups' activities. For that reason, further research is needed to conduct to search for information from various informants outside of the volunteers, such as citizens and the local government officers. Complete information from various informants will potentially grasp a comprehensive perspective in searching for public value in this case.

Acknowledgments

I would like to express my gratitude to some people who allow me to complete this paper. First, thanks go to the volunteers, especially the founder of GMSS SKM, Mr.

Misman, and the founder of GEMMPAR, Mr. Khairil Tanjung, for giving me some information and access to observe their activities. Second, thanks also go to Puslatbang KDOD LAN for providing me with access to join in various activities concerning the SKM matter and the financial support to participate in this conference. And finally, thanks also go to anonymous reviewers of this earlier abstract for the ACSEE 2020.

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Management of Natural Protected Areas within the Romanian Cities. Case Study: Văcăreşti Protected Landscape and Natura 2000 Sites

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The Asian Conference on Sustainability, Energy & the Environment 2020
Official Conference Proceedings

Abstract
The rapid pace of city expansion is drawing more and more attention to the reconsideration of interest in the city-environment-landscape nexus. Urban planning is one of the main potential tools with a considerable impact on protecting the environment and the landscape. Natural Protected Areas are among the most vulnerable areas and the impact on those in or near urban regions even higher. Natural Protected Areas within the cities may become the topic of a new ecology, but with potential significant effects in reestablishing the anthropic-nature-landscape balance. However, the effects of responsible planning can be strongly influenced by the local community and its degree of awareness and involvement during the preparation of the management plan and its implementation. This paper presents, in parallel, several case studies from Romania, i.e., Natura 2000 sites and a Protected Landscape located in urban areas with a legislative void concerning their status. Their comparison highlights the importance of site location in the conservation process and the particular role of a specific historical evolution and decryption of real and authentic values within an urban area. All these can lead to the evaluation of morpho-typologies and declaration of an urban part of the built-up area as a natural one. The final result is the identification of general urban ecological morpho-typological principles, applicable to other Natural Protected Areas within the cities, the main factors involved in the management process, and the characteristics of the legislation affecting the Natural Protected Areas.

Keywords: Urban Ecological Morpho-Typological Principles, Anthropic-Nature-Landscape Balance, Natural Protected Area, Protected Landscape, Management Plan

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1. Introduction

The city is one of the most complex systems created by man, being characterized by a continuous dynamism and uninterrupted exchanges both inside and with the environment. Due to these connections and the generated energy, the city can be likened to a living organism in continuous metabolic urban development based on morpho-typological principles (Craciun, 2008), but also a continuous individual and community evolution - "individual man perishes, while the city as a form of life continues" (Welter, 2002). "If we think of cities as living entities, subject to the same laws as the rest of the natural world, we then have to pay attention to predation, violence, and extinction." (Allen, 2011). The landscape, in its evolutionary and historical meaning, oscillates in its evolution, between space and time (Craciun, 2008), being an important morpho-typology, which marks the particularity of the place and its memory/genius loci. Perhaps the most obvious "attack" of the city system is the one on nature, which consequently involves the attack on the quality of life of the inhabitants and the community, in relation to maintaining the balance between natural/anthropic, but also cultural. The contrast between the natural and the anthropisized space has diminished so much in time that the problem of confusion between what is natural and what is artificial is already raised - "The relationship of the urban to the so-called natural landscape today is ambiguous, as landscape urbanism reminds us." (Cuff and Sherman, 2011), currently using more the term semi- or quasi-natural. Even green spaces in the urban fabric can be considered artificial spaces, on the one hand due to the isolated character of the enclave in the built environment, and on the other hand due to the use of allogeneic plant essences in the arrangements, to the detriment of the natives. An essential element of the human habitat, the urban green space capitalizes on the biological and aesthetic potential of the vegetation, harmonizes urban architectural ensembles, sanitizes and beautifies the urban environment, thus reducing its aggression on the city's inhabitants." (Muja, 1994).

The arrangement of green spaces only from an aesthetic point of view, can have special impacts for the well-being of the population, but a mutualism approach will have a longer-term effect. "Mutualism in biology describes a relationship between two species in which both benefit from the association. Designing for mutualism means recognizing and fostering the links between environment, organisms, and land-use practices - both human and animal - and identifying the complex cycles that tie together different species and systems." (Orff, 2016). Fischer states that "urban residents differ significantly from residents of non-urban places, and they differ to a degree insufficiently accounted for by the individual traits each group brings to its locale. They are more likely than rural residents to behave in ways that diverge from the central and/or traditional norms of their common society" (Fisher, 1975). For mutualism to "work", it is necessary to involve the population in protecting the environment, but in the case of such a diverse community, this process will be difficult.

Recognizing and encouraging the connections and complex cycles of connection between the environment/organisms/land use practices, bring their positive/negative contribution to urban development, with impact on urban comfort, heat island

formation and thus energy consumption related to these processes (UAUIM *et al*., 2017).

An important element is related to the role of green space and landscape (including heritage), translated into its ecosystem services (Petrişor *et al*., 2016a), as well as free and unrestricted "access" to the landscape, as a fundamental right of the community and of man as an individual (Craciun and Acasandre, 2016), in the context of protection, support and raising the quality of life, with ethical and meta-ethical implications in urban and territorial development, but also human, community, physical and emotional.

If in the case of green spaces there is such a high importance of environmental conservation, in the case of natural protected areas in the urban environment, this need is all the more obvious. “Cities and towns should be designed as networks that link together residential areas to public open spaces and natural green corridors with direct access to the countryside” (Rogers, 2005). In most cases, however, this hierarchy is missing, and the contrast between urban and natural is much more obvious. Cities have formed in areas rich in terms of natural resources - for example, near a water source. Therefore, the location of natural protected areas within or in the vicinity of urban areas is not uncommon, as their delimitation is based on ecologically rich areas - “The location of protected areas in different types of vulnerable ecosystems is done after determining the areas of richer in species, in endemic centers or in places with very high taxonomic diversity." (Pricope and Paragina, 2013).

In Romania, out of a total of 319 urban settlements, more than two thirds are tangent or overlap with a natural protected area (Figure 1). “At European level, Romania has the most diversified and valuable natural heritage due to its geographical position and varied topography. Of the 11 existing biogeographical regions at European level (Alpine, Anatolian, Atlantic, Arctic, Pontic, Boreal, Continental, Macaronesian, Mediterranean, Pannonian and Steppe) there are 5 in Romania, being the only country on the continent that has more of 4 biogeographical regions.” (Pricope and Paragina, 2013).

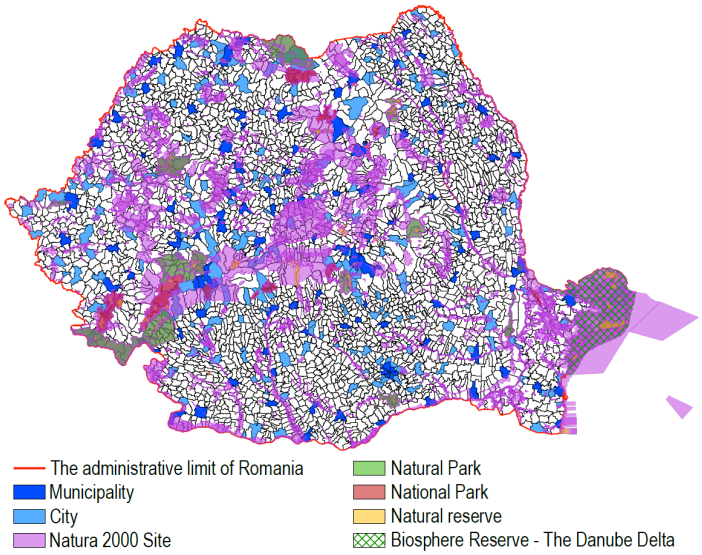

Figure 1. Natural Protected Areas in Romania

2. Management of Natural Protected Areas in Romania

Although conceived from the very beginning based on the IUCN guidelines, matching its categories, the Romanian network of natural protected areas had some conception problems, especially when new areas were declared in preparation for the Romanian accession to the EU, due to the overlapping of different categories (Iojă *et al*., 2020). The management of natural protected areas in Romania has always been difficult. The main problem was that of those responsible for the conservation of areas, which led to the syndrome of "natural protected areas on paper" (Pricope and Paragină, 2013) - areas are declared by governmental legislation, but do not have an administrator. “Until 2000, there was only one protected area with its own administration: the Danube Delta Biosphere Reserve” (Pricope and Paragina, 2013), and until 2013, only 41 custodians were declared. Before 2018, only 50% of the Romanian natural protected areas were really protected, having a custodian and a management plan (Petrişor and Andrei, 2019).

In 2018, the situation changed radically. By emergency ordinance 75/2018 for amending and supplementing some normative acts in the field of environmental protection, the administration of all natural protected areas was taken over by the National Agency of Natural Protected Areas. On the Agency's website (http://ananp.gov.ro/), 1574 natural protected areas are listed. The management of so many natural areas by a single institution can have serious consequences. It is impossible for such a small staff (probably less than 10 people) to cope with such a large volume of work. At the same time, there is a risk of adopting a superficial management, being very difficult to adapt to the context, especially when it comes to 1574 different situations. After the adoption of this legislative act, the status of custodians became uncertain. Some of them have become collaborators of the Agency, but it is not known exactly what decision-making power they have in the management process.

The potential conflicts between development and conservation, visible in the Romanian natural protected areas (Petrişor *et al*., 2016b), are even more serious in the areas neighboring human settlements. Currently, there is no legislative act with a strict impact on natural protected areas in the urban environment, at national level. Therefore, they are subject to the same rules as natural protected areas that are not inside or in the vicinity of a city.

3. Natura 2000 Network and Natural Parks

For the current study, only two types of natural protected areas were considered: Natura 2000 sites and Natural Parks, being among the areas that overlap or are mostly tangent to urban settlements. The Natural Parks correspond to IUCN "protected landscapes". The Natura 2000 network is the most important and widespread network of natural protected areas in Europe. "The instrument that will underpin the implementation of the principles of the European strategy is the European Ecological Network of Natura 2000 natural protected areas, which already comprises 25,000 natural protected areas, totaling 18% of the EU area" (ec.europa.eu as cited in Pricope and Paragina, 2013).

The situation of natural parks in urban areas is a relatively recent topic at national level, which grew with the establishment of the first urban natural park in Romania – Văcăreşti Natural Park, which will be described below, being one of the three case studies. The areas where the two types of areas are the most widespread and numerous, overlap with the Carpathian area (for Natural Parks and Natura 2000 sites) and the Danube Delta area and nearby areas (for Natura 2000 sites).

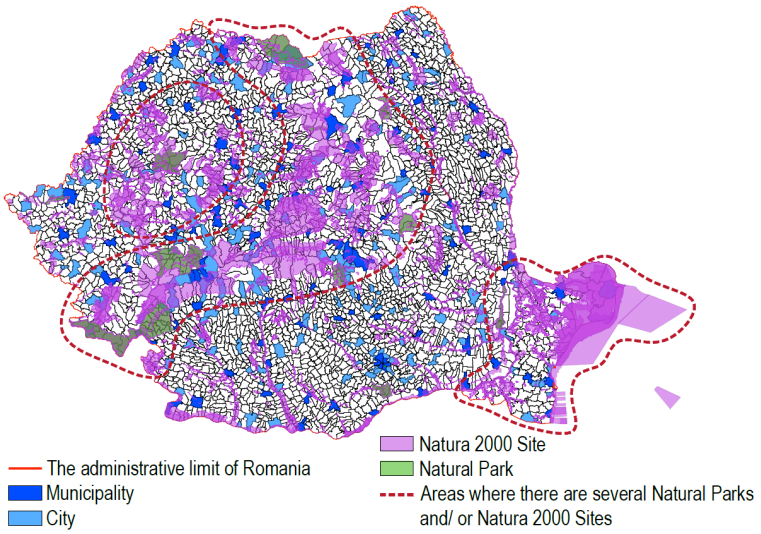

Figure 2. Natural Parks and Natura 2000 Sites of Romania

3.1 Types of spatial relationships between the Natural Protected Areas and urban settlements

3.1.1 Types of location of Natura 2000 Sites in relation to cities

Natura 2000 sites are the type of natural protected area that occupies the largest area at national level, compared to any other category of natural protected area (Figure 3). According to the National Agency of Natural Protected Areas, out of the total of 1574 natural protected areas declared in Romania, 606 are Natura 2000 Sites, of which 435 are Sites of Community Importance (SCIs) and 171 are Special Protection Areas for Birds of Prey (SPAs). Out of the total of 319 urban settlements, at least half are related to a Natura 2000 Site. Out of the total area of the country (23,839,700 ha), approximately 31.69% is occupied by Natura 2000 Sites (7,555,921 ha).

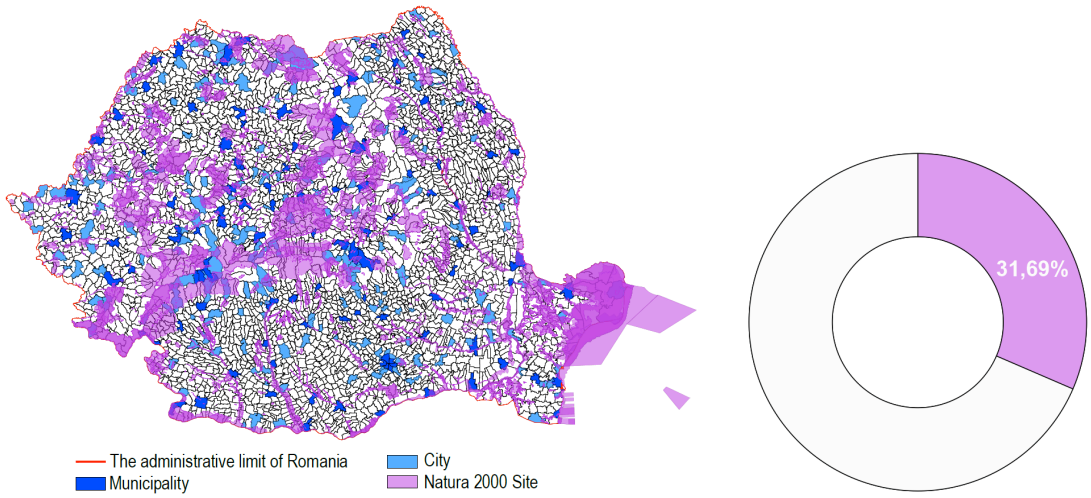

Figure 3. Natura 2000 Sites in Romania and the percentage of spread at the national level.

The arrangement or spatial relationship of Natura 2000 sites with urban settlements differs from case to case and may have different intensities, depending on their location and the type of connection between the natural area and the urban fabric. Using the intensity of connections as the main analysis criteria, the relationships were classified as follows: weak relationship - in the case of natural protected areas near the urban settlement, medium relationship - for natural protected areas tangent to the urban settlement, strong relationship - in urban settlement and very strong relationship - when one of the two is completely overlapping the other (Figure 4).

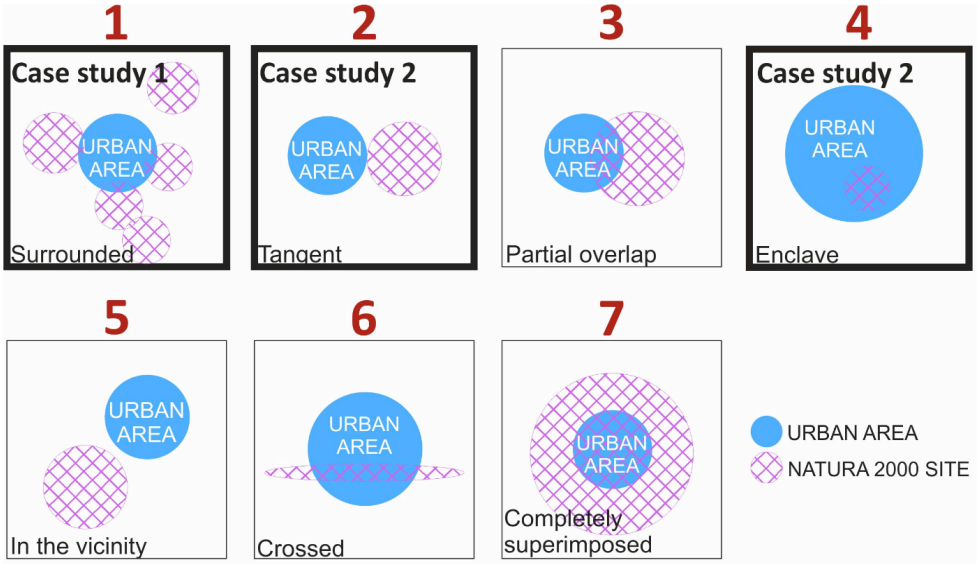

Figure 4. Typologies of spatial relation of urban settlements with Natura 2000 Sites

3.1.2 Types of location of Natural Parks in relation to the cities

Compared to the Natura 2000 Network, the Natural Parks are much smaller in number and occupy a much smaller area. According to the National Agency for Natural Protected Areas, out of a total of 1574 natural protected areas, only 14 are Natural Parks, and only one of these is a natural urban park. Of the total area of the country, approximately 2.13% is occupied by Natural Parks (506,930 ha).

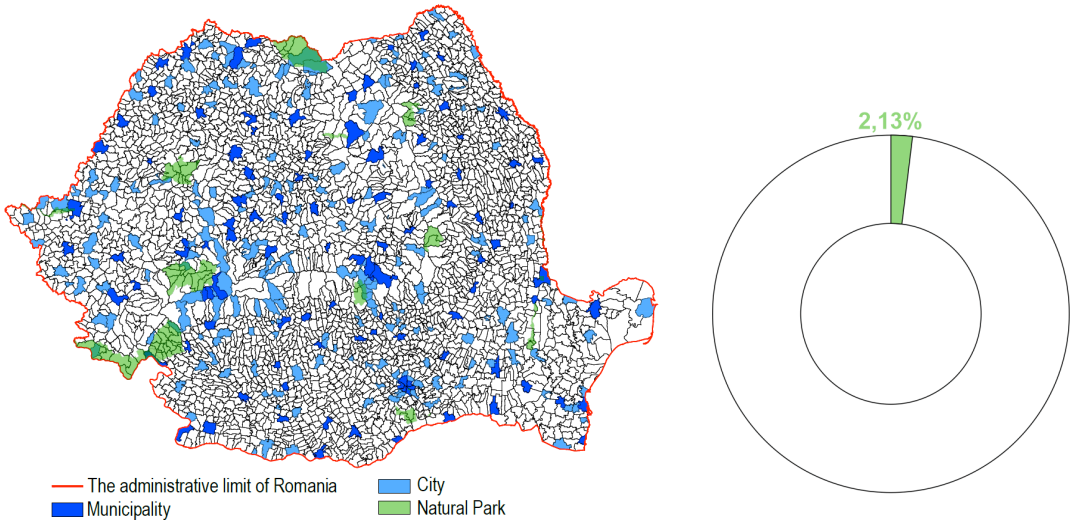

Figure 5. Natural Parks in Romania and the percentage of spread at the national level.

The ways in which the natural parks relate to the urban fabric are, in most cases, similar to those mentioned for Natura 2000 sites. What is interesting to note is that although there is only natural urban park at national level, there are numerous and different situations in which natural parks relate to the urban environment (Figure 6)

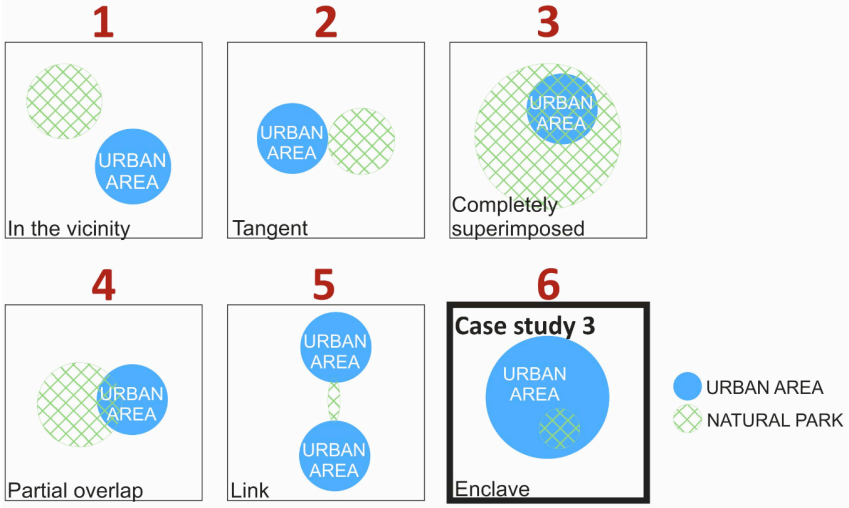

Figure 6. Typologies of relation of urban settlements with Natural Parks.

3.2 Case studies

3.2.1 Natura 2000 Sites

In order to illustrate such different ways of relating between Natura 2000 Sites and the urban environment, but also to obtain a clear image from the point of view of the way in which the management of such a type of protected area is carried out, two case studies were chosen, which comprise three different natural protected areas as morphology and as a way of location at zonal level (in relation to the urban settlement) and at national level. The first area is located in western Romania, and the other two (analyzed simultaneously and together) are located in the east (Figure 7).

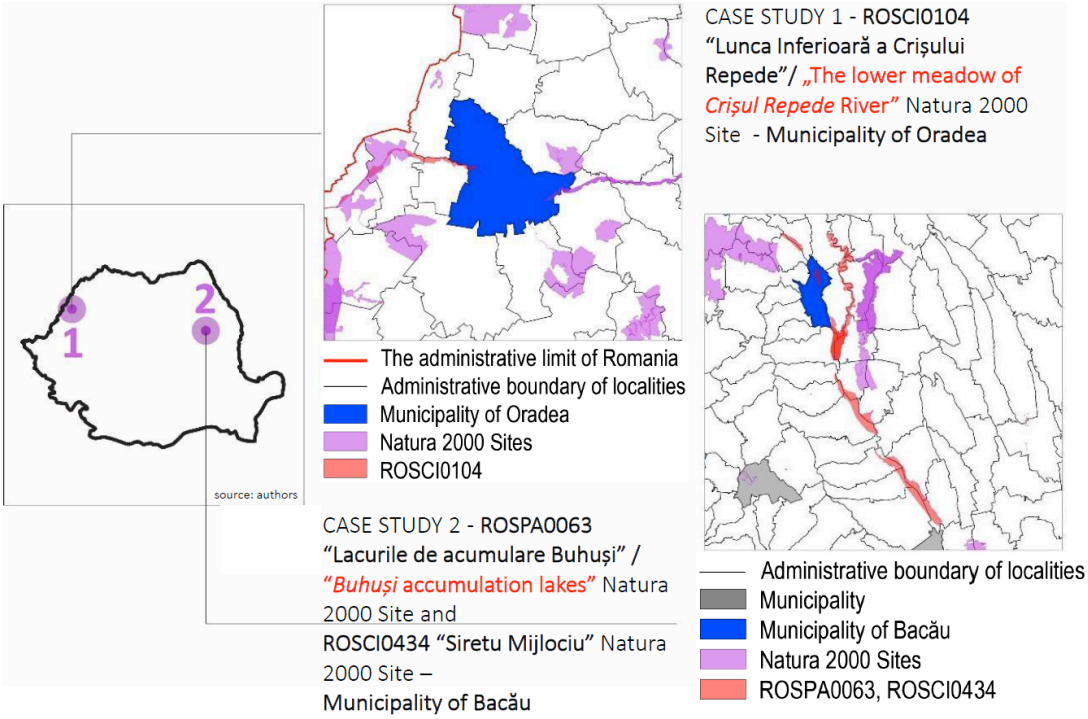

Figure 7. Natura 2000 Case Studies

The first case study analyzes an area of SCI type - area ROSCI0104 "Lower meadow of Crişul Repede", which is partially overlapping with the municipality of Oradea in its western part. From the management point of view, the area is privileged, because it has its own normative act - a management plan. Through this management plan valuable information is provided on the resources of the area, the characteristic species and habitats and their spread in the territory. However, the plan strictly addresses the territory within the boundary of the protection area, without taking into account the context in which it is located and any existing or possible relations with the outside, or even with other natural protected areas in the vicinity. From this point of view, the municipality of Oradea has a special location within the Natura 2000 Network, being related (located in the vicinity or partially overlapping) with eight Natura 2000 Sites, which are arranged relatively on the perimeter of the administrative area of the municipality. The relationship between the ROSCI0104 area and the urban fabric is completely ignored in the management plan, so there is no act to differentiate between this area or any other area that is not related to an urban settlement.

The second case study simultaneously addresses two areas: a SPA type area - ROSPA0063 "Buhuşi accumulation lakes" and a SCI type area - ROSCI0434 "Middle Siretu". The reason they were approached together is their different character and different relationship in relation to the same urban settlement (Figure 8). The ROSPA0063 site is a multi-site (consisting of several sites scattered throughout the territory) and includes a portion that is tangent to the municipality of Bacau, in the south, and a portion that is arranged as an enclave in the urban fabric, in the north. The site ROSCI0434 partially overlaps with the site ROSPA0063 and is also tangent to the municipality of Bacau, in the southern area.

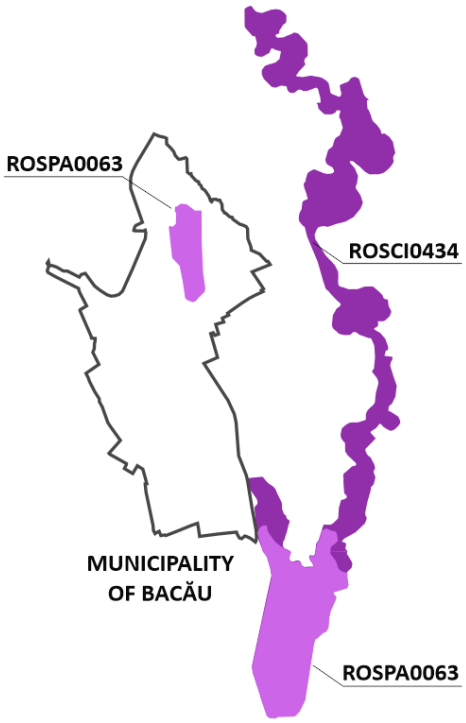

Figure 8. The arrangement of the analyzed areas in relation to the municipality of Bacău.

Unlike the first case study, the two Natura 2000 Sites do not have a management plan. The only official source of information about the two areas is the Natura 2000 Standard Forms. The information provided through these forms is presented only in written form, without being located in the territory. Similar to the first case study, the relationship with the urban environment is not addressed and regulated in the case of these two areas.

3.2.2 Văcărești Natural Park

The third case study presents the situation of the only urban natural park in Romania - Văcărești Natural Park. This area is located inside the urban fabric of Bucharest (Figure 9) The park was recently declared a natural protected area, in 2016, by Government Decision no. 349/11.05.2016. It is interesting how it has formed over time. During communism, this space was dedicated to the construction of a hydrotechnical arrangement to protect Bucharest against floods, similar to Lake Morii, located in the western part of the city. For the construction of Lake Văcărești, the houses on the surface of the current park were demolished and the perimeter dam was raised, which currently represents the limit of the natural protected area. Its construction was completed in 1989, before the fall of communism in Romania, and then it was abandoned. Over time, nature has regained control of the area once destined for the lake and is now recognized especially for the bird species that land here during the migration season. Although the park has been declared a natural protected area, it is still subject to pressure - fires that spread very quickly, illegal waste storage, real estate pressure, poaching (Merciu *et al*., 2017). The Văcărești Natural Park is still unknown to some locals, who say that they pass by the dam that surrounds the park every day, but they still don't know what is beyond it. Declaring the park as a Natural Protected Area was a long and extensive process. One of the main causes was its special character, which does not resemble that of any other natural protected area in Romania. Finally, it was declared a Natural Park category V IUCN, being the first such area located in a city in Romania.

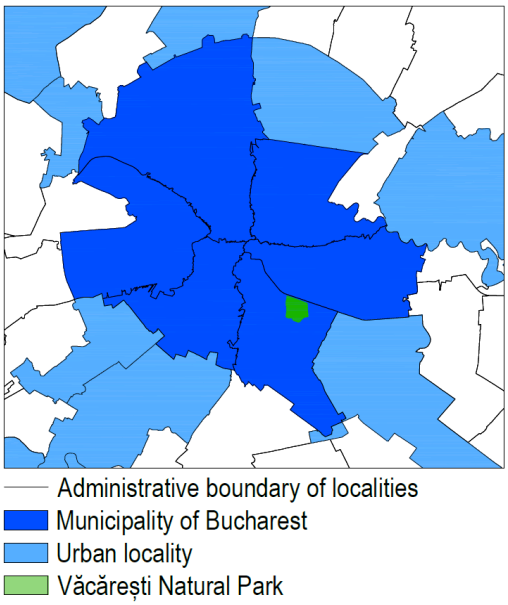

Figure 9. Framing the Văcărești Natural Park in Bucharest

The management plan of the Văcăreşti Natural Park is in the process of elaboration. In its absence, the website of the area lists only a set of "minimum protection and conservation measures" - divided into urgent measures and long-term measures. Urgent measures aim at eliminating or reducing the pressures to which the park is subjected (fires, poaching, fishing, waste storage, cutting and harvesting timber), providing security, arranging minimum visiting infrastructure, limiting access to areas where colonial birds nest, conducting studies and collecting data necessary for the preparation of the management plan. Long-term measures include: planting trees to ensure a suitable habitat for bird species characteristic of lowland forests, protecting reed areas, updating inventories for species present in the park, conducting thematic courses, conserving favorable habitats for endangered species. community interest.

The Văcăreşti Natural Park Association supports the public's involvement in the park's projects. Those who want to get involved in the activity of the association, can become volunteers/"urban rangers", by filling in a registration form, available on the park's website. Those who want to take part in projects as visitors to the park, or just to participate in one-off events, can consult the list of projects available on the website. There is also the possibility to become a shareholder by redirecting a percentage between 2% -5.5% of the income tax.

All these ways of involvement are presented on the website of the Association (https://parcnaturalvacaresti.ro/) - the main way of providing information and of acknowledging citizens on how they can contribute to the conservation of the park. The site provides the public with information about the flora and fauna of the park. This information is, however, of a general nature, and is not located in the territory.

A transdisciplinary approach to the park's relationship with its immediate vicinity and connection to the city is needed, including as historical, evolutionary, community, memory of the place, correlated with opportunities, risks and ethical values that may result in the integration of this "sensitive" natural area. In a difficult area of urbanized anthropic landscape (Craciun and Acasandre, 2015). With a "character resulting from the action and interaction of natural and/or human factors", landscape management includes "actions aimed, in a sustainable development perspective, at maintaining the landscape in order to direct and harmonize the transformations induced by social, economic and environmental developments" (Committee of Ministers of the Council of Europe, 2000).

3.2.3 Comparison of the case studies

The management plan is the most important document that regulates possible activities within a natural protected area and can significantly contribute to the conservation process. However, the analysis of the three case studies presented above shows that the way the area is managed and the custodian/manager approach can have a much stronger impact. In the case of the first area, although there is a management plan, it does not deal with the context. The next two Natura 2000 sites, presented in the same case study, are in the most unfavorable situation, not having a management plan, but only information in written form. The latest case study, Văcăreşti Natural Park, is the most privileged from the management point of view, probably also due to

its favorable location in the capital. Although the park does not yet have a management plan, it is managed in an exemplary manner by the association, being the perfect place to carry out actions with the theme of ecology, environmental protection, or any other related topics.

4. Management principles and decisive factors in the quality of management

Being the only document that regulates the protection of natural protected areas, the management plan should be adapted primarily to the context of that area. This is even more important in the case of natural protected areas in urban areas, especially in the current circumstances where there is no law dedicated to this type of area at national level. The management plan should include the main directions of the conservation strategy, but taking into account the context of the natural protected area.

As noted in the case of Natura 2000 sites and natural parks, in Romania they are arranged in different ways in relation to the urban fabric. Depending on the morphology of the area, the degree to which the urban fabric has effects on the natural protected area can be established. A natural area in the vicinity of the urban environment will be less affected by the urban fabric, as opposed to another area arranged in the form of an enclave in the urban fabric. Another criteria that can reflect the degree of relationship between a natural protected area and the urban fabric is the "collage" specific to the area in the vicinity of the natural area - defined by the functions in the area, activities, flows or building density. All these criteria that define the state of conflict between the urban fabric and the natural protected area must be found in the management plan for an area in the urban environment.

The approach in the management of the Văcărești Natural Park focuses on the involvement of the public and especially of the children. In an interview with architect Kate Orff, the mayor of Lexington said that "if you can excite the kids about a project then you've got a great chance of exciting the parents and citizens" (as cited in Orff, 2016). Involving the population in the process of conserving a natural protected area is an action that supports mutualism. Public participation can give the feeling of belonging to the place through the direct involvement of the locals, so the benefits are bilateral. Marketing and involvement of those interested in the conservation process can have a strong impact on the benefit of the natural protected area and should be taken into account in drawing up the management plan for that area.

5. Conclusions

Recent legislative changes affecting the management of natural protected areas in Romania have further complicated the process of protection and conservation of these areas. Currently, all natural protected areas in Romania are under the responsibility of a single institution, whose staff cannot manage such a large volume of work. Moreover, even if there are enough staff, it is very important to know the area and its surroundings, so that the management plan can be adapted to the context. The fact that at national level there is no law with strict reference to natural protected areas in the urban environment makes the process even more difficult - natural protected areas in the urban environment or in the vicinity, are treated similarly to areas that are not

located in the vicinity of the urban environment. Legislative issues related to custodians or legislative acts affecting natural protected areas in the urban environment are not the only dilemma in the management of areas. The management plan - the only act that regulates the conservation of the area, should be indispensable in the case of each protected area. In reality, only a very small percentage has a management plan and yet, often the relationship with the context (implicitly, with the urban fabric) is completely neglected or even completely ignored.

The importance of green spaces and urban heritage landscape areas is becoming very important today, including from the current perspective, the situation generated by the COVID-19 pandemic, which has produced major changes in human settlements. The lockdown, probably the most drastic measure imposed, has led to a very sharp decline in human activity - this is visible, especially in the urban environment but has also had ethical effects, related to raising the quality of life in urban areas and the right to landscape of each individual and of the community.

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Website of the Vacaresti Natural Park Association (https://parcnaturalvacaresti.ro/)

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Brownfield Remediation in Austria – Successful Stories

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The Asian Conference on Sustainability, Energy & the Environment 2020
Official Conference Proceedings

Abstract
Deindustrialization created brownfields throughout all traditional European industrial regions. Their significance is understood due to their adverse socioeconomic impacts. The regeneration of derelict and underused sites for inner urban development can limit the pressure on greenfield sites around cities. The process, involving their reintegration into economy, is a key element of sustainable urban development, tackling environmental, social, economic and cultural issues. Recent European brownfield policies simultaneously address environmental protection and spatial planning. Brownfield sites are an opportunity for saving resources and delivering sustainable urban development. Countries with comparable strong spatial planning institutions (e.g., Austria, the Czech Republic, Italy, Poland, Slovakia or Germany) created and developed specific instruments in order to identify the best practice for sustainable brownfield regeneration by carrying out studies in industrial core regions in which they analyzed the current practices and improved the applied procedures. During the last 50 years, structural changes (e.g., some industrial sectors disappeared, companies merged, and higher quality production is organized on smaller areas) increased the number of brownfields in Austria. Land is a valuable resource and its effective use essential for sustainable development. An important component is the increased number of brownfield sites and complexity of their renewal. This article presents representative Austrian case studies (the Styrian Iron Road, Sargfabrik in Vienna, remediation of the hydrogeological basin unit Mitterndorfer Senke, Tabakfabrik in Linz, Anker Brot Factory, W18 Simmering Gasworks and the Gasometers in Vienna), indicating that brownfield regeneration is a sustainable solution for land and opportunity for introducing sustainable solutions in design.

Keywords: Brownfield, Land Use, Urban Planning, Austria, Urban Regeneration

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1. Introduction

Deindustrialization has resulted in the creation of ‘‘Brownfield Sites’’ throughout all the traditional industrial regions of Europe. The significance of the brownfield issue is well understood at the European level. Their adverse socioeconomic impacts have brought brownfields high on the radar of European Union regional development, environmental protection and urban initiatives (Franz et al., 2006).

The reduction of the agricultural land transformation rate into urban uses and protection of agricultural lands as resources for future food production and environmental sustainability became the European Commission objectives. Regenerating derelict and underused sites and devoting them to inner urban development might be a major way to limit pressure on valuable greenfield sites around cities (Siebielec et al., 2012).

While many European directives come from a technical environmental protection and control background, addressing relevant brownfield aspects separately, a shift can be observed in European brownfield policies to simultaneously address environmental protection and spatial planning issues. Brownfield sites are not solely discussed in technical terms anymore, but as an opportunity for saving resources and delivering sustainable urban development. Such integrated thinking reflects the complexity of brownfield regeneration, and its social, environmental, economic and institutional implications (Franz et al., 2006).

In Romania, the term “Brownfield” is obviously misunderstood. Countries with comparable strong spatial planning institutions such as Austria, the Czech Republic, Italy, Poland, Slovakia or Germany have created and developed specific instruments in order to identify the best practice for sustainable brownfield regeneration by carrying out studies in industrial core regions of their territories in which they analyzed the current practices and derived improvement for the applied procedures. The result was a sustainability assessment tool – SAT, which does not stand alone, but is based on an elaborate framework of objectives, indicators, best practices and tools that reflect the multidimensional and multi-stakeholder complexity that characterizes sustainable brownfield regeneration (Franz et al., 2006).

Other efforts to address environmental and spatial planning issues simultaneously and develop an integrated approach have also resulted in a shift in attention of policy makers from the assessment of problems to the formulation of solutions that will meet the needs of society in a sustainable way, e.g., the CLARINET approach, the CircUse strategy.

The aim of this paper is to explore the spatial effects of the brownfield regeneration process on sustainable urban development by making use of the international experience of Austria in order to come up with spatial planning recommendations that might be taken as models and suit Romania’s needs for public funding and planning security.

2. The Austrian brownfield related practices

2.1. The general context

Austria is a relatively small country land-locked in central Europe and shares borders with eight countries: the Czech Republic, Germany, Hungary, Slovakia, Slovenia, Italy, Switzerland and Liechtenstein. Austria's location in the middle of Europe gives rise to specific environmental issues such as the pressures from intensive freight transit traffic (e.g. air emissions, habitat disruption) and the trans-boundary exchange of acidifying air pollutants and tropospheric ozone precursors (e.g. damage to forests and soil). In addition, only 37% of the national territory is suitable for permanent settlements. This is due to the country's geo-morphological conditions with more than 60% of the territory occupied by mountains. As a consequence, urban sprawl and land consumption occurs in restricted areas, with resulting high pressures on the environment and therefore on finding fast and effective measures for brownfield redevelopment.

Austria is among the European countries with the highest share of renewable energy sources in total consumption, and with the largest share in the use of biomass for heating and energy production. The European Union directive for energy and buildings commits the public sector to start constructing by 2019 only buildings which have almost no emissions and consume no energy (zero-energy buildings). Austria is one of the only five countries in the European Union which already fully met the target set for 2020 - that is, at least 20% of energy comes from renewable sources.

The policy document "Austria Spatial Development Concept" (ÖEROK, 2011, *3rd Strand - Climate Change, Adaptation and Resource Efficiency*) states that the protection from the effects of climate change implies the preservation and expansion of forests, which contribute to the reduction of greenhouse gases emissions. The reduction of emissions can be achieved by reducing energy consumption and increasing energy efficiency through the replacement of fossil fuel with sustainable sources. The same document mentions the following concepts that could be used in spatial development: a compact form of housing, careful and efficient use of land, building of energy efficient houses, underground multilevel parking instead of spacious parking lots typical for commercial areas, environmentally sustainable transport, recycling and renewal of land and buildings (ÖEROK, 2011).

During the last 50 years, structural changes in Austria resulted with increase in a number of brownfields. Some industrial sectors disappeared, companies merged, and higher quality production is organized on smaller areas. In 2009 the term brownfield (*Brachfläche*) was defined by the Austrian Standards Institute as a previously used site or part of a site, which is derelict or underused. Owing to the site characteristics, it offers a potential for reuse.

According to several sources (CLARINET; Battle; Marot, Cernic Mali, 2012; Siebelec, 2012), the main barriers for bringing the brownfields back to use in Austria are:

- Lack of government programs for support of the brownfield renewal at the national level;

- Lack of clear administrative procedures to handle brownfields; as a result, decisions are usually made on case-by-case basis;
- Lack of specific legislation for brownfields;
- Lack of incentives and detaxation for brownfield redevelopment;
- Lack of reliable data on brownfields;
- Brownfields are considered a low priority when it comes to receiving finances for redevelopment;
- Better conditions exist to invest on greenfield sites and investors still prefer them;
- Problems related to potential contamination and costs of remediation;
- Unsolved ownership;
- Different interests of investors and the city; opposing interests within the city administration;
- In Vienna in addition to these barriers, a significant problem is the site availability and the high price of land, especially for former railroad sites;
- More intensive use of cultural potentials of industrial sites can be hampered by low public support, lack of adequate legal support, finances and consistent heritage conservation.

The actors in the brownfield redevelopment process are: national government, regional government, local government, national institutions, private companies and NGOs. Federal Environment Agency (*Umweltbundesamt*) is responsible for the cleaning of brownfields, while the local government is responsible for brownfields redevelopment. There are no specific funding opportunities for brownfield redevelopment in Austria, but subsidies can be gained indirectly from other funding pools: housing, business, development and preservation of historical monuments.

Austria has a federal system where regional development competences are primarily decentralised to the nine Länder. Austria is an example of a country where regionalisation and multi-level governance is long-standing, with a complex distribution of policy responsibilities between and within government tiers. A new perspective on regional policy has taken place over the past decade or so, encouraged by factors such as the recognition of the ineffectiveness of more traditional approaches, changing socioeconomic conditions, slower macro-economic growth limiting any spill-over effect of growth from centre to periphery and the lessening importance of external and mobile location factors. The Structural Funds supported a more coordinated approach to the process, bringing together actors who might not otherwise have worked together within the more fragmented governmental institutional set-ups of the Länder. As early as 1989, ÖROK publication stated that "...the weak region' should no longer just be treated top down as an object of national regional policy but should be viewed as a bottom up self-steering subject.

The two most important federal-level organisations involved in regional policy are the Federal Chancellery and ÖROK, the Austrian Spatial Planning Conference. The Federal Chancellery is the coordinating Ministry for regional policy in Austria and, since 1995, the main federal-level contact with the European Commission on the Structural Fund programmes. The other federal level organisation with direct regional policy responsibilities is ÖROK, the Austrian Spatial Planning Conference, established by the Federal Chancellery in 1971 to coordinate regional and spatial planning at federal level. Its political executive body comprises all the Federal

Ministers, the Lander governors and the presidents of the Austrian Union of Towns and Union of Municipalities. Representatives of the social partners have an advisory role. At Land level, administrative considerations have formed an integral part of the reorientation of Austrian regional policy towards a strong systemic approach, and, during the past decade, a growing engagement of Länder in economic development issues can be observed. To a great extent, the initiative came from the Länder themselves, stemming from increasing awareness among policy-makers (Sturn, 1999). The Länder are increasingly transferring their research and economic policy activities to devolved units which are able, as a rule, to be more targeted and efficient and therefore are in a better position to develop and implement complex strategic programmes.

Below, we present few case studies in Austria where increasing the building density, building compact forms, recycling already used land and buildings, and including the civil and creative class in the regeneration process are successful strategies for a sustainable urban development.

3. Brownfield reclamation case studies

3.1. Styrian Iron Road

The region around the Erzberg in Styria was European pre-industrial center for iron production and manufacture. In the course of globalisation of the resource market the decline started in 1960s. Despite drastic job cuts the region still hosts the only working Central European iron mine due to modern extraction methods and production of high-quality products. The *Steirische Eisenstrasse* (*Styrian Iron Road*) was created in 1978, aiming at retracing the history of iron in Europe and saving it from disappearing. Protection and tourism contributed to the development of a more positive image and creation of the common regional identity. In 2007 the *Central-European Iron Trail* (*Mitteleuropäische Eisenstraße*) was officially recognized as a cultural route by the Council of Europe. This route is a part of the UNESCO's Tentative List for inclusion in the World Heritage List since 2002. It contains a network of sites and has 18 member municipalities.

The industrial heritage along the Styrian Iron Road features 19 ironworks dating back to the 16th century, the Gösser brewery (including a museum), the Leoben Donawitz VÖEST Alpine Plant tour, the wheelworks in Vordernberg and many other traces of the mining legacy. Significant heritage represents old railway from Leoben to Eisenerz. Its most spectacular part is the so-called 'Erzbergbahn' a railway which was opened in 1891 to bring the iron ore from the iron ore mountain to the blast furnaces in Vordernberg and Leoben. The line passes eight viaducts and five tunnels. Goods and personnel were transported until 1978. In the last years railway enthusiasts from all over the world come to watch the steam engines working, and it contributes to doubling the number of overnight stays in the region.

Eisenerz is a town next to the Erzberg (Ore Mountain) where miners' houses, old railway, show-mines and City museum (Stadtmuseum) in the former administrative headquarter of the state-owned mines can be seen. The "Abenteuer Erzberg" (Adventure Erzberg) is probably the most successful project in the area. It is the event facility that uses underground galleries and surface landscape as a spectacular set.

This attraction has a high acceptance among local and regional residents. Those who gain the most from the project are young people, unemployed and former miners. 20 new jobs were created as a result of the project.

Styrian Iron Road is today an identity-forming symbol of the region. Erzberg is the most prominent ore mining example in Central Europe (UNESCO website). Research (Cizler, 2011) revealed that people identify very strongly with the reconstruction of the railway and steam trains, whose success can be attributed to the voluntary work on its functioning. But at the same time, only 26% of young people in Eisenerz consider themselves attached to the region (Funkl, 2010). Similar studies (Cizler, Pizzera, Fischer, 2014), show that attachment to mining as the traditional activity of the region is moderate. Despite the cultural and historical importance of the local mining heritage, these potentials do not contribute significantly to the attractiveness of the region. Although the number of overnight stays increases continuously, tourism is still not an important economic factor. Developing the region into a tourist area requires the establishment of a strong identity and forming a tourist organization which would allow for the joint work of all municipalities. Notwithstanding all these positive initiatives the tourist performance remains below expectations.

3.2. Sargfabrik in Vienna

Sargfabrik is a residential complex for 120 people, located on the former coffin manufacture built in 1895. Sargfabrik was one of the pioneer projects in creating apartments on former factory sites. Production stopped in 1967 and reuse was considered since 1984. The goal of the new project was to achieve the integration of housing and culture. The project was a social experiment, and attempts were made to achieve the alternative and socially conscious way of life and the creation of the village in the city (Cizler et al., 2014). In 1996 the first tenants moved in and in 1998 the state bought the other part of complex, where in the 2000 a new project named Miss Sargfabrik with 39 residential units was completed. Design was created in cooperation with Sargfabrik residents.

People living in the complex have different backgrounds, age and nationalities, and there are subsidies for tenants. The project has received numerous awards, and the long waiting list for move-in shows its success. However, the authenticity of constructions is arguable - only a chimney, building layout and the name “Sargfabrik” resemble the old factory. In Sargfabrik and Miss Sargfabrik environmental aspects are taken into account. Applied concepts are: optimized energy consumption (energy-saving technology, good insulation), composting of waste, solar water heating, heating for the pool secured by PV panels, and large windows allowing for the maximum use of sunlight. Intelligent system of divided levels in sleeping areas increases useful built area in Miss Sargfabrik (Cizler et al., 2014).

3.3. Remediation of the hydrogeological basin unit Mitterndorfer Senke

Mitterndorfer Senke is a hydrogeological unit that stretches from the mountain ridges approximately 50 km south of Vienna towards the north until the Danube River and is home to an important Central European groundwater resource as part of the Vienna basin. This region developed its geological structure by the sinking of a basin along a geological fault system. During the ice ages this basin formed a large depository for

alluvial sands and gravels, sediments which nowadays hold a groundwater aquifer being unique and one of the most important in Central Europe.

Given its significance for groundwater, exploitation for the supply of drinking water to Vienna and its surrounding started during the early 1950s. By the early 1980s analytical laboratory methods and devices became generally available and, referring to the aquifers within Mitterndorfer Senke, a widespread contamination of groundwater by chlorinated hydrocarbons was identified. In this context, the "Fischer-Landfill" gained a remarkable negative publicity. Already since the 1970s competent authorities started combating illegal activities as well as withdrawing existing licenses for waste disposal. However, as the former operator of the landfill made full use of legal courses, it took a long time for a final verdict to come into force (Eionet NRC Soil Report, 2015). The remediation project was terminated by January 2008 and operations November 2009. Whereas the hydraulic barrier limited groundwater contamination and therefore prepared the recovery of several public drinking water wells of towns and villages south of Vienna, Mitterndorfer Senke nowadays is not at risk anymore from leaking barrels and spreading of chlorinated hydrocarbons and it contributes safely to supply drinking water to the City of Vienna and its surrounding.

3.4. Tabakfabrik in Linz

Peter Behrens and Alexander Popp designed the tobacco factory in Linz in 1935. It was the largest and most modern tobacco factory in Central Europe. With the exception of few new buildings, the whole ensemble (including the interior decorations) is listed under the historical monument protection since 1981. It was bought by the city in 2009 and a group of architects, urban planners and social scientists are engaged in the process of transforming the building today. Sponsors are private supporters, federal, provincial and local governing bodies. Since 2010 the Tabakfabrik hosts a non-profit organization *Linzukunft*, as well as the *Umbauwerkstatt*, a think tank and research lab for the future of the factory, providing independent information and transparency to citizens. The rental structure is differentiated according to the quality categories of premises and is based on transparent criteria. Financially weaker initiatives have a permanent place in the complex, according to the principles of the just society, and there are three rate levels: commercial rate, special rate and cultural rate. 2% of the complex is permanently used and about 100 people work there. There are about 15-20 events every month (Cizler, Pizzera, and Fischer, 2014).

Though the city invests in the projects, it agreed to an experiment with an open end and there is no master plan for the area. City planners recognised that since the site is a great chance for the city it should be planned carefully (Meinhart, 2012). The development of the Tabakfabrik is not planned in a conventional sense, but the space is open to experiments. This is in accordance with the approach that Behrens had while designing the Tabakfabrik and its big, open and adaptable spaces. The Tabakfabrik is not seen as solely commercial, but as a cultural policy and urban planning project, that should belong to everyone and stay public.

3.5. Anker Brot Factory (The Loft City) in Vienna

Ankerbrotfabrik is a bakery built in Vienna in 1891. This was one of the largest manufacturers of bakery products in Austria and one of the biggest bakeries in Europe. Thanks to the advancement in technology and logistics, production continues only in part of the complex and unused parts of the complex were sold. Since 2009 the new project, the Loft City has been implemented. Some of the buildings in the complex are protected and the goal is to obtain the status of a cultural monument for more buildings in the complex. As Walter Asmus, one of the architects and investors of the project stated in the interview, owners and residents generally prefer when the object is not protected, mostly because then they have greater freedom in using it. In his opinion, industrial heritage in Austria does not enjoy great protection and no importance is given to it as to other types of heritage, or as it would be the case in some other countries (Cizler, Pizzera and Fischer, 2014).

The Loft City project is characterized by great flexibility. Investors have only partially restored buildings and lofts only minimal design. Users can adapt the space according to their possibilities and needs. Lofts accommodate studios for artists, photography gallery with public library, Hilger Brot-Kunsthalle, exhibition space, music and media academy and a charity organisation. The small hall from 1912, Expedithalle, serves as a temporary space for exhibitions, musical and theatre performances, functioning through a special program allowing artists to use temporarily the space under favourable conditions (Cizler et al., 2014).

3.6. W18 Simmering Gasworks-Vienna

On October 31st 1899 the newly constructed gasworks in the Vienna district Simmering began its operation. It was the beginning of gas production by the municipality of Vienna. Previously gas had been supplied by about 20 private gasworks, mostly under foreign ownership. In the years following 1899, the private gasworks were steadily diminished. Most of the older gasworks were decommissioned and finally the entire gas production was in the hand of the municipality.

During the Second World War, the Simmering Gasworks, like other important infrastructure, were a primary target for air raids.After the end of the war, fission of natural gas became viable and the primary technology for producing “city gas”. As a consequence, the production of gas from coal at the Simmering Gasworks was terminated on May 11th 1966. Causing serious contamination of soil and groundwater, Simmering Gasworks was one of the first historically contaminated sites to be listed in the national remediation program in 1990. Since 1993 several investigation campaigns were conducted to identify contamination hot-spots and develop a good understanding regarding the distribution of contaminants. Accordingly, by the year 2000 the site was classified as “priority class 1”, indicating urgency for financing and implementing remediation measures within the national remediation program. In parallel to the remediation activities at the hazardous site W18 Simmering Gasworks, the location of the former Simmering Gasworks has been developed as a new city quarter during 1999-2016, linking the functions of housing, recreation and commercial activities.

3.7. Gasometers in Vienna

Gasometers were built in 1899 in Vienna. They were the biggest gasometers in Europe at that time and they were used until in 1975. They are protected as cultural heritage since 1986. Vienna Business Agency has played an important role in the restoration of the site and acted as a mediator between the private and public sector. It owned about 20,000 m² of land that was sold to three non-profit contractors who worked on the project. Four architectural teams that wan the competition in 1995 were in charge of re-using four gasometers (Gasometer A - Jean Nouvel, Gasometer B - Coop Himmelblau studio, Gasometer C-Manfred Wehdorn and Gasometer D - Wilhelm Holzbauer).

Although Gasometers are recognised as a successful urban renewal project in the architectural and social terms, there are doubts about their economic viability. The project has contributed to the restoration of the previously poor and neglected area, and three of the four buildings are used for social housing (Cizler, Pizzera, and Fischer, 2014). However, a large number of stores intended for commercial functions is now unused.

In the years 1998 to 2010 the site was successively adapted to the needs of a modern gas network operator. In this development phase 14 buildings were constructed or rehabilitated. Historical buildings from the time of the city gas production were partially retained and given a new purpose. In 2013 three municipal enterprises, Wien Energie Gasnetz GmbH, Wien Energie Stromnetz GmbHand and Wien Energie Fernwärme were merged into anew enterprise: Wiener Netze GmbH ("Vienna Networks"), combining networks for gas, electrical power, district heating and communications in one enterprise (Eionet NRC Soil Report 2015).

4. Conclusions

Due to the relatively small size of the country, land is a valuable resource for the Austrian state and its effective use is essential for sustainable development. The threat to this is the urbanization and expansion of urban areas. Sustainable urban development involves protection of the natural landscape and the development of compact forms of housing. An important component of land use is the increase in the number of brownfield sites and the complexity of their renewal.

Brownfield renewal is of particular importance in countries such as Austria, where one of the major challenges in the planning is migration to urban areas. Increased demand for housing and work space leads to the pressure on urban areas and to the urban sprawl. It is necessary to increase awareness of the importance of brownfield renewal and of the incorporation of climate-liable solutions, initiated through projects such as the Smart City. Awareness of the possible use of cultural resources that brownfield sites have is growing, even among private investors who want not only to preserve the original structure, but aim at social inclusion of the people into the project. Considering the fact that Austria is among European countries with the highest share of renewable energy sources in a total consumption, potentials for the further development of innovative, climate-liable solutions are great and case studies from this country can serve as good examples.

In Austria, spatial development and spatial planning are considered a joint task of the federal level, Länder and municipalities. In this context, a specific form of distribution of spending and competences has evolved historically and has become established within the multi-level system of the territorial authorities and taking into account the diverse interests to be satisfied. The further improvement of these basic cooperative structures is one of the most important ideas of the Austrian Spatial Development Concept which advocates a "space for all" (ÖREK, 2011). The hubs need to be optimised and the mutual consideration of the actors guaranteed within the current system of spatial planning and spatial development. Today, more can be achieved in collaboration; "space for all" also stands for a participative planning process that includes the political-administrative system as well as companies, associations and civil.

As shown trough the case studies, brownfield regeneration is not only a sustainable solution for the land, but it is also an opportunity for the introduction of sustainable solutions in the design. Measures in redevelopment of brownfields, especially recycling of land and buildings, have a direct positive impact on adaptation to climate changes. They increase the capacity for dealing with change. These measures will reduce emissions, increase resistance and make adaptation to the impacts of climate changes. The positive impact is reflected in encouraging a compact development, preservation of natural ecosystems, conservation of resources, and the reduction of energy consumption, which are the main causes of climate changes (Cizler, 2013).

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ASEAN and Environmental Security Taking Indonesian Haze Pollution as an Example

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The Asian Conference on Sustainability, Energy & the Environment 2020
Official Conference Proceedings

Abstract
Military, economic, trade, and political issues traditionally have been the focus of many international organizations, however, environmental issues have increased in importance, given its impact on issues of both trade and national security. In organizations including the Association of Southeast Asian Nations (ASEAN), environmental pollution and climate change are becoming prominent topics of discussion, despite being a field traditionally limited to areas of scientific research.Indonesia is both the most significant contributor and victim of the Southeast Asian haze. However, haze pollution is a transregional environmental problem affecting all neighboring countries including Malaysia, Singapore, and Vietnam. Many of these countries recognize the importance of organizations such as the ASEAN in addressing these issues and hope that treaties and negotiations can form long-term solutions.This paper investigates environmental treaties belonging to the ASEAN framework, including the ASEAN Agreement on Transboundary Haze Pollution (AATHP) and the ASEAN Peatland Management Strategy 2006 – 2020. This study uses a 'level of analysis' system to explain the long-term impact of haze pollution on Southeast Asian countries and proposes further possibilities for transnational cooperation on environmental issues in the ASEAN.

Keywords: Levels of Analysis, Environmental Overnance, Haze Pollution, Climate Change, ASEAN

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Introduction

In an international society system military, economic and political issues have been the focus of many international organizations, however environmental issues have become increasingly significant, given the impact of environmental factors on issues of both trade and national security. In response to issues of climate change, political considerations of individual countries are important meaning effective responses must be multilateral decisions (Giddens, 2011). Climate change is no only a natural science issue, but also an international political issue.

Every June to September, haze pollution originates from Indonesia, spreading to neighboring countries in Southeast Asia. Haze pollution has recently caught the attention of international community in 2019; with the air quality index of Indonesian Borneo area breaking the highest level of "dangerous level". Facing serious haze problems in Indonesia, at a public press conference in 2019. Malaysian Minster of Environment, Bee Yin Yeo expressed a wish in holding a conference with the Secretary General of Southeast Asian Nations, hoping to establish a more effective mechanism within ASEAN to solve the long-term problems of haze pollution.

The ASEAN was established in the post-cold war period, partially due to the rise of the Communist movements and the nationalism of Southeast Asian countries. At the same time, Southeast Asian countries have different national interests, national history and cultural backgrounds and must shape the integration of Southeast Asia by seeking common ground. When Southeast Asia countries face transnational environmental problems, in what role does ASEAN partake?

ASEAN Environmental Security Cross-Regions Cooperation

Background of Haze in Southeast Asia

In recent years, environmental issues have received widespread attention in Southeast Asia. The reasons why various regions are concerned about haze pollution include: 1) Haze pollution is a cross-regional problem 2) It will bring economic losses and human health problems. The issue of global warming is now widely concerned and occurrence of haze will make the effectiveness and management of environmental policies in Southeast Asia countries.

In the past, haze was typically caused by forest fires, propagated by El Niño-Southern Oscillation periodicity (James, 1999: 333). Nowadays, the primary cause of haze pollution are forest fires caused by human overcultivation and farming. Local farmers and commercial groups involved in farming and logging intentionally produce fires, particularly in Sumatra, Borneo, New Guinea and Java regions of Indonesia (Wun Cian Lin, 2006: 167). The Indonesian government encouraged develop commercial forest industry by felling tropical rainforest, resulting in rapid deforestation (James, 1999:333-334). Regions of tropical rainforest became cultivated land generally for large single cash crops such as palm, rubber, coffee, and coconut; following processing of these agricultural products and raw materials, many of these products have become the main export commodities of Indonesia. In order to maintain these economic interests, slash-and-burn strategies continue to occur.

Because of the prevailing southwest monsoon, haze pollution affects to Singapore, Malaysia and even southern Thailand; these Southeast Asia countries also to bear the problems caused by haze pollution from Indonesia. These problems including air traffic control, also affecting the economic problems caused by the delayed export of commodities. As the long-term problems of haze pollution in Indonesia have not been solved, these problems have become cross-regional environmental problems, with the ASEAN becoming a platform to solve these problems.

ASEAN Haze Governance Framework

We use level of analysis techniques to discuss the ASEAN governance framework of haze pollution, which is divided into four levels: global, regional, state, and local.

In the global level, under international environmental regimes include the United Nations Collaborative Programme on Reducing Emissions from Deforestation and forest Degradation (UN REDD+) project and the United Nations Forum on Forest and United Nations Framework Convention on Climate Change. From the emergence of environmental governance on the international stage, the World Climate Conference has been a platform for discussing the issue of environmental governance issues in the United Nations. Through multi-party of environmental conferences and scientific technological monitors, the increasingly serious environmental problem has been attributed to human factors. Scientific assessment reports penned by the Intergovernmental Panel on climate change have influenced the subsequent development of United Nations Framework Convention on Climate Change (UNFCCC), including the "Kyoto Protocol" and the "Copenhagen Agreement" to give a set of basic goals for countries, in addition with the vision announced in Agenda 21 to increase the practicality of UN environmental governance. However, the terms of implementation and the environmental costs borne differ from country to country, often affected by various levels of development. In recent years, the Paris Agreement has mentioned forests for the first time in the history of climate negotiations. A consultant to the REDD+ Safeguards Working Group, a coalition of civil society organizations. This universal agreement mandates all countries to conserve and enhance the ecosystems including oceans that draw carbon dioxide from the atmosphere. Through 'Nationally Determined Contributions' each country based on goals based on considerations of national interest including corresponding goals for various environmental issues. A more complete set of goals exist for sustainable forest development; through the United Nations Forum on Forests, more science reports have promoted sustainable forest management and restoration strategies.

At the regional level, ASEAN countries signed the "ASEAN Agreement on Transboundary Haze Pollution" in 2002, which came into effect in 2003. It established a legally binding haze governance within ASEAN to prevent, monitor, and mitigate land and forest fires, through the national, regional, and international cooperation. Among those countries, Malaysia was the first country to sign and approved the agreement in 2002, followed by Singapore, Brunei, Myanmar, Thailand, and Vietnam in 2003. Despite being the main contributor of haze pollution, Indonesia did not sign and approve until October 2014, being the last ASEAN country to sign to this agreement (Haze Action Online, 2014). All ASEAN countries signed the "Singapore Declaration on Climate Change, Energy and The Environment" in 2007, among which included Article 9, which stated a need to "Promote cooperation on

afforestation and reforestation, and to reduce deforestation, forest degradation and forest fires, including by promoting sustainable forest management, combating illegal, protecting biodiversity, and addressing the underlying economic and social drivers." To ASEAN has become a regional platform for express principled declarations on environmental issues in southeast Asia, allowing strengthened cooperation with other international organizations or non-governmental organizations. In 2019, ASEAN also submitted a statement on United Nations Framework Convention on Climate Change COP25, which include important decisions such as forest management and reducing greenhouse gas emissions from deforestation. ASEAN members also coordinate and discuss multiple times a year, examples of which include the first Technical Working Group (TWG) meeting held in Indonesia in 2007 setting up fire prevention mechanisms.

In the state level, Southeast Asian countries have cooperated with Indonesian government to reduce their own cross-regional pollution, carrying out disaster prevention by division of labor between member countries. Singapore has been responsible for supplying advanced high-tech equipment and technical personnel for pollution monitoring, together with Malaysian strengthened fire prevention, and Indonesian preparation for firefighting following an actual disaster (Yang Hao, 2006: 167). During the haze pollution in September 2019, Malaysian Minister of Environment BeeYin Yeo expressed publicly that Malaysia would be willing to help extinguish the forest fires in Indonesia's Kalimantan and Sumatra areas, as the haze also affected Borneo Sarawak areas. Hope to reduce severe haze as soon as possible by starting artificial seeding (cloud seeding) in cloudy areas to induce rainfall.

Last but not least, in local level, non-state actors play important actors in the regimes. For example, Singapore Institute of International Affairs(SIIA) has organized the "Regional Dialogue in Transboundary Haze" since 2006, penning a summary report was about the southern ASEAN region, to help predict the probability of haze in this region. The assessment includes weather, personnel, El Niño-Southern Oscillation, peat land and other indicators, with particular emphasis on an comprehensive assessment of recurrence of fire and haze in the peatlands of Sumatra and Kalimantan.

Case Study: Indonesian Haze

How to Governance

There has two reason that caused haze from Indonesia, the first part is that Indonesia's own peatland, the special soil environment and the natural factors caused by El Niño-Southern Oscillation. The second part is caused by human influence, developed rainforest and traditional cultivation way. I will focus on these two parts in the following paragraph, and under the ASEAN governance structure to put forward improvement policy and its prospect dilemma.

There are almost 25 million hectares' peatland in southeast asia, among them there are 70 percent in Indonesia. These peatlands breed more than three thousand species of plants and animals, and peatlands are the most important Carbon Storage and Its Spatial Pattern of Terrestrial Ecosystem. Extensive peatland are also the main storage places for carbon. Deforestation and conversion the land reduce to cultivated land, especially plantations of oil palm and pulp trees, and repeated fires recently caused

large carbon released into the atmosphere (Greenpeace, 2014). Peatlands from ASEAN countries drain, dry and degrade to burn 2 billion tons of carbon dioxide every year (ASEAN Haze Action Online, 2014). Among them, the fire caused by peatland is one of the important factors that cause haze in Indonesia. Peat soils is composed of plants. If the water in peat soil is drained let soils are easy to burn. And because burning occurs underground, it's easy to make thick smoke and also difficult to extinguish, caused serious forest fires and haze in Indonesia.

In order to increase Indonesia's rice production, Indonesian former president Suharto (*Haji Mohammad Suharto*) implement "Mega-Rice Project". He also took order to development of lowland peat soils in central Kalimantan, and more than one million hectares of forest peatlands were converted to commercial agricultural land (UDN News, 2015). This land cleaning method with serious El Niño Oscillation caused the worst peatlands and forest fire. About 1 million to 3 million hectares of vegetation were burned and most of them were peat without water. The fire went deep into the dry peat surface, causing serious haze pollution and soil problems.

Environment division of the ASEAN Secretariat discussed fire prevention and control actions related to peatlands in 2002, and adopted the "ASEAN Peatland Management Initiative" in ASEAN ministerial meeting 2003. There were four goals below. 1.Enhance awareness and knowledge on peatlands. 2.Address transboundary haze pollution and environmental degradation. 3.Promote sustainable management of peatlands. 4.Enhance and promote collective regional cooperation on peatland issues. The strategy sets out operational objectives that serve as guidance for ASEAN member states and other implementing departments, collaborating partners through actions and timeframe for these actions. The strategy can also play a greater role to provide the formal cooperation among ASEAN member states to solve peat-related problems in the region. Among them, it is mentioned in the management strategy that established sub-Regional Ministerial Steering Committee (MSC) and Technical Working Group on transboundary haze pollution (TWG) for monitoring and solving the haze problems in southeast asia regions. The 21st MSC hold on August 2019 in Brunei, and attended by ministers responsible for the environment, land, forest fires and haze, from, Indonesia, Malaysia, Singapore, and Thailand, and the Secretary-General of ASEAN. During the committee, those countries reiterated their willingness about provide assistance, such as providing technical resources for emergency firefighting assistance in emergencies. Through the ASEAN Meteorological Center, we, continue to monitor and evaluate regional climate and haze, strengthen haze control and management early warning, monitoring, and fire prevention and extinguishing, and improve the Fire Danger Rating System (FDRS). According to "ASEAN Agreement on Transboundary Haze Pollution" Standard operating procedures for monitoring, evaluation, and joint emergency response include alarm levels, trigger points, fire protection and suppression measures (ASEAN, 2018). Last, under the regional haze training network, establish bilateral cooperation between ASEAN members through AATHP.

About second part of the reason caused by human influence, Indonesian president Joko Widodo extended the suspension of granting new commercial concessions on primeval forests and peatlands, and suspended the issuance of new palm oil licenses for three years. And he set up the agency to restore peatlands -- Peatland Restoration Agency. 2.5 million hectares of degraded peatlands in seven provinces have been re-

maintained and restored since 2016. Under the rehabilitation of the Peatland Restoration Agency, and according to the report by Singapore Institute of International Affairs in 2019, it was mentioned that the hot spots in 2018 was much lower than in 2015 in Riau. Through the Peat Care Village (DPG) program, encourages the protection and management of peat ecosystems at the local level which contributed to strengthen the resilience of the forest-free disaster of the forest. Since 2018, it has cooperated with 262 villages, the provincial governments have participated in peatland restoration operations through directly managed financing mechanisms and also created online peatlands. The Peatland Restoration Information and Monitoring System (PRIMS) is used to monitor the recovery status of peat and provide alerts when there is new information. The Indonesian government and agri companies have strengthened the interaction between local government and rural communities, and improved the capabilities of fire prevention, detection, and rescue. Such as Free Fire Alliance (FFA), it is organized with multinational enterprise and NGOs, according APRIL, Asian Agri, Musim Mas Group, PM Haze and Sime Darby. Collaborate to share information, knowledge and resources to achieve the most economically efficient lasting solutions that would lead to a fire and haze-free Indonesia. There are three projects below：1. No burn village rewards. 2. Air quality monitoring. 3. Community fire awareness. In the no burn village program, it takes community as the center, develop the concept of fire prevention and community fire awareness, provide non- burning rewards, and provide agricultural assistance through community participation to further reduce burning risks. The fire-free village project was piloted in 2014 and officially launched in 2015. The project has been five years since last year (2019). At the same time, villages that reach the fire-free standard provided incentives of IDR 100 million per village. It also continued and expanded the scope of influence and village planning.

The challenges and visions of governance

The governance network provides funds, technology, platforms, etc. It made up for the Indonesian government's lack of relevant technology and funds, reduced economic doubts, and was more willing to carry reducing forest fire area, personnel training, and peatland management. Indonesian governance network is no longer limited to official institutions. according NGOs and Multinational Enterprise. Strengthen cross-border cooperation with other countries show the value of environmental sustainability.

The treaty and strategy of international environmental regime didn’t have responsibility to let countries abide. And smallholders find it increasingly hard to participate in these markets, they need the real benefits. Obtain financing and improve its agricultural practices, increasing its production and profits. Like Roundtable on Sustainable Palm Oil (RSPO). There are 8 principles for growers to be RSPO certified.

1. Commitment to transparency. 2. Compliance with applicable laws and regulations. 3. Commitment to long-term economic and financial viability. 4. Use of appropriate best practices by growers and millers. 5. Environmental responsibility and conservation of natural resources and biodiversity. 6. Responsible consideration of employees and of individuals and communities affected by growers and mills.7. responsible development of new plantings. 8. Commitment to continuous improvement in key areas of activity. And another company is Asian Agri. it is one of

the leading national private companies in Indonesia that produces crude palm oil through plantations that are managed sustainably. It has two projects. First, independent Smallholders Empowerment Programs. Second, no land burning policy -- is a pioneer of the smallholder partnership program with the objective to improve the welfare of smallholders' families as well as to support the sustainable palm oil management in Indonesia. Both are reducing the haze pollution in Indonesia.

Conclusion

The Indonesian haze problems is not only exist in Indonesia, it affected to other countries in Southeast Asia. It can also be seen from the case study that Indonesia has a contradictory relationship between economic development and environmental protection. Although the Indonesian government wanted to improve the problem of forest burning, the economic benefits are considerable by deforestation and burning. On the other hand, Indonesia lacks the technology and funds for environmental management to change the agricultural method of burning forests. The contradictory relationships often make relevant environmental policies ineffective. Through the ASEAN's environmental governance structure, the cooperation between transnational and non-governmental organizations, and the Indonesian haze problem is examined from the perspective of "cross-regional governance".

Under ASEAN Environmental governance network. There are three parts of environmental governance network. First, International sociality, Continue the AATHP and formulate more binding regulations to improve haze damage and forest protection. Second, Technology and Funds, through the United Nations, ASEAN Meteorological Center, ADRC and other international organizations, provide information and technology, increase communication and coordination between countries. And conduct supervision, increase fire warning systems, make the haze and fire detection network more comprehensive, and also more beneficial the establishment of a disaster prevention system. Last, Actual operation, in addition to promoting through national government policies, non-state actors must also be included in the governance structure. These non-governmental organizations or corporate organizations provide substantial technical assistance and information transmission.

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Spatial Modeling for People Forest by Using Remote Sensing-GIS and AHP to Support Rural Municipal Sustainable Development for the SDGs

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The Asian Conference on Sustainability, Energy & the Environment 2020
Official Conference Proceedings

Abstract
This research conduct to model people forest in the study area. Although there are many levels of importance to land-use, land-use of people forest must also be prioritized. Prioritizing the people forest land-use by using spatial modeling is play an important role in rural municipal sustainable development. People forest or non-state forest in rural municipality able to act as lungs that can provide coolness and ensure the sustainability of the surrounding ecosystem. Modeling is one of decision support tools for the success of people forest in rural municipal area. Therefore, spatial modeling of people forest plays an important role for fostering rural municipal sustainable development agenda. The methodology used is remote sensing - Geographic Information System (GIS) and Analytic Hierarchy Process (AHP). Remote sensing combined with GIS is done for spatial and attribute data processing which is used as input data. AHP is used to analyze the level of importance of space to find the most potential models based on the pairwise comparison technique. Pairwise comparison in AHP able to help to minimize land-use conflicts of interest by managing the level of importance every criterion. All pairwise comparisons produced are consistent to gain consistent models for multi-criteria decision making. Three potential models are gaining in this research i.e., model 1 = ± 559,14 ha, model 2 = ± 547,55 ha, and model 2 = ± 543,69 ha. Model 1 is selected as potential model for people forest in the study area. The selected model can be used as an alternative model for the spatial planning of people forest area to support rural municipal sustainable development for the SDGs.

Keywords: Modeling, People Forest, Rural Municipality, Remote Sensing, GIS, AHP, SDGs

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I. Introduction

There are increasing concerns on forest and land deforestation which reducing forest and land cover in certain areas caused by both natural and human factors (Luna et al. 2020). Deforestation caused by natural factors such as flooding, strong winds, and tidal waves (Li et al. 2017) and caused by human factor such as mining activities, clearing of plantation areas, felling trees, and fires. Based on monitoring of Forest Hansen satellite imagery from 2000-2012, many forests and lands in Indonesia have experienced deforestation. Indonesia experiences the largest deforestation among other countries in the world, amounting to 1,021 km2 / year (Hansen et al. 2013) and many rural municipalities in Indonesia undergo deforestation. The study shows that one of rural municipalities in Belitung Island experience deforestation from 2000 to 2019 i.e., rural municipality of Gantung, East Belitung Regency of Bangka Belitung Islands Province of Indonesia. The term rural municipality in this study refers to a city in subdistrict. The area of interest (AOI) of land ecosystem of rural municipality of Gantung is ± 16,001 ha. The existing forest consists of ± 8,915.50 ha forest cover and ± 203.22 ha of forest gain. In contrast, the area of forest lost is about ± 2,568.76 ha in that interval time. The percentage of deforestation, by dividing forest loss with existing forest, is 2,568.76 / (8,915.50 + 203.22) = 28,17%. It means for ten years (2000 – 2019) rural municipality of Gantung experience deforestation about 28,17%. This phenomenon if allowed to continue will result in massive deforestation in rural municipality of Gantung. Therefore, the deforestation phenomena must be intervened with appropriate programs (Velasco et al., 2020). One way proposed to address this difficult situation is people forest (Bray et al. 2008).

People forest or called as private forest in Indonesia is defined as forest in land with ownership rights which located in outside the state forest (Safe'i and Sukmara 2019). Site selection for people forest is based on suitable location for the tree planting in that area because the right site for tree planting is one of main factor for good greening with people forest based (Novotny et al. 2021). New studies show that people are willing to pay for good greening (Sass, Lodder, and Lee 2019). Trees are an important part of life (Nyelele, Kroll, and Nowak 2019). Trees can produce oxygen, cool air, provide shade in summer, prevent soil erosion and water pollution, and also tackle climate change (Helen, Jarzebski, and Gasparatos 2019). Trees in terrestrial ecosystems will provide health benefits for the environment (Berg et al. 2015) and the animal species that live around it (Pretzsch et al. 2015). In addition, trees are a transactional place for circular or sustainable economic activities in the community (Husgafvel et al. 2018). Although money does not grow directly from trees, these trees can revive community economic activities (Tate et al. 2019). So, study for site selection of people forest based spatial modeling is play an important role.

The current condition, there is minimum study about site selection modeling of people forest in the developing countries like Indonesia. Selection for people forest generally based on the land suitability for the people forest itself (Bisjoe et al. 2016). much research has been done on modeling but few have addressed modeling of people forests. In Swedia, people forest or private forest is one of important factors in supporting municipal comprehensive planning (Thellbro et al. 2017, 189). By using spatial modeling, any geomatics planner able to desain the study area for green planning like people forest. But the study only just views from forest management

side not the spatial modeling. Researches on GIS and AHP-based modeling usually discuss land suitability for green space. This is adjusted to the problems that occur in each study area. In any rural municipality in Indonesia, it is very important to conduct a community forest modeling study to support its life on land for the SDGs (Jusuf and Darajati 2017). Therefore, new research on spatial modeling needs to be done to support spatial modeling in the area of people forest (Fig. 1).

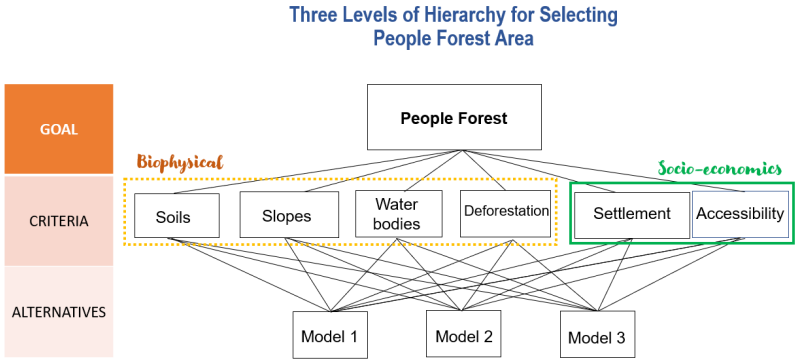


Figure 1: AHP building for People Forest

The problem is how to model the site selection of people forest in rural municipality with deforested area. Remote sensing and GIS based and AHP spatial modeling is a widely used methodology that can assist in the site selection of potential location using multicriteria decision making (Malczewski 2004). The spatial modeling of forest areas has previously been carried out in the protected forest area of Belitung Island using the AHP pairwise comparison method (Fahrudin, et. al. 2013, 594–601). Determination of land suitability for people forest can also be done using a method above with preferred criteria. People forest modeling can be carried out by integrating biophysical and socioeconomic criteria (Arnaiz-Schmitz et al. 2018). This modeling is useful as a spatial decision support system in determining community forest areas (Thellbro 017). The determination of people forest in a strategic program acts as the development of green facilities in rural municipalities to support SDGs (Ordóñez et al. 2020). Hence, people forest modeling based remote sensing-GIS and AHP is effective to be applied in deforested rural municipality area.

Modeling is one of the approaches used to support decision makers towards the complex SDGs agendas (Allen, Metternicht, and Wiedmann 2016). Spatial modeling is a widely used methodology that can assist in the selection of potential locations for community forest development in rural municipality. This approach able to reduce the gap between theory and practice that is often found in community forest area planning in rural municipality area (Bjärstig et al. 2018). Modeling enable us to evaluate spatial planning of people forest for rural municipality comprehensive planning (MCP) because people forest is one of real models of rural MCP. People forest in rural MCP is detailed regional spatial planning and it is customized with every country because every country has its own spatial regulation (Kanako, Mahesti, and Hiromi 2020). A good spatial regulation like MCP is one of key factors in supporting people forest or community forest (Baynes et al. 2015). Finally, people forest able to support rural municipality development for SDGs.

The current paper will study site selection modeling of people forest based on remote sensing-GIS and AHP for finding the best model. A combination of AHP and GIS was used to describe a site suitability model for people forest area. AHP is a very effective tool used in very complex decision making which was introduced by Thomas Saaty in 1980 (Mu and Pereyra-Rojas 2018). In addition, AHP is a suitable technique for evaluating the consistency of results, thereby reducing bias in the decision making process (Aboulola 2018). GIS is a suitable tool for processing data with attributes to obtain regional indicators of suitable locations for people forest (Dragićević, Dujmović, and Minardi 2018). In addition, GIS also has spatial data operations through robust spatial analysis and geo-statistical functions for spatial analysis of the assessment of the suitability of people forest sites (Palaiologou et al. 2020). Rural municipality of Gantung is selected as area of study because this region undergoes significant deforestation number (Figure 2). Taking all this into account, this technique was used to model the potential people forest site on rural municipality of Gantung for supporting fifteenth SDGs agenda i.e., life on land.

Figure 2: Area of Interest (AOI)

II. Data and Methods

People forest relates to biophysics and socio-economic aspects. So, the input data come from these criteria. Biophysical criteria such as soils, slopes, water bodies, and deforestation. Socio-economics such as settlement and accessibility Table I.

Table 1 : Data for modeling people forest

No	Criteria	Source	Explanation
1	Biophysics		
	– Soils	Indonesian Ministry of Agriculture	Vector data year 2003 scale 1:25.000
	– Slopes (derived from DEM Terrasar)	Indonesian Geospatial Agency (BIG)	Raster data dimension 7,5 m x 7, 5 m
	– Water bodies	BIG	Vector data year 2014 topographic map of Belitung island scale 1:25.000
	– Deforestations	Forest Hanson	Raster data Dimension 30 m x 30 m

2	Socio-economics		
	– Settlement	– BIG	– Vector data year 2014 topographic map of Belitung island scale 1:25.000
		– National Institute of Aeronautics and Space of Indonesia (LAPAN)	– SPOT-6
	– Accessibility	– BIG	– Vector data year 2014 topographic map of Belitung island scale 1:25.000
		– LAPAN	– SPOT-6

All data come from different scales and year. Biophysics criteria such as soils, slopes, water bodies, and deforestation. Soils map using in this research come from year 2003. Although it is long time data, many researchers in Indonesia are still using this data. Slope data is gained from national DEM of Indonesia with dimension or resolution 7,5 m x 7,5 m. DEM data is provided by Indonesian Geospatial Agency. By using DEM, slope information in the area of interest (AOI) is gained. Water bodies are derived from topographic maps of Belitung year 2014 scale 1:25.000. Deforestation map is come from Forest Hansen satellite imagery year 2009-2019 with spatial resolution 30 m x 30 m. Accuracy assessment is given to forest Hanson satellite imagery because in Geomatics disciplines it is important to make accuracy assessment for knowing the data accuracy. From the accuracy assessment, it is gained kappa index agreement (KIA) 0,9 and overall accuracy 99%. It is mean that deforestation data using in this research is accurate based on the forest Hanson satellite imagery.

Socio-economics criteria come from different scales and year too. Settlement is gained from topographic map of Belitung year 2014 scale 1:25.000. Settlement information is limited to year it is mapped. In recent year, there are settlement development in the AOI but it is not too significant. In other mean, there is small chance in the settlement growth. Settlement is validated with SPOT 6, year 2019. Same as the settlement, accessibility map is extracted from topographic map of Belitung year 2014 scale 1:25.000. Accessibility maps or transportation utilities are sets of road maps in the AOI which is consist of collector, local, footpath, and other streets. Besides these data, Satellite imagery orthorectified with spatial resolution 0,5 m x 0,5 m is used for positional accuracy provided by BIG Indonesia.

Method using in this research are the combination of remote sensing-GIS and AHP as one of decision-making tools for multicriteria decision analysis. This is common method in the area of site selection modeling. But, in this research there are something different with previous research. The differences are come from local characteristics of the study area and come from the pairwise comparison weighting in the AHP methodology. Although different, but the concept of people forest is same as regulation of people forest in Indonesia. The main research methodology is shown in the figure 2.

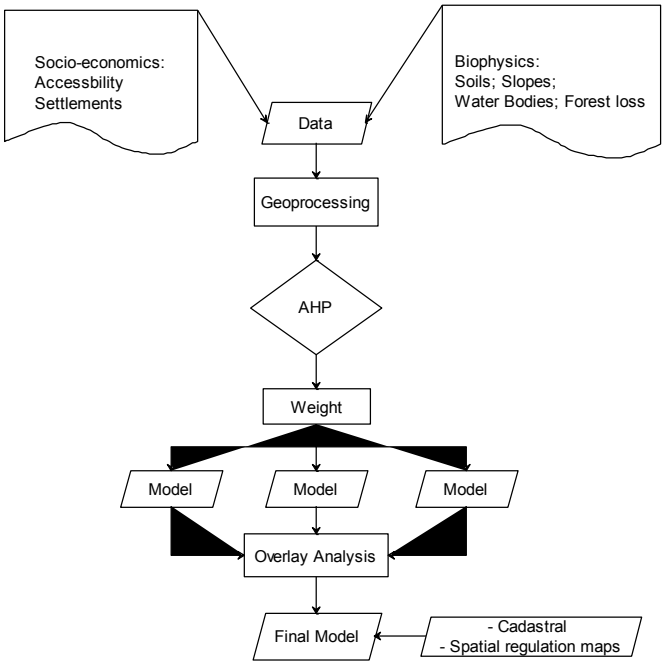


Figure 3: Methodology of spatial modeling for people forest

Step per step in this research is based on the reference from super decision literature written by Mu and Pereyra-Rojas 2018. This is only approach for modeling people forest. Other researchers are free using or not using this approach. The approaches are:

1. developing a model
2. deriving priorities (weights) for the criteria
3. deriving local priorities (preferences) for the alternatives
4. deriving overall priorities (model synthesis)
5. sensitivity analysis
6. making a final decision, and
7. final model (conclusion)

III. Results and Discussion

Hierarchy model of people forest which is used in this research as shown in figure 1. The model consists of goal, criteria, and alternatives (Fig. 2). Criteria in this research derived from the definition and function of people forest itself. Criteria is also gained by using google form quiz and literatur study. Google form quiz is used for making assessment from the expert both academic and experience expert. Literature study is used for supporting selected criteria for the people forest.

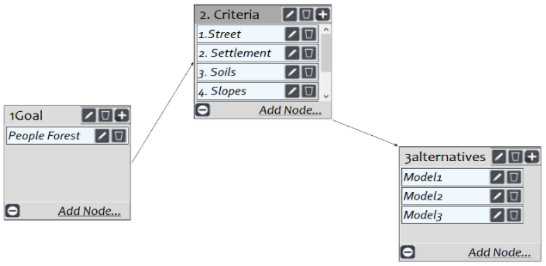


Figure 4: AHP Design for Modeling People Forest

Every criterion has different level of importance. It is the reason for the second step i.e., weighting for the criteria. Assessment for the criteria weight Is based on the level of importance from Saaty (Fig. 3).

1	Equal Important
3	Moderate
5	Strongly more important
7	Very strongly
9	Extremely strong

Figure 5: Level of importance from Saaty

Next, rescaling the spatial data and the attribute data of all criteria. It is important step in spatial modeling based AHP. Rescaling need careful assessment because rescaling result will be used as input data in modeling. So, rescaling as part of weight need to be done carefully (Table 1).

Tabel 1. Rescaling AHP with the level of importance

Soils2.tif

Value	AHP 1	Saaty
1	Extremely strong	9
2	Strongly more important	5
3	Equal Important	1

Tree_loss3.tif

VALUE	AHP 1	Saaty
1	Extremely strong	9
2	Very strongly	7
3	Strongly more important	5
4	Moderate	3
5	Equal Important	1

Water bodies1.tif

VALUE	AHP 1	distance	Saaty
1	Equal	200	1
2	Moderate	300	3
3	Strongly more important	400	5
4	Very strongly	500	7
5	Extremely strong	600	9

slope1.tif

VALUE	Percentage	Name	AHP 1	Saaty
1	0 - 5%	Flat	Equal Important	1
2	5% - 15%	Sloping	Extremely strong	9
3	15% - 25%	Slightly steep	Very strongly	7
4	25% - 45%	Steep	Strongly more important	5
5	> 45%	Very steep	Moderate	3

Settlements2.tif

Value	Count	AHP	Saaty
1	19417	Equal	1
2	16637	Extremely strong	9
3	12739	Very strongly	7
4	8350	Strongly more important	5
5	5008	Moderate	3

Accessibility1.tif

VALUE	distance	AHP 1	Saaty
1	500	Equal	1
2	750	Moderate	3
3	1000	Strongly more important	5
4	1250	Very strongly	7
5	1500	Extremely strong	9

After rescaling, spatial data or geospatial information of all criteria have special value.

The value of all criteria is different to each other. Although the spatial data is different, but the level of importance of the criteria is same. Map pattern of the criteria must different but the value of level of importance have same number based on quiz and literature study.

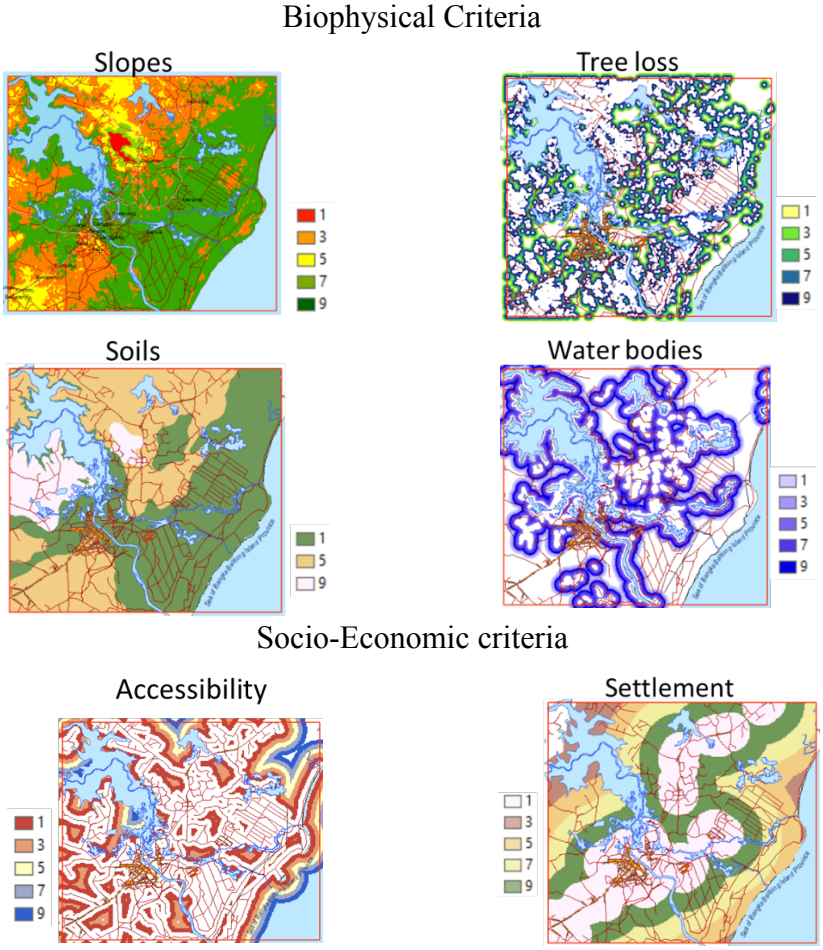
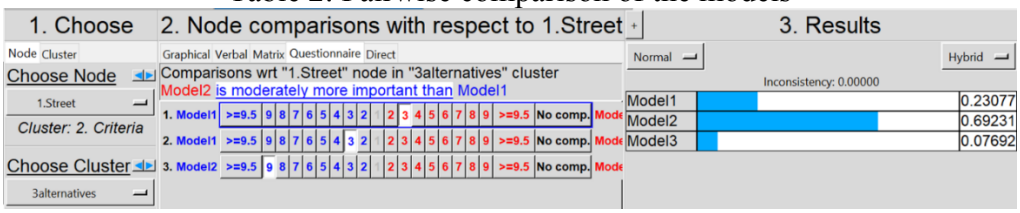


Figure 6: Spatial data of people forest after deriving priorities

All weighted criteria have met the minimum consistency ratio (CR) since numeric value derived from subjunctive preference. The minimum CR accepted is 0.1. CR in AHP modeling compare the consistency index (CI) of the matrix in question versus the consistency index of a random-like matrix (RI) or in other form CR= CI/RI. Local priorities are derived by using pairwise comparison approach. All criteria are compared each other for gaining the best model which CI < 0,1. Model 2 is the highest result model. It means that model 2 is the best model relative to the other ones.

Table 2: Pairwise comparison of the models



Final decision is made by assessing three potential models, model 1, model 2, and model 3. All models are processed by using ArcGIS software. In ArcGIS module AHP modeling able to assess by using weight sum module. Weight sum is selected for process AHP modeling in ArcGIS because it provides decimal number. It is free of using AHP software based on the skills. Weight sum is different from weighted overlay which can only accommodate the integers. All final models provide the

potential area for people forest which have same area and different level of importance.

Model 2 have highest value, 0.69231. It means this is the best alternative model. But, it can not identificate in the model map which one is model 2. To know that model map is model 2, computing the total suitable area of level of important is taken. Every model has same total area with different level of importance. Saaty values for selecting model in this research are 5, 7, and 9. So based on these value, total model 1 is ± 559.14, model 2 ± 543.69, and model 3 ± 547.55. Model 2 as the best one in Table 2 is model 1 after computing the saaty value (Figure 7).

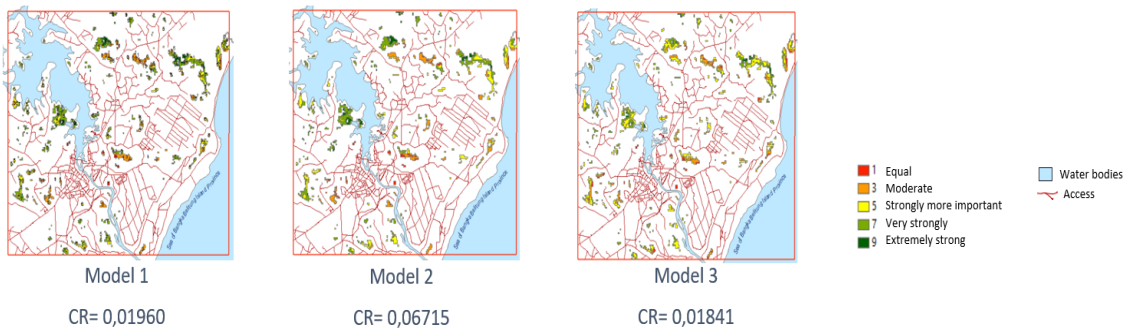


Figure 7: the final models

People forest model percentage per total land ecosystem of AOI is 5 %. This value is gained by comparing total area of people forest versus total AOI, total water bodies, and total land area. Total area of people forest is same for all models i.e., ± 743,71 ha, total AOI ± 16,000 ha, total water bodies 1,894.14 ha, and total land area ±14,105.96 ha. In Indonesia, value 5 % is accepted for fostering people forest which is at least 0,25%. It makes sense for rural municipality of Gantung allocating people forest location only 5% from total land ecosystem of AOI for supporting SDGs.

IV. Conclusion

AHP succeeds in modeling people forest: model 3.1; model 3.2; and model 3.3. Model 3.1 is the best one. Rural municipality sustainable development can be supported by spatial modeling. Spatial modeling using remote sensing-GIS and AHP success to be done. Many potential models are yielded based on AHP assessment. It depends on the decision makers in selecting the best model. The selected model can be used for the spatial planning of people forest area to support rural municipal sustainable development for the SDGs. Modeling people forest outside case study need to be adapted with the local characteristic area. A key factor for success of people or community forest in rural municipality of Gantung for the SDGs is supporting from the local government. Local government can accommodate people forest in the preferred regulation and give financial support for people forest in rural municipality for the SDGs life on land.

People forest is one way of land rehabilitation for sustainable development. Next research needs modeling land-use of forest cover like afforestation. Afforestation is important in the area which meet deforestation and land degradation. Afforestation able to enhance the proportion of tree in land ecosystem.

Acknowledgements

Special thanks to Lembaga Pengelola Dana Pendidikan (LPDP) Indonesia for the full Ph.D. scholarship given, the Government of Belitung Timur Regency, and to my wife Therissia Hati, DVM and family. Many thanks to my Promoter Prof. Ketut Wikantika, my lecturers Dr. Albertus Deliar, MT, Dr. Agung Budi Harto, and Dr. Anjar Dimara Sakti, and my friend in Ph.D. Geodesy and Geomatics Engineering of Institut Teknologi Bandung, Indonesia.

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Get Out of Your Comfort Zone: Externalization Taxonomy as an Implementation Tool for Future Designers

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The Asian Conference on Sustainability, Energy & the Environment 2020
Official Conference Proceedings

Abstract
As global warming accelerates, buildings currently account for 39% of energy-related carbon dioxide emissions annually. Architecture, however, is increasingly designed as hermetically sealed boxes, requiring mechanical support, which in turn further contributes to the greenhouse gas emissions warming up our planet. In addition to disassociating from the natural environment, this conventional approach also creates spaces where people disconnect themselves from their communities. In this project, I will examine what spaces could be externalized, removed from mechanical support, and how in doing so would provide environmental and social benefits that contribute greatly to the vibrancy and longevity of architecture and its communities. Current literature addresses various aspects of externalization, but most are missing critical vocabulary and design taxonomy. To fill this gap, I aim to develop an online interactive externalization pattern book that can support a user's design process. This pattern book will be developed through the research of four criterias in which the externalization strategies will be evaluated - ecological integration, climatic considerations, social/cultural considerations, and contextual application. The research will analyze each criteria through a series of case studies), literature review, and iterative design process (including simulation supported decision making). This will result in a holistic set of strategies that can address various contexts and scenarios, and serve as a useful tool when applying externalization strategies into architectural practice. Through this development, architectural practice can be enabled to shift towards a direction that better incorporates social and environmental resiliency through the implementation of building program externalization.

Keywords: Externalization, Sustainable Living, Climate Change, Social Sustainability, Architecture

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Introduction

Currently the challenge is twofold- there is increase in designs where spaces are disconnected from the outdoor environment, which not only has energy demand and environmental implications, but also health and wellbeing implications. Second, by designing internalized spaces that disconnect people from the outdoor environment, designers have also created socially disconnected spaces that are not conducive to increased social interaction. Without the ability to hear neighborhood chatter and noises of the community from outside our window, people gain increasing levels of isolation, and lose a sense of belonging within their local communities. Loss of community vibrancy and a lack of diversity in terms of interactions between occupants, and an understanding result in a sense of insecurity and anonymity within the neighborhood that can greatly affect the social and cultural vibrancy and resiliency of communities.

For environmental connectivity, externalization provides building performance and energy savings, biophilic benefits for health and wellbeing, and biodiversity benefits for the environment. In terms of building performance and energy savings, robust research on passive design strategies (Wang et al. 2014), mixed mode design (Loftness 2014; Loftness and Haase 2013; Watson 2013; Liebard and Herde 2009), and daylight and thermal autonomy all increase the overall environmental connectivity while reducing the overall energy demands. Dynamic envelope design is crucial as architecture becomes increasingly flexible based on weather conditions and activity levels as it reduces the energy demand of the building, but also provides alliesthesia (thermal delight) to the occupants. Furthermore, simulation softwares enable designers to further explore the potentials of integrated passive designs to best balance between the indoor and outdoor environments given local contexts.

Another benefit of increased environmental connectivity is increased biophilic benefits in terms of occupant health and wellbeing. Biophilia is a human's innate biological tendency to seek connection with nature, which can have emotional, mental, and physiological impacts on our wellbeing. Based on Edward O. Wilson's biophilia hypothesis, biophilic design focuses on designing in connection with nature (Wilson 1986). Notable research by Stephen Kellert and Bill Browning solidified the importance of biophilic design within architecture, as well as highlighted its impact on human wellbeing (Heerwagen, Kellert, and Mador 2008; Browning, Catherine, and Joseph 2014; Terrapin Bright Green 2012). For example, several studies indicated that connection to nature could lower tension, anxiety, anger, fatigue, and confusion, and could positively influence mood and self-esteem (Alcock et al. 2014; Barton and Pretty 2010; D. K. Brown, Barton, and Gladwell 2013). Biophilic design supported the connection of humans to nature encouraged the strengthening of indoor-outdoor relationships as there are studies that indicate that application can provide both biophilic and environmental benefits to architectural practice (Dreiseitl 2019).

Lastly, increased environmental connectivity can support local biodiversity through regenerative design or the creation of nature corridors and hotspots. In research by Hes and Du Plessi, regenerative design that focused on designing for local ecologies helped rejuvenate damaged ecosystems (Hes and Plessis 2014). This encourages for a close relationship between occupants and nature. Given growing climate change and biodiversity concerns, ecologically driven approaches become increasingly important.

The integration of nature and porosity within architecture can support the migration and growth of flora and fauna within an urban setting, providing both occupants biophilic benefits while also allowing nature to have spots of habitation amongst the urban concrete jungle (Jain 2019).

Building program externalization also contribute to enhanced social connectivity, which can reduce isolation, improve community cohesion and vibrancy. In January of 2019, the Health Resources and Services Administration issued the "Loneliness Epidemic", which notes that nearly 1 out of 3 older Americans now live alone, which can result in serious mental and physical health effects (Health Resources & Services Administration 2019). "Loneliness and social isolation can be as damaging to health as smoking 15 cigarettes a day", and thus serious actions need to be taken to address this concern (Health Resources & Services Administration 2019). Though spatial conditions are not the sole contributor to the loneliness epidemic, there are studies that support the impact of spatial conditions on isolation. Social capital is also a growing research topic, as social connectivity becomes a growing concern within predominantly urban design (Putnam 2020). However, what are the building level implications when there is minimal social connectivity, when one cannot open the window to hear children playing, when there is not a porch where people can interact in passing? How has the internalized approach to architecture started to discourage social interaction and connectivity, and what impacts and implications it may have? These questions are explored to varying degrees by researchers, though there exists a missing link between externalization and social connectivity.

This thesis links both environmental and social connectivity, and establish why designing for externalization would be better than the current internalized approach. Especially now in the context of COVID-19 pandemic and social inequity, what role can externalization play? Existing research already support the importance of externalization as people lean towards balconies, porches, and other externalized spaces that allow them to regain connectivity in a forced disconnected environment due to quarantine (Ottoni et al. 2016; Martin 2020; Nisenson 2020). Additionally flexible boundaries such as sliding doors or outdoor classrooms enable schools to continue teaching while enforcing safe distancing, which are all enabled through externalized design (Bellafante 2020; Superville 2020; Couzin-Frankel, Vogel, and Weil 2020). Given this new context, externalization grows in value as we become increasingly aware of the disconnectivity of existing spaces. With improved social connectivity, study also show its impact on safety and wellbeing within lower-income communities, as spaces designed often don't encourage social interaction or allow for community identity to develop (Saegert, Winkel, and Swartz 2002; Knapp et al. 2019). This can greatly affect vulnerable communities, which can lead to more severe mental and physical health impacts due to poor ventilation, lack of access to nature, etc.

Externalization Palette

First set of criteria is the environmental connectivity of building programming - based on how the space is sealed, how much daylight is available, and what kind of activity takes place in these spaces. The worst scenario is a space that is fully sealed with full mechanical support and no access to natural daylight. Then the introduction of natural daylight opportunities while remaining fully sealed and full mechanical support is the

next improvement towards environmental connectivity. With the introduction of versatility, the dynamically sealed spaces allow for added operability and access to passive strategies and natural daylight. Then externalized low function spaces introduce fully externalized transitory spaces. Lastly, the most amount of environmental connectivity represents fully externalized high function spaces where social living spaces would be fully externalized. Considerations for environmental connectivity could result in a significant amount of energy savings due to the decrease in conditioned internalized space. Additionally, this allow for an increase in physical activity and circulation, which can increase the overall social connection. Through environmental externalization, there is added visual richness and connectivity, and well as auditory and sensory richness. This allows for the community to gain a sense of vibrancy through architectural design.

Second set of criteria is the social connectivity of building programming, which focuses on the amount of social connectivity that the space enables for its occupants. The most socially disconnected is individual and disconnected spaces. Then it moves onto individual but visually connected spaces, which are typically spaces with glass facades where you can see, but not hear or interact. Then it moves onto the building community, which allows for the occupants within a building to socialize and interact with one another. It then moves onto higher levels of public engagement with the neighborhood community connection and finally the urban community connection where it is fully open to the public. The increased social connections allow for the success, resiliency, and longevity of the externalization strategies through increased social connections, an increase in the amount of outdoor activities, and allow for increased socio-cultural richness. Additionally, this encourages people to communicate and develop a level of tolerance through a sense of community, which can increase the community resiliency in times of crises such as the current COVID-19 pandemic.

When both the environmental connectivity and social connectivity are overlapped, it creates a larger palette that can then evaluate architectural design through this color schema - The Externalization Palette. The palette allows for immediate understanding of a design's externalization quality in regards to its social and environmental considerations and creates a set of vocabulary for building program externalization that can then evaluate architectural design through the criteria of environmental and social connectivity. Architectural design can then be evaluated through this palette to better understand the externalization quality of a design through this evaluation color palette. This palette is arranged so that both criteria must be considered during evaluation as both levels of connectivity determines the quality and effectiveness of externalization in application, and diversity in the types of connectivity within a design is also crucial to its overall success. This palette does not seek to over-simplify the depth of spatial quality and social spaces, but aims to better consider the multiple layers through a more defined set of criteria and vocabulary. In doing so, a better understanding of building program externalization could be reached, and result in more appropriate applications of externalization in architectural design practice.

Externalization Taxonomy

The externalization taxonomy is a series of fifty strategies that help support designers when thinking about externalization in architectural design, it doesn't serve as a

comprehensive list or a copy-paste solution, but as a series of potential inquiry sparked by existing design strategies stemming from prior case study research. However, behind each strategy generated within the taxonomy also lies deeper literature review and research that support the importance and value of the strategies generated. The full taxonomy can be divided into the following four broad categories:

- Externalize Circulation
- Externalize Family
- Externalize Community
- Embrace Ecology

Each category contains several externalization strategies, each of which includes an explanatory diagram, a description, scientific research that supports the environmental and social benefits of the strategy, and a precedent study that utilizes the specified strategy. The layout of each taxonomy is shown in Figure 1. These strategies will not be shown in this paper itself, though are accessible online. Despite each specific strategy not being covered, the broad categories will be elaborated on in this paper instead.

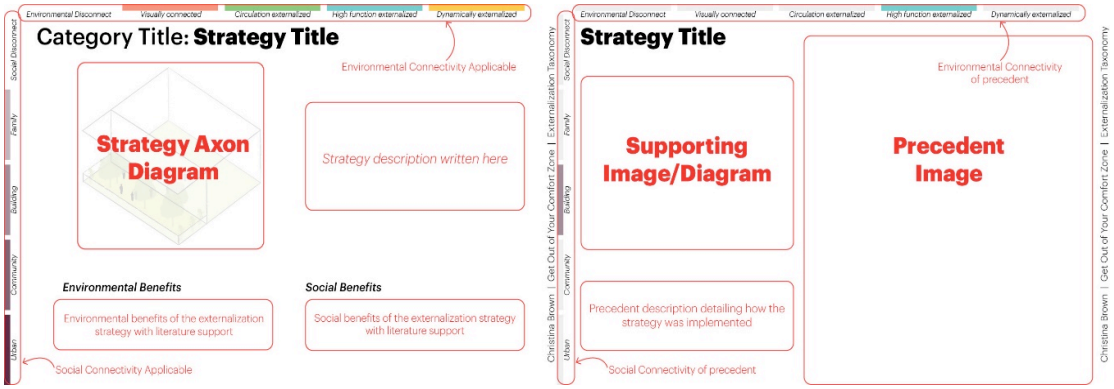

Figure 1: Externalization Taxonomy Layout

Externalize Circulation

Externalizing circulation is one of the most straightforward externalization approaches found through case study research. In most climates, (hot, cold, and benign) externalizing the building circulation was possible to certain degrees, with fire stairs and non-primary circulation routes being the most likely to be externalized. This alone can already have profound impacts on carbon emissions and the total building energy loads if all non-primary circulation was externalized. However, beyond just building energy usage, there is also addition benefits that can be found when more of the circulation and non-human dominant spaces are externalized. For example, for highly used circulatory spaces could be externalized to gain biophilic benefits and more spatial porosity that can encourage community interactions. Additionally, circulation can double as social spaces, extending beyond the function of getting occupants from point A to B, but rather help bolster the cohesion of the community instead.

In this subcategory of "circulation" also includes mechanical systems and garages, which are more transitory in nature, given that they are predominantly spaces for machines, rather than people. These spaces have greater thermal comfort flexibility, and often times for machinery the overall temperature benefits from being in a lower

temperature range. Thus, especially in climates where these conditions are naturally present outside, externalization becomes a straightforward choice to make. However even in climates that may not be the most suitable, the implementation of dynamic strategies or passive strategies allow the building to take advantage of the locale before relying on mechanical conditions. In especially synergistic case studies, the externalization of mechanical and garage spaces actually allow for those spaces to serve more human occupied functions due to the many biophilic benefits that the externalized space provides.

Externalize Family

Externalization of "family" spaces aims to apply strategies that enable small-scale spatial externalization – thus the "family". This can be applied to residential as the name applies, but can also be applied to educational, commercial, restaurant, healthcare, and much more. The focus is that this is applied at the individual unit scale, though the specific program is quite flexible.

Within this subcategory, there are twelve strategies with varying scales of intervention – French balcony, Chicago balcony, 'living room' balcony, terrace balcony, dynamic balcony, dynamic façade, center box, sky box, sandwich, porous layer(s), elevated indoor + outdoor space, and lastly shutter façade.

Externalize Community

Like 'Externalize Family', externalizing community operates at a scale, though instead of the unit scale, this category focus on the community scale or building scale. These strategies are essential in making significant contributions to social connectivity and supporting the development of social capital, and can often times become the identifying characteristic or most utilized space within large-scale projects, serving as a connection for the building occupants to the local community and beyond.

In this category, there are eleven strategies – open/porous lobby, open/porous multipurpose space, porous layer, periphery social, wall as shading, wall as placemaker, courtyard/open atrium, covered atrium, dynamic atrium, sky lobby, and rooftop social.

Embrace Ecology

The last category is embrace ecology, which covers across spatial scales but focus on the incorporation of ecology into human spaces, to create more intimate symbiotic relationships between humans and the natural environment. Some strategies focus on gardenscape and landscaping, while others address issues of water or food (through farming). These are all aspects in which humans depend on existing natural systems, and more connective spatial relationships could help improve appreciation, education on natural systems, and value on environmental issues and climate change in the public. This not only has social and environmental implications for the occupants, but can also serve as an opportunity to encourage appreciation for the natural systems that we depend on as a society.

In this category, 10 strategies are introduced – canal connection, farming atrium, garden atrium, garden balcony, adjacent garden, terraced garden, central garden, rooftop garden, rooftop urban farming, and dynamic farming.

Conclusion

From the growing impacts of climate change and concerns for building energy loads to the established importance of nature on human health and wellbeing as we become increasingly urbanized to the growing concerns for isolation and social disconnectivity, how we understand 'boundary' and shape our spaces become ever more critical. The conventional approach of internalization was supported and bolstered by the development of technology, but as new concerns arise in the 21st century, it is necessary for architecture to shift from the internalized design approach that have become the 'norm' to a new externalized design approach that reconnect people to the environment and to each other.

This synthesis establishes foundational research, framework, and design tool (the taxonomy) to support architectural design. The externalization taxonomy aims to help designers shift from the conventional internalized architectural design approach to an externalized approach. This enables architecture to be developed in a connective, dynamic, and responsive way that can better address the climatic and social issues that as a society face and will continue to face in the future.

This research is only preliminary work that scratches the surface of 'externalization', with limitations of time, resources, and the COVID-19 pandemic that restricts the depth of work the authors could take on. However, the topic is still preliminary, allowing for many areas of continuation and future explorations in terms of quantifying externalization impacts, expanding the externalization taxonomy based on climate types, program types, or cultural boundaries, as well as addressing potential conflicts such as noise pollution, security concerns, and privacy issues.

Acknowledgements

Sincere acknowledgements to Joshua Bard and Sarah Rafson, who provided encouragement and support through the development of this research. Additional thank you to the many professors at Carnegie Mellon University School of Architecture who provided valuable feedback for this body of work. Without the kindness and enthusiasm of many professionals, this work would not have been possible.

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The CIGS Building Integrated Photovoltaics: Financial Validity of Façade Applications under Current Technological and Market Conditions

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The Asian Conference on Sustainability, Energy & the Environment 2020
Official Conference Proceedings

Abstract
The recent technological shift supported by the growing recognition of the public and policy makers of the renewable energy sources, fostered the employments on the uncharted markets. The energy industry increasingly affects the other sectors that were not directly related to the energy generation before. One of such examples is the construction industry which could benefit from the Building Integrated Photovoltaics. The objective of this paper is to analyze the current financial validity of the BIPV façade applications, under most recent CIGS technological advancements and market state. The topic is approached with the case study to assess the cost of investment and to learn the economic benefits through the installation life-cycle. The research indicated at economical validity of BIPV façade solution, with the IRR values reaching over 10% in case of the most optimal systems. In relation to traditional façade materials, the CIGS BIPV façade brings the substantial economic benefits to the investors, especially while being installed according to the best practices of PV system design (South, then East and West orientation). With the potential market pool of BIPV façade installations, the scale of CO_2 emissions avoidance should not be neglected. In the further research, the importance of valid business models could be investigated.

Keywords: CIGS, BIPV, Façade, Economic Benefit

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1. Introduction

The 2019-2050's CAGR for cumulative global capacities is projected to reach 8.9%. In relation to its population, Europe leads the way in the PV transition. Only in 2019, the PV installation in Europe grew by over 100%. Regardless the past efforts, the goals of the Paris Agreement commitment, where Europe is expected to drastically reduce the CO2 emission, from 344g/kWh to 150 (65)g/kWh, might not be within the reach. In order to meet the requirements, the policies increasingly target the buildings' which are responsible for around 40% of total emission (IRENA 2019). It is especially important while construction market grows all over EU, driven by the rising prices of dwellings, immigration, and changing social structure. Moreover, the land limitations and public protests indicate the growing role of urban PV solutions. In the densely populated and wealthy areas of North Europe, residential PV stands already for majority of installations. The trend is only to be fostered with the Energy Performance of Buildings Directive which requires all new buildings to be nearly zero-energy by the end of 2020 (European Parliament and The Council of European Union, 2010). The low amount of energy that these buildings require comes mostly from renewable sources, including PV. As the natural following of technological and industrial advancement, the BIPV facade systems gradually gain on importance (PVSites, 2016). Due to the separate nature of PV and construction sectors, the sufficient proof-of-concept of BIPV should be delivered so the both parties could fully understand its advantages and challenges to disturb the long-established PV and construction processes.

2. Literature review

The growing importance of the BIPV facade application was noticed by the scholars. The topic is complex and covers numerous aspects. In top-down approach, one could enlist: market trends, the governmental policies, the equipment and solution classification; the performance of the systems; and their economic feasibility. As far as the market trends and policies are concerned, authors could point at the recent works of: Curtius (2018); Agathokleous and Kalogirou (2019); Osseweijer et al (2019); Defaix et al (2012); where scholars agree on the immense potential of the BIPV market (including facades) indicating, as well, the lack of market maturity which is caused partially by the lack of appropriate structural support and the insufficient understanding among the project developers. Further, in the solutions' classification, one should cite the findings of: Shukla et al (2016); Ceron et al (2013); Jelle et al (2012); or Frontini et al (2015). In relation to this research, the other authors often underline the difference between the mainstream and BIPV products. Unlike the large scale projects, the integrated solutions seem to be more technologically diverse due to the fact that the first generation silicon crystalline cells display the constraints in terms of application scope, customization, aesthetics and availability. Given that, after Frontini (2015) the next generation cells (here including thin-film CIGS) might stand for over 20% the BIPV applications (while for the mainstream the level does not exceed 4%).

The choice of the suitable technology is crucial to achieve the maximum of output, and therefore benefits from the BIPV installation. These, in the next stage, should be well examined and articulated since the lack of the sufficient number of reference projects (and studies) has been undermining the growth of the market. Although the

scientific literature is still relatively scarce, one could point at some recent papers which authors found especially relevant to this research. Firstly, to provide the background about the energy yields generated under imperfect tilt angle conditions (as for BIPV façade), especially for the thin film technology, one could refer to the findings of: Sanchez and Izard; and Kumar et al. In their paper from 2015, Sanchez and Izard presented the test on amorphous thin-film (silicon technology) conducted in Spain. The performance factors, with respect to the installation of the perfect tilt angle, were estimated for: 66% (South facing façade), 49% (East facing façade), 38% (West facing façade), 51% (Southwest facing façade), 17% (North facing façade). The paper from 2019, published by Kumar et al, and dedicated to the CdTe cells (the second generation thin-film technology), focused on the tropical conditions in Malaysia and the obtained PR ratios reached: 71%, 70.53%, and 66.42%, for East, West North, respectively. Regardless of the relatively high Performance Ratios, the facades have a more stable production along the year. With some current net metering proposals, non-optimal orientations could even be more economical than the maximum producing orientation.

Shifting to the key objective of this research, the literature on the quantified economic benefits of the BIPV façade is to be provided. Here, authors focus on the very recent and complex analysis of Gholami and Røstvik (2019) who delivered possibly the most comprehensive results regarding the European market up-to-date. Their paper proposed the lifecycle cost analysis (LCCA) of BIPV system taking into consideration such factors as: saving in transmission line, lost power, saving in power delivery cost, saving form carbon tax, and saving in building envelope material cost. The most significant finding to emerge from this study is that even the north façade is economically feasible in some countries in Europe if all the environmental and societal benefits of the BIPV system are being taken into consideration. The results of this investigation also showed that the BIPV façade systems could not only serve as the building envelopes, but they also become the investment vehicles generating a stable source of income.

3. Methods

The objective of this paper is to analyze the current financial validity of the BIPV façade applications, under most recent technological advancements of thin-film CIGS technology and market state. Authors referred to the recent market data acquired from industry sources and during PV industrial exhibitions and employed it in the simulation regarding the location in Central Europe, Poland. Since the BIPV literature is relatively scarce (and data often outdated), while the industry progress relatively fast, authors hope that the research could significantly contribute to the understanding of importance of BIPV façade market offer.

The methodology includes three parts. Two parts consists on the data collection, which serves then to calculate the economic benefits (figure 1):

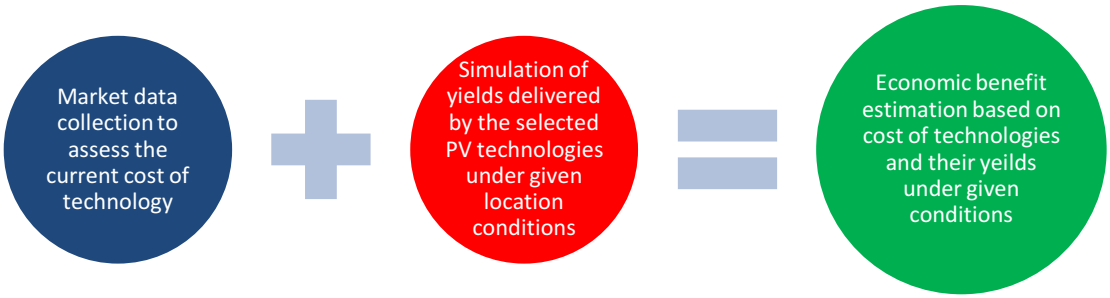

Figure 1. Research logic

3.1 Data

In the first part, authors grouped the data in regards to the major options employed in the façade solutions, traditional and BIPV. Authors delivered the actual and averaged market purchase conditions of: CIGS framed, CIGS frameless, and CIGS color printed offer. The data was acquired from industry sources and during PV industry exhibitions.

Figure 2. CIGS BIPV façade examples: CIGS frameless (left), CIGS framed (center), CIGS colored (right). (source: authors' database)

3.2 Yield estimation

In the second part, authors approached the yields that each of the above mentioned technologies would deliver once installed in the exemplary system in the location in Central Europe, Poland, Poznan (urban conditions of high building installation). The yields were estimated with the help of PVSol software accessible on its official website. For each type of solution, there were four separate simulation carried with the following assumptions: inclination angle 90 degrees; orientation to West, East, South, North; albedo of 20% (urban area); average rear ventilation; no soiling. The data regarding the yield of the colored modules was estimated according to the experiments carried on the colored solutions.

Table 1. PVSol yield simulations' assumptions.

Technolo	System	System	Power/surface	Façade	Alb	Soil	Rear
CIGS Color	4960	49.6	100	West South East North	20	none	average
CIGS Frameles	4800	32	150	West South			

s				East North West South East North
CIGS framed	4800	32	150	

Source: collected data, PVSol.

3.3 Economic benefit estimation

In the third, final, part, authors proposed the assessment of the economic benefits from the BIPV façades, based on the Talavera et al. (2016) and Kryszak and Wang (2020) who analyzed the integration of the small PV system into the buildings in Spain with the variables of: NPV, IRR.

$$NPV = PW[CIF(N)] - LCC_{USP} \quad (1)$$
$$LCC_{USP} = PW[PV_{UIN}] + PW[PV_{OM}] \quad (2)$$

The net present value of an investment project is the sum of present values of all cash inflows and outflows related, over the period. Therefore, the parameter NPV equals the present worth of the cash inflows from the system ($PW[CIF(N)]$) minus the life-cycle cost from the user standpoint (LCC_{USP}) which stands for the sum of present value of the investment outflow $PW[PV_{uin}]$ and maintenance outflow $PW[PV_{OM}]$. From the NPV, one could derive that the IRR of the project which stands for the interest rate under the assumption of $NPV = 0$. The measuremnts of NPV and IRR serve to assess the investment in general terms and their values are often used as the argument for system purchase during the selling process of PV to the end-customers.

Since the goal of this research is to indicate on the economic benefits of the potential BIPV facade investments, in context of the replacement of the traditional facade materials, the calculations focused on the materials rather than delivering the accurate cost estimation of the whole process of installation. The labor cost was not included in the calculations, while the OPEX and BOS were roughly assumed based on the industry sources and existing literature.

4. Results and discussion

Table 2 discloses the data collected during the research. The costs of traditional façade materials are easily accessible, while they do not fluctuate much on the market. As it is presented, price range is wide with the fibrocement coming as the cheapest option. On the other hand, the high quality stone is the most expensive as it could reach over 800/m2. In recent years, the metal cladding gained on popularity, and its cost falls between 120 and 530Euro/m2.

Due to the limited number of suppliers of CIGS technology, and project oriented sale, the costs of facades modules were presented in absolute, estimated numbers, which are still highly accurate. As one could conclude, the PV CIGS cost is relatively moderate, especially as far as the regular, black solutions are concerned. The colored modules, due to the high cost of ceramic printing on the glass, are pricier however their cost could be still compared to the wood's one.

It is important to underline that the traditional materials, although perceived as durable, do not offer any cash-flow from the investment, therefore they could be defined only as a cost incurred. On the other hand, the BIPV facades are, in fact, the investment vehicles which deliver the tangible economic benefits to the investors. Firstly, often, they bring the positive Net Present Value. Secondly, they leave the space for the more frequent renovations since their life-span reaches only 25 years (according to the warranties granted at the purchase), and, as it would be proved later in this research, the total pay-back of the investment capital is perfectly possible within this period.

Table 2. Facade materials data: traditional and CIGS BIPV.

Construction materials	Cost/surface (Euro/m2)	NPV (Euro)	IRR (%)	Durability (years)
Traditional materials				
Stone	130-820	negative	negative	long-term
Metal	120-530	negative	negative	75
Brick-ceramic	100-340	negative	negative	long-term
Wood	320-550	negative	negative	50
Fibrocement	40-220	negative	negative	30
PV materials				
CIGS framed	75	positive/negative	positive/negative	25
CIGS frameless	135	positive/negative	positive/negative	25
CIGS colored	300	negative	negative	25

Source: collected data, Frontini et al. (2015), Sousa and Sousa (2019), Grelk et al. (2007)

In the following part of the research, the actual economic benefit of BIPV façade was calculated. The results are to be found in table 3 below.

Table 3. Economic value estimation.

Technology	Annual system yield/surface (kWh/m2)	Avoided CO_2 emissions (kg/year)	Module cost/surface (Euro/m2)	Module cost in the system (Euro)	Module with BOS (Euro)	NPV (Euro)*	IRR (%)*
CIGS Color	40	974	300	14880	15680	-12206	-10 %
	51	1273				-10457	-8 %
	41	1000				-12008	-9 %
CIGS Frameless	20	419	135	4320	5120	-15093	-16 %
	77	1316				-177	0%
	100	1720				20493	3%
	79	1352				23	0%

	33	566				-4311	-11%
	77	1316				1743	4%
CIGS framed	100	1720				3969	9%
	79	1352	75	2400	3200	1943	5%
	33	566				-2391	-8%

*basic interest rate = 2,5%

In order to maintain the comparative value of the simulations, they were performed under assumption of the similar sizes of the systems: around 5kWp. As it was mentioned already, in the previous section of this article, authors did not take into consideration the installation costs, as they are relevant to both: BIPV and traditional materials, therefore authors assumed that they do not stand for the main and differentiating factor.

As far as the mainstream, framed modules, were concerned, the results indicate the high economic benefits to the investor. Apart of the North facing installation, the three other orientations provided a substantial positive NPV, with the IRR of at least 4% and maximum 9%. Such levels of IRR are unparalleled by the any risk-free financial investment. The frameless option provided less opportunity, however it is still highly beneficial to the investor. The South and West facing systems delivered the positive NPV while the yield cash-flows from the East facing installation almost managed to pay back the investment value. The maximum IRR reached 3% which could be related to the low-risk financial investments on some markets. The colored modules did not deliver the positive NPV. The IRR levels stayed negative and the high cost of the modules out-weighted the yield benefits. The economic assumptions of the colored modules simulation could be related to the traditional materials as they seem to be equally expensive, while they do not deliver the yield cash-flow. The core of the colored BIPV value lays rather in its aesthetics and eco-friendliness, rather that the purely positive economical metrics.

It is worth to underline the additional benefit of BIPV facades reflected in the avoided CO_2 emissions. Although it has not a direct financial impact on the investment assessment, one could not exclude such impact in the future. In order to confront the findings of this paper, table 4 presents related results derived from the other scholars' publications.

Table 4. Related literature review and results

Study	Study period	Country	Methodology	Conclusions
Facade functinality				
Sánchez and Izard (2015)	January 2011-November 2012	Spain	Photovoltaic facade with a south-west orientation and an architectural model of a building with the facades in the	Although the annual energy production for the facades and the roof is between 50% and 76% of an optimum angle installation, the facades have a more stable

			cardinal points, covered with PV.	production along the year (the experiments were based on thin-film cells). With some current net metering proposals, non-optimal orientations could even be more economical than the maximum producing orientation.
Kumar et al (2019)	1 year of model study	Malaysia	The model based the performance research of thin-film CdTe (thin film) building BIPV arrays proposed as a flat roof, and façades oriented in east, west, and north under the tropical weather conditions	The variation in performance ratio (PR) for each façade oriented in different directions and the roof (2.3 kW façade in east and west, and 5.5 kW façade in north): 71%, 70.53%, and 66.42%, respectively, and corresponding energy losses are −28.8%, −29.4%, and −33.6%.
Jannuzzi and Silva (2012)	1 year of model study	Brazil	The generation provided by the North, East, West a-Si (c-Si thin-film) facades simulated and compared with optimal angle to calculate the performance losses with software employment.	PV generation decreases considerably (40 to 45%) when the modules are installed on vertical surfaces (buildings facades). The optimum generation periods shape differently compared to the perfect orientation and tilt angle installations.
Economic benefits				
Gholami et al (2019)	Long-term simulations	China, Brazil, Italy, Bahrain	The Life Cycle Cost Analysis based on NPV metrics, extended by the societal benefits. Simulation study on actual cases.	With the societal and environmental benefits of the implemented system, replacing conventional façades and roof building materials with BIPV modules will become economically more feasible. With the traditional Payback Period and NPV metrics, the BIPV façade is still very attractive form of investment and the periods are counted below 10 years in the high irradiation locations.
Gholami	Long-te		The Life Cycle Cost	BIPV system as a building

and Rostvik (2020)	rm simulations		Analysis based on NPV metrics, extended by the societal benefits. Simulation study across European countries with the highly detailed sensitivity analysis.	envelope material for the whole building skins could reimburse not only all the investment costs but also become a source of income for the building. Even the north façade is economically feasible in some countries in Europe if all the environmental and societal benefits of the BIPV system are being taken into consideration.
Gholami et al (2020)	2016-2019 data set based research, long-term simulations	Norway	The Life Cycle Cost Analysis based on NPV metrics, extended by local market characteristics.	BIPV façade with the peak power of 127.5 kW is economically feasible with a DPP of 22 years, IRR of 6%, cumulative NPV of 478,934 NOK and LCOE of 1.28 NOK/kWh. With an average annual solar irradiance on the system of 707 kWh/sq.m., the average annual electricity production is 40 kWh/sq.m.
Evola and Margani (2016)	long-term simulations	Italy	The Life Cycle Cost Analysis of block renovation in Italy, extended by the technological comparison.	CIGS and c-Si are economically comparable, a-Si modules are currently not profitable. Without the incentives, the PBT would reach about 14-15 years, with slightly higher values for the c-Si. Even a south-facing facade presents a potential energy yield that is around 30 ÷ 35% lower in comparison with the optimal slope.
Oon and Ng (2017)	Short period simulation	Singapore	Electricity generation analysis supported by with the economic benefit perspective.	The cost/m2 of CIGS solar PV panels (without the BOS) is just a little bit more expensive compared to ceramic tiles. The cost of the entire CIGS system is potentially cheaper than aluminum composite panel as cladding material for facades with large areas.

5. Conclusions

The objective of this paper is to analyze the current financial validity of the BIPV façade applications, under most recent CIGS technological advancements and market state. The topic was approached with the case study to assess the cost of investment and to learn the economic benefits through the installation life-cycle. Authors reached the following conclusions:

1. In relation to traditional façade materials, the CIGS BIPV façade brings the substantial economic benefits to the investors, especially while being installed according to the best practices of PV system design (South, then East and West orientation).
2. With the potential market pool of BIPV façade installations, the scale of CO_2 emissions avoidance should not be neglected.

In author's assumptions, the further research could be directed towards the novel and effective business models, to channelize the already existing technological prospects of merging the construction and PV industries.

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Research on the Classification and Evaluation of Production-living-ecological Space in China Based on Land Use Functions

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The Asian Conference on Sustainability, Energy & the Environment 2020
Official Conference Proceedings

Abstract
Optimizing production-living-ecological space has become one of the cores of China's ecological civilization and sustainable development strategy, and it is also a crucial goal of land use and management in China. Constructing and identifying a land use evaluation index system based on production-living-ecological space is of great importance to sustainable land use in China. The concept of land use functions can be defined as goods and services provided by different land use types, including production, living, and ecological functions. These functions accord with the purpose of identifying production-living-ecological space. However, few studies have focused on the identification and evaluation of production-living-ecological space from the perspective of land use functions and multifunctionality. In this study, literature review methods, comparative analysis, and induction were performed to discusses the conceptual and logical connection between production-living-ecological space and land use functions, and a framework to identify and evaluate the production-living-ecological space was constructed based on the multifunctional land use framework. Taking Yubei District of Chongqing, China as a case study, this study will provide a reference for promoting the coordinated development among production-living-ecological functions and creating a reference for sustainable land use in China, especially in urban fringe areas facing rapid urbanization.

Keywords: Production-Living-Ecological Space, Land Use Functions, Evaluation, Yubei District

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Introduction

Land use involves technological and biological activities by humans for social and economic purposes and is a long-term or cyclical operation of land (Liu, Fang and Li, 2014). As an indispensable part of sustainable development, sustainable land use has risen to a universal goal for planners across the globe (Foley et al., 2005; Lambin et al., 2001; Turner, Lambin, & Reenberg, 2007). Amid the economic boom that China experiences now, poorly organized land use activities resulted in a colossal waste of resources, excessive urbanization, ecological deterioration and a slew of environmental and social ills (H. Zhang et al., 2016), thereby holding off efforts towards sustainable development.

Land is a multi-functional comprehensive system. As a crucial carrier of human life, land provides a series of services and goods, which are referred to as land use functions (LUFs). LUFs summarize the most relevant economic, societal, and environmental aspects of a specific region, and is an important issue to realize the meaning of sustainable land development (Wiggering et al., 2006). A vital step to realize sustainable land use is to determine the multiple functions of land use and evaluate these functions according to the specific geographical environment (Wiggering, Müller, Werner, & Helming, 2003). In the evolution of the LUFs concept, research on LUFs mainly includes the definition, classification and evaluation, indicator systems of LUFs. The research on land use function mainly focuses on economic, social and environmental dimensions.

Multifunctionality is a concept which is regarded as an useful way to the sustainable land use (Hagedorn, 2007). The concept of LUFs originated from the agricultural system (Helming et al., 2008), and was proposed initially by (OECD, 2001) as a concept related to the jointness of agricultural production. Within the LUFs and multifunctionality concept, it is believed that LUFs can be attached to land use types, for instance: forest land may have ecological functions (supporting biodiversity, regulating air and water) as well as economic and social functions, such as providing wood, as a cultural landscape (Pérez-Soba et al., 2008). Therefore, land use typologies and LUFs are not one-to-one correspondence, but a complex many-to-many relationship (Figure 1).

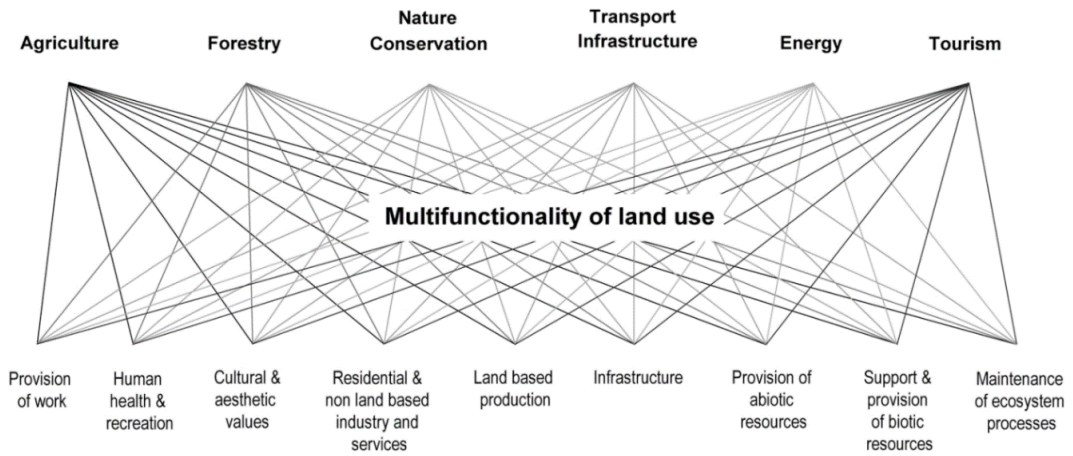

Figure 1: Many-to-many relationship between land use typology and land use functions (Adapted from Helming et al. 2008 & Schößer, Helming, and Wiggering,2010)

Based on the idea of LUFs, the Chinese government has begun to generate a new notion aiming to classify production land, living land and ecological land in the process of land use management, and the concept of the "production-living-ecology space" (PLE space) is developed. PLE space has become one of the core discourses of land use in China, and is considered to be able to tackle sustainable land use issues. The report of the 18th National Congress of the Communist Party of China (2012) pointed out that China should ensure "the space for production is used intensively and efficiently, that the living space is livable and proper in size, and that the ecological space is unspoiled and beautiful". Identifying, evaluating and optimizing the PLE space has become one of the important contents of sustainable land use in the context of ecological civilization.

The PLE space proposed by the Chinese government refers to the production space, living space, and ecology space, respectively, and the name of each space is according to its primary function (Peng, Wang, & Chen, 2019). In recent years, with the popularity of the "three pillars" theory of sustainable development, many Chinese scholars have focused on bridging LUFs with the Chinese concept "PLE space" (Fan et al., 2018; Liao et al., 2019; Xi, Zhao, Ge, & Kong, 2014; Yang, Bao, & Liu, 2020; Yu, Xu, Zhang, & Shang, 2020; Zhou, Xu, & Lin, 2017; Zou et al., 2020). Combining these two concepts and in reference to the definition of LUFs, several studies on PLE space have launched and the concept of PLE space is defined from multiple perspectives.

G. Li and Fang (2016) believe that the PLE space covering biophysical process, direct and indirect production, as well as satisfactions of spiritual, cultural, leisure, and aesthetic needs, is the product of synergistically coupling natural systems and social economic systems. Fan et al. (2018) insist that the PLE space, as a comprehensive partitioned mode of land utilization, and is a core part of optimally allocating China's land spaces guided by the goal of sustainable development. A. Huang et al. (2020) conclude that the PLE space is a functional space that is partitioned in accordance with various products and services offered by the land for human beings. As for J. Huang, Lin, and Qi (2017), production space is an area with a dominant function of providing industrial products, agricultural products and servicing products; living space is an area that is dominated by providing human settlement, consumption, relaxation and entertainment; and ecological space is an area dominantly offering ecological products and ecological services, which plays a vital part in regulating, maintaining and safeguarding regional ecological security. Identifying the primary functions of different land use patterns is the key to the classification of PLE space (Liao et al., 2019). Based on the previous studies, this study listed the definition of production, living and ecological functions under the concept of PLE space (Table 1).

Table 1: Definition of production, living and ecological functions under the concept of PLE space

PLE space criteria	**Function criteria**	**Definition**
Production space	Production function	Production space is an area with a dominant function of providing industrial products, agricultural products and servicing products. (Fan et al., 2018; Jin, He, Wang, & Gong, 2018).
Living space	Living function	Living space refers to an area that is

		dominated by providing human settlement, consumption, relaxation and entertainment. (De Groot, 2006; Geoghegan, 2002; Plantinga & Miller, 2001).
Ecological space	Ecological function	Ecological space is an area dominantly offering ecological products and ecological services, which plays a vital part in regulating, maintaining and safeguarding regional ecological security. (De Groot et al., 2012; MEA, 2005).

To sum up, land use spaces are partitioned according to the multifunctionality of land use in the PLE space. Since the PLE space is an important strategy for optimizing and managing national land space in China, the key to identifying the PLE space is to qualitatively or quantitatively identify primary and subfunctions of the space based on LUFs upon taking into account multi-functions of the land. Besides, primary functions of the land should be highlighted with the consideration of subfunctions while partitioning the PLE space as land use typologies may either have a single function, or any combination of production, living and ecological functions. Few previous studies have focused on the identification and evaluation of production-living-ecological space from the perspective of LUFs and multifunctionality.

Thus, the aim of this research is to discuss the conceptual and logical connection between the Chinese notion "PLE space" and international concept "LUFs" and identify and evaluate PLE space from the perspective of LUFs. Based on the latest Land-Use Classification guidance (GB/T21010-2017), this research provides a new reference for China's PLE space identification and evaluation. And taking Yubei District of Chongqing as a case study, this research analyzes the spatial-temporal evolution of PLE space from 2009-2018.

Methodology

- *The framework of PLE space classification system*

Based on the definition of LUFs, multifunctionality, and PLE space, this paper defines a classification framework. In figure 2, different types of land use constitute different land use patterns. The goods and services provided by different land use structures are quite different, which forms the spatial differences of LUFs. Under the regional primary function, the spatial pattern of PLE space has been formed. Taking multifunctionality into consideration, the PLE space were first divided into 9 categories according to the ability of providing goods and services.

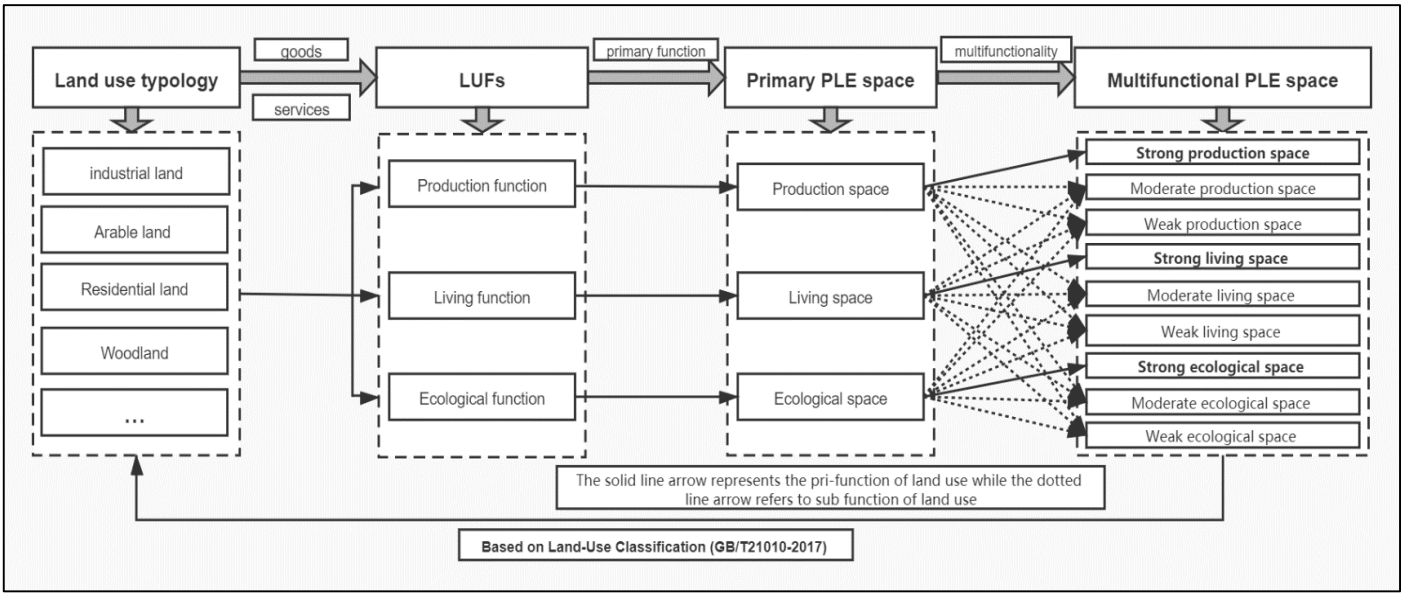

Figure 2: The framework of PLE space classification system

According to the Current Land-Use Classification (GB/T21010-2017) proposed by the Ministry of Natural Resources of the People's Republic of China, the detailed PLE space based on land use typologies is shown below (Table 2). The 1st class land use type and 2nd class land use type are consistent with the land use type in GB/T21010-2017.

Table 2: Classification system of PLE space based on Current Land-Use Classification (GB/T21010-2017)

PLE space	1st class land use type	2nd class land use type
strong production space	commercial services	retail commercial land
		wholesale market land
		catering land
		lodgings
		commercial and financial land
		recreational land
		other commercial services
	industrial and mining warehouse	industrial land
		mining lease
		salt fields
		warehousing land
	transportation	land for railway
		land for rail transit
		land for highways
		land for roads in urban villages
		land for transportation service station
		rural roads
		land for the airport
		harbor land
		pipe land

	land for water area and water conservancy facilities	land for hydraulic construction
moderate production space	arable land	paddy field irrigated land the dry land
	garden	the orchard tea garden rubber plantation other garden
	public management and public service land	public management and public service land land for press and publication land for education land for science medical and health land social welfare land cultural facilities land sports land public facilities land
	land for water area and water conservancy facilities	ditch
	special land	scenic facilities
	other land	facility farmland ridge of field
weak production space	the grass	natural grassland artificial grassland
	land for water area and water conservancy facilities	the reservoir of the water pond water surface
strong living space	residential land	town house house-site at countryside
	special land	military facilities embassies and consulates land the sites of superintendent's premises religious land land for the funeral scenic facilities
moderate living space	public management and public service land	public management and public service land land for press and publication land for education land for science medical and health land social welfare land cultural facilities land sports land public facilities land parks and green space
weak living space	commercial services	retail commercial land wholesale market land

		catering land
		lodgings
		commercial and financial land
		recreational land
strong ecological space	woodland	arbor forest
		bamboo forest
		mangrove forest
		forest swamp
		shrub land
		shrub swamp
		other woodland
	the grass	natural grassland
		swamp grassland
		artificial grassland
	land for water area and water conservancy facilities	the river of the water
		the lake water
		coastal beach
		inland tidal flat
		marshland
		glaciers and permanent snow cover
	other land	idle land
		saline alkali land
		sand
		bare land
		bare rock gravel land
moderate ecological space	arable land	paddy field
		irrigated land
		the dry land
	garden	the orchard
		tea garden
		rubber plantation
		other garden
	other land	ridge of field
	public management and public service land	parks and green space
	land for water area and water conservancy facilities	the reservoir of the water
		pond water surface
		ditch
	other land	facility farmland
weak ecological space	the grass	artificial grassland
	public management and public service land	parks and green space
		the reservoir of the water
	land for water area and water conservancy facilities	pond water surface
		ditch
	other land	facility farmland

- *The evaluation principle*

Based on previous studies conduction research on PLE space or LUFs evaluation, this research defined an evaluation principle. 5, 3, 1 and 0 points to a strong, moderate, weak

and non-existent function (Dong, Zhang, Si, Tong, & Na, 2020; Liu, Liu, & Li, 2017; X. Zhang, Zhu, & Xu, 2014). For instance, for paddy field (1st land use type is arable land), which has moderate production function, non-living function, and moderate ecological function, will be given the evaluation points 3, 0, 3, respectively.

- *Study area and materials*

Chongqing, an economic hub along the Yangtze River in China, has witnessed rapid economic and social development since being approved as a municipality directly under the central government in 1997. Compared with the metropolis in Eastern China, Chongqing's economic development potential is greater, the demand for construction land is higher, and the degree of land use change is expected to be more intense in the next few years. Thus, the sustainable development of land use is essential for the development of the region.

Yubei District (106°27'30"–106°57'58"E, 29°34'45"–30°07'22"N) is located in the northeast of the urban area of Chongqing City (Figure 3). As one of the nine main city districts of Chongqing, it is a transitional zone between downtown and suburbs of Chongqing. Yubei District has a total area of 1457.07 km^2. The south-west of its jurisdiction is located in the downtown area of Chongqing, which is defined as the core industrial area of Liangjiang New Area (LJNA), a national new district, by the government. The northeast consists of about 1000 km^2 of rural areas. This region is adjacent to Chongqing's core metropolitan area (downtown) and extended metropolitan function area (mainly rural areas at present) and is a typical urban fringe area (Yilong Li et al., 2018).

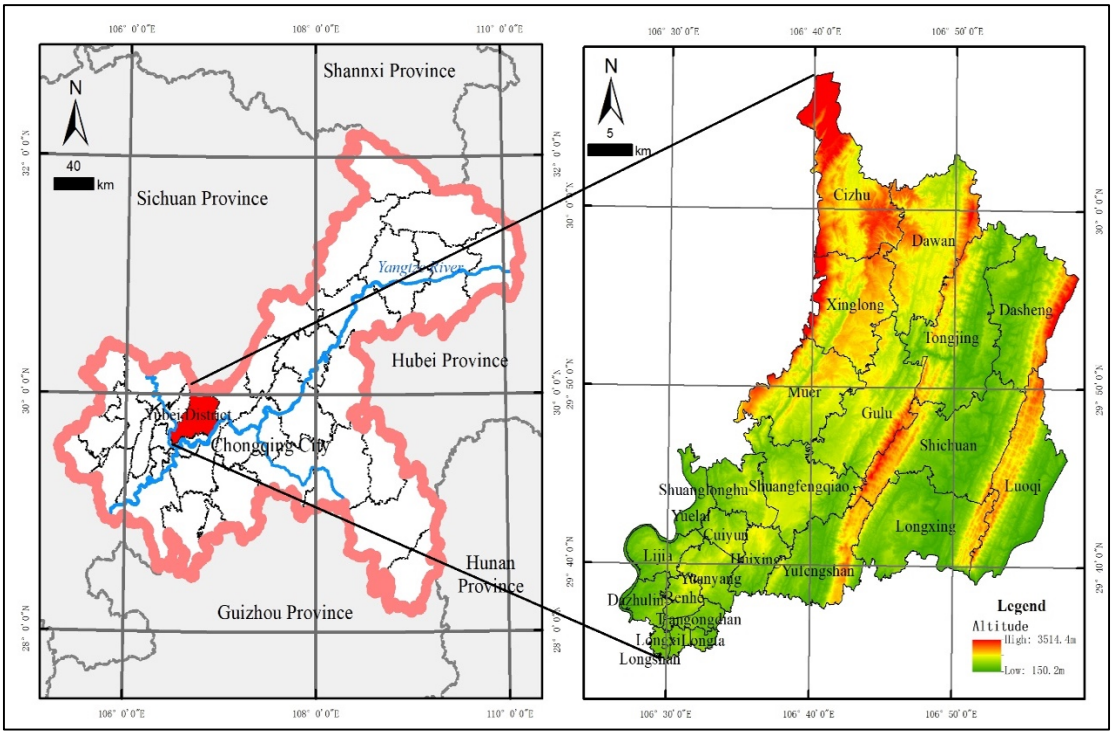

Figure 3: Location of Chongqing and Yubei District

Although there are several areas in Chongqing that can be identified as a urban fringe region, for this study, we selected the most populated and fastest growing part of

Chongqing city. In 2018, both the number of permanent residents and the GDP of Yubei District ranked first among all Districts/Counties of Chongqing (Chongqing Statistics Bureau, 2019). In recent years, due to the government's northward development strategy and the development of LJNA, the social and economic development of Yubei District speeds up and urban construction land has expanded rapidly to meet the needs of industrial economic development.

In terms of data and sources, the spatial data and statistical data of land use in Yubei District (the year of 2009, 2018), documents and maps of land use planning in Yubei District, and urban planning map are derived from the Bureau of Natural Resources of Yubei District. Digital elevation map of Yubei District is got from Geographic Information Centre of Chongqing. The satellite image (for reclassification) is downloaded via Google map.

- *Methods*

In this study, literature review methods, comparative analysis, and induction were performed to discusses the conceptual and logical connection between PLE space and LUFs, and a framework to identify and evaluate the production-living-ecological space was constructed based on the multifunctional land use framework.

To better understand the spatial and temporal evolution of PLE space in Yubei District, the study mapped the spatial distribution of PLE space via the software ArcGIS 10.3. Since the existing land use data classification method has not been unified with GB/T21010-2017, the land use data in 2009 and 2018 were reclassified based on the historical remote sensing images in google map, planning documents and field investigation of Yubei District.

In addition, the dynamic index of PLE space and the transformation of weighted center of gravity are used to track the changing trend and compare the distributions of PLE space from 2009-2018. The dynamic index of PLE space can be conducted to describe the change speed of regional PLE space in a quantitative way (Yafei Li, Liu, & Huang, 2017). The formula of the dynamic index of PLE space is given as:

$$K = \frac{S_b - S_a}{S_a} \times \frac{1}{T} \times 100\% \tag{1}$$

In this equation, S_b, S_a are the area of a certain PLE space category at the end and beginning year of the research, respectively, and T refers to the length of the research period.

The concept of gravity center originated from physics (Z. Li, Jiang, Wang, Lei, & Deng, 2019). In this paper, the theory of gravity center was used to analyze the spatial development and gravity center of PLE space and determined the changing track of PLE space in the research period. The formula of weighted center of gravity is:

$$X_w = \frac{\sum_{i=1}^{n} w_i x_i}{\sum_{i=1}^{n} w_i}$$
$$Y_w = \frac{\sum_{i=1}^{n} w_i y_i}{\sum_{i=1}^{n} w_i} \tag{2}$$

Where x_i and y_i are the longitude and latitude coordinates of the center, X_w and Y_w represent the longitude and latitude coordinates of the gravity center of PLE space.

Results and Discussion

- The Spatial Distribution of PLE space in Yubei District

Strong production spaces of Yubei District expanded from the southwest to the northeast between 2009 and 2018 (Figure 4). The original moderate production spaces were replaced by strong production spaces while the locations and areas of non-production and weak production spaces barely changed.

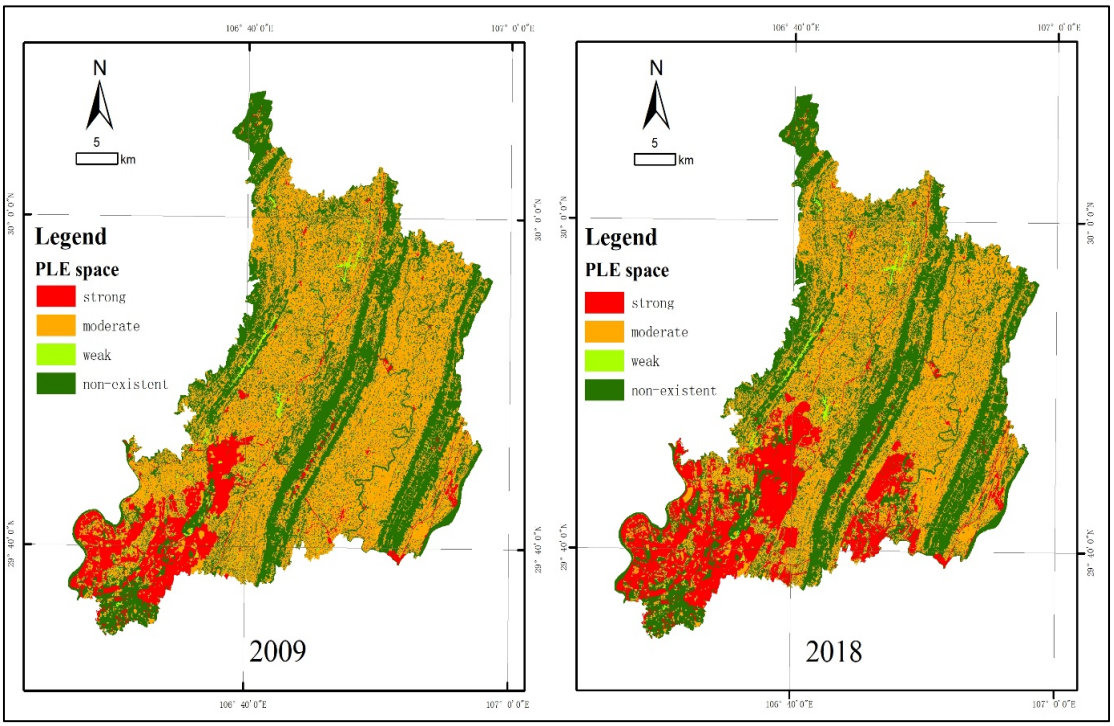

Figure 4: Spatial distribution of production space of Yubei (the year 2009 and 2018)

Living spaces of Yubei District during the research period saw significant changes (Figure 5). Strong, moderate, and weak living spaces all increased. Newly increased strong and moderate living spaces were mainly concentrated in the urbanized area of Yubei District and distributed around the strong production space. Whereas the increased moderate and weak living spaces were mainly distributed in LJNA where is undergoing rapid urbanization in Yubei District. A large number of public service facility land, mixed commercial and residential land, and commercial finance land have increased in these areas in the past decade.

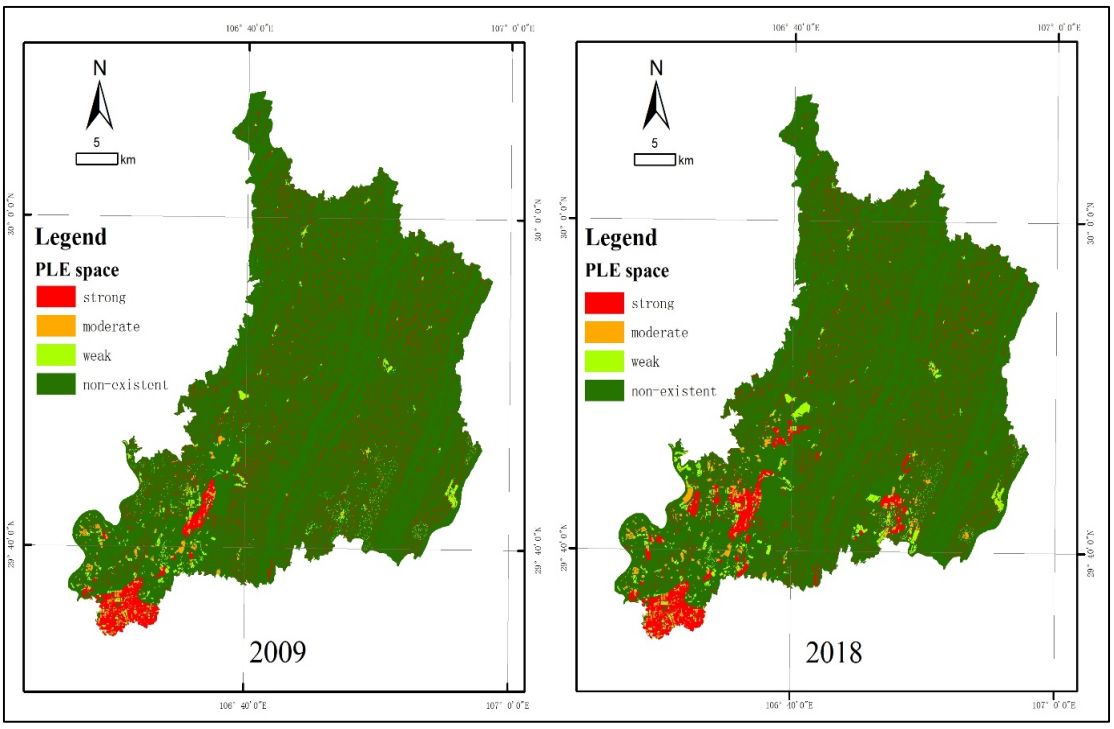

Figure 5: Spatial distribution of living space of Yubei (the year 2009 and 2018)

From 2009 to 2018, the area of ecological spaces in Yubei District has been significantly reduced and non-ecological spaces expanded significantly and demonstrated similar spatial change directions as strong production and living spaces (Figure 6). Strong ecological spaces mainly concentrated in the three mountainous regions where forests are the major land use type. These regions are not over developed as they have already become important natural reserves of Yubei District and are restricted by topographical factors. Therefore, the spatial distribution and scale of strong ecological spaces were relatively stable during the research period.

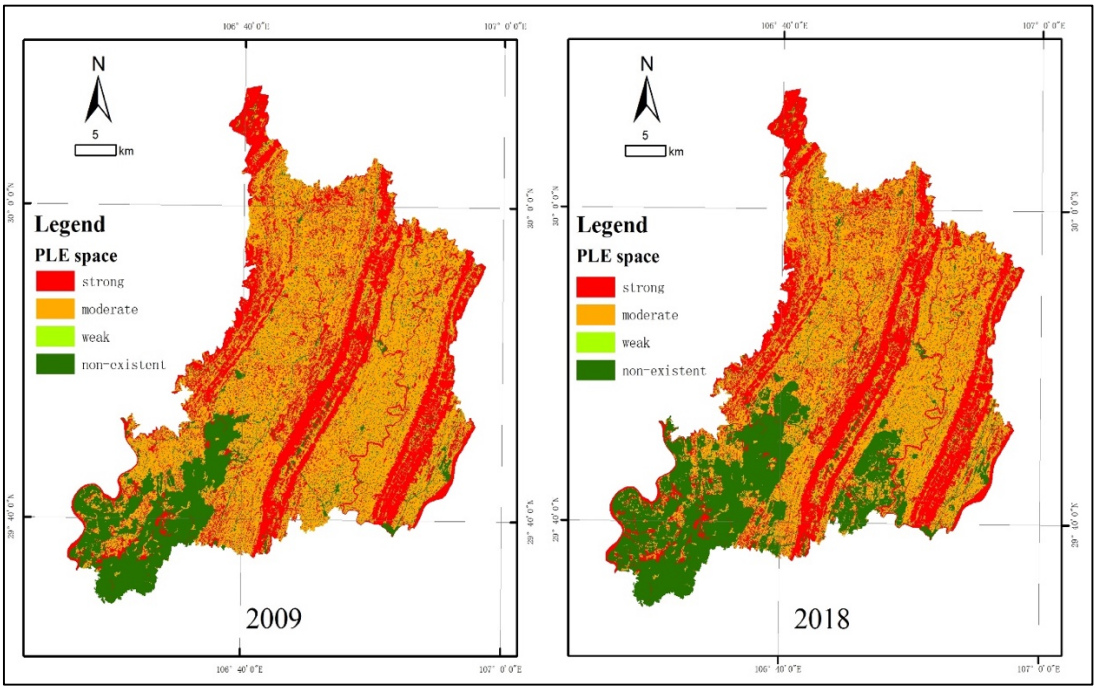

Figure 6: Spatial distribution of ecological space of Yubei (the year 2009 and 2018)

- *PLE space structure and dynamic index*

The dynamic index can quantitatively describe the rate of change of PLE spaces and plays an important role in comparing the changes in different types of PLE spaces and analyzing the variation trend of PLE spaces (Table 3). During the research period, the highest positive dynamic indexes were shown for strong production spaces, weak living spaces, and moderate living spaces. The highest negative dynamic indexes were shown for moderate ecological spaces, moderate production spaces, and weak production spaces.

Table 3: The quantity structure and dynamic index of PLE space in Yubei District

PLE space category		2009	2018	The dynamic index
Strong production space	Area (hm^2)	13817.25	23809.50	7.23%
	Proportion (%)	9.48%	16.33%	
Moderate production space	Area (hm^2)	73998.00	63594.00	-1.41%
	Proportion (%)	50.76%	43.63%	
Weak production space	Area (hm^2)	1845.00	1656.00	-1.02%
	Proportion (%)	1.27%	1.14%	
Strong living space	Area (hm^2)	12064.50	13531.50	1.22%
	Proportion (%)	8.28%	9.28%	
Moderate living space	Area (hm^2)	1451.25	2097.00	4.45%
	Proportion (%)	1.00%	1.44%	
Weak living space	Area (hm^2)	2085.75	3141.00	5.06%
	Proportion (%)	1.43%	2.15%	
Strong ecological space	Area (hm^2)	44145.00	43701.75	-0.10%
	Proportion (%)	30.28%	29.98%	
Moderate ecological space	Area (hm^2)	74000.25	62736.75	-1.52%
	Proportion (%)	50.76%	43.04%	
Weak ecological space	Area (hm^2)	0.00	0.00	0.00%
	Proportion (%)	0.00%	0.00%	

Such phenomena suggested that a regional development model based on the production functions of the secondary, tertiary industry is being established in Yubei District. The newly increased strong production spaces replaced part of moderate and weak production and ecological spaces. In this process, the changes in land utilization type were mainly reflected in the transformation from cultivated land to construction land. The increase of moderate and weak living spaces represented the increase of public service facility land, commercial land, and mixed commercial and residential land in Yubei District during the research period. The increase in such land utilization types might enrich the residents' lives, improve the overall level of the commercial service industry in Yubei District, and improve the living qualities of local residents.

- *The weighted center of gravity of PLE space*

Figure 7 illustrated the transition of weighted gravity center of PLE space from 2009 to 2018. The red Pentagon represents the geometric center of Yubei district for reference only. Past decade has witnessed the changes of PLE space center in Yubei District in different directions and degrees while taking the land use function evaluation into account. Specifically, the production space center shifted southwest from 106.7212°E, 29.7934°N to 106.7192°E, 29.7890°N, the living space center shifts southwest from

106.6924°E, 29.7655°N to 106.6884°E, 29.7602°N and the ecological space center shifted northeast from 106.7653°E, 29.8337°N to 106.7725°E, 29.8434°N, respectively.

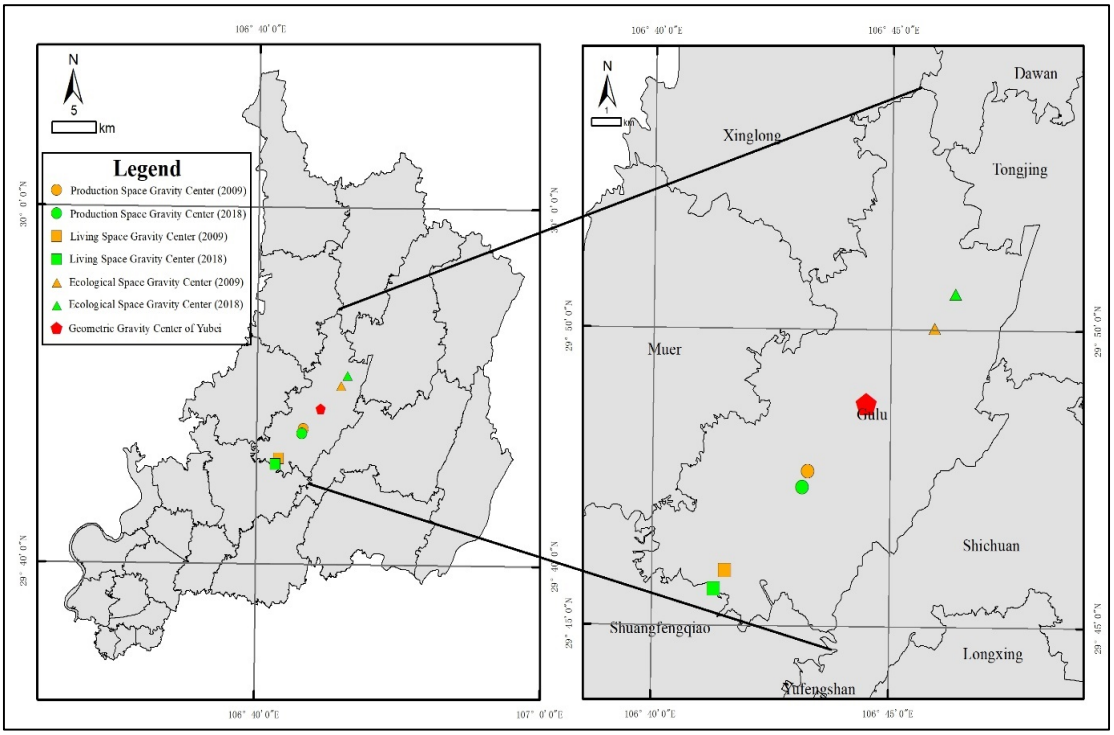

Figure 7: The weighted gravity center of PLE space from 2009 to 2018

It is worth noting that both the production space gravity center and living space gravity center in Yubei District has shifted towards southwest, which seems to be contrary to the construction land expansion in Yubei District. Therefore, this result further reflects the advantages of PLE space research in terms of studying the versatility of different land use types while comparing with traditional land use transformation research. Specifically, although the production space in Yubei District shows an expanding trend towards northeast as a whole, actually the production space center shifted southwest since the agricultural production function (moderate production function) of large rural areas in the northeast is gradually being replaced by the rapid expansion of the second and tertiary industry production function (strong production function) in the southwest urban areas. As for the living space, although there are a large number of scattered rural residential areas in the rural areas of Yubei District, the newly added production function land in the past ten years focuses on the core area of LJNA, which is mainly distributed in the southwest of the center in 2009. Therefore, the improvement of urban residence and living functions in Yubei District has become the driving force for the transfer of living space. From 2009 to 2018, the shift of ecological space center in Yubei District towards northeast reflects the fact that Yubei District occupies a large amount of ecological land in the process of urbanization from southwest to northeast and faces the mounting pressure on regional ecological protection.

Conclusion

As one of the most essential concepts in China's land use development, the PLE space has been playing an important role in improving the sustainability of land use. This

study sorted out the theoretical connections and logical relationships between land utilization functions and PLE spaces, proposed a classification and evaluation method of PLE spaces in China based on LUFs, and took the Yubei district, which is located on urban fringe area of Chongqing and undergoing rapid urbanization, as an example to conduct empirical research on this methodology framework. The main conclusions are as follows:

During the research period and the process of urbanization, agricultural land close to the urban area in Yubei District was occupied and turned into construction land. The land production function changed from mainly agricultural production to mainly non-agricultural production. Moderate production spaces were replaced by strong production spaces in the urban fringe and inside the urban area, resulting in the center of production spaces being pulled towards the city. Urbanization and the development of the secondary and tertiary industry became the driving force for the significant increase of strong production spaces in Yubei District.

The weight gravity center of living space of Yubei District moved towards the southwest, which reflected the scattered and small-scaled rural living functions of Yubei District is much lower than urban living functions within the research period. A large amount of newly increased residential land emerged inside the city and in several regions in the south of the original center, especially in LJNA. In addition, moderate and weak living spaces in Yubei District increased significantly. Regarding land utilization types, it was reflected through significant increases in commercial service land and public service facility land, which contributed to improving the living qualities of local residents and the commercial development of Yubei District. The changes of PLE space center in Yubei District implies that the importance of rural areas has been weakened in terms of production and living functions during the process of urbanization. This will affect the overall development of urban and rural areas, and even aggravate the unfairness of regional development, which has a negative impact on the land sustainable use. Therefore, we should pay attention to land use changes in rural areas, strengthen infrastructure construction in rural areas during the process of urbanization, improve the quality of life of rural residents, and appropriately develop industrial land and protect ecological land.

Ecological functions of Yubei District declined in the past decade, mainly due to a large amount of agricultural and ecological land being developed into construction land. Areas with reduced ecological spaces mainly concentrated in non-mountainous flat regions and were mostly transformed into strong production and living spaces. In the context of ecological civilization, how to balance the trade-off between conservation and development in the process of rapid urbanization is an important issue for the future sustainable development of Yubei District.

The PLE space classification and evaluation system proposed in this paper contributes to the identification of PLE spaces based on land use types and functions. The empirical study of Yubei District tested the methodology framework and provided a reference for the identification and evaluation of PLE spaces in regions where facing rapid urbanization process in China. The results in this paper further reflects the advantages of PLE space research in terms of studying the change trend of different land use types while comparing with traditional land use transformation research. Future research will discuss the leading factors that cause the spatial and temporal evolutions of PLE spaces

in Yubei District and conduct further empirical analyses on the classification and evaluation methods of PLE spaces in China.

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How Industries Integrate COVID-19 Countermeasures Support with Environmental Concern and Community Development in Bandung, West Java: The Pindad Bandung Case Study

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The Asian Conference on Sustainability, Energy & the Environment 2020
Official Conference Proceedings

Abstract
The unprecedented COVID-19 pandemic, which has also impacted all corners of Indonesia, meanwhile, has impacted Indonesian people's socioeconomic welfare adversely, as well as the financial performances of industries recently. This has motivated several industries which are economically strong enough to still resume their operations to contribute something valuable to the national effort in responding to this disaster, particularly in helping these companies' main business stakeholders as well as the local people living in the vicinity of these companies' operational areas whose livelihoods have been adversely impacted by it. The paper will address Pindad's efforts in overcoming the adverse impacts of the COVID-19 pandemic in its operational areas, while modifying its production processes to comply with the advised health and hygiene protocols, two actions which implementation the company attempts to align with its environmental management and community empowerment principles. Pindad's best practice in environmental impacts reduction has been able to reduce its energy use by 0.8 GJ, bringing down carbon emission by 0.12 tons of PM per annum, reducing toxic and hazardous waste by 12 tons, managing the non-toxic and hazardous waste by 40 tons, conserving biodiversity amounting to 5 squirrels in the area, as well as involving 15 locals in its community empowerment and agricultural land conversion program. Further, the paper will also address how the company is conducting all the activities mentioned above amid all the circumstances surrounding the pandemic-inflicted Indonesia in general, as well as within the specific context of the Bandung city itself.

Keywords: Pindad, Environmental Management, Community Empowerment, COVID-19 Pandemic, Bandung City, Indonesia

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Introduction

PT Pindad (Persero) is an Indonesian manufacturing industry corporation located in Bandung, West Java. In its production processes, Pindad also supports the manufacturing of commercial heavy equipment, industrial tools, as well as services related to these products nationwide to boost the domestic production of such machineries. No different from other manufacturing industry players, Pindad has also attempted to step up on its sustainable clean production and environmental management practices. You can see Pindad's operational location in Picture 1.

Picture 1: Pindad's operational location in Bandung, West Java

Needless to say, the COVID-19 pandemic, which has hobbled every part of the globe, has also affected various industrial sectors, be it in terms of supply chain and their products, as well as the health condition of their workers. Keeping this in mind, Pindad has continuously applied health and hygiene emergency and safety protocols to all its personnel conducting the company's production activities so the pandemic situation will not pose significant obstacle to the company's production processes. To resume its production processes under the necessary health and hygiene protocols amid the pandemic, Pindad also continues to adhere to its existing environmental management principles amid its operations, while conducting community empowerment activities as usual. The company needs to only modify the time frame and implementation mechanism of these activities with the constraints brought by the current pandemic while still endeavoring to implement these activities effectively amid the constraints.

The paper will address several of the company's innovations in environmental management and natural resources utilization minimization programs, which comprise promoting energy and water efficiency, decreasing the pollution burden from waste water and emission, conducting recycling, reusing and reducing activities for toxic and hazardous waste, as well as the non-toxic and hazardous waste category, while still implementing community empowerment programs amid the pandemic. The company continues to run all the programs which belong to these pillars, while applying the COVID-19 pandemic-related safety and health protocols more meticulously. Pindad has also implemented several disaster mitigation programs both on regional and national level, as will be elaborated in the following sections:

An Overview of Pindad's COVID-19 Impact Mitigation Efforts on the National and Regional Level

The COVID-19 pandemic is a non-natural disaster which belongs to the medical disaster category. The pandemic has to do with an infectious virus. However, due to the wide-reaching socioeconomic impacts of the pandemic, COVID-19 has also dramatically impacted socioeconomic activities of people around the world, including Indonesia.

As an industry player, Pindad has also conducted several well-structured disaster mitigation and emergency response efforts, implementing these efforts into its industrial operation activities, as well as to locals living within the vicinity of the company's operational areas. By doing this, Pindad tries to contribute as a member of the industrial sector community to the nationwide disaster mitigation efforts. You can glimpse Pindad's disaster mitigation efforts in Picture 2.

Picture 2: Pindad's Disaster Mitigation Activities

Besides that, Pindad is also planning to conduct still several other non-natural disaster mitigation programs, as you can see in Picture 3.

Picture 3: Pindad's Contribution to the National COVID-19 Mitigation Efforts

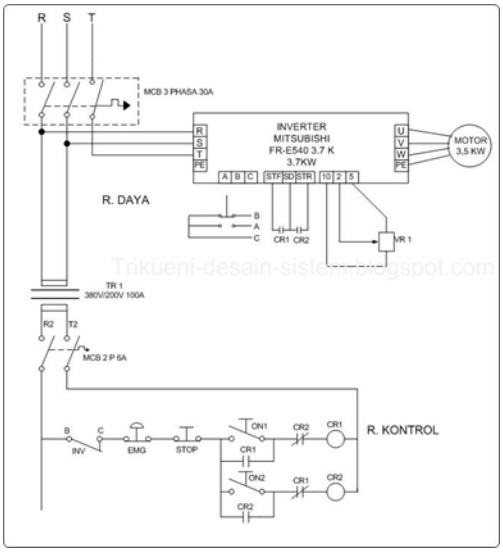
Pindad also attempts to contribute to the COVID-19 impact mitigation efforts on both the regional and national level by manufacturing supporting equipment for the healthcare sector to circumvent supply shortage amid the pandemic. This is part of the

children of the nation's innovations to drive domestic consumption while also helping the healthcare sector overcome the COVID-19 pandemic in a way which makes economic sense.

Hopefully, this would serve as a best practice role model for various industries around the world, especially in developing countries. These strategies work in boosting domestic goods production to bolster pandemic resilience not just in terms of financial benefits, but also by boosting the time efficiency of these goods' transportation and distribution processes.

Energy Efficiency Program: Promoting Energy Efficiency in High-Powered Induction Motor using Variable Speed Drive

The company also implements its energy efficiency initiative by using variable speed drive (VSD) in high-powered induction motors. Induction motor is one of the equipment frequently used in industries to propel various operational processes, including water pumps, compressors, funs, blowers, conveyors and many more, forward. Induction motor's popularity is thanks to its advantages compared to other synchronizer or DC motors, including its simple construction, durability, easy maintenance and high efficiency. Despite all its strength as equipment, however, induction motor also has several weaknesses, including a low-level velocity and initial torque adjustment. To overcome this problem, industries can just apply a control system, called the VSD, by adjusting the input voltage and its frequency to get a velocity and torque within the quantity needed by the industrial production process. The company documents its VSD use in Picture 4.



Picture 4: Pindad's Method of Applying VSD in Its High-Powered Induction Motors

Motor torque and velocity management are two important parameters of a high-quality induction motor. Users need flexible settings in these two variables by changing their inputs from 50 Hertz (according to the State Electricity Company or the PLN's standard) to the desired frequency to allow its motor to turn in the expected velocity and torque. This program contributes energy efficiency worth 0.8 GJ.

Emission Reduction: Eliminating the Weaponry Production Division's Tin Processing Chamber

Pindad's weaponry production division has a tin processing chamber which the company uses to polish the interior part of the weapons' barrels, using lead or black tin to complete the process. Unfortunately, in terms of work safety and health, workers' exposure to both lead and black tin could endanger their health and the company's awareness of the threat has prompted it to eliminate the barrel polishing process from its weaponry division. The company eliminates the tin processing chamber phase by replacing the chamber with a new machine which does not use heavy metal in its process, making it safer for its workers, besides being friendlier to the environment. The tin chamber process is being documented in Picture 5.

Picture 5: The Tin Chamber Processing

By getting rid of the barrel polishing phase, thereby removing the use of lead and tin from the weaponry manufacturing process, the company is also eliminating lead emission, which pollutes the air. In a nutshell, this program also plays a role in turning the weaponry production process into one which is environmentally friendlier by reducing the air pollution it causes.

Hazardous Waste Management: Using Rubber Gloves Instead of Sewn Fabric Gloves

To manage its toxic and hazardous waste, Pindad focuses mainly in reducing dominant type of waste, among others being fabric waste, from the sewn fabric gloves which its workers use in its daily operations. Technically, the company reduces its fabric waste by replacing the sewn fabric gloves with rubber gloves instead. Although manufacturing glove rubbers is more expensive than the sewn fabric ones, but the glove rubbers have longer durability than the fabric ones, thus contributing to the effort to reduce the toxic and hazardous waste.

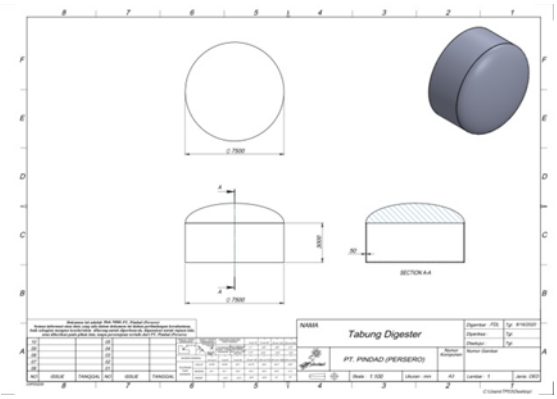
The rubber gloves are also safer to use among the field operators, because the rubber gloves have less likelihood of being stuck in the production equipment. How the workers use the rubber gloves in operational activities can be seen in Picture 6.

Picture 6: The Use of Rubber Gloves in Operational Activities

The material substitution program has been shown to be effective in reducing the toxic and hazardous waste pile with a 1:15 proportion compared to the sewn cloth gloves utilization. Considering that Pindad requires heavy utilization of these gloves across its various operational activities, the material substitution program has significantly reduced the toxic and hazardous waste pile.

Solid Waste Management: Bio-digester Equipment Design to Manage Organic Waste into Biogas

Biodigester is an equipment that the company uses to ferment organic waste, especially that of wet waste. Biodigester container functions to create an anaerob condition to ensure that the organic waste fermentation process will take place properly. The result of the fermentation process is a methane-containing biogas, which can be subsequently used as biofuel. Every day, Pindad's dining room produces organic waste from food scraps. The biodigester is expected to reduce the organic waste by turning them into biofuel which can be used for cooking. Pindad is making the biodigester machine as part of its innovation in organic waste management as depicted in Picture 7.



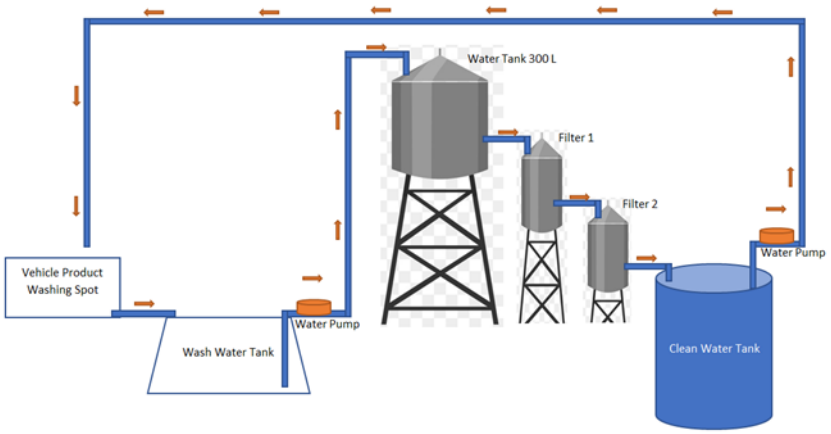
Picture 7: The Biodigester Machine, Made by Pindad, as Part of its Organic Waste Management Innovation

The program is still in its machinery design phase, yet the company has estimated that the new machine is capable of converting up to 39.8 ton of food scraps organic waste into biofuel per day. In the future, the company will move forward with its environmental management innovations in order to realize its contribution to the

manufacturing industry by managing the balance of its waste production. The company expects that the output of this program will be used in its Villages Go Gardening (locally known as *Kampung Berkebun*) initiative, which belongs to its community empowerment area.

Water Efficiency: Recycling Wastewater from Vehicle-Washing Activities

In terms of water efficiency, the company has a waste water recycling program, which recycles the waste water from its vehicle-washing activities in a water containment mechanism, which works by filtering the waste water before pumping it back to the reservoir to be used yet again in its vehicle washing activities. The company is conducting this program to optimize its use of clean water, which it sources from a groundwater well. The company filters out the wastewater from the vehicle washing activities to sterilize the water, specifically to prevent it from being mixed up with soapy water. A schema detailing the program implementation is featured in Picture 8.

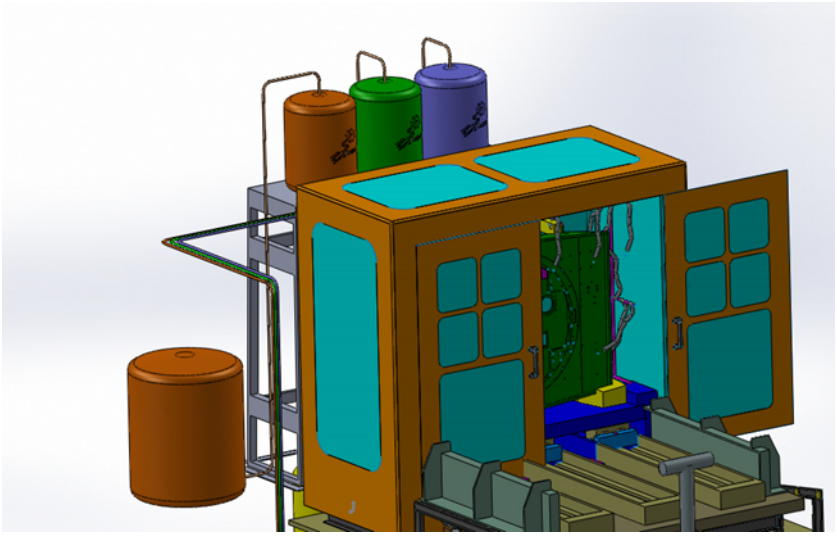


Picture 8: A Schemas Detailing the Recycling Process of the Wastewater from the Vehicle-Washing Activities

The program has been able to boost the clean water use efficiency by 30,384.00 cubic meters per annum from the company's vehicle-washing activities. This program also increases natural resources conservation as one of the company's attempts to support a global issue right now.

Wastewater Management: Fluoride Acid Chemical Material Recycling to Clean Aluminum Plates in Special Vehicle Components

One of Pindad's production process lines involve the use of fluoride acid as a chemical substance. The company uses the chemical substance to wash its special vehicle components and etchings as well as the vehicle's metal layering and convention coating. In its practice, the company innovates with the used hydro fluoride liquid circulation by still paying close attention to the liquid concentration. The whole process is depicted in Picture 9.



Picture 9: The Chemical Liquid Recirculation Process in Metal Plate Component Washing Activities

Through this recirculation program, the company can implement its waste water pollution from hydrofluoride chemical liquid reduction program. Currently, the program has been recorded to bring down the pollution burden by 0.2 tons of hydrofluoride per annum. In the future, meanwhile, the company will continue to increase its innovation programs to support its sustainable environmental management in the manufacturing sector.

Biodiversity Conservation: Conserving Squirrel Population in Pindad's Urban Forest Park

Pindad is also implementing several in situ biodiversity conservation programs by managing and maintaining the biodiversity of an urban forest park located within its operational zone. One of the unique programs which the company has consistently been implementing is conserving the regeneration of squirrels in the area. Based on the company's monitoring activities, it has discovered that squirrels in the area contribute to the plant fertilization through its manure, boosting the fertility of productive plants.

Therefore, Pindad has turned the urban forest park into a natural squirrel conservation zone. You can see the squirrels in the area being depicted in Picture 10.

Picture 10: How Squirrels Live in Pindad's Urban Forest Park Area

Based on the company's field monitoring activities, it has discovered at least 125 squirrels living across various corners of the Pindad urban forest park. The company has not conducted any specific surveys to map out the exact population number of the squirrels yet and has included these surveys into its future sustainable improvement agenda.

Community Shared Value and Development: 'Kampung Berkebun', an Organic Urban Farming Program in Bandung City's Suburban Area

Pindad's operational location in Bandung, West Java exposes it to a densely populated area, which majority of population belongs to the underprivileged socioeconomic bracket, marked by a lack of proper welfare. Keeping this condition in mind, the company has a potential to create added value both for the company's business itself and the communities living in the vicinity of the company's operational area. The company tries to tap into this potential.

In this case, PT Pindad has a land which it previously used as a landfill area but because it had proved to impact surrounding environment and communities negatively, the company finally decided to move the landfill area somewhere else, in cooperation with the local sanitation agency. To demonstrate the company's concern about its surrounding environment, it has come up with a community empowerment program to help local people make use of the land available in the area, to get additional income from various economic activities they can conduct over there.

The company organizes the community empowerment program by synergizing its team internally as well as collaborating with the local residents and the agricultural agency. The company's coordination activities with the RW 09 Sukapura neighborhood unit has resulted in the appointment of 15 local people to manage its *kampung berkebun* (villages go gardening) urban farming program, with one coordinator who also acts as a group guarantor.

Prior to implementing the program, the company has already signed a memorandum of understanding (MoU) with the RW 09 Sukapura neighborhood unit head. It has also conducted an urban farming training with representatives from the Bandung city agricultural agency.

To implement the program, PT Pindad has also provided land as well as an initial capital to fund the communities' urban farming activities. The company has also guided and monitored the local communities to help them turn the urban farming activity into a success. You can look at the local communities' urban farming activity in Picture 11.

Picture 11: The Implementation of the *Kampung Berkebun* (Villages Go Gardening) Urban Farming Program, Utilizing what Previously used to be a Landfill (*left*) into an Organic Farming Site (*right*)

Throughout the six-month program implementation period, local communities have been successful in harvesting at least seven vegetable types which they plant according to their harvest seasons. The economic benefits that the people have obtained from this activity are 2.5 times higher than the minimum wage set by the Bandung city administration. The total number of locals empowered in this program amounts to 15 people, whom previously were squatting around the landfill area. The local communities and groups managing the *Kampung Berkebun* activity have been benefiting from harvest produce, using the money they gain from it as a base capital to buy the plant seeds for their next urban farming activity.

Conclusions and Recommendations

We have concluded that out of the entire program conducted by PT Pindad to support natural resources conservation in its operational areas, the company has been successful in attaining several measurable benefits, including:

1. Energy efficiency worth 0.8 GJ per annum from the VSD program.
2. Reduction of the toxic and hazardous waste by 12 tons per annum from the use of rubber gloves.
3. Organic waste utilization worth 39.8 tons per annum using the bio-digester equipment.
4. Tin and lead emission reduction by 0.12 tons of particulate per annum by eliminating the tin processing chamber.
5. Attaining water efficiency by 30,384.00 cubic meters by recycling the wastewater from the vehicle-washing activities.
6. Reducing the hydro fluoride pollution burden by 0.2 tons per annum from its special vehicle activities.
7. Conserving squirrel species by 125 individual squirrels in the urban forest park area.
8. Empowering 15 people through the *kampung berkebun* (villages go gardening) urban farming activity from a field formerly used as a landfill area.

For the future success of Pindad's community empowerment programs, we would like to recommend that the company continuously evaluates and improves each program's implementation strategy, thus capable of producing innovations based on equipment technology, while still effecting significant environment benefits in terms of minimizing natural resource utilization.

Acknowledgement

We would like to deliver our gratitude and many thanks to the working group for environmental and sustainability of Pindad Manufacturing. We also thank to Board of Directors of PT Pindad (Persero) for their continuous support and guidance for the team to having concern in the environmental perspective. Other expression of appreciation also for the community for their kind of cooperation and vibrancy to develop their potential in a good environmental way is also part of the key success of overall teamwork. We wish to enhance the development of sustainability program in the future.

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