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朝向都市修復與生態再生的典範 - 以台北的生態城市策略為例

Towards an Urban Repair and Eco-generation Paradigm

A case study of Taipei's eco-city strategy

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Abstract

Until recently, developers of Asian metropolitan cities have largely ignored the interconnection between nature and cities. During the early stages of urbanization in Taipei this lack of planning caused many of the current challenges faced by the city. As the movement to build more environmentally sustainable cities gains momentum as we head into the 21st century; so should the desire to upgrade existing cities to these new development aspirations. Sadly however, most of the attention primarily focuses on future cities. This thesis, on the other hand, focuses on the eco-regeneration of older cities, namely, Taipei. The strategy to regenerate the city using eco-puncture is due to the fact that repairing key locations will have the most positive impact. To achieve this endeavor the goals of this thesis are twofold; firstly to investigate Taipei ecosystem to gain a comprehensive understanding of its current and future developmental challenges. Lastly to form an eco-regeneration plan using eco-puncture methods, as acupuncture is the preferred method used in Chinese culture in the process of repairing.

Key words: *urban regeneration, eco-puncture, eco-city, ecosystem, city repair, eco-regeneration*

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Introduction

Cities are the ultimate symbol of everything mankind has accomplished during its evolution; they are the evidence and testimony not only of our civilizations history and achievements, but also of our perennial mistakes and negligence. Consequently, we live in ecologically damaged cities, as rapid urbanization in many regions all over the world can only be characterized by diminishing environmental quality in urban areas through the degradation of health and pollution of: air, soil, water, microclimate, and loss of natural spaces. As overpopulation of cities continues, which occurs simultaneously with industrialization, to have a major impact on the loss of resources in the hinterlands, deforestation, building over agricultural lands, thereby producing excess industrial waste, and pollution. The world population continues to grow at an increasingly rapid rate. The migration of people from rural to urban areas has led to the expansion of cities' and thus into uncharted territories, which has resulted in "the reclassification of rural settlements to urban" status (Platt, Rowntree, and Muick 1994). A comprehensive analysis of the situation does not only point to industrialization as the sole culprit behind the influence from cities, it also points to inhabitants as another influential factor.

During recent decades humanity has awakened to the reality of their ecological footprint and therefore has desired to change the impact and reduce future damages by "Going Green". "Green" establishments are becoming increasingly popular, and using the phrase "sustainable", "green" or "eco-" in the name of saving the planet is supposed to show that humanity's main principle is environmental consciousness. However, the concept is relatively new and only in a few cases the attempt at "going green" has resulted in environmental sustainability. It is important to consider what it means to be sustainable, eco-, or green; and how these fundamental principles should be incorporated into the aspirational priorities of development. The concept of ecologically friendly and sustainable development is losing its meaning due to commercialized misinformation. Therefore it's worth investigating how roof gardens, green walls etc. are helpful in attempts to become more "green", but realizing individually they're not a silver bullet to environmental sustainability, is crucial (Rich 2007).

To overcome these and other challenges, there have been many ideas suggesting plans and designs of projects for "new" cities of the future, however the regeneration of

current cities should not be neglected. Many of these cities, if not all of them, require change. Since repairing existing cities requires a different approach because it is more complicated compared to building new ones, the process should have a strategy that starts with, understanding the goal, and pointing out the source of the challenges. The second step is to analyze propositions of solution (or improvement), finally choosing the solutions that most efficiently accomplish the goals and implementing them into our cities. City-planners need to create designs in which there are grounds and areas meant for regeneration. Some examples are: industrial wastelands, brownfields, empty spaces, dead zones, old buildings, different types of lands in the city...etc. Land can be used and transformed for various uses with benefits to the city. This thesis will analyze and present a strategic plan for Taipei City in order to regenerate the ecosystem of the city. As we create this plan it is important to explore the concept of sustainability and the meaning of ecology to better understand the interconnection with a city. Secondly, review the evolution, visions, principles and purpose of eco-cities. Thirdly, investigate *Urban Eco-puncture* and urban repair; followed by analysis of Taipei city's developmental history, a diagnosis of the geographic location, city plan and its influence on the inner city and surrounding environment. Finally, formalization of the cities ecological principles, drafting an urban eco-repair plan using *eco-puncture* to repair the city, and focusing on its current and future developmental challenges. This should lead to an initiative to regenerate Taipei City through strategic directives that will focus on connecting the city with its surrounding environment for a more sustainable future.

Chapter 1 Ecosystem and Sustainability in the Eco-city Discourse

Humanity is interdependent on the natural environment therefore modeling our city system around it is crucial. A city modeled on the ecosystem is an idea that continues to expand previous development principles in the eco-city discourse. Nowadays' older cities should aspire to become sustainable eco-cities, which is not possible without understanding the driving force behind eco-principles and why applying them in the right way with any eco-city concept is important. Ecosystems and sustainability are crucial terms in the "eco-city" concept. While it is easier to apply those eco-features into new city designs, already existing cities require a different approach. Countless examples of misunderstanding and misinterpretation of these terms have occurred, thus it is essential to begin with some explanation.

In order to capture the essence of ecology it should be described as a study of the relations that living organisms have with respect to each other and their natural environment. However, ecology is not synonymous with the term environment. There are many points of interest in the subject of ecology; this chapter pays closer attention to only one of them: ecosystems.

An ecosystem is an area where many living and nonliving organisms coexist, and biodiversity is a measure of [the] health of ecosystems (de Groot 2002). An ecosystem is defined as a system formed by the interaction of a community of organisms with their environment. Biological diversity defines "totality of genes, species, and ecosystems of a region" (Larsson 2001). Moreover, the degree of fluctuation of life forms within an ecosystem is the significance of biodiversity on which each ecosystem depends. Thus Ecosystems are sustained by the biodiversity within them. On the one hand, Biodiversity is not constant and does not distribute equally, it varies all across the globe. On the other hand, ecosystems sustain every function of life-support, thus ecosystems are hierarchical in nature, organized into a graded series of regularly interacting and semi-independent fragments (e.g., species) that aggregate into higher orders of complex integrated wholes (e.g., communities). Hence Biodiversity is the full-scale of life and its processes, including genes, species and ecosystems forming lineages that integrate into complex and

regenerative spatial arrangements. These arrangements of types, forms, and interactions create the three main aspects of ecosystems(O'Neill 1986):

- The boundaries of ecosystems (can vary and possibly will change in time).
- Organisms within ecosystems (depend on its ecosystem's inner processes)
- Nearby ecosystems (strictly interact with each other, additionally are interdependent for maintenance of community structure and functional processes that preserve productivity and biodiversity).

1.1 The Geography of Ecosystems

There are many different ecosystems: rain forests and tundra, coral reefs and ponds, grasslands and deserts. Climate differences from place to place largely determine the types of ecosystems we see. How terrestrial ecosystems appear to us is influenced mainly by the dominant vegetation.

The word "biome" is used to describe a major vegetation type (Figure 1). It always refers to a vegetation category that is dominant over a very large geographic scale, and so is somewhat broader than an ecosystem. However, there is much to be examined on a smaller scale as nearby ecosystems interdependently interact with each other for maintenance of community structure and functional processes that preserve productivity

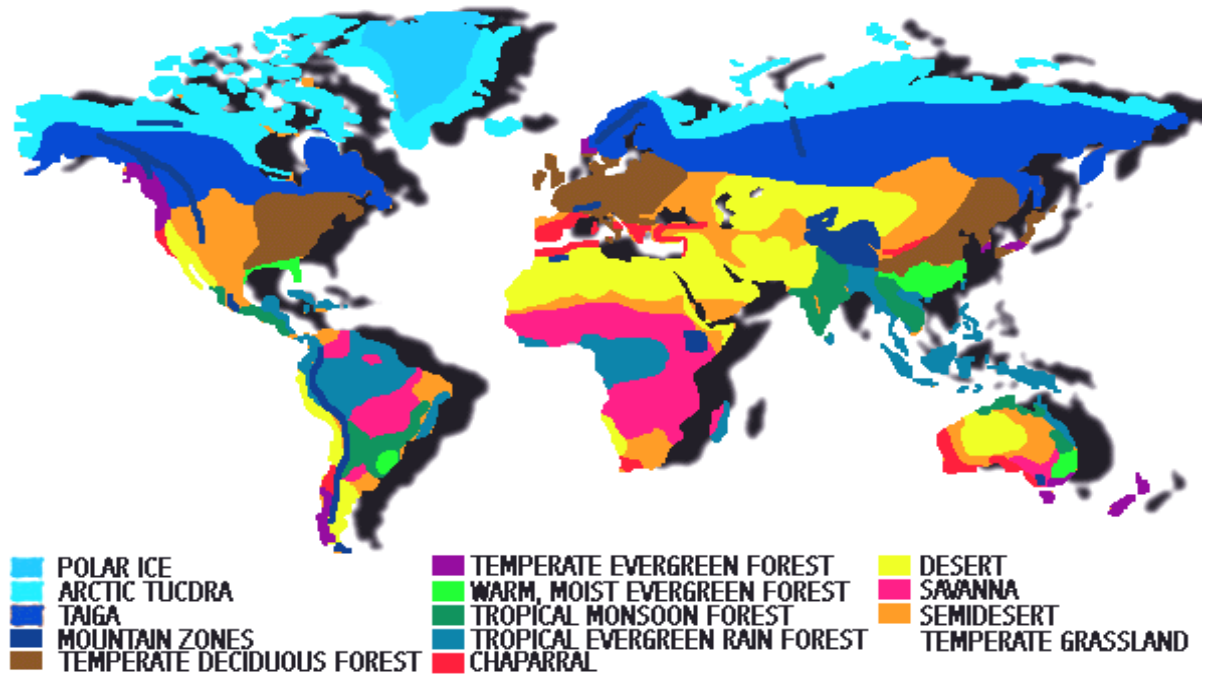


Figure 1 The distribution of biomes (Source: http://www.globalchange.umich.edu)

and biodiversity. According to David Engwicht an eco-city is ‘a place of exchange’, [a place of] “rich diversity and exchange opportunities”, [that is the essence of it, because] “we need what other people can give us” (Engwicht 2007). From this concept he derives the theory of an eco-city being an ecosystem created “by people for mutual enrichment” (Engwicht 2007), where everything is interrelated and interdependent. Each organism living within this ecosystem provides something essential for the existence of other organisms, and receives something necessary for its own survival from others. Every organism is significant in the proper functioning of the ecosystem. However, not diminishing the importance of each “unit” of the ecosystem, an ecosystem itself cannot be understood as “a process of objectively looking at individual parts” (Engwicht 2007). The final effect that they create, which is a working eco-system is essential. Organisms should be looked at as parts of a system based on mutual relationship.

Following David Engwicht’s theory, a city can be divided into parts that could be considered as many connected, co-depended small units forming a system. Their differences and uniqueness are the basis for system biodiversity, which in case of a city, may be understood as not only biological, but also structural and in social aspects as well. Thus each element is significant in every city; one unit could not exist without other.

1.2 Peri-urban Area

Urban and economic systems cannot be fully understood in isolation from their resource base, the ecological system within which they exist. Cities have to rely on the external ecosystems and maintain stable links with the surrounding landscape from which they draw energy, food, and materials and into which they release their wastes.

A peri-urban area is a specific and non-neutral space, that refers to a transition or interaction zone, where urban and rural activities are juxtaposed, and landscape features are subject to rapid modifications induced by human activities (Douglas 2006). Peri–urban areas can provide essential life support services for urban residents since they might include for example valuable protected areas, forested hills, prime agricultural lands and important wetlands (McGranahan, Satterthwaite, and Tacoli 2004).

McGranahan et al. observed that peri–urban zones are often far more environmentally unstable than adjacent urban or rural lands. From an ecosystem's point of view, physical, chemical and biological factors mutually interact, and are interrelated with socioeconomic forces. These factors have their own functions, which can be increased or reduced depending on the conditions of other factors in the same system (Fang, Gertner, Sum, and Anderson 2005).

A peri-urban area is a zone that experiences the direct and immediate impacts of land demands from urban growth and pollution. Additionally it is also a wider market-related zone of influence that is recognizable in terms of the handling of agricultural and natural resource products (Simon, McGregor, and D.Thompson 2006). The process of disordered growth of urban land use and its sprawl to peri-urban area can be referred to as a peri-urbanization. Peri-urbanization can be regarded as a driver and an effecter of global environmental changes. Changing land use and land cover over time may provide insights into the trends and effects of urbanization on peri-urban areas. The complex interactions between urban land use, environmental change, and socioeconomic system on peri-urban areas must be approached from a systems perspective to understand their dynamic interactions, function and services these peri-urban's ecosystems provide to cities.

1.3 Biophysical Valuation of Ecosystem Service

Ecosystem services refer to the benefits that human beings derive from an ecosystem's function. The figure with the plants, zebra, lion, etc. illustrates the two main ideas about how ecosystems function: ecosystems have energy flows and material cycles. These two processes are linked, but they are not quite the same (Figure 2). According to de Groot (2006), ecosystems can serve five primary functions: regulation functions (which provide and maintain the conditions for life on Earth and often provide the necessary pre-conditions for all other functions), habitat functions (relating to the spatial conditions needed to maintain biotic and genetic diversity and evolutionary processes). This is based on different species and the physical aspects of the ecological niche within

the biosphere; production functions (provides resources for human use, ranging from food and raw materials to energy resources and genetic material); information functions

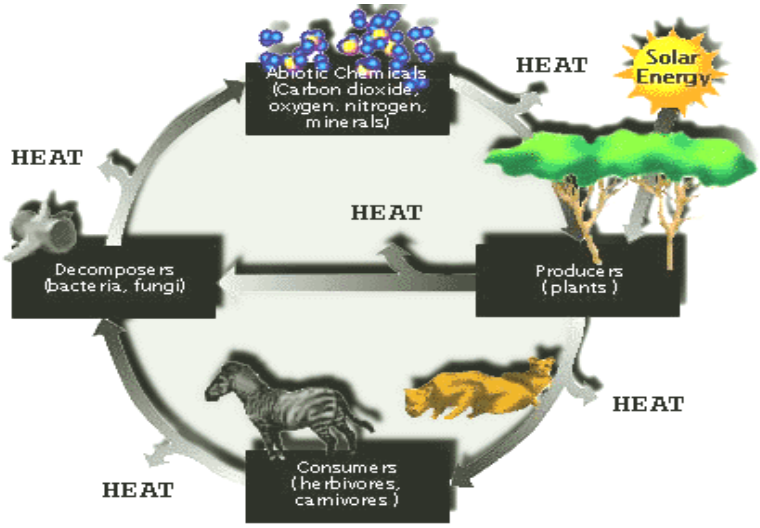


Figure 2 Ecosystem Energy flows and material cycle (Source http://www.globalchange.umich.edu)

(provide a "reference function" and reflect the ecosystem services providing opportunities to humans); and the carrier functions (can provide capacity of natural system for humans' activities and requirements limits).

In order to evaluate the contributory value of different material flows to the ecological economic system, Odum has formulated a unifying theory of system ecology of values (Odum 1971; Odum 1996; Odum 1988) and introduced the concept of *emergy*. Emergy is defined as all the available energy that was used in the work of making a product in units of one type of energy (Odum 1996). The energy content (e.g. joule) or mass of a flow can be multiplied by its solar transformity to obtain its solar emergy in solar emergy joules (sej). Emergy indices can be developed to evaluate the work of nature and its contribution to urban systems.

Monetary valuation of ecosystem services and natural capital may be useful in demonstrating their economic value but is insufficient to measure the intrinsic worth of the life support function of ecosystems (Costanza, R.d'Arge, Groot, Faber, Grasso, Hannon, Limburg, Naeem, O'Neill, J.Paruelo, G.Raskin, P.Sutton, and D.Belt 1997). Biophysically based energy analysis can provide a comprehensive framework to analyze urban ecological economic systems that allows non-market information to be

incorporated more easily. However, energy flows are not the only one of the most important unifying concepts in ecosystem development they are also the only common measure that connects ecosystems and economic systems (C. A. S. Hall, Cleveland, and Kauffmann 1986). The intrinsic value of the natural environment in providing life-support services requires a new accounting system that can assure the contribution of non-marketed natural worth to the economic system[1].

1.4 Sustainability

Ecological sustainability is another term used in biology and adapted for the sustainable city concept. Yanarella and Levine argue that ecological sustainability and homeostatic balance can be achieved by complex ecosystems, and thus can be imitated within the sustainable city concept. The crucial problem of a cities' ecosystem is that modern cities suffer from "arrested development at an immature stage where growth and change are favored over stability and sustainability" (Yanarella and Levine 2011).

Many ecosystems' features can be applied into a cities' ecosystem concept. Thus a simple foundation can be established as basic as harmonious co-existence, constant interaction with other units, maintain biodiversity and functioning as a system. However each ecosystem is semi-dependent on other ecosystems, and its existence is dependent on units within it; most importantly, preserving sustainability within the system, and taking care of the environment so that you do not destroy the source of sustainability. The last one seems to be the most problematic for humans. Presently cities are urban developments that are characterized by high building density, a high proportion of sealed surfaces (pavement, buildings), a great importation of fossil fuels for energy, a great importation of nutrients (food), building materials and goods. A concentration of diverse

[1] Further details on the concept and procedure of emergy synthesis can be found in Huang and Odum (1991), Odum (1996), and Brown and Ulgiati Brown, M. T. and S. Ulgiati. 2004. "Emergy and environmental accounting." Pp. 329-353 in *Encyclopedia of Energy*, vol. 2, edited by C. J. Cleveland. Amsterdam: Elsevier..

industries, high levels of trade and commerce, dense vehicular traffic, and many entertainment venues and cultural institutions also are typical. These things give off high waste production; contamination of air, water, and soils, light along with noise pollution (Wittig 2008).

Design, social politics planning and comfort are not enough to create a city, in which people develop, prosper and live in harmony with nature, so long as only human needs are taken into consideration. Furthermore, the concept of creating a working system city that is sustainable, and considers both human and natural environment cannot be based upon any utopian project rules. Prior research by Yanarella and Levine claims that a "sustainable city is not utopian at all" (Yanarella and Levine 2011). However, we may be able to modify them by merging significant elements such as capacity, modern technology, ecosystem and sustainable eco-city's principles.

The matter of a city's sustainability has been elaborated along with the concept of its ecological aspects by many researchers, especially by Richard Register, who in 1975 founded (with others) a Non-Profit Organization for Urban Ecology in Berkeley.

The main goal was "to rebuild cities in balance with nature" (Roseland 1997). The first international Eco-City Conference took place in Berkeley in 1990, during which the problems were discussed and solutions for urban situation were proposed. It was determined that city planning had to be based upon pointed principles, and even though general in their concept, they had to relate to more significant aspects of eco-city development. However in Register's work other principles and concept have occurred, "Eco-Polis Development Principles" (Register 2006). Summarizing the five eco-city principles related to building a city like a living system begins with; making the city's function fit within the patterns of evolution; following the builder's sequence: starting with the foundation, reversing the transportation hierarchy, building soil, and enhancing biodiversity. According to Richard Register, an eco-city design should be organic, based on the pattern of a living system, thus you cannot destroy or diminish resources unnecessarily. Therefore, the present priority of machine function in the city has to be revised, and rearranged to primarily pedestrians, bicycles, then rail transit, buses, cars and trucks; and finally, adjusting the land use pattern in order to create a healthy city.

Differences between the current state of cities and the goal we are aiming to achieve seem to be tremendous, however, not impossible to achieve. Cities and ecosystems vary from each other. Therefore to successfully diminish the unavoidable differences, it is necessary to point them out, because the bigger the differences between a cities' system and its natural ecosystem, the more harmful it is to the environment. According to Wittig, those distinctions are:

· Their main energy sources
· The origin of matter
· The composition of their surfaces and vertical structures
· The direction of energy and material flows
· The methods of waste disposal

The concept of changing cities' systems into eco-systems is based on minimizing those differences. However, to achieve this change, a sustainability plan is necessary. Wittig named 5 of the most significant principles (Wittig 2008):

1. Media that support life (soil, water, air) must be protected.
2. Energy consumption must be reduced.
3. Material use should be reduced and materials recycling increased.
4. The amount and kind of nature in the city must be enhanced through conservation and restoration activities.
5. A rich variety of spatial structure and space must be provided.

Peter Newman and Isabella Jennings have analyzed 'the city as ecosystem' and described Ten Melbourne principles: Vision, Economy and Society, Biodiversity, Ecological Footprints, Modeling Cities on Ecosystems, Sense of Place, Empowerment, Partnership, Sustainable Production and Consumption, Governance and Hope (Newman and Jennings 2008). Register's and Newman and Jennings's principles complement one another. While both concepts mention modeling on natural systems, controlling city's ecological footprints, biodiversity, fundamental urban structure of a city, Melbourne's included significant sustainable city concept elements such as vision, economy, society, empowerment, partnership, governance and hope. The Vision principle declares the necessity for cities to develop vision that will reflect a certain city's distinctive qualities,

people's needs and ideas of what is required to sustain them, and based on those ideas create a great *vision* of their sustainable future. Economy and Society, affirms that cities should learn to combine and recognize the environmental and social values in their economies, and lean toward urban eco-villages, since people seem to relate to ecosystems and each other more powerfully at local and bioregional levels. Empowerment and Partnership Principles are significant for cities to find innovative solutions for sustainability that empowers the community and region relationships through its partnership. The final principle, Governance and Hope emphasizes the crucial importance of governance and presence of hope in a city for a sustainable future. That can be achieved through pioneer programs, social events including sustainability projects, ecological programs, neighborhoods' regeneration programs and other programs or events that would provide inspiration and increase social awareness in ways to sustainability (Newman and Jennings 2008).

1.5 Conclusion

Directives are clear and simple in these forms, however even with very precise directions the essence of the concept can be lost during application. Many planners and architects have been trying to adapt different "eco" principles in their work, however, as will be proven in the next part of this research. During that process often the main ideology changes, and eventually is reduced to only minimal "green" features such as solar panels and gardens. An eco-cities' fundamental principles should be the adaptation of natural system into cities or vice versa. This concept is wider and more sufficient since it contains many elements and principles different from ecotopian cities'. Throughout the years many concepts of eco-cities have been developed, however not all of them had the "ecosystem" principle as a priority. In some cases "eco" relates to ecological, understood as "not polluting the environment", in other cases it is designed as self-sustainable; setting numerous solar panels and water-collection containers, etc. In analyzing different cases, the diversity in concepts and assumptions of designers are surprising. Not only do they establish different priorities, but also, as it frequently turns out, "eco" aspects of their entire development are minimal. For a viable future of real and functioning eco-cities and eco-structures it is significant to distinguish cases worth following.

Chapter 2 Visions of Cities

2.1 Ecotopian Cities

Eco-cities already exist and are being constructed all over the world; some are just

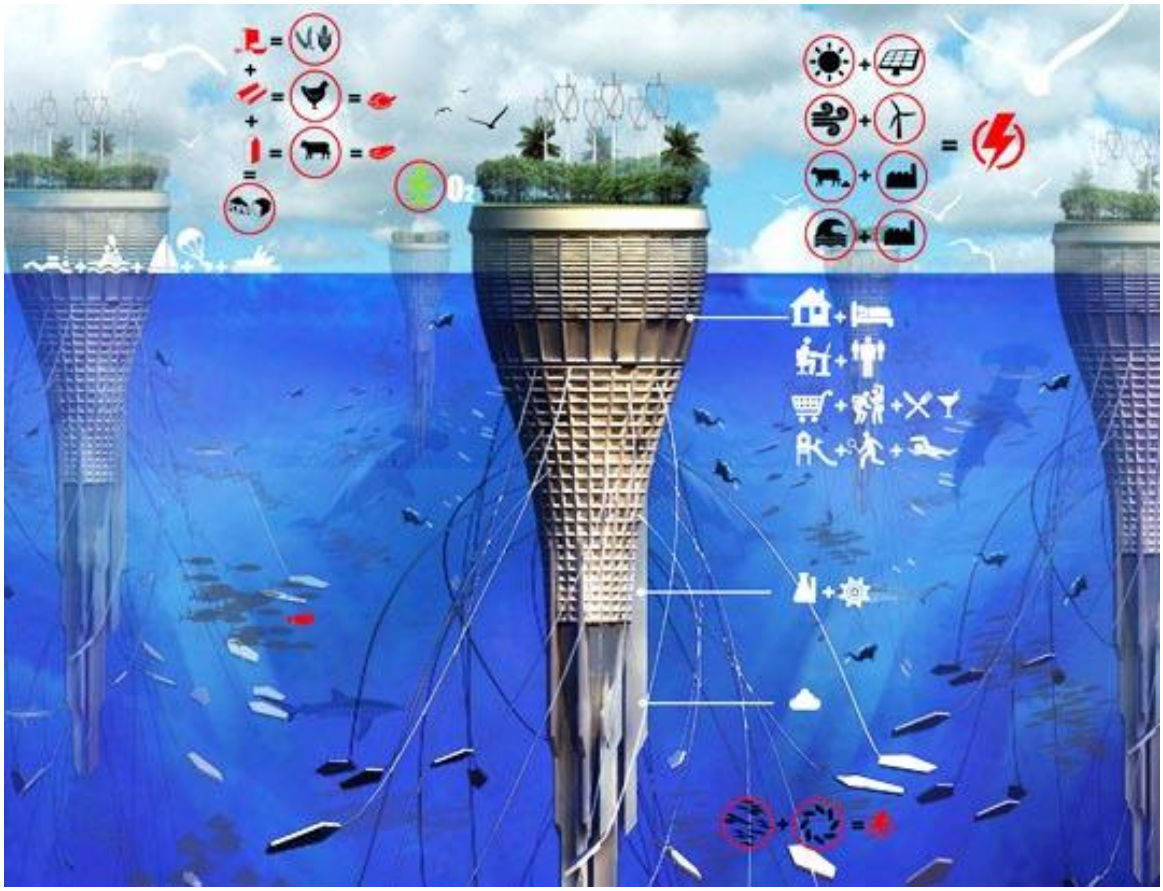


Figure 3 Self-sustainable islands (Source: http://futureblog.pl)

Figure 4 Architect Sara Mohd. Salleh, Kuala Lumpur (Source: http://sustainableperalta.org/)

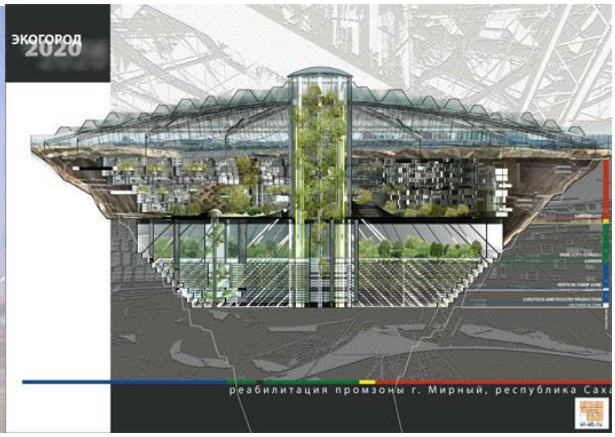


Figure 5.Eco-city in crater, Russia (Source: http://www.el-ab.ru)

concepts and others are masterplans already under construction. Ideas are various, however many of those designed structures appear to be futuristic visions of ecotopian cities we should live in, often very controversial in their structure and function.

Designs and ideas are endless, and in many cases they are simple conceptual projects of self-sustainable cities, floating on the surface of oceans, imitating islands (Figure 3). These are also called "undersea skyscrapers" and are similar to icebergs. The whole structure would be hidden underneath the water surface. Each island, according to the design, would be self-sufficient; also it would draw energy from renewable energy sources such as sun, wind and ocean waves. Besides, animal husbandry, traditional farming and hydroponic farming, the ocean would also serve as a food source.

Cases are numerous, OFL Architecture's Enoki Eco City in Rome, a fantastical series of crisscrossing metallic towers; X-Seed 4000 eco-city in Tokyo, a pyramid on the water. In Mexico, BNKR Arquitectura is planning 55-story inverted skyscraper underground; or the Lilypad, by Vincent Callebaut, a concept of a completely self-sufficient city floating on water. One of these examples is being designed in Kuala Lumpur. An architect Sarah Mohd. Salleh has designed arcologies construction that integrates housing and gardening in a naturally ventilated, small-footprint tower (Figure 4). Another example is Eco-city, (also called "Eco-city 2020"), is planned to be constructed in an excavation crater nearly a kilometer in diameter and 550 meters depth in permafrost in Yakutia, where weather conditions are considered extreme for humans (Figure 5). However from all proposals of futuristic eco-cities, the most concerning

Figure 6. Superstar 'A Mobile China Town', China, and design by MAD Architects (source: http://www.i-mad.com/)

concept was proposed by MAD Architects, the ‘Superstar: A Mobile China Town’ (Figure 6). It is a self-sustainable city that contains numerous functions, (even a ski resort within its structure). Living, working, studying, relaxing, using public spaces and facilities like hospitals, shopping centers, media center, production center, agriculture resorts, Olympic center and even cemetery, are put together into one structure.

This “super” star structure literally closes people and isolates them from natural environment. The star eco-city idea is Le Corbusier’s Unite d’Habitation taken to extreme. It is a place where humans do not need nature anymore, and are separated from it. Not only “superstar” misinterpretate the term “eco” as nothing more than ‘NOT having almost any relation with the nature or earth’ (the only need of “super star” of the outside world is probably air and gravity); but also suggests that future cities should exist singly, turning them into independent units. Considering that the best way for cities to reach sustainability is to pattern after natural ecosystem, the most basic requirement for survival is strict mutual interaction with other ecosystems. “Super star” perhaps is a pattern that could be used in places where nature does not provide resources necessary for humans to survive, like deserts. Otherwise proposed solutions results in creating a ‘dead’ independent colony above ‘living’ co-dependent urban areas. Is this the image of eco-cities we are looking for? This ‘city’ is sustainable, ecologically friendly probably with minimal footprint; however its function as an eco-city is controversial.

The “Superstar” is a representative of common mistakes made in ideologies and designs of eco-cities. Designers focus on technologies, forms, quality, and innovations; however within the process they seem to forget about the most significant element; human and nature relation. The whole concept of an eco-city should be based on joining human life style with nature, to find a balance and harmony between what we create (technology), want (comfort) and need (health, of which source is in nature). Furthermore to maintain and encourage regular interactions with other “eco-cities” is a requirement. The proposition of MAD Architects to build “all in one” sustainable structure that does not co-exist with the outside world is not the way to think about future cities, and especially eco-cities. This concept reduces its relationship with other ecosystems to a minimum, forcing people to live in the world isolated from nature (if not taking into consideration artificially created “natural” environment within the structure).

Fortunately those examples are just concepts and probably far into future, however, they lead the way in thinking about eco-cities in the wrong direction. There are numerous examples of pseudo "eco" structures, that seem to follow that wrong path, like the Antillia Residence in Mumbai (Figure 7), India (Volynets 2007), "the world's most expensive home".

However the over 1 billion dollars was not spent on eco-friendly equipment but on luxuries such as: 1000 times more personal space (than an average person in Mumbai); a grand lobby, nine elevators, lounges, dual stairways with silver-covered railings; a large ballroom where 80% of its ceiling is covered in crystal chandeliers, bar, powder rooms, green rooms, an ice room, three helipads on the roof, a 50-seat movie theatre, and swimming pools. Additionally "each family member of the Mukesh Ambani family [the founder] will have their own personal health club with a gym" etc. (Mawani 2011).

In the matter of environmental sustainability, designers included a few gardens and a "green façade", with the purpose of saving energy by cooling the building during the summer and warming it during the winter. Placing plants on an elevation and having a few gardens does not make a building ecological, and not in the least, sustainable. The amount of energy consumed by the theater, equipment of the swimming pools, gym, elevators, ice room, and air-conditioned chambers. The buildings ecological values of increased height of storeys up to 3,5m/floor, (which means that even though this building has 27 story in its height it is equal to average 50-floor edifice) cannot be compensated by "green walls". Furthermore, the more complicated and irregular the structure of a building is, the more "heat loss" and heated surfaces, there are, which increases the energy use (Alsabry and Staniec 2011). Antillia has means to save energy by its garden walls, however, its structure and designed inner eccentricities extort a necessity of increased demand for energy consumption as well.

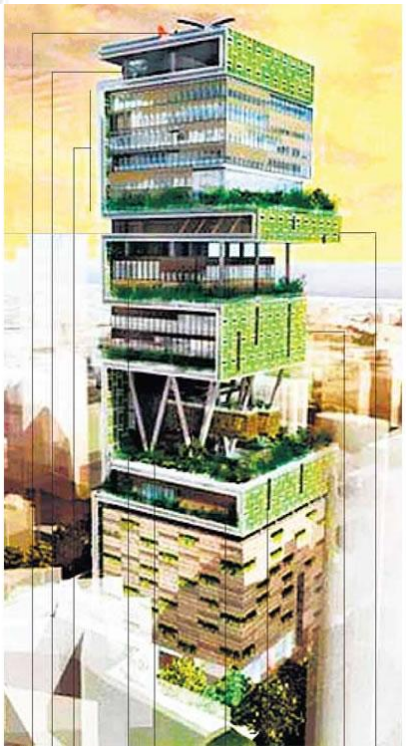


Figure 7. Antillia Residence (source: http://www.luxurylaunches.com)

Korea does not remain behind. Songdo eco-city

design is admirable and concerning at the same time. This city was planned to be a living unit, where except typical features such as green rooftops, green transportation, and solar panels, there are devices working all the time. The new solutions include active saving energy pavements, that measure pedestrian movement intensity, gathers the information, and night lighting being turned on only in the necessary places. Additionally the pavement is designed to collect the energy passed by walking people and store it. Main public transport is designed underground, and on the surface only bicycles or rental electric vehicles will be allowed. Furthermore, streets are intelligent as well; they are programmed to calculate the traffic. The different objects like trashcans and garbage truck would not exist. Instead, there would be huge pipes underneath the city transporting the wastes to a recycle center.

The artificial intelligence does not only control the outside world, it also manages private homes. Apartments are learning its inhabitant's habits and lifestyle, thus with time it regulates the amount of energy and water used in the house to the most sufficient level, by controlling the time of usage of light, water etc. (Dabrowska 2012). This case is an example of a future where your whole life is controlled by machine, and artificial intelligence. Even though the concept appears to be practical and innovative, one concern emerges, namely, how would a human function in a world controlled by computers, especially at home? Is this the way to sustainability? by controlling each individual?

Ecobay in Estonia, eco-city by the Baltic seashore; designed with awareness of weather conditions such as wind, also uses the sun trajectory. This is reflected in the shape of planned buildings, furthermore, main energy needs would be derived from a variety of clean sources; including wind farms, geo-thermal energy, hydro-electricity (Chino 2008). Public transport is covered by electric-powered busses, trams or light rail etc. Ecobay design contains most of the significant issues which an eco-city should cover as water, energy and waste distribution, ecology, landscape etc. Reading the architects' description of the masterplan, it is easy to believe that "Ecobay will be a benchmark project for sustainable urban development of the future" (Schmidt/Hammer/LassenArchitects 2008). Perhaps it is true, however the city is planned to be finalized in 15-20 years' time.

The eco-cites are not only a futuristic vision, some of them are already becoming a reality, as Masdar City in the UAE established in 2006 (Site) (Figure 8), the world's first zero carbon, zero waste city powered entirely by renewable energy sources, is one of them. It is being constructed on a 6 square kilometer site where, according to plan, it will function based on World Wildlife Foundation „One Planet Living Programme"[2] (nel 2008).

Designers have founded the principles based on 6 main components; 'orientation' of city and building, in order to minimize solar heat gain on building walls and the street, and maximize cooling nighttime breezes. Next, components are 'low rise and high density' in a 'vibrant urban realm', thereby "inviting" people to enjoy the outdoors and engage with residents and visitors.

Figure 8. Masdar City (Source: http://www.bustler.net)

The city plan is also 'pedestrian focused' and has been achieved through narrow and shaded streets encouraging walking. Since all aspects of life such as work, entertainment etc. have been designed in close proximity, the designers maintained a component of 'integration'. The last component is quality of life, based on "the highest

[2] One Planet Living is a model based on ten principles (zero carbon, zero waste, sustainable transport, sustainable materials, local and sustainable food, sustainable water, land use and wildlife, culture and community, equity and local economy, health and happiness) which provide a framework to make sustainable living easy and affordable for all. (Source: http://www.oneplanetliving.net)

quality work and living experience with the lowest possible environmental footprint" (www.masdarcity.ae/en/).

The city is planned to create a living environment for 50,000 inhabitants in the middle of a desert. At the same time it is designed to have a zero-carbon footprint, thanks to bioclimatic and an energy-efficient design, waste conversion, renewable energy resources, carbon capture and car-free environment (Bueren, Bohemen, Itard, and Visscher 2011).

The most unusual characteristic elements of the whole design are giant 'sunflower umbrellas' that use solar-power and follow the trajectory of the sun to create continuous shade during the day, and during the night they close and release the heat in the plaza. This however, is only one of many ideas for capturing renewable energy. Masdar will employ a variety of renewable power resources and will minimize energy consumption by deploying the best commercially available energy-efficient techniques. During the first phase of construction, one project will be a solar power plant, which will supply power for all other construction activity (Dilworth 2007; Sioshansi 2011). Wind farms will be established outside the city's perimeter capable of producing up to 20 megawatts, the city intends to utilize geothermal energy as well. (Dilworth 2007; Hamner 2007) Wind not only will be used as a source of energy, but also will be controlled. Masdar's perimeter wall, is designed to keep out the hot desert winds (Sioshansi 2011).In addition, Masdar is planned to host the world's largest hydrogen power plant.(BBCNEWS 2008) Hydrogen, even though it is renewable source of energy, also takes a lot of electrical energy to produce, which comes from burning coal or nuclear fuels. This combustion creates severe environmental and health problems (Chiras 2009).

Excluding an energy plan, water management is the most significant issue planners have applied. Approximately 80 percent of the water used in the city will be recycled, furthermore, waste water will be reused "as many times as possible" and the greywater would be used for crop irrigation and other purposes (Dilworth 2007; Palca 2008).

Commuting in the city will also be innovative as traditional cars will not be allowed inside the walls of Masdar. A public transport system will contain electric buses, electric cars, and other clean-energy vehicles. Additionally, Abu Dhabi's light rail and

Metro lines will pass through the center of Masdar City, providing transport within the city and serving as a link to the wider metropolitan area.

Masdar City gives the impression of an “ideal” city of the future, and it is claimed that it will pass all 10 required principles of sustainability: “zero carbon, zero waste, sustainable transport, sustainable materials, sustainable food, sustainable water, habitats and wildlife, culture and heritage, equity and fair trade, health and happiness”(Droege 2009). Chris Bosse, Tobias Wallisser and Alexander Rieck, the founders of the development say that ‘Masdar City is the world’s most prestigious project focusing on sustainable energy design. It is the city of the future and a global benchmark for sustainable urban development. We believe in the Masdar slogan “One day all cities will be like this” ’. Considering the numerous innovative solutions and technologies, different ways of gaining, storing and distributing energy, along with the cooling systems, and innovative transportation system used in the city, their founders’ claim could be considered true and accurate. However, Masdar seems to be a utopian concept for many reasons. Firstly, reducing Masdar City's total carbon footprint to zero will be difficult, if not impossible (Palca 2008). Secondly, meeting their ambitious goals is uncertain (Palca 2008), furthermore, creating an isolated “perfect” unit built with billions of dollars, is possibly merely a luxury development for the wealthy (BBCNEWS 2008) and would not set an example of a good eco-city, and would create the illusion that only wealthy people can live in an ecological and sustainable way. Lastly, living areas surrounded by walls, creates a gated community effect. Nicolai Ouroussoff claims the Masdar city is "the crystallization of another global phenomenon: the growing division of the world into refined, high-end enclaves and vast formless ghettos where issues like sustainability have little immediate relevance.”(OUROUSSOFF 2010). Therefore, the Masdar city design propagates and reflects a gated-community mentality that has been spreading like a cancer around the globe for decades. Masdar utopian purity, and its isolation from the life of a real city, are “grounded in the belief that the only way to create a truly harmonious community, green or otherwise, is to cut it off from the world at large”(OUROUSSOFF 2010).

The Masdar City without a doubt has made a great step forward in designing a city that would use a modern and innovative technology. Even if the ambitious goals can be achieved (unfortunately only time can tell), there still remains concerning elements. A

closed city in the desert is another example of the vision for an eco-city as an isolated unit. Separating people from the outside, even if with a crossable wall, creates barriers, and in case of Masdar it is not just the matter of desert or distance, but also of social status. Masdar has the greatest possibility of becoming the most technically sustainable city ever built, however in the matter of personal, individual sustainability it might be a disaster.

Different eco-city projects have also been developing in Tianjin, China since 2008 and is planned for completion in 2020 (http://www.tianjinecocity.gov.sg/). It is a "Next Generation Eco City" designed for 350,000 inhabitants, who could live in an ecologically sustainable environment. The original idea was for Chrystal Lake Eco City to offer all the same services and functions as any modern city, however in a more green and sustainable environment. The development was planned in an area described as nothing more than a wasteland, where soil was too salty to grow crops, and polluted enough to scare away potential residents. In order to proceed with the plan the soil was restored and water was cleaned up of pollution. Even though the "wasteland-to-community" is an experiment carried out by the Chinese and Singapore governments (Liu and ClimateWire 2011), it's program of a city where people can work, play and live without damaging nature is promising. The principles of energy efficiency, use of clean and renewable energy, green transportation, cycling and walking are common in the design. Reasonable water and waste management, heritage conservation, being ecologically friendly by preserving the natural wetlands and biodiversity are also featured. The design also includes lush green spaces and recreational spaces sensitively interspersed throughout the city. As a result of green building priority, an energy-conservation and environment-friendly mindset is promoted and will also be cultivated among its residents. However more importantly, as one of its features, social harmony will be achieved by affordable public housing where people of different income and social position can live together and interact with each other. Additionally, communal amenities and facilities will be widely accessible; therefore the eco-city would be socio-strata barrier-free. (http://www.tianjinecocity.gov.sg/)

Conclusion

The plans of our future cities are being created; unfortunately it seems that very often designers focus mostly on energy balance data, and modern building design. A cities' sustainability not only applies to limited carbon emission, but people living in them also should play an active role in their cities maintenance of the sustainability process. Billions of dollars are being spent to build new eco-cities, and not on trying to repair existing ones. Starting from scratch is the easiest option for planners and designers; however this is avoiding the largest challenge in the eco-city concept. Trying to "repair" an old city would be more time consuming than building a whole new eco-city, however, from each one of those futuristic designs interesting ideas and even mistakes can be acknowledged in a cities eco-regeneration. Following the capacity limit rule, and avoiding "closed in walls" city design is an example, while creating new neighborhoods affordable only to wealthy individuals is an avoidable mistake.

Existing cities cannot be entirely rebuilt, however they can be changed through new constructions, buildings upgrades, conservation adjustments, space reuse and change of functionality. These are all opportunities for regeneration, however, the choice of locations and their changes cannot be random. This should be a part of a cities eco-regeneration that has to be based on principles and priorities of a sustainable eco-city. The plan also should include specific functions of certain spaces in a city, only then, will changes bring desirable effects.

2.2 Utopian Cities

Garden City, Broadacre City, Unite d'Habitation and Radiant City (Bacon 2003) are all examples of an attempt to influence the way people perceive Utopian cities of the future, because they were designed in order to evolve their structure and provide a place for people and nature to coexist. The misperception of utopian cities lies in the ideologies that they are no limited amount of dwellings as described projects and concepts concentrated mainly on a city that is focused on structure, quality design life comfort, and providing for life within it. However, in the matters of ecology, a cities influence on the environment and sustainability, has hardly been considered in those projects. Even

though there is one common characteristic shared by each one of those concepts, namely limited capacity, the misperception that utopian cities are cities that could "do it all" could not be farther from the truth. Garden City was designed for 32,000 inhabitants, Broadacre City for one family per 4,000 m², Unite d'Habitation for 1,600 residents and Radiant City for 2,700 inhabitants with fourteen square meters of space per person. Although those concepts did not previously include sustainability as a principle goal in their design they focused on elements that are directly related to sustainability. Therefore our "current" cities should continue to reassess their capacity limit and focus on sustainability and ecological features as they are regenerated for future use.

The garden city movement for instance, initiated in 1898 by Ebenezer Howard, was a pattern for a city of 32,000 habitants on a 6,000 acres of area. The main assumptions were to control industrial development and office businesses, thereby creating a healthy, pleasant living environment, and "more efficient distribution of people and their activities in town and country" (Howard 2007); a city that would provide comfortable, high quality lifestyle for all habitants. Regardless of their social status, they could enjoy the advantages of living healthy, in the city that joins the economic, agricultural and natural beauty of the countryside.

The Broadacre City by Frank Lloyd Wright also proposed and socio-political scheme. It is an alternative for high density metropolitan city and an ideal fusion between the rural and the urban. In this almost self-sufficient city concept a typical family would receive one acre of land where they could build a house and grow their own food.

The Unite d' Habitation was a first large complex for 1,600 residents, based on the idea of bringing the villa within larger scale, thus allowing the inhabitants to have their own private space and access to public and communal spaces as well. The Unite d'Habitation project is significant, although it is just an urban city structure. The eighteen-floor building contained numerous elements for every human need: living spaces, garden terrace (on the roof), a track, a gym , restaurant and club, kindergarten, a pool, shops, medical facilities, and even a small hotel. The Unite d'Habitation is essentially a "city within a city" that is spatially, and functionally adjusted for the residents (Sbriglio 2004). The "city" is a building project that truly embodies the

perceived essence of the utopian city, it is innovative and fulfill all the needs of its residents, however it is very controversial.

Conclusion

Envisioning cities of the future such as Garden City, Broadacre City, and even Unite d'Habitation have many common elements; established capacity, comfort, high quality lifestyle, various functions, and almost self-sufficiency. However, in reality, modern designs cannot follow these design aspirations since they do not consciously include sustainability and ecological principles. Previous utopian cities have changed the perceptions of Eco-topian cities. The ideas of better cities, more natural and planned wisely are now eco-cities functioning as coexisting with nature working units. Hence eco-city concept rejects the idea of grey brick city for green city with structures of balanced development among the natural environment.

2.3 Urban Ecopuncture and Urban Repair

Cities can be treated as organisms, thus healing methods could be applied, such as urban "ecopuncture". The ecopuncture concept is based on the Traditional Chinese Medicine method of curing by acupuncture, which helps to treat diseases of the mind, body and spirit.

The concept of acupuncture is based on the ying/yang theory and the five elements[3], each of them having its own quality of *qi*. The acupuncture practitioner, by perceiving dysfunction of balance between those elements, diagnoses the body (Hicks, Hicks, and Mole 2011). A very important aspect of the diagnostic and treatment process is to treat conditions before they come to fruition (Dupuis 2012). Overall diagnosis is based on assimilated information, symptoms and conditions. It is made according to four diagnostic methods: inspection, auscultation and olfaction, inquiring, and palpation

[3] Five elements in acupuncture are: wood, fire, earth, metal and water.

(Cheng 1987). The methods are indispensable and thus, analyzed and generalized together to find the nature and connections of the illness.

Acupuncture treats by manipulating thin needles inserted into acupuncture points in the skin. The needling techniques are fairly trivial to learn, however the essence of the healing lies in selecting the correct points to use (Rhyu 2010). According to Traditional Chinese medicine, stimulation of those points can correct imbalances in the qi flow through channels known as meridians, the pathways along which the essence of vitality flows. It is believed that they connect organs and are in direct interrelationship with all of the processes in the body (Rhyu 2010). Therefore by choosing the correct spot on the body the method allows to treat the increasingly complex relationships of illnesses and symptoms. Some points are considered more therapeutically valuable than others. The points used in treatment do not necessarily have to be in the same area of the body as the targeted symptom.

Urban acupuncture, ecopuncture combines urban design with traditional Chinese medical theory of acupuncture (Parsons 2010) by viewing cities as living, breathing organisms and pinpointing areas in need of repair. It embodies most of the methods of acupuncture; however in the matter of healing an urban body, the spiritual healing is being omitted.

This concept has been elaborated by many scholars. Marco Casagrande views a city as a living environment, a multi-dimensional sensitive energy-organism, and urban ecopuncture, aiming into connect it with nature (Miller 2011) and cleaning the city from inside. In a larger context a site of urban acupuncture can be viewed as communicating to the city outside like a natural sign of life in a city programmed to subsume it (Chan 2012). Casagrande's idea of applying ecopuncture into urban repair is based on massive regeneration projects within a city to improve it by developing methods of punctual manipulation of the urban energy flows in order to create an ecologically sustainable urban development. The most significant approach is to restore urban-dead places and repair them.

Jaime Lerner proposes urban acupuncture as the future solution for contemporary urban issues by focusing on very narrow pressure points in cities. According to him urban acupuncture reclaims the ownership of land to the public and emphasizes the importance

of community development through small interventions in city design. It involves pinpointed interventions that can be accomplished quickly to release energy and create a positive ripple effect (Hinchberger 2006). Lerner also believes that it is necessary to make the city react, to poke an area in such a way that it is able to help heal, improve, and create positive chain reactions. It is indispensable in revitalizing interventions to make the organism work in a different way (Miller 2011).

Ti-Nan Chi, on the other hand, is looking with micro urbanism at the vulnerable and insignificant side of contemporary cities around the world identified as micro-zones, points for recovery in which micro-projects have been carefully proposed to involve the public on different levels, aiming to resolve conflicts among property owners, villagers, and the general public (2011).

Ecopuncture is a strategy of punctual interventions can create a new energy and help the desired scenario to be consolidated. Urban Acupuncture revitalizes a "sick" or "worn out" area and its surroundings through a simple touch of a key point. Just as in the medical approach, this intervention triggers positive chain-reactions, helping to cure and enhance the whole system. The theory of urban acupuncture suggests that cities needs scores of small-scale, and localized projects is in order to recover and renew and improve urban life in it (Mok 2012).

However the choice of those points has to consider whole city, for instance creating “green belts”. Wide green belts connected with other kinds of “channels” and parks or other green spaces along them, designed throughout city, can provide fresh air flow and air exchange through the city. However, localized only partially, or in a small area without any further connections, will only have fragmentary result and will not affect the whole system.

There are three fundamental issues that are crucial to the good quality of urban life: sustainability, mobility and socio-diversity. The significant, however often omitted element, is socio-diversity, because it encompasses the need to embrace and celebrate the multiplicity of peoples with different income levels, ages, religions, races and so on within the city, while at the same time preserving the traits that define each one's identity. This is what will ensure social cohesion, urban safety, and ultimately the

possibility of encounters within the city and the willingness to congregate in its communal spaces. Furthermore, the theory opens the door for uncontrolled creativity and freedom. Each citizen is enabled to join the creative process, feel free to use city space for any purpose and develop his environment according to his will (Bardauskait 2011).

Urban acupuncture bears some similarities to the new urbanist concept of Tactical Urbanism. The idea focuses on local resources rather than capital-intensive municipal programs and promotes the idea of citizens installing and caring for interventions. These small changes, proponents claim, will boost community morale and catalyze revitalization (West 2011). Generally, "urban acupuncture" means focusing on small, subtle, bottom-up interventions that harness and direct community energy in positive ways to heal urban blight and improve the cityscape. It is meant as an alternative to large, top-down, mega-interventions that typically require heavy investments of municipal funds.

Different spaces in the city have various functions that may require regeneration or preservation. There are many examples, such as The Treasure Hill community in Taipei, Taiwan, an urban "ecopuncture" realization in the year 2003 or UfaFabrik, an International Center for Culture and Ecology in Berlin. Interesting ideas have been implemented at the UfaFabrik, involving ecology and sustainable development, the testing of concepts for producing culture and social and neighborhood work.

In the summer of 1979 more than 100 people peacefully took over the desolate grounds and created a comprehensive work and living project. Today the UfaFabrik is a green cultural oasis in the middle of Berlin - a space for creation and culture, innovative ideas, a productive surrounding for the citizens of Berlin and for artists from all over the world. This four-acre site offers a diverse range of services, from an organic market, to a theater, ecology exhibitions and lectures. In 2004 the UfaFabrik was honored by the UN-Habitat as one of 100 projects worldwide that received the status of "Best Practice to Improve the Living Environment" (FIC 2009). UfaFabrik takes care of community's social sustainability by taking care of its inhabitants. The Neighborhood and Self-Help Center, provides encouragement and assistance in cultural as well as social, health and family matters. There are markets and celebrations regularly scheduled for the local

community and others. Additionally it connects members of various age groups in the community, through a wide range of Workshops with opportunities for young and old people to remain active whether as athletes, musicians, dancers or circus artists.

There are different methods for regenerating a city, whether it is designing green alleys, revitalizing polluted land fields or adapting old fabrics the goal maintains the same, healing and repairing of the city. However, when the whole "city's body" is ailing, and small changes seem not to be effective enough if there are contra-actions taking place at the same time. Under the assumption that a city's growth is constant, urban regeneration is an effective tool. Every city needs limits on its capacity, because the higher it is, the more difficult the regeneration process. As overall capacity is exceeded, the regeneration process cannot stand a chance, additionally not applying concepts of green and healthy urbanism will result in the loss of future ecosystem services.

Each city and each unit has its individual and unique problems. Therefore to repair a city, first it is necessary to "diagnose" the whole system, analyze it, find the source of problems and isolate the key points in order to pinpoint the location where action is needed. A city cannot be repaired by choosing random locations to regenerate, since it will not influence the system but only specific places. This process would stop spreading the "bad" (e.g. pollution) and start spreading the "good" (e.g. eco-friendly decisions) energy flow within the system.

It is impossible to change a whole city all at once, but starting from carefully selected locations such as communities, would make it possible to focus on specific projects. This is how the change could start. Co-housing and eco-communities are new living arrangements that could serve as examples of the necessary improvements that would need to be taken within cities.

2.3.1 Eco-communities and co-housing

The idea of cohousing began in Denmark and was introduced in the United States by architects Kathryn McCamant and Charles Durrett, since then the concept has continued to spread around the world. Raines Cohen, a cohousing consultant and board member of the Cohousing Association of the United States, reported in 2010 that he

believes there are approximately 120 communities built and another 100 are forming.

Cohousing is a form of cooperative living that achieves social sustainability by combining private residences with extensive common facilities. Cohousing recreates the sense of togetherness, and physical security, while providing the privacy and stability of individual home ownership. Co-housing structures can differ from each other; however the common goal is sustainability and the principles that form the foundation are: management of environmental and ecosystem's resources; balanced benefiting and contribution of resources; minimizing wastes (recycling); eliminate or minimalize the source of pollution in the ecosystem; not being the source of pollution to an ecosystem and other units; contributing to the environment; and correlating with other communities.

While not all cohousing communities embody all these characteristics, they share most of them. The most fundamental concept of cohousing is based on an idea where communities are designed, developed, and managed by their residents. Inhabitants participate in the whole planning and designing process of their future community. The physical design creates a cohesive neighborhood and promotes individual interaction. Additionally residents take responsibility for the ongoing management, cooperating to address their changing needs. Cohousing communities are designed to be long lasting and environmentally sustainable, many green materials and passive energy design are used in the constructing. Furthermore, it creates child-friendly neighborhood, gathering people regardless their age, nationalities, political, ethnical, or religious differences. Communities also include a mix of couples, single and partnered adults, with or without children. The differences are not important, as long as residents are committed to knowing and caring about each other while maintaining a balance between personal privacy and community living.

A process of designing co-housing includes future habitants' participation from the very beginning. A community is planned according to their needs; therefore every common space, common house and grounds, their layout and planned equipment placement is precisely designed. Cohousing communities emphasize the importance of partnership and collaboration of developer, architect, builder and residents.

Furthermore, from the beginning the house design is based on principles of green architecture with the purpose of being sustainable using building spaces that are multi-generational. The governance and maintenance of a community is dependent on its inhabitants, however according to the concept of co-housing, decision-making should be a non-hierarchical and an inclusive activity in self-management. Even though common living is the bases of the idea, each family maintains their own economic and social independence.

Generally, each community is a neighborhood of 7-56 individual homes with a central "common house" where community members meet once or twice a month or a week for meals. Other rooms in the common house vary, however would generally include children's play rooms, a laundry, workshop, office, television room, an exercise room perhaps a garden. Economies of group purchases and shared common facilities are maximized but each household is economically independent. All residents meet regularly to develop the policies that govern the community and address any community issues.

Beddington Zero Energy Development (BedZED) in the United Kingdom is the largest mixed use sustainable eco-community consisting of 100 households that were designed to create a thriving community in which ordinary people could enjoy a high quality of life, while living within their fair share of the Earth's resources.

This particular development has a different approach to the ecological and sustainable functions of community. BedZED was designed to minimize its ecological impact in construction and operation (BioRegional 2012). The principles and aims were to reduce water consumption, electricity consumption, space heating needs, private fossil fuel car mileage to 50% of the UK average and to eliminate carbon emissions due to energy consumption (BioRegional 2012). All of the goals have been achieved. Additionally 86% of BedZED residents buy organic food and 39% grow some of their own food. However in transportation matters, even though the community has a much lower car ownership, residents also fly more often so their overall impact from transport is slightly higher than for the average person in Sutton. Through waste audits with ten households, it was determined that 60% of waste (by weight) is being recycled or composted. However this does not apply to the entire community, since residents pay

more attention to recycling and composting when they are being audited (BioRegional 2012).

The results are impressive, however, more significant is the way the resident live in and out of the community, revealing the kind of solutions and attitudes they have toward sustainability.

The BedZED development site was chosen for its excellent public transport links, which include bus stops and a train station within 5 minutes walking distance, from which it is possible to reach other node locations in the city within 20 minutes. Additionally, functional public transport reduces the need to travel. BedZED has an Onsite Car Club, (which also attracts members from the wider community) membership has risen steadily to 35 people, sharing the use of three vehicles. Roughly half of the club members' work for BedZED-based businesses, and half are BedZED residents (BioRegional 2012). Besides common car use, the community also is equipped to run electric cars, and as a result, public transport or car club vehicles may only be used for journeys out of range for electric vehicles. However motorized vehicle transportation is not the only means accessible. Residents are encouraged to cycle.

BedZED has also been designed to make it easy to recycle, with the aim of reducing household waste output and attaining a recycling rate of 60%.
People have moved to BedZED with typical lifestyle and over the years they have changed their behavior significantly. In order to encourage residents to "make sustainable choices", during the first year of residency, BioRegional[4], employed a Green Lifestyles Officer, to help residents to maximize the green living potential of the development. However, the key part was not only offering training, but also support to residents to run these patterns in the long term. Sustainability is not limited only to food and wastes recycling, the BedZED community concept embodies a lot of practical and functional adjustments for residents considering comfort, technology and ecology of life.

[4] BioRegional Development Group is an entrepreneurial charity, which goal is to invent and deliver practical solutions for sustainability. The organization was founded in 1992 based on concept that overconsumption of resources was the driving force behind environmental degradation.
(Source: http://www.bioregional.com)

Co-housing and eco-housing are examples of opportunities for the use of land in a city or suburb meant for new residential structures. The structures do not necessarily have to serve only as "living units" but also can be a place for community life, to encourage and create a place for local business, provide space for students, propagate team-work, healthy lifestyle and sustainable living. Co-housing and eco-communities are just one possibility for "new" lands, however there are many other solutions available.

2.4 Environmental Sustainability Evaluation

Asia has yet to become a fully urbanized continent, but has seven of the ten world's biggest urban areas[5] (Friederich, Jaunky, Xu, and Vohra 2011). According to the United Nations the population of Asia between 1500 and 1999 increased 159.2 percent. It is predicted that by 2025 Asia will hold 61 percent of world population (Baer 2009). Such a rapid growth of population in urban areas will lead to overpopulation. Overpopulation which will place stress on all natural resources, which, in turn, will lead to diminished quality of life (Nielsen 2005). Resource strain depends on size, density, and the ratio of population to available sustainable resources. Additionally, the rate that those resources are being used and distributed throughout the population, have great effect. Resources such as air, clean water, food etc. have to be considered while planning for the living environment of such a large population, and even utilities like sewage systems, waste disposal and energy supplies in more developed cities are critical (Biello 2009). The increasing imbalance between population and life sustaining resources, are an essential concern as humans must maintain cropland, freshwater, energy, and biological resources.

Developing countries must take action immediately, especially is Asia, where they have to be aware that rapid population growth has damaging effects on the Earth's resources and is diminishing human well-being (Pimentel 2009). A research project

[5] *Tokyo (Japan), Seóul (South Korea),* Mexico City (Mexico), New York City (USA), *Mumbai (India),. Jakarta (Indonesia),* Sáo Paulo (Brazil), *Delhi (India), Ô saka/Kobe (Japan), Shanghai (China) (*Sources**:** Varied international public domain sites, the U.S. Census Bureau and Times Atlas of the World)

conducted by the Economist Intelligence Unit of 22 Asian cities[6], including Taipei developed an Asian Green City Index (AGCI) that measures and rates the environmental performance of all participating in the study. To create the green city index, cities were graded according to the following indicators: energy and CO_2, land use and buildings, transport, waste, water, sanitation, air quality, and environmental governance. Discussed below are the selection criteria for each indicator which are based on eco-city principles and relevance to green city development.

Energy and CO_2 is considered since economic development and rising living standards raise the energy consumption and carbon emissions. Although, average carbon emissions in Asia, according to the Green City Index is 4.6 tons lower than Europe's 5.2 tons. The index also measures the share of renewable energy production from renewable resources and government strategies for renewables performance.

Land use and buildings relates to living conditions, density, different regulatory systems, the amount of green spaces and eco-building standards. These named factors are part of polices to promote energy efficiency that influence and regulate land and building use in a city.

Mass transport is an important element in the development of cities, therefore the government has to account for the emissions produced by it. Water on the other hand is a necessary of life and is rated by consumption, quality, and basic infrastructure. In addition, water leakage, meters, grey water recycling and collections are also major factors that influence the score on the AGCI. Sanitation is related to water issues, however it forms a separate category because it is necessary to establish the rate of access and its environmental impact. A serious and often concerning indicator is air quality, since most Asian cities exceed the safe levels set by the World Health Organization (WHO). The ability of initiatives to address the problem and concentration of pollutants in the air, are factors taken under consideration while setting the AGCI. Finally, environmental governance was evaluated by the form of established institutions for environmental challenges, as environmental departments, their legal capacity to implement regulations; and environmental monitoring and providing public access to

[6] Bangkok, Beijing, Bengaluru, Delhi, Guangzhou, Hanoi, Hong Kong, Jakarta, Karachi, Kuala Lumpur, Kolkata, Manila, Mumbai, Nanjing, Osaka, Seoul, Shanghai, Singapore, Taipei, Tokyo, Wuhan, Yokohama

information. The involvement of NGO's and private interest groups is necessary, since the management of cities is not limited to only government authorities, but should also allow and encourage public participation.

Implementing policies to handle waste disposal, water management or sanitation and emissions will affect a city's eco- performance. The goal of Energy and CO_2, land use and buildings, transport, waste, water, sanitation, air quality are eco- initiatives meant to cover mainly inner city sustainable development processes, and to ensure limited damage or polluting influences on the environment. Although not an indicator in the AGCI, there is an additional variable significant in most all eco-city principles, namely, capacity of a city. Capacity is important because theoretically a city should accommodate and sustain a certain number of inhabitants; otherwise the system may lose its inner balance due to strain and became unsustainable.

According to the AGCI, Taipei City is above average compared to another 21 Asian cities. In categories of energy and CO_2, transport, land use and buildings, waste, sanitation, air quality, and environmental governance Taipei was ranked as above average. Only in water category Taipei turned out average, due to the high level of water consumption.

Even though Taipei City got very good results, because more than average in most of categories of the AGCI, according to the 2005 Environmental Sustainability Index[7] (ESI 2005), Taiwan was ranked 145th in the world (Sun, Chen, and Clements-Croome 2006) and 5th by Growth Competitiveness Index in 2005 (WEF 2005). This implies that Taiwan and especially Taipei City still needs to pay more attention to sustainable development strategy, since the economic competitiveness is much stronger than environmental in sustainable development (Sun, Chen, and Clements-Croome 2006).

The AGCI is a great analytical tool in humanities green city initiatives to create eco-cities. However it must be followed by possible approaches that are cost effective and propel the initiatives to the next level. It would be economically costly and environmentally unsustainable to repair entire cities, and urban regeneration offers the best solution for current green city initiatives in moving towards eco-cities. According to Tallon (Tallon 2009), urban regeneration is understood as the "rebirth, revival and

[7] 2005 ESI was conducted by Yale University and Colombia University

reconstruction" of spaces by analyzing a city according to pointed out indicators, recognizing the problems and needs of the city, then offering solutions that will restore specific functions and improve living and environmental conditions as an ecosystem, based on the previously discussed AGCI indicators. The purpose of urban regeneration is to connect the city's eco-system with the natural environment, the source of its restoration. Modeling a city funded on an eco-system principle, can be understood as a system based on mutual relationships. Each unit's functionality and health ensures the proper function of the entire system, and guarantees the inner balance. Since each ecosystem is semi-dependent on other ecosystems, the connection with other ecosystems is crucial. While the inner city connections are regulated by various indicators, management of the connection with other eco-systems is a major focus of the regeneration project.

Eco-regeneration compatible with the concept of the eco-city is based on the principles of a natural eco-system. The preferred applicable method in the case of Taipei is eco-puncture which is an urban regeneration method developed with a mixture of eco-city principles, urban acupuncture, and urbanism. Therefore the proposed research question is whether eco-puncture can be used to initiate the regeneration process to transform Taipei into an eco-city by addressing growth capacity and managing the challenges of: energy and CO_2, land use and buildings, transport, water, air quality, and environmental governance?

The goal of this research is to form strategic planning of eco-regeneration for Taipei City, based on eco-city guidelines, principles, indicators while applying ecopuncture as a repairing method. Research methodology is based on mapping, researching and analyzing data, in order to gather information about Taipei City as a city and as a geographical location. Based on collected data, the city will be analyzed and then diagnosed. As part of diagnosis a SWOT analysis will present strength, weaknesses, opportunities and threats to the city, which will be used in the following eco-regeneration:

Taipei is in dire need of urban regeneration, however to plan it correctly it is important to do the entire process of planning, collecting data, and providing solutions as a comprehensive exercise. By employing the above research methodologies the

answer to the research question will be found. The main source of information gathered by literary research will be data from sources such as governmental institutions, regional environmental bureaus, and environmental ministries. Additionally, related literature journal articles, city and country reports are used. Methods of collecting data will be ascertained through maps. Analyzing historical and modern maps will enrich the research and provide significant insights into the developmental trends of Taipei city.

The purpose is to create a plan that will provide a basis for the eco-city adaptation process, by forming the eco-systems connection, fulfilling eco-city principles and enhancing the actions taken on the indicators.

Chapter 3 Analysis of Taipei City

There is a lot to be done in the city of Taipei in the matter of urban regeneration, thus diagnosing the challenges and their source is critical for establishing an appropriate approach to problem area resolution and regeneration. Therefore, analyzing Taipei city's geographic location, and understanding the historical forces behind its development, will lead to clarifying some questions related to current problems that city has. This in turn will provide answers that will lead to the data for the eco-regeneration.

3.1 Taipei's Ecosystem Service Evaluation

Taipei and its peri-urban areas have widely varying environmental characteristics. A conceptual urban ecological economic system of Taipei-Taoyuan area can be drawn by using the Howard Thomas Odum energy diagram (Figure 9). Locally available renewable energy sources power natural ecosystems and human-subsidized agricultural production systems to provide important life-support services to urban system. Goods and services must be imported from another economic system to transform and extract indigenous resources needed for life-support in urban areas (Huang 2009).

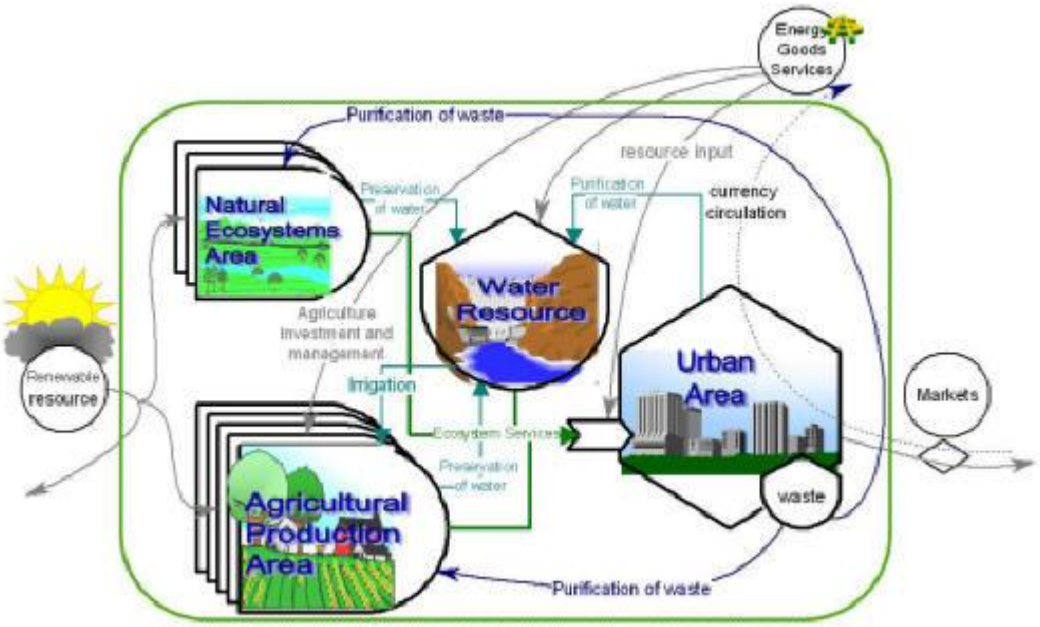


Figure 9 Ecological economic system of Taipei-Taoyuan area (Source http://web.ntpu.edu.tw/)

According to Huang, the biophysical evaluation of ecosystem services begins with an analysis of energy flows within the examined system. The conceptual energy system diagram of three natural ecosystems, agricultural, forest and water, can be represented as energy diagram (Figure 10). Agricultural areas in the Taipei-Taoyuan, for example, include paddy rice field, crop land, orchard, range farm and fallow land. The energy flows of a typical agricultural production system explicitly include renewable energy, agricultural land, crop biomass, soil, inflows of irrigated water and goods and services. The amount of renewable energies used by the agricultural production area depends on the size of the agricultural field. In addition to renewable energy, this human-subsidized production system must feedback energy and materials (e.g. fertilizer, irrigation, labor, etc.) to match the renewable energy to enhance crop production. Food provision is the major ecosystem service offered by agricultural production area. Since

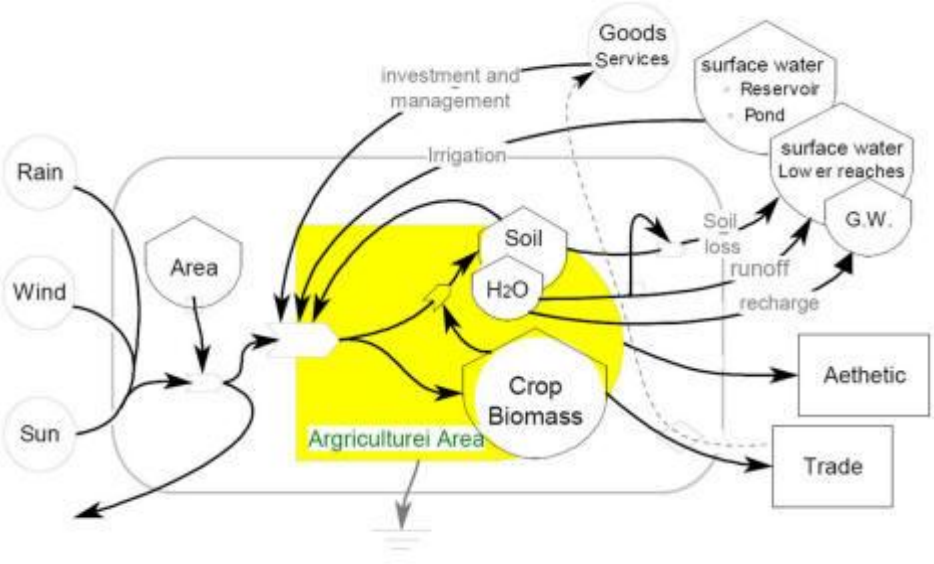


Figure 10 Energy diagram of agricultural ecosystem (Source http://web.ntpu.edu.tw/)

large volumes of irrigated water are required to grow rice in paddy fields, the water contained in the soil can also recharge ground water. Agricultural production in peri-urban areas can also provide an aesthetic value to nearby urban dwellers. The major crops areas are rice and vegetables and due to the excess agricultural production in Taiwan, about 50% of the agricultural land is currently fallow and government subsidized (Huang, Chen, and Wang 2008).

Accordingly, the flows of energy sources, outflows and internal processes of ecosystems were used to calculate the emergy values in 2006 (Huang 2009). The

agricultural system for example, using emergy as an enumerative, rice paddy field, crop land and fallow land captured most renewable energies. The emergy value of livestock production is 1.21 E21 sej/yr and higher than that of all crops due to the higher goods and services fed back from the economic system to its production. The emergy value of rice production and vegetable crops are 1.31 E20 sej/yr and 1.24 E20 sej/yr, respectively. The paddy rice field requires more irrigated water (2.05 E20 sej/yr) to grow rice than to grow other crops and also functions to recharge ground water (1.18 E20 sej/yr). The emergy evaluation of aesthetic value (cultural service) from an agricultural production area is calculated by summing all emergy inflows in the system, which totals to 8.06 E20 sej/yr (Huang 2009).

The system components were entered into a symmetrical impact matrix, and the influences of each component on all other components was recorded to illustrate the connected flows between components. Assessments in a row indicate how one component influences other components, whereas assessments in a column indicate the influence of the other components on it. The components with high active sum (AS) include upstream rivers, soil nutrients and crop biomass of agricultural production area, and soil water in forest ecosystems. The upstream rivers, crop biomass and soil water in forest ecosystems also have high passive sum (PS), leading to their highest value of total sum (TS=AS+PS), and indicate their critical influence in the entire system. By calculating the activeness and passiveness of each system component, the components can be situated in a system grid.

The forest ecosystem can conserve water resources by storing excess runoff and discharging ground water to surface water. The component of soil water thus provides a regulating service of water flow and plays a critical role in the entire system. The soil nutrients in the forest ecosystem are an active component because they support biomass production. However, since harvesting timber is prohibited, no provisioning service is available from forest biomass, and its role is less active. Riparian wetland, however, tend to fall in the indifferent sector of the system grid due to its smaller area as compared to the other ecosystem. The high active sum and passive sum values of agricultural production system components reveal the critical role of ecosystem services in agricultural production area of the study region. Given the topographic characteristics of the study region, reservoirs are used to designate water resource as upstream and downstream. The

upstream rivers provide provisioning services of surface water and hydroelectricity. These rivers are considered the most critical component and have an active role in the entire system. The downstream portion of the surface water tends to receive runoff and discharge from other system; its role is less active than that of the upstream portion.

3.2 Geography of Taipei Basin

Staying true to the ecosystem approach in analyzing Taipei as an organism is the matter of urban regeneration. A comprehensive diagnosis of Taipei city must include its surrounding areas, namely, Taipei County, Keelung City and Taoyuan County, which has an area of 3659 km2. Geographically, the region is quite diverse, ranging in altitude from sea level along the coast to about 2450 m in the mountainous region at its southern tip. The region spans a range of landscape types, from urban centers in the Taipei Basin where rivers play a major role as they intersect, and reduce in the slope areas, through rural/agricultural and forested slope lands. The North-South Expressways link the major cities and extend along the west coast towards southern Taiwan. Although, this region has a strong agricultural history, the agricultural landscape has rapidly been transformed from rural to industrial and urban development as a result of urban expansion and uncontrolled urban sprawl.

Thus the urbanization which occurred along the North-South transportation corridor of Taipei City was due to the close proximity to Taiwan's major socioeconomic center, and the existence of major public facilities such as Taoyuan International Airport.

Taipei is located adjacent to Taoyuan and Keelung city. Together they make up the most densely populated area in Taiwan. In just 35 years (1971-2006) urban development has dominated the Taipei Basin, population of the Taipei and adjacent Taoyuan area increased 44.26%, from 6.0 to 8.7 million, making the region home to one-third of the total population of Taiwan. As the population of Taipei and adjacent Taoyuan County grows rapidly, both areas have become increasingly urban resulting in uncontrolled urban sprawl. The speed at which urban sprawl grew has been most noticeable between Taipei and Taoyuan. Statistics shows that urban areas have grown by

more than 58% and agricultural areas have decreased by 160.54 km^2 during 1990-2006. According to scholars the region can generally be considered as a "mixed urban-rural prototype", and thus representative of Taiwan's rural landscape, which has undergone a major transformation from an agricultural to post-industrial economy.

Because the Taipei Basin is overwhelmingly dominated by urban land development, as urban densities shifted from the city center toward hilly sloping areas, the impact in the city was not seen during the 35 years (1971-2006). The population of Taipei-Taoyuan area increased by 106%, from 4.2 million to 8.7 million, which is equivalent to one third of Taiwan's population. The impact became more evident as represented by data related to land use distribution in 1995. Agricultural lands were distributed mainly on around western Taoyuan County, moreover the eastern and southeastern areas of Taipei were previously dominated by forests. Sadly, it has been rapidly converted for industrial and urban uses, spread fragmentarily into the southwestern areas along the Dahan Creek.

Rural planning within the context of Taiwan's planning spatial system divides the country into two spatial domains: urban planned districts and non-urban land. The purpose of delineating "urban planned district" is said to be a guide meant to regulate the locations and intensity of land development under the Urban Planning Act. Furthermore, within the "urban planned districts", municipal governments were to exercise land use control through strict and inflexible zoning ordinances. "Non-urban land", the conversion of land use regulated under the Regional Planning Act, is through a permit system, in which each piece of land is designated a use zone with density limits lower than in urban planned district.

The Non-urban land covers three fourths of the region in the Taipei-Taoyuan area. Approximately 72% of non-urban land is dominated by national park, slope land conservation district, forest and national forestry, which are distributed in the eastern, southern, and northern areas. The areas of general and special agricultural districts account for 16.74% of non-urban land, which are concentrated in the western part of Taoyuan County.

Despite the government's plan for land use the land cover map developed in 1971 by the Council of Agriculture (Figure 11), the land cover maps from 1990 and 2006 (Figure 12) interpreted from SPOT images, show a clear pattern of increased urban sprawl extending both from urban centers to nearby agricultural areas and along major transportation corridors.

Taipei and Taoyuan area were previously dominated by forests (＞60%) in 1990. Built-up lands were centered on Taipei city, spreading fragmentarily into the northern areas of the Dahan River, and covered about 678.16 km2 (18.54%).

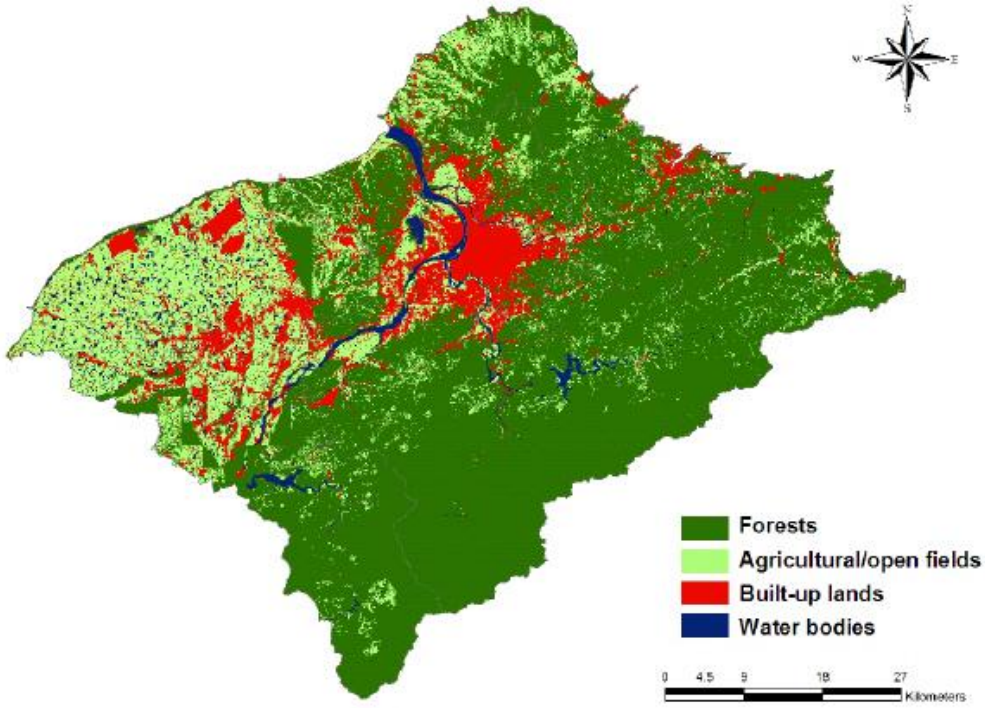


Figure 11 1971 Land Cover Map (Source: Aerial Survey Office, Forestry Bureau, Council of Agriculture, 1971, (Source http://web.ntpu.edu.tw/)

The 2006 classification map reveals that the major type of land use in 2006 was still forests, covering 2124.79 km2. However, built-up lands amounted to 1071.43 km2 increasing by nearly 400 km2 over the past sixteen years. (Table 1)

Table 1 Land use statistics 1990 and 2006 (Source http://web.ntpu.edu.tw/)

	1990		2006	
	Area (km^2)	Percentage	Area (km^2)	Percentage
Built-up land	678.16	18.54%	1071.43	29.29%
Agricultural/open field	480.25	13.13%	319.61	8.74%
Forests	2262.06	61.83%	2124.79	58.10%
Water body	238.19	6.51%	141.56	3.87%
Total	3658.66	100.00%	3657.39	100.00%

Compared the land cover in 1971 with the interpreted land cover for 2006 in the Taipei-Taoyuan area, the change from agriculture/open field to built-up areas is the main land cover change. Predictably, places with a significant amount of agricultural lands near fast-growing urban areas experienced the highest rates of agricultural land conversion. Over 648.13 km^2 of the land cover, including forests (294.83 km^2) and agriculture/open field (353.30 km^2), were converted to built-up areas. Apparently, the rate of land converted from rural to urban use increased faster than population growth, which is possibly explained by industrialization and urban development. In the

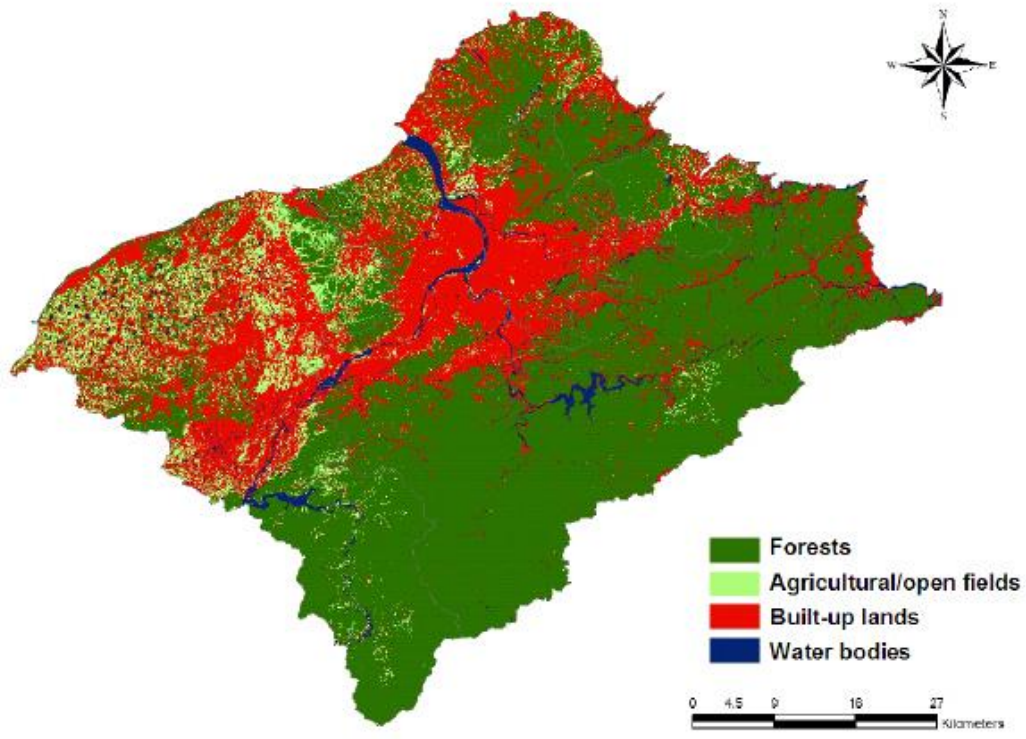


Figure 12 2006 Land Cover Map (resulting from interpreting SPOT image, 2006) (Source http://web.ntpu.edu.tw/)

Taipei-Taoyuan area, while population grew by 44.26% from 1971 to 2006, built-up lands increased 130% (Figure 13).

Landscape metrics for 1971, 1990, and 2006 for the region are shown in the Table1. The increase in Total Area of built-up areas and decreased values for agricultural/open field areas show that substantial urban growth had occurred in and around the Taipei area, mainly during the period from 1990 to 2006. Number of Patches indicates that the fragmentation of built-up areas was more obvious than for agricultural/open fields in 1971.

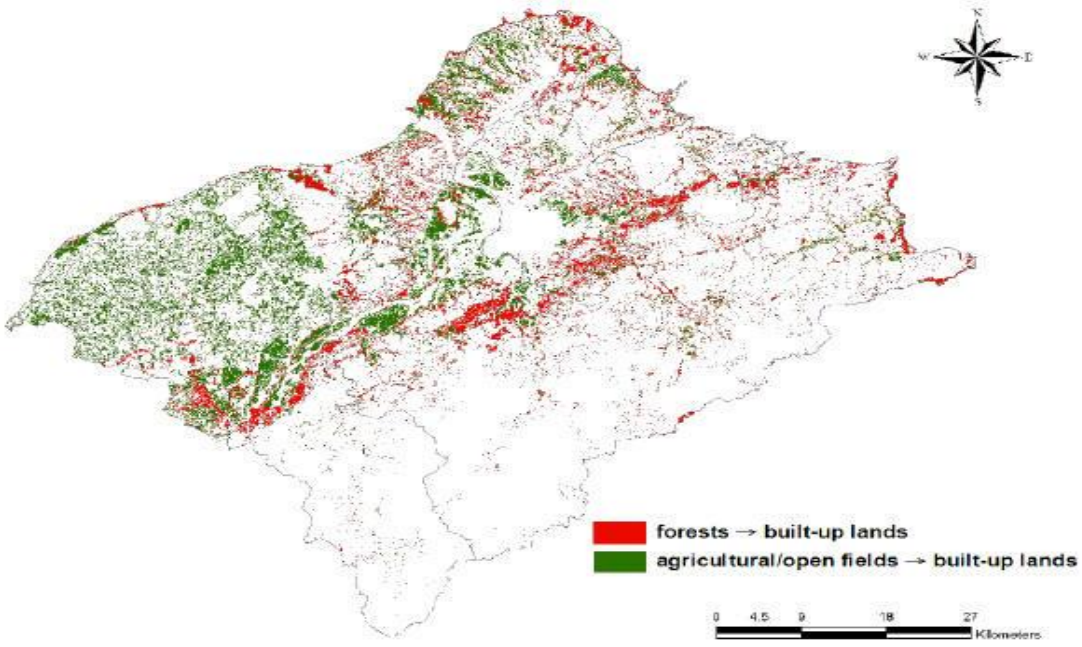


Figure 13 The Map of Land Cover Change between 1971 and 2006 (Source http://web.ntpu.edu.tw/)

Fragmentations of both of these land cover classes increased in 1990 and lessen in 2006. Note that this was due to ongoing conversion of agricultural lands resulting in smaller patches of built-up areas being combined into larger patches and therefore producing a decrease in the number of urban patches.

3.3 Climate

Taipei-Taoyuan area has a humid continental climate resulting from a prevailing wind pattern that brings cool air from the interior of the China. The characteristics are serene and hot during the summer as well as cold and rain in the winter. In 2006, the coldest month was in January (14.7℃) and the hottest month was in July (28℃). The warmest area is in the center of Taipei City and the coldest area is Chutzu Lake of Yangmingshan National Park on the north of Taipei.

3.3.1 Air (wind)

Taipei has a monsoon-influenced humid subtropical climate of four-seasons. Summers are very hot, humid and occasional heavy rainstorms and typhoons. Additionally in summer the prevailing wind is a southwesterly monsoon. On the other hand, winters, are short, mild and generally very foggy due to the northeasterly winds (CentralWeatherBureau) from the vast Siberian High being intensified by the pooling of this cooler air in the Taipei Basin. Due to Taiwan's location in the Pacific Ocean, it is affected by the Pacific typhoon season, which occurs between June and October.

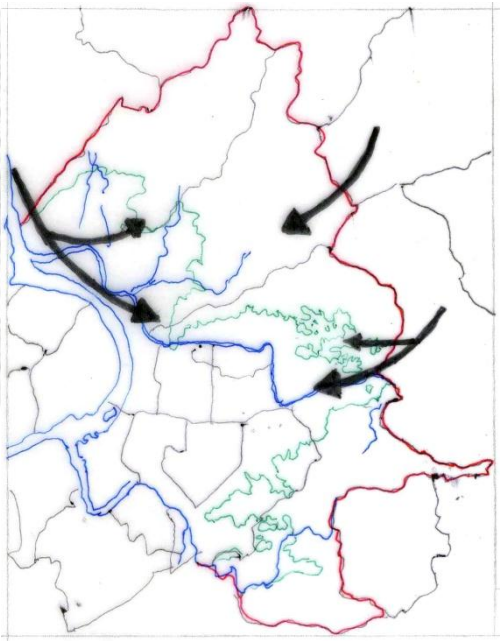


Figure 14 Monsoonal flow into Taipei City

Monsoons have an influence on Taipei City's air circulation. The East Asian monsoon is a monsoonal flow that carries moist air. The flow of East Asian Monsoons (北季風) into Taipei City is marked on Figure 14. There are 3 ways for air to get into the city area, from northern area of Danshui along Danshui River, and form eastern area of Wanli (萬里) and Xizi (汐止) along Keelung River. Those air corridors play a very important role in the city's air circulation; hence their permeability have a direct effect

Figure 15 Songshan Airport Plan (Source: Google Earth maps)

on air quality in the city. The influence and importance of the East Asian monsoon is evident especially due to the Songshan airport (臺北松山機場).

Taipei Songshan Airport is located in the Songshan District of Taipei, surrounded by the Keelung River riverside from the north and east, and Fuxing North Street (復興北路) from the west and Minquan East Road (民權東路) from the south what makes it easily accessible from the town centers (Figure 15).

The airport was designed with east-west alignment along the strong monsoon winds (Figure 16). Currently the total space of this airport is 182 hectare and is situated in proximity to the downtown. Because of its location the city suffers from noise, pollution, restrictions on urban planning, and traffic congestion the airport brings about.

Air pollution is a global problem, however during the last decade Taiwan has managed to decrease ambient levels of nearly all pollutions. Taipei is an exception, annual average of daily maximum 1 hour ozone level has increased steadily by 26% for the period of 1994-2003 (Chou, Liu, Lin, Shiu, and Chang 2006).

There are two main reasons for current air quality in Taipei City: the geographical location of the city and secondly, high density. Taipei City accommodates over 2.7 million people. The city, along with Taipei County, and Keelung City form the Taipei metropolitan area with a population of 6,900,273, hence is an area of density of 9,789.9 p/km^2 (Friederich, Jaunky, Xu, and Vohra 2011).

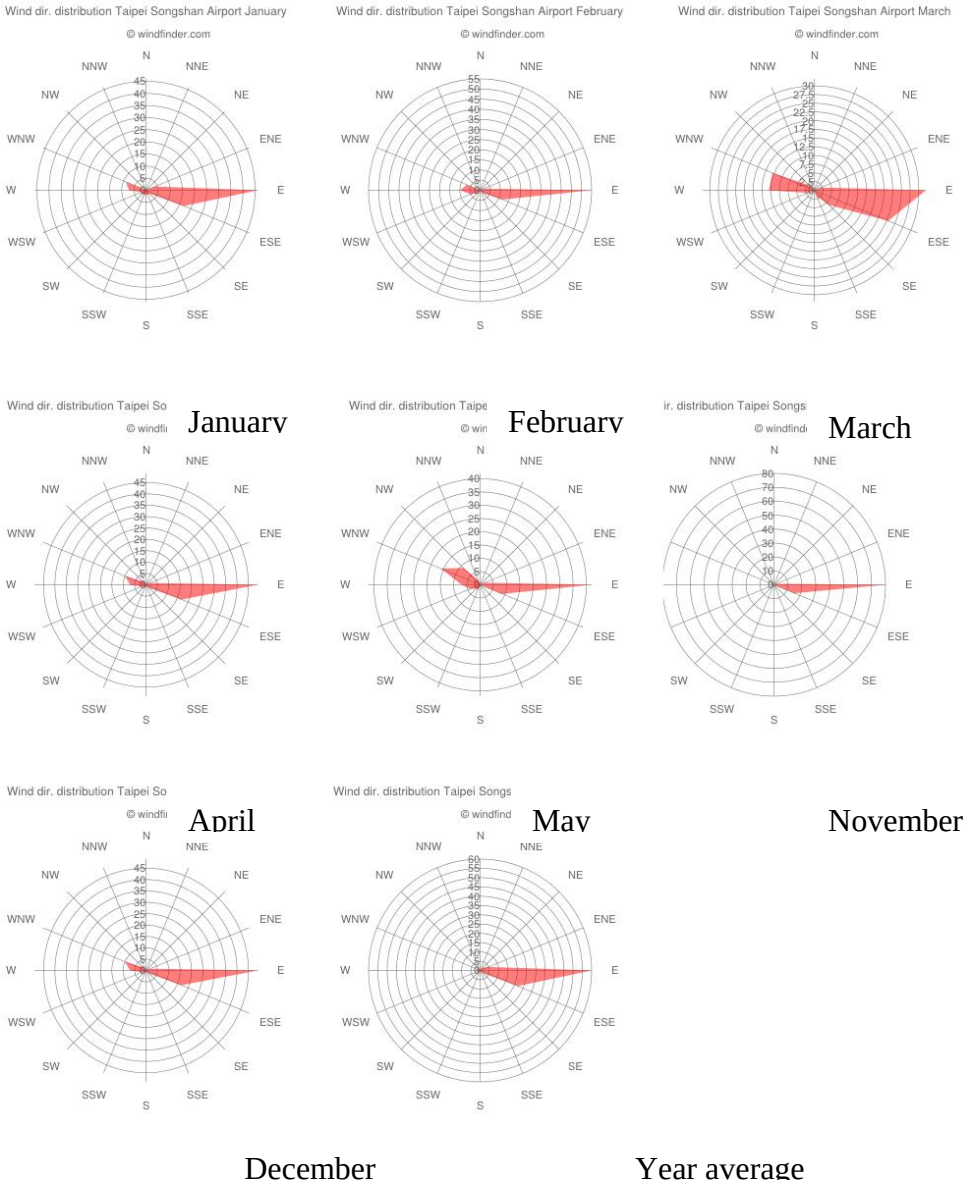


Figure 16 Songshan airport Winds (Source: http://www.windfinder.com)

Air pollution is a very significant factor of quality of life in Taipei. Dense traffic emissions, particularly from motor scooters, and Asian continental outflows due to long range transport of pollutants carried by the winter monsoon are the main source of air pollution in Taipei. The levels of fine particulate matter, are consistently more serious in the mornings as there is less air movement; sunlight helps clear up some pollutants, which tend to be trapped close to the ground (Oung 2007). The total suspended particles (TSP) in Taiwan are equal to the weight of a Taipei 101 building (700,000 ton). The results are the human respiratory system is under serious distress. When people are constantly

exposed to air pollution, the health of lung is worsened and the risk of heart disease increases.

Figure 17 clearly indicates that the nation's air quality in recent years has been greatly improved and that efforts to control air pollution have paid off. To reach the same air quality standards as other advanced countries, and to improve overall air quality, the EPA has set the objectives of reducing the percentage of days with PSI>100 by 2016： below 1.5%. Based on current situations and forecasts of air quality concentrations, Taipei needs to further reinforce control measures or tighten standards for fugitive particulates and ozone precursors in addition to existing control measures and programs.

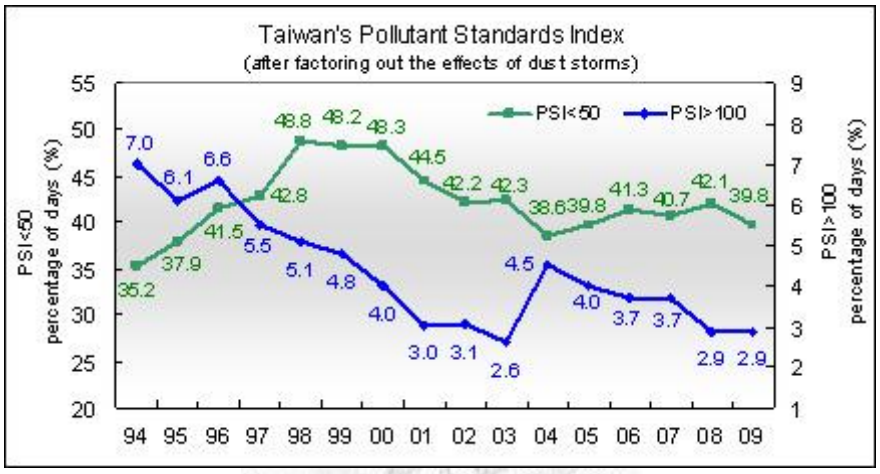


Figure 17 Taiwan's Pollutant Standards Index (Source: EPA)

According to statistics released by the Environmental Protection Administration's automatic monitoring stations, there was a total of 10 station-days throughout the year 2010 in which Taipei's air quality was unhealthy (PSI, pollutant standards index higher than 100), that is 22 fewer days compared to 32 days in 2009. This is the best record in recent years since the establishment of the air-quality monitoring network in 1994 (EPA).

Clean Air Zone is a Taipei City Government program that aims at improving air quality, enhancing the quality of living environment, raising awareness of ecological and environmental protection, and lastly achieving sustainable use of natural resources. It is claimed that within clean air zones, vegetation and beautification is enhanced and bike lanes and other greening facilities or landscapes are installed. (EPA) In Taipei City there

has been over 8 Clean Air Zones[8] created. However by year 2010 in the city there had been only six Environmental Protection Parks; and one Bike lane. Also by 2010 no Vacant land (Community greening), Greenbelts, Landfill reclamation greening, Green boulevards, Campus improvement zones, Pollution sites greening restoration or Barren land greening had been established (EPA).

Taipei City is situated in a very difficult area. The Taipei Basin is surrounded by mountains and dirty air accumulates and lingers to increase the air circulation. Therefore, factors such as mountain-valley temperature difference, land-sea breeze, or *urban heat island effect* directly influence the quality of air and its local circulation in the city. The land-sea breeze has a major influence on the dispersion of air pollutants, therefore, it is important to maintain clean and open airflows into the basin since any "pollutants emitted near the shore could be confined to the closed land-sea breeze circulation region under stagnant conditions" (Liu, Huang, Shieh, and Wu 1994). Additionally, air pollution produced by the city intensifies *greenhouse effect*, creating in the basin microclimate in which contaminated air is trapped between the mountains and *greenhouse gasses*. Those factors have a major influence on reducing airflow, isolating the warm air inside the structure, and therefore heat is not lost by convection.

Taiwan is committed to reducing GHG (Greenhouse Gasses) emissions. In May 2010 the Master Plan of Energy Conservation and Carbon Mitigation was approved. It is comprised of 10 strategies. The main policy aims to usher in a low carbon economy and an environmentally friendly society dedicated to GHG emissions reduction. GHG mainly from carbon emissions come from electricity generation. However, according to Sun, Chen and Clements-Croome, (Sun, Chen, and Clements-Croome 2006) diminishing of greenhouse effect and air pollution has to be enhanced because of large use of air conditioners and motors. That is due to the fact that the average summer temperature

[8] Songshan District: Environmental Protection Park 305 公 305(舊宗 1 號環保公園); Beitou District: Environmental Protection Park 204 (公 204 環保公園); Neihu District: 1 Huzhou Environmental Protection Park 48 (公 48,葫洲一號環保公園）,2 Zhouzi Environmental Protection Park 105 (公 105,洲子 2 號環保公園), 1 Zhouzi Environmental Protection Park 104 (公 104 洲子一號環保公園）, Beishihu Environmental Protection Park 103 (公 103,北勢湖環保公園）;Wen Shan District: Taipei bicycle path system overall planning - Muzha MRT Shido South Bridge bike lanes (1,4 km)(台北市自行車道系統整體規劃-木柵捷運站至道南橋自行車道); 3 Xinglong Street Ln 207, Sec. 3 (興隆路 3 段 207 巷)

since 1998 to 2005 maintained around 30 centigrade degree, despite the air pollution reduction policies.

The energy-intensive construction industry accounts for an estimated 29 % of Taiwan's Co_2 emissions. In 1999 the EEWH green building evaluation system was instituted to help developers, architects and others involved in construction of green buildings and encourage people to purchase and use such buildings.

Location of Taipei City challenges the air circulation due to natural land formation as surrounding mountains that create a barrier that makes it difficult for fresh air and winds to pass through; and obstacles that are an effect of human activity, as greenhouse gasses over city, additional blockage for air circulation. Therefore, for Taipei City, air exchange is one of the biggest problems that cannot be omitted or ignored. Furthermore, it should be the priority in eco-regeneration, since fresh air supply is essential for a healthy and well prospering city eco-system.

3.3.2 Water (Flood Prevention in Taipei)

According to geological estimates, the Taipei Basin was a large lake in ancient times; and after years of sedimentation, it then developed into a basin. It is the second largest basin in Taiwan covering 243 square kilometers. The basin is bounded by Yangmingshan (陽明山) to the north, Linkou mesa (林口區) to the west, and the Ridge of Xueshan Range (雪山山脈) to the southeast. The shape of the basin is close to a triangle and formed by the three vertices, Nangang (南港區), Huilong (迴龍) of Xinzhuang (新莊區), and Guandu (關渡) of Beitou (北投). The main rivers in Taipei Basin include Danshui River (淡水河), Keelung River (基隆河), Dahan River (大漢河) and Xindian River (新店溪).

According to the Central Weather Bureau, Taipei-Taoyuan area has the greatest rainfall in June and from August to November. In 2006, the mountainous forest in the eastern and southeast areas have the greatest annual average rainfall (5,889.1mm and

5,287.7mm) in 2006. The costal plain in Taoyuan county has the least rainfall (e.q. Shihmen: 1315.7mm).

Additionally, Taipei City is located on the Danshui River, about 25 km southwest of Keelung (基隆). It lies in the two relatively narrow valleys of the Keelung River and Xindian River, which join to form the Danshui River along the city's western border. The rivers create the Taipei Basin area and set most of Taipei city boundaries. Each one of these rivers are sources of flood risk, although, they contain riverside parks for citizens to relax and enjoy.

Keelung River (基隆河)

Agriculture landscape is strictly connected and dependent on rivers. Keelung, Danshui and Xindian Rivers are the source, not only of agricultural expansion, but also a fundamental factor for The Taipei-Taoyuan area development. The Taipei-Taoyuan area ranges in altitude from sea level along the west coast to over 2000 m in the southern tip of Taoyuan County. The Taipei Basin, which is situated in the central area, is surrounded by hill slope areas. Danshui River, the major stream network in northern Taipei, flows approximately 158.7 kilometers from its headwaters in Xinzhu County and passes through Taoyuan County, Taipei County and Taipei City before draining into the Taiwan Straits. The Keelung River, Xindian Creek and Dahan Creek, are all major tributaries of the Danshui River, they intersect in Taipei Basin and become the main branches of Danshui River.

The Keelung River is one of the major rivers in the Greater Taipei City Area. It passes through seven districts of the city, including Nangang (南港區), Songshan (松山區) and Neihu (內湖區). The over 86 kilometers river originates in the mountains west-northwest of the town of Jingtong (菁桐) in Pingxi District (平溪區), New Taipei City, flows down to a rift valley and then flows east-northeast to Sandiaoling (三貂嶺). Then it flows northward to a point between Jiufen (九份) and Keelung City (基隆市), and then heads back in a general west-southwest direction to Taipei, where it joins the Danshui River and flows out to sea.

The river used to be deep and surrounded by forests, lakes and wetlands. Important cultures developed along it, as those found at the Yuanshan Site and Tatayou. In 1966, due to recurring floods, river-straightening projects began, and riverside parks were built on the recovered land. Therefore, plans have been adopted to straighten the watercourse to alleviate the problem[9]. High embankments were built to contain floods, blocking the water access from people. Because of the snaking watercourse, relatively shallow riverbed and the huge amounts of silt carried within its waters, the Keelung River has a tendency to overflow its embankments and flood into the eastern districts of Taipei including Songshan (松山), and Neihu (內湖), and Nangang (南港) during the typhoon season each year.

Straightening a river is one of the methods of flood control. However is has a major impact on the environment. First, it will make the river straight, thereby shorter. Twists and turns help control the river's course speed, thus shortening it increases the flow (Grischy 2009). It causes faster soil erosion which affects animal habitats. Secondly, straightening a river leads to a reduction in wetlands, which prevent flooding naturally by absorbing water and keeping water on normal level. Even though straightening a river reduces flooding in one section, it opens up increased flooding downstream. Therefore, reduction of wetlands increases the risk of flooding. Additionally, straightening a river also modifies its characteristics. Wetlands provide a home for wildlife and vegetation to help feed fish in the river. Therefore depriving the environment of those lands leads to a population decline in fish species (Robbins 2009) and lower diversity of animals along the river basin(Aderemi 2009). Constructing high embankments along rivers only eventually aggravate the injuries of the inundations they have been designed to prevent. The effects of changing and regulating a river's flow take major environmental consequences causing damages that take over 40 years[10] to recover.

Residents are often under the impression that the river is the source of floods in the summer, thus a means of carrying the stench of agricultural wastewater all year long. Due to that fact people do not go to the riverbanks, schools do not use the area for field observation etc.

[9] On the map 2 is marked the current and previous river bank.
[10] Source: www.wikipedia.com

After 1970's urban and industrial development brought serious pollution to the river. The Keelung River is heavily polluted by both raw sewage, industrial pollution from illegal industry and household wastewater. The increasing pollution level of the water has led citizens to abandon the river and utilize the space of the riverside. The restoration of the natural river is on the agenda of the Taipei City Government, Taipei Central Government and several citizen organizations. As a result, the section of river between the Zhongshan Bridge (中山橋) and the Nanhu Bridge (南湖大橋) has undergone aesthetic modifications. Today, both riversides of the Keelung River in Taipei City have been converted into 224 hectares of park space for city dwellers to relax and enjoy the natural environment.

Xindian River (新店溪)

The Xindian River flows through New Taipei and the capital Taipei for 82 km. The Feitsui Dam (翡翠水庫) spans the river southeast of Taipei.

The Xindian River is one of the three major tributaries into the Danshui River. Its main tributary is the Beishi River (北勢溪) which originates in Shuangxi District (雙溪區), New Taipei City at an elevation of 700 meters. It flows west past Xindian before merging with the Nanshi River (南勢溪); it is at this point that it can be called "Xindian River". It then turns north and merges with the Jingmei River (景美溪), before finally merging with the Dahan River and feeding into the Danshui River.

The Xindian River is one of the main sources for drinking water in Taipei City. According to the Taipei City Running Water Center, over 4 million Taipei residents obtain 97% of their drinking water from this river. Today, there are 22 bridges that span this river.

The Xindian River was also heavily polluted by both raw sewage and industrial pollution from illegal industries. The EPA's efforts to clean up the rivers have helped with wildlife conservation and the Xindian River's biodiversity survey released in 2010 indicated the presence of 38 different species.

The restoration of the Xindian River to its natural state has also seen the development of riverside parks that include recreation, bird watching, as well as protected areas, hence any kind of development on the river banks are forbidden, because they belong to the flood protection area.

Danshui River (淡水河)

Danshui River is the biggest river in northern Taipei; it is the heart of northern Taiwan's political, economic and cultural activities. The river represents many fond memories for a lot of people, and is a symbol of Taipei's cultural heritage.

In the 18th century, Danshui River was the primary artery and main waterway access to Taipei. The city's development started along this riverside, and Dadaocheng was the busiest and most commercial district. At that time, the foreign firms and embassies clustered in the area. The development and urbanization caused a large number of people to enter the basin area taking the lands of watershed[11]. Therefore, the rate of pipe connections increased to 100% in 2010 because of the City wastewater and sewage connections for households in Taipei City. Danshui River similar to Xindian River became heavily polluted by both raw sewage and industrial pollution from illegal industries. Domestic wastewater a primary source of pollution in the Danshui River and more so became all rivers in the five counties converge and empty into the Danshui River. The source of Danshui River at Pintian Mountain (品田山) in Xinchu County (新竹縣) and flows through New Taipei City, Taoyuan County (桃園縣), Taipei City, and Xinchu County (新竹縣). It has a length of 159 km and a drainage area of 2,726 km². It empties into the Taiwan Strait, a 180-km-wide strait separating the island of Taiwan from the Asian mainland.

Taipei is located at the center of the Taipei basin with low-lying terrain. The Keelung River, the Jingmei River (景美溪), the Xindian River and the Danshui River flow around and converge at Guandu outlet and flow into the sea. Besides, the Shuang

[11] Information source: Department of Urban Development, Taipei City Government

River (雙溪), the Huang River (磺溪), the Huanggang River (磺港溪), the Guizikang River (貴子坑溪), the Neihu River (內湖河), the Dakeng River (大坑溪), and the Sifen River (四分溪) transversely flow within the city. According to meteorological data, it is rainy in summer and autumn, and flood flow rises rapidly during heavy rain and typhoon seasons, which frequently causes high flood levels due to interactions of the narrow outfall pass at Guandu (關渡), rising sea tide and land substance. The geological structure of Taipei Basin is as a result of flood disaster causes unexpected loss of life and damage to the city. The Danshui River merge with the Dahan River (大漢溪), Xindian River and Keelung River, and flows to the ocean by the Guandu and Shezi Island, has a basin area of 2726 km^2. Floods caused by those rivers are enormous because of the unique landforms of the basin (The.10th.River.Management.Office 2011).

Guandu Plain and Shezi Island (社子島) compose an 823-hectar waterfront space to Taipei city. Taipei basin is surrounded by mountains, and the site is located just on the outlet for floods. The area includes the 57-hectare Guandu Natural Park and designated Natural Reserves, a very important bird sanctuary outside the levee along the river. In addition, a transit line runs along the edge of the area.

Environmental issues include storm water and flood water control, natural wetland, bird sanctuary protections, transportation limitations etc. Guandu Plain and Shezi Island are alluvial natural wetlands created by the Danshui and Keelung Rivers. During the 1950s, high growth in agriculture and due to industry unregulated pumping for underground water caused various environmental issues, such as waste dumping, pollution and severe land subsidence. Guandu Plain and Shezi Island turned into a problematic area for Taipei City.

The Guandu Plain and Shezi Island due to flooding have formed the last agricultural and low density residential area in Taipei City. Due to the over development in Taipei, the city government is currently reviewing the zoning plan and flood prevention plan. From the 200-year flood prevention plan, concrete embankments with 9 meters height are proposed to surround Shezi Island and the southern edge of Guandu Plain. In 1960 in order to mitigate floods, Taipei City government started planning the overall flood control project for the Taipei area. The entire project uses the

200-year-flood frequency as criteria for its planning, and includes building dikes alongside the banks of Danshui River and its branches. Additionally, the strategy was constructing the 9 meters high concrete walls all around the city. The consequences of this embankment were reflected on improved flood protection; however it also influenced people living inside the city. They became encircled by higher and higher embankments, even though the government strongly relies on concrete serious disaster to the city. Furthermore, the barrier created by embankments not only constructions as the only solution for flood, water still finds its way out and creates even fragmentizes the natural environment from the city, but also separates people from water and decrease human awareness and appreciation of nature.

The effects have severely influenced on the city structure. Embankment walls have created a boarder of the city, and space adjacent to it difficult to manage, as a result it has created a great location for elevated highways which only intensifies the fragmentation.

Embankment walls are necessary in Taipei City in order to prevent it from annual floods. The most important thing is for walls to fulfill this purpose, however its form, design and the space nearby it does not have to be just a high plain grey concrete wall. It should provide a connection and create opportunities for citizens to maintain, as much undisturbed access to the riverside, while also protecting the city from floods.

3.4 Green Fingers

The city itself is surrounded by volcanic group of mountains called Datun Huoshanqun (大屯火山群). Located approximately 15 km north of Taipei, to the west of Keelung, it adjoins the northern coast of the Taiwan Island. Currently, some hydrothermal activities and gas fumaroles are still active among these volcanoes (Kim, Chang, Ma, Chiu, and Chen 2005). Qising Mountain (七星山) is the highest mountain located on the Datun Huoshanqun and also the highest mountain at the rim of Taipei City and Taipei Basin. It is located in the center of Yangmingshan National Park (陽明山國家公園) and its main peak is 1,120 meters (3,675 feet) above sea level (Figure 18).

Green fingers connect the inner city with surrounding ecosystems. They are extremely important formations in every city as natural areas that manage to maintain in the primary state in the city. Green fingers are the "ecological windows" for the city. In Taipei, they are located mainly in the east of the city (Map 2). For example, mountain slope are connected to wide streets as Xinyi Road (信義路) and Renai Street (仁愛路), creating very useful environmental eco-connections to the city.

Generally, those spaces in the city are the main connection to mountains and the out-of-the city natural environment. Green fingers serve as eco-corridors, therefore by joining them with cities' green belts and parks, a continuous network can be created. Thanks to uninterrupted systems like this, the ecosystem of the city can have an opportunity to slowly begin its regeneration.

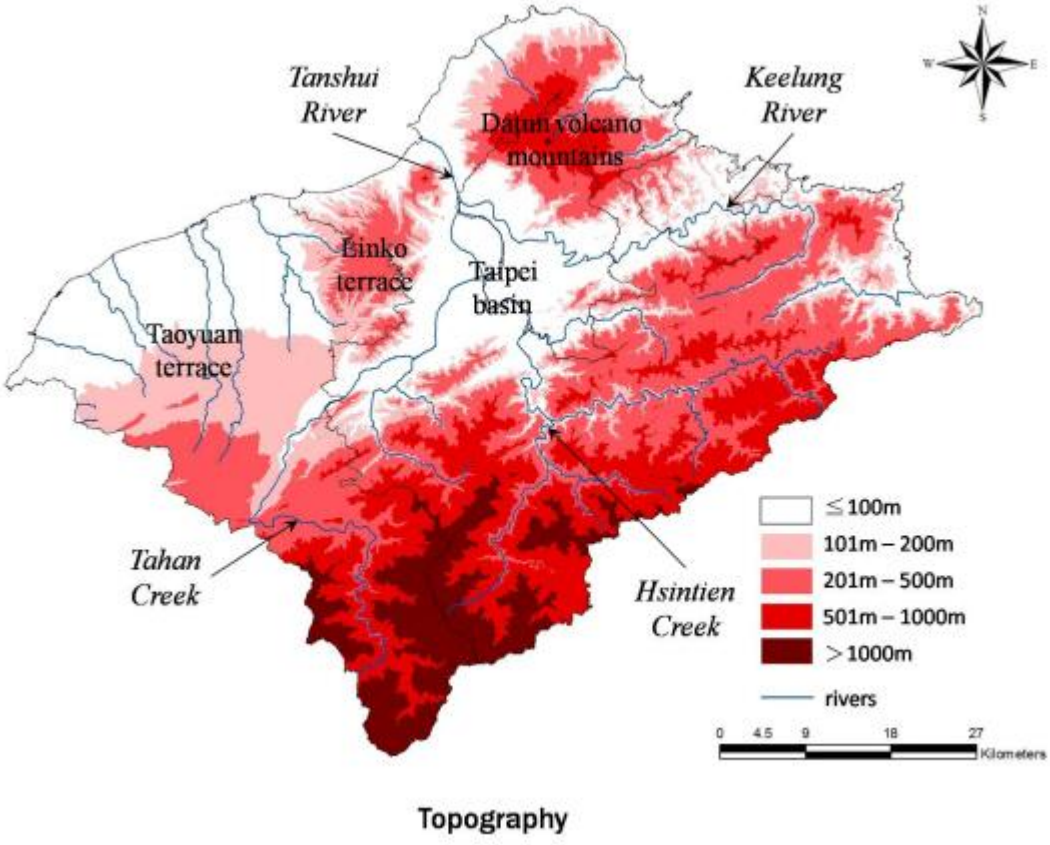


Figure 18 Topography (Source (Wang, Huang, and Budd 2012)

Not allowing green fingers to develop, along with connected channels, would result in blocking and breaking a cities ecosystem. Separated from the source of its "natural resources", it simply could not survive on its own. Therefore, for the sake of the city

green fingers cannot be separated from the city, built over, or intervened with in any way. Taipei should protect those areas, and most importantly maintain wide eco-corridors linked to them and plan the entire network consisting of: green fingers, green belts, parks, and other elements that would improve and benefit the ecosystem.

3.5 Taipei Urban Development

Until the 18th century, before the Han Chinese arrived, the Taipei Basin was the home of the aboriginal Ketagalan Tribe, survived by gathering, fishing, hunting, and nomadic cultivation. Rivers played a very important role in Taipei's irrigation and agriculture, since they led to the creation of trade routes and port towns (Pong 2009). According to the Japanese scholar Kanori Ino, the Ketagalan settlement in Sandiaoling was established near the western seashore, via Keelung, Jinbaoli, Fuguijiao, Huwei, following along the Keelung River into the Taipei Basin. They were the earliest documented inhabitants in the Taipei Basin.

Besides from Danshui most of northern Taiwan and the Taipei Basin were undeveloped. In 1709 the "Chen Lai Zhang (陳賴章) Land Development Company and Zhuluo (諸羅) County was founded and a development permit was issued approving the cultivation of the Tagal (大佳臘) region. The area of the Company's development covered the areas such as Leili (雷里, present-day Wanhua [萬華]), Xiulang (秀朗, presently Zhonghe [中和]), Parihoon (八里坌, presently Bali [八里]), Gandou (干脰, presently Guandu [關渡]), the foot of Mount Xinzhi (興直山腳, presently Xinzhuang [新莊]), and Dalangliu Ditch (大浪泵溝, presently Dalongtong [大龍峒]), including the center of today's Taipei City, Xinzhuang, Yonghe (永和), Bali, and other areas of Taipei County. In addition to the Chen Lai Zhang Land Development Company and Chen Tianzhang, "Chen Guo Qi (陳國起),"and "Dai Tian Shu (戴天樞)" were also established. The development companies developed lands in the area of Bali and the Shilin (士林) Plain (Yin 1999). The early 18th-century was the period of the large-scale land development in Taipei.

In the early 19th century the Qing dynasty constructed the Taipei City Wall in the heart of the Taipei Basin. The city was planned to build up regular shop-houses along well-lined streets until the Japanese colonial authorities took control in 1895. The colonial planners refashioned the city and transformed Taipei into a modern city. The year after Taipei's population reached 264,420, the Japanese presented the Urban Plan for Greater Taipei (Map 1). It was prepared in 1932 and covered an area of 25,7 square miles. The plan was projected to the year 1955 when the population was expected to reach 600,000 (Pong 2009). Although the plan focused on a hierarchical road network and parkway system, it drastically modified the original plan, in outlying areas of the Taipei basin and demarcated the boundary of the present city. (Kishiue, Cal, Amano, and Lidasan 2005).

Approximately 80 years ago, the Japanese authorities already had a very mature planning philosophy for building future park systems in Taipei (NMTH 2010). The plan included road network development, zoning for a civic center and over seventeen parks with a total area of 256 Hectares. Each park followed the balanced space allocation principle and was planned in the old Taipei City area surrounded by the Keelung, Danshui, and Xindian Rivers and Keelung Road. Additionally it was connected to the major parks next to the Keelung River and Xindian River with "Park Roads". Parks in the north were connected by green roads to the parks in the center (presently Daan Forest Park), in the east and west and in the south of the city (presently Treasure Hill, Riverside Park, and National Taiwan University Campus, Sun-Yat Sen Memorial Hall etc.). These lined park road green space systems with widths ranging from 50 to 100 meters, fulfilled transportation, landscape and recreation functions, and additionally disaster prevention, disaster relief and evacuation functions (NMTH 2010).

However, in 1949, the green park spaces and park roads that were planned to be levied mostly became places for many military dependents that retreated to Taiwan with the KMT. Due to that fact, in those areas many illegal construction were built (NMTH 2010).

Upon retrocession in 1945, Taipei was designated as a provincial city (Figure 19). In October of the same year, the Japanese administrative system was abolished, and the city government was instituted. After World War II, when Chiang Kai-shek Guomindang

regime resumed rule over Taiwan, it adopted almost entire Japanese planning and zoning codes. However, in the 1950's the government instituted policies to move the labor out of the agricultural sector and into industrial production. Thus intensive industrialization resulted in rapid urbanization, and the influx of people into the Taipei city. Due to that fact, the capital's population reached half of million in the 1950's and had increased to 4.07 million by 1980. Such a rapid population growth caused transportation crisis and bridges connecting both sides of Danshui River that used to serve as escape routes on case of war, became responsible for Taipei's urban sprawl.

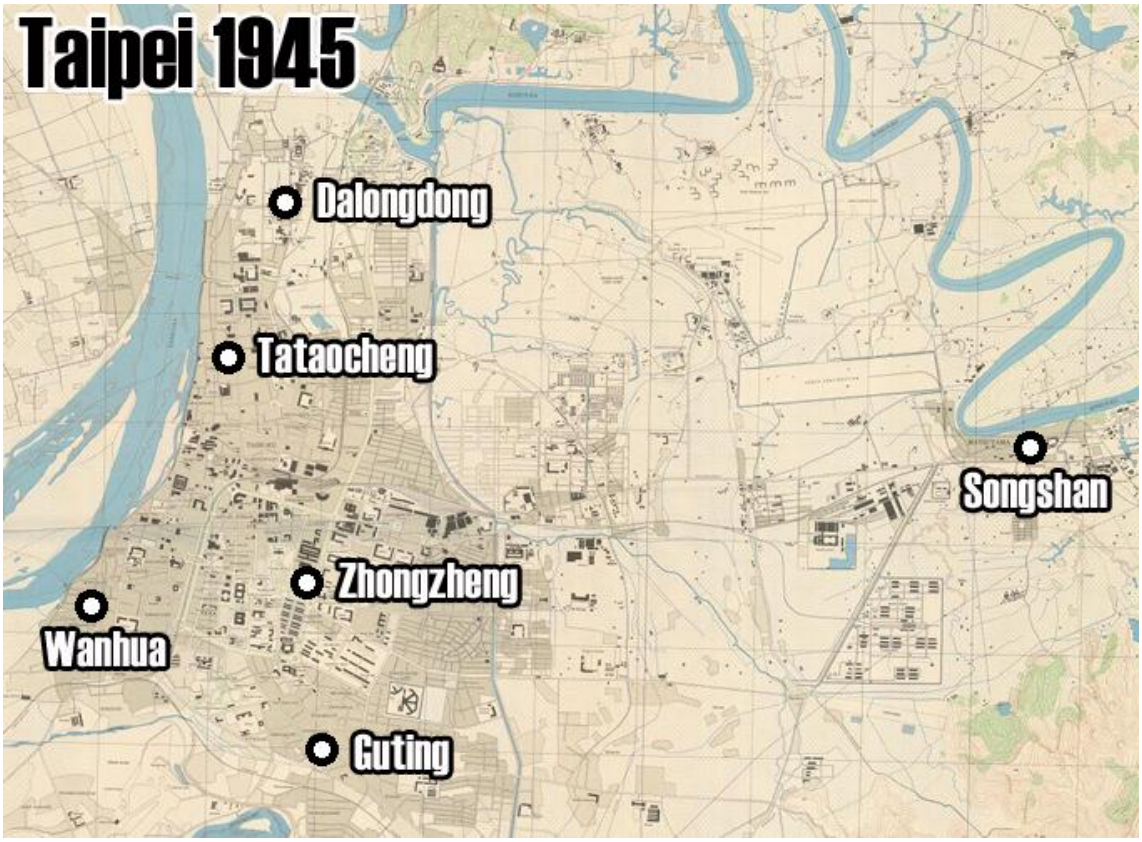


Figure 19 Taipei map 1945, early settlements (Source: Princeton University Library)

Taipei City density started to rise soon after 1950 along with city development. Most of these seventeen large city parks only remained as paperwork and were not able to be actually implemented. Because of this growth, some of the scheduled parks from 1932 until now were never built. In addition, many of those that had been built parks begin to disappear as land development took advantage of. Taipei maintained the same basic city structure developed during Japanese occupation (Kishiue, Cal, Amano, and Lidasan

2005), therefore certain land arrangements, designs and spatial solutions could be restored or at least can serve as a suggestion for an eco-regeneration.

3.5.1 Socioeconomic Development

Taipei Basin is dominated by urban land use; urban densities decrease from there center of the city toward hilly sloping areas. Owing to its close proximity to Taiwan's major socioeconomic center, the Taipei City, and the existence of major public facilities such as Taoyuan International Airport, the populations of Taipei County and Taoyuan County are growing rapidly and are becoming more urban. In just 35 years (1971-2006), the population of Taipei-Taoyuan area increased 106%, from 4.2 million to 8.7 million, which is equivalent to one third of Taiwan's population (Table 2).

Table 2 Area, population and density of Taipei-Taoyuan area (Source http://web.ntpu.edu.tw/)

Items	Taiwan	Taipei-Taoyuan area				
		Taipei City	Taipei County	Keelung City	Taoyuan County	Total
Area(km^2)	36,006	271.80	2,052.57	132.76	1,220.95	3,678.08
Population in 1971	14,994,823	1,839,641	1,301,513	329,509	748,404	4,219,067
Population in 2006	22,876,527	2,632,242	3,767,095	390,633	1,911,161	8,701,131
Density in 2006(pop/km^2)	635	9,684	1,835	2,942	1,565	2,366

The employed population of primary industries (including agriculture, forestry, fishery, and stock raising) was 223 thousand in 1971 and decreased to 29 thousand in 2006. On the contrary, the employed population of manufacturing industry increased significantly from 379 thousand in 1971 to 1.3 million in 2006. The employed population of service industry also increased over 3 times (from 76 thousand in 1971 to 2.5 million in 2006).

The speed of the recent rural transformation in Taiwan has been most pronounced in the Taipei-Taoyuan area. According to the land use distribution of 1995, the eastern and southeastern parts of Taipei-Taoyuan area are dominated by forests. Urban built-up lands are centered on Taipei city and spread fragmentarily into the southwestern areas along the Dahan Creek. Agricultural lands are distributed mainly in western Taoyuan County, however, it has been rapidly converted to industrial and urban uses. The study region can be considered as a representation "mixed urban-rural prototype" in Taiwan.

Within the context of Taiwan's planning spatial system, the country is divided into two spatial domains: urban planned district and non-urban land. The purpose of delineating "urban planned district" is to guide and regulate the location and intensity of land development under the Urban Planning Act. The conversion of land use in "non-urban land" is regulated under the Regional Planning Act through a permit system.

Within "urban planned district", municipal governments exercise land use control through strict and inflexible zoning ordinances. In "non-urban land", each piece of land is designated a use zone with density limits lower than in urban planned district.

Non-urban land covers three fourths of the study region in the Taipei-Taoyuan area. Approximately 72% of non-urban land is dominated by national park, slope land conservation district, forest and national forestry, which are distributed in the eastern, southern, and northern areas. The areas of general and special agricultural districts account for 16.74% of non-urban land, which are concentrated in the western part of Taoyuan County.

3.6 Taipei City Today

Taipei City is the 7th densest City in the world with 15,200 people per square kilometer and presently is depleting its spatial resources. Even though Taipei never developed into a manufacturing city (Wheeler and Beatley 2004), pollution has become one of the biggest problems of the city. Additionally, the sacrifice of environmentally sensitive areas to unbridled urban growth became "inevitable".

Due to high water consumption of 342 liters per person per day (compared to the Asian average of 278 liters per person per day) Taipei remains average in the water category compared to other major Asian cities[12]. Furthermore, household consumption accounts for over 70 percent of the city's water use. This could be the result of Taipei's lower water price of NT$8.21 (US$0.28) per metric ton, which is only one-fifth that of Tokyo and half that of Singapore (Liu 2012). Since 2007 Taipei has reduced its water consumption about 15 percent. These phenomena must be addressed by government policies and implications, and not by urban planning. .

Though more than 70% of the hillsides surrounding Taipei had been assessed as "improper" places to pursue construction work, a "mountain-removing, then town building" movement still took place. In the early 1970s hillside lands around the Taipei basin began to be sold. During the next decade regulations had changed the designated land use from observed to developable lands, which required building permits. Even though bylaws have changed and become more rigorous, they unfortunately did not apply to the building permits that had already been issued, which has affected current large hillside housing (Wheeler and Beatley 2004). By the end of 2011, the urban development plans had an area of 27,180 hectares that covered the entire administrative districts. Flat land suitable for city development accounted for 12,994 hectares (47.8 %of the City); and hills, slope land and low-lying land that were not suitable for city development accounted for the remaining 14,186 hectares (52.2 %). Land for City development can be classified based on location, mode of use, socio economic structure and future trends of development. The largest was the land used for public facilities occupying 7,114 hectares (26.2%), the residential area occupied 3,803 hectares (14 %), the commercial area had an area of 869 hectares (3.2 %) and the industrial area covered 420 hectares (1.5 %).

Figure 20 presents the zoning the city according to land use. It is visible how commercial and residential sectors occupy most of the space of the city, which park and green field has become insignificant. The conclusion is obvious, since Taipei is situated in a basin, the geographical nature of the surrounding environment imposes limits on

[12] Based on "Asian Green City Index, Assessing the environmental performance of Asia's major cities" that compares Asian Cities such as Bangkok, Beijing, Bengaluru, Delhi, Guangzhou, Hanoi, Hong Kong, Jakarta, Karachi, Kolkata, Kuala Lumpur, Manila, Mumbai, Nanjing, Osaka, Seoul, Shanghai, Singapore, Taipei, Tokyo, Wuhan and Yokohama.

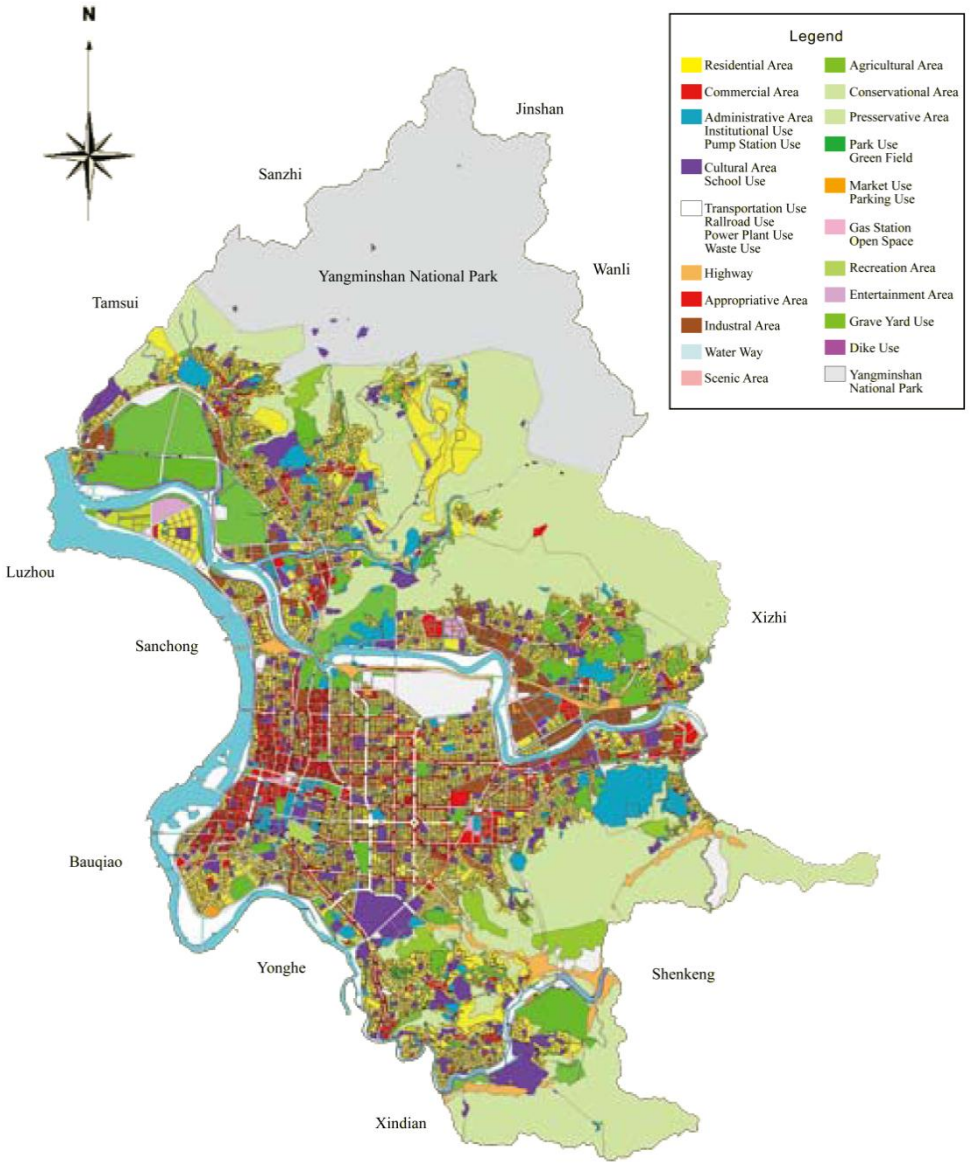


Figure 20 Zoning Map of Urban Development of Taipei City (Source: Department of Budget, Accounting and Statistics, Taipei City Government)

urban growth (Chiang and Hsiao 1985). The Japanese planned the city for 600,000 inhabitants. The plan in 1932 suggested a balanced amount of green spaces and infrastructure in the city. Unfortunately, further rapid development and constant increase of population, required major changes in the city plan and space management, therefore it has exceeded its originally established size and capacity. Analyzing the present plan of Taipei, it seems like the surrounding rivers and mountains have slowed down its growth by limiting potential development area.

The city was deigned on a square grid configuration. Although the size and density are different, the basic structure of the city remained relatively unchanged. Blocks are

huge by international standards at 500 meters. Lanes run perpendicular to streets and alleys are parallel with streets, or perpendicular to lanes. Occasionally minor roads run through the block diagonally. There are many streets in north-south[13] and east-west[14] alignment (Map 2). Considering the east-west monsoon winds, green finger locations and river locations, the described street grid is advantageous in using and creating eco-corridors and air-channels. Mentioned streets form functional interconnected alignment that would favor fluent and uninterrupted flow within the city, since most of the main streets start and end near the riverside parks, pass by big open spaces. Other spaces could be regenerated for new functions to enhance the system. Additionally, thanks to the perpendicular grid of streets, main streets intercross forming many important node places that enforce the system as well, for instance Keelung Road, Civic Boulevard or Roosevelt Street.

However, the city has a much greater potential than just streets' arrangement. Taipei City hides underneath its structure, a historical water canals called Liugongzun (瑠公圳) (Map 2). Liugongzun is a system of canals and irrigation ditches that once crisscrossed the city of Taipei. Most of the canals were covered over by roads, streets and parking spaces in the 1970's due to increasing volumes of traffic and diminishing necessity of water transportation and irrigation. The canals range from wide, navigable waterways used for transportation to narrow ditches used primarily for irrigation and drainage. They ranged from the Keelung River in the north, to the Wenshan District (文山區) in the south of the city. The waters of much of the Liugongzun canal system still flow beneath the city streets, and there remain a few locations where the canal is still exposed and visible, most notably at the northern end of Xinsheng North Road (新生北路).

There have been recent proposals to daylight sections of the canals. If Liugongzun were to be connected with parks, eco-corridors or other interesting spaces, like it was done in Community Park (營造社區公園) in New Taipei City, it would have a revitalizing effect on the city ecosystem.

[13]Guangfu Street, Dunhua Street, Fuxing Street, Xinsheng Street, Jianguo Street, Songjiang Street, Zhongshan Street, Chengde Street and Chongqing Street

[14]Minquan Street, Minzu Street, Minsheng Street, Nanjing Street, Bade Street, Changan Street, Civic Boulevard, Zhongxiao Street, Renai Street, Xinyi Street and Heping Street with Keelung Street, Xinhai Street and Roosevelt Street

The street grid, under city water cannel system, and previous plans for the city reveal the potential and possibilities of Taipei. The entire city system does not require urban renewal, just a few adjustments and regenerations in order to improve the eco-system. The basic structure was designed according to a certain plan that included an already hierarchical road network and parkway system, which could be reconstructed or acknowledged in the eco-regeneration.

Chapter 4 Diagnosis

Climate has created challenging conditions for Taipei city to develop. The surrounding environment has a direct effect on living quality and safety within it. Numerous rivers and surrounding mountains endanger the city with floods, which resulted in constructing embankment walls along most river shores, limiting air circulation within the city, intensifying the greenhouse effect, and increasing poor air quality.

Taipei's geographical location, and the proximity to the natural environment, is an advantage for the eco-system and people in the city. Taipei Basin's natural environment is diverse and close to the city. In some places it forms Green Fingers, thus the eco-system enters the city structure in numerous areas, creating important inner-system connections valuable to the city. Additional advantages of unique location are rivers, Keelung, Dahan, Xindian or Danshui Rivers are the source of development and existence of nearby ecosystems. Since the very beginning of Taipei, rivers have been vital part of peoples' lives, hence maintaining them in the best condition and restoring the connection between them and city is important.

Taipei is surrounded by mountains that, in two major locations, let the monsoon winds through and allow it to reach the city. Knowing the source and area of the inflow, it is easier to canalize corridors in the city and choose the ones that will fulfill the function of aeration in the most efficient way.

Except for geographical aspects, the city also embodies features worth mentioning and even incorporating. First, streets are constructed across the city on the perpendicular grid that can be effectively used in constructing corridors in the city. For example Keelung Road runs across the city connecting Keelung Riverside Park with Xindian Riverside Park's ecosystems, however because of the structure of the road the connection is theoretical. Keelung Road is an elevated highway that does not serve any eco-corridor functions and Civic Boulevard connects Keelung River with the Danshui River ecosystems. Other roads also provide connections of rivers, parks and open spaces in the city; it is very solid grid structure for corridors and green belts system in the city. Creating the network and its structure will be crucial for regeneration of eco-systems in the city.

Those streets not only play a linking role between two extreme points of the city, but also make connections with inner city eco-system possible.

Secondly, Taipei City can be proud of its effective and efficient public transportation. Well-developed public transportation along with good communication design, should limit the use of private cars. In addition the city also promotes cycling. Those are very common ways to translocate, and both part of a desirable, and important features of, an eco-city. Cycling is popular mainly because of distances in the city. Due to high density, many everyday services more than often are a walk or a bike ride away. Therefore high density, focused locally, can be an advantage because of walkable distances, which limits the necessity for car or even public transport use.

The next positive feature of Taipei City also involves its citizens; namely, community gardening. Walking along, for example, Roosevelt Street, there are over 4 small green spaces with garden plots. Gardening is also noticeable especially in the suburbs of the city. Many communities engage in the common responsibility of taking care of their space and using it for common and private purposes. Vegetables and fruits from these gardens are being consumed by them or sold in traditional markets. In addition to that, people also care about their environment, thus recycling is very common. However, it is not only peoples' initiative, the Taipei City Government has created a project that makes it possible. Taipei City enforces a "No waste drop" policy that forbids residents littering and at the same time encourages bringing out the garbage to dump trucks (Andriyanto 2010). It is a functioning longstanding "pay-as-you-throw" (PAYT) waste charge. People are charged a rate based on how much waste they present for collection (Friederich, Jaunky, Xu, and Vohra 2011). Except for recyclable materials such as plastic, glass and paper, kitchen wastes are collected separately and categorized into "Fertilizing Kitchen Waste" and "Feeding Kitchen Waste." The waste is auctioned off in public bids to agriculture agency-licensed pig farmers for reuse in qualified pig farms. Generally, around 95 percent of collected garbage is incinerated and the rest ends up in a landfill (Andriyanto 2010). The solution established by Taipei City government is not flawless. At times people have refused to dispose of the garbage in the required matter, and against the "trash cannot touch the ground" policy, they litter and dump (Andriyanto 2010). The trash disposal policy has created an unusual phenomenon, namely the

opportunity for social interactions. Many citizens treat this time as a chance to have a conversation with their neighbors. It is significant in the city, since the interaction within dense and large societies is challenging, and if no opportunity for social interaction is created, often it is the result of individual choice (Ross 2009). Therefore, the city government can reinforce social integrity and a sense of security by simple creating an opportunity for citizens to interact, and know each other, this enhances a sense of community among people.

Even though Taipei City has done a lot in matter of improvement there are still areas that require attention and consideration. Taipei's Geographical location limits coast of access, which challenges the air inflow into the basin, and therefore its exchange. The city is blocked from an ocean breeze, filled with polluted air generating greenhouse gasses (GHG), and a layer above it emerges the city. Surrounding mountains do not let the gasses disperse, trapping the air and creating smog. Polluted air trapped in the city and the sun light heat the zone between the ground and GHG cloud. The two main sources of air inflow are not enough to improve the process of air exchange, especially if there are barriers that limit the flow. Air pollution is dangerous and harmful, for people and every other living creature in the eco-system, therefore eliminating the source of pollution and keeping the airflow paths as permeable as possible is the main mean of improvement.

Although the mountain breaks are not the only ways for air to get into the city, rivers can play that role as well, the embankment walls successively block it. A flood prevention wall is constructed along almost all river shores in the Taipei Basin. Additionally they not only divide the city from rivers, but also cause losing the connection between city and river. Because of the space the wall has created, highways have been constructed along the embankment, which only enhanced the separation from the water. Additionally, embankment wall along with the river-straightening of the Keelung River caused destruction of wetlands, therefore natural flood protection and environment of the river.

Streets and highways are the main infrastructure in any city, therefore it is impossible to avoid them. However their amount and scale can be controlled in order not to create a "city for cars", where numerous elevated highways in the city divide it and form boundaries within the city structure, as it is in Taipei. Keelung Road, Civic

Boulevard, Jianguo Road are just few examples of elevated highways in the city that should be eliminated or at least redesigned to diminish the barriers they have created. This form of commuting structure, wide roads and highways, additionally to dividing, they also discourage slower form of transport as cycling. Big transport arteries are dangerous and unhealthy for cyclist, therefore cycling is mostly common in recreational areas like riverside parks or outside of the city. The problem seems to be in transportation hierarchy. The city is constructed mainly for car use; however the priority should be reversed to people, cyclist, scooters and automobiles.

Transportation problems occur along with development. In Taipei it progressed very chaotically and started to emerge in the worst locations for the cities and natural eco-system, on the mountain hills. Situation like this are caused mainly by rapid population growth. Increasingly the density has changed the city, starting from the sudden necessity for transport and road infrastructure improvement, because of increased car use, which led to air pollution, and the formation of greenhouse effect. Those factors significantly changed the city into being overpopulated and unlivable.

However, among the city's advantages and problems, Taipei is a city of opportunity. Almost every element that is beneficiary and often problematic at the same time contains prospects. For example natural environment is rich in biodiversity and is prospering, this creates a great opportunity for restoring the city ecosystem. The connection of the city eco-system and surrounding the environment can be made by Green Fingers that already exist in the city. Different connections are possible through the rivers, since they allow for eco-system development. They are the source of life, therefore establishing better access by reconsidering the form of embankment walls, can help restoration and additionally, would restore the connection to the river that always was very important for people of Taipei City.

Liugongzun is another example of great opportunity for the city. The canal is part of the history of the citizens of Taipei, therefore, if regenerated it would become an active part of the eco-system and enhance the diversity as a source of water; and if uncovered would increase the sense of social integrity as a part of common history and heritage. The attempt to enrich social sustainability is significant, and could be done by creating opportunities for activities that are beneficial for society and the city, such as community

gardening. Citizens of Taipei do engage in the projects, hence providing more spaces would increase social relations and interactions, along with a sense of common responsibility and social sustainability.

Another aspect that creates many opportunities is development, uncontrolled and chaotic development is destructive and harmful, however controlled and pointed in the right direction, it can have healing and repairing effects. In the city the structure constantly changes, which creates opportunity for land reuse and regeneration in certain areas part by part. Certain streets, highways and lands could be regenerated, especially because of the advantageous gird that creates an opportunity for new green streets, green belts, and corridors. Planning the space would lead to using space more efficiently and accurately.

While planning, it is also important to consider the threats. Taipei City is located in a basin that, due to numerous rivers, interventions in their banks route easily become flooded especially during heavy monsoon rains and typhoon season.

Certain threats are unpredictable, however the ones caused by human interaction are, and it is possible to diminish them. For example water and air pollution is dangerous for an entire eco-system. If it is going to progress, the greenhouse effect will worsen, and will affect the city's environment, eco-system and living conditions. Even though the Taipei City Government is making an effort to decrease the pollution, it still exists in the air and water.

Another threat that is predictable, and should be controlled, is development. As mentioned, uncontrolled development destroys the environment, spoils the city structure, and in many cases is damaging to the city eco-system and its surrounding environment. Emerging constructions on hillsides, parks or urban sprawl in areas that should be protected, are in the most serious danger for the city since it changes the area for indefinite amount of time. Buildings appear in places unfavorable for city regeneration, and often occupy very significant places in the city. Therefore, the development has to be planned in order to avoid unnecessary land loss.

A modern city like Taipei has to cope with many difficulties. Every element that has contributed to its existence also has various negative influences. Geographic location of

Taipei serves as naturally protection from outside threats, however at the same time creates an easily flooded valley. Development, and spread is one of the sources of destroying natural ecosystems, hence the city eco-systems. Transportation and roads providing access to many important locations, all play a very important role in development. However at a certain point, instead of connecting the city, because of the size and capacity, they started to divide it, and this in the end became one of the reasons for its pollution.

On the other hand Taipei is a city that already has some of the eco-city qualities; people participate in community gardening, recycling, biking, and the city is undertaking different actions to decrease the air pollution; for example, creating clear air zones. The willingness to, change the city for the better, diminish the threats and improve the positives, present possibilities that can be enforced by an urban eco-regeneration.

The eco-regeneration proposes solutions that would help to solve the major problems of Taipei City, which are:

1. **Air circulation:** All factors and places that influence the air circulation process have to be acknowledged in the plan. Namely, green fingers, adjacent areas and green belts and any corridors connected to them, and consequently the entire city aeration system (wide streets, open spaces, parks, riversides etc.) also needs to be considered. To significantly maintain clean and open airflows; regain connections between city and surrounding environment, and most importantly maintain those connections as clean, natural and unpolluted is the goal. Thus protecting green fingers and creating the possibility for city eco-system to develop by re-designing/adapting wide streets as green belts and eco-channels is advantageous. Since those places are the only sources of fresh air; it is in the city's best interest to manage them consciously. Moreover, perhaps considering the Master Plan for Taipei of 1932 and implement the ideas of a "Park Roads" system would suggest certain solutions, since they not serve a purpose of transportation, landscape or recreation functions, but more importantly they are significant aspects of disaster prevention, disaster relief and evacuation functions. In general, solving air circulation problems would cause different changes and numerous adjustments in the city, starting with

establishing protected areas, creating or improving air- and eco-corridors with adjacent open spaces.

2. **Flood prevention:** because of geographical location, and human intervention in river banks, Taipei has become a high risk to floods. Creating more open spaces near riversides, especially where a river's flow has been changed, would provide an additional zone for the river to flood, in a place planned in advance. Additionally, redesigning or modifying of embankment walls should be considered in order to form space that would serve a different purpose and create interesting and more useful function than a 9-meter wall with highway near it.

3. **Capacity**- Speaking of regeneration of the city it is important to mention capacity. It is very important in the concept of an eco-city. Although it is difficult to establish an exact number, it is possible to attempt to define a limitation by growth management control. In the case of Taipei it seems that the city has exceeded its capacity, simply by looking on its boarders and range. Map 2 presents simplified boundaries of the city, which should not be crossed. It represents a general line for city structure. Crossing that line would effect, in developing the areas ear mountains that are so important for the city; damage the eco-system. Growth management also controls the population density and land use. Spreading the city structure on the land is only one aspect that has to be covered by management under "smart growth" policy. Land capacity is its inherent element, since it controls amount of built structure and within population. Capacity is strictly related to transportation, since the better the street connections, the higher the capacity of the area. When roads in the city are not capable to the fulfillment of this function, the city may construct underground transportation systems. The Taipei Metro system, since its opening in 1996, has opened 9 lines, of over 100km. The point of constructing subway system was to decrease the traffic on the streets. However, creating additional underground transport systems, and maintaining wide streets in the same form they were before the MRT (Mass Rapid Transit), only encourages private car use, since streets are unloaded. Therefore, to remain balance within the city, perhaps by locally increasing

density, which would decrease the need for transport. Additionally, transport should be reconsidered, by "returning" parts of streets to the city and people.

4. **Transport**- Many roads, high-quality road network, traffic laws are effective. When congestion process appeared the city government responded with applying new policies in traffic light sequencing, traffic information system, and creating access points around the city (Friederich, Jaunky, Xu, and Vohra 2011) Is this the approach of the city? If the road network is not sufficient, the way to deal with it is to build more roads? Perhaps the solution is to encourage people not to use cars, create policies against private automobiles in certain areas of the city, or as in Warsaw by limiting parking lots and increasing the parking fees and in certain areas only city authorities and inhabitants of that area are allowed to enter. In Manila for example, according to *the Department of Transportation and Communications (DOTC)*, the scheme says for a certain day of the week, some vehicles are prohibited. Specifically: on Mondays, , vehicles with plate numbers ending 1 and 2 are not allowed, Tuesdays - 3 and 4, Wednesdays - 5 and 6, Thursdays - 7 and 8, Friday - 9 and 0 due to major traffic problem.

5. **Society. A c**ity consists of many various elements that change, evolve or disappear with time, the only constant is people. They are the core of every city; therefore their participation in the city repair process is crucial. Citizens can contribute to regeneration by promoting and helping to build for example eco-communities that help to develop social sustainability and increase cultural and social diversity in the city. Additionally, inhabitants could participate and support the regeneration of their city by, taking part in community garden programs, promoting cycling over automobiles, as for instance Village Homes, BedZED, or Cotati Co-housing inhabitants. However those requirements cannot be included in an eco-regeneration since they are strictly dependent on the people. However city government has the opportunity and possibility to inform citizens about up-coming city repair plans, and

by explaining the entire process, informing people of how and why they may contribute to the city.

4.1 Strategic Locations

In order to repair the system it is not only necessary to understand its problems, and their sources, but also to know from which point to start the process. The analysis of Taipei City, its environment and inner situation suggests the following locations (Map 2): Green Fingers and Green streets, Beitou (北投), Guandu plain, the Shezi island, Treasure Hill, Songshan airport, Civic Boulevard, and adjacent to it, Taipei Workshop.

The locations have been chosen because of their significant influence on the overall system, namely: location, connections, and function and the effects, every selected location is different, and their roles are various.

The fundamental connection system is based upon the triangle of corridors (Keelung Road, Civic Boulevard and Roosevelt Street), connecting three locations, that will join the eco-systems of Keelung River, Xindian Diver and Danshui River. This structure will be the main "circular" corridor that will serve as an inner city greenbelt to which many other corridors, green streets etc. could be join with. (Map 2)

Since the "circular" corridor connects the east-west and south of the city it is important to create a north point that could provide a connection. Songshan Airport's location is perfect for it, especially because of the riverside park proximity, and by adapting[15] it to new functions.

[15] If the plan proposed in 2002 of closing Songshan Airport would succeed, what this eco-regeneration encourages.

– **Guandu Plain (關渡)**

The Guandu plain is an important location for few reasons: flood prevention, its environmental value and air supply.

The site is located at the foot of the Yangmin (陽明山) and Datun (大屯山) Mountains. The elevations of the land are somewhere between 1 to 2.5 meters and the highest point of the site is at the northeastern corner, with the lowest point being at the southwestern corner of the site. During the rainy season a two-hour rainfall could easily create flood problems in the southwestern corner of the site. Building embankment walls to protect the plain, as city government proposes, could cause even more severe flooding in the city, since yet another river would be deprived of its flood plain area. This site is a flood plain located at the intersection of two rivers surrounded by mountains on the northern and western sides. The area includes a 57-hectare Guandu Natural Park and designated Natural Reserves, a very important bird sanctuary outside the levee along the river. Even though, Guandu Plain has not avoided pollution. The pollution was caused by the natural spring streams within the site. Studies show that the Arsenic pollutant of over 60 ppm in some areas, but most of the land area is under 60 ppm. Domestic wastewater is the other source of pollution in this area. This area was mainly used for agricultural purpose in the past. Therefore, abundant ecological resources have been kept safely within the planning area. These include irrigation streams, a bird sanctuary, and a natural reserve and rivers. One of the issues of developing Guandu Plain is how the development would affect the natural ecological system that has existed for hundreds of years on the site.

In addition, a transit line runs along the edge of the area. Guandu Plain is the last large piece of agricultural land that the city holds this land has been held for decades without allowing development to occur. However, the landowners' pressure for development has grown tremendously in recent years. There is a fear that the development of Guandu Plain will change the micro-climate of the city, mainly because (as Figure 15 showed) there are two areas of fresh air flow into the city, and one of them is in Guandu Plain. Hence further development would limit incoming airflow. Furthermore Guandu plane is a good location for a renewable energy farm, since most of the GHG comes from electricity generation, enforcing a GHG Emissions Reduction Plan,

in the eco-regeneration would also provide space for renewable energy resources like solar, wind or hydro and tidal energy in this area.

Guandu Plain is a very important location for Taipei City, it not only contains a natural environment, belongs to one of two main air inflow routes, but also is one of the regions where the rivers flood during certain seasons. Developing this area would require a great amount of funds, and would bring additional problems to the city. The Guandu Plain is one of the ecological "windows" for the city of Taipei, therefore should be acknowledged during eco-regeneration.

– **Civic Boulevard Expressway (市民大道)**

On map 2 are presented green streets and their connections, however there also are marked (red circles) dead ends that need attention and change. Most of the green streets end at Civic Boulevard Expressway. It was completed in 1997 as part of a multi-modal reconstruction project to improve transportation. The highway begins at the MacArthur Bridges in the east (connecting the Neihu district, and Keelung Road), heads west to an interchange with the Zhongxiao Bridge and the Huanan Expressway, (providing direct access to Taipei Main Station). In addition Civic Boulevard is elevated, it is also a surface-level frontage road system below the highway, connecting intersecting arterials with highway ramps. As part of the larger project, the elevated Civic Boulevard Expressway was constructed to provide a new, east-west highway through Taipei, moving the Taipei Railway Administration's railroad tracks underground to reduce congestion at surface railroad crossings, and providing new underground parking options.

Although construction of an elevated highway could be a relief for traffic, considering the ecological aspect, it is damaging for city eco-system. Due to developing the underground subway system, is an elevated highway in the center of a city really necessary?

Map 2 demonstrates the possible corridor fluency. The entire system could function if based on main artery connection to blue vein or green fingers, and then joined with many smaller green streets. Civic Boulevard due to its location, east-west

route, width, and different important part of the city it run across, could be turned into the “spine” green belt, the core from which regeneration could start.

– **Songshan Airport**

Songshan Airport is one of the biggest open air spaces in Taipei City. It is adjacent to the Keelung River and major streets Fuxing North Road (復興北路) and Minquan East Road (民權東路), potential green city veins that directly connect the north and south of the city with roads and the MRT subway system. This unique and valuable city location, with river proximity and corridor connections, is being wasted on an airport, when it could provide numerous and various functions for the city.

The airport is situated in the center of the city. The fact that the land has a very good and convenient transport connection, and is near the river shore, makes it an attractive and valuable land for investment, especially since the 2002 plan of closing Songshan Airport was proposed. Additionally, since the Taiwan High Speed Rail could quickly take up the traffic load between Taipei and western Taiwan cities, and the remaining service to outlying islands and eastern Taiwan could be easily taken over by the Taiwan Taoyuan International Airport after the completion of Taoyuan International Airport Access MRT System in early 2014. This rapid transit system will provide direct and convenient connection between Taipei and Taiwan Taoyuan International Airport. Therefore, the MRT system will make the international potential of Songshan airport less attractive.

One of the concepts for airport reuse was land regeneration that included developing land into road way, huge park, a detention basin and a sports arena, however much more could be done. Songshan Airport covers an area of 182 hectare, therefore it is large enough to be multifunctional. It could be the biggest park in Taipei city and because of its proximity to the Keelung River would be connected with its riverside parks. Because of its size, the land could contain forest, open spaces, recreational areas, and zones for land reuse or citizens activities. Additionally, the design should include land functions as part of a flood prevention plan, without the construction of embankment

walls. Not only does the airport area require attention due to change of land function, the surrounding buildings and plots are in danger of rapid development, since proximity to the airport forced limited-height buildings. Current building structure around the airport would be beneficial to future regenerating functions, because low dwellings would not interrupt airflow into inner city.

Possibility of closing Songshan Airport creates great possibilities for the city. Changing this area into a large park of various functions, connecting it to the city's eco-system, along with wise land management of the surrounding area, could be a great contribution to the natural environment and Taipei itself. In addition it would play a very important role in the city regeneration process.

– **Treasure Hill**

Treasure Hill is a community settled in very important location in Taipei City, because of few reasons. Firstly, it is not only located nearby a river, close to a green finger, but is the connecting point between the natural environment and the city. Secondly, it is a place with famous community significance built on the terrace of a mountain, therefore represents social values, heritage and integrity for its inhabitants. Thirdly, it is located at the junction of wide Keelung road and the blue belt such as Xindian River, which creates an "air" corridor entrance into the city.

Inner city air exchange is only one of aspect concerning Treasure Hill. River ecological restoration also requires attention and intervention, which would influence local farming in the neighborhood as well. However, all undertaken actions, especially the ecological restoration of the urbanized Taipei Basin must be a solution, designed especially for needs of this location, because new technologies and solutions must concern environmental aspects and respect the way of life of the Treasure Hill veterans.

Treasure Hill is a former veterans' community in Taipei City's Gongguan (公館) area (formally illegal settlement) and is an urban farming community enclave inside the modern city. Recently, in 2010, Treasure Hill was reopened to the public as an artist village after four years of renovation. Presently the community is home to 22 families of

the original squatters; and the neighborhood includes 14 art studios, two exhibition rooms and two rehearsal rooms.

The Treasure Hill community is located by the Xindian River, which was an important lifeline for the settlement providing drinking water, fish and gravel for construction work before the river became polluted. Urban farming and community gardens have always existed together with the river. The Xindian River used to have extensive urban farms between the settlement and the river and the collective farming alongside it was as essential to the sense of community as the river itself. However the Taipei City Government prevents people from farming on the river banks. In fact it forbids any kind of plantations there, because they belong to the flood protection area.

The banks of the nearby Xindian River are used as platforms for highway bridges leaving the ground level open. The river also acts as a wind corridor all the way from the river mouth in Danshui. Additionally the Treasure Hill settlement is built on a terraced mountain facing straight south. These are ideal conditions for the effective use of solar energy. The banks of the Xindian and later Danshui Rivers could be suitable for urban wind energy farms. Treasure Hill is a structure and landscape that should be protected and preserved because of its open connection with the river[16], opening the air flow into the Keelung Road, possibility of community farming, and is a great opportunity for creating the first location of restoring citizens' connection to the river.

Treasure Hill is an example of how smaller scale intervention can influence the whole city. Therefore any plan for that community and area should consider its key location, connections and recognize the possible effects of intended changes in the city's environment.

– **Taipei Workshop**

The Taipei Railway Workshop (台 北 機 廠) is located in Taipei, Xinyi District (信義區) along Civic Boulevard (市民大道) and Keelung Road (基隆路) near Sungshan

[16] Treasure Hill is the only section of the river without embankment walls.

Tobacco Factory. It is one, if not the last great area in its district that is not a construction site and still has the possibility to make changes in the city structure. The Workshop covers an area of 19 hectares and until January 30th 2012, it was divided into 4 large work sites under the jurisdiction of 12 workshops. In addition to 4 large work areas, there are large open cranes, General Office and bathhouse, open space facilities such as basketball courts and an Auditorium.

There are quite a few railway cultural assets inside the workshop area, including an employee bathhouse that has been designated by the Taipei City Government as a historic site of the city. Facilities such as this stamping and assembly workshop, have witnessed the 100 years of history of the TRA.

The Taipei Railway Workshop (when) was relocated at the Fugang Base in the Yangmei Township of the northern county of Taoyuan and the railway leading to the workshop was officially closed. As the Taipei Railway Workshop is adjacent to the Xinyi Project area, it has become the most piece of valuable land in Taipei. This land, and the closed railway adjacent to it created a great opportunity for city eco-regeneration. The railway runs across the city. Therefore turning it into green belt could be the beginning of "green veins" for the city. The Workshop, on the other hand "opens a door" for many different possibilities in that area; for instance adapting existing buildings to new functions, as was done in UfaFabrik, organizing different activities or museums etc. that would increase diversity in the city. Considering the area of The Taipei Workshop, this space should serve as an open green and eco infrastructure, especially considering its proximity to Civil Boulevard. The Taipei Railway Workshop is a great opportunity for Taipei City to regenerate its ecosystem.

4.2Conclusion

The afore mentioned locations are exemplary. In Taipei City many other places could be chosen, however this plan approaches the matter starting at larger scale, and more influential locations. Every space represents different kinds of regeneration possibilities: Guandu Plain (關渡) repair focuses on protection and preservation of the

natural environment; Treasure Hill, additionally, covers community and social sustainability aspects; Songshan Airport presents possibilities for land reuse, and benefits it can bring to the city. Civic Boulevard Expressway brings attention to the larger arteries in the city, and shows some additional function they could provide. Taipei Workshop on the other hand, illustrates how differently land reuse could be approached. Not all land in the city has to be for new construction, since they can serve the society in many different ways.

Each space, plot and land in the city has its potential, it is significant to recognize it and use it most effectively. An eco-regeneration will propose a system for Taipei City and by providing and explaining sets of compatible solutions to selected key locations would improve and strengthen it. The repairs would not only regenerate the ecosystem, but also enhance and fortify those areas.

Chapter 5 Eco-Regeneration

The city eco-regeneration is a very broad project that before setting any strategy first requires establishing certain principles and directives that would lead and control the future plan. This thesis focuses on the city as a sustainable eco-system, analyzing its principles and guidelines in order to answer the question of how and by what means we can repair a city. To accomplish this, first of all, the city should be considered and modeled on a natural sustainable system, by acknowledging biodiversity (understood in a much wider aspect, as social, cultural, personal, biological, and structural diversity) and a set of principles of sustainability. Additionally an eco-city should establish a capacity limit, plan its smart growth and recognize peoples' function within the city. In order to achieve these all principles of a sustainable eco-city, the city should have an urban eco-regeneration combining the following elements: ecosystem as model for eco-city; biodiversity; sustainability principles; capacity limit, smart growth and people.

The preferable way to repair a city would be through an eco-puncture method since it considers a city as an organism. Punctual regeneration would create a variety of city structures and improve energy flows within a city. Each crucial location could perform different functions, for example applying brownfield regeneration, creating eco-corridors and eco-communities would have a curing effect on a city. Only properly chosen locations and their solutions could fulfill the function of healing and be an active part of city system, thereby enriching the variety of its structure. Since city repair is based on environmental harmony and correlation, every case in every city needs to be examined individually. Consideration of its unique geographical location, weather condition and surrounding environment are also needed.

In order to achieve what it is necessary in the establishment of an inner city system, it is crucial to set its directives. The system will be based partially upon the Taipei Master Plan of 1932, however, adapted to present needs and possibilities. The system has to connect city surrounding with inner city spaces in an uninterrupted way. Due to keeping the system fluent, the eco-regeneration also has to control city development. As the diagnosis showed there are certain locations in the city that should remain protected, others could be re-used, redesigned or regenerated. The entire idea of regeneration is based on using as much as possible of the existing available resources, in

order to restore the natural environment in the city and connect it with the surrounding areas, to maintain prosperity, or reuse the existing infrastructure. The plans for those connections and lands will be the basic structure of the system.

Having an exact plan for the system, the next step is to form a strategy to embody it. The main goal of regeneration is to restore the connection between city and nature and reach the point where the city is livable, functioning and balanced in its development. Repairing the city it not only about making it prosper in the way it is expected to be, but also advancing a modern, healthy, eco-aware environment for humans to understand and live.

Certain changes as mentioned could be considered not beneficial for city development, since it limits the amount of land for sale and construction. However, each city should establish development limits. The limit may be reached and exceeded, which would lead to overpopulation thus increasing the density of a city which will have direct impact on livability in the city. That does not mean limiting the growth, but balancing new developments with consideration of their effects on the city conditions and correlating it to the city eco-system. Therefore knowing the limit and maintaining city growth within it, should be the balance each city should aim for.

5.1 Ecological Principles for Eco-Regeneration

(Roseland 1997) proposes the following principles for eco-regeneration:

- "Revise land use priorities to create compact, diverse, green, safe, pleasant, and vital mixed-use communities near transit nodes and other transportation facilities;
- Revise transportation priorities to favor foot, bicycle, cart, and transit over autos, and to emphasize "access by proximity";
- Restore damaged urban environments, especially creeks, shore lines, ridgelines, and wetlands;
- Create a decent, affordable, safe, convenient, and racially and economically mixed housing;

- Support local agriculture, urban greening projects, and community gardening;
- Promote recycling, innovate appropriate technology, and resource conservation while reducing pollution and hazardous wastes;
- Work with business to support ecologically sound economic activity while discouraging pollution, waste, and the use and production of hazardous materials;
- Promote voluntary simplicity and discourage excessive consumption of material goods;
- Increase awareness of the local environment and bioregion through activist and educational projects that increase public awareness of ecological sustainability issues."

Roseland's principles should be acknowledged in an eco-regeneration process, since they cover its most important aspects. Taipei eco-regeneration process will include most of those principles and additional directives, in order to form most appropriate solution for the city. The eco-regeneration will take into account following principles: transportation principles, land reuse, land priorities, and will involve society into the process by increasing knowledge and propose possible actions inhabitants can take to support it. These principles are an addition to eco-regeneration actions already undertaken by Taipei City government. The following directives will supplement principles and will be the foundation for eco-regeneration strategy:

1 Limited capacity- or more specifically the carrying capacity of a city. This concept defines the population size that can exist and be supported in a certain environment, and can be sustained indefinitely in the aspect of food, habitat, water and other necessary resources in the environment. Population size decreases below carrying capacity due to a range of factors such as insufficient space, food availability, or sunlight, water supply, environmental conditions and living space. The application of the carrying capacity concept for the human population in the urban environment has been criticized for not successfully capturing the multi-layered processes between humans and the environment, mainly because it has a nature of fluidity and non-equilibrium (Cliggett 2001). One way to estimate human demand compared to an ecosystem's carrying capacity is "Ecological footprint" accounting. It compares historical regeneration rates (biocapacity) against

historical human demand (Ecological Footprint) in the same year (Wackernagel, Schulz, Linares, Deumling, Monfreda, Kapos, Jenkins, Randers, Norgaard, Loh, and Myers 1994). One result shows that humanity's demand for 1999 exceeded the planet's biocapacity for 1999 and grew to 120 percent (Wackernagel, Schulz, and et.al 2002). Taiwan's ecological footprint was 5.09 global hectares per capita in 1994 and had increased up until the year 2007 (Figure 21) (Wang, Chou, and Lee 2012). Taipei City's footprint in 2007 was 6.54 with a population of 22 million, and for example Japan, with population of 127 million, has a footprint of 4.73 global hectares per capita (Ewing, Moore, Goldfinger, Oursler, Reed, and Wackernagel 2010). Therefore, establishing capacity for a city, especially a metropolis like Taipei, is crucial since capacity is the foundation of an ecosystem based on balance. Capacity is related to all the resources that a population requires surviving, such as water, food, air quality and transport.

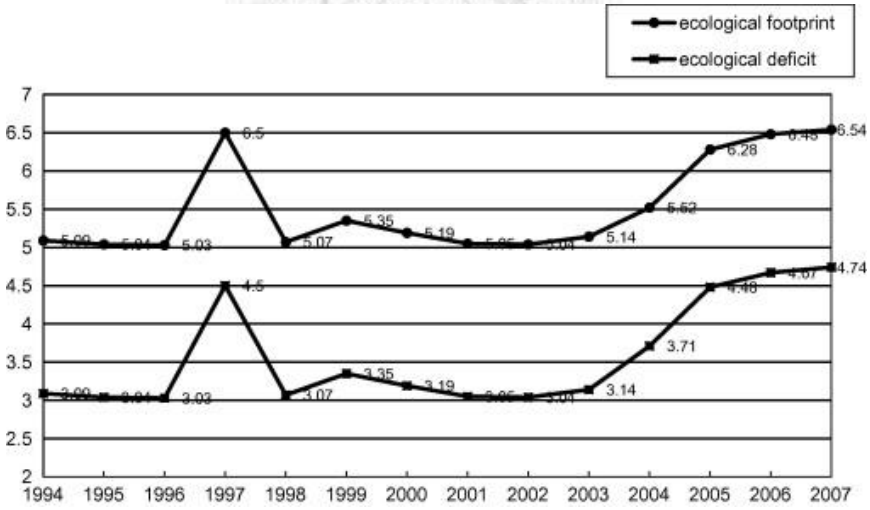


Figure 21 Ecological footprint and ecological deficit of Taiwan from 1994 to 2007 (Source: (Wang, Chou, and Lee 2012))

2 People's eco-responsibility- People should play an active role in a city's eco-system. They should not be only users of spaces but also share responsibility for it by taking care of spaces such as community parks. Furthermore, supporting a regeneration process by making life decisions compatible with on-going changes, for instance transferring to public transport, bicycles and not intensifying private car and motorcycle use, is crucial. If people want to live in a city with clean air and good

living conditions they must to devote to change, and make some eco- decisions in their lives. A city can encourage this change and definitely should, through information meetings, conferences, and providing constant access to knowledge.

3 Revise transport priorities- Cities constantly improve public transport in order to decrease private automobile use. Therefore, for instance, if there is a metro line constructed along a street, there is no need for the street to remain wide. Streets could be reduced in width and part of it given back to society as green belts, green lanes, bike lanes etc. In additional transport has major influence on air quality, thus livability and living conditions in the city.

4 Revise land use and land re-use- Taipei City needs more open green spaces and diverse environment. Hence if the local situation makes it possible, lands such as along wide streets should be reused and redesigned into parks, squares or other land providing diverse city environment conditions.

Additionally, avoid big transit roads in the city since they create barriers between communities, ecosystems and increase pollution. Land use and land reuse are directly related to city space management. City space, if managed in balanced way, provides diversity in the structure, and ensures the existence of spaces necessary for the city. Variety within the city will increase the quality of the ecosystem.

Furthermore, the smart land use also will plan places for potential community use, as community gardening, eco center, or other facility of community needs that would positively influence the society.

Land use and re-use is a great tool for eco-regeneration, since a city has a chance to revitalize its structure and system while utilizing existing infrastructure and human creativity.

5 Establish protected areas and plan smart growth – A city like every ecosystem consists of numerous elements and areas, and each one of them is just as important

as the other. However, their influence on the system can differ. Therefore the most vulnerable places of crucial impact on the system should be protected.

Hence some lands should not be meant for construction. Special attention should be paid to lands located in significant locations in the city. Areas that connect the city with natural environment, such as riversides, parks, and channels connected to large open spaces within the city should be carefully planned and protected, because they are the most vulnerable valuable for the city's ecosystem. A city needs open spaces and parks of different sizes. Additionally a city should plan its "smart growth", namely revise land use, transport priorities, establish protection and most importantly, acknowledge peoples role and priority in the city.

6 Create and encourage community gardening- People live in the city, therefore they are part of its eco-system and should take care of it. Citizens' participation in the regeneration process is essential. There are various possibilities for people to improve the eco-system, such as community gardening. It increases the sense of community and common land responsibility, therefore it is important for a city's ecosystem as land that contributes diversity and social sustainability. It is important to encourage community eco-activities, provide information centers and paces for them to contribute to the city, and themselves.

7 Create and maintain connections between nearby ecosystems – Ecosystems contain numerous smaller co-dependent ecosystems within it, and at the same time it is co-dependent on the others. Their existence depends on those connections; therefore, the links need to be continuous. Creating corridors between those ecosystems will ensure crucial diversity and biodiversity.

5.2 Strategy

Based on previously established priorities and values the strategy plan is organized according to merging top-down and bottom-up planning methods.

The top-down approach is focused on keeping the decision making process at the government level, since they concern large areas of the city. The top-down planning process is a way to make a plan. It allows government to divide a project into steps, choose techniques to align projects and goals that will be applied, and to manage their implementation.

The bottom-up approach, on the other hand, gives the project deeper and more detailed focus. The initiative starts at the lowest level, citizens in cooperation with NGO's and other organizations reach the higher level, government for approval. This approach is believed to be the most effective in small, community scale projects.

Merging top down and bottom up creates realistic plan, since they work on many levels. Therefore, large scale projects will focus on larger areas in Taipei City, namely Guandu, Shezi Island, Songshan Airport, Neihu/Nangang, Civic Boulevard and other corridors, transportation management and protection plan. Simultaneously smaller scale projects will take place, such as community gardening, green roofs etc. However, certain projects can be approached with both the bottom-up and top down methods, such as land reuse. Land reuse process, can be initiated by government or citizens and NGO's, for example Taipei Workshop.

The entire process will start with planning the basic structure of the overall system. Due to previous analysis of the Taipei Basin, its air circulation, flood control, and many other factors, the plan will point out areas of priority that immediately require protection. Next, all necessary elements of the system will be described, like corridors and their structure, location and connections with different important spaces. Additionally, an eco-regeneration will bring to attention specific places, as an example of procedure in similar cases.

5.3 Large Scale Projects

5.3.1 The System

The plan for Taipei is based on previous research, current problems and some historical plans. Analysis and diagnosis pointed out certain phenomena and problems in Taipei City. Consideration of those issues like air circulation, floods etc. their reasons (density, pollution, geographical location) and effects (greenhouse effect, hot island effect, living conditions), we found that certain simple solutions could improve the situation. For instance the Parkway system designed by Japanese in 1932, would improve livability in the city and air conditions. It is possible to partially regenerate the city using main concept. However, it is first necessary to construct a green-corridor system, it sources and routes. This can be achieved through adapting certain major existing roads into eco-corridors and air channels as a basis for the city's ecosystem connections, adjusting them to a new function and ensuring continuity. In addition, every main corridor has to be connected to open spaces in the city as part of an eco-system air circulation process.

The main requirement for the system is to maintain its fluency, thus connections between all corridors, those spaces and spaces of external fresh air supply are the protection priority.

5.3.2 Protection Plan

Protection of the areas should be divided into two zones (Map 2). The first zone is the locations excluded entirely from the development process and left it to the natural environment to evolve. While structures as temples are acceptable, since they are part of the cultural heritage, objects like residential and commercial dwellings should be strictly prohibited. Therefore, regardless the ownership of the land, if it is included in the protection area, the matter of prohibited development should remain unchanged. Generally, city development should not preceed toward mountain hillsides, especially Green fingers (Map 2).

The second zone should limit building development in order to protect the area adjacent to the first zone. The surrounding areas cannot interfere with the function of the first zone, thus the building density, and their structure should be adjusted in order not to block or minimize the airflow or eco-corridor deeper into the city.

Since the major problems that influence all of Taipei are air circulation, and disappearing eco-systems in the city, it is necessary for both zones to be unpolluted, and permeable. Thus prior to creating the system of corridors, that will carry the fresh air and connect ecosystems, it is crucial to establish their main sources. Map 2 presents those areas, namely:

Guandu Plain it is the last large piece of agricultural land and maintaining it would preserve and encourage natural habitat to prosper, which would be beneficial to Taipei City's eco-system regeneration. Additionally Guandu Plain serves as a flooding area what prevents water from flowing towards the inner Taipei Basin.

Next**,** is Neihu (內湖) and Nangang (南港) districts along the Keelung River, since they are one of two major air corridors for Monsoon winds. Hence those districts should implement certain regulations for construction development and density (for instance the area around the Songshan Airport). The same rules apply also to the Riverside parks and other spaces along rivers, because they also function as air corridors.

Space that also has great influence on the city eco-system and social diversity is Treasure Hill. The area should be absolutely protected and even enlarged. In the map of 1932 it is clear that Treasure hill by green road was connected with National Taiwan University Campus and further connected to Neibu Mountain (內埔山). This connection should be revitalized. Additionally, the riverside near Treasure Hill is one of few left without embankment, which should be its permanent state, because this is also one of the city's blue and green vein connections, where river and green corridors along Keelung Road, is planned.

Every green finger connection, river, riverside park and city system corridor, should be protected. It is crucial for the eco-system to limit the height and amount of

buildings in both zones, because it will ensure the permeability of the corridors and their functionality.

A part of establishing protected areas is including inner city green spaces as well, since they are the "green islands" within the city. Taipei City has a clear street grid, numerous small parks, community parks, protected areas and schools as marked on Map 2. However, the numerous green spaces and wide streets are not sufficient for proper air circulation within the city. The amount of green areas in the city is significantly important. If the number of them falls below 30% of the city area, it starts to be unlivable, difficult, and unpleasant to live and encourages people to leave the city in order to seek a living environment with better access to greenery.

Because of their size, there are many influential spaces such as campuses, parks and spaces like Taipei Workshop. Although there are over 20 universities situated in Taipei, not all of them have a campus the size of National Taiwan University. However every campus, school area, and public spaces such as Chiang Kai-shek Memorial Hall, Sun-Yat Sen Memorial Hall, or Da-an Forest Park (Map 2**)** create great possibilities for regenerating eco-system. Green islands in the city have to include completely natural environment. Each of the named spaces should devote a certain amount of its area to natural habitat in order to support eco-system regeneration. City has great amount of lands that if connected with each other, will create codependent and cohesive eco-system.

Considering the function of green islands, they also require protection; especially if they are part of riverside parks and are a part of the flood prevention zone. Unfortunately, that means including the embankment walls along the river shores. These create blockades. There are different possibilities of forming that kind of structures (Figure 22). High walls along the shore enforce specific space use, and limit it to parkland on the one side, and a dead zone, suitable mainly for a highway, on the other side.

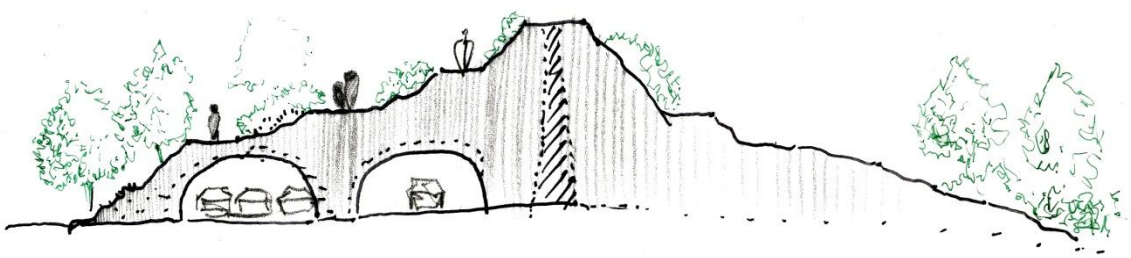


Figure 22 Exemplary Embankment Wall

Constructing an expressway in such a location creates barriers of various natures; therefore their form should be reconsidered carefully before building or redesigning.

5.3.3 Land Reuse

Changes in the city structure should happen within an area by regenerating, or re-using land, for instance Songshan Airport. If the plan of closing Songshan Airport were to be initiated, the property could be reused in numerous ways, especially considering its size. The space of 182 hectare should be changed into a natural habitat for eco-regeneration and as a recreation area for citizens. Additionally, since it is by the Keelung River, it could also function as flood control land, where land formation and design would serve as a flood prevention mechanism instead of embankment walls. Moreover, the entire area could be divided into zones of various functions such as: nearby community gardens, community center, recreation, or other spaces that would enhance social integrity, enrich diversity, and ecological awareness. Finally, due to the current function of the land, surrounding areas are under building restrictions, which should be kept, since they are compatible with the new function and its requirements. The communities in the area could be turned into eco-communities and cooperate with the post-airport land regeneration project. In addition, this park connected by green belt with National Taiwan University campus and riverside park (the way the area of NTU was designed by the Japanese in 1932) would create a north-south corridor with green fingers and blue vein connections (Map 2). Songshan airport is an opportunity for Taipei City for a great beginning of a regeneration process. It creates spaces for various functions necessary in the city landscape and for citizens, it would additionally open new corridors into the city. Hence, after the completion of land reuse processes, the entire area should be established as a first protection zone, and space around it, a second.

5.3.4 Corridors

The system is designed in order to connect the corridors, by adjustments of spaces based on minor changes, space reuse and regeneration. Air corridors, like wide boulevards, streets or rivers that provide fresh, unpolluted, oxygenated air form outside city areas such as forests, or mountains; could be joined with eco-corridors that maintain the connection between eco-systems, by applying certain solutions.

The following important resolution is a function and structure of corridors. Firstly, it is necessary to plan the system's basic structure, then establish the corridors route and priorities, and finally the structure of the corridor. The main wide streets will serve as air-corridors and eco-corridors (later named "corridor"). Roads of smaller scale, without significant further connections, could function as green streets if the situation makes it possible.

Map 2 presents the basic structure of the system, the planned airflow into and throughout the city, originating at main sources: first, from Guandu Plain, through Shezi Island (社子島) from the north-west and into the city; the second, from the East Keelung River, and through Neihu region; and then the Xindian River from the south. Air from those areas flows into corridors and is then distributed through the city by channels. Preferably the surrounding natural environment system be the source in the cities by penetrating the city and providing fresh air thanks to parks, and other green spaces. Additionally it would enrich inner ecosystems with eco-corridors and water channel assistance, like Liugongzun or rives.

However, in order to enable circulation, certain requirements have to be fulfilled. Corridors must be permeable; and connected to large open spaces within the city and green fingers on the border. Even more important is their continuity (Map 2). Air exchange in the city area is a process that requires working system, therefore all elements which purpose is to improve air circulation should be linked with each other and a fresh air source. Currently, there are many parks in the city, however, in most cases they are just green islands in the city without any connections to corridors or between other similar spaces. Furthermore not all corridors are linked to main channels, which should have their beginning in key locations, for instance green fingers or rivers.

Taipei's green fingers are connected to parks or wide streets that are linked with further avenues, alleys, parks etc. Those connecting points are crucial, and must be protected from building development. In the case of Taipei City, those areas are Guandu Plain and Shezi Island in the north and the Keelung River basin since they are main areas of fresh air supply. Furthermore, Taipei's riversides, especially near the street entrances for example Treasure Hill, riverside parks etc. have to be wide open in order to allow air inflow into corridors. These locations are crucial for proper functionality of corridor system.

Various elements in the city structure can function as corridors. In Taipei City those elements are revealed on Map 2:

- Rivers- in the case of Taipei, the Danshui River mainly functions as an air corridor providing air from north, and the Keelung River creates a channel through which monsoon winds can flow past mountains and straight into the city;
- Different water channels in the city such as Liugongzun and smaller rivers;
- Wide streets with continuous green lines alongside;
- Open green spaces in the city such as parks, schools, university campuses, green fingers etc.

Although the circulation involves streets and even highways; a corridor, in order to become a corridor, should include a green belt of constant vegetation along the entire length of the road and provide connections to nearby green islands (ecosystems in the city). Green belt should be constructed according to rain garden concept that allows rainwater runoff absorption from impervious urban areas. This idea is based on allowing stormwater to soak into the ground, and not flow into storm drains and surface waters which causes erosion, water pollution, flooding, and diminishes groundwater[17]. Rain gardens additionally to improve water quality in nearby bodies of water and can cut down on the amount of pollution reaching creeks and streams by up to 30% (Coyman and Silaphone 2011). Therefore green belt has to be undisturbed by humans, and should be treated as part of protected park.

[17] Source: University of Rhode Island. Healthy Landscapes Program. "Rain Gardens: Enhancing your home landscape and protecting water quality."

Second, establishing corridor routes and priorities is based on the fact that the system of corridors has to be based on few main "spine" roads that are connected to green fingers, blue vein etc. on both ends; and intersect with further smaller corridors, green streets and "green islands". Considering the street grid in Taipei City, their size and connections, the corridor system should be based upon following major streets (Map 2): Civic Boulevard (市民大道), Dunhua Street (敦化路), Keelung Road, Roosevelt Street (羅斯福路), Xinsheng Streets (新生 and 松江路) and Chongqing Street(重慶).

The final step of creating the corridor system in the city is forming the structure and design of mentioned streets. This could be achieved by adjusting existing streets and implementing small changes that would improve its efficiency as corridors.

Civic Boulevard (市民大道) is the most important road in Taipei City, since in begins at the Keelung River, runs across the entire city, intersects with all north-southern major streets, passes by Taipei Railway Workshop, Taipei Railway Station and finish at the Danshui River. Therefore it includes all major elements of a main corridor, in the aspect of location, intersection and size.

Figure 23 presents a typical section of Civic Boulevard. The highway's structure is designed for traffic and does not create the space for an eco-corridor function. The possible changes that would transform the major elevated highway into an eco-corridor include creating green belts by transforming the street. The goal of transformation is to connect the Keelung River and Danshui River, therefore the green belt should start and end by the riverside parks. The design possibilities of the greenbelt are various, parts of the ground level street or elevated highway can be turned into the belt. Regardless the location of the belt on the street, its continuity, connection to nearby open spaces and

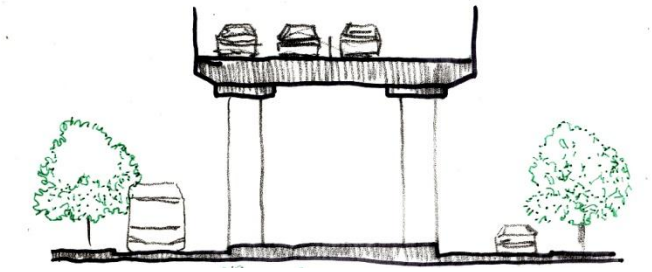


Figure 23 Current typical section of Civic Boulevard

ecological aspects of it, has to be addressed.

Dunhua Street (敦化路) runs from Songshan Airport in the north until it intersects with Keelung Road in the south near Treasure Hill and Green Finger. Dunhua Street is a very good example of an air corridor, however not an eco-corridor. There is no space for natural habitant to develop and prosper (Figure 24). Dunhua Street is street of 60 meters in width, and along the parallel of Fuxing Street there is an MRT available. Hence Dunhua Street could be narrowed to two lanes, and create space for green belts, either two on each side of the road or one bigger on one side of the street.

Figure 24 Section of Dunhua Street

Keelung Street (基隆路), even though the street is not connected to many roads (only Dunhua Street, Xinhai Street (辛亥路) and Roosevelt Street (羅斯福路), it is one of few streets that begins and ends with a blue vein connection (Keelung River and Riverside park by Xindian River) and additionally, it runs by important areas such as Sun Yat Sen Memorial Hall, city center, along National Taiwan University campus, and Treasure Hill by the Xindian River.

Roosevelt Street (羅斯福路) begins in the south of Taipei by the Xindian River and goes up north and even though it does not end in the blue vein, green finger etc., it is adjacent to National Taiwan University- one of the biggest open green spaces with its own ecosystem. It is also close and parallel to the riverside park and finishes at the intersection with Chiang Kai-shek Memorial Hall. Additionally it intersects with Keelung Street, Xinsheng Street and Heping Street.

Xinsheng and Songjiang Streets (新生 and 松江). Songjiang starts by the Dajia Riverside Park, and goes south until if crosses with Civic Boulevard and continuous as

Xinsheng street. This route is adjacent to one of the biggest parks in Taipei City, Daan Forest Park and National Taiwan University campus, another big open space and ends at the intersection with Roosevelt Street. Xinsheng road has additional advantage, namely Liugongzun that runs underneath it. Therefore, while regenerating the street it would be very beneficial for a corridor, this utilizing eco-system to uncover the water channel and include it.

Finally, Chongqing Street (重慶路) is one of the most interesting because of its beginning close to the Shezi Island. It is located nearby 228 Heping Park, then intersects with many big road in the city including Civic Boulevard, Aiguo Street close to the Chiang Kai-shek Memorial Hall, Heping Street and finally ends in the Riverside Park at the Xindian River.

Named streets are significant, and considered the best for spinal construction of a system. Most of them are part of the connection of main air-inflows with the Taipei City. However they are not the only roads that could be considered as main corridors, like Jianguo Street (建國), Fuxing Street (復興), Guangfu Street (光復), Zhongshan Street (中山), Chengde Street (承德), Minquan Street (民權) etc. also could be adapted as corridors. However further development of the system should be followed by careful analysis of the functionality of the established first few corridors.

Redesigning or readjusting certain streets would be the second important step towards regeneration. Map 2 presents the “dead ends” in secondary corridors. One of the largest and most difficult problems is to restore those connections. In many cases, it could be achieved by changing certain streets into corridors, and in others into green streets. In Taipei City many “dead ends” are at the Civic Boulevard or Keelung Street. Exemplary roads that could be considered as corridors are as follows: (Map 2):

Renai Street (仁愛路) is a good example of an air corridor, since it intersects with Xinsheng Street, Fuxing Street, Dunhua Street, Keelung Street, and ends at the 228Heping Park. Although the width and amount of trees is sufficient, it should include a biologically active green belt.

Lequn Street (樂群路) and Minshui Street (明水路) are two roads by the Keelung Riverside Park and divided from the park with an embankment wall. Figure 26 provide a proposal of connecting the Park with the city, and on the Map 2 are marked the specific locations of its implication.

In Taipei many streets are very narrow, and this limits the possibilities of the adaptation. Therefore not every road can be changed into a green street or corridor, simply because of its width or location. In this case (and even in case of every corridor) there is an alternative. Streets have to be looked at in 3-dimentional way, thus also vertically. Roads can be turned into green, not only by green belts or trees along, but also by appropriate design of the buildings. Green Architecture is the solution. Applying ideas like vertical gardens, green elevations, eco-architecture and vertical farms could also improve city conditions. The ideal concept assumes that all buildings should be designed, constructed and utilized in sustainable and ecological way. However an eco-regeneration is a process, therefore the approach should be a matter of stages, hence it implies beginning with the most necessary locations and then evolving it further. That is why, the first requirements should be established for the buildings along the corridors and green streets. Additionally, the rule should be set for newly constructed and modernization of the existing buildings as an obligatory requirement.

The frontline building of the corridors, and green streets should be a requirement to be awarded with LEED (Leadership in Energy and Environmental Design), BREEAM (Building Research Establishment Environmental Assessment Method), CASBEE (Comprehensive Assessment System for Building Environmental Efficiency) or, in the case of Taiwan EEWH (Ecology, Energy Saving, Waste Reduction, Health) another certificate that sets the standard for practice in sustainable design. Applying this law would begin a slow process of changing roads into green ways in 3-dimentional way. Furthermore, with time, the requirements would not only refer to buildings in corridors and green streets but later on it would spread into further structure of the city.

5.3.5 Transportation

While regenerating streets it is also important to revise the transport priorities, since the city should change according to its needs. Along with the development of underground public transport (MRT), the surface transport should also be adapted to the ongoing changes.

Road capacity should not increase. However since the early 2000 car and motorcycle ownership has increased, this has led to traffic congestion (Friederich, Jaunky, Xu, and Vohra 2011). Transport should be intended mainly for pedestrians and cyclist, then emergency purposes and public transport. Roads have to be walkable, and the design has to follow that need. Hence highways are not preferable structures in the city, and should not be the part of its landscape, especially near important locations like riverside parks. While constructing roads it is essential to consider their actual necessity, and location. Streets should provide access and not be a major structure in the city.

5.4 Small scale projects

People living in the city are a part of the eco-system and they should take care of it. Citizens' participation in the regeneration process is essential. There are many possibilities how inhabitants can contribute to the process, such as community gardening, initiating eco-communities, and creating green roofs.

Community gardening is beneficial to the city and a community on many levels. It organizes the community by increasing the sense of community ownership and stewardship, fostering the development of a community identity, spirit and by bringing people together from a wide variety of backgrounds. Community gardening offers unique opportunities to learn about block clubs, neighborhood groups, and other community information and also to take advantage of the experience of elders to produce food. It also provides inter-generational exposure to cultural traditions. Additionally, community gardens add beauty to the community and heighten people's awareness and appreciation for living things.

Community gardening influences also environment, because it helps to rainwater, helps to keep lakes, rivers, and groundwater clean. Additionally gardens restore oxygen to the air and help to reduce air pollution. Moreover community gardens recycle huge volumes of tree trimmings, leaves, grass clippings, and other organic wastes back into the soil but mostly it provides a place to retreat from the noise and commotion of urban environments.

Community gardening is a great way to increase the sense of community, common land responsibility, and restore the human-land relation. It is also important for a city's ecosystem as land that contributes diversity and enhances social sustainability.

Initiating eco-communities is another project that can be achieved by citizens and NGOs cooperation, like it was done in the case of BedZED. Since an eco-community might be urban, suburban, or rural, they can range in size from a few to hundreds, there are no zoning limitations. This type of community can be formed in various locations, and they should, since the main concept of eco-community is to fit into surrounding environment while maintaining certain principles. Some eco-communities are attempts to shift existing neighborhoods or towns toward more sustainable living and more of a sense of community. Others are newly built, often featuring green or natural building techniques. Eco-communities, or in larger scale eco-villages, vary a lot in their degree of community connection and their ecological focus. Therefore NGOs can spread the knowledge about an eco-community concept, its advantages to the citizens, the city and the environment.

Another type of small scale intervention is spreading green roofs or *living roof*. This concept is based on an idea that a roof of a building is partially or completely covered with vegetation and a growing medium. Considering the fact that many of existing buildings were not built to carry that big of a load, it would be dangerous to apply traditional technology of green roofs. Traditional roof gardens require a reasonable depth of soil to grow large plants or conventional lawns, and are considered intensive because they are labour-intensive, require irrigation, feeding, and other maintenance.

Green roofs can be categorized as intensive, semi-intensive, or extensive, depending on the depth of planting medium and the amount of maintenance they need.

Extensive green roofs support 10-25 pounds of vegetation per square foot. Extensive green roofs, by contrast, are designed to be virtually self-sustaining and should require only a minimum of maintenance, perhaps a once-yearly weeding or an application of slow-release fertilizer to boost growth. Extensive roofs are usually only accessed for maintenance[18]. They can be established on a very thin layer of soil (most use specially formulated composts): even a thin layer of rockwool[19] laid directly onto a watertight roof can support a planting of Sedum species and mosses.

Intensive roofs, on the other hand support 80-150 pounds of vegetation per square foot. They are more park-like with easy access and may include anything from kitchen herbs to shrubs and small trees.

Some green roof designs incorporate both intensive and extensive elements. Therefore, the technology should be adjusted to the building possibilities. However it is also possible to create living roof without intervening into its structure by installing boxes with soil in which plants will grow. That way the weight put on a roof and building is under control and it makes it possible to create a safe green roof.

It is important to encourage community eco-activities, provide information centers and paces for citizens to contribute to the city, and themselves. Inhabitants can participate in the eco-regeneration process in a larger scale as well. Land reuse is an example where citizens can initiate and create a space they need in a community, and in the city. Each city has numerous places that could be reused, and by inhabitant and NGOs' participation it can be accomplished. However many aspects have to be considered such as location in the city, the function that would be the most beneficial for the cities ecosystem, its inhabitants, and the surrounding of the location, because the eco-regeneration is about balance in the ecosystem.

The good example of a land of great potential in Taipei City is Taipei Workshop. Considering the railway cultural assets inside an employee bathhouse that has been designated by the Taipei City Government as a historic site of the city, this area could be developed into an eco-cultural center of the city. Furthermore, the space could be reused

[18] Source: Seattle Department of Planning and Development
[19] Rockwool is type of mineral wool, that is made from natural or synthetic minerals used as thermal isolation.

in a similar way as was done in UfaFabrik, by adapting existing buildings and turning them into social ecological information and exhibition center. Additionally some land could also be used as park area and community gardening. The possibilities are numerous, however, regardless of the solutions, they must enrich the city eco-system, and social diversity. The adjacent next to Civic Boulevard requires upgrading and compatibility with the nearby corridor. Therefore the land reuse plan must include a certain amount of natural green open space. Applying different special and functional solution the Taipei Workshop would be beneficial for the city inhabitants, would be compatible with surrounding corridor system, thus cities ecosystem and surrounding environment.

Chapter 6 Conclusion

This thesis proposed an eco-regeneration based on eco-puncture method using Taipei City as an example. In order to create this plan it was necessary to review the history and visions of different cities; explore the concept of sustainability and ecology to better understand the interconnection with a city; and investigate the visions, principles and purpose of eco-cities. This data served as a foundation for understanding the concept of eco-city, which is essential for planning regeneration.

City is like an organism, thus needs air, water, and also has it limits. This is the basis of understanding the system of eco-city. In its structure there are places more vulnerable but significant that need protection. On the other hand, different infrastructure like streets and rivers, are cities' veins that also require protection, just as much as smart management. City can be seen as ill organism, thus treating city as such eco-system requires a method that is based on the same principles, hence eco-puncture.

Due to examining the method, the next step led to choosing an exemplary location, Taipei. The diagnosis is the first and the most important, since during this process, the problems and their sources are being analyzed. Among numerous factors that influent the city, it is crucial to select potentially profitable ones and use them in the eco-regeneration.

Correct diagnose leads to the locations that are the source of problem and solution at the same time. Often the main mistake is dividing city from its external environment. Surrounding environment has major impact, and can be healing to the city. Thanks to restoring the connections, it is possible to repair what rapid development has preoccupied. Forming a plan that will protect, reuse and adjust the city structure is the first step of progress; hence it is more profitable for the city to enhance it by managing also new developments as well.

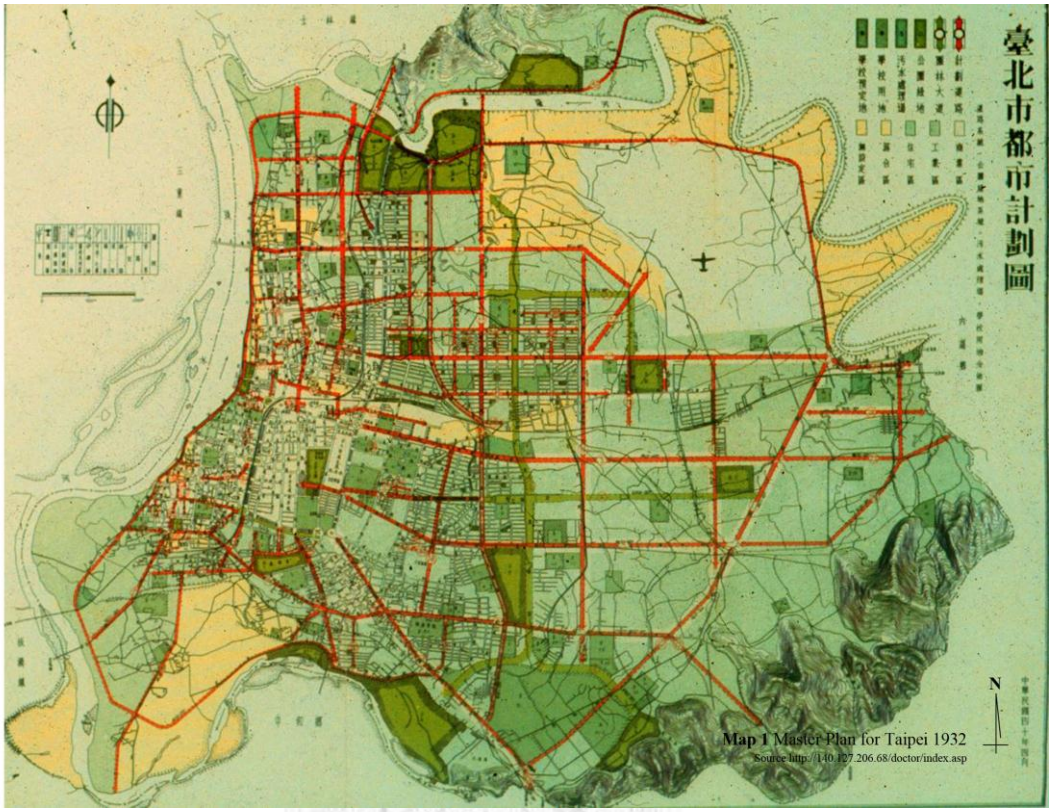
To prevent further negligence of cities, it is essential to create a plan that will control the development. Although development is the biggest opportunity for cities it is also the biggest threat. It enlarges the city structure, causing infrastructure like streets, highways and buildings to emerge excessively. At the same time thanks to development we have opportunity to rebuild and reconstruct areas of the city. The main difficulty lies

in distinguishing positive and negative development processes. City has to establish its priorities and main goal. In the nearest future city will reach its development limit and the land re-use will be probably only possible solution.

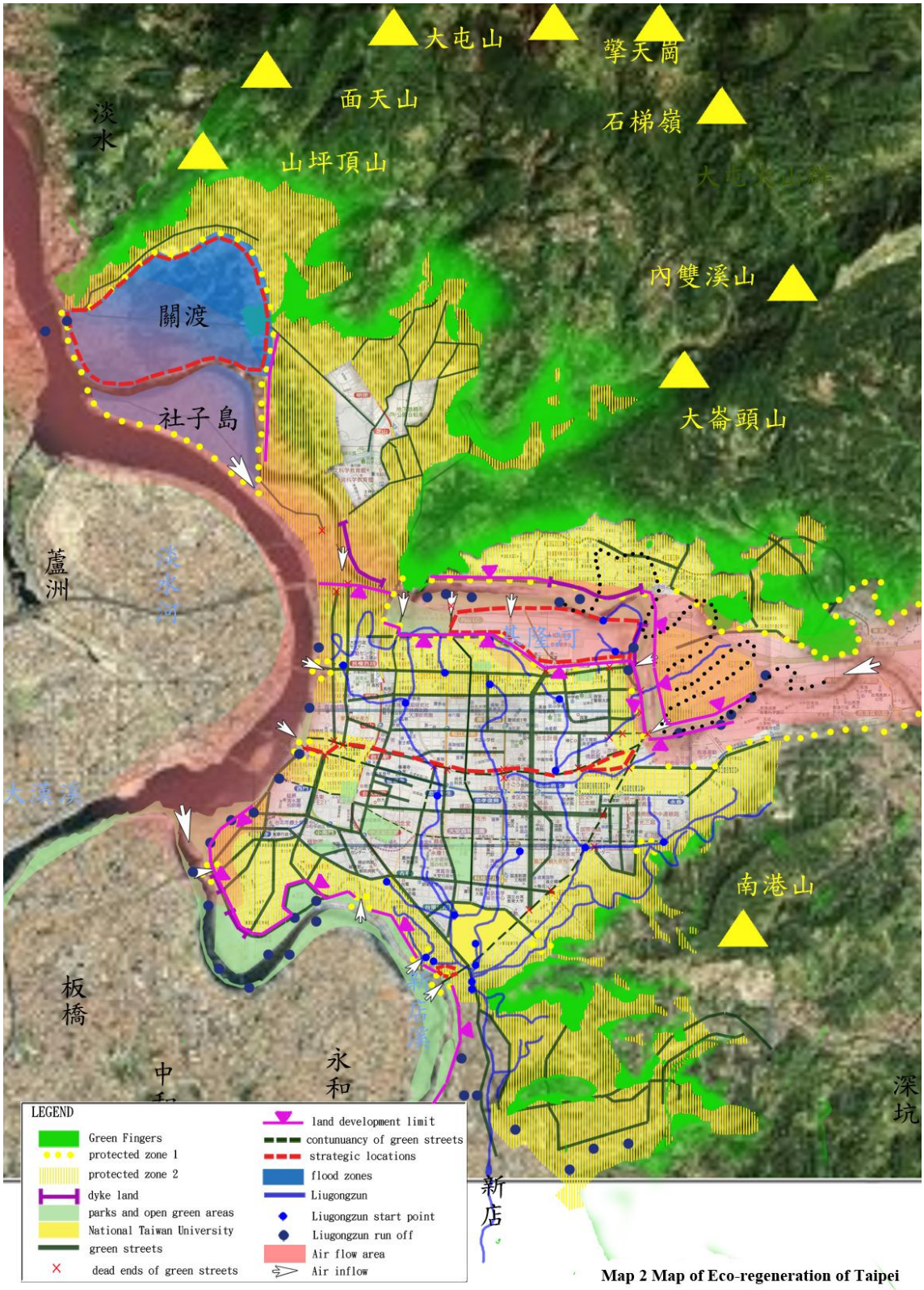
Land reuse is the major chance for city regeneration. It can be transformed for various uses with advantage, however city has to settle the principles and accept its limitation in order to use entirely this opportunity. Constant change is a benefit and should be used. Planning the smart growth can be achieved by balancing the "desirable" and necessary development. Therefore land in the city should be analyzed in the aspect of potential benefits for cities' ecosystem and its inhabitants. Only then the city has a chance to begin regeneration.

The further goal of the repairing process it to adapt city to current requirements, therefore, to make it ecological and sustainable. The key to turn cities into eco-cities is smart land management and creating opportunities for citizens to engage in the process by creating spaces that would engage local communities. In that way the complicated and time-consuming process, would take effect on many levels, city planning scale by new land governance and management; and on social level by increasing awareness and encouraging participation in the process.

Therefore, the key to begin regeneration and change into eco-city is reanalyzing a city and its environment; ensuring land and social diversity, various land re-use programs, taking care of livability; paying attention to its growth and controlling development and do not exceed capacity. However the most important is to always remember the prior established principles and goals of regeneration during the entire process.



Map 1 Master Plan for Taipei 1932
Source http://140.127.206.68/doctor/index.asp



Map 2 Map of Eco-regeneration of Taipei

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