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Conceptual Framework of Ecosystem Services in Landscape Planning, Malaysia

Yeo Lee Bak*[1], Ismail Said[2], Kei Saito[3], Gabriel Ling Hoh Teck[4]
[123] Department of Landscape Architecture, Faculty of Built Environment, Universiti Teknologi Malaysia.
[4] Department of Urban and Regional Planning, Faculty of Built Environment, Universiti Teknologi Malaysia.

*Corresponding author: lbyeo2@live.utm.my

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ABSTRACT

This paper presents the concept of ecosystem services and its trend, scale and gradient, through reviewing articles, books and internet sources. Result shows that evaluation of ecosystem services in small towns within urban-rural gradient in developing countries still not being scrutinized explicitly, especially trade-offs' concern. Environmental damages in the developing countries are burgeoning. As land conversion from natural capital to built capital is also keep on rising for temporal economic interests. Therefore, it has induced changes in ecological functions and affected the ecosystem services supply. In the context of Peninsular Malaysia, ungoverned built capitals and flaw of policy further contribute to fallacious decision making. And yet, there is still no specific framework or initiatives directly deals with ecosystem and biodiversity. A conceptual framework has been proposed to assess and value ecosystem services through integration of InVEST model (Integrated Valuation of Ecosystem Services and Tradeoffs) and bundle of ecosystem services. The framework allows stakeholders to have an insight of the pros and cons about the landscape changes, be it in ecological, economic or social-cultural perspectives. Therefore, it may help to ameliorate the trade-offs and enhance the synergies of ecosystem services that eventually can contribute to attaining human well-being, and to promote sustainable growth.

1. Introduction

To date, more than 7 billion people inhabit the Earth, an increasing of more than 4 billion of people for the past 53 years compared to 1960 (World Bank, 2014). Overpopulation has brought undesired environmental and social problems such as shortages of all resources, climate changes, war and social conflicts, habitat fragmentation, limited space and overcrowding (IPS, 2014). However, in a recent study, dense population not necessary leads to environmental problem. But urbanization appears positively contribute to environmental problems such as raise in energy consumption and carbon emission (Liddle, 2013). Rapid urbanization has inducing change of natural capital such as habitat fragmentation, reduction of cultivated fields as well as deprivation of open space for recreational uses (Shrestha et al., 2012). Thus, it has changed the ecological function and process and affecting the flow of ecosystem services that can contribute to human well-being. In fact, the consideration of urban ecosystem is becoming difficult under the growing development pressure especially inappropriate policies and ineffective planning (UN-Habitat, 2011). Meanwhile, most nations are not explicitly measured and assessed the value of ecosystem services (Seppelt et al., 2011), especially values to be factored into trade-offs' consideration (IPBES, 2013). This consideration is pivotal for making effectual decisions in sustainable planning because attempts to enhance certain service often lead to neglect of other services (Bennett et al., 2009; Grêt-Regamey et al., 2013). For example, multi-functional landscape that caters rafts of ecosystem services were converted into single-function land use that only provides a few services for temporal economic profit (De Groot et al., 2010). Hence, this paper explored the concept of ecosystem services that may assist in trade-offs' amelioration of multiple ecosystem services in landscape and urban planning which essentially can contribute to the betterment of environment, human well-being and economic progression. But the question is, to what extent of this conceptual framework can assist in trade-offs amelioration? Are certain services should be given more weight than other services in certain scenario? If improvise certain services and neglect other services, how they influence toward human well-being?

2 Concept, Trend, and Scale

We conducted a broad range of literature review from 1990s to 2010s. We explored the concept, trend, and scale of ecosystem services through books and peer-reviewed journals, particularly from the disciplines of landscape and urban planning, ecological economics, population and environment, urban forestry and urban greening, landscape ecology, biological conservation, land use policy and others. We used Goggle Scholar engine to identify relevant literature with the combination of keywords, including ecosystem services, biodiversity, land use/ cover, trade-offs, scales, model and urban-rural gradient. We integrated three conceptual ideas to assess and value ecosystem services. More importantly, our intention is to emphasize the ecosystem services assessment in developing country for better-

coordinated decision making and policy innovation. This section comprised three sub-sections. Section 2.1 explained the doctrine of ecosystem services. Section 2.2 illustrated the patterns and trends in the literature. Section 2.3 explicated the appropriateness of scale and gradients that need more attention.

2.1 Definition and Concept

Ecosystem can be defined as "a dynamic complex of plant, animal and microorganism communities and the non-living environment, interacting as a functional unit" (MEA, 2005; pp. v). The functioning of ecosystem is subjected to the balance of biotic and abiotic factors such as nutrient cycle, food chains and energy fluxes. And these functional ecosystems are pivotal to support life system whereby people utilize the properties and process of ecosystem functions to cater food and manage waste (De Groot et al., 2002).

Ecosystem functions are defined as the processes of transformation matter and energy within the ecosystems (Costanza et al., 2006). These processes of ecosystem supply heaps of benefits to human, directly or indirectly. For instance, food derives from ecosystem are the 'goods' that benefits human for consumption. While, air purification from the functioning of ecosystem processes are the 'service' that nature provided (Costanza et al., 1997). Therefore, ecosystem services can be defined as tangible or intangible goods that human derive from the processes of functional ecosystem. Ecosystem services are divided into four categories: provisioning, regulating, supporting, and cultural services (TEEB, 2010, 2011, 2012). Four type of ecosystem services are described in Table 1 but not exhaustively, for detail explanation about indicator and services description can refer to MEA (2005), De Groot et al., (2010) and TEEB (2011).

Wallace (2007, pp.241) advocates to distinguish the processes and services in valuation of ecosystem services because "ecosystem services are specifically related to human value while processes and assets do not". Similarly, Costanza et al., (2014) illustrate that ecosystem services do not generate human well-being directly through natural capital. It is through the interaction of natural capital with the social capital (communities), human capital (people) and built capital (man-made environment). In general, built and human capitals (the economy) are embedded in the society which is embedded in the rest of nature. When nature contributes significantly to human welfare, it is a major contributor to the de facto economy (Costanza et al., 1997, 2014) This signifies each and every decision makes about development, the concern should be given to society welfare rather merely looking at how best to proliferate the economy. For instance, are we going to cut down the forests to harvest its wood for the sake of economy gain while neglecting the benefits that forest ecosystem delivered such as carbon sequestration, air purification, clean water and continuously oxygen that nature is supplying? Veritably, natural capital that benefits human well-being should be given adequate weight as well in the decision-making process (Costanza et al., 1997). Essentially, the valuation of ecosystem services should be focused on how to balance all the other assets to achieve a sustainable outcome.

Table 1: *Categories of Ecosystem Services*

Type	Services Delivered
Provisioning services	Food, raw material, water, medical resources, ornamental species
Regulating services	Air quality regulation, climate quality regulation, natural hazard mitigation, wastewater treatment, erosion prevention, pollination, biological control
Supporting services	Nursery habitat, maintenance of genetic diversity
Cultural services	Recreation, mental and physical health, tourism, aesthetic appreciation and inspiration, spiritual, religious inspiration and cultural heritage

2.2 Trend and Pattern

The top-down approach was used to explore the trend and pattern of ecosystem services studies from 1990s to 2010s. Firstly, we identified the research field that still need emphasis. Then, we highlighted what dimensions that still need to explore further. For the last two decades, a plethora of research on urban ecosystem has witnessed a prominent rise of concern through the valuation of ecosystem services. Early 1990s and 2000s, many literatures have focused on the classification and concept of ecosystem functions, services and their economic value (e.g., Bolund and Hunhammar, 1999; Costanza et al., 1997; Folke et al., 1997; Daily, 2000; De Groot et al., 2002; MEA, 2003). Later on, year 2005 onward there was a great deal of literatures assess ecosystem service by monetization and commodification value which incorporated into markets and payment mechanisms (see Gómez-Baggethun et al., 2009, 2013; Leimona et al., 2015). Meanwhile, there were also studies related to ecosystem services but mainly focused on the practice of green infrastructure assessment, conceptualization, pricing (Netusil et al., 2014; Tzoulas et al., 2007; Weber et al., 2006) and management in agro-environment (Tscharntke et al., 2005). Until recently, little attention has been given to restoration and sustainable development in landscape and urban planning (Blignaut et al., 2014; De Groot et al., 2010; Foo and Hashim, 2014; Frank et al., 2012). Despite the uptrend of publications related to ecosystem goods and services in different fields, however, one domain still need more attention is the assessment and valuation of ecosystem services to ameliorate trade-offs and enhance synergy in landscape and urban planning that can contribute to future sustainable growth and development trajectories.

In landscape (land use) planning, landscape changes influence the functions of ecosystem properties and thus affecting the service supplies. Usually, the affection is not limited to particular service alone but multiple ecosystem services (bundle) provided by that ecosystem (De Groot et al., 2010). When the ecosystem services respond differently to landscape changes, this is where the trade-offs emerge. Foley et al. (2005) qualitatively illustrated three different patterns of the hypothetical landscapes to show the trade-offs of provision, regulating and habitat services. While, Raudsepp-Hearne et al. (2010) quantitatively measured the trade-offs of provision, cultural and regulating services in a diverse landscape. Both studies have shown the provision services (farming) has contributed to the diminution of other services. In this circumstance, we agree that intensive farming has degraded the environment and ecosystem. At the same time, other question arises. How about the increasing of unrestraint built capital particularly housing development affects the bundle of ecosystem services especially in developing country? Would it affect bundle of ecosystem services more profoundly?

2.3 Scale and Gradient

Ecosystems are categorized into two scales- ecological and institutional.

Ecosystem services are delivered at all ecological scales ranging from global, biome, landscape, ecosystem, and plot to individual plant. And it affects all institutional levels differently from international, national, state, municipal, and family to individual (Hein et al., 2006).

Many previous studies on ecosystem services focused in relatively broad context, for example from state to national levels (Bolund and Hunhammar, 1999; De Groot et al., 2002; Kroll et al., 2012; Larondelle and Haase., 2013; Troy and Wilson, 2006) and to international level (Costanza et al., 1997; Lavelle et al., 2006; Nelson et al., 2009; Seppelt et al., 2011; Tscharntke et al., 2005; Weber et al., 2006); despite it was qualitative or quantitative research. There are also a few studies emphasized on the municipal level (Grêt-Regamey et al., 2013; Neuenschwander et al., 2014). While, the assessment of ecosystem services on municipal level within urban –rural gradient boundary is still in lacunae, particularly at village spatial scale (see Malinga et al., 2014). So what is urban-rural gradient? Gradient implies spatial environmental patterns' variation in term of its structure and function in which usually is related to the degree of environmental changes in space due to urbanization (McDonnell and Pickett, 1990). Usually, the landscape pattern in urban-rural gradient consists of natural, semi-natural and built environments areas. Natural areas include river, forest and mountain while semi-natural areas are such as agriculture land, grazing land and mountain pasture. While, built environment includes buildings, housing, parks, recreational, commercial and industrial facilities or other constructed elements. According to Halfacree (1993), pioneer research about urban-rural continuum was deviated by Redfield as early as 1941 in which his study covered a wide range of spectrum from the remote area through the transitional areas and to the modern city. Then, modest research about urban-rural gradient continue to strive in different field of studies such as human and environment (Newby, 1986) ecosystem structure and functions (Albert, 2005; McDonnell and Pickett, 1990), and lately, there are few studies focused on ecosystem services (Kroll et al., 2012; Larondelle and Haase, 2013). Assess ecosystem services in local level offers better opportunity to reveal the richness of biodiversity which eventually can contribute to the global ecosystem (Seidl and Moraes, 2000). Lack of ecosystems assessment in urban-rural context may result to misinforming policy and poor mechanism that will affect global sustainability, particularly in social-ecological perspective (Haase et al., 2014). For instance, one of the developing countries, Ho Chi Minh City, Vietnam, transformed 660.2 km2 of cropland to built-up areas in 22 years period with the intention to attract more foreign investment. Economically, it sounds beneficial, but it may also lead to food crisis (Kontgis et al., 2014). Then, how do we determine that it is good for the human well-being? Hence, assessing ecosystem services in developing countries within village spatial scale at urban-rural areas is crucial to preclude that all the rural area riches in natural resources tardily converted to high density urban areas.

3 Problem and Policy

After identifying the trend and pattern of study, we further reviewed local (Peninsular Malaysia) literature and policy that explicated urbanization and unrestraint development problem including the case that induced harm to the environment and human. Besides, we also explained three environment related policies in Malaysia, including National Policy on the Environment (NPE), National Landscape Policy (NLP), and National Physical Plan (NPP). Many of the developed countries have recognized the importance of ecosystem services especially its value to the human well-being. To name a few, The Economics of Ecosystems and Biodiversity (TEEB- http://www.teebweb.org); Intergovernmental Platform on Biodiversity and Ecosystem Services (IPBES-http://www.ipbes.net); UK National Ecosystem Assessment (http://uknea.unep-wcmc.org); United Nations Environment Programme (UNEP- http://www.unep.org) and The Ecosystem Service Partnership (ESP- http://www.es-partnership.org/esp) are some of the organizations and initiative established to ameliorate, appraise, and safeguard Earth's ecosystem on all scale, be it at local, national or global level. Whereas, to date, in most of the developing countries, there is still no guideline and framework that directly deals with the provision of ecosystem services, especially Malaysia in the tropic region.

3.1 Problem in Landscape and Urban Planning

Urbanization in Peninsular Malaysia has been burgeoning from 54.3% to 65.4% between 1991 and 2000 and is expected will reach 75% by 2020 (JPBD, 2006). Besides, Peninsular Malaysia also has lost a substantial forest cover from 9.5 million hectares in 1954 to 6 million hectares in 2000 and slight dropped to about 5.9 million hectares in 2008 (JPBD, 2010). According to Lyytimäki and Sipilä (2009) environmental damages in developing countries are caused by the economic interests, and this phenomenon is reflected in Malaysia at the tropical region. Unrestrained development such as land conversion from forest to agriculture, infrastructures and housing has appeared to degrade the condition of ecosystem in sustaining life on Earth (Foo and Hashim, 2014). More critically, rapid development and urbanization has continually inducing changed in ecological functions and processes of natural capital (Shrestha et al., 2012). Thus, it influences the provisioning, regulating and cultural services supply. In Malaysia, one of the main concerns is the expansion of ungoverned built capitals resulting all the natural and semi-natural resources shrinking sporadically. For instance, recent evidence at Johor Bahru coastal area reclamation project, Danga Bay development that reclaimed 250 meters of land to create new waterfront developments that transforming all the mangroves and pre-existing residential areas to higher-density urban forms which have threatened the local ecosystem, traditional livelihood and cultural identity (Nasongkhla and Sintusingha, 2013). Malaysia has shown a gradual improvement in term of education, economic growth, environment quality, social and recreation opportunity, health and safety (EPU, 2012). But there are still growing evidences such as inappropriate planning of land-use and build environment has contributed to calamity such as flood and erosion (Foo and Hashim, 2014; Tan-Soo et al., 2014) and raises in energy consumption and CO2 emission (Bari et al., 2011; Hosseini et al., 2013; Safaai et al., 2010). This means, the imperativeness of natural capital in Malaysia is still inadequate, as the benefits of ecosystems services supplied still not being widely recognized. Therefore, raising awareness of stakeholder and decision makers are crucial. As strengthening the local policy in safeguarding and restoring the natural capital is also necessary.

3.2 Flaw of Policy

To strengthen the local policy and guidelines, we have reviewed NPP and two others environmental related sectorial policies there were NPE and NLP. NPE aims at "continue the economic, social, and cultural progress of Malaysia and enhancement of the quality of life of its people, through environmentally sound and sustainable development" (MOSTE, 2002; pp. 2). Similarly, NLP aims to enhance the quality living environment, conserve of natural resources, implement of planned development, as well as establish effective management system (NLD, 2011). Both NPE and NLP have established a good initiative to improve quality of life and living environment.

However, both policies did not accentuate the importance of natural capitals that benefits people in environmental, economic and social-cultural aspects. In contrast, NPP has emphasized the importance of "natural and rural landscapes should be conserved for the supply of oxygen, recreation, and enjoyment" (JPBD, 2010; pp. 2-12). And to achieve sustainable development, contemporary conceptualization was formulated (JPBD, 2010; pp. 2-3). At this point, we did not completely agree that society is dependent on the well-being of the economy as stated by the sustainable concept. The reason is, built and human capitals (the economy) are an integral part of society and embedded in the rest of the environment (Costanza et al., 2014; pp. 153). This indicated, the well-being of society is dependent on the well-being of environment instead of the economy. Perhaps, due to this reason, Malaysia's forest covers were declining and fragmenting since 1954 (JPBD, 2010). In this situation, we opine that a framework is necessitated especially in landscape and urban planning, biodiversity conservation and resource management to raise awareness among stakeholders the importance of ecosystem services. Subsequently, rectifying the sustainable concept and instilling ecosystem services studies into Malaysia's policies are rather crucial as well. We do not urge to promulgate the policy immediately. Instead, we provide a terminus a quo to think policy in a real sustainable way.

4 Conceptual Framework

Due to the sequent problem in landscape planning and inappropriate concept of policy explained in Sections 3.1 and 3.2, respectively. We proposed a conceptual framework to evaluate the trade-offs of ecosystem services in Peninsular Malaysia. To assess and value multiple ecosystem services, we integrated InVEST model and bundle of ecosystem services that demonstrate the landscape changes (transformation). The changes mean the decision of the stakeholder to conserve, develop or plan the existing landscape. And each decision they made can have future impacts, and this can be captured and analyzed through the use of simulation models (Nelson et al., 2009).

4.1 InVEST and Bundle of Ecosystem Services

In order to attain human well-being, natural capital needs to interact with social, built and human capitals (Costanza et al., 2014). For example, the transformation of rural area to urban housing area. How to estimate the value of ecosystem service that contributes to human well-being? Is it better to investigate on single factor or multi-factors? Often, it is inadequate to look merely on single perspective, for example the nature. Rather, it should also look into the communities, people and their man-made environment. In fact, concentrate on managing a particular habitat like treating the symptoms rather than provision for sustainable land management (Hostetler et al., 2011). Hence, to evaluate multiple ecosystem services within different landscape and capitals, we can adapt the concept of InVEST model. InVEST consists a suite of models that use land cover patterns to estimate ecological, social-cultural and economic values of ecosystem services provided by the natural capitals (Nelson et al., 2009). It aims at modeling multiple ecosystem services, biodiversity, and trade-offs, spatially (De Groot et al., 2010). The evaluation of InVEST model is profound, but the prognostic modeling presented single factor (service) only, such as water quality, carbon sequestration, market value of commodity production, soil conservation, storm peak management and biodiversity conservation due to landscape change (Nelson et al., 2009; pp. 8). In this circumstance, we suggest to integrate the InVEST model with the conceptual framework of Foley et al., (2005) looking at how the landscape changes affect bundle of ecosystem services as shown in Figure 1.

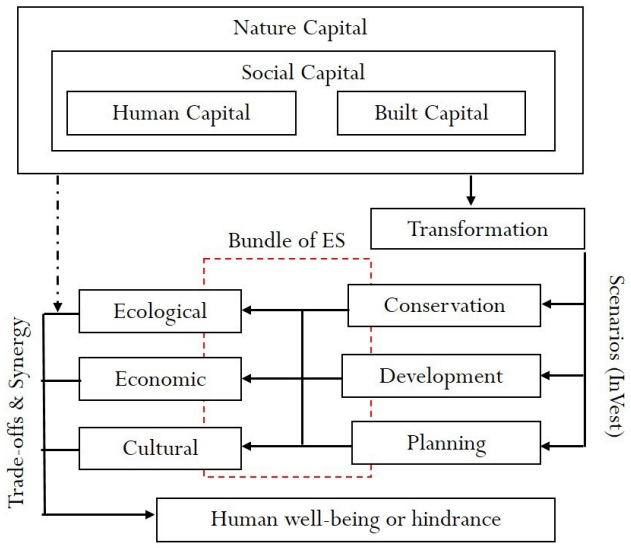

Figure 1: *Affection of landscape changes with three different scenarios toward the bundle of ecosystem services. Bundle of ecosystem services includes all the services shown in Table 1.0.*

(Source: Adapted and modified from Costanza et al., 2014; Nelson et al., 2009; Foley et al., 2005).

Foley et al., (2005) proposed three hypothetical landscape patterns: (i) natural ecosystem, (ii) intensive cropland, and (iii) crop land with restore ecosystem service to estimate the trade-offs of bundle ecosystem services. Firstly, conserving natural capitals can provide many benefits and support many ecosystem services such as regulate climate and air quality, preserve biodiversity, maintain forest production, regulate water flow and quality, carbon sequestration and mediate infectious disease. Secondly, intensively conversion of the natural ecosystem to agriculture can provide maximum crop production and high financial gain, at least in the short term. But this will hamper other services. Thirdly, the approaches to manage a cropland explicitly together with the natural ecosystems yield.

The conceptual framework proposed is suitable in any context and scale. The framework will be used to forecast the aftermath of urbanization and rapid development towards bundle of ecosystem services in Malaysia. For example, it can be used to evaluate the trade-offs between provision service (food), regulating service (temperature) and cultural service (recreation) within three different trends: conservation, development and planning. Each trend will infer bundle of ecosystem services differently. This allows, stakeholders to have an insight the pros and cons of each decision they make, be it in ecological, economic or social-cultural perspectives. Therefore, it is easier to identify whether the transformation of land can lead to human well-being or perhaps, a hindrance. Our further intention in this conceptual framework is to offer a pragmatic way to evaluate ecosystem service through spatial mapping (Frank et al., 2012) which include multi-criteria evaluation and analytical hierarchy process. But, the conceptualization of the methodological framework is not the main concern in this paper. Therefore, the methodological framework of spatial mapping techniques will not be elaborated.

5 Preliminary Review of Study Area

We selected Malaysia as our preliminary study area because it is one of the developing country, to-date. Malaysia is located in the equatorial zone separated by the South China Sea into two regions, Peninsular Malaysia and East Malaysia (Malaysian Borneo). Malaysia's ecology is diverse, riches in both flora and fauna. And it is categorized as one of the countries comprises the highest level of biodiversity (Caldecott et al., 1996). However, inappropriate landscape planning (see Section 3.1) and ineffective environment management and multiform policies (see Section 3.2) has continually contributed to the degradation of ecosystem and biodiversity. The conceptual framework established will be used to examine the ecosystem services delivered in small towns of Peninsular Malaysia. But, before that, we need to identify all the small towns in Peninsular Malaysia first. When we reviewed the potential study areas, four steps were being deliberated. Firstly, the site should be a small town. As asserted by previous literature and syntheses of ecosystem services, assess the ecosystem within local boundary offer better opportunity to reveal the richness of biodiversity and produce a more accurate mapping that will benefits policy maker in conservation practice and contributing to the global ecosystem (Foo and Hashim, 2014; Seidl and Moraes, 2000). Secondly, the landscape of the small towns should consist both urban and rural characteristics as suggested by Haase et al., (2014). Because the assessment of ecosystem services on urban-rural gradient's towns can be helpful to stakeholder to draw the right decision especially on selecting trade- offs. Thirdly, we extracted the information of small towns from the map of Peninsular Malaysia (see JPBD, 2006; pp. 38). Approximately 114 small towns have been identified across the Peninsular Malaysia that falls under different level of conurbation. For detail classification of conurbations can refer to NUP (JPBD, 2006; pp. 88-93). This paper specifically focuses on municipal level as discussed in Section 2.3 hence district growth conurbation with population ranging from one hundred thousand to three hundred thousand (JPBD, 2006, 2010) is more suitable to be the potential study areas. Lastly, Muar, Batu Pahat, Kluang, Manjung and Temerloh are the selected potential study areas as shown in Figure 2. While pertaining the landscape characters such as forest cover, water body, agriculture, and housing area, Muar and Manjung districts have shown more diverse landscape pattern compared to others. Therefore, we recommended to explore and assess ecosystem services within this two areas. Both towns

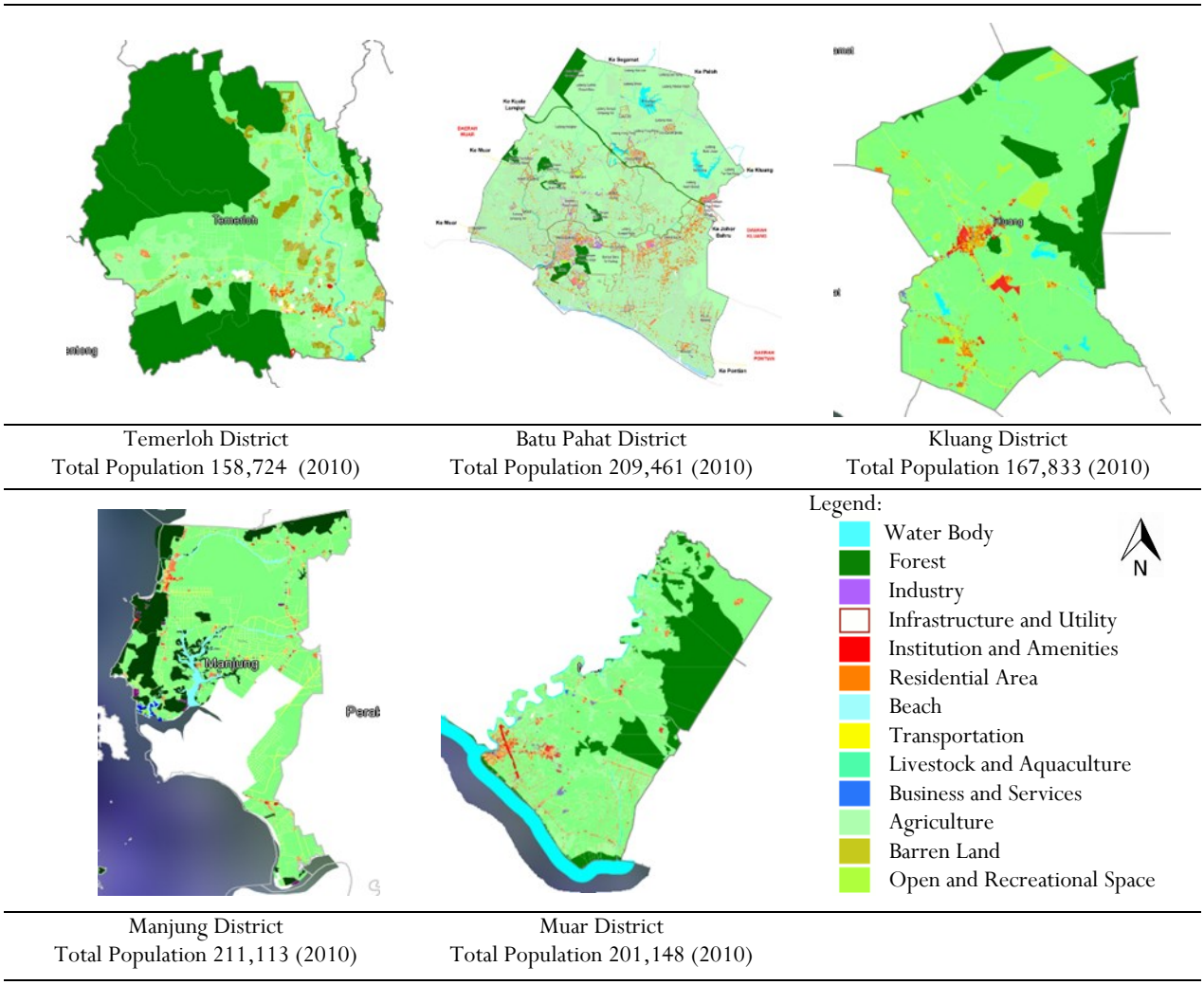

Figure 2: *Spatial land use maps of district growth conurbations*

are still covered with substantial natural resources and therefore it is important to cue the stakeholders the significant to conserve and manage it in good order. Nevertheless, this does not mean other towns are a notch below. In fact, those highly urbanized towns should concern on how to restore the natural resources to balance all other assets for the long run.

6 Conclusion

We have accentuated the importance to assess and value ecosystem services in small towns in developing countries within urban-rural gradient to preclude further detriment of biodiversity. Developing countries often favored to the immediate economic interest. For example, rampant development to attract domestic and foreign investments. We are at a critical point where biodiversity loss is occurring daily due to increasingly human needs, unrestraint development and unsystematic policy.

This paper answered the research question of the established conceptual framework to assist in ameliorating trade-offs. The conceptual framework (Figure 1) laid out here provide a platform to evaluate the changes of land pattern affects the bundle of ecosystem services. It also uses to facilitate the development strategies in landscape planning through projecting future impact in visualization form through the use of mapping. In this way, it assists stakeholder to identify trade-offs and synergies, subsequently provides alternate choices to maximize synergies and reduce trade-offs. Stakeholder's decision and public needs play an important role to determine the weightage given to different scenarios in landscape planning. If the towns are looking to achieve high biodiversity, riches both in flora and fauna, then the built environment will follow conservation trend. In contrast, if the towns are seeking to generate high economic profit, then development trend will be adapted. However, this trend will result to neglect other ecosystem services significantly. Due to this reason, the ultimate goal of ecosystem services concept is to protect people welfare, safeguard ecosystem and biodiversity and simultaneously to generate long term economic profit. And this can be achieved through planning trend. One of the constraints in this framework is it includes too many factors and therefore requiring a large amount of real world land use/ cover and socio- economy data. Because of that, the framework is not final yet and need to adjust and upgrade from time to time. Anyhow, the output of the framework can use to assist and guide stakeholders to attain better decision and eventually produce a more coordinated environmental policy in landscape and urban planning. Therefore, architect, engineer, landscape architect, urban planner, developer and other practitioners have a uniform standard to follow. Besides, it also aids designers to develop a more livable built environment and community with multiple functional ecosystem services that provide health and well-being benefits to society. Meanwhile, calamity such as flood and erosion, energy consumption and greenhouse effect can also be mitigated indirectly.

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