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Review

Ecological connectivity framework in the state of Selangor, Peninsular Malaysia: A potential conservation strategy in the rapid changing tropics

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Ecological connectivity refers to the structural and functional connectivity of landscapes that facilitates suitable habitats for flora and fauna. The state of Selangor, peninsular Malaysia, is hosting a natural mosaic of landscapes ranging from montane, hill, lowland, peat-swamp, and mangrove forests to lake, river and coastal landscapes. This is a unique feature in the tropics and valuable habitat for diverse flora and fauna. It is reported from many studies that a considerable number of the species are vulnerable and endangered. This unique region has been facing tremendous pressure from anthropogenic activities. Commercial agriculture, urbanization and industrialization are causing a massive threat to sustain its unique natural heritage. Understanding the need for restoring connectivity within its natural habitat is important to conserve the uniqueness of such tropical landscapes. Therefore, this paper discusses (i) the understanding of importance of the ecological connectivity within the remnant habitats for restoration and conservation planning and (ii) the approach to develop a framework for ecological connectivity network through bridging science and policy. Though Malaysian National Physical Plan grossly identifies the issues but scientific assessment is lacking there. This study will give a guide line to the understanding of the importance of ecological connectivity network, in one hand, and it will help to develop an approach for the ecological connectivity network in such rapidly changing region in the other.

Key words: Ecological connectivity network, functional connectivity, structural connectivity, conservation, landscape planning.

INTRODUCTION

Safeguarding biodiversity and natural habitats are the prime objectives in conservation planning. Spatial connectivity of natural habitats is necessary for biodiversity conservation (Lindenmayer et al., 2006; Matisziw and Murray, 2009). Though some unwanted situation may prevail due to the connectivity network (as for example, Turner et al., 1989), but the approach is still important for ecological integrity of natural ecosystems (Merriam, 1991; Foreman et al., 1995; Fagan, 2002; capturing concentration of policy maker while global FitzGibbon et al., 2007). Such a concept has been transitional “Macro shift” (Laszlo, 2001) forced the world to a severe ecological, cultural and socio-economic crisis. Perhaps there is no other choice but a strong breakthrough is required towards a “sustainability revolution” (Naveh, 2007).

It has been argued that the arrangement of ecological units (that is, patch mosaic) is also important for the integrity of natural landscapes e.g. protected areas (see Blaschke, 2006).

A decade ago, assessment of the integrity and suitability of habitat convinced ecologists that the spatial context is crucial (Wiens, 1997). Further-more, the connectivity of habitat areas increases the effective size of existing protected areas and plays a critical role in

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species persistence. It also has long been known that loss of connectivity within habitat patches can lead to localized extinctions (Carroll et al., 2004). The scientific concept of ecological connectivity network that allow the ecological flow, movement of organisms, has become popular in recent decades (Jongman et al., 2005; Jongman, 2007). Furthermore, this network concept is especially applicable in highly fragmented landscapes where species behave as metapopulations (Jongman, 2007), such as in the tropics. Southeast Asia, the hub of biodiversity which is degrading rapidly due to commercial agriculture and urban sprawl (Laurance, 1999; Laurance et al., 2004; Achard et al., 2002; Lepers et al., 2005) is also in need of such network. It is also alarming that protected areas in this region are facing severe habitat loss in and around their legislative boundaries (DeFries et al., 2005). The state of Selangor, Peninsular Malaysia has also been facing similar threats in the natural landscapes (forest and wetland landscape) through anthropogenic activities especially by commercial agriculture (Abdullah and Nakagosshi, 2006, 2008).

Many countries and regions are trying to rebuild the disturbed ecosystems through establishing protected area network or corridors (e.g. Foreman et al., 1995; Bennett, 1998; Bennett, 2004; Jongman et al., 2005). Landscape connectivity, through corridors between patches of natural areas is important for ecological integrity of the landscape. Ecological processes such as nutrient cycling, water flow, and animal movement, are enhanced through the connected habitat patches. Moreover it also ensures the continuous forest cover which is important for such composition and processes (Cook, 2002). Structural connectivity network also enhance functional connectivity that facilitate dispersal ability and movement of wildlife among patches (Taylor et al., 1993; Rizkalla and Swihart, 2007). This eventually can improve species persistence and stability (Fahrig, 2000).

Wildlife protected area is one category of protected area in peninsular Malaysia. The country started to establish wildlife protected areas in 1903 with the establishment of Chior Game Reserve (Elagupillay, 1993). Currently there are 7 wildlife protected areas in the State of Selangor, Peninsular Malaysia under the management of the Department of Wildlife and National Parks (here after as DWNP) where they are varying in size and habitat quality. Many of them overlapped with permanent forest reserve, which is managed by the Department of Forestry.

The gazettement and regazettement of wildlife protected areas under different Acts and Enactments have caused considerable confusion and hindering proper management goals. It also makes the protected areas less representing to the ecosystems that exist in peninsular Malaysia, where this is very important for conservation. Moreover rapid economic development have make wildlife protected areas prone to the disturbances. They are now facing severe severe pressure from different anthropogenic activities and loosing its natural harmony and health (e.g. Rafaai et al., 2008).

National Physical Plan (NPP) of Malaysia has designed Environmentally Sensitive Ares (ESA) where natural landscapes are in tremendous threat from rapid land use change and other anthropogenic activities. It emphasizes on some environmental issues that responsible for such degradation, such as forest fragmentation, wetland destruction, degazettement of protected areas for economic development, highland development, and coastal degradation. NPP in the section 18 remarked such area as Environmentally Sensitive Area (ESA) and ranked into three criteria according to the conservation priority. It also highlighted, 'the protected areas (PAs) network shall be enlarged to include a full representation of the diversity of natural ecosystems'. In the section 19 of NPP, it is highlighted as the central forest spine is the backbone of ESA and remarked, 'studies shall be undertaken to determine the possibility of re-establishing the integrity and connectivity of forests and wetlands through the implementation of the linkages between the central forest spines and major forest complexes'. We want to emphasize on such important suggestions from NPP where it mentioned the issues grossly. Furthermore, we also want to say that it needs understandings of scientific concept and the scientific assessment. Then the protected area network can be incorporated to the national policy for the conservation of natural landscapes in this region. So, there is a need for urgent stand to connect science with policy while it has been exercising in many developed countries (Van Der Windt and Swart, 2008) (Figures 1a and b).

In this circumstance this study discusses (i) the understanding of the importance of ecological connectivity for conservation of valuable habitats and (ii) the approach to develop a framework for ecological connectivity network through bridging science and policy. Malaysian National Physical Plan grossly identifies the issues and gave some suggestions to protect natural landscapes from degradation but scientific assessment is lacking. This study discusses the importance of understanding the scientific concept of ecological connectivity network at the earlier part. Here we discuss the scientific, societal and political conception regarding the connectivity of natural habitats. We also try to describe how the concept readily attract policy maker to incorporate in the conservation policy. Later we discuss how this approach can be included in conservation policy in this region. The study area, the state of Selangor in peninsular Malaysia, has been hosting many different types of ecosystem. It is a host of diverse array of habitats, including a broad range of elevation as well as rare ecosystems.

On the other hand the region is very fast developing and anthropogenic activities are also very severe. That's why this region should get the conservation priority and thus can be a model in the tropics.

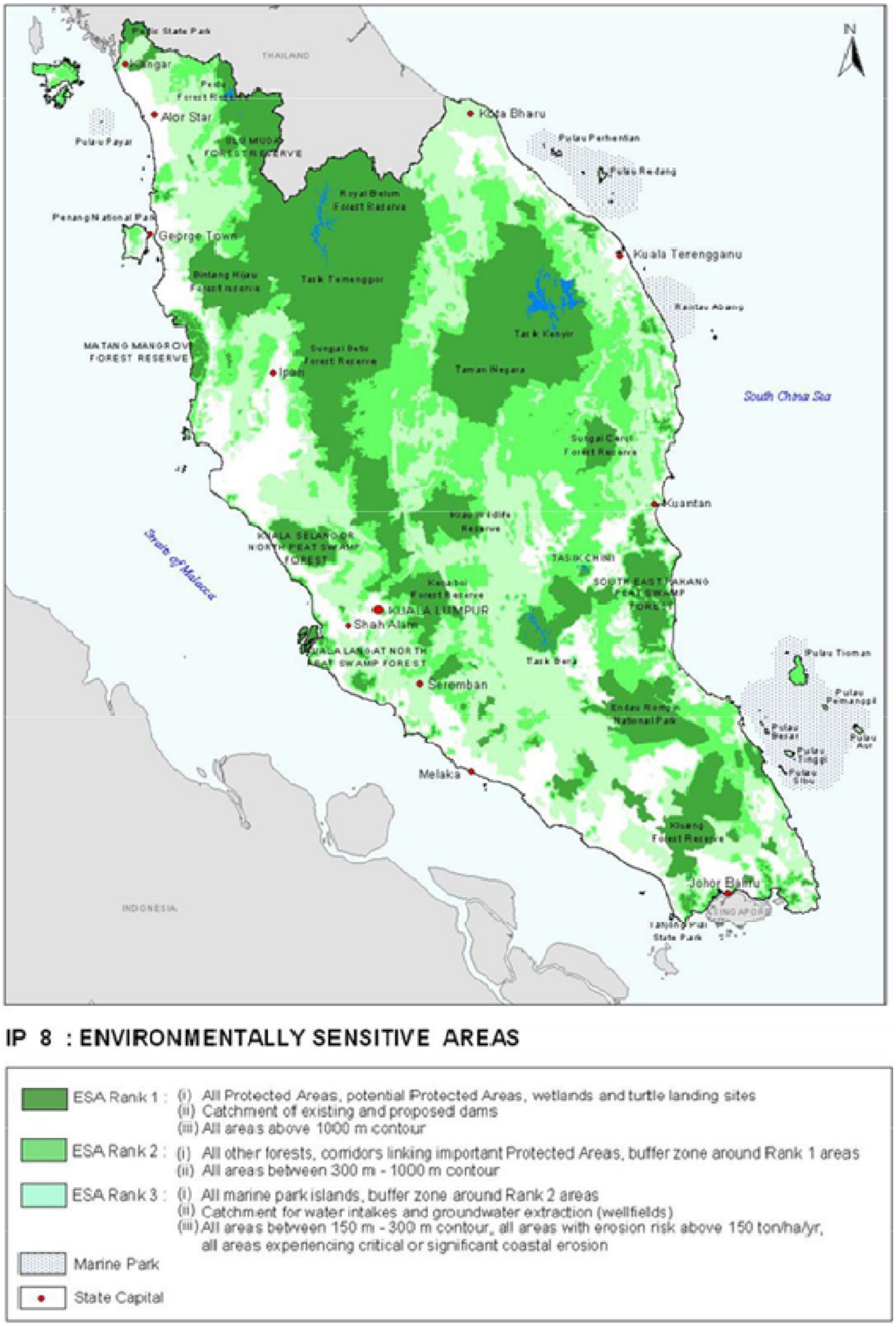

Figure 1a. Environmentally sensitive areas (ESA) showing three rank categories according to their conservation priorities. Arrows mark the linkages that must be constructed to design natural habitat network for re-establishing the integrity and connectivity of forests and wetlands in Peninsular Malaysia (Source: NPP 2005 - 2010).

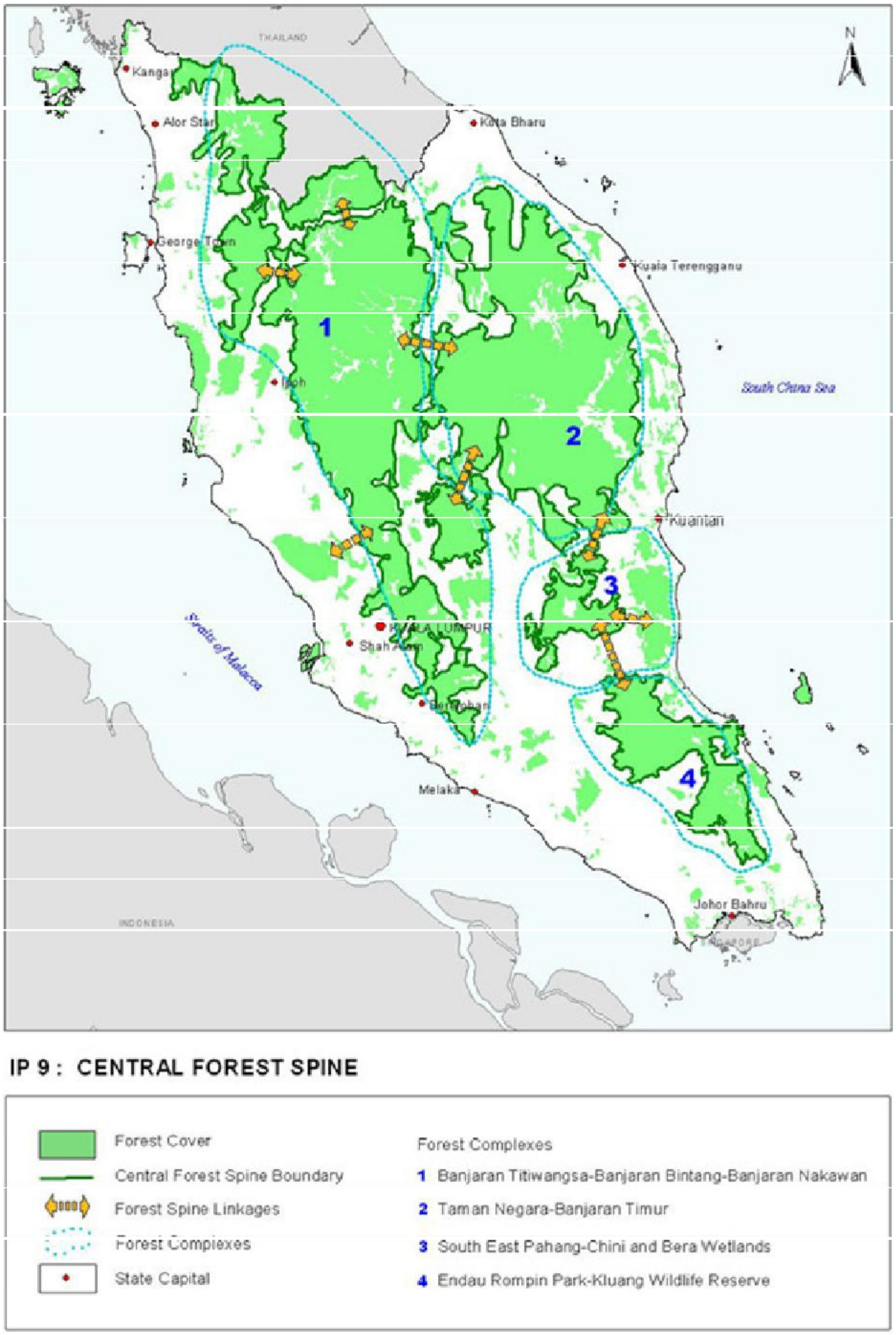

Figure 1b. Central forest spines and major forest complexes. Arrows mark the linkages that must be constructed to design a natural habitat network for re-establishing the integrity and connectivity of forests and wetlands in Peninsular Malaysia (source: NPP 2005 - 2010).

ECOLOGICAL CONNECTIVITY TO CONNECTIVITY NETWORK (HABITAT NETWORK)

The concept in landscape ecology provides a base to develop the idea of landscape connectivity. Landscape ecology is the study of interactions between the spatial components and processes of a particular landscape (Ward et al., 2002). It also concerns about the flow of energy, minerals and nutrients among different elements of the landscape and their continuous effects (Forman and Godron, 1981). Basically the concept of landscape connectivity emerged by the synthesis of theories including Island Biogeography (MacArther and Wilson, 1967), Metapopulation Theory (Levins, 1969), and Behavioural Ecology.

Connectivity has been described as the degree to which the landscape facilitates or impedes movement of organisms among resource patches (Taylor et al., 1993; Tischendorf and Fahrig, 2000). It is also defined as the functional relationship among habitat patches due to their spatial distribution and movement of organisms (Taylor et al., 1993; With et al., 1997) and the ease with which these individuals can move about within the landscape (Kindlmann and Burel, 2008). Both the structural components and biological components of a landscape included in the domain of landscape connectivity. Structural components describes the shape, size and location of landscape features; and the biological components consists of both the response of individuals to landscape features, and the patterns of gene flow that result from those individual responses (Brooks, 2003).

Structural connectivity

Structural connectivity means the measurement and properties of connectivity based on landscape structure with no direct link to any behavioral or functional aspects of organisms (With et al., 1997; Metzger and Decamps, 1997; Collinge and Forman, 1998; Collinge, 2000). Structural connectivity have been measured or described through different methods (for example, O'Neill et al., 1988; Turner et al., 1991). These measures are ranging from simple landscape parameters to more complex ones where all surrounding patches within dispersal distance of a patch contribute to landscape connectivity (Moilanen and Nieminen, 2002). For example simple landscape parameters such as nearest-neighbor-distance, proximity index (Whitcomb et al., 1981) and complex parameters such as fractal dimension, patch contagion, patch cohesion, or patch isolation (O'Neill et al., 1988; Turner, 1989; Wiens et al., 1993; Schumaker, 1996; Gustafson, 1998; Hargis et al., 1998). Each index describes an aspect of the spatial configuration of habitat. Such empirical studies of structural components have focused on the utility of landscape corridors (Andreassen et al., 1996, 1998; Hjermann and Ims, 1996; Haddad, 1999; Haddad et al., 2000).

Functional connectivity

On the other hand functional connectivity considers organism's functional or behavioral responses to individual landscape elements and the spatial configuration of the entire landscapes (Gustafson and Gardner, 1996; Tischendorf and Fahrig, 2000; Sweeney et al., 2007).

This is also known as biological (genetic) connectivity (Brooks, 2003) and defined as the actual movement of individuals and their genes between populations in the landscape. Movement and probability of movement between patches are being used to quantify landscape connectivity (Fahrig and Paloheimo, 1988; Heinen and Merriam, 1990; Taylor et al., 1993). However, Tischendorf and Fahrig (2000) suggest that fine-scale responses to landscape features are required to measure connectivity and in such cases it is much appropriate to measure gene flow within the landscapes. Gene flow within the landscapes has been quantified extensively through autocorrelation analysis by the pollination within plant populations (Chung et al., 2000; Miyazaki and Isagi, 2000).

Connectivity network or habitat network

In the last decades landscape ecological principles have become part of biodiversity conservation. Species have extreme difficulties to survive in fragmented landscapes (Jongman, 2007). Site based nature conservation although as wider as Russia, suffered to provide protection to larger carnivores. This consequents change in the concept of conservation from site specific to a wider landscapes such as ecological network, habitat network, based on principle from population dynamics (McArthur and Wilson, 1967; Opdam, 1991). As a result the theme of connectedness of national parks or reserves becomes an effective alternative approach for conservation of biodiversity in the wider landscapes (Naveh, 1994; Jongman, 1995; Foreman et al., 1995). It has been undertaken to improve the quality of biodiversity and also to reinforce the recent policies for conservation and management of wildlife (Ro and Hong, 2007).

Scientific concepts

Many scientists link the concept of an ecological corridor to the equilibrium theory of island biogeography and metapopulation theory (Perrow and Davy, 2002). The theory predicts that the number of species in an insular situation is in a dynamic equilibrium between local on-site extinction of resident species and stochastic immigration to the site by new species (McArthur and Wilson, 1967). One such principle stipulates that a network of connected reserves is better than a group of similar reserves that are isolated from one another (Diamond, 1975). Moreover, isolated species are more likely to decline than species that are not isolated (Davies et al., 2000). During recent decades many studies supported that corridors are very important in overcoming the problem of fragmentation (Bennett and Mulongoy, 2006; Damschen et al., 2006), diversity and migration of birds (Beier and Noss, 1998).

Many other scientists still are not convinced with the

Table 1. Forested area in the Peninsular Malaysia and in the state of Selangor, total forested area and classified forest area.

State	Land area (ha)	Forested area (Total and classified)				
		Total area (ha)	%	Inland forests (ha)	Peat swamp (ha)	Mangrove (ha)
Selangor	796,084	239,782	30.31	145,063	75,762	18,957
Peninsular Malaysia	13,167,245	4,711,264	44.72	4,422,890	185,860	102,514

Source: Forestry statistics 2005, Peninsular Malaysia.

thought as it has uncertainties about the functioning of corridors for many organisms (Simberloff and Cox, 1987; Rosenberg et al., 1997). A survey among European ecologist and conservationists reveals that the majority regards the concept of ecological corridors as sufficiently relevant and valid, but 23% of the respondents express reservations about its scientific basis (Rientjes and Roumelioti, 2003).

Societal context and policy perspectives

During recent decades, ecological connectivity has become a popular concept among ecologists, politicians and nature conservationists. Though the concept still been criticized from a scientific point of view but the concept has been accepted so readily in policy and practice (Jongman et al., 2005; Van Der Windt and Swart, 2008). This ecological corridor concept is so influential because its broad and flexible character facilitated the coming together of various stakeholders and scientist. Scientists from the policy-oriented research centre finally were able to link the concept to fundamental science, policy and practice (Van Der Windt and Swart, 2008).

In 1980, the International Union for the Conservation of Nature and Natural Resources (IUCN) adopted the idea of ecological corridor into its World Conservation Strategy (IUCN, 1980). Soon after, the United States and Europe has adopted the concept by their governmental and non-governmental organizations (Simberloff et al., 1992; Jongman et al., 2005). There are many combined efforts and enthusiasms been demonstrated across the world for the concept (Rientjes and Roumelioti, 2003; Bennett, 2004) and the concept has been recognized as a successful societal enterprise (Simberloff and Cox, 1987).

ECOLOGICAL NETWORK IN SELANGOR

Development of a model ecological connectivity within the protected areas and natural habitats in the state of Selangor, the peninsular Malaysia is a need of time. This state is hosting much unique type of natural ecosystems within a matrix of anthropogenic settlements and cultural landscapes. Natural landscape varies from montane, hill, lowland, peat-swamp, and mangrove forests, to lakes, rivers and coastal landscapes. Variation in the elevation and life form are also diverse. The States of Perak, Pahang and Negeri Sembilan are surrounding this state in the north, east and southern side respectively and the Strait of Malacca covered its western side. Mountain Titiwangsa (Banjaran Titiwangsa) and Bintang (Banjaran Bintang) (about 2000 meter above sea level), the central forest spine, is attached with eastern side of this state. From this high area land is gradually sloping down with hill and terrain and finally meets to the Strait of Malacca.

The State of Selangor: Facts and trends

The state of Selangor (latitude 2°35’-3°60’N and longitudes 100°45’-102°00’E) is the most developed and highly populated state in Malaysia. Country’s capital, Kuala Lumpur and newly constructed Administrative capital, Putrajaya, are the federal territory but situated within this state. With these two highly developed federal territories, a big area of the state of Selangor architected the conurbation. Selangor is sharing 16.5% Built up area, 49% Agriculture area, 32.4% Forest and 2.1% Water bodies of its total land area (NPP, 2005 - 2010; Forestry Statistics, 2005, Peninsular Malaysia). The total forested land is about 241,289 hectares, where it is about 239,781 hectares are within Permanent Reserved Forest (managed by the State Forest Department) and rest of the area about 1,507 hectares are within Wildlife Reserves (managed by the DWNP) (Tables 1 and 2). Many of the reserves are overlapped by their respective legislative area with other type of reserves (State Forest Department and DWNP) which is a limiting factor for proper management from either side.

Two main commercial cash crop, rubber and oil palm, plantation had caused deforestation of its inland forests and wetland forests remarkably (Abdullah and Nakagoshi, 2007). Intensification of rubber and oil palm land use causes a shift from natural dominated landscape to an agriculture dominated landscape within a very short duration from 1960s to 1980s. But next two decades (1980s to 2000) the state of Selangor expe-rienced more drastic damage in the natural landscapes, this time it had converted to the built-up area due to industrialization and urbanization (Abdullah and Nakagoshi, 2006). These two major radical changes in the land use and shifting to the landscapes, particularly in the state of Selangor, were due to the economic

Table 2. Wildlife protected areas in the state of Selangor and their establishment, IUCN conservation category, location, elevation and special conservation features. These PAs are under the management of department of wildlife and national parks (DWNP).

Wildlife protected areas total area (ha)	Establishment year and the enactments	IUCN category	Location	Elevation (meter above sea level)	Special feature
Fraser's Hill 2,634	1922, Wild animal and bird protection Enact. 1921.	VI	3°36′-3°42′N and 101°40′-101°48′E	350-1,200	Lower montane, upper dipterocarp forest, eco-tourism area
Bukit Kutu 1,844	1922, Wild animal and bird protection Enact. 1921.	VI	3°30′-3°33′N and 101°42′-101°46′E	250-1,053	Lower montane, upper dipterocarp forest,
Templer Park 1,299	1955, Land code (Selangor).	V	3°16′-3°20′N and 101°39′-101°41′E	160-500	Hill dipterocarp forest, park
Klang Gate 1,299	1935, Wild animal and bird protection Enact. 1921.	II	3°12′-3°16′N and 101°43′-101°46′E	130-400	Lake, park, granite habitat, hill forest
Bukit Sungai Puteh 40	1931, Wild animal and bird protection Enact. 1921.	IV	3°05′43″-3°06′N and 101°45′-101°45′34″E	300	Hill dipterocarp, bird conservation
Sungai Dusun 5,116	1964, Wild animal and bird protection ordinance.1955	Ib	3°39′-3°41′N and 101°20′-101°29′E	25-253	Lowland dipterocarp, peat-swamp
Kuala Selangor 144	1922, Wild animal and bird protection Enact. 1921.	VI	3°19′-3°21′N and 101°13′-101°14′E	0-7 at the coast and 50 at the hill	Silver haired monkey, mangrove forest

Source: DWNP/DANCED. 1996, capacity building and strengthening of the protected area system in Peninsular Malaysia, and official website of the department of wildlife and national parks (DWNP), Malaysia.

development policy by the government that been taken from 1980 to 2000 by several five year plans (Abdullah and Hezri, 2008).

Approach to design an 'ecological connectivity network' in Selangor

To overcome the complexity of landscapes that has prevailed due to unsustainable development of so called human civilization, one sided economic development, and an approach is a must which will bridge the gap between the natural science and society. In this cir-cumstances landscape ecological approach, which has a broad scope to mitigate the gap and injury, has to be more diverse. It shouldn't be confined with geographical and ecological aspects only rather to deal all relevant natural and human-ecological aspects (Naveh, 2007). Malaysia's natural landscapes like other Asian developing countries are also facing severe anthropogenic distur-bances through commercial agriculture, industrialization, urbanization, and tourism (Abdullah and Nakagoshi, 2006, 2007; Abdullah and Hezri, 2008) (Figure 2). In such a context the state of Selangor which is a rapid deve-loping landscape not only in Malaysia but also in -South-east Asia has a combination of unique natural land-scapes, but it can develop an approach for sustainability which is needed for Asian tropics.

Suitable approach

As the state of Selangor most developed in Malaysia and also one of the first growing regions in the tropics, it has scope to be a model area. As revealed from the scenario of the challenges (Figure 2), it is wise to rebuild the connectedness of protected areas within the region. A connectivity network within its protected areas can be established using GIS and Remote Sensing technology. Firstly the approach should consider the structural connectivity. According to the understanding and discussions in the section 1 and 2 of this study, structural

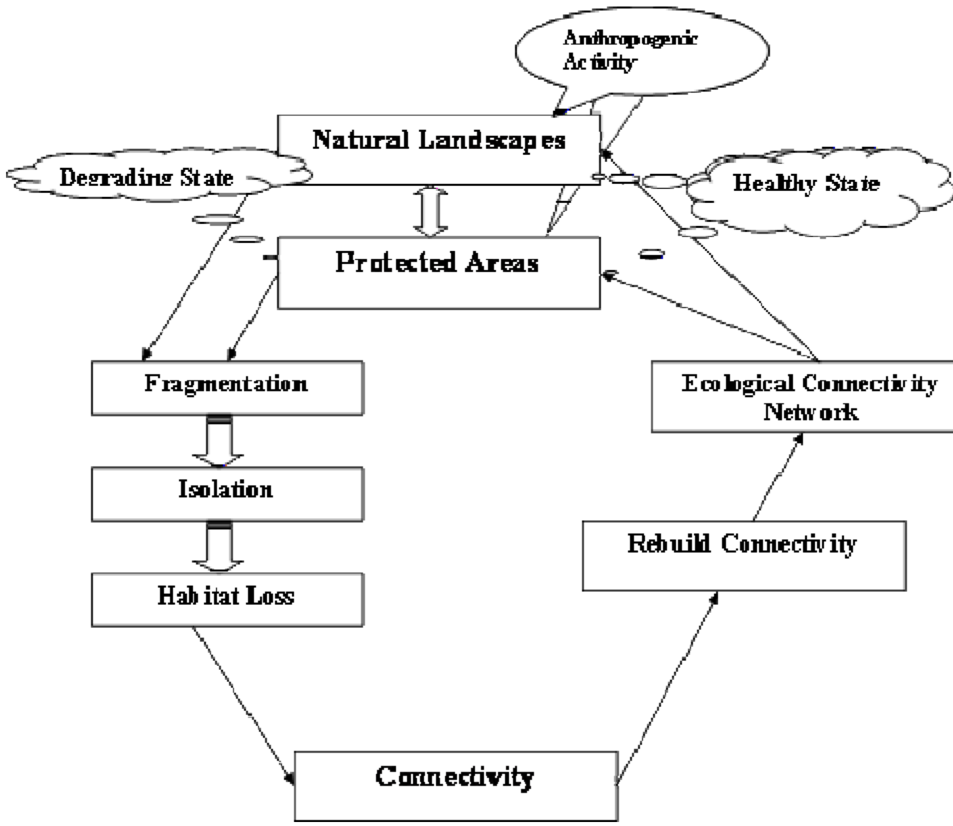

Figure 2. Under tremendous anthropogenic pressure, natural landscapes and protected areas have been experiencing fragmentation and followed by isolation and habitat loss. The process causing connectivity loss within the habitat patches of a natural landscape. To change this degraded health of these ecosystems into a healthy state, rebuild in connectivity through the ecological connectivity network within the protected areas and natural landscapes is urgently needed.

connectivity can facilitate the functional aspects of the landscapes. On the other hand the approach is easier but time and cost effective to design in such a rapid growth region. Landscape ecological techniques are providing support to evaluate and design such approach and also been practicing many part of the Earth. Incorporation of social sciences, arts and humanities with the landscape ecological science are also important for the success of the approach (Naveh, 2007).

The following sequential steps will have to take to implement such an approach. Though the opening study will be a landscape ecological study but experts and individuals from all the sectors need to sit under the same umbrella hosted by the decision makers.

(1) Landscape ecological study

- Study of structural connectivity
- Study of fragmentation and ecosystem representativeness of protected areas
- Consequence and changes of historical and cultural landscapes

(2) Socio-economic study

- Socio-economic involvement as pressure group
- Ethical perspectives/perceptions
- Understanding level of the stakeholders about the approach
- Inter-relationship between the agencies related
- Effective awareness programme

(3) Policy perspectives

- Evaluation of existing policy suggestions
- Gap analysis between science and policy
- Scope to initiate such unique policy

(4) Implementation

- Strengths, weaknesses, opportunities, and threats (SWOT) analysis
- Action for implementation.

The sequential activities may take a considerable longer period but all the stages are important to make the approach a success. While it may be a possible scientific task to reconnect the landscape, the decision about the extent to management is a social one. This network approach should be linked to regional strategies as well as the strategic planning system so different institution can align their activities and can work more collaboratively. Therefore, a strong national policy strand can only lead such integrated and comprehensive network right from the front. A set of site-scale connectivity improvement activity can be initiated simultaneously for the implementation of such ecological connectivity network. These activities will accommodate general public to the policy personnel and the natures of activities are as follows:

1.) Restoring, rehabilitating, and protecting important habitats, such as lakes, cannels, riparian areas, roadsides and private land that is potential for important ecological connections as stepping stones or corridors.

2.) Improving links between protected areas and important adjacent ecosystems

3.) Improving links between small, fragmented areas such as patches of remnant vegetation

4.) Constructing highway underpasses to link separated adjacent habitats

5.) Restoring and protecting valuable and unique granite habitat and highland in the central forest spine

6.) Restoring connections between peat-swamp forests, wetlands and rivers and thus protecting hydrological systems

7.) Improving connections within coastal vegetation, especially mangrove forest and estuaries

8.) Removing threats and providing protection for threatened species habitats and populations

9.) Buffering protected areas and ecologically-connecting isolated reserves and habitat

CONCLUSION

Now we are at a stage of crucial transitional period when it requires a shift from a "fossil age" to the "solar age" of a new world economy. It requires a shift from depletion of natural resources to their more efficient and wiser sustainable use (Naveh, 2007) while there are probably no places on earth free of the footprint of humanity (Sanderson et al., 2002; Kareiva et al., 2007). One-sided economic goals of quantitative and materialistic values of West and their followers are mostly responsible for such consequence. Malaysia, like some other Asian magadiverse developing countries e.g. China, India and Indonesia, still have chance to avoid the fatal mistakes in highly developed industrial countries (Naveh, 2002, 2007). It has the opportunity to develop the model of sustainability that whole world can follow and can get a lesson to think individually using their own valuable faith, ethics and culture not just copy from so called value of the West.

As this study demonstrated that the approach of ecological connectivity network is very successful to combine science and policy in many part of this earth, so such diverse tropical Asia should take the opportunity. Still it has a considerable part of it's landscape covered with natural features and so she has responsibility and rationale to construct a model approach for sustainability. Ecological network in the state of Selangor can be an instance of thinking for sustainability using own cultural, ethical and moral uniqueness and strength.

As we have already mentioned the policy trend for such thinking (introduction) and also the need for the sustainability and scope of the approach so all it needs a strong policy decision. We must understand that restoring the land and improving connectivity does not mean eliminating agriculture from landscape. However, sustainable and productive agro-farms can be an integral part of connectivity network.

Improving connectivity does not mean revegetating large-scale "corridors" of land, although this could be an aim for some areas of Selangor over the longer term. Initially, providing well-managed 'stepping stones' such as existing remnants in the landscape can improve connectivity. More particularly this approach can rehabilitate many important habitats such as depleting valuable granite habitat, lowland and hill dipterocarp forests, wetlands, degrading lakes, banks of river, riparian zones and streams for aquatic and terrestrial biodiversity. Further, enlargement of these 'stepping stones' through restoration, buffering and connection of these to similar or different habitat types would provide a diversity of habitat across the landscape. It will also promote recolonisation and movement of biota and will support the space to self adjust against environmental changes. It can involve local indigenous community, land managers and farmers, who can help minimize the barriers to ecological connectivity that human settlement and land use have created.

This approach could provide a strategic framework to unify many activities that currently operating independently. In many cases, we do not necessarily need to do new things rather to link those in a scientific manner. We wish this study will provide a better understanding and importance of connectivity network. Proposed work plan can provide a base to initiate such approach with the help of modern scientific tools. We also hope the success of such approach can perform a vital role in the sustainable planning of valuable natural resources, in the tropics and any part of this world.

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