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Spatial Analysis of Environmentally Sensitive Areas in Kuala Selangor District, Malaysia

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Abstract: This study addresses the issue of conserving the important areas known as environmentally sensitive areas in Kuala Selangor District, Malaysia. Presently, the existence of these natural elements which are also considered as environmental goods to the community faces a prolong development pressure, regardless its role in enhancing the quality of life. Therefore, this research was embarked to conduct the spatial analysis mapping on the importance of environmentally sensitive areas found in Kuala Selangor. The study highly employed the collection of secondary information regarding textual and statistical data in the form of GIS/MapInfo format to assemble the relevant data for mapping purpose via the sieving technique. The results demonstrate that the environmentally sensitive areas could be categorised into natural heritage, disaster risk and life support, ranging from coastal zones, forestry, paddy field, wetland sites and others. It is noticeable that these areas are essential not only concerning its environmental value but also supports the economic growth of Kuala Selangor. In this regards, the identification of these areas is crucially needed for both the quality and quantity of stock for a longer run. As a conclusion, it is evident the identification of environmentally sensitive areas in Kuala Selangor has benefited many stakeholders involved in the planning and management of the district of Kuala Selangor.

Key words: Environmentally sensitive area, natural heritage, disaster risk, life support, Kuala Selangor

INTRODUCTION

The Malaysian government put a strong emphasis on the environmental conservation in developing the nation. The availability of invaluable natural resources must be well protected and planned to ensure a balanced development achievable (Jahi *et al*., 2009). The Ministry of Science, Technology and the Environment has set the policy of environmental conservation. From the planning perspective, the environmental aspects have been successfully incorporated into the land use planning system. It is essential to integrate the Environmentally Sensitive Areas (ESAs) into the overall land use spatial planning to conserve and preserve the Mother Nature for future generations as propagated in the notion of sustainable development. The Malaysian Development Plan (DP) system has clearly indicated the importance of the environmental sector which is in line with the aspiration of attaining the sustainable development nation. For instance, the District Local Plan (DLP) addresses the issue pertaining to the environmental aspects covering the water quality, air quality and ESAs (Town and Country Planning Department, 2010; Ministry of Science, 2002). This situation indicates that environment plays a crucial role in relation to the quality of life of the community (Selman, 2000).

In this regards, Kuala Selangor was chosen to be the subject area as it has a diverse ecology of permanent reserve forest, rivers, coasts, Important Bird Area (IBA) and more. Simultaneously, this district also faces development pressure that might affect its surroundings. Environmentally Sensitive Areas (ESAs) refer to the landscape elements or places which are vital to the long-term maintenance of biological diversity, soil, water or other natural process, both on site and in a regional context. ESAs occur within all landscapes but are relative to surrounding land uses (Reganold *et al*., 1990)

MATERIALS AND METHODS

The study is about producing spatial mapping on the ESAs of Kuala Selangor district whereby the plans can

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Table 1: Selected GIS data used for ESA classification

Geospatial category	Data analysed	Vector data by
Environment	Geology, soil classes, contour, river network, wild life, forest, mineral sites, wetland areas, ex-mining lakes	Land use map Geological heritage malaysia map Selangor permanent forest reserve map
Economy	Plantation areas (paddy), aquaculture, fishing areas, tourism spots	Malaysia minerals and geology map Cadastral map (land lot)
Utility	Electricity supply network, gas supply network, water treatment plant, power station, waste disposal sites	

show the distribution of the relevant parameters of the selected environmental elements. Therefore, this study highly employed the series collection of secondary information regarding textual and statistical data in the form of Geographic Information System (GIS)/MapInfo format to assemble the relevant data for mapping purpose. The fundamental technique used was the sieving plan, whereby several pre-determined environmental parameters were selected and arranged accordingly. The information was layered to produce the final composite map of ESAs indicating the types, locations and sizes of the ESAs. The government of the state of Selangor has its manual on ESAs, guiding the identification of ESAs for preservation purpose (Town and Country Planning Department, 2007). There are three types of integrated ESAs, covering the natural heritage, disaster risks and life support with its specific areas of consideration and its level of sensitivity, either level one, two, three or non-ESAs. Figure 1 shows the methodology employed in the study, depending highly on the GIS spatial data of the selected ESAs aspects. Table 1 shows the list of selected GIS data and data that has been utilised in parliamentary procedure to create a classification of ESAs in Kuala Selangor.

The study area of Kuala Selangor disctrict: The district of Kuala Selangor covers total areas of 119,000 haqctares, consisting of nine mukim (Mukim Kuala Selangor, Api-api, Tanjong Karang, Hujong Permatang, Bestari Jaya, Ijok, Jeram, Pasangan and Hulu Tinggi) (Fig. 2). The district is located in the Northern part of Selangor which is regarded as the most developed state in Malaysia. Kuala Selangor is bordered by the district of Sabak Bernam on the northern side, districts of Hulu Selangor and Gombak on the eastern side, districts of the Klang and Petaling on the southern side and Straits of Malacca on the western side. This district has a 60 km stretch of coastlines rich with muddy plains and mangroves. The natural drainage system in Kuala Selangor district comprises of the river basins of Tengi River, Bernam River, Buluh River and Selangor River. In terms of the type of land use, the agricultural sector is the dominant land use, covering an area of 59,065 ha (49.3%) of the total district area. The major plantations are oil palm and paddy. This

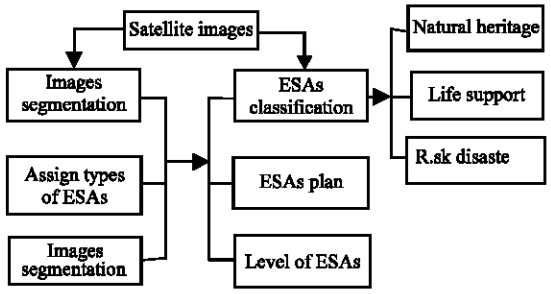

Fig. 1: The overall methodological framework for the study

district has a total of 205,257 populations in the 2010 census with its growth rate of 2.45% annually. The town of Bestari Jaya and Kuala Selangor function as the sub-regional centres in the state of Selangor. There are several small growth centres such as Ijok, Assam Jawa, Puncak Alam and Pasir Penampang. Kuala Selangor has a very accessible road network with its neighbouring districts where by the Federal Route 5 passes through the district from the Klang District (South) going to Sabak Bernam District (North). The LATAR highway connects Ijok with Kuala Lumpur, reducing the time travel from this district to Kuala Lumpur that is located about 60 km away.

Kuala Selangor is rich with natural resources such as coastlines, marshes, mangrove estuary, alluvial soil, flora and fauna (Town and Country Planning Department, 2007) (Haslam, 2004; Kathiresan, 2012; Jusoff, 2009) state that these resources require preservation for the benefit of the balance of the ecosystem. The existence of many socio-economic activities such as agriculture, fisheries and tourism in coastal areas which are very dependent on natural resources.

The study of physical plan for national coastal zone by the department of town and country planning in 2010 states that a coastal Planning Unit (PU) have been formulated to provide a rough indication of the dominant coastal processes along the coastline based on three criteria which are biodiversity/ecological, land use and administrative. The coastlines along Kuala Selangor district was designated as PU1. Permanent Forest Reserves (PFR) are an important contributor to the biological diversity, economics and the environment. According to the Selangor Forestry Department, there

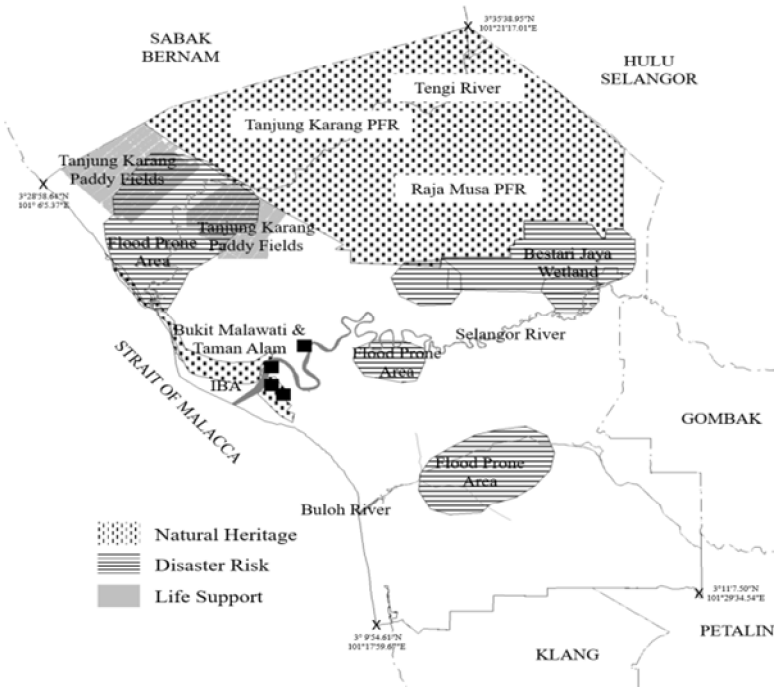

Fig. 2: Type of ESA for Kuala Selangor

Table 2: List of permanent forest reserves in Kuala Selangor, 2012

Name of forest	Size (ha)	%
Banjar utara forest reserve	1,011.64	2.70
Banjar utara forest reserve (additional)	226.04	0.60
Kapar forest reserve (addition) (part of Klang district)	124.38	0.33
Total	1,362.06	3.64
Type of forest: peat swamp		
Raja Musa forest reserve	23,486.43	52.13
Sungai Karang forest reserve (part of Sabak Bernam district)	12,542.49	44.22
Total	36,028.92	96.36
Grand total	37,390.98	100.00

Department of forestry, 2013

are two types of PFR in Kuala Selangor which are mangrove and peat swamp forests. Selangor has 250,128.83 h as a total of permanent forest reserves and 37,390.98 ha (14.9%) from it situated at Kuala Selangor. Raja Musa PFR compartment cover with peat swamp which covers 23,486.43 ha of land. Table 2 shows the information on Kuala Selangor PFR.

The study of the Central Forest Spine (CFS) has identified Bukit Raja Musa Forest Reserve and Bukit Gading Tarek Forest Reserve located within CFS2-Secondary Linear (SL) 3 which also involves the Hulu Selangor district. Whereas, mangrove forest is found at Banjar Utara PFR and Kapar PFR. The area is overgrown with mangrove trees along the coastline which is necessary for coastal erosion mitigation besides essential for fish breeding areas. Taman Alam Kuala Selangor functions as a public park, covering 240 ha which fortified by forests and muddy plains (Asmaw *et al*., 2009). This area has the value as an area of interest for birds, i.e., Important Bird Areas (IBA) in Selangor. The area is located at the mouth of the Sungai Selangor where it is abundant with mangrove tree species such Avicennia, Rhizophora and Bruguiera. Beautifully landscaped nature transformed into secondary forests when it is increasingly entering into terrestrial lands (landward) which occupied by long-tailed macaques (*Macaca fascicularis*) and silvered leaf monkeys (*Trachypithecus aurata*). On that point are also coastal birds such as milky storks (*Mycteria cinerea*) and egrets. In addition, various wildlife such as beavers (*Lutra perspicillata*) can be spotted at Taman Alam Kuala Selangor. As recorded, there are >156 species of birds including Nordman's Greenshank (*Tringa guttifer*) and *Pitta megarhyncha*.

Healthy habitat as referred to Mastaller is important for flora and fauna where it depends on river water quality factors (Mastaller, 1997). There are three major river basins in the District of Kuala Selangor which are Tengi River basin, Selangor River basin and Buloh River basin. Selangor River basin covering an area of Kuala Selangor district, Hulu Langat district and Gombak District. Selangor River basin is among the important water source for the Selangor State in addition to the river basin of the

Klang and Langat river basin. Selangor river basin is the third largest one in Selangor with an area of 2,200 km^2. This 110 km of the river starts from foothills of Fraser Hill toward the South West of Selangor.

Selangor River is contributing >60% of the water supply for Selangor and Klang Valley. Selangor River basin runs through along Kuala Kubu Baru, Rawang, Serendah, Rasa, Bestari Jaya and Kuala Selangor. Rambai River, Kelah River, Tiram Buruk River and Darah River are the tributaries of Selangor River (within Kuala Selangor district). More than half of the Selangor river basin areas, cover with natural forest and 22% of the total area is used for agricultural activities.

RESULTS AND DISCUSSION

Type of ESAs: According to the Manual of Standards and Guidelines provided by the Town and Country Planning Department Federal Malaysia, the Environmentally Sensitive Areas (ESAs) refers to a "special area that is very sensitive to any activity or development and need to be preserved for its heritage value, preserve life and minimize support disaster risk due to land use changes". As such, this statement becomes the essential foundation for determining the type and level of ESAs in Kuala Selangor. The manual says that the integrated ESAs is divided into heritage, disaster risk and life support as shown in Table 3. Each of the integrated ESAs has its own ESAs sectoral, referring to a much specific ecosystem, such as river and lake, coast and wetlands.

By dividing the ESAs into several levels, it forms a process of organising, managing and regulating the use of lands and their resources to meet the socio-economic development of the country while safeguarding the environment (Table 4). Land use planning and management mechanisms that design and incorporate the needs of various sectors are therefore necessary to help reduce any possible land use conflicts, conserve critical ecosystems, protect and manage environmentally sensitive habitats and restore degraded conservation areas.

Levels of ESAs: The level of ESAs indicates the sensitivity standards of the natural resources in adapting to the changes due to any development. For instance, the more sensitive of the natural resources, the less development impact it can bear to ensure that its ecosystem condition can function as usual. Therefore, based on the management guidelines of the level of ESAs, the environmental parameters were sieved by using GIS/MapInfo. Based on the ESAs categories, there are several areas in Kuala Selangor district need to be avoided from a large-scale development, high density and significant potential become pollutants. Table 5 shows details of assessment for ESAs levels in the Kuala Selangor district. Meanwhile, Fig. 3 displays the distribution of the levels of ESAs indicating the most sensitive area, i.e., level 1 covers an area of >46,000 ha. The study discovered that there are several areas in Kuala Selangor district need to be avoided from a large-scale development, high density and significant potential become pollutants, e.g., The ex-mining lakes within the area of UNISEL campus.

ESAs level 1 (full coverage area)

Kg kuantan and kg Bukit Belimbing: Kg Kuantan and Kg Bukit Belimbing have similar habitat features which suitable for fireflies breeding area. Fireflies in Kg Kuantan have been spotted as the early 1970s. Fireflies at Kg. Kuantan and Kg. Bukit Belimbing dominates by Pteroptyx Tener beetles which are unique as it produces three rhythmic flickering light per second. This insect is very dependent on Berembang tree (*Sonneratia caseolaris*) as a source of food and shelter.

The insect also is very sensitive to any changes in physical, biological and chemical of its surroundings. Due to the uniqueness of this insect, these areas should receive a full protection from any threat. Under Selangor Water Management Enactment 1999, these areas have been gazetted as Protection Zones (declared and restricted area) 2009, numbered 2171. It is intended to protect the Selangor River reserve (150-400 m left and right of riverbanks), buffer zone and the surrounding environment of Selangor River.

Taman Alam Kuala Selangor: Taman Alam Kuala Selangor comprises of 201 ha area that have a variety species of fauna, especially birds (Asmawi *et al*., 2009). It has been distinguished as a zone interest of birds (Important Bird Areas) by the Bird Life International (Bild Life International, 2010). The record shows that there is a total of 156 species of birds in which 57 of whom are immigrant's birds. Taman Alam became a stopover for birds that usually come from countries like Russia, Mongolia and Siberia. These birds usually migrate during the winter season at northern hemisphere to New Zealand and Australia. The Park also has a variety of fauna such as macaques, monkeys, mudskipper and mud crab. A ubiquitous mangrove tree also provides a balanced environment of flora and fauna ecosystem. As a result, it

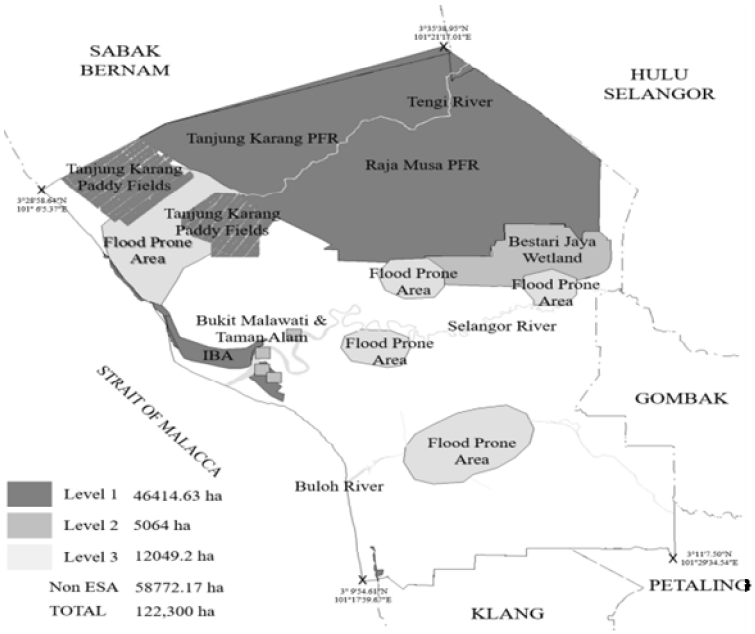

Fig. 3: ESA Level for Kuala Selangor

Table 3: Type of ESAs identified in Kuala Selangor

Type of ESA	ESA (sectoral)	Availability of resources in Kuala Selangor
Natural heritage site	History and archaeology	Kota Malawati
	Biodiversity	Taman Alam Kuala Selangor (IBA), Kg Kuantan, Kg Bukit Belimbing, Forest Reserves
Disaster risk	River and lake	Tengi River, Selangor River and Buloh River, lake and ex-mining ponds
	Coast	Along coastal area
	Peat swamp and wetlands	Raja Musa PFR (peat swamps), Bestari Jaya (wetlands)
	Flood prone area	Buloh River and Selangor River
Life support	Clean water	Tengi River, Selangor River and Buloh River
	Basic food	Paddy field (part of agriculture and agro-based industry project)

Table 4: Level of ESAs

Level of ESA	Explanation of the levels
Level 1	Full coverage area (no development allowed except for works that involve with the conservation and preservation, eco-tourism activities are limited while research activities such as forest reserves are allowed)
Level 2	Retention area (not allowed any urban development except for recreational activities that give minimum impact to the rivers and lakes as well as forested area)
Level 3	Controlled development (any development subject must be complied with the specific requirements contained in specific guidelines)

Table 5: ESA level in Kuala Selangor District

ESA level	Criteria	Management guidelines
ESA level full coverage area (46,414.63 ha)	Natural heritage site Biodiversity: Kg Kuantan Kg Bukit Belimbing; Taman Alam Kuala Selangor (IBA); Forest Reserves: Pet swamp and Wetlands Raja Musa FR, Sg Karang FR, Banjar Utara FR and Banjar Utara (additional) Kapar FR (additional) Life Support Basic Food: Tanjung Karang paddy fields	There are no development activities allow within this area, either municipal agricultural or logging activities Allowable activities are minimal impact activities such as eco-tourism, research and education activities but there must be 'carrying capacity' study conducted to know the ability of the area to bear the development
ESA level 2: Retention area (5,064 ha)	Natural heritage History and archeology: Bukit Malawati Disaster Risk by (peat swamp): Old Mines at UNISEL and Kg Bestari Jaya	Municipal development and agricultural activities are not are not permitted. Only sustainable logging and 'low impact tourism' are allowed but subject to physical barriers and 'carrying capacity' of the area
ESA level 3: Controlled development (12,049.2 ha)	Disaster Risk Flood prone area, Coastal Area: within 5 km landwards Coastal erosion: Along Pantai Remis Clean Water: main river basin	Municipal development and agricultural activities are permitted but must comply with the development control issued by the area. Factors to be considered: type, intensity scale of development, density and the outcome of development must not produse envoirmental pollutens in addition any development within the area must come out with mitigation to counter the impact of development

is essential to protect the area which full of heritage and rehabilitate from development that would threaten the stability of natural systems.

Permanent Forest Reserve (PFR): Raja Musa PFR is located at the North of Kuala Selangor district which covers 23,486.43 ha of land. It is merging with Sungai Karang PFR, partially located in the District of Sabak Bernam where Tengi River is passing through the forest reserves and acts as a natural boundary dividing the Raja Musa PFR and Sungai Karang PFR. Raja Musa PFR is a peat swamp forest that becomes its key characteristic. A peat swamps land functions as a natural sponge where it will absorb large amounts of water and as a result, it can reduce the flood problem. However, peat swamps also a fragile fire prone area as soil texture could keep the fire embers for a prolonged period stored in a thick layer of humus. This Raja Musa PFR area has experienced several times cases of wildfire. Because of its nature in controlling flood and fire sensitive area, it makes Raja Musa PFR as reasonably placed for protecting from of any development.

Paddy Field in Tanjung Karang: Paddy field in Tanjung Karang is an important ESAs under the category of basic food (a permanent food crop production zone) to accommodate the demand of food supply in the country. The paddy area covers an area of 5,587 ha with a high production of yield yearly. Area of Kuala Selangor is one of the main zones that must be maintained to ensure the continuation of production of rice and protect a productive paddy cultivation area which gradually decreasing due to high development pressure that requires the change of agricultural land to built-up areas. This area is part of the agriculture and agro-based industry program. In the economic development of Kuala Selangor district, the agricultural sector is the main economic contributor about 59,298,96 ha (49.64%) from the Kuala Selangor district covered by the agricultural activity area which makes it one of the most important for the agriculture produce area.

ESAs level 2 (retention area):

Bukit Melawati: Kota Malawati positions on top of a hill located behind the town of Kuala Selangor known as Selangor Hill.' Within this area, there is abundant historical heritage of Sultanate of Selangor. Among the historical heritage is Tomb-mausoleum complex of Sultan Selangor, a lighthouse, a few Government officials' residential houses and several attractions near the fortress are Radio Transmitting Towers and Government rest house. In addition, Kota Malawati itself is rich in values where Dutch-made iron arsenal was placed facing the mouth of Selangor River. Apart from that, the old castle site has now been developed as a Historical Museum Kuala Selangor which houses various artefacts dated from the first three rulers of Sultan Selangor. Due to the high value of the heritage of the monarchy system in Selangor, the area should be placed as a limited development area to preserve its historical heritage.

UNISEL campus and Kg Bestari Jaya: Bestari Jaya is a former tin mining activity covering an area of 2,656.3 hactares. It is located at Kg Bestari Jaya and UNISEL campus. Each of the old mining ponds has a different type of ecosystem. There are contaminated land, open lakes and small ponds, wetlands, waste from old tin mining activities and dredge sand (sand and slime tailings) and peat forests in Bestari Jaya. The level of surface water quality in this area is categorised under unsatisfactory because it does not meet national standards. The tailings are deposits and due to its hazardous characteristic, it requires a very long time to become neutral naturally. Therefore, it cannot be utilised as a source of raw water at the surface. Swamp characteristics and old mining area is not suitable for high-intensity development and should be limited to certain types of appropriate development only.

Shellfish farming area: Shellfish farming like mussel-cage activities is actively carried out in the coastal areas, mainly located along Kg Sungai Asam Jawa and Kg Sungai Yu. These areas provide shellfish products for local consumption and other districts as well.

Esas level 3 (controlled development)

Flood prone area: Geographically, Kg Parit Mahang, Kg Bukit Cerakah and Kg Bukit Kucing located <20 m from the sea level. As a result, these areas are frequently hit by the flash flood during the monsoon season. The rapid development of surrounding areas such as rapid development in Puncak Alam causing an excessive surface runoff and overflowing in this flood prone area.

Coastal area and coastal erosion: the analysis shows that along 60 km of coastal area is threatened by prolonging coastal erosion due to both natural and man-made activities which prompt the erosion process. Over the years, it is slowly encroaching the settlement areas such as Kg. Baharu-Jeram-Sg Sembilang, causing damage to property such as roads and shops at the picnic areas. A study conducted by Asmawi and Ibrahim states that the level of erosion in these areas is ranked 1 indicating it is severely dangerous. Selangor has taken short-term and

medium measures through engineering approaches such as the beach protection approach to combat this erosion problem (Asmawi and Ibrahim, 2013). However, due to the nature of the sea water, the engineering approach that involves lots of money could not protect the coastlines for a long time. The structure can damage and needs to be structurally replaced after a certain period.

CONCLUSION

In this challenge of time, the existence of natural resources that are considered as Environmentally Sensitive Areas (ESAs) is essential to manage the development in a sustainable manner. In this regards, the study was embarked to analyse the distribution of ESAs in Kuala Selangor district spatially. The employment of series of GIS/MapInfo environmental related data in collecting and running the analysis has produced the spatial mapping of the various types of ESAs in Kuala Selangor district.

The main composite ESAs plans demonstrate that this district has a broad range of natural resources and ecosystems categorised as ESAs, covering the natural heritage, disaster risk and life support together with their sectoral ESAs. Kuala Selangor district has a diversity of natural resources and ecosystems that require conservation efforts for the benefits of the future generations. These ubiquitous natural resources and ecosystem often get pressure from development that involves physical, economic and social sectors. Thus, an integration of the environmental elements in the preparation of any development plan is highly required to ensure a balanced condition is achieved. A state of a win-win situation between environmental protection and development growth should be practiced in the Kuala Selangor district with the intention of sustainable development.

NOMENCLATURE

ESAs = Environmentally Sensitive Areas
PFR = Permanent Forest Reserves
GIS = Geographic Information System
Kg = Kampung

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