Spatial Analysis Model Assessing Habitat Quality of Selangor

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Abstract. In recent years, ecosystem services mapping has become key as its practical application and offer a wide range of assessment. One of them is habitat quality assessments, which are an excellent significance for protecting biodiversity. This study analyses the changing habitat quality of Selangor, specifically in the Hulu Langat catchment. The spatial analysis model of Integrating Valuation of Ecosystem Services (InVEST) Habitat Quality was used. The tool provides a rapid approach to assess the status and changes in biodiversity. Data used were the land use maps for 2005, 2010 and 2015 and the main threats of wildlife. The model calculates habitat quality and degradation based on intensity and sensitivity. Results show that a number of the area with habitat degradation and degree of habitat quality ranged 0 to 1, which indicate that 0 are the low area biodiversity and nearly to 1 with high biodiversity. The analysis provides input to the government and local authority in assessing ecosystem services through mapping using presented spatial analysis models.

1. Introduction
Biodiversity conservation has been the main focus in many countries around the world, including mega-diverse countries such as Malaysia. Wang et al. [1] explain the main challenge of biodiversity conservation efforts is maintaining habitat quality and connectivity in the face of anthropogenic disturbance.

Habitat quality refers to the ability of the area to provide the right conditions in terms of resources, ecosystem services to the wildlife and functioning for biodiversity. Suitable quality habitats offer resources such as food, safe places and the right weather. Habitat quality is one of the indicators of biological diversity in an area. Assuming an area of suitable habitat quality, it can provide the appropriate resources and ecosystem for biodiversities such as flora and fauna. The role of habitat quality is crucial in maintaining and guaranteeing the survival of biological diversity.

The objectives of this study were to assess the habitat quality of Selangor, specifically of Ampang and Hulu Langat Forest Reserves FR using spatial analysis model established, Integrating Valuation of Ecosystem Services and Trade-offs (InVEST).
2. Methodology

2.1 Study Area

This study covers two Forest Reserve (FR) area of Ampang and Hulu Langat, Selangor. The total area of the forest reserves were 2,292 hectares and 12,842 hectares respectively (Figure 1). For the assessment, we conduct a catchment boundary for both forest reserves.

Digital Elevation Model (DEM) downloaded from https://earthexplorer.usgs.gov (was used as a basis elevation structure of the study area. ArcSWAT modules using Soil and Water Assessment Tool (SWAT) extended with ArcGIS software were used to generate delineated catchment.

Ampang and Hulu Langat Forest Reserve are essential as water catchment areas to the surrounding area. The extensive forest network of both forests was also home to several species of fauna.

![Figure 1. Ampang and Hulu Langat forest reserve catchment of the study site](image)

For this study, the time constraints and the financial resources for conducting a detailed study on the diversity of fauna in the forest reserves, we took the approach of obtaining fauna information through the literature gathered from respective agencies who have done work such as DWNP, The National University of Malaysia (UKM) and WWF.

Full review of the Environmental Impact Assessment (DEIA) study by UKM, 2010 [2] on the KLORR proposal, there are species of large and small mammals, birds and bats. A study conducted at Hulu Langat forest reserve found that 18 species of large and medium mammals from 12 families and 5 orders. Among these species, nine were categorized as Totally protected. The two species were categorized as Protected under the Wildlife Conservation Act (2010). According to the IUCN Red Data Book published by DWNP, 2010 [3], five species are under the category Vulnerable, five were Endangered and three were Near Threatened species. Two mammalians from the ‘Big Five’ group found in Selangor forest reserve, tiger and tapir.

2.2 InVEST Habitat Quality Model

Habitat quality InVEST model incorporates information on land use and biodiversity threats to produce habitat quality maps. This approach yields two sets of information that are useful in making an initial assessment of conservation needs: relative distance and degradation of these habitats. This approach enables rapid evaluation of habitat status and changes. If habitat changes taken as representative of genetics, species, or ecosystem changes, consumers assume that areas of the high quality habitat will better support all levels of biodiversity. InVEST habitat quality assessment takes into account fauna
information rather than flora information. This is because the nature of the fauna has a broader range of wildlife and food sources and needs more significant than the flora/vegetation that is more site-specific.

The analysis was conducted over three different years to assess the impact of land use change on the suitability and quality of habitat change to fauna, especially the dominant mammalian fauna in the area.

2.2.1 Threats
The main threat to habitat is forest loss. Forest loss whether deforestation or logging is a significant factor contributing to habitat disruption as described by Salman, 2011 [4]. Rapid development in Peninsular Malaysia especially in industrial and agricultural states demanded the opening of more forest areas to the event. In this assessment, we constructed a forest degradation with a comparison of 2015 and 2010 forest land use. The threats of forest loss as in Figure 2. Kawanishi et al. [5] reveals among the significant threats too large mammals were the constructions of structures in the habitat such as roads or highways. Statistics show that the number of animals killed on the way was 453 cases in 2015, compared to 136 cases in 2007, news by News Straits Times [6]. Road and highway network was used as a threats of the structures developed near FR as in Figure 3.

![Figure 2. The source of threats; forest loss of Ampang and Hulu Langat catchment.](image1)

![Figure 3. The source of threats; road network in Ampang and Hulu Langat catchment.](image2)

2.2.2 Sensitivity Data
The first factor to be identified as the relative impact of each threat. Some threats may be more damaging to the habitat; some do not have a significant effect on the habitat. Values were based on 0 to 1 index relatively 0 represent the lowest impact to the highest one most considerable effect. The maximum distance between the source of the threats and the habitat of fauna was also required in the model as listed in Table 1. In general, the impact of threats to habitat decreases as the distance from the source of degradation increases. The model also acquired information on the relative sensitivity of each species to the risk in the landscape. It assumed that more habitat types are more sensitive to the source of the threat, which interferes with the quality of the habitat. All the values were evaluated from index 0 to 1, and was obtained from several literature studies conducted by Bhagabati et al. [7] and Sulistyanwan et al. [8]. The Figure 4 showed a flow chart of the model.
Table 1. Maximum distance between the source of the threats and the habitat

| Threat        | Maximum Distance (m) | Weight |
|---------------|-----------------------|--------|
| Road          | 5                     | 0.7    |
| Forest loss   | 1                     | 1      |

![Flow chart of the methodology using the InVEST Habitat Quality model](image)

Figure 4. Flow chart of the methodology using the InVEST Habitat Quality model

3. Results and Discussion

Results in Figure 5, Figure 6 and Figure 7 show the habitat quality index of 2005, 2010 and 2015, respectively. Analysis of 2005 habitat quality, there were some areas within Ampang and Hulu Langat forest reserves value nearly 0, while the entire forest reserves were in index 1. The value of habitat quality is fragmented in both Ampang and Hulu Langat forest reserves especially at the reserve boundaries. The result as shown in Figure 2.

In 2010, the analysis showed the value of habitat quality is improving. The index of Ampang and Hulu Langat forest reserves worth 1. Threats of a forest clearing in the Hulu Langat forest reserve have improved compared to 2005, as in Figure 3.

Analysis of 2015 habitat quality almost identical to 2010, which indicated that there were no significant changes in the catchments. Only a few changes in habitat quality of the basin outside the forest reserve. It is a reflection that the implementation of the moratorium by the Forestry Department of Selangor State
in 2009 had a positive impact not only on land-use changes but also on the quality of habitat to accommodate biodiversity, including flora and fauna. The analysis, as shown in Figure 4.

Figure 5. Habitat quality of Ampang and Hulu Langat FR in 2005

Figure 6. Habitat quality of Ampang and Hulu Langat FR in 2010
4. Conclusion

In conclusion, the value of habitat quality within the Ampang and Hulu Langat forest reserves improved 98% with index quality ranked 1. 2005, 2010 and 2015 changes also showed that the impact of the introduction of moratorium in 2009 had a positive effect on habitat quality and the extent of habitat in this Forest Reserves.

Improvement was also seen not only around forest reserves but some areas outside showing higher quality improvement compared to 2005.

Increasing enforcement to protect these forest areas is necessary to ensure that it can serve as a suitable habitat for much other wildlife and biodiversity. It is an important agenda for the state of Selangor, adding that the surrounding area is involved with a variety of development demands such as the opening of residential or commercial areas, as well as an opening for the construction of highways.

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