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Rerouting Framework for Sustainable Management in Elephant Conservation

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Abstract: Human-Elephant Conflict (HEC) has been identified as one of the major threats to wild elephants throughout their range in thirteen countries, including Malaysia. With development encroaching on the elephant's natural territories, the number of HEC cases has increased. The aim of this study is to focus on developing a framework for elephant rerouting and causeways using geomatics technology and 3D geo-visualization as a strategy to conserve elephants in a sustainable way for Taman Negara Rompin. The framework was used to propose alternative pathways based on rational model. As a result of the framework, four main elements strongly highlighted in the rerouting framework are elephant diet's sources, tracking trails, fencing and deterrents, and the corridor monitoring. These elements are important for rerouting and causeway of the elephant. With the integration of geographical information system, the knowledge needed to protect elephants from HEC can be enhanced.

Keywords: Human-elephant conflict (HEC), Geographical Information System (GIS) in conservation, Taman Negara Rompin

1. Introduction

Malaysia and Indonesia are the only Asian elephant range states with two subspecies. For Malaysian circumstances it is divided into the Borneo and Peninsular Malaysia [1]. Internationally, Asian elephant (*Elephas maximus*) are red-listed under Convention on International Trade in Endangered Species of Wild Flora and Fauna (CITES). Due to the apparent rapid decline of their populations, the conservation status of Asian elephants in Peninsular Malaysia was elevated from 'Protected Species' in 1972 to 'Totally Protected Species' in 2010 [2]. Based on IUCN records, there are only around 40,000 to 50,000 Asian elephants left in the wild.

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Protected Areas (PA) and the condition surrounding PA are crucial for conserving biodiversities, such as large terrestrial mammals such as the Asian elephant and Malayan tiger [3]. One of the important habitats of PA is Taman Negara Rompin Pahang, and Endau-Rompin National Park (ERNP), is one of the last remaining extensive tracts of largely undisturbed rainforest in southern Peninsular Malaysia, where there are estimated 48 Asian elephants within and 87 in the contiguous Permanent Forest Reserve [4]. Although ERNP is almost intact, the forest cover surrounding the park has significantly declined due to intensive agricultural activities [5].

Human-Elephant Conflict (HEC) has been identified as one of the significant threats to wild elephants through its range in thirteen countries, including Malaysia, whereby crop depredation by elephants is often of great concern to plantations and farmers. The conflicts increase when forces such as human population, land use transformation and fragmentation escalate [6]. The main threats were timber logging, forest clearance for agricultural activities and urbanization, which caused habitat fragmentation. Most of the HEC cases are recorded in Johor, according to PERHILITAN's statistics (2006-2015), and the majority of the HECs are due to crop raiding by the elephant. The locations mostly affected are orchards (32% of HEC cases) and plantations (29%). Therefore, a strategy needs to be planned to reduce and prevent the HEC. The advancement of geomatic technology can aid elephant conservation and reduce HEC.

Geomatics technology plays an important role in elephant species conservation. This technology can be used to track elephants' movements and use that data to make appropriate decisions and implementation for conservation purposes. The collection of movement data in the field of wildlife research has been completely transformed by the introduction of GPS technology in wildlife telemetry [7][8]. Strong inference on spatial needs, such as home range size, range changes by season, and movement patterns within the home range, is made possible by the capacity to gather huge quantities of high temporal resolution of location data. Understanding the spatial context of movement and space usage patterns may be ascertained with reasonable simplicity when combined with powerful open-source technology, such as Google Earth Engine [9].

The elephant in Myanmar has been monitored with the help of tracking from GPS collared and high-resolution satellite imageries. This results in a better understanding of how elephants move through human-dominated environments and the efficiency of possible HEC reduction strategies [9]. In addition, with the geomatic technology, by tracking and locating the whale populations or individuals quickly and effectively, you can make effective conservation decisions, including – ship rerouting around critical areas, ship speed reduction recommendations, and fishing gear re-deployment [10]. Besides, the study focuses on developing a framework for elephant rerouting and causeway using geomatics technology and 3D geo-visualisation as a strategy to conserve elephants in a sustainable way for Taman Negara Rompin, Pahang. Geomatics techniques will be used in this project to integrate landscape ecology and elephant behaviour. Digital Terrain Models and features extracted from satellite imagery or aerial photographs of the habitat's area of interest may aid in the understanding of the elephant's conservation biology by providing information such as the terrain type, vegetation, type of water source, and potential harm from nearby human activities.

The objective of this study is to study and review current problems and practices in wildlife elephant conservation and to design a framework for elephant rerouting and causeway.

2. Study Area and Data Used

2.1 Study Area

The area for this study is Taman Negara Rompin, Pahang. Figure 1 shows the location of the study, while Figure 2 shows the area of study that is conducted around Taman Negara Pahang Rompin.

Fig. 1 - Study area surrounding corridor and Taman Negara Rompin Pahang (hashed red) in state of Pahang

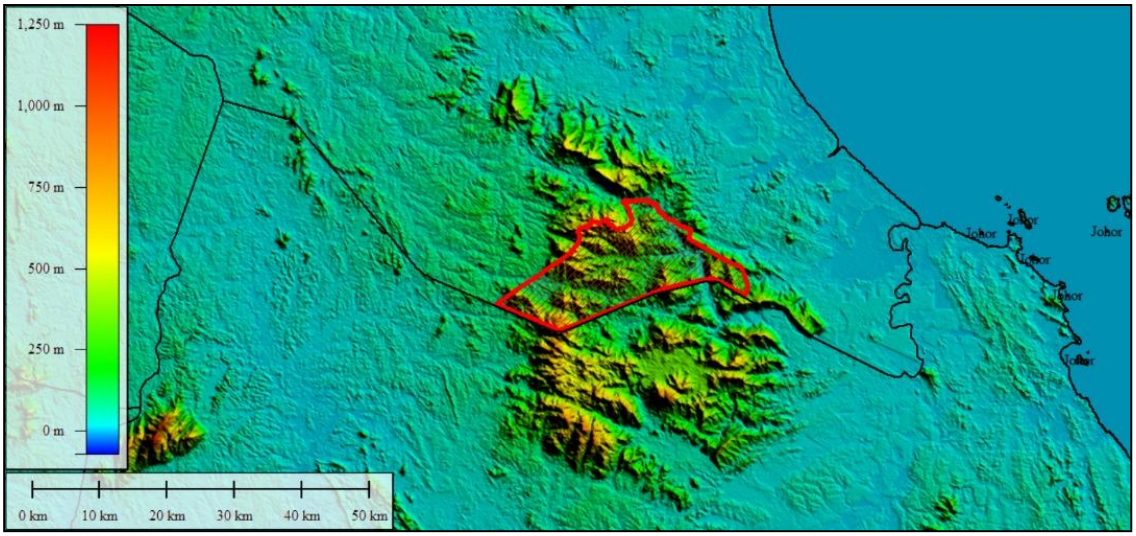

Fig. 2 - The study is conducted around Taman Negara Pahang Rompin with different range of topography

Based on study conducted on ERNP area by [3], the surrounding of ERNP experience significant decrease in forest cover and increase in forest fragmentation due to agricultural land expansion especially for oil palm plantation. Due to important sources of the elephant food supply, this secondary forest surrounding ERNP will affect home range size and movement patterns of the local Asian elephants [11]. Since HEC concern cases in Pahang or the surrounding TNRP, this demonstrate that there is urgent need to have a better strategy in reducing HEC. Therefore, TNRP was chosen as a study area to strategize ways to conserve elephants in a sustainable manner in Pahang.

3. Methodology

3.1 Design Objective

The main objective of the proposed design is to reduce human-elephant conflict through the introduction of a framework for a route planning system by using a Geographical Information System (GIS). The framework of the route planning system has been driven by the information manipulation theory which plays with relevant information in myriad ways within their discourse [12].

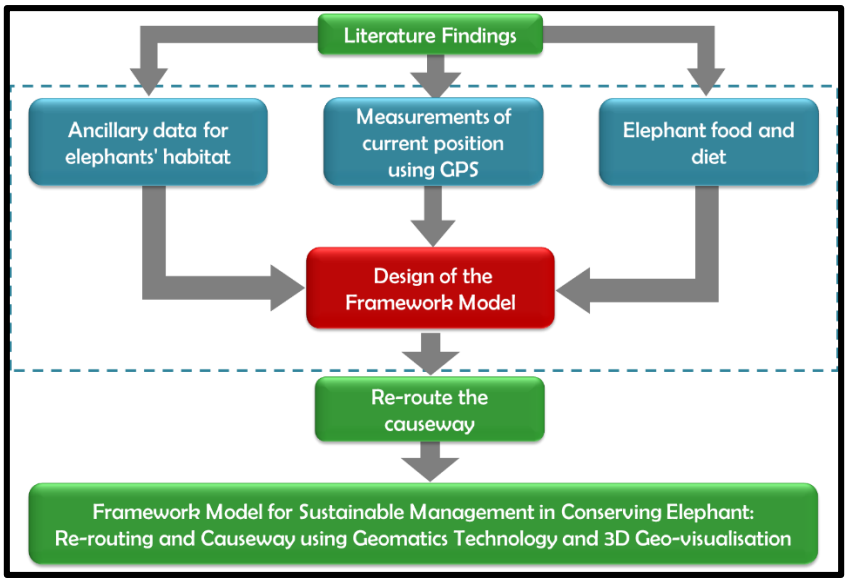

Fig. 3 - Layout of a framework of the elephant route planning

3.2 Design Layout

As is design aims to propose a framework of the elephant route planning system, it needs a layout plan to explain how this framework will work. Ideally, the framework will be used to propose an alternative pathway based on rational model. However, for this research study, the applications of the framework will not be conducted; instead, an expert view

will be considered. Figure 4 shows the proposed design of the framework of the elephant route planning system for the research project.

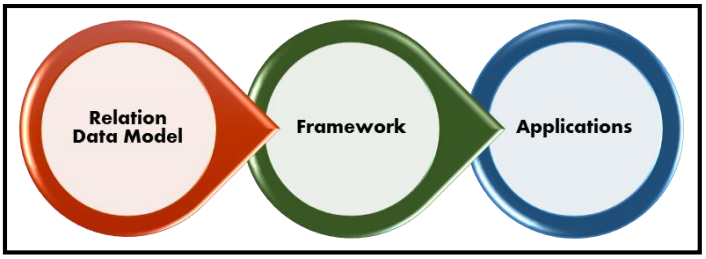

Fig. 4 - Layout of a framework of the elephant route planning

3.3 Technology Assistance

Technology has helped researchers and conservationists uncover several unexpected things. Organizations are employing artificial intelligence-based tools to unravel some other long-held elephant mysteries to save them. Researchers are also studying to find elephants' social systems and communication manners with the assistance of AI algorithms and neural networks. Artificial intelligence can ensure a better future for these marvelous creatures of the earth.

3.4 Geographical Information System

With human-elephant encounters becoming increasingly frequent, MEP is looking for ways to promote co-existence. "One of our big goals is to come up with strategies for how elephants and people could live together," Wall said. To find effective solutions, MEP wants to understand the issues on both sides better. With the help of a Vancouver-based developer, Neeraj Rao, MEP developed Terra Chart, an app for Android phones. The app is used to collect data on fencing, infrastructure, and other key ecological datasets like watering holes and salt licks. MEP then queries the data using advanced spatial analytics in GIS to help answer conservation questions. In partnership with other organizations, MEP has created a spatial database called Landscape Dynamics. Through these efforts, the team documented nearly 2,500 miles of fencing in two years. These long-term changes to habitat, and the loss of range, cause a huge concern about the persistence of elephant populations in the Mara.

Strategies for long-term human-elephant co-existence focus on engaging people in wildlife. It is a goal that requires adaptation to the changing environment in Mara. MEP trains local men and women as rangers who patrol unprotected areas of the Mara. They continue to compile data for GIS analysis and maps that inform spatial planning and help engage and work with local communities.

4. Result and Discussion

Figure 5 demonstrates the essential elements of the elephant rerouting framework. The proposed framework for rerouting the elephant pathway generally consists of mapping the elephant's required sources, tracking path, deterrent and fencing, and monitoring their suitable corridor in the Taman Negara Rompin (TNR). The area of TNR is approximately 730 km^2.

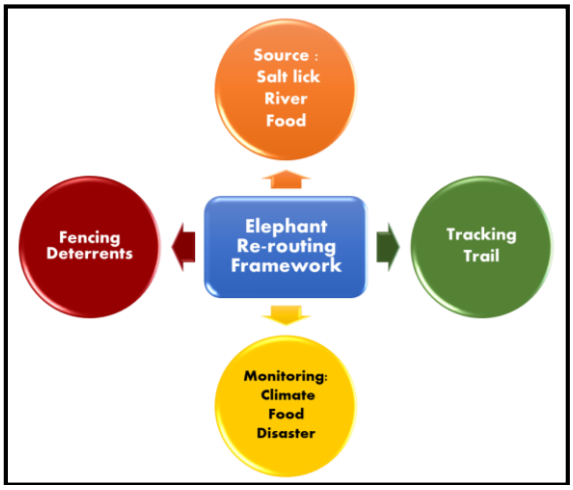

Fig. 5 - Framework of rerouting the elephant

Geomatic technologies tools, known as GIS, will be used to map the source area. The floral distribution on the TNR required to be identified to plan a suitable new route for the elephants. Moreover, the elephant trail obtained from the PERHILITAN, the deterrents or fencing will also be recorded in the GIS. Additionally, the climate change information in that area will be updated, and the vulnerability map of elephant intervention will be produced based on the spatial analysis.

This framework will be the guideline for identifying the most suitable new region and range of the elephant corridor. The corridor for the new route and causeway is necessarily far-off the human territory. Identifying this area can reduce the HEC and enhance the elephant's natural activity. Moreover, by recognizing the elephant behaviors concurrently with the increasingly fragmented human landscapes, the HEC can be reduced and overcome [13]. Elephants can wander for food for approximately 10 km^2 in four months [14]. On that account, the selection of the home range or the trail needs to be determined laboriously.

Another element in the framework is the determination of the fencing and deterrent plantation. This can be implemented at the radius toward the human territory. Some deterrents that can be utilized are beehives or chili since beehives produce buzzing noise and stings. Moreover, electric fences also need to be installed [15] [16].

However, the realization of this framework is a challenging mission. Some aspect needs to be contemplated. For example, the implementation cost and the suitable method to allure the elephant for them to follow and adapt to the new designated route need to be catered. This is due to the cost of the new plantation for their diet since this megaherbivore consumes about 150 kg of food per day [17]. Moreover, the elephant is known as an animal with a very good memory; therefore, elephant rerouting might be onerous.

5. Conclusion

This study showed how the framework works in rerouting elephants from their original route. In rerouting for these elephants, some characteristics need to be considered, such as sources around the area like a salt lick, river, or food, tracking trail, deterrent and fencing around the original route and monitoring their suitable corridors like climate, food and disaster. A low-cost remote sensing system will be used to map this source area, and deterrents and fencing, PERHILITAN will provide a data tracking trail, and spatial analysis will be used in monitoring the suitable corridor for this elephant's habitat.

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