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Rain Forest Recreation Zone Planning Using Geo Spatial Tools

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ABSTRACT

Development and management of forest recreation areas require sound planning. Forest recreation planning is a process of planning recreation areas and their uses in a rational and systematic manner. It is based upon knowledge of the existing state of forest resources, identification of potential recreation sites, identifying pressures from surrounding physical development and the need for proper management of the sites. The advent of Global Positioning System (GPS) and Geographical Information System (GIS) technologies, with their efficient spatial data storage and analysis capabilities, has created a large field of opportunities for the development of new approaches to computer processing of spatial or geographically referenced data, hence, adding a new dimension to the management of large volumes of information needed in forest recreation planning. This paper describes the application of GPS and GIS technologies to map and identify forest recreation zones at Gunung Tebu Forest Reserve (GTFR), in Terengganu, Malaysia. Using GIS spatial modelling techniques, the location and extent of five recreation zones were identified: Campground (7.5 hectares), Hiking (13.7 hectares), Interpretive (4.4 hectares), Picnic (6.7 hectares), and Infrastructure (67.2 hectares). The study showed that GPS and GIS technologies are capable as Decision Support tools in forest recreation planning.

Keywords: Rain Forest, Recreation Planning, Global Positioning System (GPS), Geographical Information System (GIS)

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INTRODUCTION

Tropical forests offer a wide variety of attractive landscapes, fauna, flora, rivers and unique geological features that people seek in outdoor recreation (Chee, 1986). Forest recreational activities range from active pursuits like hiking, camping and swimming to the most passive activity

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such as appreciating the interesting ecological associations, historical and science attractions of the wilderness. The demand for recreational use of the forests in Malaysia increases with population growth, higher educational background, income, mobility and easier access to forest areas. The Forest Department of Malaysia is the main provider of forest recreation resources, managing more than one hundred and fifty forest recreation sites and continuously seeking and setting aside more forests for recreational uses (Anon, 2009).

Forest recreational planning is a complex task. The traditional approach in recreation site planning requires forest managers to identify existing and new recreational resources, followed by identification of zones for specific recreation activity. Thus, an extensive field survey had to be carried out and it resulted in voluminous amount of spatial and non-spatial data both in digital and thematic forms, which in turn had to be stored, displayed and analyzed in the planning tasks.

Information required in forest recreational planning is mostly spatial in nature, and hence, data management and decision making can be improved using geo spatial tools. The advent of GPS and GIS technologies has created an opportunity for computer processing of spatial data, adding

Fig.1: The location of Gunung Tebu Forest Reserve (GTFR) in the State of Terengganu

a new dimension to the management of large volume of information required in decision making process (Healy, 1988). This paper describes the applications of GPS and GIS technologies as Decision Support tools in identifying forest recreation functional zones at Gunung Tebu Forest Reserve (GTFR), in Terengganu, Malaysia.

METHODOLOGY

Study Area

The 25,529 ha Gunung Tebu Forest Reserve (GTFR) is located in Besut District (Fig.1) within the quadrant of latitudes 5° 34' N and 5° 37 N and longitudes of 102° 33' E to 102° 39' E. The topography of GTFR varies from flat to hilly terrains, with the highest point at Gunung Tebu (1037 meters). There are two recreation forests sites at GTFR; the Lata Belatan and Lata Tembakah forests.

METHOD

Outdoor Recreation Resource Survey and Mapping Using GPS

The survey objective was to identify and locate existing and new forest recreation attractions. Existing and new hiking trails were mapped using Garmin GPS. For trails, GPS stations were established at 30 meters interval and their coordinates were recorded. The unique recreation attributes were noted at the stations. Unique fauna along the trails were also recorded. Permanent features such as buildings and campsites were also noted.

Outdoor Recreation Usage and Opinion Survey

A survey on users' opinions towards recreation resource allocation survey was conducted using open-ended questionnaires. The objective was to determine the preferences for the existing facilities and services, as well as future ones. The results were used to establish the criteria for identifying forest recreation functional zones in the study site.

GIS Development and Application

The first requirement is GIS database. This involved database design, followed by data automation and database organization to generate the intended information and spatial analysis. The cost effective approach is to have only information required for recreation planning as it is time consuming and costly to collect and store large volumes of data. The second requirement is data automation. This requirement is the ability to collect and integrate data from various sources in the database. Data sources were existing records, field surveys, remote sensing images and others within the GIS environment. Thirdly, the GIS database must be organized to facilitate easy ad hoc query, generation of new information and spatial analysis. Within the spatial analysis function, the GIS must be able to perform alternative decision scenarios and to display results of advanced spatial modelling technique. The ESRI's ArcGIS Ver. 9.3 software was used in the development of GIS database and spatial modelling application in identifying forest recreation zones.

GIS Database Design

In database design, the basic information is required in the database and both spatial and non-spatial attributes data must be identified. Six main layers were created (see Fig.2): a) Base map, b) topography, c) drainage, d) infrastructure, e) forest stand, and f) other resources.

GIS Database Automation

The GIS database automation processes are:

a. Digitizing existing maps
b. Input of GPS survey coordinates
c. Input of attributes or non-spatial information linked to map features in the GIS layers
d. Data transformation into a common coordinate system

GIS Database Retrieval and Spatial Analysis

The GIS basic operation in the spatial analysis is the ad hoc query and display of spatial features and their attributes. In support of decision-making, "what" and "where" the resources are can be answered quickly. Information on the queried spatial features can be displayed because of the established linkages between the features and their attributes in the database table. Meanwhile, outputs of the query can be viewed in the forms of maps and reports. More importantly, new information and map layers can be generated through various geo-processing capabilities provided by the GIS software.

Various map layers and information were queried from the GTFR's GIS database. The queried locations of the available and

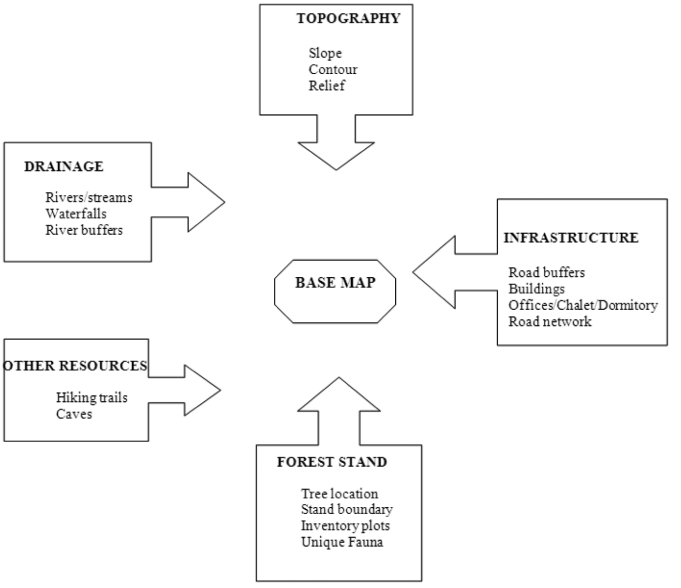

Fig.2: The GIS Database Design for Gunung Tebu Forest Reserve (GTFR)

new recreational resources will be put in the recreation functional zone model in the GIS.

Identification of Forest Recreation Functional Zones

The advanced operation in GIS, as a decision support tool, is spatial modelling. Here lies the advantage of GIS over cartographic, database and statistical software. The spatial modelling technique allows manipulation of the GIS database to generate new information and visualization of "scenarios" from different decision alternatives. "What if" results enable further analysis and refinement before the "best" decision is chosen by the planner? This minimizes the risk of poor planning.

Prior to modelling and identification of forest recreation functional zones at GTFR, the recreation zones must first be determined. The five recreation functional zones were:

- Campground
- Hiking
- Interpretive
- Picnic
- Infrastructure

As the names suggest, these zones reflect the primary recreation activities to be in these locations. Users' preferences obtained from the Outdoor Recreation Usage and Opinion Survey were analyzed and considered in determining the criteria for respective activity zones.

Using the GIS software for spatial modelling, the vector based binary model approach was used. A similar approach was chosen in some previous studies, specifically

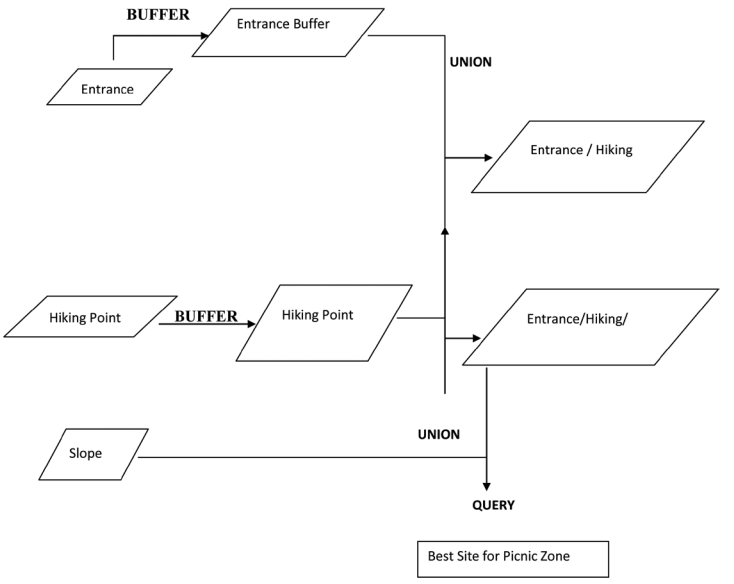

Fig.3: The flowchart of GIS Spatial Modelling Process for Picnic Zone

for site and habitat suitability analysis (Isaac *et al*., 2008; Silberman & Rees, 2010) was used and several phases were involved. These included the generation of new map layers and database queries. Geo processing capabilities, such as "surface generation (slope), "buffering" and "union" tools, were also applied. The "query" function was the final application used to identify the forest recreation zones based on the predetermined user preference criteria. The output created visualization of the respective zone locations, together with spatial statistics. The Picnic Zone identification is used to illustrate the GIS spatial modelling process.

The logical expression for "Query" (using the predetermined criteria for "Picnic zone") is as follows:

IF	land is within 200 meter buffer of the main entrance
AND	land is within 250 meter buffer of first hiking trail
AND	land has slope less than 15 degrees
THEN	the land is selected as Picnic Zone

The above expressions are translated into the ArcGIS software modelling commands, as follows:

INSIDE .LE. 1 AND WITHIN .LE. 1 AND SLOPE-CODE = 73

Where,

INSIDE	Areas within 200 meters buffer from main entrance
WITHIN	Areas within 250 meter buffer from first hiking trail
SLOPE-CODE	Slope code

The attribute code values in the database are:

INSIDE	1 (in 200 meters buffer from the main entrance)
	2 (outside 200 meters buffer from the main entrance)
WITHIN	1 (in 250 meters buffer from the first hiking trail)
	2 (outside of 250 meters buffer from the first hiking trail)
SLOPE – CODE	73 (0 – 15 degrees)
	83 (16 – 25 degrees)
	84 (greater than 25 degrees)

RESULTS AND DISCUSSION

Recreational Resources

With GIS, retrieval and display of natural features and recreational resources of the study site can be carried out. Fig.4 shows the general topography of the study area. LANDSAT TM satellite image of GTFR draped over drainage features is also shown (Fig.5). The "Query" function also enables the visualization of the existing and new recreational resources, specifically the location of the present recreational forests, maps of hiking trails measured in the field using GPS, and the elevation ranges in the study site (Fig.6). This information is necessary as an input into the recreation planning process, where planners are provided with a useful perspective of the study site. The GIS stored information on the

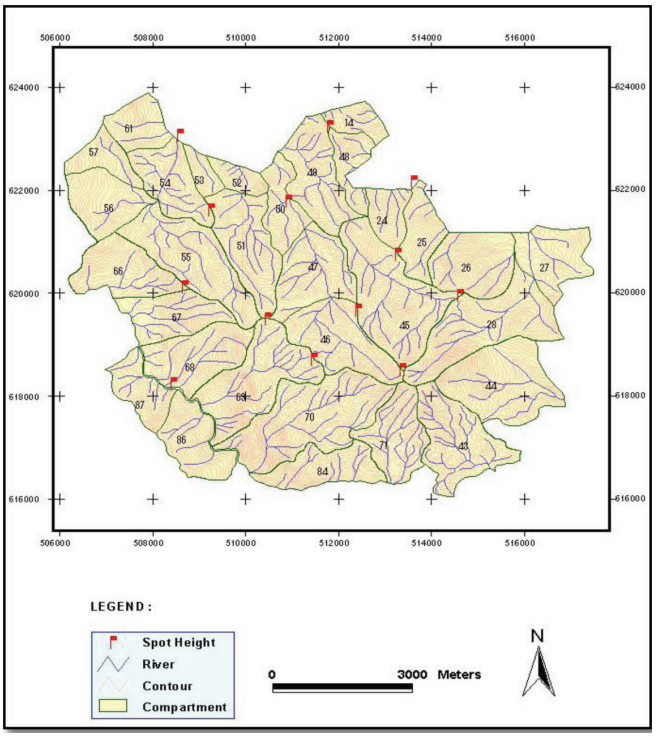

Fig.4: The Topographic Features of Gunung Tebu Forest Reserve, Malaysia

recreation resources can be displayed easily upon request. The spatial analysis capability of the GIS software can also generate new information useful for decision support and modelling such as slope classes (Fig.7).

Forest Recreation Functional Zones

The five recreational functional zones and their aerial extent are shown in Fig.8 and summarized in Table 1, respectively.

TABLE 1
Area Distribution of Forest Recreation Functional Zones

Zone Classification	Area (ha)
Campground	8
Hiking	14
Picnic	4
Interpretive	7
Infrastructure	67

cont'd Table 1

Campground Zone

A campground zone for 7.5 hectares was identified near the peak of Gunong Tebu. The rationale was to provide campers with seclusion for an "optimum" outdoor enjoyment. The backcountry campground type was the most preferred (see Fig.9).

Picnicking is the most popular activity in GTFR. The Lata Belatan Recreational forest is maintained as the Picnic Zone at the study site. The river corridor is popular for bathing as it provides picnickers

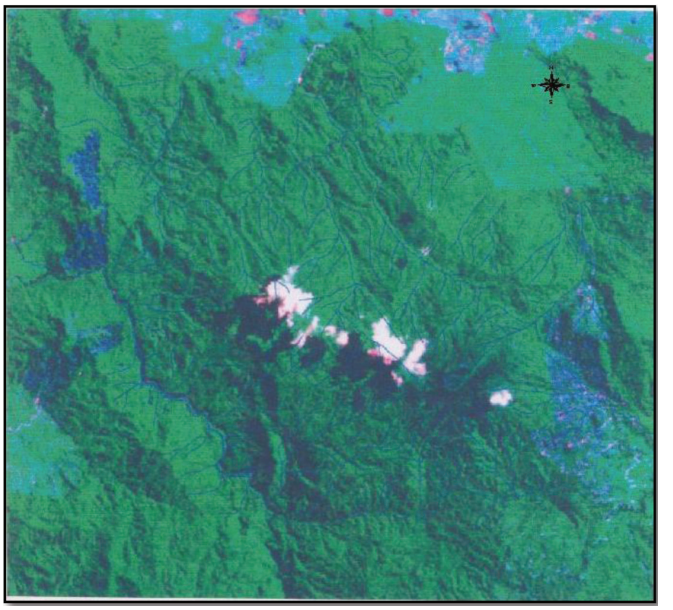

Fig.5: The Landsat TM Satellite Image of Gunung Tebu Forest Reserve, Malaysia Draped over Drainage Features

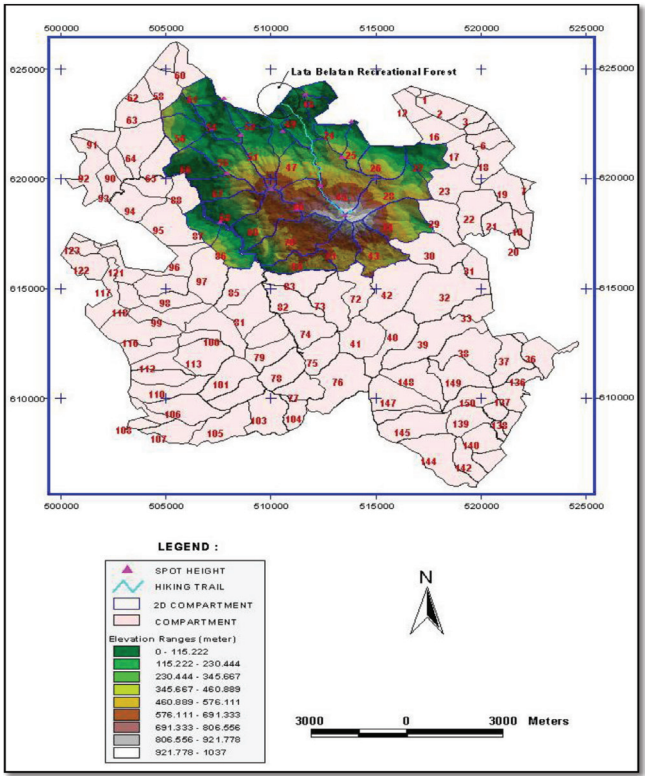

Fig.6: Gunung Tebu Forest Reserve, Malaysia, Elevation with Hiking Trails

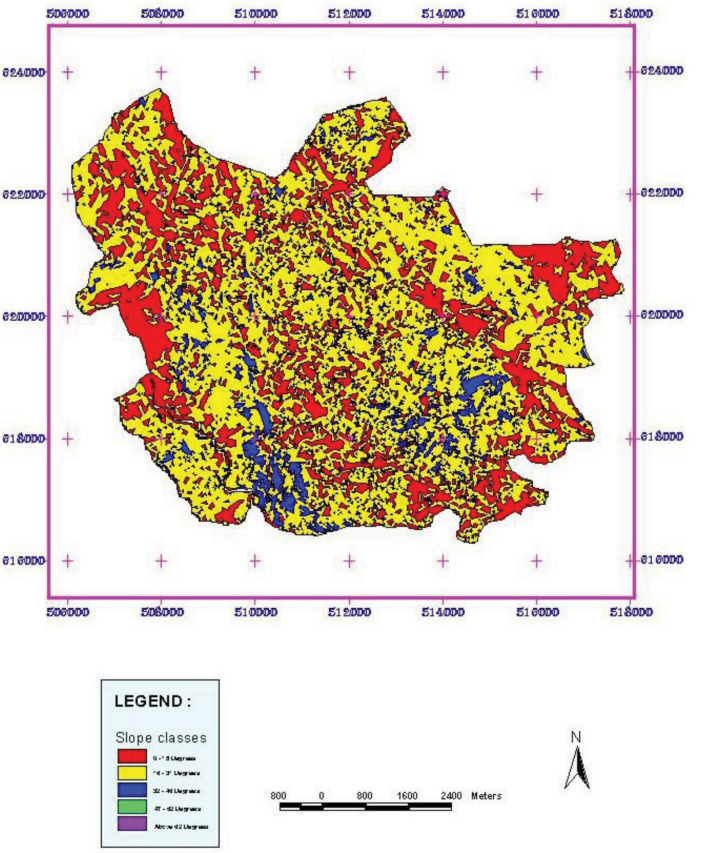

Fig.7: The Slope Classification of Gunung Tebu Forest Reserve, Malaysia

with a nice forest setting for family or group oriented activities. Included in the Picnic zone is a general–use picnic area covering 4.4 hectares (Fig.10). This zone requires establishment of developed activity infrastructure. Developed activities not only add to the convenience, safety and enjoyment of the users, they also serve to keep the people grouped together in places designed to accommodate them, and hence, centralizing wear which reduces soil and water pollution, facilitates rubbish clean-up and infrastructure maintenance.

Hiking, one of the most popular activities among users in GTFR, gives enjoyment at the vistas, unique spots and diverse environments along the trails established at Gunung Tebu (Fig.11). In managing hikers, strict zoning and separation of competing user groups are necessary. The identified hiking zone covers an area of 13.7 ha.

Interpretive Zone

The 6.8 ha interpretive zone is recommended at Gunong Tebu peak (see Fig.12). This was based on the existing and new nature trails

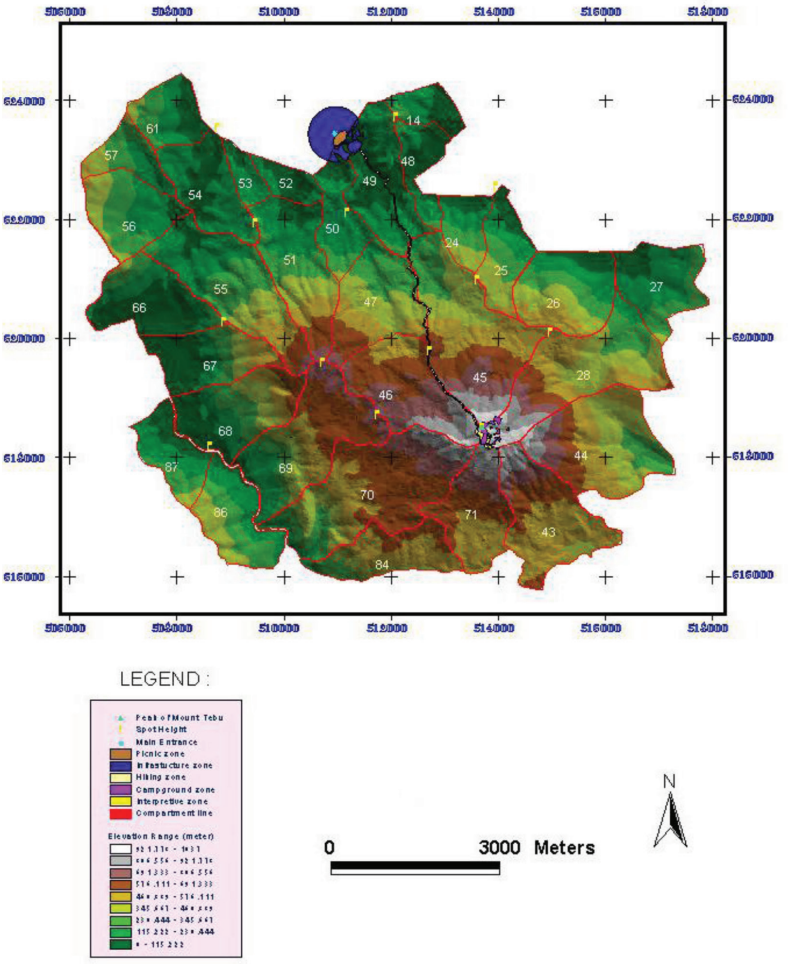

Fig.8: The Slope Classification of Gunung Tebu Forest Reserve, Malaysia

that were identified and mapped using GPS and GIS. Two new trail lines, with trail points characterized by "Medicinal" and "Historical" themes, will be established. This zone is intended to connect users to the legacy, cultural and natural heritage of Gunong Tebu from their first-hand experience. Planners can increase users' recreation enjoyment and experiences by using interpretive techniques such as signage and brochures.

Infrastructure Zone

The infrastructure zone is located at the main entrance of Lata Belatan Recreational Forest (Fig.13). This 67.2 ha zone contains facilities needed to administer and manage GTFR. The administrative offices, infirmary, equipment storage sheds, service personnel living accommodations, store and a central washhouse are sited in this area.

The best location for the administration area is at the end of the existing public access

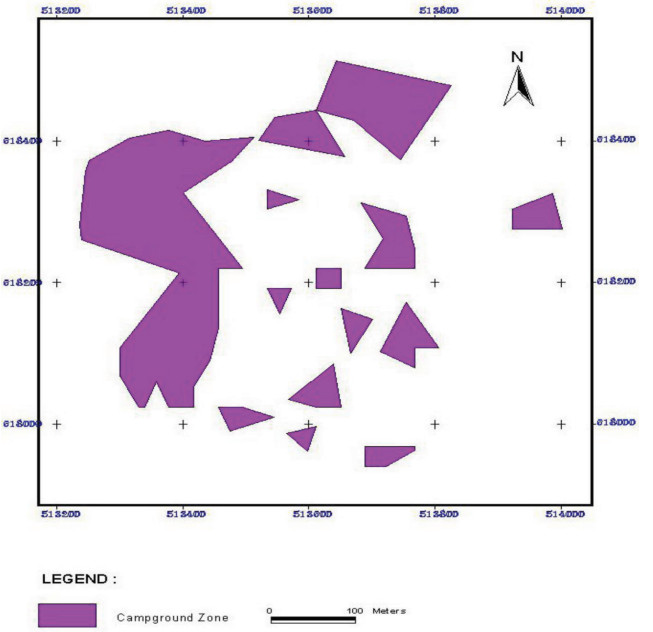

Fig.9: The Campground Zone of Gunung Tebu Forest Reserve, Malaysia

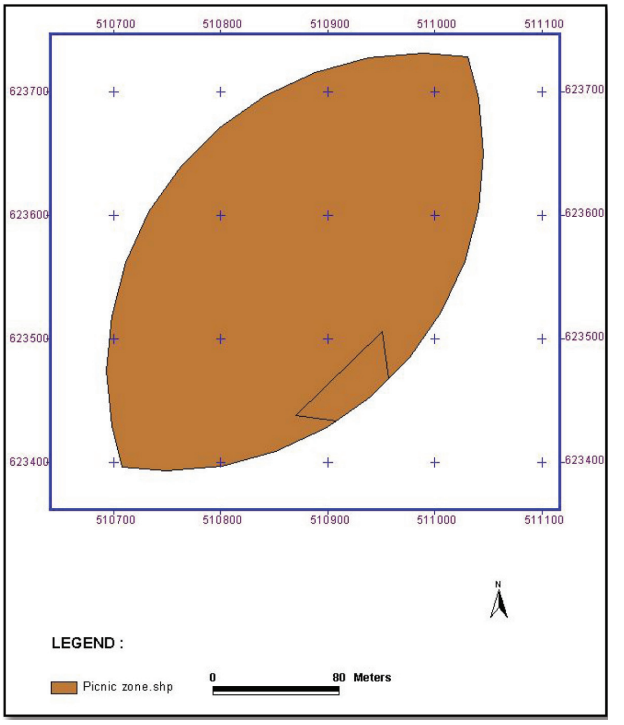

Fig.10: The Picnic Zone of Gunung Tebu Forest Reserve, Malaysia

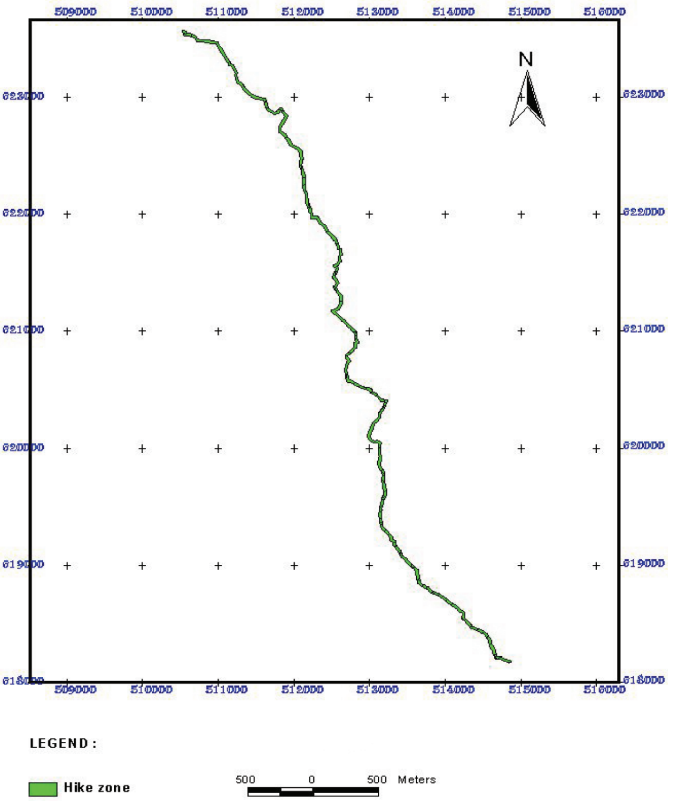

Fig.11: The Hiking Zone of Gunung Tebu Forest Reserve, Malaysia

road. This is more suitable for supplying information and greeting incoming visitors. Being in the vicinity of the main entrance, it is first seen by visitors upon their arrival and last seen before departing. Information on the proper use of the GTFR facilities and public safety can be disseminated in this zone. The road should pass in front of the administrative buildings with adequate parking facilities for staff and the public.

CONCLUSION

The GPS application and GIS spatial modelling techniques have provided some useful information for Forest Recreation Functional Zone Planning at Gunung Tebu Forest Reserve (GTFR). These tools can be used for decision support as alternatives to the traditional manual planning approach. However, it is crucial to note that an effective GIS implementation is possible only when a comprehensive and accurate database is available.

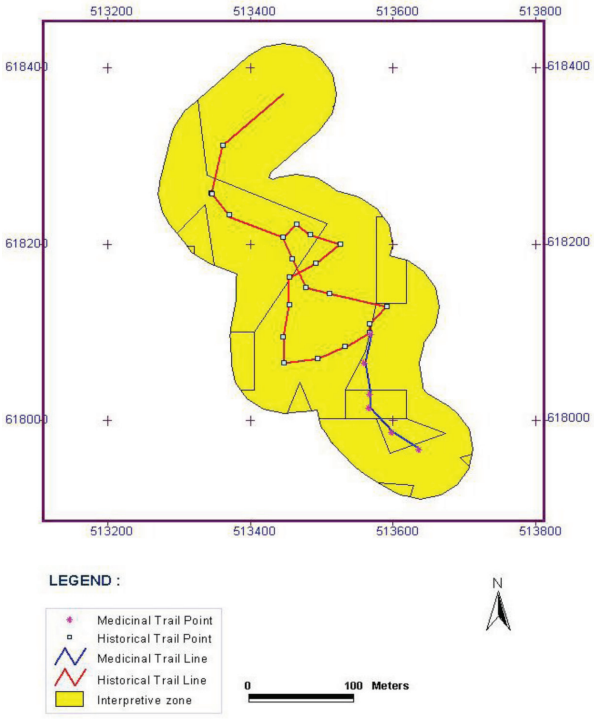

Fig.12: The Interpretive Zone of Gunung Tebu Forest Reserve, Malaysia

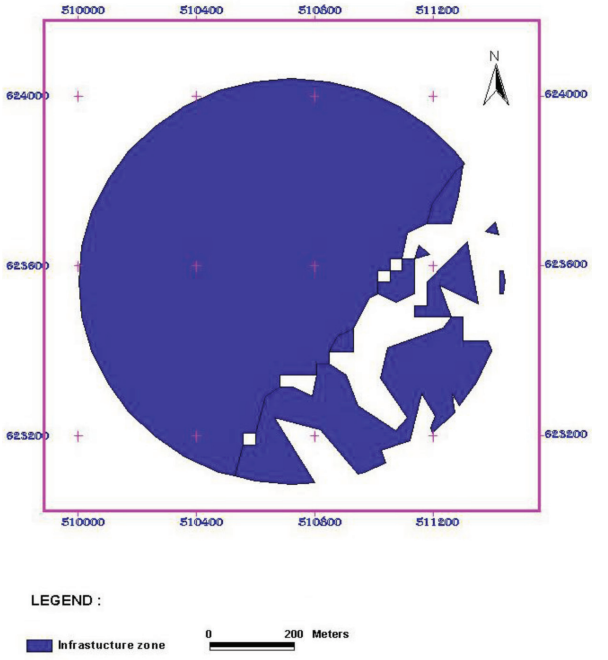

Fig.13: The Infrastructure Zone of Gunung Tebu Forest Reserve, Malaysia.

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