

A GEOGRAPHIC INFORMATION SYSTEM (GIS) AND MULTI-CRITERIA  
ANALYSIS FOR SUSTAINABLE TOURISM PLANNING

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This project is dedicated to the entire members of my family

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## **ABSTRACT**

The need for a sustainable approach in tourism development is very often addressed among the academia, the authorities and the stakeholders, as well as the apparent need for tools which will guide the decision environment in evaluation and planning. This project aims to identify conservation and compatible areas for tourism development in Johor Ramsar site, using spatial modeling in Geographic Information System (GIS). The study describes a methodological approach based on the integrated use of Geographic Information System (GIS) and Multi Criteria Decision Model (MCDM) to identify nature conservation and development priorities among the wetland areas. A set of criteria were defined to evaluate wetlands biodiversity conservation and development; the criteria include tree age class, harvesting season, size of endangered fauna, habitat's proximity to natural land use/ land cover, habitat area and water quality. Having defined the criteria, the next step was selecting suitable indicators and variables to measure the selected criteria. Subsequently the criteria were evaluated from conservation and tourism development point of view. These criteria were then ranked using the pair wise comparison technique of multi criteria analysis (MCA) and the results integrated into GIS. Several conservation scenarios are generated so as to simulate different evaluation perspectives. The scenarios are then compared to highlight the most feasible and to propose a conservation and development strategy for the wetlands area. The generation and comparison of conservation and development scenarios highlighted the critical issues of the decision problem, i.e. the wetland ecosystems whose conservation and development relevance is most sensitive to changes in the evaluation perspective. This study represents an important contribution to effective decision-making because it allows one to gradually narrow down a problem.

## ABSTRAK

Kepentingan pendekatan mampan di dalam pembangunan pelancongan kerap kali di tekankan oleh golongan akademik, pihak berkuasa dan pemegang hakmilik tanah, begitu juga keperluan yang jelas untuk kaedah bagi menentukan cara membuat keputusan di dalam penilaian dan perancangan. Tesis ini bertujuan mengenalpasti kawasan pemuliharaan yang sesuai sebagai kawasan pembangunan pelancongan di kawasan RAMSAR Johor, dengan menggunakan model spatial dalam Sistem Maklumat Geografi (GIS). Kajian ini menerangkan pendekatan metodologi berdasarkan kepada penggunaan bersepadu GIS dan 'Multi Criteria Decision Model' (MCDM) untuk mengenalpasti pemuliharaan alam semulajadi dan keutamaan pembangunan di kawasan paya bakau. Satu set kriteria telah dikenalpasti dalam penilaian pemuliharaan biodiversiti dan pembangunan; kriteria-kriteria adalah seperti kelas umur/kematangan pokok, musim penebansan, saiz haiwan yang terancam, habitat berhampiran dengan gunatanah semulajadi, kawasan habitat dan kualiti air. Melalui pengkelasan kriteria, langkah seterusnya adalah dengan memilih pendekatan/penunjuk bersesuaian dan kepelbagaian untuk mengukur kriteria terpilih. Seterusnya, kriteria-kriteria ini akan di nilai melalui aspek dan pandangan pemuliharaan dan pembangunan pelancongan. Kriteria-kriteria ini akan di susun mengikut carta menggunakan teknik perbandingan cara berpasangan dari 'multi criteria analysis' (MCA) dan keputusan digabungkan di dalam GIS. Beberapa jenis senario pemuliharaan telah di hasilkan seperti untuk kesamaan perbezaan perspektif penilaian. Perbandingan senario dilakukan bagi menentengahkan strategi pemuliharaan dan pembangunan yang berpotensi untuk dilaksanakan di kawasan paya. Penghasilan dan perbandingan bagi senario pemuliharaan dan pembangunan menekankan isu-isu kritikal dalam masalah keputusan, i.e. kawasan paya yang mana pemuliharaan dan pembangunan berkaitan adalah sangat sensitif untuk sebarang perubahan di dalam perspektif penilaian. Kajian ini menjelaskan sumbangan penting bagi penghasilan keputusan yang efektif kerana ia membantu untuk menyelesaikan masalah dengan lebih fokus dan mudah.

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## **CHAPTER 1**

### **INTRODUCTION**

#### **1.1 Background**

The proliferation of mass tourism over the last 50 years has often occurred with little concern for environmental and cultural protection. As outlined by Inskeep (1991) the coastal resorts of the Mediterranean and tourism development in the Caribbean bear witness to this uncontrolled planning and development process. Most of the tourism destinations in developing countries, try to make the best out of this, taking everything out of the environment and causing damage to their land that sometimes can be permanent.

Throng tourism has been responsible for the destruction of valuable wetlands and threatening water supplies in the Mediterranean (World Wildlife Fund, 2005). It warns an expected boom over the next 20 years, with tourist numbers set to reach 655 million people annually by 2025, will strain supplies further. France, Greece, Italy and Spain have already lost half of their original wetland areas. In the case of Spain, tourism expansion near Donana National Park can be seen to compete with the park's wetlands

for already scarce resources. It is further stated that resorts planned on the Moulouya estuary in Morocco could further threaten the endangered monk seal and the slender-billed curlew, one of the rarest birds in Europe. These problems have been responsible for pollution, shrinkage of wetlands and the tapping of non-renewable groundwater in some regions (World Wildlife Fund, 2005).

Not only do they use up their natural resources to support the growing tourism industry, but they also deprive local population of what is rightfully theirs. Yet, all they do is taking without putting much back in. Unless appropriate action is taken, continued growth of tourism will further damage such ecosystems with serious consequences in sustaining long term development and human well being.

Most significantly, however, tourism planning processes have lacked the refined modeling and simulation tools now available to predict potential outcomes from the medium to long term. Similarly, the authorities in charge have lacked tools that can provide them with value-added information that is information about remote locations and unexploited potentials.

Geographic Information System (GIS) are valuable instruments to resource managers in identifying "hot spots" or problem areas needing immediate work, and allow experimentation with various management approaches to working with those resources, without risking those resources in experimentation. Decision support systems, ecosystem modeling, and resource assessment allow users to put GIS data bases to their full use for individualized applications or research studies. GIS is now recognized widely as a valuable tool for managing, analyzing, and displaying large volumes of diverse data pertinent to many local and regional planning activities. Its use in environmental planning is rapidly increasing. Tourism is an activity highly dependent on environmental resources. Hence, the strength of sustainable tourism planning can be enhanced by GIS applications.



## 1.2 Statement of research problem

Wetland ecosystems are often mistakenly undervalued. Few people realize the range of products derived from freshwater habitats such as wetlands - food such as fish, rice and cranberries, medicinal plants, peat for fuel and gardens, poles for building materials, and grasses and reeds for making mats and baskets and thatching houses. These complex habitats act as giant sponges, absorbing rainfall and slowly releasing it over time. Wetlands are like highly efficient sewage treatment works, absorbing chemicals, filtering pollutants and sediments, breaking down suspended solids and neutralizing harmful bacteria (World Wildlife Fund, 2005).

Yet half of the world's wetlands have already been destroyed in the past 100 years alone (World Wildlife Fund, 2005). Conversion of swamps, marshes, lakes and floodplains for large-scale irrigated agriculture, ill-planned housing and industrial schemes, toxic pollutants from industrial waste and agricultural run-off high in nitrogen and phosphorous pose some of the main threats to wetlands. Among threatened species are several river dolphins, manatees, fish, amphibians, birds and plants. In addition, alien 'invasive' species brought from ecosystems in foreign lands disrupt functions in native ecosystems. Africa alone spends about US\$60 million annually to control aquatic invasive species (World Wildlife Fund, 2005).

Johor wetland reflects an extraordinary diversity of Malaysia: a region of lakes, mangroves, and woodlands. Owing to a variety of habitats with fascinating landscape, the wetlands support an incredibly high species biodiversity with a high level of endemism. It has been a major source of attraction to visitors from all over the world. However, tourism development is taking place rapidly in this sensitive wetlands environment with modest concern on the environment. For example the threats faced by the Sungai Pulai mangrove forest around the Port Tanjung Pelapas (PTP) area, it is

alarming to note that the site is surrounded by development, which has encroached into the locale; in addition to this is the continuous logging of its forest in an unsustainable manner. Rapid and unsustainable development of these wetlands and the river basins especially the construction of a new port at the river estuary represent a direct impact on the wetland ecosystem, causing coastal erosion, water pollution and natural habitat destruction from associated dredging and reclamation works and traffic which has led to the disruption of natural hydrological cycles.

The degradation and loss of wetlands and their biodiversity has imposed major economic and social losses; and costs to the human populations of these river basins. Thus, appropriate protection and management of the wetlands is essential to enable these ecosystems to survive and continue to provide important goods and services to the local communities. The main threat to Pulau Kukup comes from the agricultural activities in the straits, coupled with unplanned tourism, hunting, and water activities.

In view of these problems spatial modeling and Geographic Information System (GIS) can be regarded as powerful tools that facilitate mapping of wetland conditions, which is useful in varied monitoring and assessment capacities. More importantly, the predictive capability of modeling provides a rigorous statistical framework for directing management and conservation activities by enabling characterization of wetland structure at any point on the landscape. Spatial (environmental) data can be used to explore conflicts, examine impacts and assist decision-making. Impact assessment and simulation are increasingly important to tourism development in wetland areas, and GIS can play a role in examining the suitability of locations for proposed developments, identifying conflicting interests and modeling relationships. Systematic evaluation of environmental impact is often hindered by information deficiencies. GIS seems particularly suited to this task.

### **1.3 Aim of the study**

The study aims to identify conservation and compatible areas for tourism development in Johor Ramsar site, using spatial modeling of Geographic Information System (GIS) and Multi Criteria Decision Model (MCDM).

### **1.4 Objectives of the study**

1. To study the concept and principles to sustainable tourism/ wetland assessment, environmental modeling and multi criteria evaluation.
2. To identify suitable areas for tourism and economic development in Ramsar site.
3. To conserve unsuitable areas for tourism development in Ramsar site.
4. To develop a GIS and multi criteria evaluation model for the conservation and development of Ramsar site.

### **1.4 Significance of the study**

The study area comprises of Johor wetlands that have been declared as wetlands of international importance at the Ramsar convention, namely Sungai Pulai, Tanjung Piai and Pulau Kukup; all in Southern Johor State not far from Singapore, particularly rich in mangroves and inter-tidal mudflats. These coastal and estuarine sites support a

large number of species, notably vulnerable and threatened species, and provide both livelihoods and important functions for the local population.

These study areas are chosen because of their ecological significance, serving a source of food and water, a place for recreation, education and science and most importantly, a home for the many plants and animals which need wetlands to survive. As well as providing a buffer against coastal erosion, storm surges and flooding; they also provide breeding and roosting sites for migratory birds and local water birds. Wetland plants shelter many animals and birds and are vital for the survival of many threatened species. Information on the location and conservation value of existing wetlands is valuable for anyone, particularly those who are involved in coastal activities including management, recreation and living on the coast.

These study sites are selected among others in view of the problems they face despite their declaration as wetlands of international significance at the Ramsar convention. The Convention on Wetlands, signed in Ramsar, Iran, in 1971, is an intergovernmental treaty which provides the framework for national action and international cooperation for the conservation and wise use of wetlands and their resources. There are presently 154 Contracting Parties to the Convention, with 1650 wetland sites, totaling 149.6 million hectares, designated for inclusion in the Ramsar List of Wetlands of International Importance.

Study will attempt to utilize spatial modeling tools in GIS software, which can be used for tourism development and conservation in the wetland areas. The use of GIS in sustainable tourism development and planning demands the development of indicators of sustainable tourism. This study will be carried out because most previous research have only focused on identifying potentials of the area with regard to tourism, without

looking at its environmental effects. On the other hand a significant number of preceding researches have tended to use the conventional methods of planning and evaluation.

Therefore, Geographic Information System (GIS) application in this respect will be of significant benefit. Since, most environmental planning problems can be shown to have spatial or geographical characteristics and tend to be increasingly multi-dimensional and complex, it is likely that such a project could be more accurately managed using the techniques and tools found in a GIS environment.

The study intends to apply GIS tools and techniques to bring significant value in tourism planning; (a) emphasis remote localities or situations where tourism development is only at the consideration stage and (b) where issues of sustainability are on the planning agenda because the environment remains largely unprotected. The result of this research will aid in exploiting hidden potentials for tourism development, also it will help in preventing conflict between environmentally sensitive areas and the areas to be developed for tourism. Moreover the authorities will be able to monitor developmental activities, to ensure compliance. This in the long run will ensure a sustainable tourism development.

## **1.6 Scope of study & methodology**

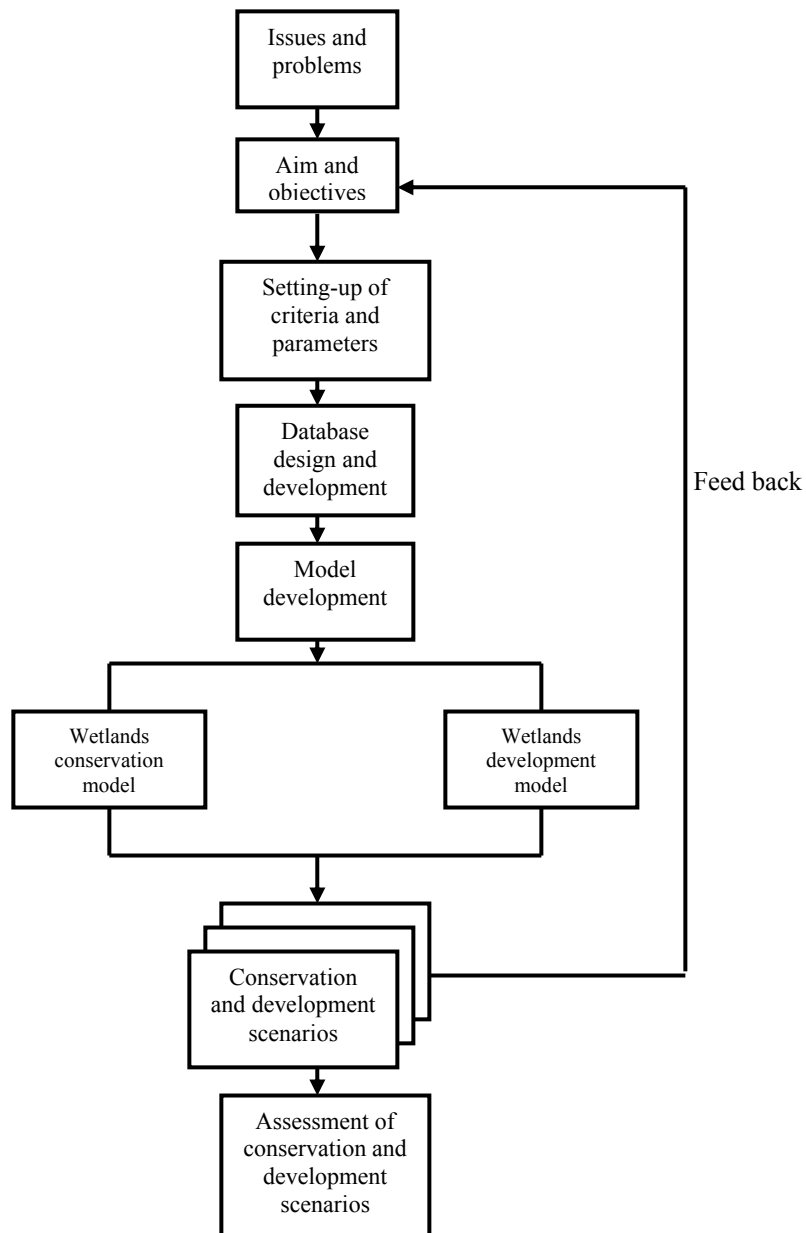
The study will focus only on the physical assessment of the wetlands i.e biodiversity value of the study area using spatial modeling techniques and Multi Criteria Decision Model (MCDM). It will centre on identifying potential tourism areas and areas that needs to be conserved in the wetland area. This study is to understand how GIS can be used to identify potential areas for tourism development; at the same time locating environmentally sensitive areas that needs to be conserved.

Considering the project objectives, the methodology will be looked at from two perspectives i.e conservation and development. The data collection procedure will mainly be based on secondary sources with partial primary investigation of the study sites. The data collected will be processed by the use of Multi Criteria Decision Making model (MCDM) and Geographic Information System (GIS).

In order to assess the relevance for wetlands conservation and development, a set of evaluation criteria will be selected and suitable indicators to measure the selected criteria. These criteria will be represented in form of data layers, representing different needs for conservation and development. Subsequently the criteria will be evaluated by reclassifying the data layers; they will be evaluated from conservation point of view by considering areas of high biodiversity as most relevant for conservation and low biodiversity areas most appropriate for development. This will be computed by using typical functionalities of raster-based GIS; such as distance operators, conversion and reclassification functions. The GIS package ArcGIS 9.0 will be used because it is provided with tools for analysis and transformation of raster data.

Pair wise comparison method of Multi Criteria Evaluation will be used in order to support solution of a decision problem by evaluating possible alternatives from different perspectives. The pair wise comparison will be developed in Microsoft Excel and results transferred into ArcGIS framework. Alternatives to be evaluated and ranked will be represented by different criterion maps. As different criteria are usually characterized by different importance levels, the subsequent step of MCE will be the prioritization of the criteria by means of pair wise technique; which allows for the comparison of two criteria at a time. This can be achieved through the assignment of a weight to each criterion that indicates its importance relatively to the other criteria under consideration. Conservation and development scenarios will be generated, with each scenario representing the best solution to decision problem, according to the assessment perspective adopted. Map scenarios reflecting the opinion of different experts or

stakeholders involved will be compared using the Boolean overlay approach of GIS, in order to highlight the robustness of the solution and support decision making (Figure 1.1)



**Figure 1.1: Conceptual framework of the study**

## **1.7 Limitations of the study**

This project will be restricted to identifying potential tourism and conservation areas only and will not be dealing with other aspects of tourism as; travel cost, perception, definition of wilderness and other principles inherent to sustainable tourism. Also the study will dependent on secondary data, with partial primary investigation of the study sites.

Another limitation is in the technique to be used in data analysis. This technique (pair wise comparison method) has the capacity of comparing only two criteria's at a time. Also the highly subjective nature of preference weights and rapid elicitation of the method can lead to questions of validity. Moreover problems with inconsistencies in preferences between objectives sometimes arise.