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Research Article

A Framework for Sustainable Tourism Planning in Johor Ramsar Sites, Malaysia: A Geographic Information System (GIS) Based Analytic Network Process (ANP) Approach

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Abstract: This study presents an approach based on an integrated use of GIS, ANP and Water Quality Index (WQI) for sustainable tourism planning in a wetland environment (Ramsar site). ANP will be utilized to evaluate the relative priorities for the conservation, tourism and economic development of the Ramsar sites based on chosen criteria and indicators (elements). Pair wise comparison technique will be used in order to evaluate possible alternatives from different perspectives. To reflect the interdependencies in the network, pair wise comparisons will be conducted among all the elements. As different elements are usually characterized by different importance levels, the subsequent step will be the prioritization of the elements, which allows for a comparison among the elements using expert opinion as input and the results transferred into GIS environment. Elements to be evaluated and ranked will be represented by criterion maps. The criterion maps will be evaluated by reclassifying the data layers, to represent different needs for conservation and development of the Ramsar sites. To determine the water quality of the river, parameters of the sampling stations will be used to calculate the sub-indices. Consequently surface data of water quality will be generated from the points of the sampling stations and decisions taken appropriately. Map layers reflecting the opinion of different experts involved will be compared using the Boolean overlay approach of GIS. Subsequently conservation, tourism and economic development models will be generated, which will ensure that tourism maintain the viability of the study area for an indefinite period of time.

Keywords: Analytic network process, geographic information system, sustainable tourism, water quality

INTRODUCTION

Tourism is the fastest growing industry in developing countries (TIES, 2009). However, it is associated with negative impact which includes deforestation, pollution, indigenous culture loss, habitat and biodiversity loss, have caused an enduring damage to pristine environments in some of the regions. Tourism is the major environmental burden in some of its destinations (Tubb, 2003). In fact, generally this pressure degrades the natural values of the protected areas resulting in lower amenity value for tourists. Therefore, tourism should be proposed as a driving force for sustainable development, not as an aim in itself. Several scholars (Cottrell and Vaske, 2006), have been advocating for a certain type of tourism as desirable as it could contribute to the conservation of biological diversity, environmental education to the tourists, protection of the local culture, economic development for the inhabitants and provide funding for maintaining their environmental values.

The 1992 World Summit held in Rio de Janeiro, asserted that there is a need for a more balanced approach in development planning and therefore charted a framework in which economic, socio-cultural and environmental aspects are equally important for a sustainable future. Since then, governmental and non-governmental organizations, international, national and the academic community have been trying to construe the term sustainable development. One way of doing this is to examine the concept of sustainability and establish how it applies in the various sectors of the economy. Tourism is an economic activity and cannot be ignored as its progress strongly relies on the environmental and socio-cultural resources. A definition of sustainable tourism is rather clear; Sustainable tourism may be thought of as "tourism which is in a form which can maintain its viability in an area for an indefinite period of time" (Butler, 1993).

For any proposal to be sustainable it means having a model in which to compare the proposal: criteria and indicators. It is an established fact that such a model is difficult to obtain because of the need to consider a number of variables and the relationships among them, which are usually complicated to set. On the other

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hand, for a model to be accepted, it has to arise from a compromise among the stakeholders as much as possible. Otherwise some of the stakeholders may feel biased. Therefore, they may not give their support on the chosen decisions according to the model (Grundey, 2008). Thus making decision in the field of sustainable tourism means reaching a compromise about sustainability models and also asking stakeholders to make assessments of a proposed plan (Videira *et al*., 2003). Leskinen (2007) and Gómez-Navarro *et al*. (2009) have highlighted the importance of truthfully modeling reality when handling decisions that affect sustainability in one way or another. In particular, Leskinen (2007) has proved the outcome of the end model of the problem when the aim of the decision deals with protection of the environment.

Analytic Network Process (ANP) which is a Multi Criteria Evaluation (MCE) can help the decision makers to translate a number of variables and the relationships between them into manageable units of information. ANP has the capability to evaluate physical processes such as sustainable tourism using expert opinion to make the best selection among the variables under consideration. The result of the ANP will be integrated into Geographic Information System (GIS) environment. GIS can be regarded as a tool that eases the mapping of wetland conditions, which is useful in varied monitoring and assessment capacities. In addition to this, the predictive capability of modeling provides a thorough statistical framework for directing management activities by enabling characterization of wetland structure at any point on the landscape. Spatial data can be used to explore conflicts and assist decision-making. 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 hampered by information deficiencies. GIS seems particularly suited to this task. Hence, the strength of sustainable tourism planning can be enhanced by a GIS based Analytic Network Process.

One of the first studies of GIS in tourism planning is discussed by Berry (1991) in the US Virgin Islands. Using three models he defined conservation areas, ecological research areas and areas of residential and recreational development while, a fourth model was used for conflict resolution among competing uses. Mahsa *et al*. (2011) used multi-criteria evaluation method and GIS as a practical instrument to evaluate the suitability of Guilan Province coast of Iran for sustainable tourism destinations. In order to select destination of sustainable coastal tourism using Analytical Hierarchy Process (AHP) and GIS, three distinct procedures were exercised, namely: Using GIS to generate information layers; GIS was used to analyze layers of information in order to determine primary coastal tourism sites by Boolean logics.; and lastly the utilization of GIS to analyze layers of information in order to determine priority of sustainable coastal tourism destination with AHP.

Similarly, Boyd and Butler (1993) demonstrated the application of GIS in the identification of areas suitable for ecotourism in Northern Ontario, Canada. At first, a resource inventory and a list of ecotourism criteria were developed. At a next stage GIS techniques were used to measure the ranking of different sites according to the set criteria and therefore, identify those with the 'best' potential. Minagawa and Tanaka (1998) used GIS to locate areas suitable for tourism development at Lombok Island in Indonesia. The main objective was to propose a methodology for a GIS based tourism planning. Using map overlay and multi-criteria evaluation, a number of potential sites for tourism development were identified. Williams *et al*. (1996) also used GIS to record and analyze tourism resource inventory information in British Columbia, Canada. He developed a tourism capability map which indicates areas of high, moderate and low capability for specific tourism activities. Boers and Cottrell (2007) used GIS in sustainable tourism infrastructure planning, which involves three phases: a visitor segmentation phase, a zoning phase and a transportation network planning phase. Bunruamkaew and Murayam (2011) used GIS and AHP to identify and prioritize the potential ecotourism sites in Surat Thani Province, Thailand. He used four steps to produce site suitability map for ecotourism and these are: finding suitable factors to be used in the analysis; Assigning factor priority to the parameters involved; Generating land suitability map of ecotourism; and determining ecotourism potential areas.

Looking at the previous studies, they only utilized Analytic Hierarchy Process (AHP) of Multi-Criteria Evaluation (MCE) on dealing with tourism issues. However, AHP has been criticized to be insufficient in handling complex decision problems like sustainable tourism. AHP considers elements to be independent of all others, which rarely occurs in real life situation. For this reason, the AHP technique has been widely condemned (Nekhay *et al*., 2009). In general, AHP's failure is attributed to the fact that, the weight of each criterion is independent of the evaluations of the available alternatives with respect to this criterion, which is caused by the way, in which the method derives these weights from decision-makers.

ANP which is a more general form of the Analytic Hierarchy Process (AHP) in Multi Criteria Evaluation (MCE) will provide a significant benefit to sustainable tourism planning. ANP can model complex decision problems where AHP is not sufficient. ANP allows interaction and feedback within clusters (inner-dependence) and between clusters (outer-dependence) (Neaupane and Piantanakulchai, 2006). Like in many real world situations ANP considers elements to be interdependent to each other thus making accurate

predictions. ANP provides a thorough framework to include clusters of elements connected in any desired way to investigate the process of deriving ratio scale priorities from the distribution of influence among elements and among clusters (Saaty, 2003). The Analytic Network Process through feedback can better capture the complex effects of interplay in human society and subsequently guides to the best choice in a way that matches the common sense. This study therefore aims to make the best selection among the factors responsible for wetland conservation, tourism and economic development using ANP and translate the result of ANP into spatial models using GIS techniques.

DEFINITION OF TERMS

Ramsar: Is a name of a city in Iran, where an international treaty for the conservation and sustainable utilization of wetlands was signed, i.e. to stem the progressive encroachment on and loss of wetlands now and in the future, recognizing the fundamental ecological functions of wetlands and their economic, cultural, scientific and recreational value.

Wetland: A wetland is defined as an environment at the interface between truly terrestrial ecosystems and truly aquatic systems making them different from each yet highly dependent on both (Mitsch *et al*., 1986).

MATERIALS AND METHODS

Study area: The study area consist of three designated Wetlands of International Importance, namely; Sungai Pulai, Tanjung Piai and Pulau Kukup; all in southern Johor State of Malaysia 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 (Fig. 1):

- Pulau Kukup is a state park (Johor), located at 01°19'N, 103°25'E. It is an uninhabited Mangrove Island situated 1 km from the southwestern tip of the Malaysian peninsular with a land area of 647 ha; this is 1 of the few intact sites of this type left in Southeast Asia. The wetlands support a large number of threatened species; it has been identified as one of the Important Bird Areas (IBA) for Malaysia.
- Sungai Pulai is located at 01°23'N, 103°32'E; it's a forest reserve and the largest riverine mangrove system in Johor State, having a land area of 9,126 hectares. With its associated sea grass beds, inter-tidal mudflats and inland freshwater riverine forest the site represents one of the best examples of a lowland tropical river basin, supporting a rich biodiversity dependent on mangrove.
- Tanjung Piai is a state park (Johor) located at 01°16'N 103°31'E, with a land area of 526 hectares. The site consists of coastal mangroves and inter-tidal mudflats located at the southernmost tip of continental Asia, especially important for protection from sea-water intrusion and coastal erosion.

Fig. 1: Study area

DATA SOURCES AND TECHNIQUES

Considering the research objectives, the methodology will be looked at from wetland conservation, tourism and economic development point of view. The data collection procedure will mainly be based on secondary sources with primary investigation of the study sites, including the administration of questionnaire and interview. Secondary data will include a high resolution satellite image, hard copy maps and CAD files and attribute data. Data extraction will be performed on the satellite image in order to generate part of the vector data. Hard copy maps will be scanned in TIFF format, cleaned, geo-referenced and digitized into a GIS compatible format. Cad files such as AutoCAD will be imported into GIS environment through data migration, to generate another set of vector data. Attribute data will be captured into GIS by using the JOIN function to relate it to object geometry as part of database generation. Primary data will be captured through a physical survey of the study area in order to confirm some points on the satellite image, also static Global Positioning System (GPS) will be used to get points of interest. Data source agencies will include department of survey and mapping Malaysia, Malaysia center for remote sensing, department of national parks and other relevant agencies. The data collected will be processed using Geographic Information System (GIS) and Analytic Network Process (ANP) of Multi Criteria Evaluation (Fig. 2).

In order to assess the relevance for wetlands conservation and development, a set of criteria and nodes (elements) for sustainable tourism development will be selected. Pair wise comparison technique will be used in order to support solution of a decision problem by evaluating possible alternatives from different perspectives (Aminu, 2009). This can be achieved through the assignment of weight to each element that indicates its importance relatively to the other criterion or node under consideration using expert opinion as input.

After the weights have been derived from the pair wise comparison technique, the next step will be to compute the unweighted super matrix, weighted super matrix and the limit matrix. Unweighted super matrix will be generated using the results of all pair wise comparisons made throughout the network. The weighted super matrix will be obtained by multiplying all the elements in a component of the unweighted super matrix by the corresponding cluster weight. Afterwards the limit super matrix will be computed by raising the weighted super matrix to powers until it converges. When the column of numbers is the same for every column, the limit matrix has been reached and the matrix multiplication process will be halted; and the

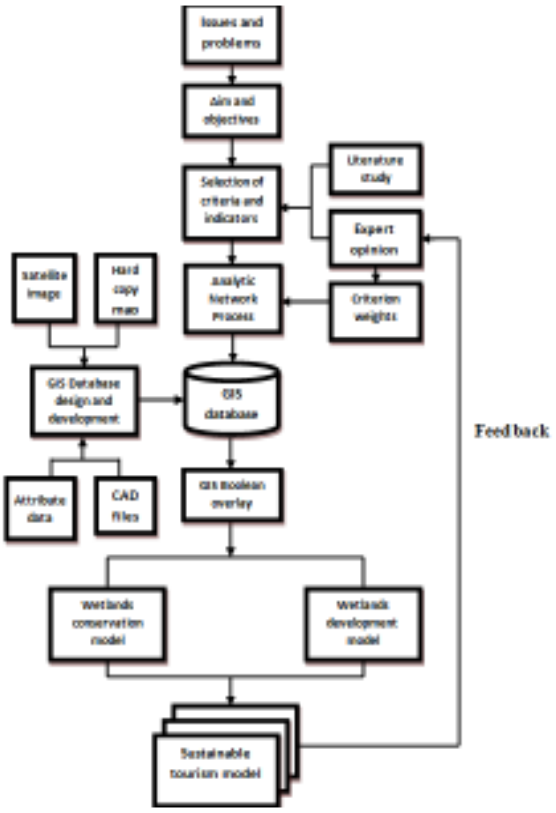

Fig. 2: Methodology

limit matrix will be normalized to obtain the priorities. The ANP computations will be developed in the super decision software and results transferred into GIS environment, with the aid of ArcGIS software.

Elements to be evaluated and ranked will be represented by criterion maps. The criteria will be evaluated by reclassifying the data layers, to represent different needs for conservation and development. This will be computed using typical functionalities of raster-based GIS such as distance operators, conversion and reclassification functions. To determine the water quality of the river in the study area as part of the wetlands evaluation, parameters of the sampling stations will be used to calculate the sub-indices and the result will be substituted into the equation for Water Quality Index (WQI) in order to obtain the final result. Having computed the result, surface data of water quality will be generated from the points of the sampling stations using interpolation technique of GIS to predict values in unknown locations. Decisions will be taken based on the classes of interim national water quality standards of Malaysia.

EXPECTED RESULTS

This research will produce a new model based on an integrated use of GIS and ANP for sustainable tourism development. The model will have three sub-models, namely: conservation model, tourism and

economic development model. The conservation model will map out wetlands areas that will be protected from certain form of tourism activities and other forms of development, identifying different suitability levels for wetland conservation. The tourism development model will map out areas in the wetland that could be used for tourism activities that do not cause any form of negative impact in the area of study. And, the economic development model will map sections of the wetland that could be utilized to yield some economic gain to the local people, without causing harm to the wetland environment. This research will also map out water quality of the river in the study area, therefore revealing sections of the river that should be conserved as well as areas that could be utilized for low impact tourism and economic activities. This will be in accordance with Malaysia's Department of Environment (DOE) Water Quality Index (WQI) classification.

CONCLUSION

The development of a GIS based ANP for sustainable tourism development in Johor wetlands will offer many prospects; such as those for nature conservation which, given the increasing interest in high quality natural and cultural experiences, can help to reverse the destructions caused to these destinations. This study will provide an economic incentive to conserve natural environments and habitats, which might otherwise be allocated to more environmentally damaging land uses, thereby, helping to maintain the bio-diversity. Areas that can be used for tourism development will be determined in the wetland area. Tourism activities in these areas will ensure a viable one, considering the variety of regulations and guidelines to be imposed in carrying out these activities i.e., the more the biodiversity level and threats of an area in the wetlands, the more strict regulation for the execution of tourism activities. Economic development areas will also be ascertained, by identifying forest compartments and water areas that could be used by the local people and the authorities for economic gains. Hence, boosting their economic level and providing quality employment, at the same time minimizing the impact in the wetland environment. This in the long run will ensure a form of tourism development that will maintain its viability in Johor Ramsar sites for an indefinite period of time.

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