Ecotourism Prioritization: A Geographic Information System Approach

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ABSTRACT

This article demonstrates the significant and uses of Geographical Information System (GIS) in multi-criterion decision-making framework (MCDM) in solving a spatial multi-objective problem of ranking and prioritizing tourist spots for ecotourism development. The ranking model adopted allows formal analysis of the effects of alternative weighting schemes and their spatial sensitivity on national park ranking. Through this modern technique of GIS sanctuaries/national parks of the world can be ranked accordingly for prioritization in order to allocate funds for ecotourism development so as to derive at desired and maximum goals.

KEYWORDS: *Ecotourism, environmental, biological, cultural diversity, spatial analysis, GIS*

INTRODUCTION

Ecotourism, also known as ecological tourism, is a form of tourism that appeals to ecologically and socially conscious individuals. It typically involves travel to destinations where flora, fauna, and cultural heritage are the primary attractions. Responsible ecotourism includes programs that minimize the negative aspects of conventional tourism on the environment and enhance the cultural integrity of local people. Therefore, in addition to evaluating environmental and cultural factors, an integral part of ecotourism is the promotion of recycling, energy efficiency, water conservation, and creation of economic opportunities for the local communities. Ideally, ecotourism should satisfy several criteria, such as conservation of biological diversity and cultural diversity through ecosystem protection promotion of sustainable use of biodiversity, by providing jobs to local populations sharing of socio-economic benefits with local communities and indigenous people by having their informed consent and participation in the management of ecotourism enterprises tourism to unspoiled natural resources, with minimal impact on the environment being a primary concern. minimization of tourism's own environmental impact affordability and lack of waste in the form of luxury local culture, flora and fauna being the main attractions For many countries, ecotourism is not simply a marginal activity to finance protection of the environment but is a major industry of the national economy. For example, in Costa Rica, Ecuador, Nepal, Kenya, Madagascar, and Antarctica, ecotourism represents a significant portion of the gross domestic product and economic activity.

In the 1980s, alternative forms of tourism began attracting the interest of governments, communities and scholars alike. These were given a raft of names—"nature tourism", "soft tourism", "responsible tourism", "green tourism", "ecotourism" (Schaller, 1999), but all were seen as alternatives to mass tourism. Among these various labels, the term "ecotourism" has become prominent, although a consistent definition is by no means found, even among scholars (Schaller, 1999). Most definitions do, however, incorporate concepts associated with

sustainable development. For example, in *Sustainable development*: *Exploring the contradictions*, Redclift (1987) attempted to integrate economic development with ecological sustainability, and his work has served as a conceptual basis for ecotourism researchers such as Zurick (1992). Dearden (1991) and Hunter and Green (1995) use the definition espoused by the World Commission on Environment and Development: "development that meets the needs of the present without compromising the ability of future generations to meet their own needs" (WCED, 1987). Many scholars now agree that ecotourism should require a two-way link between tourism and environmental conservation (Valentine 1993; Cater, 1994). As the understanding of the close relationships between tourism and environmental conservation increases, researchers are calling on ecotourism industry to incorporate economic development as a fundamental element of conservation (West and Brechin, 1991:392). These concerns highlight a critical difference between “nature tourism” and “ecotourism,” at least as the latter term will be defined here. Nature tourism is "based directly on the use of natural resources in a relatively undeveloped state, including scenery, topography, water features vegetation and wildlife" (Healy, 1988: 1). It is also based upon the desire of people to experience nature in their leisure time. The growing levels of participation have led to the recognition of sub-markets. Eagles (1995a) proposed that nature-based tourism has at least four sub-markets (Figure 1), differentiated according to the travel motives of the tourists.

Figure 1. Tourism sub-markets

Among these subdivisions ecotourism may be the fastest growing tourism submarket. The growth of ecotourism primarily involves travel by Europeans and North Americans to all parts of the world. For example, Eagles and Wind (1994) found that Canadian ecotour companies visited fifty different countries in 1992. Recently, with rapidly developing economies in Asia, ecotourists from these countries are entering the market as consumers. The number of ecodestinations expands with the increases in park numbers. There is now a worldwide nature travel market, with tourists from many countries travelling to destinations in many other countries (Zurick, 1992). Ecotourism has an idealistic agenda, defined by Drumm (1991: 54) as "progressive, educational travel, which conserves the environment and benefits local communities." Because it is both succinct and sufficiently ambitious, this definition will be used here.

Tourism has always been considered a vital medium for widening the scope of human interests (Eagles, 1997). It contributes positively to the nurturing and exploration of cultural heritage of nations. It therefore serves indirectly to improve the individual cultural understanding of both residents and foreigners, while at the same time contributing to the gross national product. At the local level, domestic tourism creates an understanding and appreciation of the attractions thereby, contributing to sustainable tourism development (Eagles, 1997). It should be noted also that eco-tourists uses local resources and expertise, which in turn translates into import savings. The use of local resources and expertise also translates into environmentally sensitive patterns of resource use and local participation in the tourism industry (Pigram, 1980). Its emphasis on local resources and employment makes it attractive to developing countries, which, although rich in natural resources are disadvantaged by rural poverty and the lack of export earnings (Eagles, 1997).

ECOTOURISM: GLOBAL AND LOCAL PERSPECTIVES

From the perspective of the tourist, ecotourism is ecologically sustainable tourism that has as a primary focus the experiencing of natural areas while fostering environmental and cultural understanding, appreciation and conservation. According to the Quebec Declaration on Ecotourism, ecotourism *embraces the principles of sustainable tourism and the following principles which distinguish it from the wider concept of sustainable tourism:*

- *contributes actively to the conservation of natural and cultural heritage,*
- *includes local and indigenous communities in its planning, development and operation, contributing to their well-being,*
- *interprets the natural and cultural heritage of the destination to the visitor,*
- *lends itself better to independent travellers, as well as to organise tours for small size groups*

Ecotourism can fundamentally change the economic dynamics of business because it recognises the ecological and cultural costs of doing business as well as championing local economy. Through ecotourism, the community has the potential to become strong and cohesive through developing and managing their resources and visitors to those resources. Ecotourism should in all cases, aim to achieve sustainable development. Ecotourism is based on principles, guidelines, and standards and as a growing industry needs to have a regulatory system of certification. The basic elements of ecotourism must include:

- ensures prior informed participation of all stakeholders in meaningful decision making;
- ensures equal, effective and active participation of all stakeholders;
- contributes to conservation of biodiversity;
- provides direct financial benefits for conservation;
- sustains the well-being of local people by providing financial benefits and empowerment;
- involves responsible action by tourist operators and tourists themselves;
- is provided to small groups of tourists;
- provides a positive experience for tourists and local people;
- involves the least possible consumption of non-renewable resources;
- supports international human rights and labour agreements; and
- raises awareness and understanding of environmental, political, social and cultural contextual realities

MODERN TECHNIQUES OF MAXIMIZING ECOTOURISM POTENTIALITY AND DEVELOPMENT DECISIONS

Since tourism is seen as a means of obtaining foreign exchange and of developing infrastructure. A country promoting low-impact, ecological tourism may be able to better avoid the adverse environmental effects from traditional tourism and the sale of natural resources (Teye, 1987). Furthermore, since the sustainability of the ecotourism industry is dependent upon the preservation of environmental quality and biodiversity, policy makers feel that ecotourism can bolster conservation efforts (Division for Sustainable Development, 1998). Thus, while the potential for negative exploitation of this emerging industry exists, it is nevertheless seen by many as the lesser of many much more harmful options available to the world's struggling regions (Eagle, 1997).

A case study in Eastern Africa revealed that not all tourism development efforts are successful. Ankomah and Crompton (1990) identified five factors inhibiting these development efforts as negative market image, lack of foreign exchange for capital development, lack of trained personnel for tourism, weak institutional frameworks for planning and management and political instability. Sournia (1996) contrasts the management of park tourism in western Africa to that of eastern Africa. He points out that even with significant natural resources in western Africa, the tourism levels are well below those of

eastern Africa. Sournia suggests that the reasons for the lower levels of use include less visible wildlife concentrations, weak national transportation networks, inefficient hotel facilities, poorly trained tourism staff, weak marketing and a lack of tourism infrastructure in the parks.

Thus, learning from such experiences it is important to plan judiciously so that funds invested for ecotourism projects will be maximized. Therefore in the light of it, this present article emphasizes the modern technique of Geographic Information System (GIS) for Multiple Criteria Decision Making (MCDM) Framework for prioritization of important ecotourism projects for funding opportunities so as to reach the optimal level of eco-tourism development.

The important data for GIS comprises of **Spatial** (that includes topography, land use/land cover, hydrology, soil, elevation, meteorological data, transportation layers, and ecological species distribution) and **Non spatial** data (includes demographic and socio-economic data). After superimposing the spatial layers and querying the relationship of spatial and non spatial data a MCDM model can be made since in most everyday decisions, there exist multiple, conflicting, and sometimes simultaneous, objectives. MCDM framework helps decision-makers choose among alternatives by showing the tradeoffs between the criteria, which enables them to make in a rational, consistent, and documentable manner (Zeleny, 1992). Romero and Rehman (1989) argued that decision-makers are usually not interested in ranking feasible according to a single criterion but strive to find an optimal compromise among several objectives. In a multiple-criterion problem, human value judgments, tradeoff valuations, and assessments of the importance of criteria are an integral part of the evaluation process. The MCDM framework was developed to fill of the conventional mathematical programming applications to decision making problems (Strager et al., 1997). The multi-criterion problem formulation and analysis procedure includes the following steps:

- *Defining the desired goals, objectives or purpose of the project:*

Firstly, the goal is to prioritize and rank important tourist spot for funding opportunities. The criteria needed is to identify the most suitable sanctuary/national parks which has, the highest number of species, wildlife management potential, endangered species, potential to attract more tourists, and parks that have less susceptibility to encroachment and degradation over the next decade. With such criterion, the decision-makers could focus their funding priorities and help ensure that valuable sanctuary/national parks are funded without delay or confusion.

- *Selecting evaluation criteria that can relate technology capabilities for achieving the desired project goals or objectives* (Tecle et al., 1990).

This criteria attempts to build a loose connection between resource value parameters, such as national park sizes and composite wildlife value and vulnerability parameters, such as proximity to roads and developed land uses. Spatial analysis techniques within a Geographic Information System (GIS) provide the needed integration framework. Once the criteria are selected, they are traditionally rated among each other using weights, which reflect the decision makers preference structure (Tecle et al., 1988).

- *Identifying the alternatives for ranking*.

Here, the sanctuaries/national parks can be ranked with feasible alternatives. Each of the sanctuaries/national parks has certain features or physical characteristics that make it more suitable for funding than corresponding features found in the other national parks.

- *Selecting performance indices or measurement scales to describe the alternatives in terms of the given criteria, to reach the desired objectives.*

In developing the indices and scales, GIS is used. For each data layer, existing map and data units are collected from various sources to produce parameter layers in the GIS. If digital spatial information is not available, maps are acquired, registered, mosaiced, and digitized, to

produce the desired data layer. From the GIS database compilation, data could be assigned to the evaluation criteria.

- *Constructing an evaluation matrix of the alternatives vs. the criteria array.*

In evaluating the matrix, the elements of the evaluation matrix are usually expressed in a ratio scale corresponding to a value function on the interval zero to one (Strager, 1997). Such a transformation helps to eliminate the influence of widely differing numerical sizes of the criterion values upon the outcome, while enabling the description of non-common measurable criteria in a standardized dimensionless scale (Tecle and Yitayew, 1990).

- *Performing the selection process using one of the MCDM techniques.*

The MCDM model is used extensively to rank sanctuaries/national parks in GIS which provide accurate information for prioritization. The concept of non-dominance is used in compromise programming to select the best compromise solution or choice of alternatives. A solution is non dominated if there is no other feasible solution that will cause an improvement in the value of the objective function without making the value of any other objective function worse.

MODEL SPECIFICATION

An ideal solution for the compromise programming algorithm as defined by Tecle and Yitayew (1990), is the vector of objective functions' values, which is also used extensively by Bukenya. J.O in his research work on Application of GIS in Ecotourism in Uganda. He found out that this method is more appropriate when prioritization of national parks for fund opportunities is concerned. The following are the equation used for such studies:

$$F^* = (f_1^*, f_2^*, f_3^*, \ldots\ldots\ldots f_I^*)$$

where, the decision maker's ***maximum values*** for a criterion *i*, $^{i, f_i^*}$ are the solutions to equation 1:

$$f_i^* = Max\,(f_{ij}),\ \mathrm{i} = 1, 2, \ldots, \mathrm{I}\ \text{and}\ \mathrm{j} = 1, 2, \ldots, \mathrm{J}$$

and the decision maker's ***minimum*** or ***worst value*** for criterion I, fi^{**} are determined using equation 2:

$$f_i^{**} = Min\,(f_{ij}),\ \mathrm{i} = 1, 2, \ldots, \mathrm{I}\ \text{and}\ \mathrm{j} = 1, 2, \ldots,$$

where

fij = the performance index for the values of implementing the alternative Aj to meet the desired objectives expressed with respect to ith criterion

j = the number of alternatives

i = the number of criteria.

Using equations (1) and (2) the decision maker's maximum (best) and minimum (worst) criteria from the payoff matrix is identified. In a compromise programming procedure, the ideal point serves as a reference point for evaluating the comparative performances of the alternatives in achieving the desired objectives (Zeleny, 1982). The alternative that gives a solution '*A'* closest to the ideal point is the most preferred. The closeness of a solution to the ideal point **i f* is determined using a standardized family of Lp metric values (Tecle and Yitayew, 1990). According to Romero and Rehman (1989), this type of metric can be very helpful, if used as a measure for human preferences. The Lp metric as a compromise solution with respect to *p* is expressed as:

$$Min\left\{L_p(A_j)-\left[\sum_{i=1}^{N}(W_I)\left[\frac{(f_i^*-f_{ij})}{f_i^*-f_i^{**}}\right]^p\right]^{\frac{1}{p}}\right\}$$

where, Lp (Aj) = the distance metric, a function of the decision alternative *Aj* and the parameter *p*

W_1= the standardized form of the criterion weight, w_i, in which the decision maker's relative preference structure among the ***i*** criterion is represented using,

$$W_i=\frac{w_i}{\ni w_i}\text{, so that } \ni W_i=1 \text{ for all I;}$$

f_i^* = the ideal or best value for criterion I (Equation 1;)

f_i^{**} = the minimum or worst value for criterion I (Equation 2), and the parameter p can take on values 1<p

To solve the multi-criterion problem using the compromise-programming algorithm, the vector of ideal point values, f_i^* and worst values f_i^{**}, are determined using equation(1), (2) and (3) to compute the Lp distances value from the ideal points. The preferred alternative has the minimum Lp distance value for each p and weight set that maybe used and is the best compromise solution. Obviously, the best compromise solution changes according to the values of the parameter p and of the weights chosen. The parameter p acts as a weight attached to the deviations according to their magnitudes. Similarly, w_i become the weight for the various deviations signifying the relative importance of each criterion (Romero and Rehman, 1989). In this project, equation (3) is implemented into the GIS with a parameter p value of 1 while using the payoff matrix data and the criteria weights imputed from the graphical user interface.

CONCLUSION

The work of Bukenya on Uganda's eco-tourism development which was extensively drawn from the mathematical algorithm given by Tecle and Yitayew proved to be successful particularly in prioritizing national parks for funds opportunities which took care of why a particular national park should receive more attention with the combination of GIS layers and multi-criteria decision making framework. Thus solving a spatial multi-objective problem of ranking and prioritizing sanctuaries/national parks can be easily done based on the stated objectives and criteria for the development of ecotourism industry. The ranking model allowed formal analysis of the effects of alternative weighting schemes and their spatial sensitivity on national park ranking. While the problems addressed in this study appears to have been simple, yet it demonstrates the applicability of MCDM to more complicated problems. The advantage of the methodology is that sensitivity analysis can easily be performed on the results by employing graphical user interface, which allows the decision-maker to query individual national parks for critical information.

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