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Decision Support System for Sustainable Management Planning of Nature-Based Recreation Areas in Thailand

Noppawan Tanakanjana, Wanchai Arunpraparut, Nantachai Pongpattananurak, Ratikorn Nuampukdee & Theerapong Chumsangsri

Kasetsart University, Thailand

ffornwt@ku.ac.th
fforwca@ku.ac.th
fforncp@ku.ac.th
yok59@hotmail.com
ffortpc@ku.ac.th

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Introduction

The project "Decision Support System for Sustainable Management Planning of Nature-based Recreation Areas" was a 5-year project funded by Thailand Research Fund aimed at developing standard protocol and models to assess recreation resource potential, recreation opportunity spectrum, and the acceptable limit of change of resource-base from uses, and to develop a recreation monitoring system for the nature-based recreation areas in Thailand. The project was divided into two phases. The first phase of the project covered a two-year period beginning from October 2003 to September 2005. The second phase began in October 2005 will continue until September 2008. This paper presents a summary of results from phase one of the project, which had 2 specific objectives. The first objective was to develop a recreation resource potential assessment system. The second one was to classify the recreation opportunity spectrum of nature-based recreation areas that are compatible with site characteristics and use patterns within the country. The end results of the project included a full technical report and computer software developed to enable recreation area managers to easily assess resource potential and define opportunity classes for the recreation sites under their supervision.

Methods

Nature-based recreation areas in this project were classified into 9 types based on ecosystem differences. The 9 types of recreation areas were waterfalls, rivers and lakes, caves, hot springs, geo-morphological sites, scenic areas, nature trails, islands, and beaches. The study began with compiling existing databases on nature-based recreation areas in Thailand. The total number of individual recreation sites recorded was 1,504 sites. 119 sites around the country were selected as the study samples, based on their distribution and their diversity in size and use patterns. The sample sites included 27 waterfalls, 10 rivers and lakes, 14 caves, 10 hot springs, 10 geo-morphological sites, 10 scenic areas, 13 nature trails, 10 islands, and 15 beaches.

Indicators for recreation resource potential and the recreation opportunity spectrum were developed primarily based on related literatures (Clawson, 1968; Clark & Stankey, 1979; Chubb & Chubb,1981; Eagles & McCool, 2002) and empirical data from within the country. A focus group meeting of in-country academics and practitioners was conducted to obtain opinions on those indicators. The final set of indicators was composed of 10 groups for recreation resource potential indicator and 7 groups for recreation opportunity spectrum indicator. Each indicator had multiple indices. Number of indices was different from one type of recreation area to another. The total number of

Table 1: List of indicators and indices used for the assessment of nature-based recreation resource potential and the classification of the

Indicator	Index / Measurement detail
Recreation Resource Potential 1. Distinctiveness of the plant community	1) quantity of trees with 100 cm. girth at breast height 2) completed tree structure 3) crown cover
2. Opportunity for wildlife sighting	1) amount of bird species 2) amount of small and medium sized animals 3) amount of large mammals
3. Physical uniqueness of key resource	1) width of waterfall base 2) number of waterfall level 3) number of months waterfall contains at least half water quantity 4) average width of river/lake 5) width of the largest room within a cave 6) accessible cave depth 7) presence of stalagmite and stalactite within a cave 8) size of overall area of hot spring 9) size of overall area of geo-morphological site 10) height of view point 11) diversity of trail topographic characteristics 12) reef size 13) assessable beaches at an island 14) width of beaches 15) length of beaches 16) beach type
4. Scenic quality of landscape	1) Overall quality of natural landscape within the recreation site evaluated in 5-point rating scale
5. Significance for resource interpretation	1) Overall distinctiveness of natural resources within the recreation site that can be use to develop interpretive themes and sub-themes evaluated in 5-point rating scale
6. Suitability for certain types of recreation activity	1) size of accessible swimming area at a waterfalls 2) water turbidity 3) river length 4) depth of rivers/lakes 5) amount of rapids in a river 6) number of months with sufficient water for recreation 7) slope of cave floor 8) ventilation within a cave 9) wetness of cave floor 10) size of activity area at a hot springs 11) sulfurous stink at a hot springs 12) size of activity area at a geo-morphological sites 13) size of overlook area 14) trail slope 15) trail loop 16) length of trail (short/long hiking trail) 17) percentage of live coral 18) diversity of coral species 19) diversity of living things at reef 20) water transparency 21) slope of beaches 22) size of tree shed at beaches
7. Site resistance	1) resistance of soil to trampling 2) soil shear strength 3) type of plant community 4) slope of the area 5) presence of endangered species 6) reef location compared to wind direction 7) presence of endangered sea animals
8. Proximity of the site to others	1) distance to next nearest recreation area 2) number of recreation areas within 80 km.
9. Safety	1) likelihood of touching toxic plants 2) likelihood of encountering dangerous animal 3) likelihood of natural disaster (landslide, flash flooding, etc.)
10. Suitability of climate	1) temperature 2) relative humidity 3) number of rainy days
Recreation Opportunity Spectrum	
1. Access	1) road/trail access conditions 2) distance from mainland to the site (island) 3) number of months site is accessible
2. Remoteness	1) distance of the site from motorized area 2) visitors' perception of the remoteness of the site
3. Naturalness	1) percentage of areas left in their natural state
4. Opportunity for social encounter	1) number of other visiting parties encountered within the site
5. Evidence of human impact	1) amount of litter 2) amount of broken tree branches along the trail 3) percentage of broken stalagmites and stalactites within a cave 4) amount of scars on trees 5) visibility of soil erosion on trails 6) length of trail with exposed tree roots
6. Site management	1) quantity and size of facilities within the site
7. User management	1) direct surveillance and control by staff 2) indirect control by interpretive programs

indices for resource potential was 63 and for the opportunity spectrum, 16 indices. A list of all indicators and indices is presented in Table 1.

Biophysical resource inventories and visitor surveys were conducted at each site, based on the developed indicators and indices. GPS and associated forest engineering tools were used in site inventories. Questionnaires were used for the visitor surveys. The number of site visitors who participated in the survey was 1,550 persons. Descriptions of each indicator were provided in the questionnaire. The survey participants then were asked to subjectively evaluate recreation resource potential and recreation opportunity classes based on the given indicator descriptions. Descriptive statistics as well Ordinal Regression Analysis and Logistic Regression Analysis were used in the process. Opinions on resource potential and the opportunity class of each site of visitors with post-graduate education were put together with the opinions of the research teams and used to develop initial equations to assess recreation resource potential and recreation opportunity spectrum for the sample sites.

Results

Biophysical resource inventories and analysis found that most recreation areas had moderate levels of distinctiveness of plant communities, while the opportunity for wildlife sighting was low. The majority of recreation sites had moderate levels of physical uniqueness of key resources, scenic quality of landscape and significance for resource interpretation. The suitability for certain types of recreation activity and site resistance were mostly moderate to high. The potential for connection of the site to others, safety, and climate were high.

In assessing recreation resource potential, the research team separated the analysis into 2 parts. In the first part, ordinal regression analyses were employed to develop equations to assess "Basic recreation resource potential (Brrp)". "Site Resistance" (SR) was separately evaluated. The research assumption was:

Overall Recreation Resource Potential (ORRP) = f (Brrp + SR)

Different Brrp equations were used for different types of recreation area due to the differences in number of indicators and indices used to assess the resource potential of each type of recreation area. The total number of equations developed was three, as follows:

Equation 1: To be used for waterfalls, caves, hot springs, geo-morphological sites, scenic areas, and nature trails

$$Y = 4.716 + 0.515X1 + 0.187X2 + 0.868X3 + 0.837X4 + 0.541X5 + 0.044X6 + 0.146X7 + 0.070X8 + 0.471X9 \quad (R^2 = 0.610)$$

Where Y = Basic resource potential
X1 = richness of plant community
X2 = opportunity for wildlife sighting
X3 = physical uniqueness of resource-base
X4 = scenic quality of landscape
X5 = significance for resource interpretation
X6 = suitability for certain types of recreation activity
X7 = proximity of the site to others
X8 = safety
X9 = climate

Equation 2: To be used for rivers/lakes and beaches

$$Y = 4.320 + 0.356X1 + 0.903X2 + 0.911X3 + 0.724X4 + 0.031X5 + 0.143X6 + 0.032X7 + 0.455X8 \quad (R^2 = 0.599)$$

Where Y = Basic resource potential
X1 = opportunity for wildlife sighting
X2 = physical uniqueness of resource-base
X3 = scenic quality of landscape
X4 = significance for resource interpretation
X5 = suitability for certain types of recreation activity
X6 = proximity of the site to others
X7 = safety
X8 = climate

Equation 3: To be used for islands

$$Y = 4.241 + 0.955X1 + 0.976X2 + 0.817X3 + 0.032X4 + 0.169X5 + 0.011X6 + 0.469X7 \quad (R^2 = 0.596)$$

Where Y = Basic resource potential
X1 = physical uniqueness of resource-base
X2 = scenic quality of landscape
X3 = significance for resource interpretation
X4 = suitability for certain types of recreation activity
X5 = proximity of the site to others
X6 = safety
X7 = climate

The factors strongly influencing basic resource potential for most types of recreation areas, taken from the equations, were physical uniqueness of resource-base and scenic quality of landscape.

In the second part, the results from Brrp and SR analysis were used to develop a matrix of management alternatives, yielding five different management alternatives. Different management alternatives recommend different solutions for site management and impact prevention. Different management recommendations were made for each group of recreation areas. The final assessment found that the majority of recreation areas was in group 2 as presented in Table 2. As for the classification of the recreation opportunity spec-

Site Resistance: SR						
Basic recreation resource potential: Brrp		Very high	High	Moderate	Low	Very low
	Very High	Group 1	Group 1	Group 2	Group 3	Group 3
	High	Group 1	Group 1	Group 2	Group 3	Group 3
	Moderate	Group 2	Group 2	Group 2	Group 3	Group 3
	Low	Group 4	Group 4	Group 4	Group 5	Group 5
	Very low	Group 4	Group 4	Group 4	Group 5	Group 5

Figure 1: Matrix to group recreation sites based on their basic recreation resource potential and site resistance.

trum, seven recreational setting indicators were included in the inventories and analysis. It was found that access to most recreation areas was by dirt road that could be easily used during the dry season. The majority of the sites had a low level of remoteness. They were left, to a moderate degree, in their natural state and had a moderate to high level of opportunity for social encounters. The evidence of human impact found in most sites was moderate. Most recreation sites had moderate to high physical development and visitor control.

Logistic regression analysis was employed in order to develop the recreation opportunity spectrum classification equation. The same equation was used for every type of recreation area. The final ROS equation was:

$$Y = 3.762 + 0.462X1 + 0.677X2 + 1.073X3 + 0.483X4 - 0.162X5 + 0.308X6 + 0.189X7 \quad (R2 = 0.631)$$

Where Y = sum of recreation experience to be gained from visiting recreation area in each ROS

X1 = access

X2 = remoteness

X3 = naturalness

Table 2: The results from final recreation resource potential assessment.

Grouping	Number of site	%
Group 1: Very high to high basic recreation resource potential and site resistance	18	15.13
Group 2: Very high to moderate basic recreation resource potential and moderate site resistance	59	49.58
Group 3: Very high to moderate basic recreation resource potential with low to very low site resistance	29	24.37
Group 4: Very low to low basic recreation resource potential with very high to moderate site resistance	11	9.24
Group 5: Very low to low basic recreation resource potential and very low to low site resistance	2	1.68
Total	119	100.0

Table 3: The results from final recreation opportunity spectrum classification.

ROS class	Number of site	%
Primitive (P)	5	4.20
Semi-primitive Non-motorized (SPNM)	36	30.25
Semi-primitive Motorized (SPM)	41	34.45
Modified Natural (MN)	20	16.81
Urban (U)	17	14.29
Total	119	100.0

X4 = opportunity for social encounters

X5 = evidence of human impact

X6 = facilities and site management

X7 = visitor management

From the equation, factors that highly influenced the differences in opportunity class were naturalness, remoteness, and opportunity for social encounter, respectively. The ROS for nature-based recreation areas in this study was classified into 5 classes primarily based on the results from recreation diversity analysis, recreation motivation in particular. The five 5 classes were: Primitive (P); Semi-primitive Non-motorized (SPNM); Semi-primitive Motorized Area (SPM); Modified Natural or Rural (MN); and Urban (U). The final classification found that the highest number of recreation sites (34.45%) was in the SPM class, as presented in Table 3.

At the final stage of the project, the research team developed simple Decision Support System (DSS) computerized programs by using Visual Basic language and GIS applications. This program was produced to assist recreation area managers in Thailand to assess recreation resource potential and to classify the recreation opportunity spectrum of the recreation site under their supervision. Prior to the utilization of the DSS program, resource managers had to collect data and perform basic analysis following the guidelines specified by the research team. Following the implementation of this program they could input the data into the DSS program to get the final results of the assessment and classification. General recommendations to manage recreation sites with different recreation resource potential and recreation opportunity spectrum were also provided to all DSS users. The overall results from this research and development project were beneficial to the country of Thailand though follow up assessment is still needed in some areas.

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