Evaluation of Environmental Effects on Tourism Development in Penghu Islands

Dr. Shui-Liang Yu, Professor of National Penghu University of Science and Technology, Taiwan
Ying-Chien Chu, Corresponding Author, Lecturer of National Penghu University of Science and Technology, Taiwan

ABSTRACT

With the implementation of the two-day weekend policy, it encourages the people of Taiwan to participate in more recreational activities and traveling. However, the increased popularity of tourist attractions and the limitation in recreational resources also bring impacts on natural recreational resources. When a recreational area becomes overly popularized but cannot maintain its quality of tourist facilities, the area will lose its appeal to tourists, and readily declines due to the lack of economic support.

To preserve a natural environment in its pristine state, it is necessary to invest in more conservation efforts in recreational areas. In this study, the area around Penghu County is used as a case study for investigating the current recreational activities from the viewpoints of tourist experiences and conservation of recreational resources. The aim is to find out the impacts of recreational activities on the natural environment of the recreational areas.

The study has employed the method of random sampling for investigating vegetation and biological species along a transect line, at the intertidal zone on six sample beaches in Penghu, so as to find out what effects the current recreational activities have on the natural environment. The subsequent results showed that the index for the biodiversity in the intertidal zone of the island is higher than that of the insular region, but the index for the biodiversity of the vegetation is lower than that of the insular region. The results of the study indicated that the environment of Penghu has not been fully saturated by recreational activities, and that it is critical to devise strategies for alleviating environmental impacts in the future in order to make sure the natural resources of Penghu will be well conserved.

Keywords: Penghu, biodiversity, tourism impacts

INTRODUCTION

The implementation of the two-day weekend policy has helped encourage the people of Taiwan to participate in more recreational activities. Though the trend should be promoted, one cannot overlook what impacts an increased popularity of tourist attractions and limitation in recreational resources may bring on the natural environment. There is a close correlation between the development of recreational activities and the natural environment. When a recreational area becomes overly popularized but cannot maintain its quality of tourist facilities, the area will lose its appeal to tourists, and ultimately declines due to the lack of economic support (Smith & Eadington, 1992).

The Penghu Islands have rich natural resources and cultural heritage, and are located where the northeast monsoon regularly visits; the monsoon constantly shapes the local landscape to give rise to a variety of geological features that are unique to the Penghu Islands. For example, the naturally formed and shaped basalt rocks, the unique biological features of the subtropical region and the historic cultural heritage, all of which help make the Penghu Islands an attractive tourist spot on the international stage (Yu et al., 2015).
Penghu County is located in a group of islands in the Taiwan Strait, and is reachable via sea or air. The inter-island air transport allows tourists to reach various islands in the Penghu Islands within one hour. This type of transportation allows tourists to enjoy the natural beauty of Penghu easily. As transportation improves, the number of tourists and various infrastructures has grown rapidly. Artificial developments and requirements related to tourism have both increased in regards to the Penghu Islands. It has brought major impacts on many of the unique natural features of the Penghu Islands such as the illegal mining or damage of the exposed basalt rocks, illegal fishing and tourists’ recreational activities that threatens the growth of the coral reefs. On the other hand, developments undertaken by the tourism operators have also influenced the ecological environment of the beaches and impeded the growth of windbreak forests, as well as contributing to the rapid corrosion and recession of the coastal areas (Hess, 1990).

To protect the current natural features from further damage, preserve the natural beauty, and reinforce the conservation efforts at the recreational areas of the Penghu Islands, the study has employed the area around the Penghu Islands as a case study, and carried out investigation about the current recreational activities in Penghu from the viewpoints of tourist experiences and conservation of recreational resources. The objective is to find out what impacts the recreational activities have on the natural environment of the recreational areas on the islands.

**OBJECTIVES**

Based on the reasons described above, the objectives of the study are summarized as below:

1. To investigate the characteristics and developmental potential of resources on six coastal areas within the Penghu Islands (Lintou, Aimen, Houliao, Jibei Islet, Dacang Islet, and Kupo Islet) (Figure 1).
2. To select factors for monitoring environmental impacts, so that the effects as a result of the use of lands related to recreational activities and facilities on the environment may be revealed, and to propose strategies for alleviating the environmental impacts at each coastal area.
3. To find out if there is any difference in the environmental stress as a result of the recreational activities between the main island (Lintou, Aimen, and Houliao) and the insular region (Jibei Islet, Dacang Islet, and Kupo Islet).

![Figure 1: Study Area of the Penghu Islands](image-url)
Because of the peculiar combination of geological features, geographical location, and local climate, the Penghu Islands have many special geological features and landscapes. Various coastal areas are the breeding grounds for a diversity of oceanic creatures and the coastal areas are made up of estuaries, beaches, sandy mud, reefs, and coral shelves. The widely distributed coral reefs are the most important biological resource in Penghu. Further, the coral reefs, which are composed of stony coral, provide a shelter for many marine creatures including fishes, shrimps, and shellfish; which is also an essential factor that draws tourists to Penghu (Lee, 2009).

Since Penghu consists of many islands and islets, the local ecological environment is relatively fragile and susceptible to damage resulting from artificial activities. This is particularly true for many islands that have been regarded as deserted in the past. Once the trend of tourism made these islands popular again, the problem of artificial damage has worsened and would have continued if there were no laws in place for controlling such a problem. Moreover, the number of tourists visiting the coastal areas and insular regions climbs sharply in the summer, and the resultant intensification in the use of natural resources easily leads to enormous and irrevocable impacts on the environment (Kelman & West, 2009).

Recreational activities are concerned with mental relaxation and satisfaction, they are usually considered less exploitative on natural resources. However, factors like an increase in the number of people who take part in recreational activities, the extension in the span of recreational activities, the concentration of recreational activities at particular locations and times, and the invention of recreational equipment have all contributed to considerable alteration or damage to the natural environment and resources at the recreational areas. The alterations or damages may include loss of soil, stress on road surfaces, contamination of air and water, noises, decimation of vegetation, alteration or disturbance to the natural habitats of wildlife, accidental fires caused by recreational activities, invasion of foreign plants as a result of inadequate importation, and accidental or intentional artificial damage to historic heritages (Leung & Marion, 2000). The artificial effects caused by recreational activities – or recreational impacts, could lead to a general deterioration in the environmental quality of the recreational areas, and consequently affect the recreational experience of tourists. The problem is more pronounced in areas with vulnerable natural resources. Past literatures have indicated that tourists readily notice impacts on the natural resources, which subsequently reduces their recreational experience (Roggenbuck et al., 1993; Vaske et al., 1993).

Due to differences in the environment and the original planning of recreational areas, the developmental status of the recreational areas differ from one another, but the possible effects to the environment may be classified as follows (Hammitt & Cole, 1998): changes in the use of lands (including changes in the methods of production and in usage), changes in the environment for wildlife and vegetation (including changes in natural habitats and species), changes in tourist attractions and scenery, changes in water sources (quality and quantity of water), changes in geological features and landscape (soil erosion, runoffs, and destruction of vegetation), air and noise contamination (Leung & Marion, 2000; Tyser & Worley, 1992).

While the above-mentioned problems may occur during the process of development; other problems may arise from the opening of recreational areas to a vast number of tourists, such as the problems of environmental contamination as a result of rubbish, contaminated water, and aggregation of vendors. If such problems persist, the natural resources may suffer from irrevocable damage. A number of domestic and international studies related to the topic of environmental impacts are available (Wall &
In their study, the impacts of outdoor recreational activities on soil, vegetation and wildlife, and water resources were analyzed and the outcome was used to sort out a mutual relationship between recreational activities and the environment.

From the viewpoint of management, a balance should be struck between legal guidance, management policy of the protected area and the tourist usage of the protected area, in order to achieve the goal of resource protection. The recreational area may be managed and protected on the basis of carrying capacity and management structure, which includes factors like the limit of acceptable capacity (Lucas & Stankey, 1974; Stankey et al., 1985), as well as visitor experience and resource protection (National Park Service, 1997).

**RESEARCH METHODS**

During the investigation of the ecological environment in the intertidal zone, the method of random sampling along a transect line was used to make the most out of labor and resources available then. When the outdoor investigation was carried out, GPS positioning was done first. The route for the investigation was decided by using the line transect method along a fixed route; when the tide had receded to low ebb, several transect lines were set up between the high-tide zone and the low-tide zone on the beach according to actual needs. In the next step, three transect lines were randomly selected, then a person had to slowly walk on foot along the transect lines and record the species, quantity, and type of habitats for all animal species found within one meter at each side of the transect line.

To understand the process and outcome for which a natural environment is affected by artificial or natural interferences and its subsequent recovery, it is necessary to monitor the natural environment. For this reason, vegetation-sampling areas of 10m x 1m were set up around the coastal recreational areas, and the growth or decline of the vegetation in the sampling areas were observed monthly from June to August, 2015, which helped researchers understand more about the stability of vegetation and the outcome as a result of interfering factors.

During the investigation, samples were collected and recorded along viable routes, and then verified individually by referring to references and information from past samples, in order to ensure the species had not been recorded erroneously. The collected plant species were listed one by one and then statistically analyzed to reveal the local vegetation resource.

Analyzing various ecological indexes found in the outdoor investigation data more easily reveals the ecological status of each sampling area. Therefore, adequate ecological indexes should be computed from the results of the outdoor investigation data and presented in clear and concise graphs. The diversity index analysis analyzes the biological data collected on the spot with indexes commonly used in ecological studies:

Simpson’s dominance index (C):

$$C = \sum_{i=1}^{n} \left( \frac{N_i}{N} \right)^2$$

$N_i$: the number of the $i^{th}$ organism

$N$: the number of the total species found

Therefore, changes in groups of different species and effects of environmental changes may be calculated from the indexes above. Subsequently, the method of 2-way analysis of variance (2-way ANOVA) was used to explore the relationship between the aforesaid factors and the environment.
RESULTS AND DISCUSSION

Analysis of Animal Species in the Intertidal Zone

According to the statistical analysis of the number of visitors to Penghu in 2015, it was found that April marked the onset of the tourist season and the number of visitors began to climb, which totaled around 90,813 people. The period between June to August was the peak of the tourist season and the number of visitors reached its highest point of around 143,944 people. The number of visitors started to decline from September onwards, and the tourist season came to a close.

It was observed from Figure 2 that the diversity indexes for the intertidal zones of the six sampling areas between April-May and June-August show no remarkable difference. This is because the peak tourist season in Penghu is between April and August, thus there are no clear differences between the period from April to May and the period from June to August. Therefore, the results suggest that the recreational activities around the beaches of Penghu did not bring major impacts on the growth of the organisms in the intertidal zones on the beaches, and the carrying capacity for recreational activities has not yet become saturated. On the other hand, the diversity indexes for Lintou and Aimen were both <0.001; this is because tourism operators have established businesses related to water sports around these two areas and the natural environment of the areas has suffered from damage as a result of such development, which consequently gave rise to low diversity indexes.

![Figure 2: Diversity Indexes of Animal Species between April-May and June-August](image)

Figure 3 clearly shows that there are no significant differences in the diversity indexes between the main island and the insular region. This is due to the fact that development and recreational activities are undertaken in both the main island and the insular region. Houliao is the site where the diversity index for the main island was taken; it is a harbor that has been developed for recreational activities, and is a key link to the northern sea while Lintou and Aimen are still under development. Jibei Islet is the site where the diversity index for the insular region was taken; the area has been fully developed and the usage of recreational facilities is high whereas Kupo Islet and Dacang Islet are still not fully developed and more remote. Therefore, even though there are some differences between the main island and the insular region, the differences are not significant.
Table 1 indicates that the factors for different sites under investigation can lead to major differences in the animal species of the intertidal zones. According to the study by MacArthur and Wilson (1967); the larger an island, the more species it has. In other words, the size of the island affects the biodiversity on the island, hence the larger the size of the island, the greater the biodiversity, and the fewer the distantly related organisms, thus Jibei Islet > Houliao > Kupo Islet > Lintou and Aimen > Dacang Islet. The times when the investigation is carried out does not seem to have any effects on the organisms in the intertidal zones. Moreover, because the span of the tourist season in Penghu is between April to August, and the carrying capacity for local tourism does not reach saturation, the differences between April-May and June-August are not clear.

**Table 1: Results of Animal Species from the 2-way Analysis of Variance**

<table>
<thead>
<tr>
<th></th>
<th>F</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Time</td>
<td>0.124</td>
<td>0.734</td>
</tr>
<tr>
<td>site</td>
<td>5.552</td>
<td>0.046*</td>
</tr>
<tr>
<td>Time x site</td>
<td>0.046</td>
<td>0.835</td>
</tr>
</tbody>
</table>

*: P≤0.05 ; **: P≤0.01 ; ***: P≤0.001

**Analysis of Vegetation**

Figure 4 shows no significant differences of the vegetation diversity indexes between April-May and June-August. Although there are some differences between the period from April to May and the period from June to August, the differences are not significant, which means the tourists’ participation in recreational activities around beaches in Penghu did not seriously affect the growth of vegetation on beaches. Because the carrying capacity for local tourism did not reach saturation, the differences between April-May and June-August were not significant.
Figure 4: Diversity Indexes of Vegetation between April-May and June-September

Figure 5 shows a comparison between the insular region and the main island. A clear difference in the diversity index was observed between the two. Because the three sites (Jibei Islet, Kupo Islet, and Dacang Islet) where the investigation of the insular region were carried out had been developed and used for recreation, and Jibei is one of the most famous insular recreational area in Penghu; Jibei has seen the most recreational activities and tourists. On the other hand, though two of the three sites (Lintou, Aimen, and Houliao) where the investigation of the main island were carried out had been developed and used for recreation, the insular region has been impacted to a greater extent due to the more frequent recreational activities. Furthermore, the combined size of the three sites of the insular region is less than the combined size of Houliao, Lintou and Aimen. Therefore, according to the theory of MacArthur & Wilson (1967), which states that the larger the size of an island, the greater the biodiversity on the island; the diversity index for the vegetation of the insular region should be smaller than the diversity index for the vegetation of the main island, which may help explain the difference in the diversity index between the insular region and the main island.

Figure 5: Diversity Indexes of Vegetation between the Main Island and the Insular Region

Referring to Table 2, which shows that the time when the investigation was carried out does not have significant influence on the growth of vegetation in the intertidal zone whereas the location where the investigation was carried out does have significant influence on the growth of vegetation in the
intertidal zone. However, the interaction between the time and the location at which the investigation was carried out does not have significant influence on the growth of vegetation in the intertidal zone.

**Table 2**: Results of Vegetation from the 2-way Analysis of Variance

<table>
<thead>
<tr>
<th></th>
<th>F</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Time</td>
<td>2.41</td>
<td>0.15</td>
</tr>
<tr>
<td>Site</td>
<td>9.98</td>
<td>≤0.001***</td>
</tr>
<tr>
<td>Time x site</td>
<td>1.51</td>
<td>0.19</td>
</tr>
</tbody>
</table>

* : P ≤0.05 ; ** : P ≤0.01 ; *** : P ≤0.001

After analyzing the diversity indexes for the vegetation, no significant differences were found between the investigation and analyses completed in separate seasons. On the other hand, although differences were discovered between the results found in separate seasons according to the t-test analysis, the value of the differences did not reach the standard indicating significant differences. Therefore, it might be concluded that the carrying capacity of the recreational activities did not reach saturation yet. The six sampling areas of the study included Jibei Islet, Kupo Islet, Dacang Islet, as well as Lintou, Aimen, and Houliao from the Magong Island. In this study, Houliao is regarded as an individual area from the Baisha Township, while Lintou and Aimen are regarded as another individual area from the Husi Township, thus the ratio for the surface area of the five locations is: Husi Township > Baisha Township > Jibei Islet > Kupo Islet > Dacang Islet. The results indicated that the size of the sampling area evidently affects the diversity of vegetation in each sampling area, which clearly echoes the “Geographical Theory for Island Organisms” proposed by MacArthur and Wilson (1967), in which the authors suggested that the larger an island, the greater the biodiversity on the island.

The results of the study indicated that the environment of Penghu has not been fully saturated by recreational activities, and that it is critical to devise strategies for alleviating environmental impacts in the future in order to make sure the natural resources of Penghu will be well conserved. To ensure tourism will be able to develop sustainably in Penghu, more emphasis will be focused on resource management and environmental conservation in the future. In addition, it is also recommended to include more environment monitoring indicators like water quality and air quality into future studies, so as to obtain results that are more comprehensive. It is expected that the results of this study will help create better conditions and environment for developing ecotourism in Penghu.

**REFERENCES**


