Research Reports

Damage Schedules for Thai Coastal Areas: An Alternative Approach to Assessing Environmental Values

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EXECUTIVE SUMMARY

The growing concern over environmental degradation has heightened the role of environmental economics and the valuation of natural resources as analytical tools that facilitate policy design for sustainable management. Research of the past four decades, however, has not provided reliable methods for measuring the economic value of most non-marketable environmental assets involved in damage claims and allocation decisions. In this study, rather than relying on current valuation practices to guide resource allocation policies and to determine compensation awards, a 'damage schedule approach' is proposed as an alternative.

Damage schedules are constructed based on scales of relative importance obtained from people's judgements about values of various resource losses and activities causing losses. It is a non-monetary valuation approach as people are asked to indicate their preferences and values about the resources without any reference to monetary values. The scales of relative importance are derived from the responses of people to series of paired comparison questions. People are simply asked to choose one item in each pair that they consider more important. The damage schedules, developed based on these importance scales, reflect community values which should be considered in the natural resources management and policymaking.

This study is an empirical test of the possibility of developing meaningful scales of relative importance that could be used to construct the damage schedules. The study aims at investigating people's ability in providing consistent judgements about the importance of resource losses and activities in consideration. The resulting scales of relative importance are then examined for their usefulness in providing a basis for the development of the damage schedules.

Four main steps were followed in this study. First, a questionnaire, containing series of paired comparison questions, was designed and used as an instrument to elicit people's judgements about the importance of the resources and activities. Second, Dunn-Rankin's variance stable rank sum method was applied to the paired comparison responses to obtain scale values and rankings for various groups of respondents. These results were then tested for their association using Kendall rank-order correlation coefficient T and Kendall coefficient of agreement u. These statistical tests determined how many importance scales were needed to properly represent the responses from all respondents. Finally, the scales of relative importance were constructed and later used to develop the damage schedules.

The research was conducted using actual situations in the two coastal areas of Thailand, namely Ban Don Bay on

the southeastern coast of the Gulf of Thailand, and Phangnga Bay on the southwestern coast of the Andaman Sea. These two coastal areas provided good comparative sites to test the approach as they differed in the resource characteristics and in their economic importance to the region. Ban Don Bay was the major area where the rapid expansion of shrimp farming industry began. In the early age of shrimp farming, many farms were built very close to the coastline, involving clear-cutting of mangrove forests in the area. Although clear-cutting of mangroves was no longer a practice, the impacts of shrimp farming in the area was still a major issue. Phangnga Bay, on the other hand, was known as a tourist destination because of its natural attractions such as coral reefs, sandy beaches and mangrove forests. Tourism-related activities, in particular hotel development, were of prime interest in the area.

The respondents to the survey comprised of two main groups of people: formal experts and lay experts. Formal experts were researchers and scientists who were knowledgeable about the resources in the study areas, as well as policy makers and administrators who had responsibility in the management of the coastal resources. Lay experts included resource users, other stakeholders and people who lived in the study areas. Lay experts were divided into four groups based on their occupation. Three groups of lay experts were common in the two areas, i.e. fishers, shrimp farmers and others. The last group of lay experts in Ban Don Bay was shellfish culturers, whereas that in Phangnga Bay was tourism-related business.

Four resources and three activities were included in the study. In Ban Don Bay, the resources were mangrove forests, mudflats, shellfish culture grounds and fishing grounds. The activities were shrimp farming, housing development and oil spills. In Phangnga Bay, the four resources were mangrove forests, sandy beaches, seagrass beds and coral reefs; and the activities included shrimp farming, hotel development and oil spills. Different levels of damages to the resources and different sizes of activities were used to provide eight resource losses and eight activities for paired comparisons. These losses and activities were kept separated in the questionnaire so that the comparisons were either between any two resource losses or any two activities. In other word, no comparison was made between a resource loss and an activity. For example, in the case of resource losses, respondents were asked to choose which member within each pair of losses was more important. Similarly, in the case of activities, they were asked to indicate which member within each pair of activities was more serious.

The actual survey was conducted from March to April 1997. About 200 people answered the questionnaire in each study area, 20% of which was formal experts and the rest was equally distributed among the four groups of lay experts. Intransitive responses, commonly found in the study using paired comparison method, occurred but their impacts on the scale values and the rankings were insignificant. The results also showed a significant agreement in the rankings of formal experts and lay experts and among lay experts of different occupations. Based on these findings, it was concluded that the respondents were able to provide consistent judgements about the resource losses and the activities in consideration, and the scales of relative importance were derived using the responses from all respondents to the survey.

Two damage schedules were developed in each study area: a loss schedule based on the scale of importance of resource losses, and an activity schedule based on the scale of importance of impacting activities. The differences in the resource characteristics and the economic importance of resources in the two coastal areas were properly captured in the schedules. Although clear-cutting of the mangrove forests was considered to be the most important loss in both study areas, the importance of activities causing this loss differed in each area. Shrimp farming involving clear-cutting of mangroves was ranked first on the Ban Don Bay activity schedule, while hotel development involving clear-cutting had the highest scale value on the Phangnga Bay schedule.

An attempt was made to obtain monetary values of the resource losses using the same method of the paired comparisons. Respondents were asked to choose between a loss of resource and a loss of money. A considerable number of respondents (about 48% in Ban Don Bay and 35% in Phangnga Bay) was not willing to make any trade-off between the resource loss and the monetary loss. This could be because the amount of money included in the study was too low, or it could be that respondents considered the resource losses to be much greater than any amount of money. Based on the responses of those who were willing to make the trade-off, the monetary estimate for partial damage to mudflats in Ban Don Bay was 1,350 Baht. For Phangnga Bay, the estimate was 850 Baht for partial damage to sandy beaches and 2,850 Baht for severe damage to sandy beaches. These monetary estimates were agreeable with the importance of the resources indicated by the importance scales.

The damage schedules have a wide range of application for natural resource management. Based on these damage schedules, different policy responses could be assigned in accordance with the relative importance of the resources or the human activities affecting them. For example, a resource that is considered to be of high importance in the loss schedule might be prohibited from use, assigned a high user fee, or expected to require a high payment if the resource were damaged. A less important resource may be assigned a smaller user fee or damage payment. The magnitude of the fee or payment would reflect the relative importance of the resource as indicated in the public or expert judgments.

Damage schedules offer certain advantages over traditional valuation methods. They provide predictability and enforceability by specifying in advance the payments that will be required in the event of a loss, rather than waiting until the damage has taken place. This feature is essential when the transaction costs associated with the typical post-incident assessment are unaffordable. Announced damage schedules also provide clear incentives to resource users whose activities may damage the resource. The damage schedules could be fine-tuned over time, when other losses or activities of different form or magnitude occur, by interpolating or extrapolating from the initial scales. The method could be implemented quickly and inexpensively, and could be improved with experience and further knowledge about the resources. The damage schedule is thus another practical and effective tool that could aid policymakers in the management of dynamic and complex ecosystems such as those of coastal areas.

1.0 INTRODUCTION

1.1 Valuation of Natural Resources and Environmental Assets

Considerable effort has been devoted to economic valuation, one of the key aspects of natural resource and environmental management. Vatn and Bromley (1994) reported that from 1990 to 1993, about one-third of the articles in the *Journal of Environmental Economics and Management* and *Land Economics* dealt with valuation.

Valuation plays a significant role in resource allocation, which is usually based on economic analysis of resources and their values. It is also crucial in environmental damage assessment. The concept of environmental damage awards can be used to ensure that those responsible for degrading the environment are liable for the costs incurred by their behaviour. Thus, apart from identifying the link between the impacting activities and the resources, policy makers must decide on damage awards and compensation. The difficulty lies, however, in quantifying the monetary values of the damages, particularly those linked to misuse of natural resources and environment.

The value of natural resources and environmental assets is commonly separated into two groups: use value and non-use value. Use value represents the resource's value to those who actually use the resource, either directly or indirectly. Direct use values, including consumptive and non-consumptive uses, are derived from the economic uses of the natural system's resources and services, while the indirect use values are the indirect support and protection provided to economic activity and property by the resource system's natural functions or environmental services (Barbier 1994).

Non-use value represents a resource’s value to those who have not used, and may never use, the resources (Heyde 1995). Non-use values can be broken down into three separate categories: option value, existence value, and bequest value. Option value is based on how much people, who are not currently using a resource, are willing to sacrifice today to preserve the option to use that resource in the future (Munasinghe and Lutz 1993; Wruck 1994). People can also value resources only for their existence (existence value) which is unrelated to either current or future use. The last kind of non-use values, the bequest value, is derived from knowing that the resource remains available to future generations.

A variety of techniques has been proposed and applied to quantify the different values of natural resources and environmental assets. For example, use values can be measured using techniques such as value of changes in productivity, hedonic pricing, and travel cost method. When environmental goods that are not traded in markets must be valued, complications arise because their values are not revealed in market prices. As pointed out by Barbier (1994), the values of marketed products and services of resources (e.g., wetlands) are easier to measure than the values of their non-commercial and subsistence direct uses. Where values cannot be estimated by reference to market prices, other means must be used to estimate the values (Green and Tunstall 1991). The main approach used for measuring non-use values is the contingent valuation methods.

Methods such as change in productivity, hedonic pricing methods, and travel cost method are all based on actual behaviour, but differ in the type of market on which they rely. The change in productivity method is a direct market-based technique involving the assessment of effects on productivity caused by, for example, a development project. Market prices for inputs and outputs are used in the benefit-cost analysis of the project. This method requires that the cause and effect relationships be known (Dixon et al. 1988). For complex systems such as those of coastal areas, it is unlikely that the magnitude of impacts could be determined without considerable speculation and arbitrary assumptions. Thus, the measures of changes in production usually involve great uncertainty. As recognised by Ruitenbeek (1994) in his study of mangrove resources in Indonesia, results of benefit-cost analysis could vary depending on assumptions concerning the nature and degree of linkages among many components of the complex mangrove resources system. These linkages are, unfortunately, not easy to identify. The change in productivity method is a general approach for resource valuation. However, the non-use values of resources and environment are not considered. Although the technique is well-suited for use in developing countries and is readily intelligible to decision-makers (Winpenny 1991), its limitations are recognised, especially in relation to the availability of the information on the physical relationship between activities affecting the environment, the output, and costs or damage.

The hedonic pricing and the travel cost methods are indirect approaches to resource valuation based on actual behaviour, but in implicit markets. Hedonic wage and price techniques ascribe the differences in wage rates and property values, between a normal area and a degraded area, to the value of good environment (Munasinghe 1992). Some limitations of the hedonic pricing methods are large data requirements and the need for statistical competence in generating and interpreting results (Winpenny 1991). Furthermore, these methods are not appropriate to the study of environmental damages since many damages are seldom linked to the values of surrounding areas.

The travel cost method aims at deriving the demand for and the valuation of recreational areas from the costs incurred in travelling to such areas. The method relies on the fact that the visits made by people to any location is an indication that their willingness to pay for the environmental good exceeds the total travel costs (Angelsen et al. 1994). Although the travel cost method has been used extensively to value recreational goods and services, it has virtually no application to the valuation of environmental losses or damages.

The last group of valuation techniques, contingent valuation or CV methods are a survey-based method, widely used for determining economic values of natural and environmental resources in the absence of market prices. CV methods are designed to measure both use values and non-use values. This technique has been used to value various types of natural resources, including air, water, land, fish, wilderness area, and other wildlife. Other applications of CV methods include its use in natural resource damage assessment, especially in the case of oil spills (For details, see Binger et al. 1995; Heyde 1995; and Wruck 1994).

Apart from certain biases (e.g., strategic bias, hypothetical bias and anchoring bias) associated with survey-based methods in general, CV methods are criticized for the type of values they measure and their credibility. This technique relies on obtaining information on consumer's preferences by posing direct questions about willingness to pay (WTP) for goods and services. Although it is more appropriate to use willingness to accept (WTA) to measure resource and environmental losses, in practice WTP is more commonly used for two reasons. First, it is difficult, or impossible, to obtain WTA responses, and second, it has long been assumed that WTP and WTA both yield essentially equivalent assessments.

Recent research has, however, provided strong evidence suggesting that the assumption of WTP and WTA equivalence is not valid. Findings from numerous studies show that people commonly value losses much more than they do gains. This discrepancy between valuation of gain and loss is referred to as endowment effect and has been repeatedly reported in the professional literature. (For examples, see Knetsch 1994.) The use of WTP to measure losses will result in very serious understatements of losses, and should therefore be considered inappropriate. Because of the problems associated with contingent valuation methods, it can be concluded that reliance on the survey results in either damage assessments or government decision making can be misguided. Management policies for development projects based on these estimates may consequently fail to promote the most efficient use of natural resources and environment.

1.2 Scale of Relative Importance and Damage Schedule as an Alternative Approach

Realizing the growing concern for obtaining accurate measures of natural resource and environmental values, and the problems associated with existing techniques, the damage schedule method is proposed in this study as an alternative approach. The method aims at providing a comprehensive understanding of the values of natural resources and environmental assets, without the need for direct monetary valuation. This is done by using people's judgements in the ranking of the relative importance of different resource losses and of different impacting activities. While people may not be able to provide consistent monetary measures of environmental losses (Rutherford et al. 1998), they are faced with a much less difficult task when asked to compare the severity of the two losses or the two activities. Therefore, they may be able to provide consistent rankings of the relative importance of different resource losses and activities that have adverse impacts on the environment. Even in the case when two losses or events are incommensurable, reasonable choice and ordinal ranking can still be made: "*Options can be incommensurable in this way while still being very much subject to reasonable choice… Indeed, reasonable choices among incommensurable options are the stuff not merely of law, but of everyday life*" (Sunstein 1994).

The proposed strategy involves determining a scale of relative importance of resource losses and impacting activities which are used as a basis to develop the damage schedule -- an empirical test of Knetsch's "interim damage schedule" (Knetsch 1994). A similar approach has been used to a limited extent for damage assessment of compensation schedules in cases of minor discharge pollution and marine oil spills (Geselbracht and Logan undated; Plant et al. 1993). Both studies use base figures for the value of the natural resource as a guide for the evaluation and assessment of damages to natural resources.

Damage schedules reflect people's judgements of the relative importance of different resource losses and impacting activities. They also provide useful benchmarks to guide the assessment of specific resources or environmental losses. They can aid policy makers in designing resource regulations, in deciding on allocations, and in determining compensation and damage awards. The damage schedule aims to facilitate the decisions made on resource use, especially when confidence in physical measurement and market information is lacking.

Damage schedules provide predictability and enforceability by specifying in advance the payments that will be required in the event of a loss (Rutherford et al. 1998). Traditionally, economic valuation of resource damage takes place after the incident has occurred and usually involves long processes of collecting information, identifying impact, and calculating costs of restoration or replacement. Hence, not only are value assessments problematic, but the cost of assessing the damages could easily exceed the recovery cost of the resource itself. With the damage schedule, loss assessment could be implemented quickly at low transaction cost. Further, developers and planners can take the predictable outcomes into account when considering alternative actions and differing precaution levels.

Unlike other methods, data requirement for developing the damage schedule is relatively small, making its application to developing countries more attractive. Table 1.1 lists the kinds of information needed for this approach as opposed to the change in productivity method.

Table 1.1 Information needs for the change in productivity method and the damage schedule approach

Information needs	Change in Productivity	Damage Schedule
Level of knowledge about the resources and their uses	Good, complete understanding is required.	Good, complete understanding is required
Ability to quantify resource productivity	Yes, with significant degree of certainty.	No, only relative importance is needed.
Prediction of changes in production as a result of an activity	Yes, with certain accuracy of magnitude and time.	No, only direction of changes and the relative magnitude is required.
Market prices of inputs and outputs	Yes, some assumptions must be made about costs and prices - including those for non-market values.	No, not using benefit-cost analysis.

1.3 Objectives of the Study

Although the suggestion that environmental damages be assessed on the basis of a fixed schedule (e.g., damage schedule described in this paper) is not a new idea, its application is still limited. Consequently, the possibility of developing damage schedules that successfully indicate the relative importance of natural resource and environment is subject to criticism. The main objective of this research project is, therefore, to provide an empirical test of the feasibility of developing damage schedules, using actual situations in the two coastal areas of Thailand: Ban Don Bay, on the Gulf of Thailand, and Phangnga Bay, on the Andaman Sea. The testing of this approach in Thailand is suitable since, as a developing country, Thailand faces many constraints in applying other methods that are far more demanding in terms of information, human resources, and financial resources.

Specifically, there are three underlying questions relating to this project. First, can respondents provide consistent scales of relative importance of various resource losses and impacting activities? Second, can these scales be used as a basis to construct meaningful damage schedules that reflect people's real preferences and values? Lastly, what are the implications of the damage schedule approach in the management of natural resources and environmental assets?

In this study, a damage schedule is a fixed schedule of various resource losses or environmental impacting activities, constructed using experts' judgement and assessment of the relative importance of the losses and the activities. Experts include formal experts such as researchers, policy makers and administrators, and lay experts such as resource users and stakeholders. The experts are presented with questionnaires containing paired-wise comparisons of different losses or activities. Their job is to choose, between each pair, which loss or activity is considered to be more important. The responses from all the paired comparisons are analysed and translated into a scale of relative importance. The initial scale of relative importance could be expanded over time by including other losses of different form or magnitude, or by interpolating or extrapolating from those previously scaled. Although such a scale does not provide direct assessment of economic values, it serves as a foundation for the structuring of the damage schedule which can be used as a tool for the management of natural resources and environmental assets.

Chapter 2 of this report describes the methodology used to obtain the scale of relative importance and the damage schedules. Details on the paired comparison method, the experimental design, and the analyses of paired comparison data are provided. Chapter 3 describes the case studies conducted in the coastal areas of Thailand as a test on the application of the damage schedule approach in actual situations. The results of the study are reported in this chapter. Chapter 4 discusses some of the problems relating to the method used and the damage schedule approach in general. The final chapter gives an example of how damage schedules can aid policy makers in the management of Thailand's coastal resources. It also gives suggestions for future research.

2.0 CONSTRUCTING THE SCALE OF RELATIVE IMPORTANCE AND DEVELOPING THE DAMAGE SCHEDULES

2.1 Theoretical Background

The construction of the scales of relative importance are derived using people's judgements about the importance of the resources and impacting activities. These judgements are believed to reflect the values that people place on resources in consideration. The values in this study are comparable with Brown's definition of value, that is, "v*alue is the expressed relative importance or worth of an object to an individual or group in a given context*" (Brown 1984). This kind of value is relative, not absolute, and thus can only indicate the importance of the object by implicit or explicit comparison (Brown 1984). The type of values, provided by people in this study, is also similar to the 'full value' referred to by de Groot (1992), and include ecological, social, and economic values. All these values are captured together, not separately, and are qualitatively described in terms of relative importance.

The concept of value specified in the current study can be expressed in terms of utility function, following Sinden and Worrell (1979):

$$\text{Value} = f\,(\text{utility, environmental conditions, circumstance of evaluator at time of valuation})$$

This relationship suggests that people use utility (defined as the satisfaction of a human want or desire) as a criteria in ranking things in order of relative values. Value depends, not only on the nature of the thing itself, but also on the environment in which the value is being assessed and on different circumstances (such as personal, emotional, social and political situation), of the people who evaluate it at that time. It is generally assumed that individuals seek to maximize utility subject to constraints such as costs, resource availability, and others (Randall 1987).

In complete and perfect markets, where individuals seek to maximize personal utility, economic values of goods and services are determined by their market prices. These measures, however, do not accurately reflect true economic values when markets are not perfect, as in cases involving environmental resources, with their nonexclusive and public good properties. Given the inadequacy of markets to reveal environmental values and to allocate resources, mainstream economists suggest cost-benefit analysis as a routine procedure for evaluating proposed projects (Randall 1987). Cost-benefit analysis is based on the concept of potential Pareto improvement, which states that a change is economically desirable if the gain exceeds the loss or if gainers could compensate the losers. This criterion only requires that compensation be possible, not that it actually has to occur, and no consent of the involved parties is needed (Randall 1987).

The scales of relative importance and the damage schedule developed in this study can be used to guide resource allocation decisions in much the same fashion as direct valuation (e.g., cost-benefit analysis). The values obtained from the study, although not necessary leading to maximum economic efficiency or welfare do reflect the choices that people make. They should, therefore, be socially acceptable. This point is particularly obvious when considering environmental issues that concern the community as a whole. Rather than expecting that people would always make a decision that maximizes their utility, the study allows for the possibility that an individual's judgement may be a result of intrinsic value, altruistic reasons, or ethical duty (Sagoff 1994).

The construction of the scales of relative importance is based on people's expressed value judgements. As in social choice theory, individuals are presented with a set of alternative social states (in this case, a set of resource losses or activities causing losses). For any individual, a preference ranking or ordering of these alternatives is constructed, and thus individual choice behavior is determined and indicated in the form of relative importance. Note that preference in this context has logical syntax and is not a semantic one that refers to a state of mind as in psychological meaning (Sagoff 1994). The concept of social choice theory demands that in order for individual choices to be rational, they must be transitive and anti-symmetric. Choices are transitive and rational if when object A is ranked higher than B and B higher than C, it follows that A is ranked higher than C (e.g., A>B, B>C, and A> C). Anti-symmetric refers to a condition where if A is ranked higher than B, B cannot be ranked higher than A. The representation of the choice mechanism by ordering relations, as attempted in this study, has certain advantages over the more conventional representations in terms of utility functions (Arrow 1951). As it may not be possible to assign real numbers to the various alternatives so as to satisfy the usual requirements of a utility function, representing the ordering relations of choices directly is sufficient, especially when concerned with ordinal properties of such alternatives (Arrow 1951).

2.2 Experimental Design

A four-part questionnaire containing series of paired comparison questions, was used as an instrument for the study. Considerable effort was taken in developing the questionnaire and several pre-tests were performed. Sufficient information about the resources and activities in consideration was given at the beginning of the questionnaire. This standardized information was given to all respondents, many of whom had different backgrounds and interests. Furthermore, reference tables of resource losses and impacting activities (i.e., outlying certain attributes of the resources/activities that should be considered when making the comparisons) were provided. Several layouts of the questionnaire were tested since it was considered a key aspect in determining the success of data collection. The format that seemed to work well was to have only one paired comparison question on a half-sheet paper. Although the final questionnaire contained several paired comparison questions, it did not appear too complex when the four parts were kept separate.

Instead of personal interviews, the survey method was used in data collection to reduce biases that could be induced by different enumerators. The trade-off was, however, the exclusion of illiterate respondents. The target population for the survey was formal experts and lay experts. Formal experts included researchers, administrators and policy-makers who were knowledgeable about the resources and activities in the study areas, or who were responsible for the management of coastal resources. Formal experts were from different areas of specialisation, including biology, fisheries, mangrove forests, economics, and social sciences. The list of formal experts was based on suggestions from known experts and from the National Research Council of Thailand.

Lay experts included resource users, stakeholders and other people residing in the coastal areas. There were four occupational groups of lay experts in each of the two study areas, three of which were common in both cases, namely fishers, shrimp farmers, and others. In Ban Don Bay, the fourth lay expert group comprised shellfish culturers; that of Phangnga Bay comprised people in tourism related business. Quota sampling was used to obtain a reasonable amount of experts for each occupational group.

2.3 Paired Comparison Method

The method of paired comparisons involves presenting objects in pairs to one or more judges. The paired comparison method is used primarily in cases where the objects to be compared can be judged only subjectively (David 1988). The method is mostly employed in the study of preference and choice behaviour. Some applications have been in taste testing, colour comparisons, and personnel rating. This method is preferable to other ranking methods when the number of objects to be compared is large and the differences between objects are not apparent (David 1988).

In their study of assessing non-pecuniary environmental losses, Rutherford et al. (1998) presented several pairs of losses to the subjects in accordance with the paired comparisons method. Peterson and Brown (1998) used the same methodology in their study of valuation of public and private goods. Both studies show that the method of paired comparisons can be used successfully when applied to public goods such as natural resources and environment.

The number of pairs presented to each respondent does not seem to be an issue of concern in general behavioural studies using paired comparison method. In the case of natural resource and environmental losses, however, too many pairs for comparison might pose some problems, in particular, of intransitivity, which occurs when choices are not consistent. Peterson and Brown (1998) noted that a circular triad (e.g., A > B > C) may be caused by systematic intransitive preference random choice in cases where the two objects were too similar, incompetence of respondent, or simple mistakes. The extent to which intransitive response has impact on the development of the damage schedules is discussed later in the paper.

Two types of paired comparison questions were used in this study. Type I was the comparison of similar items, such as between two resource losses or between two impacting activities. Type II involved comparisons of different items, such as between a loss of resource and a loss of money. The details on the different kind of analysis required for each type of paired comparison questions are presented below.

2.4 Analysis of Paired Comparison Data

In the paired comparison method, objects are arranged in pairs so that each item is compared with every other one. The total number of possible pairs for comparisons can be calculated using equation (2.1):

$$N = n (n - 1) / 2 \qquad (2.1)$$

where N is the total possible pairs, and n is the number of objects for comparisons. When a pair of objects (in this case, resource losses, monetary losses, or impacting activities) is presented to an expert, he or she must choose one object that is considered more important. No ties are allowed in this study (i.e., respondents must choose one of the two choices, even if they feel that these are of equal importance).

Suppose there are four objects, A, B, C and D, presented to one respondent for comparisons. The total number of pairs, in all possible comparisons, calculated by the above formula is 6. The hypothetical results of these six comparisons by the respondent are shown below. The underlined object is the one preferred by the respondent.

Pair number	1:	A vs. B
	2:	A vs. C
	3:	A vs. D
	4:	B vs. C
	5:	B vs. D
	6:	C vs. D

These results can be tabulated into a square array as in Table 2.1. When object A is preferred to object B, a count for the column object A and the row object B is 1, and the corresponding count for the column object B and the row object A is 0.

Table 2.1 Sample matrix for the analysis of Type I paired comparison data

	A	B	C	D
A	-	0	0	0
B	1	-	0	0
C	1	1	-	0
D	1	1	1	-
Total	3	2	1	0

The number of times the object is selected over all other objects is a preference score of that object. In this example, the preference score of A, B, C, and D is 3, 2, 1, and 0, respectively. These scores are aggregated across all respondents and are used to calculate the scale of relative importance of the objects compared, based on the variance stable rank sum method proposed by Dunn-Rankin (1983). According to Dunn-Rankin (1983), the scores obtained by this simplified rank method are isomorphic with values obtained under Thurstone's Case V method.

To apply the variance stable rank sum method, the aggregated preference scores are normalised to a scale of 0 to 100. This is done by dividing the preference scores aggregated across all respondents by the total possible score, and multiplying the result by 100. The total possible score is simply the multiplication of the number of respondents and the maximum score that could be obtained if the object is considered to be most important. In the above example, if the number of respondents is 10, the total possible score is then 30. These normalised scores are the scale values of the relative importance of the objects in consideration.

In the study of Ban Don Bay and Phangnga Bay, paired comparison data of Type I (Part I and Part II of the questionnaire) were analysed following the above description. In these two parts, eight objects were presented for comparison. Once the preference scores for each respondent was obtained, these scores were checked to determine the level of intransitivity of the responses. If the preference scores of a respondent contained all eight integers from 0 to 7, then there was no intransitive response (no circular triad). On the other hand, if some integers appeared more than once while others disappeared, then it could be expected that there were some intransitive responses. Based on the choices made in all the pairs, it was possible to work out the number of intransitive responses that each individual made. Respondents were categorised into groups according to the number of intransitive choices ranging from 0 to 2. The ways in which respondents were assigned to each of these intransitive groups are explained in detail in Chapter 3.

2.5 Non-parametric Statistical Tests of the Rankings and the Scale Values

Two measures of rank association were used in this study: Kendall rank-order correlation coefficient T, and Kendall coefficient of agreement u. The first measure involves converting the preference scores from paired comparison data to rankings while the latter deals directly with paired comparison data. Each of these measures is briefly described in the following sections. Details of the methodology, including the treatment of tied observations and the test of significance, can be found in most nonparametric statistics books.

2.5.1 Kendall rank-order correlation coefficient T (Kendall T)

Kendall T is a measure of association or correlation between two variables that are measured in at least an ordinal scale. Although the use of Kendall T is limited to two sets of rankings or two judges, in this study the method was adapted to use as part of the sensitivity analysis of the results.

The basic model can be explained using hypothetical rankings of four objects (A to D) by two judges. Suppose the individual preference scores of judge 1 and 2 are:

Objects:	A	B	C	D
Judge1:	3	2	0	1
Judge2:	2	3	1	0

The ranking of preference could be assigned to these scores, given rank '1' for the highest score and rank '4' for the lowest score. The rankings of the four objects for these two judges would then become:

Objects:	A	B	C	D
Judge1:	1	2	4	3
Judge2:	2	1	3	4

If the order of the objects in the natural order is arranged based on the ranking of Judge 1, then the rankings become:

Objects:	A	B	C	D
Judge1:	1	2	3	4
Judge2:	2	1	4	3

The number of agreements and disagreements in the ordering are counted and Kendall T is calculated using the following equation

$$T = 2S / n (n -1) \tag{2.2}$$

where T = Kendall rank-order correlation coefficient
S = number of agreements - number of disagreements
n = number of objects ranked.

This coefficient T determines the degree of correspondence between the two sets of rankings. If the two rankings were in perfect agreement, T would equal +1, but if they were in perfect disagreement, T would equal -1. Increasing values from -1 to 1 thus correspond to increasing agreement between the ranks (Kendall and Gibbons 1990). The test of significance in the value of rank correlation used in this study indicates whether the two sets of ranks are unrelated. When the null hypothesis is rejected, it can be concluded that the two ranks are related at a certain level of significance.

2.5.2 Kendall coefficient of agreement u

Kendall u measures the degree of agreement among individuals in their preferences. It is most suitable for data from paired comparisons. If the paired comparisons for each judge are consistent (i.e., a ranking of the n objects could be done), Kendall u would be equal to the average Kendall T among several judges (Siegel and Castellan 1988). This property is useful in verifying the resulting rankings of relative importance obtained in the study.

The preference matrix is first constructed as in Table 2.1 for each judge and aggregated across all judges. An aggregated preference matrix based on hypothetical preference scores for the four objects, A, B, C, and D of four judges is:

	A	B	C	D
A	-	3	2	1
B	1	-	0	0
C	2	4	-	1
D	3	4	3	-
Total	6	10	5	2

The number in each cell (a_{ij}) indicates the number of times the column object is selected over (or preferred to) the row objects. The coefficient of agreement u among the judges can be calculated by:

$$u = [\, 8 \,(\sum a^2_{ij} - k \sum a_{ij}) / k\,(k - 1)\, n\,(n - 1) \,] + 1 \qquad (2.3)$$

where the summation is taken over the a_{ij}'s below or above the diagonal, k is the number of judges and n is the number of objects in the paired comparisons. Based on this hypothetical data, u is calculated to be 0.2778.

The test of significance of u is based on the null hypothesis that there is no agreement among the judges and the alternative is that the degree of agreement is greater than what one would expect had the paired comparisons been done at random (Siegel and Castellan 1988). When sample size is small (number of judges less than 7 and number of objects less than 9), the test of significance of u can be done by comparing the calculated u with the critical u in a probability table. For four judges and four objects, the probability of occurrence that the observed value of u is greater than or equal to 0.2778, is 0.0877 for random preferences. Based on this example, the null hypothesis cannot be rejected at probability level 0.05 and thus it cannot be concluded that there is significant agreement among the judges.

For larger sample size, X^2 can be calculated to test the significance of u:

$$X^2 = [\, n\,(n - 1)\, \{ 1 + u\,(k - 1) \} \,] / 2 \qquad (2.4)$$

This test statistic X^2 is asymptotically distributed as chi-square with degree of freedom equal to [n (n - 1) / 2]. The null hypothesis is rejected if the calculated X^2 is greater than the critical value of x^2 at a certain level of significance.

When there is a complete agreement among the judges, Kendall u will be equal to one. The minimum value of u is [- 1 / (k - 1) when k is even, and [- 1 / k] when k is odd.

2.6 Construction of Scales of Relative Importance

A scale of relative importance of resource losses and impacting activities can be constructed based on the scale values obtained from Dunn-Rankin's variance stable rank sum method. Results from the sensitivity analysis determine the number of scales that could represent the relative importance of the resource losses. Although scale values are relative, the ranking is informative and useful. A damage schedule can be developed based on these scales to indicate relative importance of the resources. Such damage schedule could be used directly to aid policy makers in resource management. For example, policy makers can direct their efforts toward resources considered most important, when faced with budget constraints and time limitation. The damage schedule can be fine-tuned when different kinds or levels of losses or damages occur.

Two kinds of important scales could be developed based on this study, a scale for consequences or losses (Part I) and a scale for events or activities (Part III). Both are derived using experts' judgement of the relative importance of specific resource losses and impacting activities. Based on these important scales, the loss schedule and the activity schedule are developed. The loss damage schedule could be used to assess payments for specific losses or damages measured after the occurrence of a particular event (Rutherford et al. 1998). For example, the loss schedule in this study would incorporate four kinds of losses, each with two levels of magnitude. When an event occurs, on-site measurement of the losses is required and the application of remedies is specified based on the loss schedule. With the activity schedule, damage payments could be assessed without having to measure the specific losses resulting from that activity. This is because the activity schedule has already incorporated the information via experts' *ex ante* judgements of the most likely consequences of particular activities and their relative significance. Therefore, when an event occurs, there is no need to measure the losses following this event. Instead, the event would be assessed based on the standard payment specified by the activity schedule. The association of the two schedules is examined in this study to assess if the activity considered most damaging is related to the most important resource loss.

2.7 Paired Comparison of Monetary Loss and Resource Loss

The main purpose of including Part II in the questionnaire is to demonstrate how different resource losses could be compared with monetary losses, as in the setting of paired comparison questions. The extent to which the results obtained from this part could be used as additional inputs to the development of the damage schedules must still be discussed. As will be seen in Chapter 3, the results are subject to the same kinds of biases as in CV studies (e.g., anchoring bias, hypothetical bias and others).

When the paired comparisons are of Type II (e.g., comparison between a resource loss and a loss of money), a different kind of analysis is performed. As in Type I, the number of possible pairs can be calculated using equation 2.1. However, when monetary values are presented in the comparisons, it is not necessary to include the comparisons between two monetary values. In Part II of this study, four monetary values are presented in the paired comparisons with four resource losses. The total number of pairs included in this part should be 22 (28 total possible pairs minus 6 pairs of the four monetary values against each other). However, because the four resource losses are already compared in Part I of the questionnaire as Type I question, the number of pairs could be reduced further to 16 (22 minus 6 pairs of the four resource losses against each other).

The analysis of Type II questions is similar to that of Type I. Take again the example in Section 2.4 where four objects, A, B, C, and D are compared. This time, the four objects are compared are four amounts of money: 100, 200, 300 and 400 Baht (where 30 Baht is roughly CAD $ 1). The number of pairs for comparisons is 16 (i.e., A vs. 100, A vs. 200, A vs. 300, A vs. 400, B vs. 100, B vs. 200, B vs. 300, B vs. 400, C vs. 100, C vs. 200, C vs. 300, C vs. 400, D vs. 100, D vs. 200, D vs. 300, and D vs. 400). The results are tabulated into a square array of a reduced form (Table 2.2) since the monetary values are not compared with one another and the four objects have already been compared. As before, when object A is preferred to 100 Baht, a count for the column object A and the row money 100 is 1 (the corresponding count for the column money 100 and the row object B is also 0, not shown in this table).

Table 2.2 An example of a matrix for the analysis of Type II paired comparison data

Baht	A	B	C	D
100	1	1	1	1
200	1	1	1	0

300	1	1	0	0
400	1	0	0	0

Once the data are tabulated, a check of consistency of responses could be done. Based on the responses in Table 2.2, the respondent makes consistent choice in all 16 pairs. For example, when A is considered to be more important than 400 Baht (indicating by the count of 1 at column A, row 400), for the choices to be consistent, A must be considered more important than 300, 200 and 100 Baht. When B is considered to be less important than 400 Baht, a count of 0 is put for column B, row 400. But when B is considered more important than 300, it is also considered more important than 200 and 100 Baht (thus, a count of 1 for column B, except in the last row). The responses of these types are considered to be consistent. The same consistency check is used for C and D.

Inconsistent choices occur, for example, when A is considered more important than 400, but less important than 300, 200, and 100. The count of column A from top to bottom is therefore 0, 0, 0, 1. Another example for the count of column B, if it reads from top to bottom is, 1,0,1,0. This shows that there is a degree of inconsistency in the responses. Using this method, inconsistent choices can be observed.

It is possible that respondents consider all objects to be more important than any amount of money. In other words, they are not willing to make any trade-off between the objects and the money. Thus, the count in the whole table is 1. Respondents with this kind of responses are called *no-trade* respondents.

Respondents to Part II of the questionnaire were categorised into three groups -- consistent, inconsistent, no-trade -- according to the consistency of their responses, as outlined above, and further analysis was performed.

One way to analyse Type II paired comparison data is to estimate the monetary value of a resource loss by calculation of median values. First, the counts of preference, as tabulated in Table 2.2, are aggregated across respondents in each of the three consistent groups. These aggregated scores are converted into proportions of respondents considering the resource loss to be more important than a certain amount of money (i.e., rejecting the money). The proportions are plotted against the monetary value and the median values are obtained by linear interpolation of the proportions. The median point is used here as a value that is acceptable to at least 50% of the sample (Peterson and Brown, 1998). In this study, the proportions and the median values were obtained for three subsets of respondents: consistent respondents, consistent and inconsistent respondents, and all respondents. Finally, the analysis was done to test the sensitivity of results when excluding formal experts.

3.0 EMPIRICAL APPLICATION ON COASTAL AREAS OF THAILAND

3.1 Overview of Coastal Resources of Thailand

Thailand's coastal areas share similar problems with other countries in Southeast Asia. Natural resources such as fisheries, coral reefs, mangrove forests and coastal beaches are exploited by various conflicting activities and are under pressure from urban and industrial development. Coastal resource management has not been very successful for lack of a comprehensive understanding of the complex and interactive system. The problem of resource allocation to multiple users with different interests adds to the management difficulties. Furthermore, policies and regulations are not successfully implemented due to several factors such as absence of a well-defined property rights regime, and an overlapping authority of various government agents involved in coastal resource management.

Thailand has an extensive coastline of about 2,600 kilometers in the eastern and the southern parts of the country. The southern coasts are divided into the eastern side adjacent to the Gulf of Thailand and connecting with the eastern coast, and the western side in the Andaman Sea. Most of the coastal areas are characterized by heavily exploited resources, rapid population growth, and human activities along the coastline. Among many activities in the coastal areas, fishing is one of the most important as it involves a large amount of people, either as fishers, boat builders, fish processors, wholesalers and distributors. Although GDP for fisheries in 1992 was only 41 billion baht (12.5% of agricultural GDP and 1.5% of the country's GDP), it expanded to a very high annual rate of 17% from 1984 to 1992 (Midas Agronomics, 1995). Coastal fishery involves more than 50,000 households, 67% of which are small-scale fishers with outboard-powered boats (Department of Fisheries 1996). Commercial fishers operate from many ports in major towns, but small communities of small-scale fishers scatter along the coastal areas and on the islands are more dominant. Competition and conflicts among commercial and small-scale fishers intensify as fisheries resources become less abundant. Unfortunately, fisheries in the Gulf of Thailand have been greatly depleted since the introduction of trawl fishing. The regulation prohibiting trawlers from operating within 3 km from shore is not effective and the conflicts between trawlers and small-scale fishers using other gears remain.

Apart from fisheries, coastal areas offer other productive and diverse ecosystems, such as mangrove forests, seagrass beds, mudflats and coral reefs. Besides being important as individual ecosystems, they interact in a way that is difficult to understand. The mangrove ecosystem is perhaps one of the most studied and is considered to be one of the most important. Ruitenbeek (1994) provides comprehensive examples of uses and environmental functions of mangroves. The list includes production uses such as timber, firewood, charcoal, fisheries products, and traditional uses of mangrove forests. Some of the conversion uses are industrial and urban land use, aquaculture, salt ponds, and rice fields. Mangroves provide other environmental functions, for example, shoreline stabilization, provision of nursery and breeding grounds, nutrient supply and regeneration, and recreational opportunities. Thus, it is clear that degradation and exploitation of mangrove forests affect other components of the coastal system.

The mangrove forest area in Thailand has steadily decreased in the past 32 year, from 2,299,375 rai in 1961, to 1,054,266 rai in 1993 (Royal Forestry Department 1996) (where 6.25 rai is 1 hectare). The recent development of the shrimp farming industry in Thailand is one of the major causes of this decrease in mangrove forest areas. LandSat data from 1993 showed that 17% of mangrove forests was converted into shrimp farms (Charuppat and Ongsomwang 1995). Impacts of shrimp farming on the mangrove ecosystem are vast, starting from excessive siltation or sedimentation, overloading of nutrients, and alteration of water quality in mangrove forest areas. Consequently, shrimp farming has effects on fisheries and coastal aquaculture in the areas. Apart from environmental impacts, the shrimp farming industry has altered the livelihood of the people in the coastal communities. In their paper, Barraclough and Finger-Stich (1996) quoted Weigel (1993) who called the shrimp industry's expansion in Thailand as one of "aquacultural colonization." By this, Weigel meant the commercialization of land and labour - through the displacement of the local markets providing labour and bringing fish protein to inland areas with commercial distribution channels aimed at high-income urban consumers (Barraclough and Finger-Stich 1996).

It should be recognized, however, that shrimp farming is not the only cause of mangrove degradation. In fact, conversion of mangrove forests into shrimp farming is no longer a common practice in Thailand due to many factors. First, the availability of mangrove forest areas for such purpose has been greatly reduced. Second, the regulations and the zoning of mangrove areas are being enforced more strictly. More importantly, some shrimp farmers no longer consider shrimp farms near mangrove forest areas an advantage. Although the intake and the exchange of seawater can easily be done when the farms are near the sea, the risk of disease outbreaks in intensive shrimp farming areas, generally in or near mangrove forests, is much greater. As a result, shrimp farming is moving upland into land previously allotted for rubber plantations, oil palm plantations, rice fields, and other agricultural purposes. Nowadays, shrimp farms can be found more than 5-km inland. These farms rely on transportation of water over land, and most are operated in a semi-closed system, or closed system (very little or no exchange of water). The concern regarding shrimp farming in Thailand has thus taken a new form because its environmental impacts, such as saltwater seepage into the area adjacent to shrimp farms, are again undetermined.

Other coastal activities, such as industrial development, port development, urban development, tourism-related industry and mining, also have impacts on mangrove ecosystems, other coastal resource systems, and coastal environment in general. Some of these activities will be discussed under the description of the study areas. The details of other coastal ecosystems, such as seagrass beds and coral reefs, will also be provided in the same section.

Two of Thailand's coastal areas were selected for the study, in order to test the validity of the proposed method when used in two areas with different characteristics. These two areas were Ban Don Bay on the eastern coast, Gulf of Thailand and Phangnga Bay, on the western coast, Andaman Sea. The main reason for the choice of these areas as study sites is the availability of information on them. These areas were extensively studied in 1986 by a team of experts in various disciplines under the Association of Southeast Asian Nations (ASEAN) - United States (US) Coastal Resources Management Project (CRMP) (Paw et al. 1988). Several aspects of coastal areas were included in the coastal environmental profile, including physical setting and land use, natural resources and environment, fisheries and aquaculture, tourism and other economic sectors, population, and institutional and legal framework. Because of this project, formal experts were available as respondents of the survey.

These two coastal areas, although differing in some basic characteristics, are of great importance to the region, in terms of their natural resources, cultural values, and potentials for exploitation and development.

3.2 Description of the Study Sites: Ban Don Bay and Phangnga Bay

3.2.1 Ban Don Bay

Ban Don Bay covers the coastal area of Surat Thani Province, from Chaiya District on the west side to Don Sak District on the east side (Figure 3.1). The coastal area includes the upland area within 5 km from shore (landward), the shore area (intertidal), and the extended seaward area to about 5-km.

Ban Don Bay is a small, open bay area, exposed to monsoon weather. Strong waves and high winds along the coast, especially during the northeast monsoon season (October to April), cause high turbidity. The coastal area has a gradual slope and the water is shallow. A large band of mudflats extends along the coast to about 2-km from the shore, contributing to high sedimentation in the bay area. The area is connected to many freshwater canals and the big river (Tapi River). This flow of freshwater results in low salinity, accumulation of organic matter from freshwater sources, and wastes from industrial and agricultural toxic chemicals. Dredging is needed once a year to keep the channel from becoming too shallow.

Important coastal resources of Ban Don Bay include mangrove forests, shellfish such as shrimps and molluscs (mainly mussels and cockles), and pelagic fish such as Indo-pacific mackerel and Indian mackerel. About 3,288 households in Surat Thani province rely on fisheries for their major source of income (Department of Fisheries 1996), 83% of which are small scale fishers, operating with outboard powered boat. Fishing is concentrated in Don Sak district where shrimp gill nets and squid traps are dominant gear. Trawls and push nets are used much less since they are not allowed within 3 km offshore. Other important industries related to fishing are dried fish factories, dried shrimp factories, and other fish processing plants.

Because of its large mudflat areas, Ban Don Bay is rich in shellfish resources such as cockles, mussels, mud crabs, and oysters. The bay area is one of the best locations for coastal aquaculture, particularly the large oyster (*Crassostrea belcheri* Sowerby), which has a very high market demand (Khaonuna 1994).

Both fishing grounds and coastal aquaculture areas of Ban Don Bay are being degraded by human activities such as conversion of mangrove forests, urban development, and industrial development. A plan to develop a southern seaboard project in Surat Thani has been proposed. This project involves the development of a petroleum industry, among other heavy industries, and thus could have great impacts on the natural resources and coastal environment of Ban Don Bay.

As mentioned above, conversion of mangrove forests is one of the major causes of environmental degradation in

Ban Don Bay. Based on Landsat images and GIS mapping of 1984 and 1993, changes in land uses and in size of mangrove areas are observed (Table 3.1). There was a considerable decrease in areas devoted to paddy field, forest, and rubber plantation. Areas classified as mangroves declined as well while shrimp pond and urban areas expanded. According to the GIS maps, areas for shrimp ponds came mainly from mangrove forests, orchards, and paddy fields. As a result, only a narrow band of mangrove fringe, about 50-100 meter wide in Ban Don Bay is left (Figure 3.1). The most severe mangrove destruction in Ban Don Bay was found in Don Sak district where in 92% of the mangroves have already been converted (Rattakul 1995).

Table 3.1 Changes in land use pattern in Ban Don Bay, from 1984 to 1993, based on satellite images and GIS mapping (based on unpublished data supplied by R. Ratanasermpong)

Land use	1984		1993		Changes	
	Area (ha)	%	Area (ha)	%	Area(ha)	%
Forest	958	0.9	686	0.6	-272	-28.4
Scrub	4,649	4.3	-	-	-	-
Mangrove	2,740	2.5	2,332	2.2	-408	-14.9
Orchard	17,269	16.0	16,114	14.9	-1,155	-6.7
Homestead garden	383	0.4	-	-	-	-
Rubber plantation	16,843	15.6	12,432	11.5	-4,411	-26.2
Oil palm plantation	1,892	1.8	1,889	1.7	-3	-0.2
Paddy field	24,805	23.0	14,082	13.0	-10,723	-43.2
Tropical grass	1,355	1.3	-	-	-	-
Urban area	694	0.6	1,910	1.8	1,216	175.2
Swamp area	4,318	4.0	6,147	5.7	1,829	42.4
Shrimp pond	2,176	2.0	6,456	6.0	428	196.7
River and sea	29,962	27.7	29,936	27.7	-26	-0.1
Mixed orchard	-	-	2,484	2.3	-	-
Oil palm	-	-	65	0.1	-	-
Others	-	-	13,511	12.5	-	-
Total	108,044	100	108,044	100	-	-

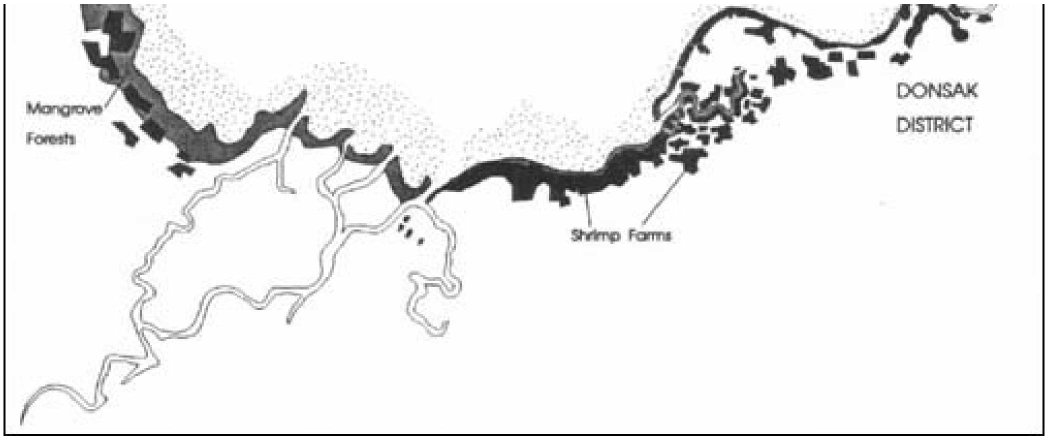


Figure 3.1 Map of Ban Don Bay

Ban Don Bay is considered more suitable for the development of shrimp farming than the west coast because of its abundant natural stock of shrimp larvae, which include the economically important species *Penaeus monodon* (black tiger prawn) and *P. merguiensis* (banana shrimp). Development of shrimp farming, mainly black tiger prawn, in the area has received support from the Department of Fisheries (DOF), and financial support from the Asian Development Bank (ADB) and the World Bank. As shown in Table 3.1, shrimp farm areas have increased almost 200% from 2,176 ha (13,600 rai) in 1984 to 6,456 ha (40,350 rai) in 1993. In 1994, there were 1,845 shrimp farms in Surat Thani Province, taking up an area of 9,900 ha (a 53% increased in 1993) (Surat Thani Provincial Fisheries Office, unpublished data). This increased was not as dramatic as in 1995, when 2,144 farms took up an area of about 10,760 ha.

The effect of the loss of mangrove forests is highly significant, considering its major role as natural habitat for many marine animals such as crabs, shrimps, and fish juveniles. An example is in the reported annual decrease in the natural production of mud crabs (*Scylla serrata* Forskal), one of the most important fishery resources harvested commercially in Ban Don Bay (Khaonuna and Ratanachote 1994).

3.2.2 Phangnga Bay

Phangnga Bay is a large, semi-closed bay area in the Andaman Sea (West Side of the southern coast of Thailand). Phangnga Bay covers coastal areas in three provinces, Phuket (east side), Phangnga (inner bay area) and Krabi (west side up to Muang District) (Figure 3.2). Using the same criteria as in Ban Don Bay, the coastal area includes 5 km of landward area and extends to about 5 km in a seaward direction from the coastline.

The bay is wide and irregular and has many archipelagic islands which provide shelter to the bay area. The sea bottom is mainly mud and sandy-mud with the deepest part being about 35 meters. There are two tidal movements a day with tidal range larger than that of Ban Don Bay. The bay is influenced by the wet southwest monsoon (May-October), with strong westerly winds and peak rainfall in July; and the dry northeast monsoon (November-April). In the rainy season, the diluting effect of fresh water flow can extend up to 10 km further south into the bay than in the dry season when lowered salinity (25-30 ppt) is restricted to the mangrove area (Limpsaichol 1988).

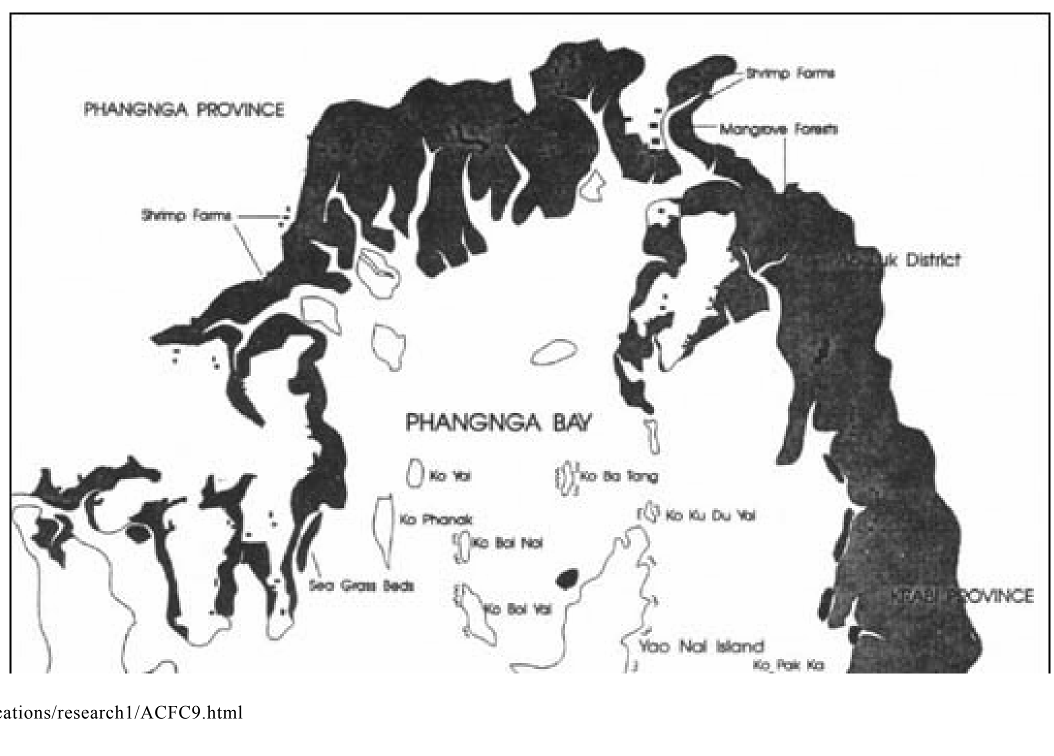
Landsat images of Phangnga Bay have been obtained recently, but the GIS mapping has not yet been completed. Thus, there is no comparative data to show the pattern of land use. In general, land use conflicts are due to conversion of upland forests for rubber plantation and agriculture, and conversion to rice farms of land suitable for fruit orchards. A new trend is, however, the conversion of rubber plantations into shrimp farms which could cause salt-water leakage into adjacent agricultural lands. The mangrove forests have similar problems: conversion to shrimp farming, urban development, and illegal cutting. Table 3.2 shows some 1993 land use patterns for the mangrove forests of the three provinces in 1993. According to this data, there is a substantial amount of mangrove forests in Phangnga and Krabi provinces which were used for economic activities.

Mangroves, coral reefs, and seagrass beds are dominant coastal ecosystems along the coast of the Andaman Sea, including Phangnga Bay (Chansang and Poovachiranon 1994). The bay area is surrounded by about 3000 km^2 of mangrove forests. Sea grasses are found in many parts of the bay and around small islands (Figure 3.2). Many rivers flow into the bay. Phangnga River is the main one, bringing in nutrients and minerals. This has made it an important spawning ground, nursery area, and habitat for many economically important species such as marine shrimps, lobsters, swimming crabs, mud crabs, clams, and Indo-pacific mackerel, Indian mackerel and promfet (Pimonjinda 1995).

Mangrove forests in Phangnga Bay are classified as old growth stands whereas those in Ban Don Bay are young growth stands that have been subjected to heavy selective cutting for human utilization (Paphavasit 1995). Mangrove forests in Phangnga Bay, especially in the inner part of the bay, are protected in a national conservation forest areas. Some of the dominant species are *Rhizopera mucronata*, *R. apiculata* and *Avicennia* spp. (Wattayakorn et al. 1995). Several species of benthos, such as molluscs and crustaceans, inhabit the mangrove area (Paphavasit 1995).

Fisheries started from small-scale operations in front of the bay, but developed into large scale operations with more efficient technologies. Common fishing gear used include trawler and small otter board trawler, anchovy purse seine, shrimp gill net, crab gill net, push net, and fish trap (Pimonchinda 1995). Fisheries resources have been degraded by illegal, destructive fishing gear. The push net is a good example. Catch from push nets comprise 85% of trash fish, while shrimps, the target species, comprise only about 10%. Furthermore, push nets compete with other gears such as the gill net for the same fishing ground and same target species, and crab gill net and fish trap for grouper (Boonragsa and Nootmorn 1990). Because of these, push nets are banned within the 3 km offshore and around the marine conservation area in Phangnga Bay (Boonragsa 1988). From the push netters' point of view, regulation for push nets to stay off the 3 km from shore is impractical. Their boats are not equipped to go very far and can only be operated in shallow water no deeper than 10 meters.

Coastal aquaculture in Phangnga Bay started about ten years ago, with black tiger prawn, cockle, and oyster being the species commonly cultured. Cage culture of giant sea perch and, in particular, of groupers, is also important due to the high market demand. Shellfish culture in Phangnga Bay, in general, is not as successful as in Ban Don Bay, as the products receive much lower prices.



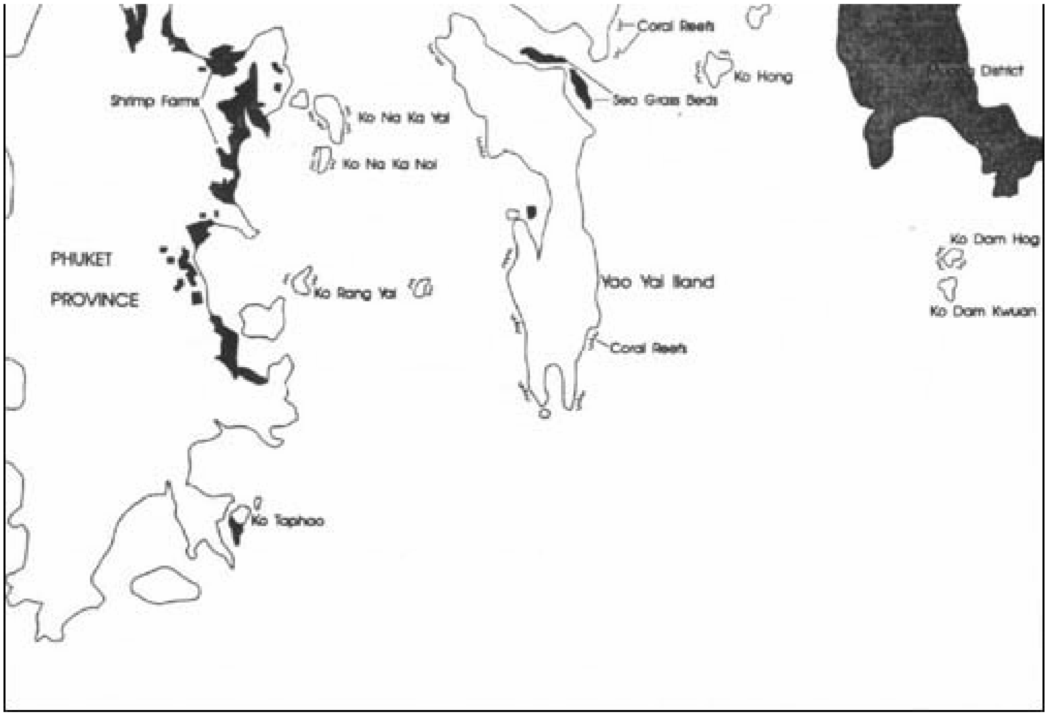


Figure 3.2 Map of Phangnga Bay

Table 3.2 Land uses in mangrove forests, Phuket, Phangnga and Krabi provinces, 1993.

PHUKET (unit = ha)				
Type of use	Conservation Zone	Econ. Zone A	Econ. Zone B	Total
Mangrove forests	265	1283	-	1548
Shrimp ponds	3	98	-	101
urban area	1	10	-	11
Others	172	938	-	1110
Total	441	2329	-	2770
PHANGNGA (unit = ha)				
Type of use	Conservation Zone	Econ. Zone A	Econ. Zone B	Total
Mangrove forests	10118	19542	1056	30716
Shrimp ponds	54	745	27	826
urban area	-	-	-	-
Others	712	10925	799	12436
Total	10884	31212	1882	43978
KRABI (unit = ha)				
Type of use	Conservation Zone	Econ. Zone A	Econ. Zone B	Total
Mangrove forests	2586	25367	574	28527

shrimp ponds	660	388	19	1067
urban area	-	-	-	-
Others	1919	7135	1271	10325
Total	5165	32890	1864	39919

Source: Charuppat and Ongsomwang (1995)

Land development and real estate becomes a major business since it is more popular for both Thais and foreigners, to acquire a second home. Land ownership is a problem. Foreigners are allowed to buy land and to obtain exclusive use of resources. Industrial development will have direct impact on the coastal environment of Phangnga Bay's coastal environment. In particular, there is the proposed southern seaboard project in Krabi which will link it to one proposed for the south of Surat Thani. The economic bridge mentioned in the project includes a deep sea port, oil tanker jetty, railroad or pipeline for oil transportation, oil-based industry, and gas-based industry (Krabi Provincial Office 1994). This rapid development, coupled with the expanding tourism-related business would result in the destruction and degradation of the coastal ecosystem, starting from the mangrove forests to the sandy beaches, seagrass beds, and coral reefs.

3.3 Coastal Resources and Activities for Paired Comparison Questions

Due to the limitation on the number of pairs that should be included in the paired comparison study, as described in Chapter 2, an informal pre-survey was conducted to determine what resources and activities should be included in each of the two study areas. The objective was to ensure that resources and activities of different levels of importance were considered in the study. This allows for an interpolation or extrapolation on the scale of relative importance of other losses or activities of different forms or magnitude, which are not included in the survey.

Selected experts in different disciplines were asked in the pre-survey to indicate the level of importance of various resources and activities in the study areas. Results from this survey, together with the information obtained from the field visits, personal interview, and literature review, were used to formulate the initial list of resources and activities to be considered in each study area. These lists were later altered in response to the outcomes of the pretesting surveys. Table 3.3 summarizes the coastal resources and activities included in the study.

The measure of relative importance of resources in this study was determined in the form of losses or damages to the resources. For each study area, a different set of four resources was chosen, each with two levels of losses or damages. Table 3.4 shows the eight resource losses or damages included in the study for Ban Don Bay and Phangnga Bay. The selected resources were natural habitats in different coastal transects: inshore, intertidal, and offshore areas. Resources considered in each study area represented those with different levels of importance, as suggested by the pre-survey.

Table 3.3 Coastal resource systems under study: Ban Don Bay and Phangnga Bay

	Ban Don Bay	Phangnga Bay
Resource components	Mangrove forests Mudflats Shellfish culture grounds Fishing grounds	Sandy beaches Mangrove forests Seagrass beds Coral reefs
Coastal activities	Shrimp farming Housing development	Shrimp farming Hotel development

	Oil spill	Oil spill

Table 3.4 List of resource losses or damages in Ban Don Bay and Phangnga Bay

Ban Don Bay		
	Resource Loss/Damage	Code
1	Severe damage to mangrove forests	MF1
2	Clear-cutting of mangrove forests	MF2
3	Partial damage to mudflats	MUD1
4	Severe damage to mudflats	MUD2
5	Partial damage to shellfish culture grounds	SCG1
6	Severe damage to shellfish culture grounds	SCG2
7	Partial damage to fishing grounds	FG1
8	Severe damage to fishing grounds	FG2
Phangnga Bay		
	Resource Loss/Damage	Code
1	Partial damage to sandy beach	SB1
2	Severe damage to sandy beach	SB2
3	Severe damage to mangrove forests	MF1
4	Clear-cutting of mangrove forests	MF2
5	Partial damage to seagrass beds	SG1
6	Severe damage to seagrass beds	SG2
7	Partial damage to coral reefs	CR1
8	Severe damage to coral reefs	CR2

Table 3.5 lists selected impacting activities presented for paired comparisons in each study area. These included activities reported by respondents during the pre-survey as having, or could be having, negative impacts on coastal resources in the areas. Three activities were considered, two of which were common in both study areas (shrimp farming and oil spills). Three levels of impacts were indicated for two activities (shrimp farming and housing development for Ban Don Bay; hotel development for Phangnga Bay) and only two levels for the oil spills. The scenario presented for each activity was based either on existing condition or potential situation.

Table 3.5 List of impacting activities in Ban Don Bay and Phangnga Bay

Ban Don Bay		
	Impacting activities	Code
1	Shrimp farming, 25 rai, no clear-cutting of mangrove forests	SHRIMP1
2	Shrimp farming, 100 rai, no clear-cutting of mangrove forests	SHRIMP2
3	Shrimp farming, 100 rai, with clear-cutting of mangrove forests	SHRIMP3
4	Housing development project, 50 units, no clear-cutting of mangrove forests	HOUSE1
5	Housing development project, 100 units, no clear-cutting of mangrove forests	HOUSE2
6	Housing development project, 100 units, with clear-cutting of mangrove forests	HOUSE3
7	Offshore crude oil spill of 20,000 litre	OIL1
8	Offshore crude oil spill of 200,000 litre	OIL2
Phangnga Bay		
	Impacting activities	Code
1	Shrimp farming, 25 rai, no clear-cutting of mangrove forests	SHRIMP1
2	Shrimp farming, 50 rai, no clear-cutting of mangrove forests	SHRIMP2
3	Shrimp farming, 50 rai, with clear-cutting of mangrove forests	SHRIMP3
4	Hotel development project, 75 units, with sewage system, no clear-cutting of mangrove forests	HOTEL1
5	Hotel development project, 75 units, without sewage system, no clear-cutting of mangrove forests	HOTEL2
6	Hotel development project, 75 units, without sewage system, with clear-cutting of mangrove forests	HOTEL3

7	Offshore crude oil spill of 20,000 litre	OIL1
8	Offshore crude oil spill of 200,000 litre	OIL2

3.4 The Questionnaire

The questionnaire was in the form of a half-sheet booklet with four parts. Part I and Part III of the questionnaire were paired comparison questions, based on resource losses or damages in Table 3.4 and impacting activities listed in Table 3.5, respectively. Part II involved paired comparisons of resource losses or damages with losses of four amounts of money. Part IV asked information about the respondents and their opinion on management of coastal resources of Thailand (see Appendix I for an example of the questionnaire).

Examples of the paired comparison questions were provided to respondents, together with the map of the study area and a general description about resources and their usefulness. A reference table was given, listing the four resources under consideration, level of losses, expected changes in the level of productivity due to such losses, and recovery period. Similar tables were provided for Part II and Part III. The latter also contained general descriptions about each coastal activity. Respondents were encouraged to refer to these tables as often as they needed while completing the questionnaire.

For each of the paired comparison questions, respondents were asked to choose the one they considered more important or more damaging, not only to themselves, but also to the environment, the community's economic and social values, and the area's future. An exception was in Part II where the respondents compared a resource loss with a one-time loss of money on their part and on the part of every household in the study area. It was stated clearly at the beginning of Part II that the money lost would not be used to eliminate or reduce the resource loss nor be used to benefit the community in any way. In other words, the money too would be lost, just like the resource values to be lost.

The typical question for Part I and Part II was: Which of the two losses is more important, A or B? For Part III, the question was phrased as: Which of the two activities is more important, A or B? The choices A and B were put side by side on a half-sheet of paper. Random ordering of pairs, and random positioning of A and B (right or left side) were used in the first three parts of the questionnaire to avoid bias due to the sequencing of pairs.

Instead of using all possible 28 pairs for comparisons in Part I, the questionnaire excluded the three obvious pairs. It was assumed that severe damage of a resource should always be considered more important or more severe than partial damage of that same resource. For Ban Don Bay, the exclusions were partial damage vs. severe damage to mudflats, to shellfish culture grounds, and to fishing grounds. For Phangnga Bay, partial damage vs. severe damage to sandy beach, to seagrass beds, and to coral reefs were omitted. However, the comparison between severe damage to mangrove forests and clear-cutting of mangrove forests was left in the questionnaire since it was not apparent how the respondents considered these two losses. The total number of pairs for comparison in Part I of the questionnaire was 25 in each study area.

Part II contained pairs of comparisons between a resource loss or damage with a loss of money. Four resource losses and four amounts of money were included in the paired comparisons. The total number of pairs for Part II was 16, instead of the 28, expected when eight objects were paired in all possible combinations. Twelve pairs were excluded for two reasons. First, there was no need to include the six paired comparisons of the four resource losses which were already performed in Part I. Another six pairs that were excluded were the comparisons of the loss of the four amounts of money. It could be assumed that the loss of a higher amount of money must be more important than the loss of a smaller amount of money. In both study areas, severe damage to mangrove forests and clear-cutting of mangrove forests were included in the comparisons. Other resource losses were partial damage and severe damage to mudflats for Ban Don Bay and partial damage and severe damage to sandy beaches for Phangnga

Bay. The four amounts of money for comparison were 300 Baht, 700 Baht, 1500 Baht, and 3000 Baht.

Unlike the first two parts, Part III included all 28 possible pairs because respondents were asked an additional question regarding the level of impact of a chosen activity in relation to the other one. For example, it may be obvious that clear-cutting of mangrove forests for a 100 rai shrimp farm was more damaging than the establishment of the same size shrimp farm without clear-cutting. However, the question of how much more damaging the first case is than the second case, is still unknown. The extra question was added to enable a different analysis on the paired comparison data that may provide more accurate scale values. The results and the discussion of this additional data are not included in this report but can be found in Chuenpagdee (1998).

Part IV asked respondents about their occupation, the time they had lived in the area, their age, education, and if they had been involved in the management of coastal resources in the area. Respondents were also asked to express their opinions about Thailand's coastal resource management stating agreement with a set of ten questions at the end of the questionnaire.

3.5 Selection of Experts

Formal experts and lay experts were the target population for the survey. Formal experts included researchers, academics, administrators and policymakers. Formal experts were selected based on their knowledge and experiences in the study areas. Those who were responsible for the management of the coastal resources were also included. Formal experts were from different specializations such as biology, fisheries, mangrove forests, economics, and social sciences. A list of formal experts was made, based on suggestions from known experts and from the National Research Council of Thailand. This was used as a starting point for the selection of the formal experts. Formal experts could be from anywhere in the country.

Lay experts included resource users, stakeholders, and other people residing in the coastal areas. Lay experts were divided into groups based on their occupation. in order to test for the differences in the rankings of those with various interests in the resources. There were four occupational groups of lay experts in each of the two study areas, three of which were common to both cases, namely fishers, shrimp farmers, and others. In Ban Don Bay, the fourth lay expert group comprised of shellfish culturers while Phangnga Bay has people in tourism-related business. Quota sampling was used to obtain a reasonable number of experts in each occupational group. Lay experts were not selected at random, but were selected based on their ability and their willingness to answer the questionnaire.

3.6 The Survey

The survey was conducted during two separate trips, first to Ban Don Bay (March 1997), then to Phangnga Bay (April 1997). Field assistants helped with the preparation of the questionnaires (randomizing the pairs and putting them in booklets) and the data collection. In general, formal experts were individually approached and, after the explanation, the questionnaires were left for them to complete and return at a later date, either personally or by mail. Most of the formal experts were pre-identified, but some new ones were suggested and added during the survey. There was no limit on the number of formal experts surveyed, although special effort was made to collect data from experts in as many disciplines as possible.

The survey of lay experts was done mostly on the spot and on an individual basis without prior arrangement. Enumerators conducted the survey part by part, and were present to answer any question. Only in Phangnga Bay, when surveying lay experts working in hotels and tourism business were the questionnaires explained, left to be completed, and later picked up. On the average, lay experts spent 45 minutes on the questionnaire.

3.7 Data Analysis and Results

The questionnaires were first checked for completeness and those with missing data were excluded. The analysis was done separately for each part, resulting in different numbers of cases included (Table 3.6). The same kind of analysis was performed for Part I and Part III, but a different one was used for Part II.

Table 3.6 Total number of respondents for each part of the questionnaire(Ban Don Bay and Phangnga Bay).

Ban Don Bay					
	Total surveyed	Total analyzed			
		Part I	Part II	Part III	Part IV
Formal experts	43	41	42	43	41
Fishers	47	45	47	45	45
Shrimp farmers	40	40	40	38	40
Shellfish culturers	44	43	44	42	43
Others	36	35	35	34	33
Total	210	204	208	202	02
Phangnga Bay					
	Total surveyed	Total analyzed			
		Part I	Part II	Part III	Part IV
Formal experts	52	51	52	52	51
Fishers	45	45	45	44	45
Shrimp farmers	41	40	38	35	37
Tourism	39	39	39	35	37
Others	46	46	46	43	39
Total	223	221	220	209	209

3.7.1 Scale values and rankings of resource losses and activities

For Parts I and III of the questionnaire, data were tabulated into a square array, as described in Chapter 2. The total number of counts for each column was aggregated to obtain preference scores at the bottom of the array, and the Dunn-Rankin's variance stable rank sum method was used to obtain the scale values.

The first part of the analysis determined the effects of intransitivity on the scale values and the rankings. The second part investigated the differences in the responses of formal experts and lay experts. A general conclusion from these two analyses was that intransitivity did not have a significant impact on the final scale values and both formal experts and lay experts were able to provide consistent rankings of the importance of losses and activities.

3.7.1.1 Effects of intransitivity on the scale values and the rankings

Respondents were categorized into different intransitive groups based on the level of intransitivity (Table 3.7). *Intransitive group 0* referred to respondents with no intransitive choice. When there was only one pair of responses that needed to be switched in order to obtain transitivity, the respondents were placed in *intransitive group 1*. When there were two pairs that needed switching, they were recorded as *intransitive group 2*. *Intransitive group > 2* included those with more than two pairs of intransitive choices.

Generally, respondents of the Phangnga Bay questionnaire were more transitive than the respondents of the Ban Don Bay questionnaire. Only about 19% of the total respondents of the Ban Don Bay Part I questionnaire had no intransitive choices. The respondents of the Ban Don Bay Part III questionnaire were more consistent with 32% of the total respondents in *Intransitive group 0.* The number of respondents with no intransitive response was higher in Phangnga Bay (about 39% in both Part I and Part III).

Table 3.7 Number of respondents by occupation and by intransitive group (number in parenthesis are percentages of total)

Ban Don Bay - Part I					
Group of experts	Intransitive group				Total analyzed
	0	1	2	> 2	
Formal experts	14 (34.14)	14 (34.14)	4 (9.76)	9 (21.95)	1 (100)
Fishers	4 (8.89)	9 (20.00)	11 (24.44)	21 (46.67)	45 (100)
Shrimp farmers	5 (12.50)	8 (20.00)	6 (15.00)	21 (52.50)	40 (100)
Shellfish culturers	8 (18.60)	15 (34.88)	7 (16.28)	13 (30.23)	43 (100)
Others	7 (20.00)	7 (20.00)	4 (11.43)	17 (48.57)	35 (100)
All groups	38 (18.63)	53 (25.98)	32 (15.69)	81 (39.71)	204 (100)
Phangnga Bay - Part I					

Group of experts	Intransitive group				Total analyzed
	0	1	2	> 2	
Formal experts	28 (54.90)	12 (23.53)	5 (9.80)	6 (11.76)	51 (100)
Fishers	18 (40.00)	9 (20.00)	5 (11.11)	13 (28.89)	45 (100)
Shrimp farmers	14 (35.00)	11 (27.50)	0 (0.00)	15 (37.50)	40 (100)
Tourism	13 (33.33)	12 (30.77)	3 (7.69)	11 (28.21)	39 (100)
Others	14 (30.43)	11 (23.91)	5 (10.87)	16 (34.78)	46 (100)
All groups	87 (39.37)	55 (24.87)	18 (8.14)	61 (27.60)	221 (100)
Ban Don Bay - Part III					
Group of experts	Intransitive group				Total analyzed
	0	1	2	> 2	
Formal experts	24 (55.81)	7 (16.28)	7 (16.28	5 (11.63)	43 (100)
Fishers	5 (11.11)	11 (24.44)	9 (20.00)	20 (44.44)	45 (100)
Shrimp farmers	13 (34.21)	9 (23.68)	4 (10.53)	12 (31.58)	38 (100)
Shellfish culturers	14 (33.33)	9 (21.43)	6 (14.29)	13 (30.95)	42 (100)
Others	8 (23.53)	11 (32.35)	6 (17.65)	9 (26.47)	34 (100)
All groups	64 (31.68)	47 (23.27)	32 (15.84)	59 (29.21)	202 (100)
Phangnga Bay - Part III					
Group of experts	Intransitive group				Total analyzed

	0	1	2	> 2	
Formal experts	27 (51.92)	20 (38.46)	2 (3.85)	3 (5.77)	52 (100)
Fishers	13 (29.55)	20 (45.46)	4 (9.09)	7 (15.91)	44 (100)
Shrimp farmers	8 (22.86)	15 (42.86)	4 (11.43)	8 (22.56)	35 (100)
Tourism	17 (48.57)	9 (25.71)	6 (17.14)	3 (8.57)	35 (100)
Others	17 (39.54)	12 (27.91)	5 (11.63)	9 (20.93)	43 (100)
All groups	82 (39.23)	76 (36.36)	21 (10.05)	30 (14.35)	209 (100)

Formal experts were more transitive in their responses than lay experts. The percentage of formal experts with no intransitive response was 34% in Ban Don Bay Part I, 55% in Phangnga Bay Part I, 56% in Ban Don Bay Part III, and 52% in Phangnga Bay Part III (Table 3.7). Among the four lay expert groups, the most consistent group (the highest percentage of respondents with no intransitive responses) was shellfish culturers in Ban Don Bay Part I, fishers in Phangnga Bay Part I, shrimp farmers in Ban Don Bay Part III, and those involved in tourism activities in Phangnga Bay Part III.

The aggregated preference scores for each resource loss or damage in Part I and for impacting activities in Part III were used as inputs in the calculation of scale values and Kendall u (coefficient of agreement), as explained in Chapter 2. Dunn-Rankin's analysis of paired comparison data was performed on four sets of respondents: '0 intran', '0+1 intran' (included responses from 0 and 1 intransitive groups), '0+1+2 intran' (included those of 0, 1 and 2 intransitive responses), and for all cases (total respondents). Table 3.8 shows the scale values, the rankings, and Kendall u obtained from the analysis.

In general, the agreement among respondents in all four groups was highly significant at 0.001 level of significance (the observed X^2 for Kendall u was much greater than the critical value of x^2 of 56.89 at alpha 0.001, and 28 degree of freedom in all cases). Therefore, it can be concluded that the agreement among the respondents in all intransitive groups was higher than it would be by chance had their rankings been random or independent. The null hypothesis that the respondents' rankings were unrelated to each other was rejected, and thus there was a good consensus among respondents in the ranking of the relative importance of resource losses and impacting activities.

The next test was to measure the relation between the rankings of the relative importance obtained from these four groups of respondents. Kendall rank-order coefficient of correlation T, estimated based on mean ranks, showed that correlation in all subgroups was significant at 0.05 level of probability (Table 3.9). The null hypothesis was rejected and the conclusion made that all sets of rankings were related.

The above findings suggest that adding the respondents with intransitive responses into the sample did not significantly alter the resulting scale values and the importance rankings of the resource losses and activities. Thus, it could be concluded that the impact of intransitive responses on the scale values and the rankings was negligible. As a result, all respondents were used in the subsequent analyses, regardless of the level of intransitivity.

3.7.1.2 Scale values and rankings of formal and lay experts

Similar to the above analysis, the Dunn-Rankin's method was used to obtain the scale values from the paired comparison responses. The calculation was performed on seven groups of respondents:

1. all respondents
2. all formal experts
3. all lay experts
4. fishers;
5. shrimp farmers;
6. shellfish culturers in Ban Don Bay or tourism group in Phangnga Bay; and
7. others.

Table 3.8. Scale values and rankings of resource losses and activities based on respondents in different intransitive groups

Table 3.9. Kendall correlation coefficient T of the rankings of resource losses and impacting activites by respondents in different intransitive groups

The scale values and the rankings of resource losses and activities in Ban Don Bay and Phangnga Bay are shown in Table 3.10 for all seven respondent groups. The null hypothesis that there was no agreement among the respondents in each respondent group was rejected in all cases (the observed X^2 was much greater than the critical value of chi-square of 56.89 at 0.001 level of probability). In general, the agreement among formal experts, measured by Kendall u, was higher than that among lay experts. The correlation coefficients of the rankings of resource losses and activities in both study areas were highly significant at alpha level 0.05 among all groups of respondents (Table 3.11).

In Ban Don Bay, clear-cutting of mangrove forests was considered to be the most important loss by all respondent groups. Severe damage of mangrove forests was the second most important loss, according to all the groups except shellfish culturers. The next important resource loss was severe damage to fishing grounds. The resource losses with little importance were partial damage to mudflats and partial damage to shellfish culture grounds.

Similar to Ban Don Bay, clear-cutting of mangrove forests was ranked first in terms of relative importance by all groups of respondents in Phangnga Bay (Table 3.10). The severe damage of coral reefs was considered the second most important resource loss by all groups of respondents, while severe damage to mangrove forests ranks third place. The least important resource losses were partial damage to sandy beaches and to seagrass beds.

In terms of activities, all groups of respondents in Ban Don Bay agreed that clear-cutting of mangrove forests for 100 rai of shrimp farms was the activity with the most impact in the area. Most lay experts considered 200,000 litre of spilled oil to be second in terms of impact while most formal experts mentioned housing development with clear-cutting of mangrove forests as the activity with the second most impact. They cited small-size shrimp farming and housing development without any clear-cutting as the activities with the least impact on the area.

Formal experts and lay experts in Phangnga Bay agreed on the rankings of importance of all activities, except on the most important one. While formal experts considered the 200,000 litre oil spill to have the most impact, lay experts (including those in tourism business), ranked first the development of 75 hotel establishments system with no sewage involving clear-cutting of mangrove forest. All respondent groups agreed on the rankings of the three least important activities: shrimp farming (50 rai), shrimp farming (25 rai), both without clear-cutting development of 75hotels, with sewage system and no clear-cutting (in descending order).

3.7.2 Construction of the scales of relative importance

Based on the above analyses, the scales of relative importance of resource losses and activities were developed using the responses of all respondents (as shown in Table 3.10). The scales of relative importance were constructed by placing the scale values directly on the vertical scale of 0 (bottom end of the scale) to 100 (top end of the scale). Figure 3.3 shows the scales of relative importance of resource losses in Ban Don Bay and Phangnga Bay. Figure 3.4 shows the scales of relative importance of impacting activities in these two areas. The scales of relative importance were divided into three regions of high (scale value greater than 60), medium (scale value between 35 to 60), and low importance (scale value lower than 35). This division of the scales captured the pattern of importance better than dividing the scales into three equal regions.

Table 3.10. Scale values and rankings of resource losses and activities in Ban Don Bay and Phangnga Bay based on respondents in different expert groups

Table 3.11. Kendall correlation coefficient T of the rankings of resource losses and impacting activites by respondents in different expert groups

The scale values of resource losses in Ban Don Bay covered a narrower range on the importance scale than those in Phangnga Bay (Figure 3.3). In both areas, the two losses on mangrove forests (MF1 and MF2) had high scale values, placing them in the high importance region of the scale. The severe damage of the fishing grounds in Ban Don Bay (FG2) and the severe damage to coral reefs in Phangnga Bay (CR2) were also considered to have high importance. The resource losses of low importance were partial damage to shellfish culture grounds (SCG1) and mudflats (MUD1) in Ban Don Bay, and partial damage to seagrass beds (SG1) and sandy beaches (SB1) in Phangnga Bay.

The activity scales were similar in both areas, except for the top part (Figure 3.4). Shrimp farming of 100 rai involving clear-cutting of mangrove forests (SHRIMP3) was considered to be most damaging in Ban Don Bay. On the contrary, the highest intensity of shrimp farming in Phangnga Bay was considered to be less impacting than hotel development with no sewage system and involving clear-cutting of mangrove forests (HOTEL3). The similarity lies however, in the importance of oil spills, which received the same rank with almost the same score in both study areas.

The association between resource losses and impacting activities was observed in the scales of relative importance. The two activities involving clear-cutting of the mangrove forests (SHRIMP3, HOUSE3, HOTEL3) in both study areas, were considered to be highly important on the activity scale, same as clear-cutting of mangrove forests (MF2) on the loss scale. Large-scale oil spill (OIL2) was considered to have a high impact on the coastal environment, in particular mangrove forests and coral reefs, and thus was placed on the top part of the activity scale. The associated losses, such as severe damage to mangrove forests (MF1) and severe damage to coral reefs (CR2), were also ranked in the upper region of the loss scale. Partial damage of resources and low impact activities fell at the bottom end of the scale, as expected.

3.7.3 Monetary valuation of resource losses or damages

Respondents of Part II of the questionnaire were divided into three groups according to the consistency of their responses -- consistent, inconsistent, and no-trade -- as described in Chapter 2. The number of respondents in each group is shown in Table 3.12. The observed proportion of respondents who considered the resource loss to be more important than a certain amount of money was calculated for three subsets of respondents: consistent group only, consistent and inconsistent combined, and all respondents (Table 3.13). The calculation was based on total respondents in each subset. Furthermore, formal experts were removed from the total to test the effects of their responses on the monetary estimates.

Although the median values are reported in this paper, it should be stressed that they were merely illustrative and should not be considered actual values representing the resource losses in consideration. The limitation in applying this value was due to biases such as anchoring bias and hypothetical bias. More research work is needed before the values can be used with a certain degree of confidence.

Figure 3.3. Scale of importance of resource losses for Ban Don Bay and Phangnga Bay (based on all respondents)

Figure 3.4. Scale of importance of impacting activities for Ban Don Bay and Phangnga Bay (based on all respondents)

Table 3.12. Number of respondents, by expert groups, for Part II of the questionnaire, administered in Ban Don Bay and Phangnga Bay (numbers in parenthesis are percentages within the consistency group)

Table 3.13. Proportions of respondents considering resource loss to be more important than monetary loss

Median values were estimated graphically by finding the point where the proportion of respondents rejecting the money was 0.5. The value based on consistent respondents of partial damage to mudflats in Ban Don Bay was found to be about 1,050 Baht and about 2,500 Baht for severe damage to mudflats. The estimate increased to about 1,350 Baht in the first case, and greater than 3,000 Baht in the latter, with the inclusive of inconsistent respondents (Figure 3.5). In Phangnga Bay, the median values were obtained for partial damage and severe damage to sandy beaches, for both consistent respondents and consistent with inconsistent respondents. Figure 3.6 shows the median value for each case. Similar to Ban Don Bay, the median value increased with the inclusive of inconsistent respondents, and also when all cases were considered. The median value inclusive of inconsistent responses increased from 550 Baht to 850 Baht for partial damage to sandy beaches, and from 2,200 Baht to 2,850 Baht for severe damage to sandy beaches.

In both study areas, excluding formal experts did not affect the median values, as shown in Table 3.13. However, one might suggest that this could be because the number of formal experts was small in relation to the number of lay experts. Formal experts (both with consistent and inconsistent choices) comprised of about 21% and 27% of total respondents in Ban Don Bay and Phangnga Bay, respectively. This is clearly not the case since further analysis on individual expert group showed that median values of formal experts fell in the same range as those of the other four lay experts groups of comparable sample size.

3.7.4 General description of the respondents

Descriptive statistical analysis was performed on data from Part IV of the questionnaire. Table 3.14 summarizes the number of respondents based on their gender, education, number of years lived in the area and age. Most respondents were male (75% in Ban Don Bay and 68% in Phangnga Bay), with average age of 37 for Ban Don Bay and 35 for Phangnga Bay. In both areas, most respondents were from the age group 31 to 40 years old. A large number of lay experts (36% in Ban Don Bay, 30% in Phangnga Bay) had completed only Grade 4 in school (minimum education requirement in Thailand). Majority of formal experts in both study sites had bachelor degrees. The average number of years that respondents lived in the study area was 20 for Ban Don Bay and 18 for Phangnga Bay.

The respondents in the two study areas differed in their involvement with management. While about 57% of respondents in Ban Don Bay had never been involved in resource management, 52% of respondents in Phangnga

Bay had some resource management involvement, particularly with mangrove forest reforestation. Nonetheless, respondents in Ban Don Bay and in Phangnga Bay, and formal experts and lay experts in each area had similar opinions about resource management in Thailand (Table 3.15). About 90% of formal experts and lay experts in both areas agreed that coastal resources were being degraded and heavily exploited. About 95% of formal experts, and about 75% of lay experts in both areas disagreed that coastal resource management was the sole responsibility of the government. When asked if resource users should be involved in the management, almost all formal experts and lay experts in the two areas agreed. They acknowledged, however, that collaboration with stakeholders may be hard to obtain. More than half of respondents in both areas agreed that non-government organization (or NGO) played an important role in the management of coastal resources. Finally, most respondents (about 93% of formal experts and at least 60% of lay experts in both areas) recognized the non-use value of resources, such as aesthetic value and option value.

Figure 3.5. Median values of all resource losses in Ban Don Bay

Figure 3.6. Median values of all resource losses in Phangnga Bay

Table 3.14. General descriptions of the respondents in Ban Don Bay and Phangnga Bay

Table 3.15. Respondents' opinion about the management of Thai coastal resources

The opinion on the effectiveness of coastal resource policies differed in the two study areas. The majority of formal experts (80%) and lay experts (47%) in Ban Don Bay did not think that the policies were effective. In Phangnga Bay, however, 43% of the formal experts stated the same but only 28% of the lay experts considered the policies to be ineffective. Another 29% of lay experts in Phangnga Bay, in fact, thought that the policies were effective. Another point of divergence was over the opinion on whether greatest economic return was management's priority. There are 74% of formal experts in Ban Don Bay and 67% of those in Phangnga Bay who disagreed with the statement. However, 51% of lay experts in Ban Don Bay and 45% of those in Phangnga Bay agreed.

Continued