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THE POTENTIAL OF ECOTOURISM MANAGEMENT SCENARIO FOR SUSTAINABLE SETIU WETLANDS ECOSYSTEMS: AN INTEGRATED ECOSYSTEM APPROACH

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Abstract: Setiu Wetlands has unique ecosystems endowed with high diversity of flora and fauna. Thus, the area has huge potential to become a prime ecotourism destination in Terengganu. However, the fragile wetland ecosystems currently support a significant level of aquaculture activities with trivial impacts on the environments and the local communities. Given the scenario, the objectives of this research are to achieve a sustainable state of wetland ecosystems by identifying the best management scenario and explore the potential of ecotourism management scenario using an integrated ecosystem approach. The research employed a three-stage framework; firstly, a Bayesian Belief Network (BBN), secondly, the Choice Experiments (CEs) and thirdly, a Multi-Criteria Decision Analysis (MCDA). The management policy for this wetland proposes four types of scenarios which is Ecotourism, Intensive Aquaculture, Conservation and the Status Quo. Here, the potential of Ecotourism scenario was explored and compared with the alternative scenarios. The findings of this research identified Ecotourism along with the Status Quo scenarios as the second preferred, in the eyes of most of the stakeholder sub-groups. Meanwhile, conservation was identified as the most desirable scenario and Intensive Aquaculture was the least desirable scenario. The developed methodologies and results from this research provide an opportunity for improving planning and decision-making processes in Ecotourism which aims to deliver sustainable management of wetland ecosystems in Malaysia. This research also produced clear guidelines to inform policy makers considering alternative wetland management scenarios.

Keywords: Wetland ecosystems, ecotourism, integrated ecosystem approach.

Introduction

Setiu Wetlands is a natural wetland area situated in Setiu, Terengganu on the East Coast of Peninsular Malaysia. It has unique and diverse wetland ecosystems with high species biodiversity of flora and fauna. The wetlands consist of nine inter-connected ecosystems; the sea, beach, mudflat, lagoon, estuary, river, islands, coastal forest and mangrove forest (Nakisah & Fauziah, 2003). The diversity of the ecosystems extends to a habitat, breeding, nesting and nursery ground for invasive and endangered species of mammals, reptiles and marine life such as sea turtles, painted terrapins, estuarine crocodiles, fireflies and giant freshwater prawn (WWF, 2014). The diversity of flora and fauna in Setiu Wetlands has considerable ecotourism potential and currently offers a handful of nature-based ecotourism products such as the panoramic view of the lagoon, river and estuary, mangrove, coastal and riverine forest, swamp forest, beaches, sea and traditional fishing village. The visitors and tourists may participate in abundant of ecotourism activities such as recreational fishing, river and lagoon cruising, mangrove forest tracking and wildlife watching particularly migration bird, firefly, terrapin and turtle. Moreover, Setiu Wetlands is listed in the National Ecotourism Plan as a potential ecotourism destination, drawn up by the Ministry of Tourism and Culture Malaysia.

Since 1990s until presently, the management policy of the local authorities for Setiu Wetlands have been focusing on aquaculture development. Moreover, the Terengganu state government has recognized Setiu lagoon as a prime aquaculture area under the Aquaculture Action Plan (Department of Town and Country Planning, 2004). However, rapid and intensive expansion of fish cage culture activity which is concentrated particularly in the lagoon is likely to pose a major threat to the ecosystem functions and processes which underpin delivery of many of Setiu's other ecosystem service outputs. These threats arise primarily through cage aquaculture's impacts on nutrient enrichment, mangrove clearance and the risk of invasive species introductions. Setiu Wetlands have recently experienced significant ecological problems, especially regarding water quality, due to the high intensity of fish cages and development of fish ponds. A number of studies have been carried out to investigate the environmental impacts caused by the rapid growth of aquaculture activities in this area of Setiu Wetlands (see for example Faridah *et al.,* 2015; Alipiah, 2010; Najiah *et al*., 2010; Nakisah *et al.,* 2009; Norhayati *et al.,* 2010; Suhaimi *et al.,* 2004).

Realizing the importance of the goods and services produced by the Setiu Wetlands ecosystems, specifically the potential of ecotourism that this area has to offer, the objectives of this research are to identify the best management scenario and then explore the potential of ecotourism management scenario. This research applied the concept of sustainable management based on the developed hypothetical management scenarios using an integrated ecosystem approach.

Sustainable Wetland Ecosystem

Despite the fact that wetlands undoubtedly deliver a wide variety of ecosystem services to a very substantial number of stakeholders, a number of literatures has established that loss and degradation of wetlands is a significant and serious problem worldwide (see for example Ramsar 2009; Mitsch & Gosselink, 2007; Zedler & Kercher 2005; Lehner & Döll 2004; Finlayson *et al*., 1999). This suggests that it is difficult to manage wetlands sustainably, i.e. to manage wetlands in such a way that their continuing ability to deliver valuable ecosystem services to diverse stakeholder groups is not impaired by threats such as over exploitation, drainage, siltation, pollution or land conversion. The issue of sustainable wetland management requires an integrated multidisciplinary approach for informing sustainable wetland management in situations where diverse stakeholder groups hold conflicting preferences for delivery of a number of different ecosystem services.

Wetland degradation with consequent reductions in ecosystem service delivery and stakeholder well-being typically arises through: 1) lack of information and understanding of physical changes in wetland ecosystem services and their impacts on stakeholders and the wider ecosystem, 2) lack on appreciation of the economic value of such changes (particularly for indirect and non-use values) and 3) consequent failures in planning and managing wetland resources effectively and efficiently by government and stakeholders. Given these failures, it is crucial to understand how a wetland ecosystem is impacted by human activities and also to devise improved methods for incorporating valuations of wetland ecosystem service delivery into management decision support tools. For the most part, ecologically focused studies of wetland management tend to ignore human elements, apart from the human role as an external driver of change (Bockstael *et al*., 1995). Also, stakeholders and decision makers need a better evidence basis to produce predictions of future impacts for planning and management. This is not an easy task, especially for a complex system such as a wetland, for which interactions and cause-effect relationships are not well understood or documented. A proper evidence base must first be constructed and then integrated into an appropriate legal, institutional and economic context and conveyed to wetland stakeholders or local communities in order for them to produce well-informed decisions about sustainable management of their system.

Other significant challenges in sustainable wetland management include the selection of relevant ecosystem service variables for valuation purposes whilst simultaneously accounting for issues of uncertainty, irreversibility and disparities in temporal and spatial scale. Multidisciplinary approaches are therefore required to integrate insights and expertise from ecologists, environmental scientists, economists and wetland managers. For decision making purposes, ecological modelling and ecosystem valuation should be combined with an understanding of the interests of various stakeholder groups (particularly those stakeholders who directly utilize the services provided by the ecosystem) under different management scenarios if the ultimate goal of sustainable management of wetlands is to be achieved.

Methodology

This research aims to achieve a sustainable wetland ecosystem using an integrated ecosystem approach by modelling a three-stage research framework; firstly, a Bayesian Belief Network (BBN), secondly, the Choice Experiments (CEs) and thirdly, a Multi-Criteria Decision Analysis (MCDA). Initially, a three-stage research framework was developed for modelling the cause-effect interactions and impacts of aquaculture activity on the wetland ecosystems. The framework identifies the drivers and pressures imposed on the wetlands and their impacts to the ecosystem and the local communities. The first stage employed an ecologically based model which explains the impact of human activities on wetland ecosystem under different management scenarios. Here, an ecological modelling tool, the Bayesian Belief Network (BBN) will be used to capture some of the uncertainties in the complex linkages between wetland ecosystem structures, processes and functions. Secondly, this research quantifies the preferences of wetland stakeholders regarding the ecosystem impacts under the various management scenarios. A Choice Experiments (CEs) approach is used to quantify these preferences. The existence of sub-divisions of preferences within the stakeholder groups will also be tested. Thirdly, the research integrates the findings from the ecological and socioeconomics modelling by using a Multi-Criteria Decision Analysis. For methodology, this paper will focus on the integrated approach and demonstrate how to integrate these three models.

The first stage of the integrated ecosystem approach utilizer a probabilistic BBN-based model to investigate the impact of fish cage culture in Setiu Wetlands by exploring the interactions and relationships that occur between natural and human elements within the Setiu Wetlands ecosystem. The implementation of this aquaculture cause-effect model on the ecosystems proceeded via the following step by step process starting with; 1) define objectives and required outputs, 2) determine the structure of the model, 3) identify key variables and the states of those variables, 4) estimate conditional probabilities and finally 5) implement the network. Details on the construction and application of this model can be referred in Alipih (2010).

Secondly, Choice Experiments (CEs) were used to quantify the relative preferences which key wetland stakeholder group (aqua culturists) held for delivery of different levels of these key ecosystem services. The implementation of CEs generally involves four main elements as follows: 1) set-up of CEs, 2) experimental design, 3) questionnaire development and 4) survey design and sampling methodology. A list of attributes and attribute levels for the CEs was produced by using the BBN cause-effect model to predict likely levels of ecosystem service delivery under the four chosen management scenarios (Table 1). The selection of attributes and attribute levels for the choice cards in the CEs through the elimination of irrelevant and inter-related variables from the BBNs was based on expert opinion, consultation with administrators and policy makers, interviews and discussions with the stakeholders and literature reviews. The main choice experiment survey was administrated in June and July 2009. A random sampling approach was used to select respondents. However, only 50 culturists were interviewed, as this represented almost the entire population of local aqua culturists. The implementation of the CEs elicits the aqua culturists preferences for the changes in aquaculture income, fisheries income, shellfish collection and water quality which would be likely to occur in Setiu Wetlands under future management scenarios which focus on Aquaculture Expansion, Conservation or Eco-Tourism or maintaining the Status Quo.

Aqua culturists were identified as a focal stakeholder group in the present study because of the considerable impacts which aqua culture imposes on the wetland ecosystem. The management practices of aquaculturists influence the condition of the lagoon ecosystem and thus affect its ability to deliver ecosystem service outcomes to other stakeholder groups. Based on the decision nodes in the BBN, up to six hypothetical scenarios could have been visualised; however, the selection of alternative management scenarios for use in the CE should be consistent with potential future management scenarios for Setiu. The four selected future scenarios were compatible and consistent with government planning outlined in the Setiu Action Plan (Department of Urban and Rural Planning, 2004) for agriculture, tourism and environment.

Exploring the same management scenarios in the ecosystem impacts modelling work and in the CE also ensured that results from the BBN approach could be linked to the socioeconomic results from CE models in a subsequent inter-disciplinary exploration of potential management alternatives. A list of attributes and attribute levels for the CEs was produced by using the BBN cause-effect model to predict likely levels of ecosystem service delivery under the four chosen management scenarios. (Table 1).

The outcomes from BBN model of the Setiu Wetlands ecosystem and CE-derived portrayals of the relative preferences which different stakeholder groups hold for delivery of different ecosystem services must be further integrated to achieve this ultimate objective. This synthesis requires the use of an analytical approach which can overcome all the issues which arise when attempting to combine results from the BBN-based ecological model and discrete choice modelling of CE-derived stated preference data. In the present study, Multi-Criteria Decision Analysis (MCDA) has been identified as the most appropriate method to resolve the above issues.

Table 1: Ecosystem service attributes chosen to represent BBN nodes and CE attribute

Ecosystem Service	**BBN Variables**	**BBN Variable States**	**CE Attributes**	**CE Attribute Levels [coding]**
Provisioning	Aquaculture production	a. Low b. Medium c. High	Harvest rate (%) [HR]	a. 30 % [0] b. 40 % [1] c. 50 % [2]
Regulating	Sediment invertebrates	a. Normal b. Elevated c. Reduced	Shellfish collection [SC]	a. 10kg/day [0] b. 20kg/day [1] c. 30kg/day [2]
Provisioning (indirect)	Fisheries income	a. Low b. Medium c. High	Fisheries income [FI]	a. RM500/month [0] b. RM700/month [1] c. RM1000/month [2]
-	-	-	Annual license fee [F]	a. RM1/cage [0] b. RM1.50/cage [1] c. RM2/cage [2] d. RM10/year*

The implementation of the integrated approach is illustrated in detail in Figure 1. To begin with, a two-step hierarchical procedure is applied. The first step of MCDA (represented by Box A) uses the results from the BBN-based ecological model which predict the likelihoods (probabilities) of each level of delivery of the different ecosystem services arising under the four alternative management scenarios. The probabilities of the various states of ecosystem service delivery arising in the future under the four alternative management scenarios for cage culture activity in Setiu lagoon are summarized in Table 2. The second stage of MCDA (Box B) utilises the preferences which the stakeholder group hold for the different levels of delivery of the various ecosystem services, as estimated from the CE Latent Class (LC) model. Aqua culturists' preferences for ecosystem service delivery as predicted by these best fitting CE models are presented in Table 3.

The next step, Step 3 is the beginning of MCDA approach proper. In this step (Box C), the expected utility value which each stakeholder group associates with each level of delivery of each ecosystem service is calculated by multiplying the relative preferences which aqua culturists sub-groups hold for delivery of each level of each ecosystem service (Box B) by the probability of that level of ecosystem service delivery actually arising under each of the alternative wetland management scenarios (Box A). For the aqua culturists, under a management scenario, a higher (or lower) expected utility value signifies that a level of delivery of an ecosystem service is perceived to be more (or less) favourable in the eyes of the sub-groups concerned. By contrast, a negative expected utility value must arise from an underlying aversion for delivery of a level of an ecosystem service.

Table 2: The probabilities (%) of different levels of delivery of the various ecosystem services arising under four difference management scenarios

No.	Ecosystem Services	Levels of Ecosystem Services	Scenarios			
			Intensive Aquaculture	**Conservation**	**Ecotourism**	**Status Quo**
			Probability	**Probability**	**Probability**	**Probability**
1	Aquaculture production	Low	**43.6**	15.0	24.7	27.7
		Medium	26.3	21.7	25.6	25.1
		High	30.1	**63.3**	**49.7**	**47.2**
2	Dissolved oxygen	Polluted	**45.8**	0.00	8.75	14.2
		Reduced	26.6	28.9	34.0	36.8
		Normal	27.6	**71.1**	**57.2**	**49.0**
3	Sediment invertebrates	Polluted	**42.0**	6.00	24.0	23.3
		Elevated	40.0	32.0	36.0	37.3
		Normal	18.0	**62.0**	**40.0**	**39.3**
4	Aquaculture income	Low	35.6	10.5	17.8	21.0
		Medium	26.9	24.9	26.5	26.5
		High	**37.5**	**64.6**	**55.6**	**52.5**
5	Fisheries income	Low	**43.1**	18.1	24.6	28.5
		Medium	31.4	34.2	33.7	33.3
		High	25.5	**47.7**	**41.7**	**38.2**

* The highest probabilities of delivery for ecosystem services are highlighted in bold

Table 3: Aqua culturists preferences for ecosystem services as predicted by the CE models

Ecosystem Service	Attributes	Sub-group 1	Sub-group 2	Sub-group 3
Provisioning	Harvest rate 1	-0.7324	0.1683	0.2730
Provisioning	Harvest rate 2	2.6340	0.7835	-0.2715
Regulating	Shellfish collection	-0.7510	0.4285	-0.1595
Provisioning (indirect)	Fisheries income	0.9336	-0.2954	0.1446
	ASCSQ	-27.7375	3.1639	-2.0386

Note: (-) indicates an adverse preference or an aversion for delivery of a particular level of an attribute.

The fourth and final stage in the MCDA is summation of the expected utility values for all levels of delivery of all the ecosystem services under a particular wetland management scenario to produce an overall expected utility score for each management scenario for the stakeholder group (Box D). Higher expected utility scores signify a 'better' scenario, in the eyes of the stakeholder group concerned, with the highest expected utility score indicating the best scenario as far as that sub-group is concerned. A negative expected utility score indicates an undesirable scenario i.e. a scenario which must contain moderately likely outcomes which the sub-groups dislike strongly and/or highly likely outcomes to which the sub-groups are mildly averse, or both.

Results and Discussion

The integrated ecosystem approach was used to derive the expected utility values, overall utility scores and scenario rankings under the four different management scenarios for different stakeholder sub-groups. The results for each stakeholder sub-groups are demonstrated in Figure 2, Figure 3 and Figure 4, and summarized in Table 4. The probabilities of the different levels of delivery of the various ecosystem services arising under the four different management scenarios remain unchanged irrespective of which stakeholder group is being considered. However, the relative preferences for delivery of different levels of the various ecosystem services between sub-groups are different, but remain unchanged within each sub-group. Thus, within any stakeholder sub-group, the differences in the expected utility values for each level of delivery of each ecosystem service will be driven completely by the changes in the probability values between the different management scenarios. Differences in expected utility and in the preference ranking of the different management scenarios between stakeholder sub-groups will arise because of both differences in preferences and differences in the probability of levels of ecosystem service outcomes arising. Details on results and outcomes from the BBN and CE models were presented in Alipiah (2010). Based on the objectives of this research, the discussion of the results will be focused on the expected scenario

Table 4: Summary of scenario ranking results for the aqua culturists' stakeholder sub-groups

Scenario	Aquaculturists		
	Sub-group 1	Sub-group 2	Sub-group 3
Ecotourism	2	3	2
Intensive Aquaculture	3	4	1
Conservation	1	2	3
Status Quo	4	1	4

rankings under the four different management scenarios.

The scenario rankings indicate the ordinal ranking of overall preference for predicted delivery of a bundle of ecosystem service attributes under four different potential management scenarios for Setiu Wetlands, as viewed by the different stakeholder groups and sub-groups. Table 4 summarizes the scenario rankings which range from 1 (the best or most desirable) to 4 (the worst/most undesirable scenario). These rankings are also visualized by a colour scheme to indicate the most desirable and least desirable scenarios, where the best or most desirable is coloured with green, followed by yellow and amber (less desirable) and the worst/most undesirable scenario is coloured in red.

Overall, Conservation is revealed to be the most desirable scenario for Aquaculturists Sub-group 1 with the highest expected utility score of 1.262 and Ecotourism as their second most attractive scenario with an overall expected utility value of 0.874. A slightly negative overall expected utility score for Intensive Aquaculture (-0.030) suggests that this sub-group are not likely to be well served by expansion of the aquaculture industry in future. Meanwhile, Status Quo being regarded as the most undesirable scenario, by a very considerable distance. For Aquaculturists Sub-group 2, Status Quo management recorded the highest expected utility score (3.485), revealed to be the most attractive scenario (3.485) followed by Conservation (0.675) and Ecotourism (0.349). Whereas, Intensive Aquaculture with a negative overall expected utility score (-0.053) is considered to be the least attractive scenario. Overall utility scores reveal that in the eyes of Aquaculturists Sub-group 3, Intensive Aquaculture (-0.013), Ecotourism (-0.081), Conservation (-0.174) and Status Quo (-2.125) ranked from least undesirable to most undesirable. Intensive Aquaculture is their preferred management scenario, but this is still considered to be unattractive compared with a (non-existent) scenario which could deliver the zero preference baseline bundles of attributes.

In overall, Table 4 summarizes the derived ranking under this stakeholder group. Ecotourism scenario was ranked relatively highly in overall utility terms by most of the stakeholder sub-groups. However, Conservation was found to be the most attractive scenario. By comparison, the Status Quo and Intensive Aquaculture scenarios appeared much less attractive to many stakeholder sub-groups and it is hard to judge which of these two scenarios is the least preferred.

Conclusion

The integrated ecosystem approach presented in this research combined the scientific predictions from the BBN-based ecosystem impact model (the probabilities of occurrence of different levels of ecosystem service delivery) with the outcomes from discrete choice models derived from CE data (stakeholders' relative preferences for ecosystem service delivery) to estimate the relative utility associated with each level of delivery of relevant ecosystem services for Setiu Wetland stakeholders under four different management scenarios. These results were used to estimate an overall expected utility score for each of the four management scenarios for each of the stakeholder groups, thus allowing the management scenarios to be ranked in preference order. Overall, the ordinal rankings produced suggest that Conservation and Ecotourism are regarded as the best or second-best management scenarios in the eyes of most Setiu Wetlands stakeholder groups. The overall rankings also indicate that the Intensive Aquaculture and Status Quo scenarios are regarded to be less attractive by most stakeholder groups. These results will help decision makers to rank management alternatives and should facilitate decision making for management of Setiu Wetlands in the future. In practice, these results should not be the only influence on policies for wetland management. The actual rankings of these potential future management options for Setiu Wetlands can be readily interpreted and applied for management and policy making purposes, in this case for informing the management of a wetland ecosystem like Setiu in a more sustainable way.

As a conclusion, one of the focal stakeholder groups in the Setiu Wetlands Ecosystems, that is the Aqua culturists, ranked Ecotourism as a preferable management scenario, compared to the Intensive Aquaculture and the Status Quo management scenarios. Local decision makers would find this information useful for planning improved management policies for the wetlands. These results will help local decision makers to facilitate decision making for the development of ecotourism industry in the Setiu Wetlands in the future. The potential of ecotourism was identified by the local government particularly the Setiu District Council to catalyst the development of rural economy whilst preserve and conserve the natural ecosystem of the Setiu Wetlands.

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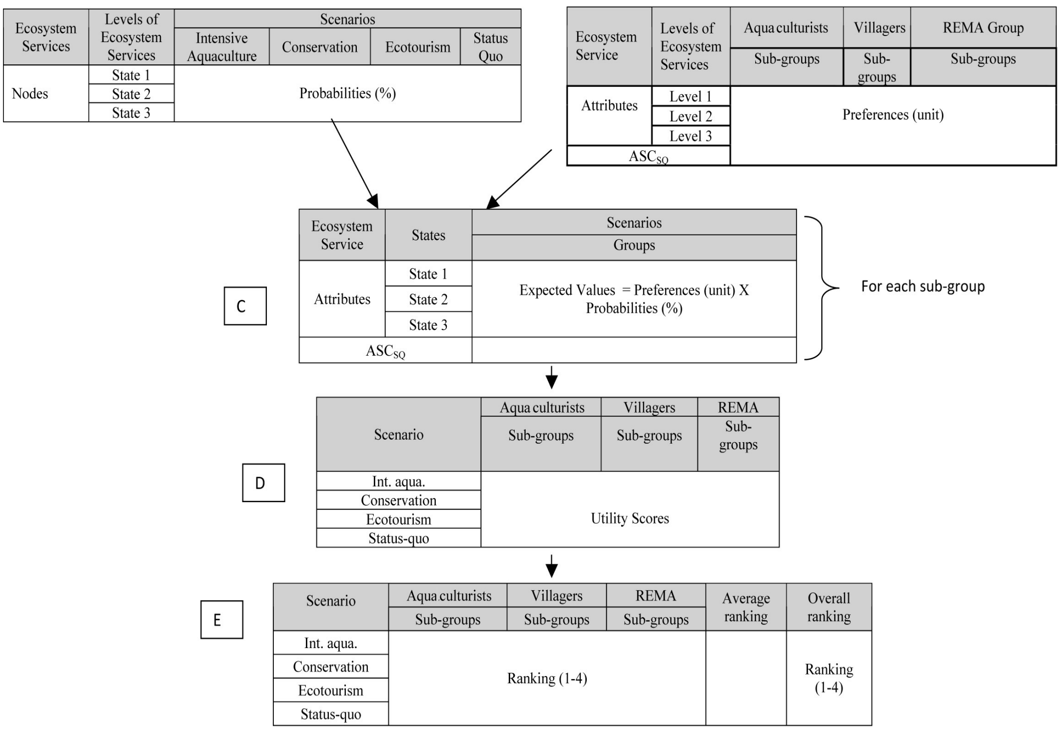

Figure 1: Application of MCDA in Setiu Wetlands

No.	Variables /Attributes	States	BBN (Probability)				Preferences	Expected Utility Value			
			Intensive Aquaculture	Conservation	**Ecotourism**	Status Quo		Intensive Aquaculture	Conservation	*Ecotourism*	Status Quo
1	Aquaculture production	Low	43.6	15	**24.7**	27.7	-1.902	-0.829	-0.285	*-0.470*	-0.527
		Medium	26.3	21.7	**25.6**	25.1	-0.732	-0.193	-0.159	*-0.187*	-0.184
		High	30.1	63.3	**49.7**	47.2	2.634	0.793	1.667	*1.309*	1.243
		Total	100	100	**100**	100		**-0.229**	**1.223**	***0.652***	**0.533**
2	Shellfish collection	Reduced	42	6	**24**	23.3	0.000	0.000	0.000	*0.000*	0.000
		Elevated	40	32	**36**	37.3	-0.751	-0.300	-0.240	*-0.270*	-0.280
		Normal	18	62	**40**	39.3	-1.502	-0.270	-0.931	*-0.601*	-0.590
		Total	100	100	**100**	100		**-0.571**	**-1.172**	***-0.871***	**-0.870**
3	Fisheries income	Low	43.1	18.1	**24.6**	28.5	0.000	0.000	0.000	*0.000*	0.000
		Medium	31.4	34.2	**33.7**	33.3	0.934	0.293	0.319	*0.315*	0.311
		High	25.5	47.7	**41.7**	38.2	1.867	0.476	0.891	*0.779*	0.713
		Total	100	100	**100**	100		**0.769**	**1.210**	***1.093***	**1.024**
4	ASC_{SQ}						-27.738	NR	NR	*NR*	-27.738
Expected Utility Score								**-0.030**	**1.262**	***0.874***	**-27.051**
Ranking								**3**	**1**	***2***	**4**

Figure 2: Expected utility values, expected utility scores and scenario rankings for Aquaculturist Sub-group 1

No.	Variables /Attributes	States	BBN (Probability)				Preferences	Expected Utility Value			
			Intensive Aquaculture	Conservation	**Ecotourism**	Status Quo		Intensive Aquaculture	Conservation	*Ecotourism*	Status Quo
1	Aquaculture production	Low	43.6	15	**24.7**	27.7	-0.952	-0.415	-0.143	*-0.235*	-0.264
		Medium	26.3	21.7	**25.6**	25.1	0.168	0.044	0.037	*0.043*	0.042
		High	30.1	63.3	**49.7**	47.2	0.784	0.236	0.496	*0.389*	0.370
		Total	100	100	**100**	100		**-0.135**	**0.390**	***0.197***	**0.148**
2	Shellfish collection	Reduced	42	6	**24**	23.3	0.000	0.000	0.000	*0.000*	0.000
		Elevated	40	32	**36**	37.3	0.429	0.171	0.137	*0.154*	0.160
		Normal	18	62	**40**	39.3	0.857	0.154	0.531	*0.343*	0.337
		Total	100	100	**100**	100		**0.326**	**0.668**	***0.497***	**0.497**
3	Fisheries income	Low	43.1	18.1	**24.6**	28.5	0.000	0.000	0.000	*0.000*	0.000
		Medium	31.4	34.2	**33.7**	33.3	-0.295	-0.093	-0.101	*-0.100*	-0.098
		High	25.5	47.7	**41.7**	38.2	-0.591	-0.151	-0.282	*-0.246*	-0.226
		Total	100	100	**100**	100		**-0.243**	**-0.383**	***-0.346***	**-0.324**
5	ASC_{SQ}						3.164	NR	NR	*NR*	3.164
Expected Utility Score								**-0.053**	**0.675**	***0.349***	**3.485**
Ranking								**4**	**2**	***3***	**1**

Figure 3: Expected utility values, expected utility scores and scenario rankings for Aquaculturist Sub-group 2

No.	Variables /Attributes	States	BBN (Probability)				Preferences	Expected Utility Value			
			Intensive Aquaculture	Conservation	**Ecotourism**	Status Quo		Intensive Aquaculture	Conservation	*Ecotourism*	Status Quo
1	Aquaculture production	Low	43.6	15	**24.7**	27.7	-0.002	-0.001	0.000	*0.000*	0.000
		Medium	26.3	21.7	**25.6**	25.1	0.273	0.072	0.059	*0.070*	0.069
		High	30.1	63.3	**49.7**	47.2	-0.272	-0.082	-0.172	*-0.135*	-0.128
		Total	100	100	**100**	100		**-0.011**	**-0.113**	***-0.065***	**-0.060**
2	Shellfish collection	Reduced	42	6	**24**	23.3	0.000	0.000	0.000	*0.000*	0.000
		Elevated	40	32	**36**	37.3	-0.160	-0.064	-0.051	*-0.057*	-0.059
		Normal	18	62	**40**	39.3	-0.319	-0.057	-0.198	*-0.128*	-0.125
		Total	100	100	**100**	100		**-0.121**	**-0.249**	***-0.185***	**-0.185**
3	Fisheries income	Low	43.1	18.1	**24.6**	28.5	0.000	0.000	0.000	*0.000*	0.000
		Medium	31.4	34.2	**33.7**	33.3	0.145	0.045	0.049	*0.049*	0.048
		High	25.5	47.7	**41.7**	38.2	0.289	0.074	0.138	*0.121*	0.110
		Total	100	100	**100**	100		**0.119**	**0.187**	***0.169***	**0.159**
5	ASC_{SQ}						-2.039	NR	NR	*NR*	-2.039
Expected Utility Score								**-0.013**	**-0.174**	***-0.081***	**-2.125**
Ranking								**1**	**3**	***2***	**4**

Figure 4: Expected utility values, expected utility scores and scenario rankings for Aquaculturist Sub-group 3

References

Alipah, R. M. (2010). *Valuation of Ecosystem Services for Wetland Management: Case Study of Setiu Wetlands, Terengganu, Malaysia*. University of York. Environment Department.

Bockstael, N., Costanza, R., Strand, I., Boynton, W., Bell, K., & Wainger, L. (1995). Ecological Economic Modeling and Valuation of Ecosystems, *Ecological Economics,* 14(2): 143-159.

Department of Town and Country Planning. (2004). *Technical Report of Setiu District Local Plan 2003-2015*. Setiu District Council. Kuala Terengganu.

Faridah, M., Jamilah M. S., Jarina, M. J., & Rohani, S. (2015). *Setiu Wetlands: Species, Ecosystems and Livelihoods*. Kuala Terengganu: Penerbit UMT.

Finlayson, C. M., Davidson, N. C., Spier, A. G., & Stevenson, N. J. (1999). Global Wetland Inventory-Current Status and Future Priorities. *Marine and Freshwater Research,* 50: 717-727.

Lehner, B., & Döll, P. (2004). Development and Validation of a Global Database of Lakes, Reservoirs and Wetlands. *Journal of Hydrology,* 296(1-4): 1-22.

Mitsch, W. J., & Gosselink, J. G. (2007). *Wetlands*. New Jersey: John Wiley and Sons.

Najiah, M., Nadirah, M., Sakri I., & Shaharom-Harrison, F. (2010). Bacteria Associated with Wild Mud Crab. *Pakistan Journal of Biological Sciences,* 13(6): 5.

Nakisah, M. A., & Fauziah A. H. (2003). *Setiu Wetlands: Tranquility Amidst Plenty*. Kuala Terengganu: Kolej Universiti Sains dan Teknologi Malaysia (KUSTEM).

Nakisah, M. A., Syafaz-Syazwani S., & Antonina A. (2009). Genotoxic Effects of Mercury and Zinc on Acanthameoba sp, a Free-living Ameoba from Setiu Wetlands Water: A Laboratory Study. *Journal of Sustainability Science and Management,* 4(2): 5.

Norhayati, M. T., Hasra, M. A. R., Hui, T. J., Seng, T. H., Fais, M. F., & Radzi, M.

A. (2010). Distribution and Sources of Hydrocarbons in Lagoon Sediments of Setiu Wetland, Terengganu, Malaysia. *Aquatic Ecosystem Health & Management,* 12(4): 6.

Nik Fuad, N. K., Fauziah, A. H., & Fathilah, I. (2003). Chapter 6: Socio-economics and Potential for Eco-tourism. In Nakisah, M. A., & Fauziah, A. H. (Eds.), *Setiu Wetlands: Tranquility Amidst Plenty* (pp. 77-103). Kuala Terengganu, Terengganu: Kolej Universiti Sains dan Teknologi Malaysia (KUSTEM).

Nik Fuad, N. K. (2008). Ecosystem Functions and Services and Sustainable Livelihood of the Wetland Communities. *The International Journal of Economic, Social, Cultural and Environmental Sustainability*, 4 (4).

Ramsar. (2009, 10/08/2009). *What are Wetlands? Retrieved* from http://www.ramsar.org/cda/en/ramsar-about-faqs-what-are-wetlands/main/ramsar/1-36-37%5E7713_4000_0__

Suhaimi, S., Norhayati, M. T., & Suriyati, S. (2004). Dissolved Nutrients and Chlorophyll a Status of the Setiu River, Terengganu, Malaysia. *Bulletin of Environmental Contamination and Toxicology,* 73: 6.

WWF. (2014). *Setiu Wetlands: The Hidden Gem of Terengganu*. Malaysia.

Zedler, J. B., & Kercher, S. (2005). Wetland Resources: Status, Trends, Ecosystem Services and Restorability. *Annual Review of Environment and Resources,* 30(1): 39-74.