



UNIVERSITI PUTRA MALAYSIA

***MULTI-CRITERIA DECISION MAKING ANALYSIS FOR RESPONSIBLE
MANAGEMENT OF MARINE PROTECTED AREA IN
SEMPORNA SABAH, MALAYSIA***

MADHAVAN BALAN NAIR

IPTPH 2016 3



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By

MADHAVAN BALAN NAIR

**Thesis Submitted to the School of Graduate Studies, Universiti Putra
Malaysia, in Fulfilment of the Requirements for the Degree of
Doctor of Philosophy**

February 2016

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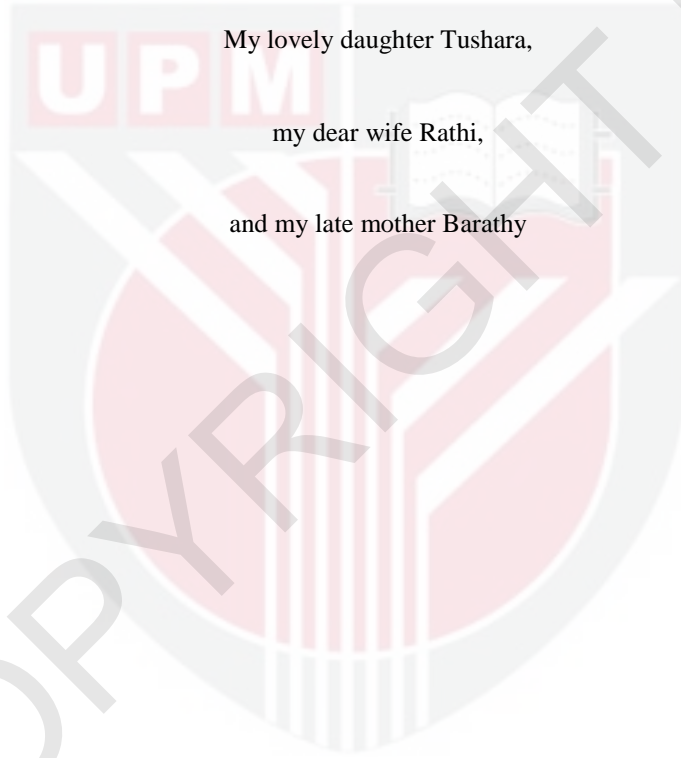


This thesis is dedicated to

My lovely daughter Tushara,

my dear wife Rathi,

and my late mother Barathy



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Abstract of thesis presented to the Senate of Universiti Putra Malaysia in fulfilment of the requirement for the Degree of Doctor of Philosophy

**MULTI-CRITERIA DECISION MAKING ANALYSIS FOR RESPONSIBLE
MANAGEMENT OF MARINE PROTECTED AREA IN SEMPORNA SABAH,
MALAYSIA**

By

MADHAVAN BALAN NAIR

February 2016

Chair : Associate Professor Sridar Ramachandran, PhD
Institute : Tropical Forestry and Forest Products

This study aims to develop a multi-criteria decision making model to analyse and investigate stakeholders' preferences in Marine Protected Area Management towards a responsible management approach in Semporna, Sabah. This study was driven by the challenges faced by Sabah Parks in Managing Marine Protected Areas (MPAs). Sabah Parks have to deal with resource conflicts that include stakeholders' interests in the decision-making process. The objectives of this study are: (i) to identify the current practices for the responsible management of the MPAs in Semporna; (ii) to identify critical decision making criteria related to the responsible management of these MPAs; (iii) to develop a decision-making model to analyse the decision criteria preference towards responsible management of the MPA in Semporna. This study adopts an exploratory sequential mixed methods approach through the lens of a critical realist employing multi-criteria decision-making as the underpinning theory. Data was collected from two main sources, namely, stakeholders, and documents related to MPA management. This data was used in three stages. In the first two stages, the modified Delphi method was used to gather the background of MPA management and criteria relevant to decision making towards responsible management from a group of selected experts. An in-depth interview was conducted during the first stage, while a structured questionnaire was applied during the second. Thematic analysis was applied on the data during the first stage. Criteria reduction using a geometric mean was performed for the questionnaire in the second stage. In the third stage, the questionnaire using pairwise comparison was fed to the Analytical Hierarchical Model (AHP) to analyse stakeholder decision-making preferences. The key contributions of this study in addressing responsible MPA management in Semporna, Sabah include: (i) a methodological contribution in analysing stakeholder preferences using AHP; (ii) the identification of decision objectives and critical criteria in the decision making process towards responsible MPA management; and (iii) acquiring deeper insights on stakeholders' perceptions and choice of management alternatives towards responsible MPA management. This study provides valuable insights on the issue related to MPA management, and on the perception of stakeholders on the manner in which MPAs in Semporna should be managed. The findings are of benefit to Sabah Parks in understanding the underlying conflicts that exist in the current management practice, and the expectations of stakeholders, especially the local community. Moreover, the

findings provide better insights on core issues of responsible MPA management in a general sense, which focus on the human factor, rather than purely on ecological factors. This would enable policy makers and institutions that manage MPAs to evaluate current practices of MPA management, and consider including social factors in their decision-making processes.



Abstrak tesis yang dikemukakan kepada Senat Universiti Putra Malaysia sebagai memenuhi keperluan untuk Ijazah Doktor Falsafah

**ANALISIS PELBAGAI KRITERIA MEMBUAT KEPUTUSAN TERHADAP
PENGURUSAN BERTANGGUNGJAWAB KAWASAN TAMAN LAUT DI
SEMPORNA SABAH MALAYSIA**

Oleh

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Tujuan penyelidikan ini adalah untuk menganalisa kehendak pihak berkepentingan dalam pengurusan kawasan taman marin (MPA) terhadap pendekatan pengurusan yang bertanggungjawab di Semporna, Sabah menggunakan model pembuat keputusan pelbagai kriteria. Kajian ini didorong oleh pelbagai cabaran yang dihadapi pengurusan Taman-Taman Sabah dalam mengurus MPA yang berhadapan dengan konflik sumber melibatkan pihak berkepentingan dalam proses membuat keputusan. Objektif kajian ini adalah (i) untuk mengenal pasti amalan sedia ada pengurusan yang bertanggungjawab MPA di Semporna, (ii) untuk mengenal pasti kriteria membuat keputusan yang kritikal berkaitan dengan pengurusan bertanggungjawab dalam MPA di Semporna, (iii) untuk membina model keputusan bagi penilaian kehendak kriteria keputusan dengan pendekatan pengurusan yang bertanggungjawab terhadap MPA di Semporna. Kajian ini mengamalkan pendekatan kaedah penyelidikan “exploratory sequential mixed method” melalui kanta realis kritikal menggunakan pelbagai kriteria membuat keputusan didokong teori utama. Kajian ini mengumpulkan data daripada dua sumber utama iaitu, pihak berkepentingan serta dokumen-dokumen yang berkaitan dengan pengurusan MPA. Kajian ini melibatkan pengumpulan data utama dalam tiga peringkat. Dalam dua peringkat pertama, kaedah Delphi yang diubahsuai telah digunakan untuk mengumpul latar belakang pengurusan MPA dan kriteria yang berkaitan untuk membuat ke arah pengurusan yang bertanggungjawab daripada pakar-pakar yang dipilih. Temu bual mendalam telah dijalankan pada peringkat pertama, manakala soal selidik berstruktur digunakan di peringkat kedua. Analisis tematik digunakan untuk menganalisa data dalam peringkat pertama. Pengurangan Kriteria menggunakan min geometri yang telah dilaksanakan dalam soal selidik peringkat kedua. Pada peringkat ketiga, data soal selidik menggunakan perbandingan dari segi pasangan telah disertakan dalam model “Analytical Hierarchical process” (AHP) untuk menganalisa keutamaan pihak berkepentingan dalam membuat keputusan. Sumbangan penting yang muncul daripada kajian ini dalam menangani pengurusan MPA bertanggungjawab di Semporna Sabah termasuk; (i) Sumbangan metodologi dalam menganalisis keutamaan pihak berkepentingan menggunakan AHP; (ii) pengenalan objektif dan kriteria penting dalam proses membuat keputusan ke arah pengurusan MPA yang bertanggungjawab; (iii) mendapatkan gambaran yang lebih mendalam terhadap persepsi pihak berkepentingan dan pilihan alternatif pengurusan terhadap

pengurusan MPA yang bertanggungjawab. Tesis ini memberikan pandangan yang lebih luas dalam isu yang berkaitan dengan pengurusan MPA dan persepsi pihak berkepentingan mengenai kaedah MPA di Semporna patut diuruskan. Hasil kajian kritikal terhadap pengurusan Taman-Taman Sabah untuk memahami konflik asas yang wujud dalam amalan pengurusan semasa dengan pemahaman yang lebih mendalam terhadap jangkaan pihak berkepentingan terutamanya masyarakat setempat. Walau bagaimanapun, penemuan memberikan pandangan yang lebih telus mengenai isu-isu asas pengurusan MPA dalam pengertian umum yang mempertimbangkan faktor manusia dan bukan semata-mata faktor ekologi dalam menguruskan MPA bertanggungjawab. Ini akan membolehkan pembuat dasar dan institusi yang menguruskan MPA untuk menilai amalan semasa pengurusan MPA dan mempertimbangkan faktor sosial dalam proses membuat keputusan.



ACKNOWLEDGEMENTS

First and foremost, I would like to express my deep sense of gratitude to my main supervisor Associate Professor Dr Sridar Ramachandran for his persistence, valuable guidance and continuous encouragement throughout my research journey. Without his implausible patience and positive attitude of encouragement that may be harsh at times has brought about the completion of this dissertation.

I would also like to thank my supervisory committee members Prof Ahmad Shuib that was more of a fatherly figure who was always willing to give constructive feedback on my work, guidance on research analysis and Dr Syamsul Herman who was ever willingly there to give his academic guidance.

In addition, I would like to thank Sabah Parks for giving their overwhelming support to this research by giving access to their documents, staffs and transportation to the islands in Semporna. I would also like to extend my special appreciation to Mr Boni Antiu for always being there to assist my team and me to gain access to the MPAs in Semporna. I would like to further extend my gratitude to the District office in Semporna and the Sabah state government for giving the necessary permission to carry out this research.

I would like to express my special thanks to the Ministry of Higher Education Malaysia under the Long Term Research Grant Scheme (LRGS) Reference No.: JPT.S(BPKI)2000/09/01/015Jld.4(67) for funding this research.

Finally, I would like to thank my wife and daughter for their unconditional love, patience and support during my study period. I would not be able to complete this dissertation without their continuous support and encouragement.

I certify that a Thesis Examination Committee has met on 17 February 2016 to conduct the final examination of Madhavan Balan Nair on his thesis entitled "Multi-Criteria Decision Making Analysis for Responsible Management of Marine Protected Area in Semporna Sabah, Malaysia" in accordance with the Universities and University Colleges Act 1971 and the Constitution of the Universiti Putra Malaysia [P.U.(A) 106] 15 March 1998. The Committee recommends that the student be awarded the Doctor of Philosophy.

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LIST OF ABBREVIATIONS

AHP	Analytical Hierarchical Process
ANP	Analytical network Process
ELECTRE	Elimination and Choice Expressing Reality
FBA	Fisheries Prohibited Area
CTI	Coral Triangle Initiative
GP	Goal Programming
ICJ	International Court of Justice
IUCN	International Union for Conservation of Nature
KMO	Kaiser-Meyer Olkin
MAUT	Multi-Attribute Utility Theory
MCDA	Multi-criteria Decision Analysis
MCDM	Multi-criteria Decision Making
MCS	Marine Conservation Society
MPA	Marine Protected Area
NCR	Native Customary Rights
NGO	Non-Governmental Agencies
PROMETHEE	Preference Ranking Organization Method for Enrichment Evaluation
SIP	Semporna Island Project
SMART	Simple Multi-Attribute Rating Technique
SMCE	Social Multi-Criteria Evaluation
TOPSIS	Technique for Order Preference by Similarity to Ideal Solution
TSMP	Tun Sakaran Marine Park
WWF	World Wide Fund for Nature

CHAPTER 1

INTRODUCTION

1.1 Research Background

Marine Protected Area (MPA) is a tool used to protect marine biodiversity in areas threatened by human exploitation of marine resources. The concept of MPAs is not new. One of the earliest MPAs can be traced back to Fort Jefferson National Monument in the state of Florida in the US, which has an area of 18,885 ha, and was designated in 1935 (Gubbay, 1995). Claudet (2011) categorised MPAs into two main groups, namely, multiple use MPAs and Marine Reserves. A multiple use MPA allows some form of restricted resource extraction, such as those practiced by traditional fishers, and recreational activities such as scuba diving. Most marine parks fall under this category, and are commonly used as tourist attractions. A marine reserve, however, is a specific type of MPA where resource extraction is forbidden. In some marine reserves, even non-extractive activities such as diving and boating are forbidden. These marine reserves are typically termed as no-take zones. IUCN defines a protected area as, “A protected area is a clearly defined geographical space, recognized, dedicated and managed, through legal or other effective means, to achieve the long-term conservation of nature with associated ecosystem services and cultural values” (Dudley, 2008, p. 8).

The definition considers three major points. The first identifies that a clear delineation of the area being protected must be managed. The second looks at how the MPA should be managed, which is usually through a legal body. The third stresses on maintaining the ecosystem that includes the community living within it.

Frequently, the emphasis of MPAs is to protect the eco-system, and at the same time, perhaps neglecting out the issue of community involvement as a secondary goal in the management of the park. Communities are either forced or compensated to move out of an MPA. There is limited studies in the literature that focus on how the establishment of an MPA affects the livelihood of communities living within the park, or whether communities were involved during the planning and implementation stage of the MPA (Voyer, Gladstone, & Goodall, 2012). Many marine reserves are embedded within a multiuse MPA through the implementation of zoning. It has become a flagship in many parts of the world, as it is often seen as a tangible approach for marine protection (Gubbay, 1995). The number of MPAs is gradually increasing. According to recently published statistics, an estimate of 1.17% of the world’s ocean reside within an MPA (Toropova, Meliane, Laffoley, Matthews, & Spalding, 2010). The area of protection has increased by 150% in the last decade. This estimate represents 5,880 MPAs around the world, covering 4.2 million km² of the ocean’s surface (Hoyt, 2012).

However, this figure falls far behind terrestrial parks, although the ratio of sea coverage is larger than land. There seems to be a rush in implementing MPAs around the world,

with over-zealous advocacy and unrealistic expectations that an MPA is a “trump card” for marine conservation (Rodriguez-Martinez, 2008). It is yet to be established that such implementation is an effective means of protecting marine biodiversity without the availability of audit measures on the effectiveness of managing the MPA (Alder, Zeller, Pitcher, & Sumaila, 2002; Pomeroy, Watson, Parks, & Cid, 2005). According to Pajaro, Mulrenan, Adler and Vincent (2010), only 10-35% of MPAs have achieved their planned objectives, which raises concerns about the management style of marine parks. Insufficient funds, small management size, lack of scientific information, decision making and political support often challenge the ability of the MPAs to meet their objectives. The management of a marine park, with a concern for biodiversity protection and socio-economic wellbeing of the local community, is typically preferred as the responsible management approach. It is shown that an MPA, as a management tool, becomes effective with the participation of local stakeholders, together with government agencies, in the planning and decision making process (Marques, Ramos, Caeiro, & Costa, 2013; Pajaro, et al., 2010; Pomeroy, 1995). The lack of success in the management of protected areas is due to several factors, including poorly designed objectives and enforcement at the initial stage, minimal resources for the management of the park, fragmented legal framework for coastal and marine areas, overlapping government institutions with jurisdiction over marine concerns, and finally, the absence of experience in the consolidation and establishment of intergovernmental and multi-stakeholder participatory space (Rodriguez-Martinez, 2008). Hence, there is an urgency to relook at the decision making process for marine parks that have passed the planning stage, and are currently in the operational stage. There are bureaucratic hurdles to overcome in order to make changes to the existing plans, although there may be flaws in the originals. The approach in the management of marine parks is currently moving towards a more focused approach, where critical decisions need to focus on what can be achieved, rather than what should be achieved.

In the past decade, multi-criteria decision-making (MCDM) was increasingly applied in decisions related to environmental and natural resource management (Aminu et al., 2013; Diaz-Balteiro & Romero, 2008; Garmendia et al., 2010; Herath, 2004; Kiker, Bridges, Varghese, Seager, & Linkov, 2005; Lahdelma, Salminen, & Hokkanen, 2000; Mendoza & Martins, 2006). Lately, there were many studies that begin to show an increase involvement of multiple stakeholders in the area of MPA management (Himes, 2007b; Yang, Li, & Chiang, 2011). The merits of MCDM are beginning to be realized in MPA management where their use is gaining traction in areas to analyse and assist the decision making process (Heck, Dearden, & McDonald, 2011; Himes, 2007a). A decision-making tool that can consider multiple alternatives with the ability to make calculated comparisons would be ideal.

The environment and resources related to the natural environment require a more liberal approach in decision making, as they often involve indigenous populations where the social factor is an important element in the process (Garmendia, et al., 2010). Although there were many studies on effective MPA management, their main focus were on environment rehabilitation and protection (Pajaro, et al., 2010). What was missing in most of these studies was the aspect of social factor that not only include the voice of the community but their participation in the decision making process as well as their livelihood (Reed, 2008). This inclusion of social context in management has brought about the expression, responsible management. The term responsible

management is not new but have been widely used in tourism management and interchangeably with sustainable management (Middleton & Hawkins, 1998), and responsible tourism management (Spenceley et al., 2002). According to Frey and George (2010), responsible management in the field of tourism has an objective of reducing negative social, economic and environmental impact on the natural ecosystem. The approach should benefit the local community, the natural ecosystem whilst not forgetting the business environment. Frey (2007) further supports this argument indicating that organizations should include social and environmental objectives in their management practices. It was suggested that they look beyond profit maximisation. Furthermore, a recent study on MPA management in Tanzania (Tobey & Torell, 2006), showed that social elements might be a limiting factor in achieving MPA management goals. Since most MPA's in this region are tourist destinations with communities living within them (Pollnac & Pomeroy, 2005), the term responsible management as a management practice is suitable in the area of sustainable MPA management. This evidence suggest the term responsible management offers a more inclusive aspect to effective management where the social component that is often abandoned is included in the overall goal of environmental management.

Marine resource management is not new in the regions of Malaysia, Indonesia and the Philippines, all of which exhibit common demographic and ecological settings. White (1986) recommended effective management schemes through community participation and resource management. The conservation of marine species in Malaysia such as turtles were implemented even before the formation of Malaysia (Chan, 2006). In the last two decades, there has been a great drive to protect the coastal area in the state of Sabah in Eastern Malaysia. There have been countless occurrences of destructive ecological activities such as fish bombing carried out in these waters (May-Ling, Ramachandran, Shuib, & Afandi, 2014). The human population is high in this area, and as a consequence, this creates intense pressure on the ecosystem. According to Sabah Parks (2010), there were 405 violations of park enactment regulations, and 378 accidents within the park. Tunku Abdul Rahman Park, which has the highest rate of tourist arrivals among the marine parks in Sabah, recorded the highest number of accidents. Among the 378 accidents, six took place in Semporna, and one resulted in a fatality (Sabah Parks, 2010).

Semporna is small district situated in the Tawau division located in the south-eastern coast of Sabah. The district is the main destination for dive tourist due to its surrounding that is rich with marine biodiversity (Sabah Parks, 2013). The local community mainly from the Bajau ethnic rely on fishing, seaweed farming and tourism for their livelihood (Kleinen & Osseweijer, 2010; Wood, 2001). There are 40 islands in the district out of which 9 are located within the marine protected area. Tun Sakaran Marine Park (TSMP) that is located in the district of Semporna Sabah took almost two decades to be gazette and launched as an MPA. The main stakeholder that contributes to the management of this MPA were Sabah Parks, government agencies such as the district office and fisheries department, the local community mainly from the Bajau ethnic group, non-governmental organizations such as the Marine Conservation Society (MCS) and World Wide Fund for Nature Malaysia (WWF), and tour operators. MCS was the brainchild in preparing the management plan for TSMP. Many non-governmental organizations such as WWF Malaysia and the MCS have attempted to push the Sabah State's Government to protect this area since the early 1980's (Garrod

& Wilson, 2003). According to May-Ling, et al. (2014), Semporna district is plagued with illegal migrants of Philippine decent due to the political unrest in the southern islands of Philippines. Furthermore, the presence of communities living in the park and making claims on land ownership became a subsequent hurdle for the state government to proceed with the initial gazette (Wood, 2001). Aggravating the situation, the local communities have poor awareness on managing waste as it is habitual to dump waste directly into the sea (Prabhakaran, Nair, & Ramachandran, 2013). Historically, communities in other marine parks under the management of Sabah Parks were compensated to relocate to areas outside of the park, since human interference and visitor pressure degrades the environment in the marine park. This is currently taking place in TSMP. Figure 1.1 shows the number of tourists visiting the area has been growing steadily for the past seven years, since there are no limits for tourist arrivals to this area. In contrast, Sipadan Island Park limits tourist visitation to 120 people on a daily basis. Figure 1.2 shows an almost steady visitor arrival rate to Sipadan over the last seven years (Sabah Parks, 2014).

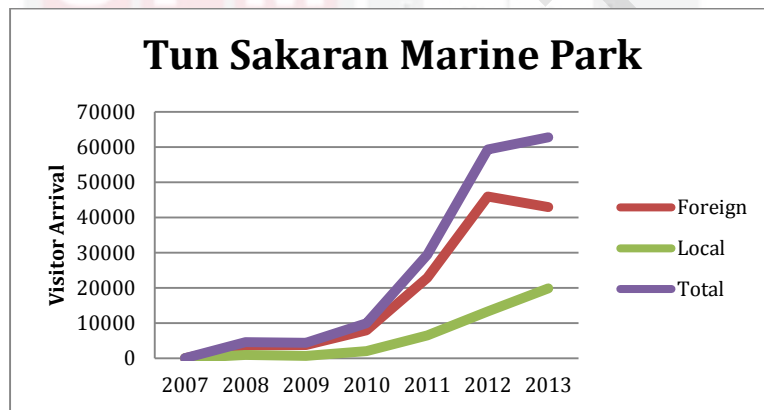


Figure 1.1. Tourist Arrival in Tun Sakaran Marine Park (Sabah Parks, 2014)

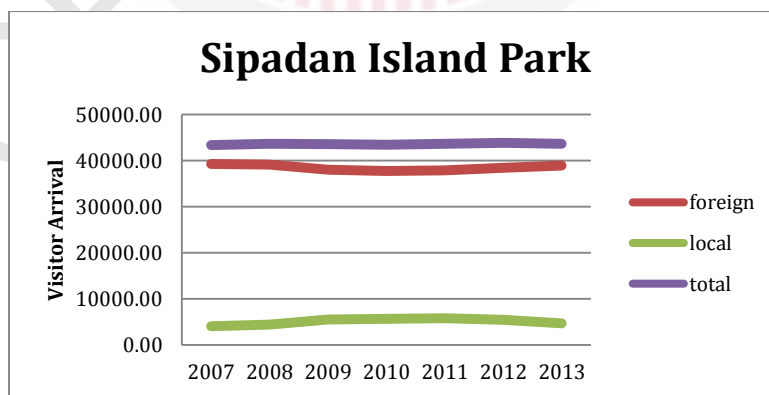


Figure 1.2. Tourist Arrival in Sipadan Island Park (Sabah Parks, 2014)

Studies have shown that overcrowding in other marine parks in Malaysia have resulted in damage to the country's coral reefs (Ahmad & Hanley, 2009; Yeo, 2004). Hence, given this evidence, perhaps it's an indication for Sabah Parks to prioritize areas that urgently need to be looked into when managing their parks with a responsible approach.

1.2 Statement of the problem

TSMP and SIMP are the epitome of a MPA suitable for examination and the evaluation of responsible MPA management in Malaysia. There is remarkable diversity in the resources that it protects. The TSMP and SIMP are chosen as the main focus of this study, mainly due to their dramatic history, prolonged community conflict, sizeable number of interested stakeholders, while also being among the poorest districts in the country (May-Ling, et al., 2014). Discussions in the area of MPA management and experiential knowledge of current challenges in managing the MPA responsibly may deduce that MPA in Semporna is not achieving some of the objectives outlined in the management plan. There are two works that support this argument. According to Wood (2006) in the year 2006, a draft action plan on the sustainable use and conservation of biodiversity was prepared five years after the original management plan. It can be observed that stakeholders are adding to the problem by misunderstanding the long-term impact of MPA establishment. There remains no standard consensus on resource extraction, such as issuance of fishing permits, and half of the communities interviewed did not agree, or were not sure, about its implementation. The unending existence of such problematic scenarios shows the urgency to identify them, and provide necessary remedies, hence, the primary source of motivation for this research. The area is new and currently unexplored in terms of responsible management. There is great subjectivity in how the marine park is currently managed, as the management plan is only a guide, and may not be strictly followed by the park managers, unlike a policy document. In the last decade since the gazettement of TSMP and Sipadan Island Park, the parks have seen a change of stewardship more than three times (B. Antiu, personal communication, December 3, 2012). This may indicate lack of continuity in the process of managing the park. It is not certain at this point why the park managers were changed frequently.

In the draft management plan for TSMP, the formation of a joint action committee comprising the local community, Sabah Parks and local government agencies, was recommended to resolve community conflicts with the state in terms of land claims made by the committee living within the park (Wood, 2001). However, to date, there were no obvious indications that the committee was formed, or land claim matters were being resolved, by other appointed agencies (B. Antiu, personal communication, December 3, 2012). To further complicate matters, land claims were allowed under native customary rights, as outlined in the gazette. This is unprecedented, as other marine parks that are managed by Sabah Parks do not face this problem. Typically, land belongs to the state the moment a gazette is in place. Being a custodian of the park, Sabah Parks is left with a burden that may take years to resolve if not handled carefully. There have been many studies that support this notion of little evidence in developing nations that sustain progress and mark the successful implementation of effective MPA management (Alder, Sloan, & Uktolseya, 1994; Glaser, Baitoningsih, Ferse, Neil, & Deswandi, 2010; Marinesque, Kaplan, & Rodwell, 2012). Sabah is

archeologically and socially similar to its neighbours, the Philippines and Borneo Indonesia, which face similar management issues in the responsible management of social and natural resources (Dahl-Tacconi, 2005; Glaser, et al., 2010). In reality, there is a wide implementation gap between what is written in policy documents, management plans and laws compared to the actual practice in the field. The management of an MPA often requires the management body to carry out a balancing act in satisfying conflicting management goals (Himes, 2007b). Decisions related to responsible management are often complex, and involve many different stakeholders with diverse objectives. Most MPAs, TSMP being no different, affect assorted communities with varied and conflicting viewpoints on the marine environment (Gleason et al., 2010; Heck, et al., 2011; Pajaro, et al., 2010). It is therefore fundamental to the successful management of an MPA that these diverse viewpoints are explored and considered (Yang, et al., 2011).

One of the main objectives of TSMP is the sustainable use of its resources, which will eventually benefit the local community and encourage conservation (Wood, 2001). However, currently, not all seaweed farmers are registered with Sabah Parks. Some farmers are non-resident, illegal settlers or sea gypsies, and thus are reluctant to register themselves. Another critical objective of TSMP is to encourage recreational use to maximise sustainable resource consumption (Wood, 2001). Studies (Alino, Palomar, Arceo, & Uychiaoco, 2002; Claudet, Pelletier, Jouvenel, Bachet, & Galzin, 2006; Marinesque, et al., 2012; Pajaro, et al., 2010; Thur, 2010) show that the introduction of tourism should eventually provide alternative livelihoods for the local community, as well as channel earnings from tourism back to the park management. This will eventually provide the necessary funding to support environmental protection and conservation initiatives. However, the local community within TSMP is limited in its involvement in tourism (M. Kapital, personal communication, December 3, 2012). Besides “diving tourism”, there are no other tourism related recreation activities specific to TSMP and Sipadan Island Park (May-Ling, et al., 2014). This can evidently be seen in the brochures of the tourist operators in Semporna. At present, the entrance to the park is through a tourist jetty in Semporna. There are no park fees collected for entering TSMP and Sipadan Island Park, although the company manning the jetty collects jetty fees from tourists. Fees have been proposed in both the action plan (Wood, 2006) and draft management plan (Wood, 2001) for TSMP. There is limited evidence that shows that tourism income is directly channelled to Sabah Parks Management in Semporna. Studies have shown that park fees are required for the sustainable management of marine park operations (Depondt & Green, 2006; Reid-Grant & Bhat, 2009; Thur, 2010). This may contravene the very reason the park was created. The aim of protecting the park that provides for the care of the natural environment may not see the value in monetary terms returning back to the stakeholders. The absence of park entrance fees may further increase the financial burden of the body that is solely responsible for managing the park. However, it is uncertain why park fees (conservation fees) are not collected, when other parks managed by Sabah Parks have implemented a means of conservation fee collection successfully.

TSMP has an area of over 350 km² requires a wide range of resources such as rangers, field officers, boats and monitoring equipment, which is currently limited in its availability to Sabah Parks. There are less than 10 rangers for both marine parks in

Semporna (B. Antiu, personal communication, December 3, 2012). This limit in manpower may jeopardise monitoring and enforcement efforts. There are currently no linkages with the local community to jointly manage the park, although community participation was proposed in the management plan as part of encouraging the community to be responsible for the park (B. Antiu, personal communication, December 3, 2012). Studies have shown that perceptions and attitudes of the stakeholders concerned with the MPA can significantly affect its overall performance (Heck, et al., 2011; Himes, 2007b; Yang, et al., 2011). The success or failure in reaching the management objectives can be noticeably affected by the reaction of those affected by the regulations and participation levels in the MPA (Dahl-Tacconi, 2005).

Most stakeholders, when confronted with such a problem, may use intuition or heuristics to make the problem more manageable. Doing so results in loss of information, viewpoints of other stakeholders are discarded and elements of uncertainty are ignored. Tourist operators and hoteliers may be concerned with monetary returns, local communities are looking for increased wages, non-governmental organizations are pushing for environmental conservation, whilst government agencies are concerned with policy implementation and execution. What is evident here is the presence of stakeholder conflict, since the stakeholders' objectives vary. In the presence of conflict, it is important to disclose the perception of current MPA management practice by exploring the perception of the diverse stakeholder groups (Himes, 2007b; Wattage & Mardle, 2005; Yang, et al., 2011). This will lead to the identification of performance indicators to the preferred management objectives. The challenge here is for decision makers to put these preferred objectives in some ordinal order, and investigate which management alternatives satisfy the objectives that will eventually lead to effective management of the MPA.

What seems to be alarming is the presence of illegal migrants in the vicinity of the park (Prabhakaran, et al., 2013). The local community and indigenous community are made up of fisherman with little access to education (Sabah Parks, 2008). However, the majority of the residents are stateless, nomadic and do not have proper documentation (Torres, 2005). This problem was expressed in the management plan (Wood, 2001). The sense of responsibility ceases to exist, as these communities do not feel that they need to be responsible in a "nomads land". As for the local residents, the access to proper sanitation and structured waste disposal is absent. It is also surprising that the authorities such as the local council have failed to look into the wellbeing of the local community (Sabah Parks, 2008). The participation of communities in the management of the MPA may need to be explored, as studies have shown that community based management has the potential to elevate poverty, and at the same time, manage local resources efficiently (Clifton, 2003; Pomeroy, McConney, & Mahon, 2004). It is important that local communities and managing authorities agree upon common goals. Stakeholder input is critical in growing stakeholder buy-in to the management process, developing goals, identifying objectives, and management effectiveness indicators, which all lead to the successful management of the MPA (Himes, 2007b).

Insufficient awareness of policies towards responsible management may result in tour operators carrying out activities that are hazardous to the environment, such as snorkelling and diving in delicate reefs, which may cause damage to them (Nair,

Ramachandran, & Nair, 2012). Fishermen may use traditional fishing approaches such as blast fishing, which may further erode the coral reefs (Claudet, et al., 2006). Furthermore, the absence of proper waste management increases the likelihood of pollution, which may result in the dwindling of the marine population (Alder, et al., 1994; Prabhakaran, et al., 2013). Unregulated use of land for seaweed and pearl farming may cause an alarming destruction to the environment surrounding it (May-Ling, et al., 2014).

Non-governmental organizations (NGOs) may take the extreme approach in conservation, denying any form of human intervention in carrying out activities in tourist areas. This could cause conflict among the local residents and the NGOs, as the local community may perceive that the NGOs are denying them access to income for their daily livelihood.

The state authorities in Sabah have developed various policies to protect tourist sites in the state. In the recent updated Sabah Master Plan, eco-tourism has been identified as the main attraction for tourists. However, a recent report by WWF Malaysia (2009) has shown that most of the reefs in Semporna are over exploited by fishing activities. The relevant authorities such as the Sabah Parks that takes care of the protected marine park may not be fully aware of the extent of the damage that a particular activity can cause to the environment. It is difficult to predetermine the effect of the activity, as no established indicators are available to measure the suitability to implement the activity in the tourist site.

According to Adler (1994) who studied three MPAs in Indonesia, isolation itself is not a solution to protect the MPA. If left uncontrolled, the reef may be further damaged, and in turn disrupt the balance of the eco-system such as the population of fish, as well as the attractiveness of the site as a tourist destination.

In summary, the current management of MPAs in Semporna is facing an uphill task to balance social, economic and environment objectives in managing the MPAs responsibly if not effectively. The stakeholder conflict in term of marine resource use, diving permit allocation and land claims remains unresolved with Sabah Parks. Furthermore, Sabah Parks with its responsibility to manage the MPAs, is tasked to consider various factors related to environment, community and tourism in their decision making process. Presently clear guidelines are either absent or do not indicate how these factors should be prioritised to help the decision making process.

Perhaps, this signals an urgent need to design an integrated approach for responsible management of the MPA, and find a balance between environmental, governance and socio-economic factors. A multi-criteria decision-making model could be used to integrate the consideration of the stakeholders involved (Himes, 2007a). The current decision making process is confined to individual stakeholders who do not consider a collective decision making process. Although stakeholder input was taken during the planning stage of the park, operational participation may be minimal or non-existent (Sabah Parks, 2010; Spait, 2001). By implementing a multi-criteria and multi-objective decision-making model, alternatives can be weighed to identify the most suitable implementation in regards to tourist related or local community related activities. The

economic viability of the activity could also be considered, as monetary returns are mandatory for any business related activities.

A decision making model that presents multiple alternatives to stakeholders could be used to assist policy makers or state authorities. The model can assist them to weigh the various activities with the relevant criteria and indicators to decide the impact of implementing such activities.

1.3 Research questions

1. How should the MPA in Semporna be managed so that all stakeholders can participate and benefit from it?
2. What are the current management challenges in managing MPAs in Semporna responsibly?
3. How the stakeholders perceive the current MPA management approach in addressing their concerns?
4. What criteria drive decision making towards responsible MPA management in Semporna based on stakeholder's perspective?
5. What are the MPA management alternatives (styles) suitable for managing MPAs in Semporna?
6. How to evaluate stakeholder's preference of management approach using decision criteria suggested by the stakeholders?

1.4 Research Objectives

The primary objective of this study is to develop a multi-criteria decision-making model for the responsible management of the Marine Protected Area (MPA) in Semporna, Sabah. The specific objectives are as follows:

1. To identify the current practices of responsible management of the MPA in Semporna.
2. To identify critical decision making criteria related to responsible management in the MPA in Semporna.
3. To develop a decision-making model to analyse the decision criteria preference towards responsible management of the MPA in Semporna.

1.5 The significance of this study

Managing an MPA responsibly requires decision makers to consider multiple criteria that are influenced by social, environmental and economic factors (Munda, 2004). The inclusion of many criteria makes decision making a complex process. Without a structured approach, decisions in managing the MPA responsibly may be made

haphazardly, resulting in a poorly managed MPA that does not meet the original goals lined out in the management plan (White, 1986). Therefore, it is important to provide a tool for policy makers to find a sustainable approach in managing the MPA responsibly, with consideration of the input of multiple stakeholders (Dahl-Tacconi, 2005). The presence of conflict amongst stakeholders requires numerous objectives to be assimilated in the MPA management policy. An unequivocal appreciation of the different groups will expedite negotiations between the stakeholders, ensuring that more desirable compromise solutions are reached (Himes, 2007b).

This study aims to contribute to the current body of knowledge by filling the gap between protecting the marine park and managing the park responsibly, with the consideration of multiple stakeholders. The findings can be used as a guideline to encourage managing the marine park responsibly for long-term sustainability.

This study also aims to develop a decision-making model for evaluating the optimal responsible management approach for managing the MPA. The model is expected to serve as a decision-making tool for stakeholders to identify management alternatives to manage the MPA effectively and responsibly. The model is anticipated to give the stakeholders a broader understanding of the responsible management concepts when it comes to the management of the MPA. This understanding may lead to better management of the MPA.

1.6 Research Scope

The main focus of this study is on the decision making process of MPA management of the marine parks located on the coast of Semporna district in Sabah, Malaysia. The subject area considered in this study focused on socio-economic, environmental and governance factors. The two marine parks considered are Sipadan Island Park and Tun Sakaran Marine Park. The agency that is investigated is Sabah Parks (which is the custodian of Marine Parks in Sabah), and their decision making process in managing the MPA responsibly. Input from other stakeholders such as the local community, non-government organisations, academics, tourists, tour operators and government agencies were also considered. This study was conducted between the time period of January 2012 and December 2014.

There are various categories of communities living within the park. They are either legal residence with valid documents (citizenship), refugees or illegal immigrants (May-Ling, et al., 2014). It would be ideal to include all of these groups in this study to identify their perception about how the MPAs should be managed. However, security issues plague Semporna and the east coast of Sabah. This is a major concern because respondents need to be accessed repeatedly, they live further away from the mainland in remote islands that lack safety and their availability cannot be guaranteed. Hence, this study only looks at legal residence in the park that are registered citizens of Malaysia, mainly due to earlier mentioned challenges.

1.7 Theoretical Framework

The human decision making process follows a hierarchical cognitive process. Lonergan (1992) explains this process lucidly in five levels of consciousness. These levels are illustrated in Figure 1.3.

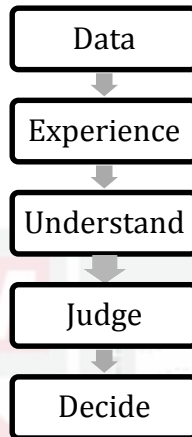


Figure 1.3. Human Decision Making Process – Lonergan’s Hierarchy

Based on the hierarchy, it is clear that decision-making is a conscious act, and confirms the notion of awareness in oneself during the decision making process. The motivation for decision-making resides in the initial doubt or question, and from this doubt follows the conscious act of inquiry. The act of inquiry is followed by the action on data. Data can be in the form of what is observed, or internal in nature, such as feelings from within. Once the data is sensed, it can be translated into some form of experience that the cognitive process can digest. Based on this experience, there is a shift towards understanding this experience. In this process, one’s background knowledge and physical experience come into play. Once the understanding of data takes place, judgement can be passed. According to (Lonergan, 1992), judgement is similar to making a decision, but it is directed to the self. This is also known as a reflective insight. The next step is the actual decision making, which is known as a practical insight. However, decision-making does not only involve making choices, but also involves going through the cognitive process of evaluation and elimination before deciding on a final worthy choice. The presence of multiple choices (options) is the catalyst that starts the decision-making process.

Decision-making involves the process of judgements, feelings, preferences and some form of risk taking. It is a subsidiary of Meta rational thinking. Using common sense, or rational thinking, a person uses logic based on explicit expectations to develop his or her conclusions. It is a human ability where decision-making is done through extracting information about comparison and preferences that belongs to the domain of emotions and feelings.

According to Bacharach and Hurley (1994), decision theory can be further described by three subsidiary principles:

1. For any person the theory applies to, one can identify domains where preference can be applied, and domains where each item can be attached to a set of probabilities.
2. For any person the theory applies to, there is a form of preference ordering over the items lined out in the preference domain. It must be possible to rank all items.
3. For any person the theory applies to, there is an appropriate probability ordering over the domain of probability.

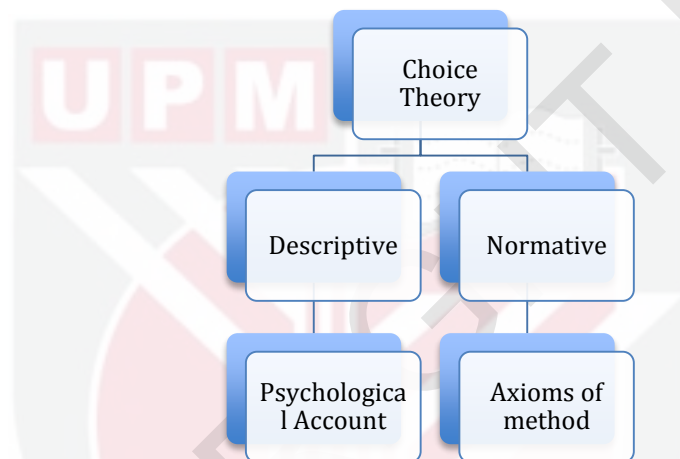


Figure 1.4. Theory of Choice

At the end of a judgement comes the process of making a choice. The theory of choice itself can be explained in either a descriptive or normative domain (Figure 1.4). The descriptive theory of choice is about a psychological account of how humans make decisions, while the normative theory of choice is about a rationalistic account on how one should decide (Bell, Raiffa, & Tversky, 1988). However, it is understood that decision makers are not always rational, and may make decisions based on the underlying emotions involved.

Furthermore, decision-making is not only about making choices, but also about going through the cognitive process of evaluation and elimination before deciding on a final worthy choice. The presence of multiple choices (options) is the catalyst that starts the decision-making process. Decision-making involves the process of judgements, feelings, preferences and some form of risk taking. It is a subsidiary of meta-rational thinking. Using common sense or rational thinking, a person uses logic based on explicit expectations to develop his or her conclusions. It is a human ability where decision-making is done through extracting information about comparison and preferences, which belongs to the domain of emotions and feelings. In this study, a

combination of descriptive and normative choice theories are adopted, which is also known as a prescriptive theory of choice (Bell, et al., 1988). Details of the decision modelling are discussed in Chapter 2.

1.8 Organisation of the Thesis

Chapter 1 gives an overview of the main topic of this study. It also outlines the research problems from various viewpoints, which are later formulated into the objectives of the study. The chapter concludes by stating the significance of the study from the methodological and decision makers' perspective, followed by the scope of the study.

Chapter 2 presents an in-depth review of the literature. This chapter is organised into several independent but interrelated sections. It reviews the topic of MPA management, decision-making theories, importance of stakeholders, and responsible management. The chapter then reviews multi-criteria decision-making methodologies, followed by the benefits of MPA, the research gap considered and the study site.

Chapter 3 presents the research methodology that has been carried out to satisfy the research objectives. The chapter begins with the philosophical approach, the research design and the framework. There are three stages of data collection in this chapter. The first is the qualitative approach in data collection that which uses the modified Delphi method, and its data collection methods (in-depth interviews and questionnaires). This is followed by a description of its validation and analysis approach. Next, the second stage is presented, which involves a part of the Delphi method of forming consensus where the panel members undertake decision criteria confirmation. Finally, the third stage is presented, which involves the development of an AHP decision model, along with the selection of respondents, data collection, data validation and the analysis approach.

Chapter 4 describes the data analysis and findings from the interviews and questionnaires collected from the various stages described in the methodology. Feedback from the questionnaire in stage 1 is tabulated and presented, describing the concerns of stakeholders regarding decision criteria in MPA management. This is followed by the results from the second stage of consensus, which presents the stakeholders' preferences of decision criteria. The next section describes the AHP decision model analysis that highlights the preference of different stakeholders using sensitivity analysis towards decision criteria and management options. In this chapter the findings are triangulated.

Chapter 5 concludes and summarizes the findings of the study. The chapter consists of the achievement of the research objectives, the implication of the findings and the contribution to the existing body of knowledge. Finally, the limitations of the research are presented, followed by recommendations for future research.

REFERENCES

- Agardy, T., Di Sciara, G. N., & Christie, P. (2011). Mind the gap: addressing the shortcomings of marine protected areas through large scale marine spatial planning. *Marine Policy*, 35(2), 226-232.
- Ahmad, S. A., & Hanley, N. (2009). Willingness To Pay For Reducing Crowding Effect Damages In Marine Parks In Malaysia. *The Singapore Economic Review*, 54(01), 21-39. doi: doi:10.1142/S02175908090003124
- Alder, J., Sloan, N. A., & Uktolseya, H. (1994). A comparison of management planning and implementation in three Indonesian marine protected areas. *Ocean & Coastal Management*, 24(3), 179-198. doi: [http://dx.doi.org/10.1016/0964-5691\(94\)90037-X](http://dx.doi.org/10.1016/0964-5691(94)90037-X)
- Alder, J., Zeller, D., Pitcher, T., & Sumaila, R. (2002). A Method for Evaluating Marine Protected Area Management. *Coastal Management*, 30(2), 121-131. doi: 10.1080/089207502753504661
- Alino, P., Palomar, N., Arceo, H., & Uychiaoco, A. (2002). *Challenges and opportunities for marine protected area(MPA) management in the Philippines*. Paper presented at the Proceedings of the Ninth International Coral Reef Symposium, Bali, 23-27 October 2000.
- Aminu, M., Ludin, A., Matori, A.-N., Wan Yusof, K., Dano, L., & Chandio, I. (2013). A spatial decision support system (SDSS) for sustainable tourism planning in Johor Ramsar sites, Malaysia. *Environmental Earth Sciences*, 1-12. doi: 10.1007/s12665-012-2198-6
- Ananda, J., & Herath, G. (2005). Evaluating public risk preferences in forest land-use choices using multi-attribute utility theory. *Ecological Economics*, 55(3), 408-419.
- Arnstein, S. R. (1969). A ladder of citizen participation. *Journal of the American Institute of planners*, 35(4), 216-224.
- Arunraj, N., & Maiti, J. (2010). Risk-based maintenance policy selection using AHP and goal programming. *Safety Science*, 48(2), 238-247.
- Authority, G. B. R. M. P. (2009). *Great Barrier Reef outlook report 2009: in brief*: Great Barrier Reef Marine Park Authority.
- Bacharach, M., & Hurley, S. L. (1994). *Foundations of decision theory: issues and advances*: Blackwell.
- Ban, N. C., Adams, V. M., Almany, G. R., Ban, S., Cinner, J. E., McCook, L. J., . . . White, A. (2011). Designing, implementing and managing marine protected areas: emerging trends and opportunities for coral reef nations. *Journal of Experimental Marine Biology and Ecology*, 408(1), 21-31.
- Bana e Costa, C. A., & Vansnick, J.-C. (2008). A critical analysis of the eigenvalue method used to derive priorities in AHP. *European Journal of Operational Research*, 187(3), 1422-1428. doi: <http://dx.doi.org/10.1016/j.ejor.2006.09.022>
- Batista, M. I., Baeta, F., Costa, M. J., & Cabral, H. N. (2011). MPA as management tools for small-scale fisheries: The case study of Arrabida Marine Protected Area (Portugal). *Ocean & Coastal Management*, 54(2), 137-147.
- Behzadian, M., Kazemzadeh, R. B., Albadvi, A., & Aghdasi, M. (2010). PROMETHEE: A comprehensive literature review on methodologies and applications. *European Journal of Operational Research*, 200(1), 198-215.
- Bell, D. E., Raiffa, H., & Tversky, A. (1988). Descriptive, normative, and prescriptive interactions in decision making. *Decision making: Descriptive, normative, and prescriptive interactions*, 1, 9-32.

- Belton, V., & Gear, T. (1983). On a short-coming of Saaty's method of analytic hierarchies. *Omega*, 11(3), 228-230.
- Belton, V., & Stewart, T. J. (2002). *Multiple criteria decision analysis : An integrated approach*. Boston: Kluwer Academic Publishers.
- Bendor, J. (2001). Bounded Rationality. In J. S. Neil & B. B. Paul (Eds.), *International Encyclopedia of the Social & Behavioral Sciences* (pp. 1303-1307). Oxford: Pergamon.
- Berkes, F. (1994). Co-management: bridging the two solitudes. *Northern Perspectives*, 22(2-3), 18-20.
- Biggs, J. B. (1989). Approaches to the Enhancement of Tertiary Teaching. *Higher Education Research & Development*, 8(1), 7-25. doi: 10.1080/0729436890080102
- Breen, D. A. (2007). Systematic conservation assessments for marine protected areas in New South Wales, Australia. James Cook University.
- Brown, K., Adger, W. N., Tompkins, E., Bacon, P., Shim, D., & Young, K. (2001). Trade-off analysis for marine protected area management. *Ecological Economics*, 37(3), 417-434. doi: [http://dx.doi.org/10.1016/S0921-8009\(00\)00293-7](http://dx.doi.org/10.1016/S0921-8009(00)00293-7)
- Burbridge, P. R. (1997). A generic framework for measuring success in integrated coastal management. *Ocean & Coastal Management*, 37(2), 175-189.
- Castro, A. P., & Nielsen, E. (2001). Indigenous people and co-management: implications for conflict management. *Environmental Science & Policy*, 4(4), 229-239.
- Chan, E.-H. (2006). Marine turtles in Malaysia: On the verge of extinction? *Aquatic Ecosystem Health & Management*, 9(2), 175-184. doi: 10.1080/14634980600701559
- Chape, S., Harrison, J., Spalding, M., & Lysenko, I. (2005). Measuring the extent and effectiveness of protected areas as an indicator for meeting global biodiversity targets. *Philosophical Transactions of the Royal Society B: Biological Sciences*, 360(1454), 443-455.
- Charles, A. T. (1992). Fishery conflicts: a unified framework. *Marine Policy*, 16(5), 379-393.
- Chen, Y., Okudan, G. E., & Riley, D. R. (2010). Decision support for construction method selection in concrete buildings: Prefabrication adoption and optimization. *Automation in Construction*, 19(6), 665-675.
- Christie, P. (2000). Taking care of what we have: Participatory natural resource management on the Caribbean Coast of Nicaragua: Idrc.
- Christie, P., Lowry, K., White, A. T., Oracion, E. G., Sievanen, L., Pomeroy, R. S., . . . Eisma, R.-L. V. (2005). Key findings from a multidisciplinary examination of integrated coastal management process sustainability. *Ocean & Coastal Management*, 48(3), 468-483.
- Christie, P., Pollnac, R. B., Oracion, E. G., Sabonsolin, A., Diaz, R., & Pietri, D. (2009). Back to basics: An empirical study demonstrating the importance of local-level dynamics for the success of tropical marine ecosystem-based management. *Coastal Management*, 37(3-4), 349-373.
- Christie, P., White, A., & Deguit, E. (2002). Starting point or solution? Community-based marine protected areas in the Philippines. *Journal of Environmental Management*, 66(4), 441-454.
- Christie, P., & White, A. T. (1997). Trends in development of coastal area management in tropical countries: From central to community orientation. *Coastal Management*, 25(2), 155-181.

- Christie, P., & White, A. T. (2007). Best practices for improved governance of coral reef marine protected areas. *Coral Reefs*, 26(4), 1047-1056. doi: 10.1007/s00338-007-0235-9
- Cicin-Sain, B., & Belfiore, S. (2005). Linking marine protected areas to integrated coastal and ocean management: a review of theory and practice. *Ocean & Coastal Management*, 48(11), 847-868.
- Claudet, J. (2011). *Marine protected areas: a multidisciplinary approach*: Cambridge University Press.
- Claudet, J., Pelletier, D., Jouvenel, J.-Y., Bachet, F., & Galzin, R. (2006). Assessing the effects of marine protected area (MPA) on a reef fish assemblage in a northwestern Mediterranean marine reserve: Identifying community-based indicators. *Biological Conservation*, 130(3), 349-369.
- Clifton, J. (2003). Prospects for co-management in Indonesia's marine protected areas. *Marine Policy*, 27(5), 389-395. doi: [http://dx.doi.org/10.1016/S0308-597X\(03\)00026-5](http://dx.doi.org/10.1016/S0308-597X(03)00026-5)
- Clifton, J. (2009). Science, funding and participation: key issues for marine protected area networks and the Coral Triangle Initiative. *Environmental Conservation*, 36(02), 91-96. doi: doi:10.1017/S0376892909990075
- Creswell, J. W. (2009). *Research design : qualitative, quantitative, and mixed methods approaches*. Thousand Oaks, Calif.: Sage Publications.
- Da Silva, P. P. (2004). From common property to co-management: lessons from Brazil's first maritime extractive reserve. *Marine Policy*, 28(5), 419-428.
- Dahl-Tacconi, N. (2005). Investigating Information Requirements for Evaluating Effectiveness of Marine Protected Areas, Indonesian Case Studies. *Coastal Management*, 33(3), 225-246. doi: 10.1080/08920750590951956
- Davidson, S. (1998). Spinning the wheel of participation. *Planning*, 1262, 14-15.
- Denzin, N. K. (1970). *The research act; a theoretical introduction to sociological methods*. Chicago: Aldine Pub. Co.
- Denzin, N. K., & Lincoln, Y. S. (2005). *The SAGE handbook of qualitative research*. Thousand Oaks: Sage Publications.
- Depondt, F., & Green, E. (2006). Diving user fees and the financial sustainability of marine protected areas: Opportunities and impediments. *Ocean & Coastal Management*, 49(3), 188-202. doi: <http://dx.doi.org/10.1016/j.ocecoaman.2006.02.003>
- DeSanctis, G., & Gallupe, R. B. (1987). A Foundation for the Study of Group Decision Support Systems. *Management Science*, 33(5), 589-609. doi: 10.1287/mnsc.33.5.589
- Diakoulaki, D., & Karangelis, F. (2007). Multi-criteria decision analysis and cost-benefit analysis of alternative scenarios for the power generation sector in Greece. *Renewable and Sustainable Energy Reviews*, 11(4), 716-727.
- Diaz-Balteiro, L., & Romero, C. (2008). Making forestry decisions with multiple criteria: A review and an assessment. *Forest Ecology and Management*, 255(8), 3222-3241. doi: 10.1016/j.foreco.2008.01.038
- Dudley, N. (2008). *Guidelines for applying protected area management categories*: IUCN.
- Easton, A. (1973). *Complex managerial decisions involving multiple objectives*. New York: Wiley.
- Edwards, W., & Barron, F. H. (1994). SMARTS and SMARTER: Improved simple methods for multiattribute utility measurement. *Organizational behavior and human decision processes*, 60(3), 306-325.

- Ehler, C. N. (2003). Indicators to measure governance performance in integrated coastal management. *Ocean & Coastal Management*, 46(3,Äi4), 335-345. doi: [http://dx.doi.org/10.1016/S0964-5691\(03\)00020-6](http://dx.doi.org/10.1016/S0964-5691(03)00020-6)
- Fabinyi, M. (2008). Dive tourism, fishing and marine protected areas in the Calamianes Islands, Philippines. *Marine Policy*, 32(6), 898-904. doi: 10.1016/j.marpol.2008.01.004
- Fernandes, L., Ridgley, M., & Van't, H. (1999). Multiple criteria analysis integrates economic, ecological and social objectives for coral reef managers. *Coral Reefs*, 18(4), 393-402.
- Figueira, J., Mousseau, V., & Roy, B. (2005). Electre Methods *Multiple Criteria Decision Analysis: State of the Art Surveys* (Vol. 78, pp. 133-153): Springer New York.
- Fishburn, P. C., & Keeney, R. L. (1974). Seven independence concepts and continuous multiattribute utility functions. *Journal of Mathematical Psychology*, 11(3), 294-327.
- Francour, P., Harmelin, J. Ä., Pollard, D., & Sartoretto, S. p. (2001). A review of marine protected areas in the northwestern Mediterranean region: siting, usage, zonation and management. *Aquatic conservation: marine and freshwater ecosystems*, 11(3), 155-188.
- Frey, N. (2007). Managing tourism responsibly. *Managing Tourism in South Africa*. Oxford University Press, Cape Town, 316-333.
- Frey, N., & George, R. (2010). Responsible tourism management: The missing link between business owners' attitudes and behaviour in the Cape Town tourism industry. *Tourism Management*, 31(5), 621-628. doi: 10.1016/j.tourman.2009.06.017
- Gal, T. s., Stewart, T. J., & Hanne, T. (1999). Multicriteria decision making : advances in MCDM models, algorithms, theory, and applications. Boston: Kluwer Academic.
- Garmendia, E., Gamboa, G., Franco, J., Garmendia, J. M., Liria, P., & Olazabal, M. (2010). Social multi-criteria evaluation as a decision support tool for integrated coastal zone management. *Ocean & Coastal Management*, 53(7), 385-403.
- Garrod, B., & Wilson, J. C. (2003). *Marine ecotourism: issues and experiences*: Channel View Publications.
- Gina Elliott, B. M. B. W. I. A. M. S. W. (2001). Community Participation in Marine Protected Area Management: Wakatobi National Park, Sulawesi, Indonesia. *Coastal Management*, 29(4), 295-316. doi: 10.1080/089207501750475118
- Glaser, M., Baitoningsih, W., Ferse, S. C., Neil, M., & Deswandi, R. (2010). Whose sustainability? Top-down participation and emergent rules in marine protected area management in Indonesia. *Marine Policy*, 34(6), 1215-1225.
- Gleason, M., McCreary, S., Miller-Henson, M., Ugoretz, J., Fox, E., Merrifield, M., . . . Hoffman, K. (2010). Science-based and stakeholder-driven marine protected area network planning: A successful case study from north central California. *Ocean & Coastal Management*, 53(2), 52-68.
- Glenn, H., Wattage, P., Mardle, S., Van Rensburg, T., Grehan, A., & Foley, N. (2010). Marine protected areas, substantiating their worth. *Marine Policy*, 34(3), 421-430.
- Gomez-Limon, J. A., Arriaza, M., & Riesgo, L. (2003). An MCDM analysis of agricultural risk aversion. *European Journal of Operational Research*, 151(3), 569-585.

- Grimble, R., & Chan, M.-K. (1995). Stakeholder analysis for natural resource management in developing countries. *Natural Resources Forum*, 19(2), 113-124. doi: 10.1111/j.1477-8947.1995.tb00599.x
- Grimble, R., & Wellard, K. (1997). Stakeholder methodologies in natural resource management: a review of principles, contexts, experiences and opportunities. *Agricultural Systems*, 55(2), 173-193. doi: [http://dx.doi.org/10.1016/S0308-521X\(97\)00006-1](http://dx.doi.org/10.1016/S0308-521X(97)00006-1)
- Gubbay, S. (1995). Marine protected area - past, present and future. In S. Gubbay (Ed.), *Marine Protected Areas* (Vol. 5, pp. 1-14): Springer Netherlands.
- Guidetti, P., Milazzo, M., Bussotti, S., Molinari, A., Murenu, M., Pais, A., . . . Boero, F. (2008). Italian marine reserve effectiveness: Does enforcement matter? *Biological Conservation*, 141(3), 699-709.
- Gwo-Hshiang, T. (2010). Multiple attribute decision making: methods and applications. *Multiple Attribute Decision Making: Methods and Applications*.
- Hackman, J. R., & Kaplan, R. E. (1974). Interventions into group process: An approach to improving the effectiveness of groups. *Decision Sciences*, 5(3), 459-480. doi: 10.1111/j.1540-5915.1974.tb00631.x
- Hamalainen, R. P., Kettunen, E., Marttunen, M., & Ehtamo, H. (1999, January). *Towards decision and negotiation support in multi-stakeholder development of lake regulation policy*. Paper presented at the In System Sciences, 1999. HICSS-32. Proceedings of the 32nd Annual Hawaii International Conference on.
- Harrison, S. R., & Qureshi, M. E. (2000). Choice of stakeholder groups and members in multicriteria decision models. *Natural Resources Forum*, 24(1), 11-19. doi: 10.1111/j.1477-8947.2000.tb00925.x
- Heck, N., Dearden, P., & McDonald, A. (2011). Stakeholders' expectations towards a proposed marine protected area: A multi-criteria analysis of MPA performance criteria. *Ocean & Coastal Management*, 54(9), 687-695. doi: 10.1016/j.ocecoaman.2011.07.003
- Herath, G. (2004). Incorporating community objectives in improved wetland management: the use of the analytic hierarchy process. *Journal of Environmental Management*, 70(3), 263-273.
- Himes, A. H. (2007a). Performance indicator importance in MPA management using a multi-criteria approach. *Coastal Management*, 35(5), 601-618.
- Himes, A. H. (2007b). Performance indicators in MPA management: Using questionnaires to analyze stakeholder preferences. *Ocean & Coastal Management*, 50(5-6), 329-351. doi: 10.1016/j.ocecoaman.2006.09.005
- Hind, E., Hironaka, M., & Gray, T. (2010). From community-based to centralised national management, a wrong turning for the governance of the marine protected area in Apo Island, Philippines? *Marine Policy*, 34(1), 54-62.
- Hockey, P., & Branch, G. (1997). Criteria, objectives and methodology for evaluating marine protected areas in South Africa. *South African Journal of Marine Science*, 18(1), 369-383.
- Hockings, M. (2006). Evaluating Effectiveness: A framework for assessing management effectiveness of protected areas: IUCN.
- Hockings, M., Stolton, S., Dudley, N., & James, R. (2009). Data credibility: what are the right data for evaluating management effectiveness of protected areas? *New Directions for Evaluation*, 2009(122), 53-63.
- Hoffart, N. (1991). A member check procedure to enhance rigor in naturalistic research. *Western Journal of Nursing Research*, 13(4), 522-534.
- Hoyt, E. (2012). *Marine Protected Areas for Whales, Dolphins and Porpoises: A world handbook for cetacean habitat conservation and planning*: Routledge.

- Hsu, C.-C., & Sandford, B. A. (2007). The Delphi technique: making sense of consensus. *Practical Assessment, Research & Evaluation*, 12(10), 1-8.
- Huang, I. B., Keisler, J., & Linkov, I. (2011). Multi-criteria decision analysis in environmental sciences: ten years of applications and trends. *Science of the Total Environment*, 409(19), 3578-3594.
- Ic, Y. T. (2012). An experimental design approach using TOPSIS method for the selection of computer-integrated manufacturing technologies. *Robotics and Computer-Integrated Manufacturing*, 28(2), 245-256.
- Iwasaki-Goodman, M. (2005). Resource Management for the Next Generation: Co-Management of Fishery Resources in the Western Canadian Arctic. *Senri Ethnological Studies*, 67, 101-120.
- Jameson, S. C., Tupper, M. H., & Ridley, J. M. (2002). The three screen doors: Can marine protected areas be effective? *Marine Pollution Bulletin*, 44(11), 1177-1183. doi: [http://dx.doi.org/10.1016/S0025-326X\(02\)00258-8](http://dx.doi.org/10.1016/S0025-326X(02)00258-8)
- Jones, P. J., & Burgess, J. (2005). Building partnership capacity for the collaborative management of marine protected areas in the UK: a preliminary analysis. *Journal of Environmental Management*, 77(3), 227-243.
- Kangas, J., Kangas, A., Leskinen, P., & Pykäläinen, J. (2001). MCDM methods in strategic planning of forestry on state-owned lands in Finland: applications and experiences. *Journal of Multi-Criteria Decision Analysis*, 10(5), 257-271. doi: 10.1002/mcda.306
- Keeney, R. L. (1977). The art of assessing multiattribute utility functions. *Organizational Behavior and Human Performance*, 19(2), 267-310.
- Keeney, R. L., & Raiffa, H. (1976). Decisions with multiple objectives : preferences and value tradeoffs. New York: Wiley.
- Kiker, G. A., Bridges, T. S., Varghese, A., Seager, T. P., & Linkov, I. (2005). Application of multicriteria decision analysis in environmental decision making. *Integrated Environmental Assessment and Management*, 1(2), 95-108. doi: 10.1897/IEAM_2004a-015.1
- Kleinen, J., & Osseweijer, M. (2010). *Pirates, ports, and coasts in Asia: historical and contemporary perspectives*: Institute of Southeast Asian Studies.
- Konidari, P., & Mavraklis, D. (2007). A multi-criteria evaluation method for climate change mitigation policy instruments. *Energy Policy*, 35(12), 6235-6257.
- Koontz, T. M. (2005). We Finished the Plan, So Now What? Impacts of Collaborative Stakeholder Participation on Land Use Policy. *Policy Studies Journal*, 33(3), 459-481. doi: 10.1111/j.1541-0072.2005.00125.x
- Lahdelma, R., Salminen, P., & Hokkanen, J. (2000). Using Multicriteria Methods in Environmental Planning and Management. *Environmental Management*, 26(6), 595-605. doi: 10.1007/s002670010118
- Lane, M. B. (2001). Affirming new directions in planning theory: comanagement of protected areas. *Society & Natural Resources*, 14(8), 657-671.
- Leikam, G. (2004). Evaluation of the Belize Audubon Society Co-Management Project at Crooked Tree Wildlife Sanctuary and Cockscomb Basin Wildlife Sanctuary, Belize. University of Michigan.
- Lein, J. K. (1997). Environmental Decision Making: an information technology approach: Blackwell Science.
- Leleu, K., Alban, F., Pelletier, D., Charbonnel, E., Letourneur, Y., & Boudouresque, C. F. (2012). Fishers' perceptions as indicators of the performance of Marine Protected Areas (MPAs). *Marine Policy*, 36(2), 414-422.
- Lestari. (1995). *Kajian Status Alam Sekitar dan Keupayan Tampungan Pulau Sipadan* (pp. 147): Institut Alam Sekitar dan Pembangunan.

- Leung, P., Muraoka, J., Nakamoto, S. T., & Pooley, S. (1998). Evaluating fisheries management options in Hawaii using analytic hierarchy process (AHP). *Fisheries Research*, 36(2), 171-183.
- Lin, C.-T., & Juan, P.-J. (2009). Developing a hierarchy relation with an expert decision analysis process for selecting the optimal resort type for a Taiwanese international resort park. *Expert Systems with Applications*, 36(2, Part 1), 1706-1719. doi: 10.1016/j.eswa.2007.11.044
- Lincoln, Y. S., & Guba, E. G. (1985). *Naturalistic inquiry*. Beverly Hills, Calif.: Sage Publications.
- Lonergan, B. (1992). *Insight: A study of human understanding* (Vol. 3): University of Toronto Press.
- MacCallum, R. C., Widaman, K. F., Zhang, S., & Hong, S. (1999). Sample size in factor analysis. *Psychological methods*, 4(1), 84.
- Macoun, P., & Prabhu, R. (1999). Guidelines for applying multi-criteria analysis to the assessment of criteria and indicators (Vol. 9): CIFOR.
- Mardle, S., Pascoe, S., & Herrero, I. (2004). Management Objective Importance in Fisheries: An Evaluation Using the Analytic Hierarchy Process (AHP). *Environmental Management*, 33(1), 1-11. doi: 10.1007/s00267-003-3070-y
- Mardle, S., Pascoe, S., Tamiz, M., & Jones, D. (2000). Resource allocation in the North Sea demersal fisheries: a goal programming approach. *Annals of Operations Research*, 94(1-4), 321-342.
- Marinesque, S., Kaplan, D. M., & Rodwell, L. D. (2012). Global implementation of marine protected areas: Is the developing world being left behind? *Marine Policy*, 36(3), 727-737. doi: <http://dx.doi.org/10.1016/j.marpol.2011.10.010>
- Marques, A. S., Ramos, T. B., Caeiro, S., & Costa, M. H. (2013). Adaptive-participative sustainability indicators in marine protected areas: Design and communication. *Ocean & Coastal Management*, 72(0), 36-45. doi: <http://dx.doi.org/10.1016/j.ocecoaman.2011.07.007>
- May-Ling, S., Ramachandran, S., Shuib, A., & Afandi, S. H. M. (2014). Barriers to community participation in rural tourism: A case study of the communities of Semporna, Sabah, Malaysia. *Life Science Journal*, 11(11), 837-841.
- Mendoza, G. A., & Martins, H. (2006). Multi-criteria decision analysis in natural resource management: A critical review of methods and new modelling paradigms. *Forest Ecology and Management*, 230(1), 1-22. doi: 10.1016/j.foreco.2006.03.023
- Middleton, V. T. C., & Hawkins, R. (1998). *Sustainable tourism : a marketing perspective*. Oxford; Woburn, MA: Butterworth-Heinemann.
- Morris, A. D., & Mueller, C. M. (1992). *Frontiers in social movement theory*: Yale University Press.
- Munda, G. (2004). Social multi-criteria evaluation: Methodological foundations and operational consequences. *European Journal of Operational Research*, 158(3), 662-677. doi: [http://dx.doi.org/10.1016/S0377-2217\(03\)00369-2](http://dx.doi.org/10.1016/S0377-2217(03)00369-2)
- Munda, G. (2005). A NAIADE based approach for sustainability benchmarking. *International journal of environmental technology and management*, 6(1-2), 65-78.
- Murry, J. W., Jr., & Hammons, J. O. (1995). Delphi: A Versatile Methodology for Conducting Qualitative Research. *Review of Higher Education*, 18(4), 423-436.
- Mustajoki, J., Hamalainen, R. P., & Marttunen, M. (2004). Participatory multicriteria decision analysis with Web-HIPRE: a case of lake regulation policy. *Environmental Modelling & Software*, 19(6), 537-547. doi: 10.1016/j.envsoft.2003.07.002

- Nair, M. B., Ramachandran, S., & Nair, V. (2012). Multi-criteria Decision Making Approach For Responsible Tourism Management. *The Malaysian Forester*, 75(2), 135-146.
- Nair, V., Hussain, K., Ramachandran, S., & Prabhakaran, S. (2013). Marine waste management indicators in a tourism environment: Exploring possibilities for Semporna District, Sabah. *Worldwide Hospitality and Tourism Themes*, 5(4), 365-376.
- Nielsen, J. R., Degnbol, P., Viswanathan, K. K., Ahmed, M., Hara, M., & Abdullah, N. M. R. (2004). Fisheries co-management, an institutional innovation? Lessons from South East Asia and Southern Africa. *Marine Policy*, 28(2), 151-160.
- Nurse-Bray, M., & Rist, P. (2009). Co-management and protected area management: achieving effective management of a contested site, lessons from the Great Barrier Reef World Heritage Area (GBRWA). *Marine Policy*, 33(1), 118-127.
- Oddershede, A., Arias, A., & Cancino, H. (2007). Rural development decision support using the Analytic Hierarchy Process. *Mathematical and Computer Modelling*, 46(7), 1107-1114. doi: 10.1016/j.mcm.2007.03.006
- Ojeda-Martinez, C., Casalduero, F. G., Bayle-Sempere, J. T., Cebrian, C. B., Valle, C., Sanchez-Lizaso, J. L., . . . Falcon, J. M. (2009). A conceptual framework for the integral management of marine protected areas. *Ocean & Coastal Management*, 52(2), 89-101.
- Okoli, C., & Pawlowski, S. D. (2004). The Delphi method as a research tool: an example, design considerations and applications. *Information & Management*, 42(1), 15-29. doi: <http://dx.doi.org/10.1016/j.im.2003.11.002>
- Olsen, S. B. (2003). Frameworks and indicators for assessing progress in integrated coastal management initiatives. *Ocean & Coastal Management*, 46(3), 347-361.
- Opricovic, S., & Tzeng, G.-H. (2004). Compromise solution by MCDM methods: A comparative analysis of VIKOR and TOPSIS. *European Journal of Operational Research*, 156(2), 445-455. doi: [http://dx.doi.org/10.1016/S0377-2217\(03\)00020-1](http://dx.doi.org/10.1016/S0377-2217(03)00020-1)
- Ostrom, E. (1990). *Governing the commons: The evolution of institutions for collective action*: Cambridge university press.
- Ostrom, E. (1999). *Design principles and threats to sustainable organizations that manage commons*. Paper presented at the Workshop in Political Theory and Policy Analysis, W99-6. Center for the Study of Institutions, Population, and Environmental Change. Indiana University, USA. www.indiana.edu.
- Pajaro, M. G., Mulrennan, M. E., Alder, J., & Vincent, A. C. J. (2010). Developing MPA Effectiveness Indicators: Comparison Within and Across Stakeholder Groups and Communities. *Coastal Management*, 38(2), 122-143. doi: 10.1080/08920751003633094
- Petrosillo, I., Zurlini, G., Corliano, M., Zaccarelli, N., & Dadamo, M. (2007). Tourist perception of recreational environment and management in a marine protected area. *Landscape and Urban Planning*, 79(1), 29-37.
- Pinnegar, J., Polunin, N., Francour, P., Badalamenti, F., Chemello, R., Harmelin-Vivien, M.-L., . . . d'Anna, G. (2000). Trophic cascades in benthic marine ecosystems: lessons for fisheries and protected-area management. *Environmental Conservation*, 27(2), 179-200.
- Pollnac, R. B., & Pomeroy, R. S. (2005). Factors influencing the sustainability of integrated coastal management projects in the Philippines and Indonesia. *Ocean & Coastal Management*, 48(3), 233-251.

- Pomeroy, R. S. (1995). Community-based and co-management institutions for sustainable coastal fisheries management in Southeast Asia. *Ocean & Coastal Management*, 27(3), 143-162. doi: 10.1016/0964-5691(95)00042-9
- Pomeroy, R. S., & Berkes, F. (1997). Two to tango: the role of government in fisheries co-management. *Marine Policy*, 21(5), 465-480.
- Pomeroy, R. S., McConney, P., & Mahon, R. (2004). Comparative analysis of coastal resource co-management in the Caribbean. *Ocean & Coastal Management*, 47(9), 429-447. doi: <http://dx.doi.org/10.1016/j.ocecoaman.2004.09.005>
- Pomeroy, R. S., Watson, L. M., Parks, J. E., & Cid, G. A. (2005). How is your MPA doing? A methodology for evaluating the management effectiveness of marine protected areas. *Ocean & Coastal Management*, 48(7), 485-502. doi: <http://dx.doi.org/10.1016/j.ocecoaman.2005.05.004>
- Prabhakaran, S., Nair, V., & Ramachandran, S. (2013). Marine waste management indicators in a tourism environment: Exploring possibilities for Semporna District, Sabah. *Worldwide Hospitality and Tourism Themes*, 5(4), 365-376. doi: 10.1108/whatt-03-2013-0013
- Prato, T. (1999). Risk-based multiattribute decision-making in property and watershed management. *Natural Resource Modeling*, 12(3), 307-334.
- Radford, K. J. (1975). *Managerial decision making*. Reston, Va.: Reston Pub. Co.
- Ramanathan, R. (2001). A note on the use of the analytic hierarchy process for environmental impact assessment. *Journal of Environmental Management*, 63(1), 27-35.
- Ramanathan, R., & Ganesh, L. (1995). Energy resource allocation incorporating qualitative and quantitative criteria: an integrated model using goal programming and AHP. *Socio-Economic Planning Sciences*, 29(3), 197-218.
- Read, A. D., West, R. J., Haste, M., & Jordan, A. (2011). Optimizing voluntary compliance in marine protected areas: A comparison of recreational fisher and enforcement officer perspectives using multi-criteria analysis. *Journal of Environmental Management*, 92(10), 2558-2567. doi: 10.1016/j.jenvman.2011.05.022
- Reed, M. S. (2008). Stakeholder participation for environmental management: a literature review. *Biological Conservation*, 141(10), 2417-2431.
- Reid-Grant, K., & Bhat, M. G. (2009). Financing marine protected areas in Jamaica: An exploratory study. *Marine Policy*, 33(1), 128-136. doi: <http://dx.doi.org/10.1016/j.marpol.2008.05.004>
- Riedmiller, S. (2000). Private sector management of marine protected areas: the Chumbe Island case. *Collected Essays on the Economics of Coral Reefs*, 228-240.
- Roca, E., Gamboa, G., & Tàbara, J. D. (2008). Assessing the Multidimensionality of Coastal Erosion Risks: Public Participation and Multicriteria Analysis in a Mediterranean Coastal System. *Risk Analysis*, 28(2), 399-412. doi: 10.1111/j.1539-6924.2008.01026.x
- Rodriguez-Martinez, R. E. (2008). Community involvement in marine protected areas: The case of Puerto Morelos reef, Mexico. *Journal of Environmental Management*, 88(4), 1151-1160. doi: <http://dx.doi.org/10.1016/j.jenvman.2007.06.008>
- Rosenhead, J. (1989). Rational analysis for a problematic world : problem structuring methods for complexity, uncertainty, and conflict. Chichester [England]; New York: Wiley.
- Roy, B. (1991). The outranking approach and the foundations of electre methods. *Theory and Decision*, 31(1), 49-73. doi: 10.1007/bf00134132

- Saaty, R. W. (1987). The analytic hierarchy process - what it is and how it is used. *Mathematical Modelling*, 9(3), 161-176.
- Saaty, T. L. (1982). Decision making for leaders : the analytical hierarchy process for decisions in a complex world. Belmont, Calif.: Lifetime Learning Publications.
- Saaty, T. L. (1994). How to Make a Decision: The Analytic Hierarchy Process. *European Journal of Operational Research*, 24(6), 19-43. doi: 10.1287/inte.24.6.19
- Saaty, T. L. (2001). Decision making for leaders : the analytic hierarchy process for decisions in a complex world. Pittsburgh, PA: RWS Publications.
- Saaty, T. L., & Shang, J. S. (2011). An innovative orders-of-magnitude approach to AHP-based multi-criteria decision making: Prioritizing divergent intangible humane acts. *European Journal of Operational Research*, 214(3), 703-715.
- Sabah Parks. (2008, 6 March 2008). Community action for sustainable use and conservation of coral reefs. *SIDP News*.
- Sabah Parks. (2010). 2010 Annual Report: The Board of Trustees Sabah Parks (pp. 121): The Board of Trustees of The Sabah Parks.
- Sabah Parks. (2013). Marine Parks of Sabah. Retrieved 28 January, 2013, from <http://www.sabahparks.org.my>
- Sabah Parks. (2014). Visitor Arrival to Sipadan Island Park and Tun Sakaran Marine Park Between Year 2007-2013. (Unpublished Statistic).
- Shih, Y.-C., & Chiau, W.-Y. (2009). Planning a marine protected area at Chinwan, Penghu, Taiwan. *Ocean & Coastal Management*, 52(8), 433-438. doi: 10.1016/j.ocecoaman.2009.06.002
- Simanaviciene, R., & Ustinovichius, L. (2010). Sensitivity analysis for multiple criteria decision making methods: TOPSIS and SAW. *Procedia-Social and Behavioral Sciences*, 2(6), 7743-7744.
- Simon, H. A. (1957). Models of man: social and rational; mathematical essays on rational human behavior in society setting. New York: Wiley.
- Simon, H. A. (1982). *Models of bounded rationality*. Cambridge, Mass.: MIT Press.
- Simon, H. A. (2001). Rationality in Society. In J. S. Editors-in-Chief: Neil & B. B. Paul (Eds.), *International Encyclopedia of the Social Behavioral Sciences* (pp. 12782-12786). Oxford: Pergamon.
- Siskos, J., Wascher, G., & Winkels, H.-M. (1984). Outranking approaches versus MAUT in MCDM. *European Journal of Operational Research*, 16(2), 270-271.
- Spait, M. (2001). *Marine park management: issues and challenges*. Paper presented at the Sabah Parks. 6th SITE Research Seminar.
- Spenceley, A., Relly, P., Keyser, H., Warneant, P., McKenzie, M., Mataboge, A., . . . Seif, J. (2002). Responsible Tourism Manual for South Africa, Department for Environmental Affairs and Tourism, July 2002. *Responsible Tourism Manual for South Africa*, 2(3).
- Teddle, C., & Tashakkori, A. (2009). Foundations of mixed methods research : integrating quantitative and qualitative approaches in the social and behavioral sciences. Los Angeles: SAGE.
- Thur, S. M. (2010). User fees as sustainable financing mechanisms for marine protected areas: An application to the Bonaire National Marine Park. *Marine Policy*, 34(1), 63-69. doi: <http://dx.doi.org/10.1016/j.marpol.2009.04.008>
- Tobey, J., & Torell, E. (2006). Coastal poverty and MPA management in mainland Tanzania and Zanzibar. *Ocean & Coastal Management*, 49(11), 834-854. doi: <http://dx.doi.org/10.1016/j.ocecoaman.2006.08.002>

- Toloié-Eshlaghy, A., & Homayonfar, M. (2011). MCDM methodologies and applications: A literature review from 1999 to 2009. *Research Journal of International Studies*, 21, 86-137.
- Toropova, C., Meliane, I., Laffoley, D., Matthews, E., & Spalding, M. (2010). *Global ocean protection: present status and future possibilities*: IUCN.
- Torres, W. (2005). Voyages and ethnicity across reordered frontiers: conflict resolution and leadership in the dynamics of ethnic identity formation among the Sama Dilaut of Semporna. *Economic Prospects, Cultural Encounters and Political Decisions: Reconstructing Scenes in a Moving Asia (East and Southeast) The Work of the 2002/2003 API Fellows*. Sasyaz Holdings, Kuala Lumpur, 19-38.
- Triantaphyllou, E., & Lin, C.-T. (1996). Development and evaluation of five fuzzy multiattribute decision-making methods. *International Journal of Approximate Reasoning*, 14(4), 281-310. doi: [http://dx.doi.org/10.1016/0888-613X\(95\)00119-2](http://dx.doi.org/10.1016/0888-613X(95)00119-2)
- Triantaphyllou, E., & Mann, S. H. (1989). An examination of the effectiveness of multi-dimensional decision-making methods: A decision-making paradox. *Decision Support Systems*, 5(3), 303-312. doi: [http://dx.doi.org/10.1016/0167-9236\(89\)90037-7](http://dx.doi.org/10.1016/0167-9236(89)90037-7)
- Trist, C. (1999). Recreating ocean space: recreational consumption and representation of the Caribbean marine environment. *The Professional Geographer*, 51(3), 376-387.
- Tsai, W.-H., Leu, J.-D., Liu, J.-Y., Lin, S.-J., & Shaw, M. J. (2010). A MCDM approach for sourcing strategy mix decision in IT projects. *Expert Systems with Applications*, 37(5), 3870-3886.
- Vagias, W. M. (2006). Likert-type scale response anchors. Clemson International Institute for Tourism & Research Development, Department of Parks, Recreation and Tourism Management. Clemson University.
- Vaidya, O. S., & Kumar, S. (2006). Analytic hierarchy process: An overview of applications. *European Journal of Operational Research*, 169(1), 1-29. doi: <http://dx.doi.org/10.1016/j.ejor.2004.04.028>
- Vanderpooten, D. (1989). The interactive approach in MCDA: A technical framework and some basic conceptions. *Mathematical and Computer Modelling*, 12(10), 1213-1220. doi: 10.1016/0895-7177(89)90363-4
- Vasconcelos, L., Pereira, M. J. R., Caser, U., Goncalves, G., Silva, F., & Sa, R. (2013). MARGov, Setting the ground for the governance of marine protected areas. *Ocean & Coastal Management*, 72, 46-53.
- Velasquez, M., & Hester, P. T. (2013). An analysis of multi-criteria decision making methods. *International Journal of Operations Research*, 10(2), 56-66.
- Voyer, M., Gladstone, W., & Goodall, H. (2012). Methods of social assessment in Marine Protected Area planning: Is public participation enough? *Marine Policy*, 36(2), 432-439.
- Walley, C. J. (2010). *Rough waters: nature and development in an East African marine park*: Princeton University Press.
- Wang, J.-J., Jing, Y.-Y., Zhang, C.-F., & Zhao, J.-H. (2009). Review on multi-criteria decision analysis aid in sustainable energy decision-making. *Renewable and Sustainable Energy Reviews*, 13(9), 2263-2278.
- Wang, X., & Triantaphyllou, E. (2008). Ranking irregularities when evaluating alternatives by using some ELECTRE methods. *Omega*, 36(1), 45-63. doi: <http://dx.doi.org/10.1016/j.omega.2005.12.003>

- Wang, Y.-M., Yang, J.-B., & Xu, D.-L. (2005). A two-stage logarithmic goal programming method for generating weights from interval comparison matrices. *Fuzzy Sets and Systems*, 152(3), 475-498.
- Warner, T. E., & Pomeroy, R. S. (2012). Creating compliance: A cross-sectional study of the factors associated with marine protected area outcomes. *Marine Policy*, 36(4), 922-932. doi: <http://dx.doi.org/10.1016/j.marpol.2012.01.003>
- Wattage, P., & Mardle, S. (2005). Stakeholder preferences towards conservation versus development for a wetland in Sri Lanka. *Journal of Environmental Management*, 77(2), 122-132. doi: 10.1016/j.jenvman.2005.03.006
- Wescott, G. (2006). The long and winding road: the development of a comprehensive, adequate and representative system of highly protected marine protected areas in Victoria, Australia. *Ocean & Coastal Management*, 49(12), 905-922.
- White, A. T. (1986). Marine reserves: how effective as management strategies for Philippine, Indonesian and Malaysian coral reef environments? *Ocean Management*, 10(2), 137-159.
- White, A. T., Hale, L. Z., Renard, Y., & Cortesi, L. (1994). Collaborative and community-based management of coral reefs: lessons from experience: Kumarian Press Inc.
- Wong, J. K., & Li, H. (2008). Application of the analytic hierarchy process (AHP) in multi-criteria analysis of the selection of intelligent building systems. *Building and Environment*, 43(1), 108-125.
- Wood, E. (2001). Semporna Island Management Plan (Draft) (pp. 168).
- Wood, E. (2006). Sustainable Use and Conservation of Biodiversity in the Tun Sakaran Marine Park: Action Plan and Proposed Regulations. Sabah Parks.
- Wu, H.-Y., Chen, J.-K., Chen, I.-S., & Zhuo, H.-H. (2012). Ranking universities based on performance evaluation by a hybrid MCDM model. *Measurement*, 45(5), 856-880.
- Yang, C.-M., Li, J.-J., & Chiang, H.-C. (2011). Stakeholders perspective on the sustainable utilization of marine protected areas in Green Island, Taiwan. *Ocean & Coastal Management*, 54(10), 771-780. doi: <http://dx.doi.org/10.1016/j.ocecoaman.2011.08.006>
- Yeo, B. (2004). The recreational benefits of coral reefs: A case study of Pulau Payar Marine Park, Kedah, Malaysia. *Economic valuation and policy priorities for sustainable management of coral reefs*, 108-117.
- Yoder, D. E. (1999). A contingency framework for environmental decision making. *Review of Policy Research*, 16(3), 11-35.
- Zabeo, A., Pizzol, L., Agostini, P., Critto, A., Giove, S., & Marcomini, A. (2011). Regional risk assessment for contaminated sites Part 1: Vulnerability assessment by multicriteria decision analysis. *Environment International*, 37(8), 1295-1306.
- Zey, M. (1992). Decision making : alternatives to rational choice models. Newbury Park, Calif.: Sage.