Ensuring local stakeholder support for marine conservation: establishing a locally-managed marine area network in Aceh

A. Syakur, J. T. Wibowo, F. Firmansyah, I. Azam and M. Linkie

Abstract Multidisciplinary approaches to managing seascapes are increasingly being recognized as best practice and therefore prioritized by conservation agencies. For most coastal areas the strengthening of customary marine tenure, rules and regulations should yield even greater biodiversity and livelihood benefits. Here, we present the conservation planning results from a locally-managed marine area programme initiated by the Government of Aceh, Indonesia, which aimed to empower coastal communities to sustainably and equitably manage marine resources with local government. In 2008 the government established a Marine and Fisheries Task Force to identify priority areas for marine biodiversity (through systematic conservation planning) and coastal communities (through participatory planning). In addition to the existing 264,788 ha of marine management units, systematic planning identified another 53,372 ha. However, the subsequent stakeholder participation phase, involving intensive local consultations, further expanded the locally-managed marine area network by 6,725 ha and to a total of 23 locally-managed marine areas. This combined approach had additional benefits because it generated a strong sense of local ownership. For communities it initiated a process for recognizing their customary claimed areas and resolved overlapping boundaries between neighbouring communities, thereby reducing the likelihood of future conflicts over natural resource use. For government, it provided the basis of a robust governance system, with 34 new or revised decrees being completed and an additional USD 1.6 million being allocated for implementation of locally-managed marine areas. This participatory approach should considerably increase the successful delivery of a sustainable and equitable locally-managed marine area network for Aceh, which has wide application for the South-east Asian region and beyond.

Keywords Aceh Green, *CLUZ*, community-based, conservation planning, marine protected area, *Panglima Laot*, social learning networks

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Introduction

The world's oceans are under threat: coral reefs have suffered widespread mortality (Hughes, 1994; Carpenter et al., 2008), marine fish catches are declining (Pauly et al., 2002), and large marine predators are likely to undergo disproportionately severe declines in the future (Jenkins, 2003). These threats are predicted to have subsequent impacts, such as lowering coral reef resilience to natural and human-induced disturbances (Bellwood et al., 2004). To reverse these negative patterns and their human-induced threats, substantial national and international efforts, especially over the past decade, have led to the establishment of marine protected areas (Wood et al., 2008).

Marine protected area networks zone the oceans into areas where fishing is either prohibited or limited to support sustainable fishing and/or increased management of marine ecosystems and their biodiversity. Several meta-analyses have demonstrated the success of marine protected areas in protecting fish populations (Molloy et al., 2009; Babcock et al., 2010) but not in improving coral cover (Hargreaves-Allen et al., 2011). The effective management of marine species and their habitats requires a multidisciplinary approach that combines biological, socio-economic and governance aspects (Hughes et al., 2005). Recent approaches to the design of marine reserve networks have shown the benefits of conservation planning (Stewart & Possingham, 2005; Game et al., 2008). This has great importance to the global marine reserve network that, at present, provides insufficient coverage for protecting the world's coral reefs (Mora et al., 2006).

The most commonly performed types of conservation planning analyses involve the systematic use of thematic data layers (e.g. biodiversity, threat and socio-economic) to identify priority areas (planning units) in need of increased management, such as the designation of a new protected area or boundary expansion of an already existing area (Smith et al., 2008). Unfortunately, most recommendations made through these planning exercises fail to immediately translate into conservation action, if at all (Knight et al., 2008). Furthermore, systematic conservation analyses do not always take into account the perspective of local stakeholders and the greater conservation gains that could be achieved if they did (Klein et al., 2008). Thus, stakeholder participation, which enables the outputs of a systematic assessment to be discussed and further developed with a

wider stakeholder network, should increase local support for and therefore sustainability of the final management units identified and increase the likelihood of their implementation (Knight et al., 2006; Knight & Cowling, 2007; Hill et al., 2010).

Adopting a combined systematic conservation planning–stakeholder participation approach has benefits for the development and implementation of locally-managed marine areas (Game et al., 2011), especially where traditional claims by communities often exist over government controlled areas. Locally-managed marine areas aim to establish a system that grants complete or significant management rights to coastal communities, rather than the top-down central government system that is sometimes used for management of marine protected areas. Thus, locally-managed marine areas that legally recognize customary fishing areas and incorporate customary rules and regulations into the governance system are more likely to be accepted and their laws adhered to by local communities (Campbell et al., this issue; Wilson & Linkie, this issue).

A comprehensive planning approach for locally-managed marine areas has particular relevance to the biodiversity-rich province of Aceh, Indonesia, where 21% of the population lives by the coast and have significant interaction with its coral reefs. In 2008 the Government of Aceh launched its innovative strategy for achieving sustainable economic development across the province (UNDP, 2008). Within the so-called Aceh Green Initiative a Task Force was specifically created for the marine and fisheries sector, chaired by the government's Marine and Fisheries Agency. One of the key roles of the Task Force was to develop a comprehensive marine management network for Aceh that met both biodiversity targets and coastal community aspirations.

In this study we (1) compile data on important components of marine biodiversity, (2) set representation targets for each of these conservation features, (3) conduct a systematic conservation planning analysis using *MARXAN* software to identify the potential management units that meet these targets, (4) conduct a participative planning analysis through stakeholder consultations and revise the management units accordingly, and (5) begin the process of implementing the identified locally-managed marine areas.

Study area

The marine protected area network in Aceh province consists of two marine tourism parks, one in Sabang (5,294 ha) and the other in Pulau Banyak (203,396 ha), both established by the Government of Indonesia and managed by the Natural Resource Management Agency, which operates under the Indonesian Ministry of Forestry. There are a further four marine protected areas that are managed by the Government of Aceh's Marine and Fisheries Agency.

The concept of a locally-managed marine area offers a new marine and coastal management paradigm. The governance system of these areas would differ from Aceh's existing marine protected areas because they would support co-management between district government and communities. In turn, this would recognize traditional claims over marine and coastal areas, which is currently lacking in Aceh. It would also enable the enforcement of customary rules and regulations over natural resource use (e.g. prohibiting destructive practices such as fishing with spear gun, poison and dynamite) alongside government laws. In this study we focus on the 18 coastal districts of Aceh, of which eight districts were initially prioritized by the provincial government based on their importance for coral reef and sea grass conservation, which are predominantly located in these districts, and on their management capacity to immediately implement the locally-managed marine areas.

Methods

The priority setting analysis for the locally-managed marine area network was conducted by the Marine and Fisheries Task Force through several key stages: compilation of existing datasets and creation of new datasets, systematic planning using these datasets, and participatory stakeholder planning through district and village level consultations (Fig. 1).

Systematic planning analyses

The spatial data were divided into conservation and cost datasets (Table 1). These data were obtained from various sources (Government of Aceh Geospatial Data Centre, Aceh Marine and Fisheries Agency, and Fauna & Flora International, FFI). The conservation data consisted of information on the distribution and/or abundance of coral reefs, mangroves and sea grasses. The coral reef and sea grass spatial coverages were obtained by interpreting remotely sensed data images from 10 Landsat 7 images at a resolution of 30 m for 2000–2002. Coral reef condition was determined from ocean surveys conducted in 2009 by FFI, the University of Syiah Kuala and a local NGO, which used the Reef Check method (F. Firmansyah et al., unpubl. data). Mangrove coverage was obtained from a province-wide survey conducted by the Government of Aceh Geospatial Data Centre in 2006 (BRR-NAD Nias, 2007).

The cost data were obtained from a Government of Aceh initiative that used a combination of questionnaire surveys and community participative mapping conducted during September–December 2009 (Firmansyah, 2010). Data were generated from 495 respondents in 148 coastal villages covering nine western and northern coastal districts. The questionnaire survey sought to obtain data on fishing

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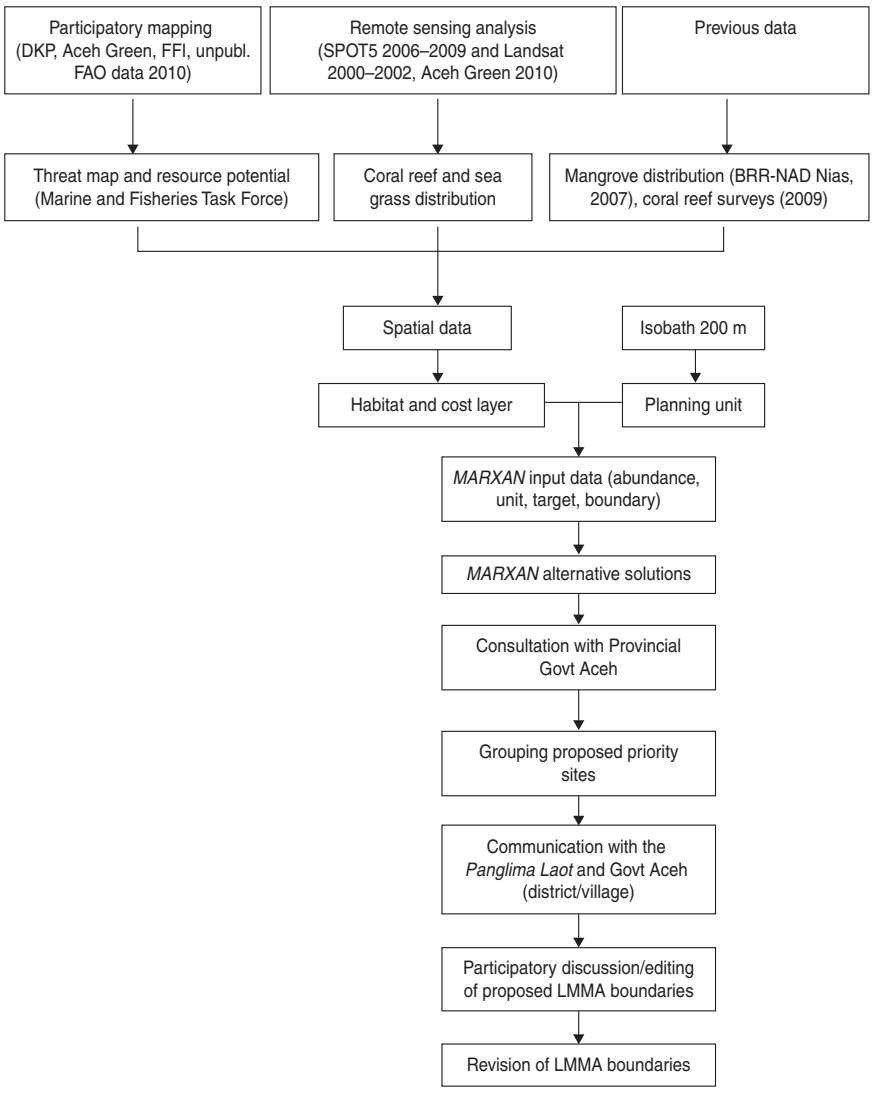

FIG. 1 Flow chart of locally-managed marine area prioritization in Aceh (see text for details).

offtake (quantity and location of fish caught, as well as the gear used) and on destructive fishing practices (dynamite and poisoning) for the planning units.

The spatial data used for the design of the locally-managed marine areas were analysed using the conservation planning software *MARXAN*, which is spatially explicit and uses simulated annealing to optimize the trade-offs between cost and benefit data (Ball & Possingham, 2000). The dataset was imported into *MARXAN* using the *CLUZ* (Conservation Land Using Zoning) extension for *ArcView* (Smith, 2004). *MARXAN* was used to identify a near-optimal set of planning units (portfolios) in which three alternative scenarios (reflecting varying priorities) for Aceh were identified.

During a multi-stakeholder workshop conducted in April 2010 the target of protecting 20% of the marine biodiversity was developed. It was decided that the design of the locally-managed marine areas should consider economic, social and scientific values, practicality, biogeographical representation, habitat heterogeneity representation, rejection criteria and size of the location.

The conservation target and species penalty factor used to generate three scenarios (A, B and C, each with a different design) were set, respectively, to include 20% of the marine biodiversity and 100 for each conservation feature. The boundary length modifier varied with the different scenarios (A, 0.1; B, 10; C, 100). Equation (1) provides the algorithm that was run three times and for 1,000,000 iterations (Watts et al., 2008),

$$\text{Objective function} = \sum \text{Cost} + (\text{BLM} * \sum \text{Boundary}) + \sum (\text{SPF} * \text{Penalty}), \quad \text{(Equation 1)}$$

where Cost is the value that was chosen and could be measured, BLM is the boundary length modifier, which controls the importance of the boundary length relative to the cost of the selected units (if it is zero then the boundary

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TABLE 1 Data layers used in the systematic conservation planning analysis. For further details of the questionnaire surveys, see text.

Habitat layer (by feature)	Data source	Description
Conservation		
Mangrove	Provincial spatial plan survey (BRR-NAD Nias, 2007)	Data obtained from Aceh spatial plan, as a point shapefile, on location & distribution of mangroves across entire province
Sea grass	Landsat imagery (2000–2002)	Polygon shapefile of sea grass created from satellite imagery
Coral reef	Landsat imagery (2000–2002) and marine surveys (2008–2009)	Polygon shapefile created from satellite imagery and point shapefile created from FFI scuba-diving surveys
Cost		
Fishing offtake	Questionnaire survey	Polygon data created using a 1 km buffer from the coast; fishing offtake data obtained from *Lhok* (smallest administrative unit) or subdistrict level questionnaire survey
Fishing gear	Questionnaire survey	Polygon data created using a 1 km buffer from coast; fishing gear data obtained from *Lhok* or subdistrict level questionnaire survey
Destructive fishing practices	Questionnaire survey	Polygon data created using a 1 km buffer from coast; destructive fishing practices data obtained from *Lhok* or subdistrict level questionnaire survey

length is not considered), Boundary is the perimeter or selected boundary area (i.e. planning unit), SPF is the species penalty factor (the parameter that controls the penalty value if a target could not be reached; the value originally assigned was 100 but this was found to have no influence and so was reduced to 0.01), and Penalty is the value that is added to the objective function for every target that is not met (i.e. not adequately representing the conservation features).

Within the *MARXAN* analysis study there were 2,947,635 ha. A total of 32,180 planning units were used in the analysis, with each unit being hexagonal and having an area of c. 100 ha. These planning units already had 8.53% of their area within existing government marine conservation areas (as demarcated in the provincial spatial plan) and were therefore set as already being conserved. The three alternative scenarios generated by *MARXAN* were presented to the Aceh Marine and Fisheries Agency and discussed in detail during a regional workshop held in April 2010. From this, the Agency chose one scenario to become the priority locally-managed marine area network for Aceh.

Stakeholder participation

To engage with the local stakeholders from the eight priority districts the Aceh Marine and Fisheries Agency, with support from FFI, first explained the objectives of its locally-managed marine area programme and then presented the network design that was generated by the systematic planning analysis. Once it was felt that there was a clear understanding of the programme the Agency conducted public consultations with coastal communities (represented by the village head and/or traditional leader), fishermen's group representatives (including the *Panglima Laot*, the name given to both the traditional marine resource management institution and its leader), Provincial and District Marine and Fisheries Agencies, district government, and other local stakeholders, such as women's groups and religious leaders. These stakeholder groups were provided with maps of the locally-managed marine areas for their region. Maps were printed on A1 paper to enable greater interaction, such as drawing on the maps, during discussions. Based on the customary laws, daily usages and other stakeholder needs identified in and around these areas, further modifications to the location, size and shape of locally-managed marine areas were made.

There was not always complete agreement amongst the stakeholders after the first round of discussions. For example, in Simeulue the proposed introduction of restrictions on certain types of fishing gear, such as compressors, raised concerns amongst its user group. In such an instance further meetings were then held and this provided an unforeseen opportunity to raise conservation awareness and create a better understanding of the anticipated benefits of locally-managed marine areas (for example, the detrimental impact of prohibited fishing gear). Discussions continued until the revised maps for each district and associated management rules had been agreed upon by the various stakeholder groups.

Results

Systematic planning

The current marine area network in Aceh consists of eight districts that cover a total of 264,788 ha. From the three scenarios the planning units identified by *MARXAN* ranged from 47,952 ha (Scenario A) to 63,692 ha (B) to 72,101 ha (C; Table 2). Based on expert advice and the priorities of the Aceh Marine and Fisheries Agency, Scenario C was selected

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TABLE 2 *MARXAN* calculation for locally-managed marine area networks under three priority setting scenarios.

Scenario	Score[1]	Cost[2]	No. of planning units	Boundary length (m)	Selected area (ha)
A	10,011,135	3,543	1,016	1,000,759	47,952
B	104,377,621	3,661	909	1,043,740	63,692
C	98,128	2,943	771	951,852	72,101

[1]Combined score for the cost, boundary length and penalty factors
[2]The cost layer was calculated by weighting and combining data on fishing gear, destructive fishing and fishing offtake for each planning unit

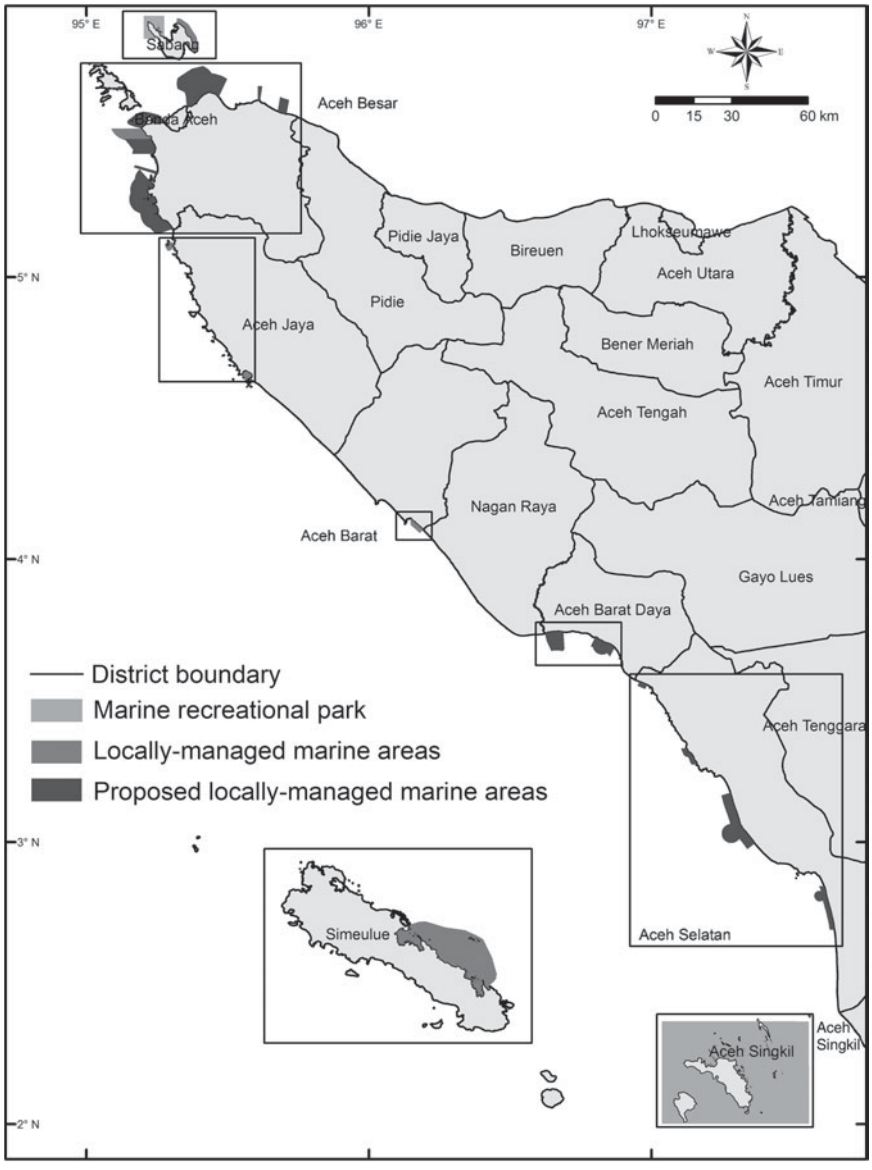

FIG. 2 Locations of the eight priority locally-managed marine areas (Table 4) in Aceh.

by the Government of Aceh as the basis for the proposed locally-managed marine area network. This network is along the west and east coast and had good representation of the coastal and marine ecosystems (Fig. 2; Table 3). The network covers 2% of the total planning units used and overlapped with 34,255 ha of the existing network.

Based on discussions with the Aceh Marine and Fisheries Agency the locally-managed marine areas proposed by the systematic planning analysis were equal to an area of 72,101 ha, of which 61,544 ha was located within the eight priority districts. The proposed locally-managed marine areas in Scenario C overlapped with 34,255 ha of the existing marine protected areas, which were located in the districts of Aceh Besar and Simeulue (established by district government in 2006 and 2010, respectively) and Singkil (a Marine Tourism Park that was established by a Ministerial Decree in 1996).

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TABLE 3 Conservation value of marine planning units in Aceh based on the outputs of Scenario C in the *MARXAN* analysis (Table 1).

Conservation value	No. of planning units	Area (ha)	% of planning region
High conservation value	79	6,573	0.22
Medium conservation value	495	41,867	1.42
Low conservation value	1,085	86,395	2.93
Not selected	30,521	2,812,800	95.43

TABLE 4 Summary of the final locally-managed marine area (LMMA[1]) design for Aceh.

	Existing MPA[2]		Systematic proposed LMMA[3]		Stakeholder proposed LMMA[4]		Intersection[5]	New LMMAs
District	No.	ha	No.	ha	No.	ha	(ha)	planned (ha)
Sabang[6]	2	8,508	1	17	2	8,508		0
Aceh Besar	1	4,904	4	1,161	16	56,802	332	828
Aceh Jaya	2	139	3	2,466	2	1,613		1,472
Aceh Barat	1	1,105	2	298	1	1,105		0
Aceh Barat Daya	0		2	100				100
Aceh Selatan	0		3	4,325				4,325
Simeulue	1	46,735	4	30,109	1	46,735	12,913	0
Singkil	1	203,397	2	23,068	1	203,397	21,010	0
Total	8	264,788	21	61,544	23	318,160	34,255	6,725

[1]LMMA is a new terminology proposed under the revised Government of Aceh draft spatial plan
[2]Marine Protected Area (MPA) is the terminology previously used under the current Government of Aceh spatial plan (BRR-NAD Nias, 2007)
[3]Systematic proposed LMMAs are the result of the *MARXAN* conservation planning analysis
[4]The stakeholder proposed LMMAs for the districts of Aceh Barat Daya and Aceh Selatan are still under discussion and a final consensus has not yet therefore been reached
[5]Between existing MPAs & systematic proposed LMMAs
[6]Municipality

Scenario C increased the number of marine protected areas from eight (based on the existing government terminology) to 21 locally-managed marine areas (based on the terminology revision proposed by the provincial government).

Stakeholder participation

In 20 meetings in eight districts, with 198 participants representing 11 community and government organizations, the results of the systematic planning analysis were well-received by both the government and community stakeholders. The meeting discussions led to the proposed network being expanded from eight (Scenario C) to 23 locally-managed marine areas and, likewise, from 61,544 ha (Scenario C) to 318,160 ha (existing = 264,788 ha and proposed = 53,372 ha; Fig. 2; Table 4).

Discussion

Indonesia's marine and coastal areas have undergone dramatic changes recently, as illustrated by its coral reefs (50% degradation over the last 50 years; P2O LIPI, 2006) and mangrove forests (52% clearance over the last 10 years; Wiryawan et al., 2005). In response, the government has set an ambitious target to expand its marine management areas from 14 million to 20 million ha by 2020 (KP3K KKP, 2011). Our study has demonstrated how a locally-managed marine area network can be established with diverse stakeholder support and government funding. In the first comprehensive conservation planning analysis for Aceh an additional 53,372 ha of priority areas were identified for inclusion within the current marine management area of 264,788 ha. All of these proposed management units were agreed by the local stakeholders who, following a process of participatory consultation and refinement, gave a firm commitment to the implementation of the proposal and also requested an additional 6,725 ha for incorporation into the network. In response, the government of Aceh made 34 new or revised decrees, with a further two decrees under legal review, to facilitate the co-management of these locally-managed marine areas through community-government partnerships. The participatory stakeholder approach brought rigour to bear in the design process and its achievements represent a critical step in ensuring the sustainability of Aceh's marine environment and coastal economy.

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MARXAN analysis

The Aceh conservation planning analysis might have been improved by incorporating more datasets, such as economics, biodiversity, ecological process and habitat risk (Linkie et al., 2004; Stewart and Possingham, 2005) to refine targets and identify more cost-effective locally-managed marine areas. However, there is a trade-off between providing more refined information and scenario analyses, or 'mental models', to inform communities and governments about the principles that may be sufficient for good decision making (e.g. Knight et al., 2010; Biggs et al., 2011). In Aceh a substantial effort would have been required to accumulate such province-wide datasets and this would have slowed and complicated the establishment process of locally-managed marine areas. Considering that the critically important marine habitats (coral reef, sea grass and mangrove forest) were all included in the *MARXAN* analysis, the provincial governor election scheduled for the end of 2011 (which could result in a complete change of Agency heads and political support for the programme), and the current head of the Marine and Fisheries Agency committing USD 1.6 million for implementation, the risks of delay would not have outweighed the benefits of incorporating additional datasets or refining current datasets.

Stakeholder engagement and implementation of locally-managed marine areas

A shortcoming identified in many conservation planning analyses is that they either fail to be implemented or influence actions on the ground because they were purely academic exercises never intended to be applied, or they lacked stakeholder support (Knight et al., 2008). The approach taken in our study overcame this by including a distinct consultation phase in which the main stakeholders were fully engaged. The workshops run by provincial government at the district and village levels were effective in obtaining both district government and coastal community support.

In Indonesia district governments are key stakeholders in the implementation of locally-managed marine areas because decentralization has granted the districts greater autonomy in designing and spending their own budgets and developing spatial plans. To obtain strong district government support it was important that the conservation planning process, although conducted at the provincial level, was not perceived as a top-down approach. Several examples demonstrate that this did not occur. The Government of Aceh Besar used the *MARXAN* results as the basis of a community conservation awareness campaign that resulted in the addition of 15 locally-managed marine areas. The governments of Aceh Jaya and Simeulue revised their current locally-managed marine area network to incorporate the identified priority areas fully. In Aceh Barat, Aceh Barat Daya and Aceh Selatan, where the last workshops were conducted, the respective governments agreed to adopt their new conservation management units, with an anticipated final designation of locally-managed marine areas in 2012. The government of Aceh Barat is currently leading discussions with its communities to reach a joint agreement for the design and implementation of a locally-managed marine area.

To obtain the support of the coastal community the project acknowledged the importance of working with the *Panglima Laot* and, as has proven to be successful elsewhere in Aceh (Wilson & Linkie, 2012), this created an enabling environment for meaningful community participation. Another encouraging aspect of the project was the eagerness of all communities to bring neighbouring communities into discussions over boundary demarcation, thus resolving in advance any disputes between neighbouring communities regarding overlapping boundaries. This proved to be an effective conflict resolution mechanism, which was assisted by the *Panglima Laot* and, for example, led to many locally-managed marine areas subsequently incorporating specific zones to accommodate their neighbours' needs, such as travel routes. It also secured community support for the broader locally-managed marine area network, rather than for just individual areas.

In the consultation workshops the most community requests for modification of the locally-managed marine areas involved their expansion, based on several socio-economic factors. The community felt that managing one large unit instead of several smaller ones would be more efficient and provide more adequate coverage for economically important marine species such as shrimp, grouper, jacks and mackerel, and protection against their illegal exploitation by international fishing vessels. In Aceh Jaya district the focal communities were also keen to develop their locally-managed marine areas in accordance with the district government's tourism plan.

The alacrity of local stakeholder support for locally-managed marine areas and their co-implementation with local government was exemplified by the large number of policies subsequently developed after the workshops. In total 32 new decrees (ranging from boundary demarcation to management rules) were signed, two former decrees revised and two are currently being drafted (28 at village/subdistrict, five at district and three at provincial level) by local government with the coastal communities. For example, the Pulau Salapan Decree was brought into effect through its signing by the subdistrict's customary leaders 3 weeks after their consultation workshop. For the first time this codified the local laws that must be adhered to by anyone entering the coastal waters of this subdistrict. It also established a punishment system through fines and equipment confiscations for those violating these laws. For all

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community stakeholders a principal benefit was the demarcation of their hitherto unrecognized customary areas. For district governments that were tasked with managing these same areas the new-found community optimism provided a new and satisfactory working model.

Social learning networks

From the outset a central project aim was sustainability. FFI therefore provided technical support and limited logistical support for community workshops, printing maps and field travel. This was important for ensuring that the initiative did not become donor dependent. It also meant that FFI did not set the conservation agenda but rather supported the agenda set by the Aceh Marine and Fisheries Agency, thereby making the locally-managed marine areas more legitimate and politically palatable (Rodriguez et al., 2007).

A recent call for establishing social learning institutions (Smith et al., 2009, but see Gardner, 2012) that bring together local and international conservationists and researchers for achieving improved conservation outcomes was facilitated by the multi-stakeholder Marine and Fisheries Task Force. Thus, expenditure of the funding obtained by FFI was coordinated by the Aceh government and used, for example, to bring in researchers to perform the technical work, such as *MARXAN* analysis, that could not be sourced internally. In such instances technical training was also provided to the relevant partners, which besides building their conservation capacity created a better understanding and interest in the conservation planning analysis and its relevance for Aceh. Social learning networks and the combined conservation planning approach conducted in this study have potentially wide-reaching benefits for marine conservation, as well as for management of terrestrial protected areas.

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