

# Establishing freshwater protected areas to protect biodiversity and improve food security in the Philippines

**Jan van der Ploeg**

*WorldFish, Solomon Islands and Mabuwaya Foundation, Philippines*

**Lien Vermeersch**

*Leiden University, the Netherlands*

**Dominic Rodriguez**

*Mabuwaya Foundation and Isabela State University, Philippines*

**Marites Balbas**

*Mabuwaya Foundation, Philippines*

**Merlijn van Weerd**

*Leiden University, the Netherlands and Mabuwaya Foundation, Philippines*

## INTRODUCTION

Wild-caught freshwater fish is an important source of food in the Philippines (Briones, Dey and Ahmed, 2004; Fernandez-San Valentin and Berja, 2012). Particularly the rural poor depend heavily on inland fisheries (Kent, 1997; Dey *et al.*, 2007). However, freshwater fish stocks in the Philippines are declining alarmingly, which threatens to aggravate food insecurity of already vulnerable households (BFAR, 2005). Overexploitation, invasive species, pollution and rapid land-use transitions have led to a severe decline in freshwater biodiversity (Kottelat and Whitten, 1996; Dudgeon *et al.*, 2006). Freshwater wetlands are the most degraded ecosystems of the Philippines (DENR and UNEP, 1997). Endemic freshwater fish species are highly threatened (de Silva, Abery and Nguyen, 2007). Waterbirds are facing similar pressures (van Weerd and van der Ploeg, 2004a). The Philippine crocodile (*Crocodylus mindorensis*) perhaps best symbolizes the state of freshwater ecosystems in the archipelago. With less than 250 mature individuals surviving in the wild, this endemic species is classified as critically endangered on the IUCN Red List (van Weerd, 2010). The Philippine crocodile might well be the first crocodylian that will go extinct as a result of anthropogenic activities.

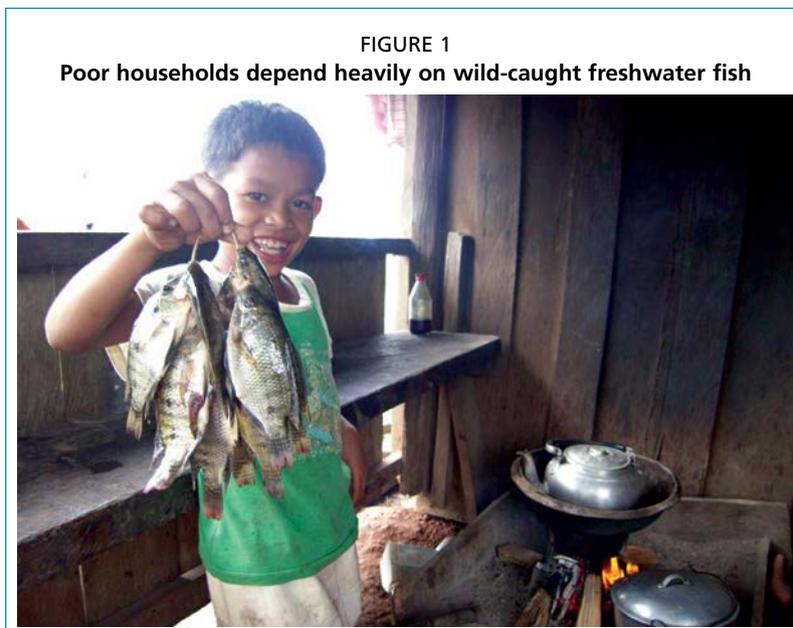
Unfortunately, little is done to address these problems. Policy-makers tend to undervalue the importance of wild-caught freshwater fish as a source of food for poor rural households (Dugan, Dey and Sugunan, 2005; Andrew *et al.*, 2007). The Department of Agriculture for example, the mandated government agency for fisheries management, focuses mainly on marine fisheries and commercial aquaculture (Green *et al.*, 2003). Similarly, the value of freshwater ecosystems is often overlooked (Darwall *et al.*, 2008). Wetlands are poorly represented in the Philippine national protected

area system (PAWB, 2013). Moreover, the Department of Environment and Natural Resources lacks the capacity and resources to enforce environmental legislation on the ground (World Bank, 2003). Solutions for the Philippine freshwater biodiversity crisis, therefore, have to be found at the grassroots level.

This paper describes the efforts to establish a network of community-conserved areas in the municipality of San Mariano on Luzon, with the dual aim to protect the Philippine crocodile and to improve inland fisheries. The necessary steps to establish a community-conserved area are summarized, and their sustainability assessed. The importance of local leadership and democratic decision-making processes in the design of community-based conservation measures is highlighted, and it is argued that implicit cultural values, such as hospitality and respect, are often a more important motivation for rural communities to protect aquatic resources than explicit concerns about food security and livelihoods.

### PROJECT AREA

San Mariano ranks among the poorest municipalities of the Philippines: 60 percent of the population lives on less than US\$2 per day and 18 percent of children below ten years of age is malnourished (LGU San Mariano, 2010). Wild-caught freshwater fish forms an important, but undervalued, source of food for rural households. Table 1 provides an overview of the most common fish species in this remote area. Nile tilapia (*Oreochromis niloticus*), introduced in the Philippines in 1972, is by far the most commonly caught species. Catch data from eight villages in San Mariano show that as much as 85 percent of total yield is derived from introduced fish species (Engelhart, 2009). This is an indication of the unprecedented ecological changes that Philippine freshwater ecosystems have undergone over the past 70 years. Native species such as Giant mottled eel (*Anguilla marmorata*) are highly valued by fishers but have largely disappeared from most rivers. Freshwater shrimps (*Macrobrachium lar*) have also become rare.



Source: Photo courtesy of Jan van der Ploeg.

People use a variety of fishing methods to catch fish: traps (*bubu*), fykes (*bukatot*), hooks (*baniit*), harpoons (*panna*) and nets (*sigay*). Spearfishing is the most common method. In more turbid waters, people use dragnets or throw nets (*tabukol*). Nets are generally the most effective fishing method in terms of catch per unit effort, but require a substantial capital investment. In shallow rivers people build large fish traps of stones or bamboo (*sarit*). Rice fields and ponds are regularly drained to harvest fish by hand (*makkammil*).

In most villages there are no rules limiting access or prohibiting specific fishing methods: fishers can catch anything, anywhere, with any method and as much as they like. To catch large amounts of fish people make bombs out of old gin bottles, fertilizer and kerosene, and then detonate these bombs underwater (*babantu* or *bung bong*). People also use 12-volt batteries to stun fish and shrimps at night (*kuryente*), or use

pesticides to poison fish. In theory, these destructive fishing methods are prohibited by law (Fisheries Code of the Philippines – Republic Act 8550). But in practice the rule of law means very little in these remote, rural areas: in many villages, dynamite is openly used when people need a lot of fish, such as during funerals, feasts or the end of the Lent season.

Most people in San Mariano fish for subsistence, or barter wild-caught fish with other people in their village. There is little information available on the importance of freshwater fish in local diets. Exploratory research suggests that wild-caught freshwater fish provides on average 12 percent of daily protein intake of rural households, based on 8.3 grams per person per day (van Velzen, 2013). Especially poor households rely heavily on this “free” resource, in some cases providing as much as 30 percent of daily protein intake.

The freshwater ecosystems of San Mariano harbour a rich variety of wildlife, including the Philippine crocodile. Previously thought to be extinct in the wild on Luzon, a small and fragmented population was discovered in the municipality in 1999 (van Weerd and van der Ploeg, 2004b). In 2003, the Mabuwaya Foundation was founded to protect the iconic species in the wild (van Weerd and van der Ploeg, 2012). Five breeding sites were identified in the municipality: Dicamay River, Dinang Creek, Disulap River, Dunoy Lake and Narra Lake (indicated in green in Figure 1). An intensive education campaign has successfully stopped hunting of the species, but the reclamation of wetlands and the use of destructive fishing methods continue to pose a significant threat to the Philippine crocodile population in San Mariano (van der Ploeg *et al.*, 2011a; Cureg *et al.*, 2016).

Over the past ten years, the Mabuwaya Foundation has aimed to establish a network of freshwater protected areas (PAs) in San Mariano. The underlying idea is that these freshwater PAs can simultaneously protect crocodiles and improve food security of the rural poor: the creation of a no-take zone allows fish stocks to recover, thereby increasing overall yields (Leisher *et al.*, 2010). This “spillover” effect has been demonstrated in several marine PAs in the Philippines, which have since then proliferated in the archipelago (Pollnac, Crawford, and Gorospe, 2001; Alcala and Russ, 2006). Very little is actually known about the dynamics, productivity and resilience of wetlands in the Philippines, but the creation of a freshwater PA seems a wise precautionary step (Johannes, 1998; Suski and Cooke, 2007).

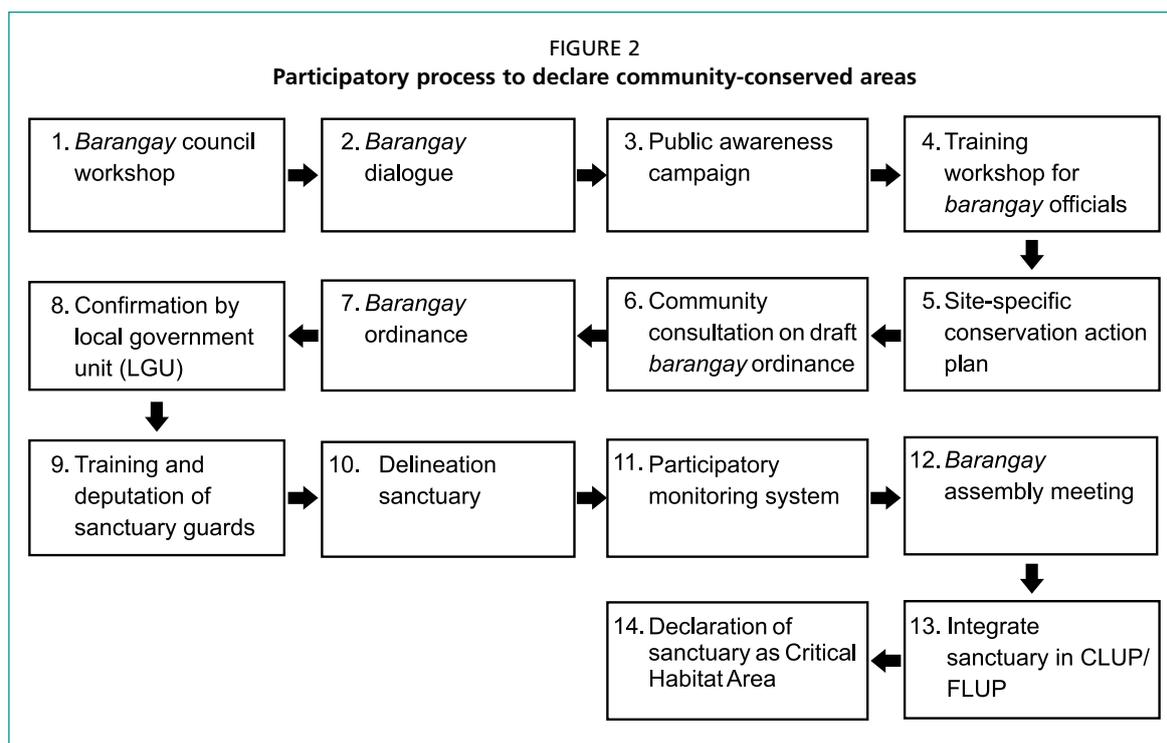
TABLE 1  
Most commonly caught freshwater fish species in the municipality of San Mariano

Scientific name	English name <sup>1</sup>	Ilocano name	Origin <sup>1</sup>	Percentage of total catch <sup>2</sup>
<i>Oreochromis niloticus</i>	Nile tilapia	Giant tilapia	Introduced	61.3
<i>Barbonymus gonionotus</i>	Silver barb	Siling	Introduced	12.7
<i>Ellochelon vaigiensis</i>	Squairetail mullet	Ikan	Native	5.6
<i>Carassius carassius</i>	Crucian carp	Imelda/Carpa	Introduced	4.4
<i>Oxyeleotris marmorata</i>	Marble goby	Bunug	Native	4.3
<i>Oreochromis mossambicus</i>	Mozambique tilapia	Native tilapia	Introduced	3.1
<i>Netuma thalassina</i>	Giant catfish	Kurilao	Native	2.7
<i>Channa striata</i>	Striped snakehead	Dalag	Introduced	2.7
<i>Clarias batrachus</i>	Philippine catfish	Paltat/Bangkok	Introduced	1.2
<i>Awaous melanocephalus</i>	Largesnout goby	Mori	Native	0.8
<i>Clarias fuscus</i>	Hong Kong catfish	Hito	Native	0.6
<i>Dermogenys pusilla</i>	Wrestling halfbeak	Balanban	Native	0.1
<i>Zenarchopterus dispar</i>	Feathered river-garfish	Susay	Native	0.1

Source: <sup>1</sup> Based on Fishbase.org. <sup>2</sup> Based on 20 fishing trips in 8 villages (Engelhart, 2009).

### A MODEL FOR ESTABLISHING COMMUNITY-CONSERVED AREAS

Through trial-and-error, the Mabuwaya Foundation developed a model to facilitate the proclamation and management of freshwater PAs by *barangay* councils (Figure 2). A *barangay* (village) is the lowest administrative unit in the Philippines. It is governed by a *barangay* council that consists of a *barangay* captain and several *barangay kagawads* (councilors), elected by and from the inhabitants. The strength of this participatory model is that people themselves identify practical solutions for the depletion of fish stocks, based on their own values, needs and knowledge.



Source: Authors.

The participatory process starts with a meeting between staff of the Mabuwaya Foundation and the *barangay* council to discuss fisheries management (Step 1). In most villages in San Mariano, people perceive a decline in fish stocks. If a *barangay* council is responsive to address this problem, a meeting is organized with the community (Step 2). In 2005, the foundation organized community dialogues in 15 *barangays* where Philippine crocodiles occur in the wild. More than 750 people attended these dialogues and asked questions about fish and wetlands, raised concerns and proposed possible solutions (van der Ploeg, Balbas and van Weerd, 2009). These community dialogues form the start of an intensive public awareness campaign that aims to mobilize broad support for the declaration of a community-conserved area (Step 3). The foundation for example distributes posters, gives lectures in schools and organizes a dance show during the *barangay* fiesta.

The Mabuwaya Foundation then organizes a training workshop to enhance the capacity of *barangay* officials (Step 4). Most captains and councilors are unaware of environmental legislation, and do not know their rights and responsibilities. Local governance can be significantly improved by addressing this knowledge gap. During the training workshop, *barangay* officials design specific conservation action plans to conserve wetlands in their village (Step 5). *Barangay* officials subsequently present their plans to the community during a community consultation (Step 6). During these consultations people can provide feedback, voice concerns or suggest alternatives. In the end, a vote is held in which the villagers can agree with the plan, or refuse it altogether.

In *barangay* Cadsalan, for example, farmers initially opposed the plan of the *barangay* council to declare a 20-metre riparian buffer zone along Dinang Creek. After several revisions and lengthy negotiations, the farmers ultimately agreed to respect a 5-metre buffer zone. Such democratic processes assure that everybody in the community is aware of, and agrees with, the new rules. Moreover, these local rules are considered *legitimate* by the community, in contrast to the national laws which are generally perceived as unfair and unrealistic, and are therefore rarely enforced (van der Ploeg and van Weerd, 2004).

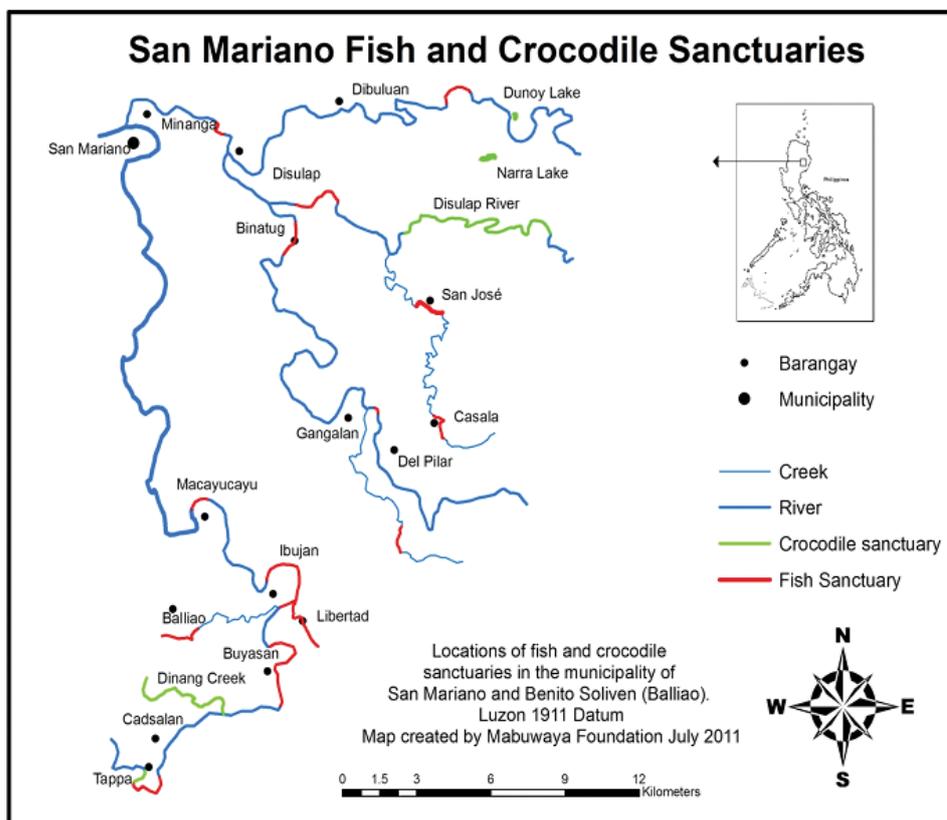
In 2005, 13 *barangays* in San Mariano passed an ordinance proclaiming a freshwater PA (Step 7). These “fish sanctuaries” as they are locally called are indicated in red in Figure 4. The rules in these community-conserved areas differ in each

FIGURE 3  
Barangay councilor presents the site-specific conservation action plan for barangay Cadsalan



Source: Photo courtesy of Merlijn van Weerd.

FIGURE 4  
A network of freshwater protected areas in San Mariano



Source: van Weerd and van der Ploeg, 2012.

FIGURE 5  
Billboards are placed along the sanctuaries



Source: Photo courtesy of Marites Balbas.

area, as they depend on the specific problems and needs of the community. *Barangay* Libertad, for example, declared a part of Disalug Creek as a “sustainable fish sanctuary” where fishing is not allowed. *Barangay* Tappa only prohibited the use of “bung bong, electro fishing, cyanide fishing, fine nets and other destructive ways of fishing” in the Ilaguen River. Fishing is allowed in the fish sanctuary of *barangay* Casala, but only during the *barangay* fiesta and the *canao*, the harvest festival. *Barangay* San Jose declared a 1.5 km stretch of Ditali Creek as a freshwater PA, and

specifically prohibited the cleaning of pesticides sprayers in the creek and the disposal of garbage along the riverbank.

The Local Government Code (Republic Act 7160) requires that a *barangay* ordinance can only take effect after approval by the municipal government (Step 8). The active support of the municipal government is also required for the deputation of guards that enforce the rules of the freshwater PAs (Step 9). Some *barangays* appointed a *bantay sanktuwaryo* (sanctuary guards). In other villages, the *barangay tanods* (local law enforcers) are responsible to monitor compliance. The Mabuwaya Foundation organizes paralegal training workshops where these guards practice how to give a warning, make an arrest and file a case. The municipal government pays a monthly allowance and medical insurance to the *barangay tanods* and *bantay sanktuwaryo* (Balbas, 2009).

It is then important to visually delineate the freshwater PAs on the ground (Step 10). In San Mariano, two billboards were installed in each freshwater PA. These billboards summarize the specific rules of the *barangay* ordinance and highlight the importance of the freshwater PAs in sustaining food security:

FIGURE 6  
Role playing game during the law enforcement training:  
barangay officials arrest two fishers



Source: Photo courtesy of Merlijn van Weerd.

each billboard prominently featured a picture of a plate full of fish. A monitoring system to report and respond to violations is obviously necessary for effective management (Step 11). Actual monitoring remains erratic, informal and unrecorded in most freshwater PAs in San Mariano (Vermeersch, 2014). In itself, that is not

problematic: what matters is that violators are deterred and that guards regularly update the *barangay* officials. To ensure that people in the village stay informed, the fish sanctuary is discussed in the *barangay* assembly meeting (Step 12). *Barangay* assembly meetings are held regularly to inform the community about important matters in the village. In this way the freshwater PAs are becoming part of everyday local governance.

FIGURE 7  
Barangay dialogue in Disulap



Source: Photo courtesy of Merlijn van Weerd.

The last steps in the participatory model are to integrate these grassroots initiatives in supra-local legislation (Steps 13 and 14). This is important to ensure support from government and to prevent freshwater PAs from being later neglected in supra-local development plans. The freshwater PAs of six villages in San Mariano were included in the Comprehensive Land Use Plan (CLUP) and the Forest Land Use Plan (FLUP) of the municipal government. The Mabuwaya Foundation and the municipal government of San Mariano are now trying to declare these community-conserved areas as Critical Habitat Areas under the Wildlife Act (Republic Act 9147).

## SUSTAINABILITY

Creating a protected area is relatively easy; sustaining its management over a long period is the real challenge. Pollnac, Crawford and Gorospe (2001), for example, report that of all community-based MPAs that are created in the Philippines, only 20 to 25 percent is maintained. Billboards are bleached by the sun or blown away during a typhoon. Fishers forget the ordinance or are tempted to harvest fish in the sanctuary. The *bantay sanktuwaryo* become weary of patrolling. *Barangay* officials are elected every three years, and the new village leaders often have different views and priorities. The policies of municipal governments are also changing rapidly. And being dependent on short-term project funding, NGOs are perhaps the most erratic management partners of all.

Ten years have passed since 13 *barangay* councils in San Mariano proclaimed a fish sanctuary. Do fishers still respect the *barangay* ordinances? Are *barangay* officials enforcing the rules and regulations? And do these community-conserved areas actually succeed to protect fish stocks and improve food security? From January to March 2014, 146 people were interviewed in ten *barangays* in San Mariano about the fish sanctuary in their village. A purposive sampling design was used, interviewing only *barangay* officials and active fishers (122 men and 24 women). People were asked if they: (1) knew the rules and regulations of the PA as specified in the *barangay* ordinance; (2) participated in decision-making processes related to the freshwater PA; (3) thought that the rules were followed; and (4) perceived an increase in fish stocks as a result of the sanctuary. Table 2 summarizes the main findings for each village.

TABLE 2  
People's perception of the effectiveness of the freshwater protected areas

Location of the fish sanctuary	Barangay	% of respondents who are aware of the rules and regulations of the sanctuary	% of respondents who participate in decision-making processes about the sanctuary (cast a formal vote)	% of respondents who think that the rules are followed	% of respondents who perceive an increase in fish stocks as a result of the sanctuary
Amisan Creek	Del Pilar	40	40	60	100
Catalangan River	Dibuluan	52	17	32	52
Disalug Creek	Libertad	66	31	64	60
Disulap River	Disulap	87	60	53	77
Ditali Creek	San Jose	95	68	47	75
Ilaguen River	Macayucayu	17	33	–	–
Ilaguen River	Ibujan	31	29	0	92
Ilaguen River	Buyasan	89	46	15	77
Dicamay River	Tappa	0	–	10	–
Dicamay River	Dicamay	46	23	54	69

Note: n = 146

Source: Based on Vermeersch, 2014.

In some villages people's awareness of the freshwater PA is much greater than in other villages. Most respondents in San Jose (95 percent), Buyasan (89 percent) and Disulap (87 percent) are well aware of the rules and regulations of the *barangay* ordinance. In Tappa, in contrast, nobody (0 percent) knew about the *barangay* ordinance: even the *barangay* officials could not recall what the specific rules or penalties were. San Jose (68 percent) and Disulap (60 percent) also score high in terms of the percentage of respondents who feel they actively participate in decision-making processes about the freshwater PA.

Compliance with the rules is clearly a more complex issue. The specific rules and regulations differ for each *barangay*. A few simple and straightforward rules are generally easier to follow and enforce than more detailed and complex regulations. Likewise, it is much easier to implement regulations in a small and accessible area than in a large and remote area. The *barangay* ordinance of Macayucayu, for example, prohibits destructive fishing methods in the stretch of river immediately adjacent to the village. But in *barangays* such as Libertad and Del Pilar the sanctuaries are located relatively far from the village. From a biodiversity perspective, these remote creeks are arguably more important than the heavily disturbed wetlands near human settlements. However, enforcing rules in these isolated and inaccessible areas is difficult, risky and time consuming, which can discourage *barangay* officials. This tradeoff between management effectiveness and biodiversity outcomes poses a challenge for community-conserved areas.

The low numbers of respondents in Ibutan (0 percent) and Buyasan (15 percent) who think the rules are followed can be explained by the fact that commercial fishers from other villages fish in the sanctuaries at night. Local villagers generally respect the *barangay* ordinances. In fact, in 2013 the *barangay* captain of Ibutan arrested three fishers who were fishing in the fish sanctuary, and confiscated their gear. Also, in San Jose, *barangay* officials have taken action against people violating the ordinance: three men who fished with pesticides in the freshwater PA were penalized. Such cases set an important precedent, and resonate throughout the municipality. Everybody in San Mariano now knows that electro and dynamite fishing is against the law, also during Holy Week.

Perhaps most relevant is the fact that 73 percent of the respondents report that fish catches are increasing as a result of the declaration of the freshwater PAs. A fisher in Ibutan, for example, mentioned: “I can catch more fish now with my *sigay* than I could two years ago. I see the tilapia playing when I walk along the fish sanctuary.” But if the benefits of creating a freshwater PA are so tangible, why do some *barangays* fail to maintain their sanctuary? Despite the fact that freshwater fish is an important source of protein for poor households, fisheries management is not a priority for most communities. This paradox can be explained by the fact that freshwater fish is regarded by most people as *substitutable*, and fishing as a *secondary* activity in a diversified livelihood strategy (Mills *et al.*, 2011). People do not seem to realize the importance of wild-caught freshwater fish. As one fisher explained: “If we can catch fish, that’s good, if there is none, we’ll eat something else, so be it”.

This clearly has important implications for community-based fisheries management: a narrow focus on increasing yields to sustain food security might not be the most effective strategy to actively engage rural communities in conservation. When asked why the *barangay* council created a freshwater PA, almost half of the respondents mentioned the need to serve fresh fish to guests during feasts or funerals. Others cited civic duty and the need to respect tradition. Such implicit, cultural values are important motivations for communities to protect fish, wetlands and wildlife; in fact, more important than explicit concerns about food security and livelihoods (van der Ploeg *et al.*, 2011b; Berkes, 2013; Jupiter *et al.*, 2014). The challenge is to transform these deeply entrenched cultural values into effective management of freshwater PAs.

## CONCLUSION

Several communities in San Mariano have successfully maintained their freshwater PAs over the past ten years. Despite many challenges and setbacks, *barangay* officials in San Jose, Disulap, Casala, Del Pilar Ibutan and Buyasan continue to protect their fish sanctuary. People in these villages are aware of and generally respect the rules of the *barangay* ordinance, and think fish stocks are recovering as a result of the fish sanctuaries. But in other villages the community-based conservation approach has failed: in *barangays* Dibuluan, Libertad, Baliao, Tappa and Dicomay, *barangay* officials are unable or unwilling to enforce the *barangay* ordinance, and people no longer respect the fish sanctuaries. Information about the fish sanctuaries in *barangays* Minanga and Binatug is unfortunately lacking.

Three factors seem particularly important in determining the sustainability of the community-conserved areas in San Mariano: (1) the active support and leadership of the *barangay* captain; (2) the functional participation of the community in decision-making processes; and (3) continuous communication between villagers, *barangay* officials, the municipal government and the Mabuwaya Foundation. These three factors highlight the strength as well as the weakness of this community-based conservation approach. Rural communities can effectively protect aquatic resources. But in most cases, communities cannot do it alone. Outside support is necessary to

initiate *and sustain* conservation action on the ground. Much can be gained if the community-conserved areas are much more actively supported by NGOs, municipal governments, national government agencies and international donors.

### ACKNOWLEDGEMENTS

The community-based wetland conservation strategy of the Mabuwaya Foundation was funded by the Ecosystem Grants Program of the Netherlands Committee for IUCN, the United States Fish and Wildlife Service, the Prince Bernhard Fund for Nature, the Disney Conservation Fund, Lacoste, the Whitley Fund for Nature, the People's Trust for Endangered Species, Zoos Victoria, Synchronicity Earth, and the Department of Environment and Natural Resources and the German Society for International Cooperation (DENR-GIZ) Protected Area Management Enhancement Project.

### REFERENCES

- Alcala, A.C. & Russ, G.R. 2006. No-take marine reserves and reef fisheries management in the Philippines: a new People Power Revolution. *Ambio*, 35(5): 245–254.
- Andrew, N.L., Béné, C., Hall, S.J., Allison, E.H., Heck, S. & Ratner, B.D. 2007. Diagnosis and management of small-scale fisheries in developing countries. *Fish and Fisheries*, 8(3): 227–240.
- Balbas, M. 2009. *Barangay workshop on crocodile conservation and wetland management*. Terminal Report. Cabagan, Philippines, Mabuwaya Foundation.
- Berkes, F. 2013. Poverty reduction isn't just about money. In D. Roe, J. Elliott, C. Sandbrook & M. Walpole, eds. *Biodiversity conservation and poverty alleviation, exploring the evidence for a link*, pp. 270–286. Conservation Science and Practice 12. London, United Kingdom, Wiley-Blackwell.
- BFAR. 2005. *Philippine Fisheries Profile*. Manila, Philippines, Bureau of Fisheries and Aquatic Resources.
- Briones, M., Dey, M.M. & Ahmed, M. 2004. The future for fish in the food and livelihoods of the poor in Asia. *Naga*, 27(3&4): 48–50.
- Cureg, M.C., Bagunu, A.M., van Weerd, M., Balbas, M., Soler, D. & van der Ploeg, J. 2016. A longitudinal evaluation of the communication, education and public awareness (CEPA) campaign for the Philippine crocodile *Crocodylus mindorensis* in northern Luzon, Philippines. *International Zoo Yearbook*, 50(1): 1–16.
- Darwall, W., Smith, K., Allen, D., Seddon, M., Mc Gregor Reid, G., Clausnitzer, V. & Kalkman, V. 2008. Freshwater biodiversity; a hidden resource under threat. In J.C. Vié, C. Hilton-Taylor & S.N. Stuart, eds. *The 2008 review of the IUCN Red List of Threatened Species*. Gland, Switzerland, IUCN.
- DENR & UNEP. 1997. *Philippine biodiversity: An assessment and plan of action*. Department of Environment and Natural Resources and United Nations Environment Programme. Makati, Philippines, Bookmark.
- de Silva, S.S., Abery, N.W. & Nguyen, T.T.T. 2007. Endemic freshwater finfish of Asia: distribution and conservation status. *Diversity and Distributions*, 13: 172–184.
- Dey, M.M., Rab, M.A., Paraguas, F.J., Piumsombun, S., Bhatta, R., Alam, M.F. & Ahmed, M. 2007. Fish consumption and food security: a disaggregated analysis by types of fish and classes of consumers in selected Asian countries. *Aquaculture Economics & Management*, 9 (1–2): 89–111.
- Dudgeon, D., Arthington, A.H., Gessner, M.O., Kawabata, Z.I., Knowler, D.J., Lévêque, C., Naiman, R.J., Prieur-Richard, A.H., Soto, D., Stiassny, M.L.J. & Sullivan, C.A. 2006. Freshwater biodiversity: importance, threats, status and conservation challenges. *Biological reviews*, 81(2): 163–182.

- Dugan, P., Dey, M.M. & Sugunan, V.V. 2005. Fisheries and water productivity in tropical river basins: enhancing food security and livelihoods by managing water for fish. *Agricultural Water Management*, 80(1): 262–275.
- Engelhart, K. 2009. *Designing a participatory monitoring system for community-based freshwater fish sanctuaries in the municipality of San Mariano, Philippines*. Leeuwarden, the Netherlands, Van Hall Larenstein. (BSc. thesis)
- Fernandez-San Valentin, C. & Berja, Jr., J.G. 2012. *Philippine food and nutrition security atlas*. Rome, World Food Programme.
- Green, S.J., White, A.T., Flores, J.O., Carreon III, M.F. & Sia, A.E. 2003. *Philippine fisheries in crisis: a framework for management*. Cebu, Philippines, Department of Environment and Natural Resources (DENR).
- Johannes, R.E. 1998. The case for data-less marine resource management: examples from tropical nearshore fin fisheries. *TREE*, 13(6): 243–246.
- Jupiter, S.D., Cohen, P.J., Weeks, R., Tawake, A. & Govan, H. 2014. Locally-managed marine areas: multiple objectives and diverse strategies. *Pacific Conservation Biology*, 20(2): 165–179.
- Kent, G. 1997. Fisheries, food security, and the poor. *Food Policy*, 22(5): 393–404.
- Kottelat, M. & Whitten, T. 1996. *Freshwater biodiversity in Asia: with special reference to fish*. World Bank Technical Paper 343. Washington, DC, United States, World Bank.
- Leisher, C., Sanjayan, M., Blockhus, J., Kotoleon, A. & Larsen, S.N. 2010. *Does conserving biodiversity work to reduce poverty? A state of knowledge review*. Arlington, Virginia, United States, The Nature Conservancy.
- Local Government Unit San Mariano. 2010. *Municipal profile*. San Mariano, Philippines, MPDO.
- Mills, D.J., Westlund, L., de Graaf, G., Kura, Y., Willman, R. & Kelleher, K. 2011. Under-reported and undervalued: small-scale fisheries in the developing world. In R. Pomeroy & N.L. Andrew, eds. *Small-scale fisheries management: frameworks and approaches for the developing world*, pp. 1–15. Oxfordshire, United Kingdom, CABI.
- PAWB. 2013. *The National Wetlands Action Plan for the Philippines 2011–2016*. Manila, Philippines, Protected Areas and Wildlife Bureau, Department of Environment and Natural Resources.
- Pollnac, R.B., Crawford, B.R. & Gorospe, M.L. 2001. Discovering factors that influence the success of community-based marine protected areas in the Visayas, Philippines. *Ocean & Coastal Management*, 44(11): 683–710.
- Suski, C.D. & Cooke, S.J. 2007. Conservation of aquatic resources through the use of freshwater protected areas: opportunities and challenges. *Biodiversity & Conservation*, 16: 2015–2029.
- van der Ploeg, J. & van Weerd, M. 2004. Devolution of natural resource management and crocodile conservation: the case of San Mariano, Isabela. *Philippine Studies* 52 (3): 345–382.
- van der Ploeg, J., Balbas, M.G. & van Weerd, M. 2009. Do crocodiles have rabies? Initiating a dialogue on in-situ crocodile conservation. *Crocodile Specialist Group Newsletter*, 28(3): 8–10.
- van der Ploeg, J., Cauilan-Cureg, M., van Weerd, M. & de Groot, W.T. 2011a. Assessing the effectiveness of environmental education: mobilizing public support for Philippine crocodile conservation. *Conservation Letters* 4(4): 313–323.
- van der Ploeg, J., Cauilan-Cureg, M., van Weerd, M. & Persoon, G.A. 2011b. Why must we protect crocodiles? Explaining the value of the Philippine crocodile to rural communities. *Journal of Integrative Environmental Sciences*, 8(4): 287–298.
- van Velzen, J. 2013. *Tilapia and cornrice: the importance of locally caught freshwater fish for rural communities in the Philippines*. Leiden, the Netherlands, Leiden University. (MA thesis)

- van Weerd, M. 2010. Philippine crocodile *Crocodylus mindorensis*. In S.C. Manolis & C. Stevenson, eds. *Crocodiles: status, survey and conservation action plan*, pp. 71–78. Darwin, Australia, IUCN Crocodile Specialist Group.
- van Weerd, M. & van der Ploeg, J. 2004a. Surveys of wetlands and waterbirds in Cagayan Valley, Northern Luzon, Philippines. *Forktail*, 20: 33–39.
- van Weerd, M. & van der Ploeg, J. 2004b. A new future for the Philippine crocodile. *Sylvatrop*, 13(1&2): 31–50.
- van Weerd, M. & van der Ploeg, J. 2012. *The Philippine crocodile: ecology, culture and conservation*. Cabagan, Philippines, Mabuwaya Foundation.
- Vermeersch, L. 2014. *Community-conserved freshwater areas; a comparative study on effectiveness of fish sanctuaries in San Mariano, the Philippines*. Leiden, the Netherlands, Leiden University. (MA thesis)
- World Bank. 2003. *Governance of natural resources in the Philippines: lessons from the past, directions for the future*. Washington, DC, United States, Rural Development and Natural Resources Sector Unit.