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Viable metaphors: the art of participatory modelling for communicating sustainability science

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Overexploitation is at the centre of an accelerating trajectory that is undermining the long-term ability of our planet to sustain human life. Therefore, the future of humans does not rely on generating new knowledge, but rather on integrating, disseminating and implementing knowledge we already have. Models are one tool for this: by synthesising and representing what we know, models can be useful in answering questions about what should be done. One approach is to create a game in conjunction with a model in a participatory setting. Integrating theory and critical reflection from field experience, I argue that, to be useful, this type of model/game must work as a 'viable metaphor'. This means making the model recognisable, playable and suitable for its intended audience and socio-ecological setting. This paper describes how to apply these three principles to create a gamified model, using the example of 'ReefGame', which has now been played with around 500 fisheries stakeholders in the Philippines. Focusing on small-scale fishers, ReefGame facilitates discussions and raises awareness about overfishing, alternative livelihoods, marine protected areas and coral reef ecology. Following a principles-based 'viable metaphor' design process enabled creating a game/model that contributed to both learning and engagement.

Keywords: knowledge management, community building, gamification, learning, ecology, modelling design, Philippines, fishing, livelihoods

Introduction

The litany of problems affecting the planet hardly bears repeating. Suffice it to comment: the issue is very serious and the causes are largely known and understood (Millennium Ecosystem Assessment 2005; Jerneck 2011). Whilst gathering ever more details about the drivers and the rates of change is potentially useful, the problems are already clear. Instead, as many authors have pointed out, integrating, disseminating and implementing current knowledge is now key (Bammer 2005; Herring 2016; Van Kerkhoff and Lebel 2006).

Models, algorithm-based representations of our understanding of a given system, are more popular amongst the academic community than with managers (Curtice et al. 2012). Nevertheless, models are generally acknowledged as providing useful syntheses of scientific knowledge, leading to fresh insights into how to tackle increasingly urgent problems (Weijerman et al. 2015). These insights, however, are of limited use if they are never understood, accepted and acted upon by those who have the power to do so. This is a compelling reason that participatory modelling is a growing field of interest (Dreyer and Renn 2011). Models can help stakeholders develop common understandings of a problem, beyond just scientific facts to the nature of socio-ecological linkages of power and relationships. Models offer a structured framework from which to explore potential solutions, with the people who are most likely to affect outcomes or be affected by them (Lachica-Aliño et al. 2006). Deliberately involving stakeholders thereby acknowledges the ethical questions at the heart of resource management decisions. That any given ecosystem “may recover given reduced exploitation” (Worm 2009) is a scientific statement, supported by the best available observable evidence. However, who should reduce their exploitation and how, is a political and social decision that unevenly impacts different groups.

Notwithstanding the above, many scientific models and even text-based tools are too complex and technical to be easily interpreted by the people who we would hope to use them. In the case of conservation, this is the managers and end-users, be they fishers, farmers or foresters. Where they have been catered for, interventions tend to be project-based, involving intensive, one-off participatory processes, resulting in tools that are specifically designed for a particular time and place, rather than ones that can be used sector-wide (see, for example, Dray et al. 2006). This has resulted in the ‘single-use’ trap identified and critiqued by Curtice et al (2012), where tools without champions end up archived and forgotten.

This paper addresses this gap by introducing a design process for creating participatory models that can have broader application, without relying on time-consuming and resource intensive processes that result in such ‘single-use’ tools. It draws upon the work of other scholars, who have found that combining participatory modelling with games promotes social learning among resource users (see, for example, Jones et al. 2009). These ‘computer-assisted’ games are explicitly focused on creating dialogue rich environments for building knowledge and creating shared understandings for conservation. By incorporating the ‘real’ decisions and inputs of stakeholders into each time-step of a model, games can help models overcome the questions of legitimacy, relevance and utility that are often levelled at them (Ravetz 2003). Perhaps most importantly, games allow for a number of different groups of stakeholders to interact around particular issues that are affecting the management of their resources. Finding effective ways to bring people together in multi-sector forums is a key to successful integrated environmental management (Courtney and White 2000; Hemmati 2002). These kind of participatory models therefore contribute to two important goals: 1) learning about the problems, and what to do about them, and 2) engagement of, and between, stakeholders.

This paper also responds to criticism that design principles for both gaming and participatory modelling tend to be informal, overly general and focused towards evaluation, rather than the design process itself (McGee 2007; Norling et al. 2013). I fill this gap by introducing design principles that are formalised, broadly applicable, helpful for creating participatory models, and, perhaps most importantly, strongly grounded in critical reflection after field experience. I then go on to describe how these principles were applied to create the game-model ‘ReefGame’, an interactive modelling tool for fisheries stakeholders. Finally, I discuss how the principles contributed to the game becoming an effective learning and engagement tool for multi-stakeholder workshops held in the Philippines.

Creating a viable metaphor: participatory modelling design methodology

Participatory models differ from standard scientific models, as they need to be interactive and interpretable. For this reason, I argue that a participatory model must operate as a viable metaphor for the resource problem it is designed to address. Let’s elaborate on this new term.

First, ‘viable’ introduces the idea that the metaphor/model must ‘work’: it must succeed in its ability to create an image of a real thing that resonates with the intended audience, in this case fisheries’ stakeholders. Second, understanding a model as a metaphor is useful, as it emphasises ‘representation’ rather than ‘replication’. A model is not a miniature world, rather it is a suggestion of what certain aspects of the world are like: a map is not the land (Ravetz 2003). Similarly, the word metaphor reminds us that art and style - that is, design choices for aesthetics and interpretability - are inherent to all models. Both input and output interfaces, whether dials, toggles, fields, graphs or maps, contain cultural and symbolic meaning that allows them to be understood. An example is the colour red signifying exceeding limits; another is ‘up’ meaning more and ‘down’ meaning less (Newell and Proust 2010).

Our foremost responsibility as creators of participatory models is to the people who will use them, not to the mathematical integrity of the algorithms they contain. Therefore the models cannot be only evaluated quantitatively, through testing stability, predictive capacity and variable ranges. Instead, they must be accepted and responded to by people, within social contexts, framed by power, knowledge, relationships and previous experiences. For this reason, the methodology for both creating and evaluating these models must be based in observation, critical reflection and consultation.

However, perhaps partly due to these ‘softer’ goals of learning and engagement, participatory model design methods have been dismissed as being ‘anecdotal’ and ‘informal’ (Norling et al. 2013). Instead, I argue that these central tenets of observation, reflection and consultation provide strong support to learn from experience in a way that is structured and evidence-based. To demonstrate this, the next section outlines three design principles for creating a viable metaphor, which are grounded in previous field experience with participatory models as well as evidence from related literature. The principles are that models should be 1) recognisable, 2) playable, and 3) suitable. Each is elaborated in turn.

Recognisable

The first, and central, design principle is that a participatory model must be recognisable: that is, players can identify their world in the interface and parameters. This principle is roughly equivalent to the virtual reality principle of ‘coherence’, where simulated environments must ‘make sense’ to players (Fiore et al 2009). The importance of being recognisable is illustrated through a computer-assisted role-play game designed for use in Mexico’s Caribbean coast. The model-game targeted regional level planning and conservation bodies, taking fishing and tourism as the two most important drivers of persistent reef degradation (Melbourne-Thomas et al. 2011a; Melbourne-Thomas et al. 2011b). Representatives from local universities, natural resource management bodies and environmental NGOs attended a calibration workshop, and strongly criticised the gamified model as lacking two very important processes. Firstly, tourism investment does not follow the patterns of ‘normal’ markets, due to money laundering from the illegal drug trade. Second, we had not included hurricanes, which interrupt both fishing and tourism, and also significantly damage reefs. This weakened the model’s believability and derailed conversations about feasible interventions for controlling the impact of mass tourism and regulating fishing capacity. Significantly, however, participants did not question those elements of the model that were, in themselves, gross simplifications of regional time-series statistics into ball-park estimates of local socio-economic dynamics (such as tourism arrivals and employment) as these still appropriately reflected local trajectories of change - and were therefore recognisable (Perez et al. 2009).

Playable

Participatory models must balance the ability to replicate known dynamics with opening up space to discuss and explore as yet unrealised futures. This leads to the playable principle, where the elements in the model should be the minimal structural elements necessary to give social, ecological and economic credence to the model, without placing undue restrictions on participants' creativity or ability to improvise. 'Playable' equates to a 'force' in game-design terminology (McGee 2007) – too much freedom or too much structure leads to problems in play. In Mexico, all socio-economic dynamics were retrofitted to past data, and bound to the trajectories emerging over the previous three decades, seriously limiting the scope participants had to make unexpected or radical changes. On the other hand, clearly linking degrading reef health to the two most important economic activities, based on the best available government and scientific data, enabled frank discussion of future trade-offs that may be necessary. As illustrated above, model dynamics do not have to be 'precise', in the sense of fine-scaled, but do need to provide scaffolding to direct discussions and promote learning. Some elements of a model are fixed - immutable relationships that structure interactions. Others are open - able to be added to, experimented with, and even taken out completely.

The game should be designed to capture feedback loops between the collective and individual decisions of the players and the modelled responses of the relevant socio-ecological system. In practice, this means identifying biophysical and social points of interaction; and codifying these in ways that a) make sense to players in terms of their known reality (recognisable, as explored above) and b) reflect scientific understandings of 'how things happen'. A simple example is from fishing: when fishing rates are above population replacement rates, stocks fall and catches drop. The process of translating an observable characteristic from the 'real world' into a playable algorithm is called gamifying. It involves making careful decisions about what will be fixed and what will be open, according to the learning and engagement that designers wish to provoke.

Suitable

The final design principle is that of suitability: the model should represent reality at a scale that is compatible with one that the players can conceive acting in or influencing. If not, designers risk 'scenario rejection', where participants reject the premise of the game (Cameron, DeShazo and Johnson 2011). For example, farmers may be able to change their cropping systems to adjust to climate change, but are unlikely to feel they have influence over setting international carbon emission targets, and may just respond with 'what's the point?'. This was again a retrospective lesson from the Mexican experience: tourism arrivals tend to respond to global economic trends far more than the decisions of state-employed conservation managers, the attendees of our workshop: the scale was unsuitable.

Following on, a 'suitable' model will allow players to makes decisions and apply levers that actually exist for them, or make choices for which they may be able to lobby or campaign. This means asking three questions: 1) what decisions can be made; 2) what are the key parameters both affecting those decisions, and resulting from them?; and 3) what do stakeholders need to negotiate and learn from each other (e.g. management activities, conservation attitudes)? Answering these questions will provide the framing through which a suitable, playable and recognisable interactive model can be created.

Applying the three principles: the creation of ReefGame

The following section describes how the three principles of recognisable, playable and suitable were used to create a gamified participatory model for use with fishers and associated stakeholders: ReefGame.

ReefGame was designed and parameterised for use in one of the most overfished areas on earth: the Philippines. Despite a forty-year history of integrated coastal management interventions, nearly 70% of reefs in the Philippines are under very high or high threat from destructive and over-fishing (Burke et al. 2012). The country's more than one million small-scale or 'municipal' fishers target the nearshore areas, including reef, mangroves and seagrass. These areas are managed by local government units (LGUs), which often have limited scientific, technical and budgetary capacity. Because of this, the marine conservation activities of LGUs commonly have reasonably marginal spatial and temporal impact (see discussion in Horigue et al. 2012; Horigue et al. 2016).

This context of weak governance and overcapacity is the backdrop for designing a viable metaphor using the design principles previously introduced. I now go on to apply the principles in reverse order - suitable, playable and recognisable.

Suitable

A suitable model offers the fisheries' stakeholders a chance to negotiate the levers that exist for them in everyday life. For example, while local fishers and governance units cannot hope to stop climate change, reducing local stressors is widely considered to be critical in reducing its impacts (Gurney et al. 2013).

Working out effective and fair ways to encourage voluntary reduction of fishing effort is a central concern, given the key issues of overfishing and weak governance introduced above. We need to understand how to change the fishers' everyday decision whether to go fishing, or to do something else. This leads to simulating a world of declining catches, alongside a range of livelihood alternatives, and asking fishers to decide and discuss their livelihood choices. With this as the focus of the game, fishers, municipal authorities, potential employers and researchers alike will be able to explore the barriers and enablers to exiting the fishery.

As well as reducing fishing effort, stocks can be protected or enhanced – most often through Marine Protected Areas (MPAs) but also closed seasons, restocking programs and gear limits. Here, the key decision for authorities is what kind of mechanisms to implement and how to negotiate their successful deployment; for fishers it is whether or not to oppose, support and/or obey any restrictions imposed on them. Power and justice are important considerations here, as the impacts of regulatory actions are felt unevenly among resource users.

Therefore, the game will focus on fishing livelihoods, possible alternative livelihoods and marine conservation/stewardship.

Table 1 Gamifying coastal and reef ecology.

Qualitative statement of ecological characteristics	Gamified translation	Supporting sources
Coastal areas are made up of land and sea areas. Key fishing-associated habitats are mangroves, seagrass and corals.	The game board is made up of land and sea cells. The sea cells can have habitat cards, picturing coral, seagrass and mangroves.	Burke et al. (2012)
Fishing reduces fish biomass, increasing the likelihood that a reef will switch from a coral dominated state to an algae dominated state.	When the biomass of fish on a coral-dominated reef cell reaches 50% of its initial value, the cell switches to algae-dominated.	Hughes et al. (2007) Fung et al (2011)
Reef associated fisheries can be broadly understood and described through dividing fish into two groups: piscivorous fish (usually larger and higher value) and herbivorous fish (usually smaller and lower value)	The model includes two kinds of fish: 'big fish' and 'small fish'. 'Big' fish are worth four times as much as small fish, with prices corresponding to local markets.	Fung et al (2011) Melbourne-Thomas et al. (2011a)
Due to overfishing, catches are declining in small-scale fisheries across the Philippines.	Populations on sea cells are big enough to initially support larger catches, but these fall off dramatically after a few rounds of fishing activity by players.	Burke et al. (2012) Lachica-Aliño et al. (2006
Some habitats support more fish than others. In particular, some habitats have a greater proportion of larger, higher value species. Coral can support the biggest biomass, followed by sea grass and mangrove.	Each of the habitat cells has a maximum possible biomass, and a different ratio of small: big fish. 1. coral dominated – 100% of total possible biomass (60: 40) 3. seagrass dominated system – 50% of total possible biomass (80: 20) 4. mangrove – 37.5% of total possible biomass (90:10)*	Maynard et al. (2010) MacNeil et al. (2015)

*Note: Percentages for the reef-associated habitats were based on suggestions by Filipino marine ecologists (Dr P.M. Aliño and laboratory) based on field experience. Note that particularly the seagrass/mangrove ratios do not correspond with relative biomass reported by Ronnback (1999), for example. However, in the Philippines case, both seagrass & mangrove fisheries are associated with older fishers who prefer 'safe' (reliable and less physically taxing) gear, and acceptance of lower catches accordingly (Fabinyi 2012). Local experience grounded in both field surveys and fisher interviews is considered a more reliable indication of target fish abundance associated with the various habitats.

Playable

Recall that the playable principle comprises two key aspects: constraint and creativity. Constraint refers to the socio-ecological boundaries within which players must operate. These boundaries are informed primarily by scientific knowledge from peer-reviewed literature or respected scientific organisations (see table 1). For example, different coastal habitats (e.g. corals, seagrass, mangroves) have different carrying capacities, and the fish that live there vary in size and value. Similarly, almost without exception, Philippine fisheries have experienced steady declines in catches due to overfishing (Burke et al. 2012). Finally, overfishing, particularly in conjunction with other human-led stressors, can lead to phase shifts and radical declines in productivity (Pandolfi et al. 2005). These, and other ecological parameters, and their gamified translations for ReefGame are in Table 1.

On the social front, constraints include local economic conditions. These govern what kinds of livelihoods are available for the fishers, at what pay, with what skills and accessibility. In addition, fishers are usually heads of household and are often responsible for ensuring enough cash income for their families to meet basic needs. How much fishers need depends again on local economic conditions, and the number of children they have. Fishers' abilities to exploit remaining stocks also rely on their access to gear and technology: well-resourced fishers with efficient gear will have larger catches, while smaller fishers' catches regularly drop below subsistence level (Cruz-Trinidad et al. 2009; Ferolin and Dunaway 2013).

Creativity, on the other hand, refers to the ways in which the game can encourage innovation in the players. Initial parameters are guided by local conditions, for example the presence of tourism, mariculture and agriculture, but fishers and other players alike are encouraged to use their imagination in terms of envisioning alternative livelihoods. Livelihood projects often get bogged down in formulaic responses, with very little evidence of success (Sievanen et al. 2005). Similarly, poor Filipinos are often viewed by development projects from a 'deficit' model, always focusing on what is lacking and needed, not assets and strengths (Gibson and Cameron 2005). This results in circular arguments around poverty and 'last-ditch livelihoods' that are not constructive (Béné 2003). Instead, the idea was to foster hope rather than stifle it with overly restrictive and narrow access to alternative livelihoods. This has three key benefits: firstly, it opens up the game to explore new futures, secondly it encourages the fishers to view themselves as agents of change rather than passive recipients of aid or handouts, and finally it enables non-fisher players to observe and reflect on social and cultural attachments to fishing, as financial and skill-based barriers to entering other livelihoods are not present in the virtual 'game-world'.

Recognisable

Adding to being suitable ('just the right scale') and playable (creative within boundaries), ReefGame also needed to be recognisable for its chosen audience. This means understanding the socio-ecological world of the small-scale fishers, and the organisations that exist in their communities, achieved by drawing on existing ethnographic and other relevant literature, and a wide-scale (n=~1000) household socio-economic survey across ten municipalities (see Muallil et al. 2011, for details on survey findings). In addition, a Scenario Development workshop was held with fisheries stakeholders to compile information about what we needed to add to our basic model/game design, described above.

This process resulted in a range of adjustments to the game characteristics and parameters. Changes ranged from which livelihoods were available as default options to refining the dynamics of the offshore fisheries. Only some of these affected the algorithms in the underlying model, others just the 'look and feel' of the game. Similarly to 'playable' considerations, 'recognisable' parameters are only hardwired into the game where necessary. For example, in many areas of the Philippines, fishers do not go out during monsoon, due to high winds and large waves. Coding this in is unnecessary as the gamemaster or facilitator can simply announce which season it is, and fishers make their decisions accordingly. Table 2 gives examples and explanations of recognisable attributes of the game.

Table 2 Designing a recognisable model/game

Known socio-ecological characteristics	Gamified translation	Supporting sources
Fishers are familiar with local coastal habitats, fishing grounds, and coastlines, and make fishing decisions based on this knowledge.	A physical game board is made up of sea cells (with or without habitats) and land cells, adjusted for each locale so it schematically resembles the coastline and habitat distribution.	Scenario development workshop Game et al. (2009)
Fishers can get the 'jackpot' – unusually or seasonally high catches commonly resulting from pelagic stocks moving through municipal waters.	Extra fish are distributed randomly across a number of sea cells at each time step, so it is possible for fishers to get high catches even where populations have fallen overall.	Hill et al. (2011) Mangahas (2000) Veloro (1994)
Fishers use many types of gear, and strongly associate their fishing identity with the kind of gear/boat they use.	Four different types of gear are set in the game (traps, bagnets, hook and line and spears). Each is set with a unique maximum and minimum, based on local catch statistics.	Mangahas (2006) Fisheries survey (reported on in Muallil et al. 2013; Muallil et al. 2011)
Fishing is a highly uncertain activity, with catches showing substantial daily variability. Ideas of luck and skill are integral to fisher identity, and are used to explain this variability.	Catches for each round are randomised minimum and maximum, based on gear and local catch statistics (see above)	van Oostenbrugge et al. (2004) Veloro (1994) Mangahas (2000)
Fishers preferentially catch bigger, higher priced species.	70% of the allotted catch is taken from the carnivore/big fish pool (or as many as are available), and the remainder is taken from the small fish pool.	Lotze et al. (2006) Pandolfi et al. (2005)
A large proportion of fisher households have more than one breadwinner (whether spouse or older children). Alternative breadwinners help with subsistence activities and supplemental livelihoods.	After a few rounds of the game, a 'household' scenario is introduced, wherein players decide on livelihoods for two people instead of just one.	Graham and Sol (2004)
Fishers opt in and out of the fishery, engaging in a wide range of alternative livelihoods according to the meso-economic characteristics of their hometowns. Fishers particularly prefer livelihoods that allow them similar incomes to fishing, to enjoy the beauty of the sea, and to 'be their own boss'	A range of livelihoods is available as default options. This includes a number of 'sea-based' options, including aquaculture, boat tourism and ferry driving. In addition, fishers can set up their own businesses.	Muallil et al. (2014) Muallil et al. (2011) Scenario development workshop with fisheries stakeholders
Fishers and local government units alike identify illegal fishing as a major issue, but are reluctant to blame locals or coordinate to improve compliance with fishery regulations.	Automated fishing agents, which catch large numbers of fish, can be deployed within the model. Their 'illegal' catches are reported on the game interface. This speeds up the rate of resource degradation, and allows discussion of this important issue without pointing fingers at particular people.	Fabinyi (2012) Scenario development workshop with fisheries stakeholders

ReefGame: summary of play

Compiling these design considerations resulted in ReefGame, a linked game and computer model for exploring alternative livelihoods and coral reef conservation in fishing communities. Game play is described briefly below, and in more detail in the manual, available from www.onefishtofish.com

The game board represents the coast of the modelled area, and is easily adaptable to different sites (see figure 1).

Figure 1 ReefGame board, showing numbered land and sea squares, marine habitat icons and model boats as player tokens

While fishers and other stakeholders play the game, a computer model calculates fish catches and the impacts of the players' decisions on marine habitats, as detailed above. The results of each round of the game are displayed on a simple graphical interface. A facilitator, or game master, guides the game by explaining the roles, interpreting the interfaces (when necessary), introducing the scenarios and facilitating discussions and debriefing.

A range of stakeholders can use ReefGame in workshops with a recommended 10 to 30 participants. The main roles are for fishers, who can play singly or in pairs. Local governments can play, aiming to keep a high public approval rating (based on the economic situation of the fishers) and a healthy environment (based on fish stocks and coral health). Tourism and aquaculture operators can be played either by respective representatives, or by NGOs, operating as employers and potential partners on any conservation activities undertaken.

ReefGame has four successive scenarios. Each introduces new interactions and decisions for the players. The first is fishing only, to familiarise players with the game, and allow them to see changes in catch volume and composition. Facilitators can introduce illegal fishers at any time during this, or other, scenarios. This can be used to spur discussion on how to control encroachment, and the impact of illegal fishing on the marine environment. Next is 'alternative livelihoods', where participants can decide either to continue fishing or to explore other options, as discussed above. Thirdly, 'household': players make livelihood decisions for themselves and another household member, allowing them to diversify their livelihood strategies. The final phase introduces management interventions**,** where local government players lead consultations and decision-making about management initiatives, for example marine protected area establishment or gear restrictions.

Discussion: a working viable metaphor and a viable metaphor that worked

Following the design process and a pilot workshop, ReefGame workshops were run across ten municipalities in the Philippines. Using a purposive sampling strategy, the sites were selected to have a broad range of meso-level economic characteristics, including different key industries such as tourism, mariculture, heavy industry/shipping and agriculture. Fishers, local government workers, NGO representatives and local employers attended the workshops. This diversity of sites and attendees allowed investigation of the adaptability of the model: was ReefGame a viable metaphor – playable, suitable and recognisable for a range of fisheries stakeholders? And would this viable metaphor generate the hoped for outcomes of education and engagement?

This section will briefly explore these questions, drawing from video data of around 200 fisheries' stakeholders playing the game during workshops, group debriefing sessions, and post-hoc interviews with both players and expert facilitators. The focus is on qualitative evidence, in accordance with Ravetz (1999) who argued the most significant advantages of using interactive modelling tools is the discussions and arguments that they elicit.

Recognisable and playable: tradeoffs for learning

Firstly, ReefGame was recognisable to the fisheries stakeholders who played it. Consistently across all sites, fishers justified their decisions through reference to local conditions, and talked about the gameboard as if it corresponded to their local fishing grounds. This helped discussions stay focused on overfishing, livelihoods and marine conservation. However, as we will explore in further detail below, the 'recognisability' did create trade-offs with our other principles, particularly 'playable'.

The playable principle exists primarily to direct discussions and promote learning. Specifically, ReefGame was created to help fishers understand overfishing, and the role of coral reefs in maintaining healthy marine systems. As Maynard et al (2010) point out, it is critical that fisheries stakeholders understand that healthy corals support more fish than degraded algal systems. ReefGame enables fishers to 'realise this for themselves' (words of a local manager), making it a much more powerful learning experience (Hills et al. 2006). Take this typical interaction between participants:
Fisher A: Patay nga ang corals, ngari wala akong nahuli dining isda (The corals are dead, that's why I haven't caught any fish.)
Fisher B: Ah ganun. (Ah, that's why.)

A number of players realised that protected areas and other conservation mechanisms were not merely a device to unfairly exclude fishers: as one fisher put it: 'Para din sa amin yun e' (It [the Marine Protected Area] is for us as well). Conflict over the acceptance of Marine Protected Areas is common in the Philippines, even after 40 years of Community-Based Natural Resource Management interventions (Gollin and Kho 2002). Fisher support is critical for MPAs to succeed, especially where enforcement is ineffective or limited (Ban 2009).

ReefGame enabled detailed discussions about the purpose and the science behind MPAs, where fishers were able to ask questions based on their observations of falling catches, and declining coral cover, both within the game and from their own experiences.

However, learning was not universal, and sometime unhelpful lessons were inadvertently transmitted or reinforced, particularly where 'recognisable' parameters were concerned. For example, the addition of 'illegal fishers' as automated entities in the game, as requested by stakeholders in the participatory design workshop, meant that fishers did not always have to confront the sobering fact that evidence points to overfishing in all study areas (Muallil 2014), irrespective of the legality of gear used. It is a tightly held belief across many fishing communities that 'illegal' gear is the principal culprit for falling catches and reef degradation (for an extensive discussion see Fabinyi 2012). Disrupting this belief to help fishers reorient to the urgent need for alternative livelihoods and marine stewardship would be an important step towards effective conservation and, hopefully, poverty alleviation. Retrospectively, whilst the 'illegal fishers' helped prompt discussion on regulation and enforcement, the provision of an in-game scapegoat was not particularly useful, especially as blame regularly turned to 'outsiders', including particular migrant or nomadic groups.

Whilst the 'illegal fishers' (described above) tended to entrench rather than challenge the small-scale fishers' belief that environmental degradation is largely the responsibility of 'outsiders', it did spark interest in, and calls for their local government to start putting programs in place. For example:
Fisher A: Kailangan na kuwang magtayo ng (Now we need to set up a…)
Fisher B: Mag-Bantay Dagat tayo. (Let's have a coast guard.)
This meant that, despite quite lowly wages, especially in comparison to other livelihood activities within the game, the coast guard positions were often filled. Fishers negotiated benefits for the Bantay Dagat (coast guards) with tourism representatives and the local government unit, rightly arguing that they were providing a social service in protecting reefs from encroachment.

Another problem emerged in an area that was not yet showing drastic signs of overfishing. Here, in order to make the model recognisable, we matched fishing catch capacity in the game to current reality. However, doing this meant that catches did not drop off in any tangible way, even after multiple rounds of fishing. Therefore the decision to move away was not an economic necessity, and far fewer fishers took up the option in those sites. In choosing to not disrupt local fishers' current experience of the marine environment, we lost a valuable opportunity to confront and discuss the prediction that the area's fisheries are among the most vulnerable in the country to rapid decline (Villanoy et al. 2010). Participatory models should take us into an uncertain future, not remain in a stable present, and it may be necessary to compromise 'recognisability' in order to achieve this. Where rapid declines in catches and reef health occurred in the game, as in other areas, fishers tended to be more innovative, more outspoken and more interested in the science and rationale behind proposed methods for recovery, such as marine protected areas and closed seasons.

Merely mimicking current ecosystem states when parameterising the game for each of the field sites meant we lost the opportunity to demonstrate the effects of overfishing. The trade-off is between 'recognisability' and 'playability'. When initial catches are much lower than fishers' real experiences, the game loses traction. However, not having catches decline in a noticeable way within game-play meant not advancing understanding of the overfishing problem that affects almost every small-scale fishery in the Philippines. Achieving a middle ground enables both acceptance and learning and requires a careful balance between these two principles.

Despite these reservations, in all sites participants expressed gratitude for the ReefGame's contribution to knowledge sharing and relationship building across the different sectors. One NGO representative explained it thus: 'it's not often that scientists come out and take the time to really talk to us'. Indeed, as Ban and colleagues (2009) claim, the usefulness of tools like ReefGame largely lies in helping canvass solutions and stimulating discussions in ways that are otherwise difficult.

Facilitators readily identified that the most significant advantage of using ReefGame over more standard delivery of educational materials was its ability to keep fishers engaged. As one noted: 'normally in workshops at least some of the participants get bored and wander outside for a cigarette, but in ReefGame everyone stays around the table'. It was telling that many groups asked to keep playing, rather than exiting with relief, when meal breaks were called: ReefGame's playability made it a successful communication tool.

Suitable: creating a rehearsal space for negotiation

Finally, ReefGame's suitability, its focus on issues that were relevant and accessible to local actors and actions, meant that workshops could relate game negotiations to 'real life'. For example, local government unit representatives clearly saw how consultation, or a lack of it, could greatly help or hinder implementing fishing regulation and reef protection. One standout example was where initially government representatives had been openly rather rude and aggressive with fishers, accusing them of not understanding the need for conservation. This resulted in fishers declaring mutiny, and threatening a 'strike'. In later rounds, the representatives tried for a much more conciliatory approach, offering training and social security benefits in exchange for agreement to a closed season. This demonstrates how the game offers a safe 'rehearsal' space for fishers and local governments alike to try out strategies to elicit cooperation and desired outcomes. Negotiating access rights, and openly acknowledging the trade-offs for livelihoods inherent in closing areas of the fishery, are critical for social justice and successful coastal management (Fabinyi et al. 2013).

Incorporating fisher voices into policy discourse is an important step to popularly accepted fisheries' regulation (Cinner et al. 2011). With over seven thousand islands and endemic problems with effective governance at all levels of the State (Gollin and Kho 2002), the Philippines does not have strong enforcement capacity. Building trusting relationships between scientists, fishers and regulators is therefore critical – compliance relies on fishers adopting behaviours that support conservation and existing fisheries regulations. This can happen if open conversations about the rationale behind initiatives such as closed seasons are possible. One example of where this took place was after heated discussions during ReefGame about the negative effects and uncertain benefits of a closed season implemented by the local government unit during 'Management rounds'. In a debriefing session, fishers were able to ask questions of an attending fishery scientist, helping them understand the reproductive biology of one of their target fish species. Fishers' confidence with this scientist had built up over the two days of game play, and they were able to match their own experience catching juveniles with what they were told. Local government representatives observed that the fishers were eager for knowledge and willing to listen – if they were in turn listened to.

Effectively involving fishers in education, outreach and decision-making is not just important from a social justice perspective. As Fabinyi and colleagues (2013) assert, small-scale fishers have the power and influence at the local level to seriously derail attempts to implement restrictions on the fishery. Local Government Units got a taste of this during 'Management' rounds, as discussed above, where they tried to establish protected areas. Fishers protested the loss of their fishing grounds and confronted Local Government Units about their attitudes and complicity in corruption and the non-apprehension of encroachers using illegal gear. Inevitably, negotiations resulted in compromises: smaller areas, the introduction of 'traditional' fishing gear within exclusion zones, and better conditions/incentives for the voluntary coast guard programs: important steps to community acceptance and adherence to fishery management strategies.

Conclusion

Facilitating learning and dialogue amongst stakeholders is critical to overcome sustainability challenges. At the same time, influencing how communities respond to both diminishing resources, and attempts to conserve that resource, continue to be the Achilles heel of environmental management. Tools must be able to flexibly adapt to local circumstances and emerging issues, in order to facilitate both learning and engagement.

ReefGame's design did this by following three principles to create a viable metaphor for fisheries stakeholders. The game was playable: it allowed stakeholders to create and improvise within bounded rules that reflected ecological realities. ReefGame was suitable: participants took decisions that related to their own lives. Finally, it was recognisable: fishers and other players related the game to their realities, and made their decisions with reference to these realities.

The game bridged a communication gap for fishers in developing countries, while also testing and improving both scientists and local managers' skills in facilitation and negotiation. Having to persuade resource users to agree to conservation measures, albeit in an 'artificial' environment, gives these participants an opportunity to practise their communication skills, and provides useful insight into what strategies are more likely to succeed in 'real' life. The game helped stakeholders explore novel and effective means of reducing fishing effort through incentives and enforcement that can be implemented and sustained at the local level.

Using a principles-based design process is a useful step towards improved application of models in participatory settings. As discussed, participatory models often fall into a single-use trap or are too complicated to be useful to community groups. The fact that 'ReefGame' has continued to be used as a learning and communication tool, both in other projects and by the University of the Philippines, is a strong indication that the design approach helped us avoid both of these outcomes. Further, an ethic of critical reflection on the shortcomings and trade-offs involved in the design and implementation of participatory models will help improve outcomes in the future.

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