Participatory modeling and development practice: artisanal fishers in Nicaragua

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Abstract

Development plans with insufficient knowledge about local realities, and that do not share technical or planning details with the target communities, bedevil development practice. We used a form of participatory modeling in three fishing communities in Nicaragua to enable fishers to explore their economy and the potential impacts of fishery-based development projects. Co-designing a model of the fishing economy in the form of a board game created a forum in which facilitators and participants could arrive at a shared understanding of local fishing practices and the costs and benefits of strategies for addressing the fishers' priorities.

Keywords

Participation; development policies; economics; environment (built and natural); Latin America and the Caribbean

Introduction

Development actors, such as governments, NGOs, and even community leaders, often have an incomplete understanding of the diverse goals and rationales underlying the behaviors and perspectives observed within a community. At the receiving end, “beneficiaries” have only vague understandings of the likely outcomes from a proposed technology or policy intervention. Top-down *or* bottom-up development decisions, when made with incomplete or inaccurate information about community-based practices, risks, constraints and values, lead to sub-optimal results. Unidirectional and partially informed communication is common even within participatory development practices.

It would be naïve to argue that poor information, the usual suspect in many analyses of failure, is the only challenge for successful community-based development. More information alone cannot produce sustainable development (Lieberman, Posner, and Tsai 2014). Moreover, critical development theorists have argued that many initiatives simplify deeply political development challenges into more tractable, less overtly political problems, seemingly capable of being solved by “technical” interventions (such as better information) (Li 2007; Goldman 2006).

In this paper, we argue that simplification in development practice is inevitable and even necessary. We hypothesize that many failed attempts at local development may stem not from “rendering technical” (Li 2007) per se, but from *how* problems are simplified and *who* does the simplifying. Institution-led planning or donor-driven aid generally produces technical “solutions” that are controlled by experts, and whose means, ends, and benefits remain opaque to the poorest stakeholders (Li 2007, 2). Co-producing new information in a dialectic manner, however, increases the potential for learning; thus the technical deconstruction of problems can take on new meaning when performed by community members themselves.

The literature on the inadequacies of development planning is vast, but it has not adequately explored the impact of processes that bring deeper community understanding about the options and tradeoffs embedded within development plans. When the logistics and implications of a proposed project are made visible to key stakeholders, they may be in a better position to evaluate its costs and its desirability. Uncovering causal processes and outcomes could help community members to develop new aspirations, demand that processes or projects be modified, modify them beyond their official intent, or acquire greater insight into their own decisions.

With learning and transparency in mind, researchers and development practitioners have explored new processes for working with stakeholder groups, and have created models and role-playing games that can be used to explore complex problems. These processes have been called participatory modeling, collaborative modeling, or companion modeling (Tuler et al. 2017; Halbe, Pahl-Wostl, and Adamowski 2018; Jones et al. 2009; Barreteau, Le Page, and Perez 2007; Renger, Kolfschoten, and De Vreede 2008), and these literatures are growing rapidly. We use the term "participatory modeling" to define a generic process for working with participants to collaboratively develop a model that elucidates some aspect of their reality, often in the form of a board game or computer model. Simulation games can be effective learning tools (Thatcher 1990), allowing users to be engaged in an iterative exploration of their circumstances. These collaborative games are low risk ways to explore new decisions while allowing stakeholders with diverse knowledges and motivations to share their viewpoints (Bousquet et al. 2002).

In 2011, we adapted participatory modeling approaches to develop a board game that explored the dynamics of village fishing economies on Nicaragua's Atlantic coast. For decades these fishers had struggled with unstable livelihoods and failed development interventions (Christie et al. 2000). Designing a model of the fishing economy as a game, we hypothesized, would create a forum in which experts and community members could arrive at a shared understanding of local realities, and of the costs and benefits of future projects intended to improve fisheries management and the livelihoods dependent on them.

In the subsequent sections, we describe the local fishing economies in which we developed the game, the process of game-development, and the details of the game itself. We then discuss how participatory modeling proved to be a useful tool for improving two-way communication and for uncovering new information about development interventions.

Background: fishing livelihoods on Nicaragua's Atlantic Coast

Our research focused on the three communities of Pearl Lagoon, Orinoco, and Marshall Point, located on the shores of the Pearl Lagoon, on the southern Atlantic coast of Nicaragua (Figure 1). The Pearl Lagoon basin consists of twelve communities with varying ethnicities, speaking primarily English-Creole. Coastal livelihoods here depend on subsistence production from fishing and agriculture, with monetary income primarily generated through the sale of fish, government jobs, small enterprises, remittances, and agriculture (Casillas, Sobalvarro, and Valverde 2010; Christie et al. 2000; Schmitt and Kramer 2010).

The site was already known to the first author, who had worked for several years in these communities through a local NGO. In prior workshops, community members had expressed interest in developing a more sustainable fishing industry. The existence of deep community connections and a clear interest in addressing challenges in the fishing industry made these communities for an exploration of participatory modeling.

(Figure 1)

While some fishers had fiberglass motor boats, the majority used wooden canoes. Fishers often worked in pairs, and a boat typically carried from one to fifteen gill nets that were set in the morning or evening. The best market prices were paid for snook and catfish. Depending on the season and the species, fish could be sold to middlemen, directly to fish processors, or simply consumed in the house or shared among community members. The largest fish processing companies were located in the nearby town of Bluefields. There were several fishing cooperatives, both within and across communities. Most fishers became members in order to gain access to loans or grants for new equipment.

Recurrent themes among many fishers were the lack of access to financing for equipment, the desire for local ice production (because fish are highly perishable), better management of fishing cooperatives, and concerns regarding declining fishery productivity. Most artisanal fishers could not access loans because they lived on communal lands without an individual land title needed for collateral.

Three issues dominated our initial discussions in these communities. First, lack of local ice production was seen as an impediment to a thriving fishing economy. The highest operational cost for fishers who had motor-boats was the gasoline. If fishers had ice and coolers, they could sleep in their boats, or nearby on the shore, without having to return immediately to sell their fish. Having coolers with ice allowed fishers to remain by their nets accumulating fish, reducing fuel costs and preventing theft of both the nets and fish. With coolers and ice, fishers could also aggregate catches within the community before delivering to a better, more distant, market.

Ice was controlled by middlemen and fish processors. Most of the main fish processors provided free ice, with the condition that the fishers sold their fish only to them. Ice was also transported up to the rural communities in large coolers, primarily by middlemen. Due to the high capital cost, ongoing maintenance, and technical complexity of ice machines, one company head argued that local ice production was not a feasible solution for rural communities.

Second, the ongoing decline of fish productivity was a critical issue (see Stevens et al. 2014). Fishers claimed that conditions in the lagoon would become worse due to overfishing unless some form of regulation was implemented. All the participants agreed that a closed season for the use of gill nets needed to be enforced. There already were several fishing regulations applicable to the Pearl Lagoon basin, yet they were not followed or enforced (Stevens, Frank, & Kramer, 2015). Most participants agreed that implementing a closed season would require the input of fishers from all of the neighboring communities, and that government enforcement was needed.

Third, fishers in many of the coastal communities argued that they were constrained by the difficulties of accessing finance, new equipment, and better fish prices. These constraints suggested a variety of technical solutions that a well-managed cooperative could potentially implement. Fishing cooperatives have been promoted as institutions that help fishers capture more market value by organizing them into groups large enough to demand better prices from wholesalers (Jentoft 1986). However, fishing cooperatives in Nicaragua have had little lasting success. In 2011, there were nine registered fishing cooperatives in the Pearl Lagoon municipality, but participants claimed many cooperatives suffered from poor organization and mismanagement of funds, and almost none functioned as a member-owned business.

Methods

The goal of our investigation was to work with small groups of fishers in order to facilitate a nuanced, quantitatively grounded, understanding of their fishing economy. Leading up to the development of the game, the first author conducted group discussions, formal and informal interviews and observations, and joined fishing trips with community members. Group meetings were spread out over several months (see Figure 2) in order to decrease the strain on the participants' personal time, as well as to integrate feedback into the game design.

(Figure 2)

The first author played the role of process facilitator and was usually the note taker (except for several sessions where a local assistant acted as a neutral observer). There were up to nine game playing sessions in each of the three communities with groups of three to ten participants. Since gill net fishing is dominated by males (due primarily to the cost of equipment and the physical difficulty of the work), most of the participants were adult males. However, there were two female participants in Marshall Point.

The participatory modeling process progressed through two phases: game-development and game-playing. During the game-development phase, there was a transfer of information to the facilitator (or development practitioner), used to modify a game prototype.. During the game-playing phase both the participants and facilitator were active learners as new projects, policies, and decisions were explored within the game.

Game-development

The game prototype provided a framework through which the participants could express and explain their decisions, and explore the dominant themes that emerged during the first several meetings. The prototype consisted of a large map of the lagoon where villagers fished. Participants were encouraged to talk through the decisions that they actually made in their daily lives. In addition to the map, the prototype included cards, with pictures of different equipment that fishers might need, and dice for determining fish catches. The prototype provided a simulated reality where participants could act out the manner in which they fished, with real world constraints forming the rules within the game, such as how much fish they might catch, how often they could fish, where they fished, and what equipment they used. An early version of the game is shown in Figure 3.

(Figure 3)

A pair of game dice was created to simulate the uncertainty of catching fish. The numbers on each die were chosen so that the sum of the two dice represented the expected per-net weight of a catch of snook, which comprised the majority of fishing income for most fishers. The values on the dice approximated the probability distribution of fish caught per net, derived from fishing surveys shared by other researchers (Stevens et al. 2014).

In addition to the uncertainty in the amount of fish that might be caught, "chance" cards were introduced in order to provide for the many random events that occured in the lives of the fishers. The fishers would draw one of the cards every other turn during the game. Some of the cards introduced positive events, such as earning extra money from the harvest of a crop, receiving money from a relative living abroad, or having an unexpectedly large fishing catch. Other cards had negative events, such as having nets stolen, buying a cell phone, making repairs to equipment, or being sick and unable to fish for a day.

An important aspect of the fishing economy was determining where the fish were to be sold. Table 1 provides an example of the gasoline costs for travel for a fisher leaving from Orinoco or Marshall Point, the fish prices offered at each location, and the minimum weight of snook that would need to be sold to the different vendors in order to cover gasoline costs. The amount of fish needed represents a minimum, since there would be additional costs, such as food, salary of the driver, etc. A round trip from Orinoco to Pearl Lagoon could be done in an afternoon, whereas the trip to Bluefields, including waiting time at the processor, could take more than a day.

(Table 1)

In the final evolutions of the game, each fisher was given a small token, which represented his or her nets, and options for the acquisition of equipment. Participants would take turns moving their boats to different fishing spots, catching fish, and bringing their fish to market. Various versions of the game were played, some in which fishers were randomly given different types of equipment, others in which they could only play with equipment that they owned in life, and others in which they could take out a loan to buy additional equipment. The equipment available in the game included nets, ice coolers, boats, and motors.

In order to keep track of earnings during the game, which would simulate the profits and losses for a week of fishing, each fisher (or pair if they were playing with a partner) received an accounting sheet. The accounting sheet allowed the players to record their daily catches, earnings, and costs, as well as the equipment that they were using. At the end of the game, gross and net earnings were calculated, leading to a discussion of how the participants fared during the game.

The game prototype proved to be a rich catalyst for discussions of fishing behavior and strategies. The participants initially familiarized themselves with the scaled map that was centered on the primary fishing spots. They often processed the information together, pointing out the various landmarks and fishing holes on the map to new participants. As they made different choices during the game, opportunities were created whereby the facilitator (in our case, the first author) could pose questions. For example, as participants decided where to place their boat to fish, or what gear to use, they could be asked why they made a certain choice, was this a common decision, or what alternatives there might be. The game, in practice, became a cross between informal interviews and participant observation. In the span of a few hours, the facilitator gained insights into a wide range of fishing behaviors. The questioning process (see Table 2) also provided a forum in which other participants could discuss or provide contrary opinions regarding the reason why a decision was made, or share variations of decisions. If a point of debate could not be resolved, it highlighted an area in which the facilitator could encourage the participants to collect more information to help resolve the dispute for the next meeting.

(Table 2)

Once the prototype was finalized and the participants agreed that it was a good representation of their economy, the game was used to present new scenarios, challenging participant knowledge and stimulating further discussions. Many questions emerged simply from observing that an alternative behavior could be valuable, or by introducing new information to the participants. For example, some fishers were unaware that some companies paid a better price per pound for deliveries of more than 3,000 pounds, or what would be the minimum weight of fish needed to make a trip profitable to different buyers.

Results and Discussion

Game-playing Process

During the initial game-playing sessions the fishers replicated their usual behaviors, fishing with the same number of gill nets that they were accustomed to and selling to the same buyers, even when presented with the opportunity to acquire more fishing gear or make different choices. The initial games provided good opportunities for understanding existing fisher behaviors and strategies, but it became apparent that various constraints or incentives were needed to stimulate the exploration of new strategies. After several sessions, the facilitator and participants jointly decided to organize the game as a competition in which participants could choose to join with others or fish alone. Each person had the option of acquiring a loan, and the group that had the largest net income at the end would be declared the winner.

The competitive element increased the energy and focus of the participants. The charged atmosphere catalyzed many of the fishers to make choices that they would not have made in real life. For example, many participants began maximizing the number of fishing nets that they bought. Following several discussions, most fishers then agreed that it was not realistic for a pair of fishers to handle more than 20 to 25 nets. They also discussed the role that a large number of nets could have on resource decline. The fishers eventually decided that they would set limits on the number of nets that they could have in the game, taking into consideration the need for resource regulation as well as the feasibility of implementing such a rule in reality.

Competition also led to some teams challenging the realism of choices made by other teams. This typically resulted in lively discussions, based on experiences, as to why or why not such an action was possible. The discussions were constructive, fleshing out the details of various fishing strategies. For example, one pair in the game had maximized the amount of fish that they could store in their cooler, so they decided to fish in the morning, travel to a processor to sell the product at midday, and then return to set their nets again in the evening. This started a discussion of travel times, costs, and transaction times, resulting in agreement that, while the strategy was possible, it would leave the fishers so exhausted that no one would carry it out in practice.

It also became apparent that fishers' choices were not based solely on income maximization. Fishers would not fish every day, even when there was the opportunity to go out. Their decisions were based on other aspects of well-being, with leisure time as an important component. While this exploratory study was necessarily limited, future iterations of the game could introduce more realistic aspects of local livelihoods, such as maximizing income subject to the constraint of having a minimum number of leisure hours, or investing profits in entertainment devices, such as TVs, before investing in more nets.

The game-playing process led to a better understanding of important aspects of the fishing economy for many participants. It allowed for deeper exploration of the operational details of fishing cooperatives, as well as discussions of the pros and cons of local ice production. In the following sub-sections we draw on our fieldwork and existing literature to discuss the potential of participatory modeling to increase the two-way flow of information between the "technical expert" and the fishers. We also reflect on the role of the facilitator in participatory modeling, and on how games can be used for the sustainable management of natural resources such as fisheries.

Artisanal Fishing Cooperatives

The primary motivation for most fishers to join a cooperative was to gain access to loans or free equipment from the government, but few fishers knew how cooperatives were supposed to function or what rights they had as members. Prior to our modeling exercise, most participants were not aware that a cooperative-owned business could offer better prices or a dividend to its members. The knowledge gaps seemed to be the result of insufficient training and communication between the government and the fishers, as well as the weak institutional structures of existing cooperatives.

Several months into the participatory modeling process, a middleman in the community of Orinoco expressed interest in exploring how a cooperative could function as a buyer and seller of fish, as opposed to just offering equipment or financing. He wanted a small group of “the more serious fishers” to participate in the game and explore how a well-run cooperative could be organized. We designed accounting sheets to comply with the financial management rules stipulated by Nicaragua’s policies for cooperatives. The middleman’s wife, who managed his finances, came to the session to play the role of accountant, along with a group of six fishers.

The most surprising outcome for the participants was the extra income received as a dividend paid to them from the cooperative. Nicaraguan law for a registered cooperative states that up to 58% of profits from the cooperative *should be* returned to the members, and *should be* allocated to each member based upon the percentage of total fish that he or she has contributed. At the end of the game, the accountant calculated the profits of the cooperative, and determined the dividend to be paid back to the fishers. Not everyone was clear on the details of these calculations, but most players understood that their earned dividend was based on the proportion of fish they contributed.

After a similar game session in the nearby town of Pearl Lagoon, the head of the cooperative there requested a second session to reinforce his understanding of how to calculate the dividend to be paid back. The fishers, the majority of whom were members of the cooperative, were surprised to learn that the rules of the game were based upon the actual bylaws that all cooperative-run businesses are supposed to follow in Nicaragua. By playing the “cooperative” version of the game, the participants gained a clearer understanding of the fiscal and organizational details of cooperatives, which had never been clearly understood in prior government workshops and meetings.

Local Ice Production

Participatory modeling provided a useful framework for exploring how the availability of ice could support strategies for decreasing costs or increasing access to markets. In the game, as in life, fishers purchased plastic ice coolers that could store fish in their boats. In most of the sessions, the game was played with the assumption that the processors or middlemen would supply ice for the coolers. During the game, fishers could purchase the coolers if they had the capital, allowing them to spend multiple days fishing in the lagoon and storing their catches.

We also introduced the possibility of a having an ice machine in one of the villages. The participants discussed estimations, based on past experience, of the capital and operation costs for running an ice machine. Capital invested in an ice machine would not remain productive throughout the year, they said, since peak demand for ice was seasonal, following the productivity of the fish or shrimp.

Playing the "ice game" with accounting sheets allowed fishers to quantify how the use of ice reduced their transportation costs. However, the simple version of the game that we developed did not reveal the complications of owning and operating the ice machine. The manager of the largest fish processor in Bluefields, for instance, was confident that an ice machine would not last long in any community, saying that time and again he had seen ice machines become the Achilles' heels for small companies, requiring scarce capital for parts and expertise for maintenance. Ice production, he argued, should be left to bigger companies. The middleman in Pearl Lagoon, however, had investigated buying an ice machine, and thought they could be operated without many maintenance problems.

This difference of opinion highlights a challenge in the modeling process. There may be details in a development plan about which information is sparse, the veracity of the information is questionable, or beliefs are determined by self-interest. It is therefore important to explore the sensitivity of outcomes on parameters such as operational costs, expected lifetimes, and ownership models. In the same way that uncertainty was introduced into the game for daily catch amounts, or for chance events, future variants in the game could allow participants to explore ice machine-related risks; versions of the game could be played with the machine failing after one or two seasons, being unfairly managed, or producing less ice than is demanded.

The range of these uncertainties was not visible to most artisanal fishers in Pearl Lagoon at the time of our study. The perceived value of local ice production, founded on partial understanding of the costs and benefits, had already manifested itself in overwhelming demand for ice machines. Both government and non-government organizations (NGOs) had responded by putting ice machines into development project plans, perhaps unwittingly ignoring the technical, managerial and financial capabilities necessary to maintain an ice machine in these precarious local economies.

The Role of the Facilitator

Engaging adults in experiential processes and facilitating dialogue are considered key aspects of transformative learning (e.g. Fanning and Gaba 2007). In the case of our participatory modeling process, the facilitator played a dual role as observer/learner and facilitator. In the first few iterations of the game prototype, the facilitator asked questions that did not necessarily increase the fishers' knowledge, but helped him come to a better understanding of the fishers' behavior. During this initial process, the facilitator both gained knowledge of the context of the fishing economy and helped determine which fishing behaviors lent themselves easily to rules that could be implemented within the game. During the later stages of game-playing, the facilitator suggested possible fishing strategies, asked why certain decisions had been prioritized over others, and sought to open up debates when participants expressed differing points of view. Thus the dual role of observer-questioner was essential for many "technical" solutions to be explored during the game-playing process.

We found that maintaining a neutral role for a facilitator could be challenging. As individuals, our actions are guided by our experiences, habits, and desires, all of which obscure an objective awareness of our reality. During several game sessions, an observer (who was not the facilitator) was present, remaining in silence outside the perimeter of the game, and taking note of the dynamics and power relations among the participants, and between the participants and the facilitator. The observer paid particular attention to players' interests and understanding, and the facilitator's ability to be respectful, stimulate discussion, and maintain interest. During later game-playing sessions a number of the players who had participated in earlier games spontaneously took over the role of facilitator, explaining the game to new players and managing the playing, allowing the facilitator to step back and become an observer.

Participatory Modeling and Resource Management

One of the most challenging problems for the Pearl Lagoon communities was sustainably managing their fishery resources. Much has been written about the governance challenges of shared fisheries (e.g., Stevens, Frank, and Kramer 2015), which have been described as "wicked" problems: hard to define, offering no technical solutions, and with no resolvable end-point (Jentoft and Chuenpagdee 2009; Rittel and Webber 1973). Wicked problems are particularly resistant to technical "fixes". Research following the path-breaking work of Ostrom (1990) suggests that cooperative management of natural resources is highly dependent on the ability of stakeholders to craft rules, learn, and trust one another (Agrawal 2003; Castillo et al. 2011). Forms of participatory games have already been used to model resource decline in fisheries (Castillo et al. 2011; Worrapimphong et al. 2010). Our experience with participatory modeling suggests that, where information discovery, communication, and negotiation among development agents and communities are essential, games offer critical insights into viable management options.

All participants that we interviewed during the modeling process believed that their fishing economy would worsen due to overfishing, unless fishing behavior changed. Both fishers and buyers claimed to support a closed season when fishers would not be allowed to fish with nets. While there is a sanctioned process to develop regulations in consultation with delegates from the municipal government and communities, at the time of this research there was no roadmap that defined how any regulations would be designed or enforced.

Game sessions revealed that fishers did want to limit the number of nets, but with a slight increase over the number that most individuals were currently using. Although most supported a closed season, they did not have a common understanding of its costs and benefits, or of how the ban would be enforced; they also felt that fishers would need alternative incomes. The majority believed that the government must set and enforce fishing regulations, such as limits on net size or banning the use of nets during spawning months. The community members lacked faith in their own ability to prevent neighbors from fishing during a closed season; the challenges to self-regulation have been well-documented in the foundational works of collective management (e.g., Baland and Platteau 1996). However, there was little evidence that the Nicaraguan government had the will or capacity for enforcement. Over the prior twenty years there had been several projects aimed at supporting community management of lagoon resources (Christie et al. 2000; González 2011, 294–98), but few of them had lasting impacts.

Based on our observations, participatory modeling in the Pearl Lagoon basin could help, especially to develop a viable management strategy and policies that would give fishers a vision of how a catch-limiting solution could work. There was no recent history of successful management of their fisheries, so both fishers and buyers were pessimistic that a solution might exist. In such cases, participatory modeling provides a forum for community members to engage with government officials to explore a range of enforcement options. Of course, the development of feasible management plans needs to address the socio-political challenges of enforcement (Stevens, Frank, and Kramer 2015), especially where financing and leadership capabilities are weak. However, the process of developing a clear vision that has both community and government support, which may admittedly take the form of “rendering technical" a set of deep development problems, is a necessary first step towards starting a dialogue or initiating change.

Caveats and Limitations

Participatory modeling has limitations that can moderate its potential effectiveness (see Jones et al. 2009). The outcomes of processes intended to be participatory can be influenced by power relations among the participants (White 1996), as well as by the facilitator. During the game-development phase, it is critical that the facilitator gain a clear understanding of the key stakeholders, and ensure that the game is understandable and accessible to groups who tend to have less influence (such sub-groups may include women, less educated people, poor or minority communities, etc.). In our experiments, there were two clear ways in which the development and use of the game was influenced by sub-groups of fishers. First, the group of participants during the initial meetings influenced the evolution of the game, providing feedback about the aspects that they liked and found useful. For example, the majority of participants enjoyed the use of accounting sheets, which necessitated ease with reading and basic arithmetical calculations. However, the use of these sheets could lead to the exclusion of less literate fishers; one older fisher mentioned that he preferred an earlier version in which the accounting was done by counting piles of beans, rather than using accounting sheets. Secondly, in Orinoco, tailoring the game to "serious fishers" for exploring the management of cooperatives was a potential form of elite capture, especially if the knowledge gained from the game was not shared, or was used in ways that marginalized other fishers.

Finally, the first author played the role of facilitator, alternately supporting and challenging the information and ideas of the participants. However, one can easily imagine a situation where the facilitator has a specific technology or policy to advance. The facilitator could provide biased information, or focus the modeling process on pre-targeted solutions. In addition, the participatory process could become truncated into a short time period, increasing the probability that information discovery and recurring themes are not given adequate time to emerge. In order for the participatory modeling method to facilitate the discovery of realistic solutions, it is critical that the facilitator plays a conscientious and self-critical role, and that participants are able to cross-check and validate information as relevant details and causal relationships emerge.

Conclusions

We introduced participatory modeling in three communities in the Pearl Lagoon basin to help artisanal fishers gain a clearer understanding of their fishing economy, their own fishing decisions, and the impacts of fishery-based projects. We were motivated by the premise that the failure of well-intentioned development is often a failure of communicating project details by the experts in charge, the failure of development practitioners to understand local nuances and rationales, and the need for participants to co-construct technical solutions. Our specific goal was to investigate a participatory modeling method that could help participants explore important details embedded in, or abstracted from, technical solutions. From a practitioner's perspective, the participatory modeling process can support the creation and review of proposed development projects and policies, uncovering false assumptions about realities and preferences of the targeted beneficiaries.

Our process resulted in the development and playing of a board game that provided an accessible learning method for understanding how a cooperative can function as a business and how a dividend is calculated and paid, uncovering a development avenue that had not been clearly communicated to fishers, despite years of government workshops. The game became a forum in which the interaction of various technical parameters, such as cost, quantity of ice, and management of ice production, could be openly explored rather than obscured in the summary analyses of experts. We found that through a *collaborative* process of simplifying reality, the intuition of facilitators and community groups were deepened regarding particular fishing practices and management policies.

We conclude that participatory modeling, through making new realities more accessible, can bring about new aspirations, new contestations of expert's plans, and, ultimately, more thoroughly communicated and negotiated "technical" projects. Without an understanding of viable alternatives, a community may be resigned to, and thus accepting of, the status quo. Games, created through a participatory process, can allow the participants to develop detailed and shared visions, potentially opening up new development pathways.

We acknowledge that there are both benefits and perils of participatory modeling within institution-led development projects. These games require a nearly-unbiased facilitator, and the creation of methods through which development details can be uncovered, verified, or challenged. Project level participatory exercises cannot be transformative unless they engage with the political and social structures that create marginalizing conditions in the first place.

Communication and information discovery do not directly bring about action; there is much work to be done to understand how, and when, participatory modeling can be a catalyst for change.

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