



UNIVERSITY
OF WOLLONGONG
AUSTRALIA

University of Wollongong
Research Online

SMART Infrastructure Facility - Papers

Faculty of Engineering and Information Sciences

2010

SimReef and ReefGame: gaming for integrated reef research and management

Deborah Cleland

Australian National University, Deborah.Cleland@anu.edu.au

Anne Dray

Australian National University

Pascal Perez

University of Wollongong, pascal@uow.edu.au

Rollan Geronimo

Conservation International Quezon City Philippines

Publication Details

Cleland, D., Dray, A., Perez, P. & Geronimo, R. (2010). SimReef and ReefGame: gaming for integrated reef research and management. In D. Cleland, J. Melbourne-Thomas, M. King & G. Sheehan (Eds.), *Building capacity in coral reef science: An anthology of CRTR scholars' research 2010* (pp. 123-129). St Lucia: University of Queensland.

Research Online is the open access institutional repository for the University of Wollongong. For further information contact the UOW Library:
research-pubs@uow.edu.au

SimReef and ReefGame: gaming for integrated reef research and management

Abstract

As threats to coastal and ocean systems grow in scale and complexity, the calls for new approaches to research and management grow in volume. The Modeling and Decision Support Working Group (MDSWG) of the CRTR Program has developed two participatory gaming tools that address the need for integrative approaches to coral reef management. SimReef is a regional model and role-play game aimed at policy makers and industry representatives. It simulates coastal development trajectories and trade-offs between environmental, social and economic concerns. ReefGame is a local-level model and board game that helps local people and reef managers explore interactions between livelihoods, reefs and fisheries. We have used these tools successfully in participatory workshops in the Philippines and Mexico. These experiences demonstrate that using games with stakeholders can be a powerful way to educate and involve the public in coral reef management.

Keywords

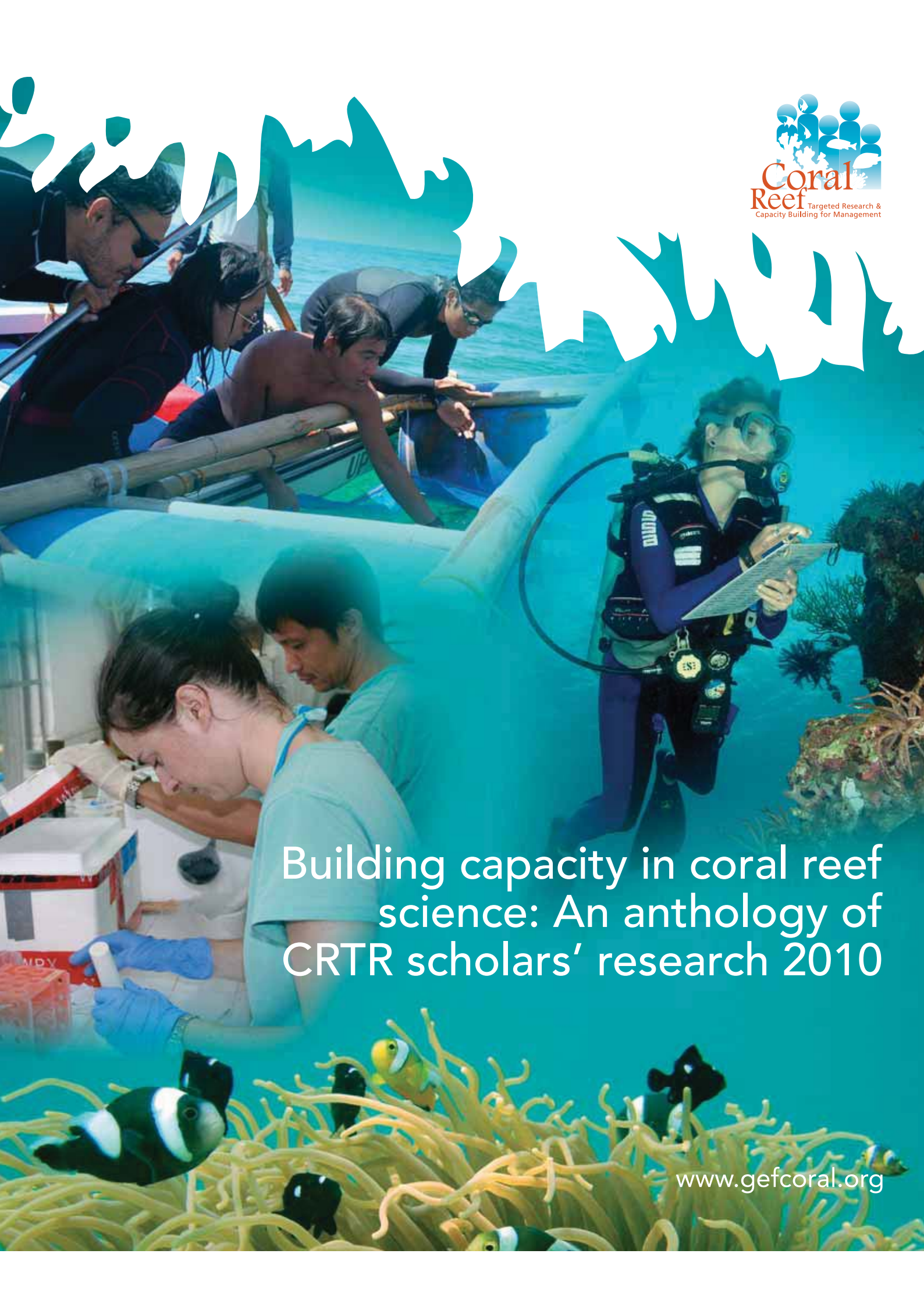
management, gaming, integrated, reef, reefgame, research, simreef

Disciplines

Engineering | Physical Sciences and Mathematics

Publication Details

Cleland, D., Dray, A., Perez, P. & Geronimo, R. (2010). SimReef and ReefGame: gaming for integrated reef research and management. In D. Cleland, J. Melbourne-Thomas, M. King & G. Sheehan (Eds.), *Building capacity in coral reef science: An anthology of CRTR scholars' research 2010* (pp. 123-129). St Lucia: University of Queensland.



Building capacity in coral reef
science: An anthology of
CRTR scholars' research 2010

Acknowledgements

This anthology has been made possible through the continued support of the CRTR Program's Executive Officer, Melanie King. Many thanks to Melanie for her tireless efforts in fostering links within the CRTR scholar network. Thanks also to Gabrielle Sheehan and Mark Paterson of Currie Communications for encouraging the scholar group to communicate their research findings in a wide variety of formats.

Thank you to the Chairs of the CRTR Working Groups and Centres of Excellence for their involvement with the CRTR Future Leaders' Forum in 2007, and for their critical role in supporting the research programs of individual scholars. Our sincere appreciation also goes to all the other presenters and facilitators at the Future Leaders' Forum, for their dedication, inspiration, vision and leadership. Thanks especially to Andy Hooten, for encouraging us to think of CRTR as our research 'family' and reminding us that there is life outside academia.

Finally, thanks go to Professor Peter Sale (Chair, Connectivity Working Group) for contributing the preface to this anthology and to Professor Roger Bradbury (Chair, Modeling and Decision Support Working Group) for initially suggesting the idea for an anthology of CRTR scholars' research.

Contributing authors: Jess Melbourne-Thomas, Deborah Cleland, Suzanne N. Arnold, Maria Vanessa Baria, Iris S. Bollozos, Courtney S. Couch, Dexter W. Dela Cruz, Romeo M. Dizon, Tak Fung, Rollan C. Geronimo, Adán Guillermo Jordán-Garza, Georgina Gurney, Kirk Kilfoyle, Narinratana Kongjandtre, Ainhua Leon Zubillaga, Mohammed Suleiman Mohammed, Angela M. Mojica, Morgan E. Mouchka, Jacqueline L. Padilla-Gamiño, Eileen.L. Peñaflor, Isabel Porto, Rachel Ravago-Gotangco, Chris M. Roelfsema, Pablo Saenz-Agudelo, Eva Salas, Victor S. Ticzon, Mark Windell B. Vergara, Kareen Vicentuan-Cabaitan and Ronald D. Villanueva.

Editors: Deborah Cleland, Jess Melbourne-Thomas, Melanie King, Gabrielle Sheehan.

Cover photos: (top left) Inspecting the nets, Bolinao Reef Flat, Philippines (Photo: M King); (top right) Jess Melbourne-Thomas recording research data (Photo: M Flavell); (bottom) Panda clownfish and three-spot damselfish, Schumann Island, Papua New Guinea (Photo: S Planes); (middle left) Courtney Couch and Mark Dondi Arboleda researching coral disease.



The Coral Reef Targeted Research & Capacity Building for Management (CRTR) Program is a leading international coral reef research initiative that provides a coordinated approach to credible, factual and scientifically-proven knowledge for coral reef management.

The CRTR Program is a partnership between the Global Environment Facility, the World Bank, The University of Queensland (Australia), the United States National Oceanic and Atmospheric Administration (NOAA) and approximately 50 research institutes and other third-parties around the world.

Contact: Coral Reef Targeted Research & Capacity Building for Management Program,
c/- Global Change Institute, Gehrman Building, The University of Queensland, St Lucia, Qld 4072, Australia
Tel: +61 7 3346 9942 Fax: +61 7 3365 4755 Email: info@gefcoral.org Internet: www.gefcoral.org

ISBN: 978-1-921317-03-0 (Online) 978-1-921317-04-0 (Hardback)

Product code: CRTR 02/2010

Editorial design and production: Currie Communications, Melbourne, Australia, May 2010.

© Coral Reef Targeted Research & Capacity Building for Management Program

Contents

Preface	iii	3. New tools for understanding and managing coral reef systems	82
The Future Leaders Network	iv	Narinratana Kongjandtre	83
Introduction	v	Insights from the genus <i>Favia</i> to overcome taxonomic uncertainties in coral	
Linking coral reef research across nationalities and disciplines		Angela M. Mojica & Eva Salas	89
1. Understanding local-scale ecological processes	1	Connectivity: a snapshot on techniques and the role of the CRTR Program in the research field	
Suzanne N. Arnold	2	Pablo Saenz-Agudelo	96
Coral survivorship in the gardens of good and evil		Estimating connectivity in marine populations: an empirical evaluation of assignment tests and parentage analysis under different gene flow scenarios	
Jacqueline L. Padilla Gamiño	10	Kirk Kilfoyle	109
Coral romance: exploring coral reproduction with a field perspective		Experimental methods of coral reef restoration: implementing a standardized module intervention and monitoring program in Mexico	
Morgan Mouchka & Courtney Couch	13	Chris M. Roelfsema	117
The effects of aquaculture effluent on <i>Porites cylindrica</i> innate immune function		A web based toolkit for using remote sensing to map and monitor marine environments	
Adán Guillermo Jordán-Garza	21	Deborah Cleland	123
Is the thin dark line sign on <i>Montastraea cavernosa</i> associated with tissue loss and caused by the presence of cyanobacteria?		SimReef and ReefGame: gaming for integrated reef research and management	
Tak Fung	27	Georgina Gurney	132
Modeling reefs at a local scale: the elements of design		Integrated models of natural and human systems: a critical component of environmental management	
2. Reef dynamics and management actions at regional scales	34	Spotlight on:	
Isabel Porto & Ainhoa Leon Zubillga	35	Mark Dondi Arboleda	8
Regional scale of genetic connectivity among <i>Acropora palmata</i> and <i>Montastraea faveolata</i> populations		Ronald Villanueva	9
Mohammed Suleiman Mohammed	42	Maria Vanessa Baria	19
Preliminary investigation of coral reef diseases in Tanzania, East Africa		Kareen Vicentuan-Cabaitan	20
Eileen Peñaflo	48	Scholars at the International Coral Reef Symposium	40
Sea-surface temperature and thermal stress in the Coral Triangle over the past two decades		Patrick Cabaitan	41
Mark Vergara et al.	59	Dexter dela Cruz	46
Status of coral reef research in the Bolinao-Anda reef complex, northwestern Philippines		Victor Ticzon	47
Jess Melbourne-Thomas	77	Rollan Geronimo	94
A decision support tool for managing coral reefs at regional scales		Rachel Ravago-Gotanco	95
		Mark Vergara	120
		Scholars in the news	
		Effective reef governance: Southeast Asia	32
		Sensing the complexity of habitat	33
		Building community capacity	75
		Lessons in coral culture	76
		Keeping watch in the Caribbean	116
		Patterns of Spiny Lobster recruitment	130
		Nong sets sights on Thai corals	131

Deborah Cleland

SimReef and ReefGame: gaming for integrated reef research and management



Deborah is a PhD student at the Fenner School of Environment and Society at the Australian National University. She graduated with a BA/BSc (Hons) from the ANU after completing a thesis focusing on using visual tools, including participatory models and board games, for coral reef and coastal management in the Philippines. Through her PhD, Deborah will continue to examine the utility and potential benefits of using creative techniques to explore alternative livelihood options and locally-based stewardship arrangements in artisanal reef fisheries, as well as the nexus between art and science.



SimReef and ReefGame: gaming for integrated reef research and management

Deborah Cleland¹, Anne Dray², Pascal Perez³, Rollan Geronimo⁴

¹ Fenner School of Environment and Society, Australia National University, Canberra

² Research School of Pacific and Asian Studies, Australia National University, Canberra

³ Research School of Pacific and Asian Studies, Australia National University, Canberra

⁴ Marine Science Institute, University of the Philippines

Abstract

As threats to coastal and ocean systems grow in scale and complexity, the calls for new approaches to research and management grow in volume. The Modeling and Decision Support Working Group (MDSWG) of the CRTR Program has developed two participatory gaming tools that address the need for integrative approaches to coral reef management. SimReef is a regional model and role-play game aimed at policy makers and industry representatives. It simulates coastal development trajectories and trade-offs between environmental, social and economic concerns. ReefGame is a local-level model and board game that helps local people and reef managers explore interactions between livelihoods, reefs and fisheries. We have used these tools successfully in participatory workshops in the Philippines and Mexico. These experiences demonstrate that using games with stakeholders can be a powerful way to educate and involve the public in coral reef management.

Introduction

Globally the health of coral reefs is in decline, largely due to human activity (Pandolfi et al. 2005). Key drivers include climate change, overfishing, tourism, and nutrient and sediment flows from agriculture, mining and towns.

Models are often used in integrated coastal management, to aid understanding, develop scenarios, and explore policy options (Siebenhuner and Barth 2005). Here, we combine models with role-playing games, bringing stakeholders together in a non-confrontational, playful environment (Lynam et al. 2002). The players are given control over certain aspects of a model, so they can make their own decisions and explore different outcomes. Role-playing helps participants (including “experts”) to understand and experience the pressures and constraints felt by others, and allows them to “see” new ways of thinking about a problem (D’Aquino et al. 2003).

The MDSWG has developed two participatory computer games, SimReef and ReefGame, which have been used in workshops in Mexico and the Philippines.

SimReef, Quintana Roo, Mexico

Tourism and coral reefs in Quintana Roo

The arrival of ever-growing numbers of tourists to Quintana Roo, on the Caribbean coast of Mexico, has had a serious impact on the Mesoamerican Barrier Reef system. From about 1975, a wave of mass tourism development has spread outward from the tourist centre Cancun, with annual tourist arrivals now numbering more than 6 million (Daltabuit et al. 2006). Across the state, damage to the reefs caused by human activities has interacted synergistically with natural disturbances, such as hurricanes and coral disease, contributing to the widespread degradation of the reefs (Harborne et al. 2001).

Many industries, communities and families in Quintana Roo are wholly or partly dependent on the ecosystem services provided by reefs, such as coastal protection (Iglesias-Prieto 2009). These groups influence the outcomes of reef management proposals, supporting those they agree with, and blocking those they do not. Improving reef management therefore requires bringing these groups together to create partnerships, share knowledge and, most importantly, negotiate the necessary change in current practices to protect the future of the reefs and the local economy.

SimReef coupled model and role-play game

'SimReef' is a model and coupled role-play game that captures the regional-scale drivers of social and economic change triggered by tourism development in Quintana Roo. The model was kept as simple as possible, so stakeholders could contribute to scenario development, without being presented with a "finished product".

Each group interacts with the SimReef interface, shown on a projector screen. The interface is a schematic representation of the Quintana Roo coastline, showing the location of key ecosystems and human settlements (Figure 1).



Figure 1. Sim Reef Interface

Green = forest, blue = open sea, brown = urban, light blue = lagoon, dark blue = fringing reef, teal = seagrass, pink = temples, grey = cenotes (fresh water holes), pale yellow = scrub and open land, dark yellow = agriculture

The SimReef role-play game mimics real-life negotiation patterns, whilst maximising interactions between groups. The roles represent four major interest groups in Quintana Roo – conservation agencies (public and private), tourism, fisheries and the government (shown as circles in Figure 2 and Figure 3). Each group is given simple goals to structure play and aid strategy formation (indicated in brackets in Figure 2 and Figure 3). For example, the tourism industry's goal is profitability, measured by the income of resorts over each time step.

3. New tools for understanding and managing coral reef systems

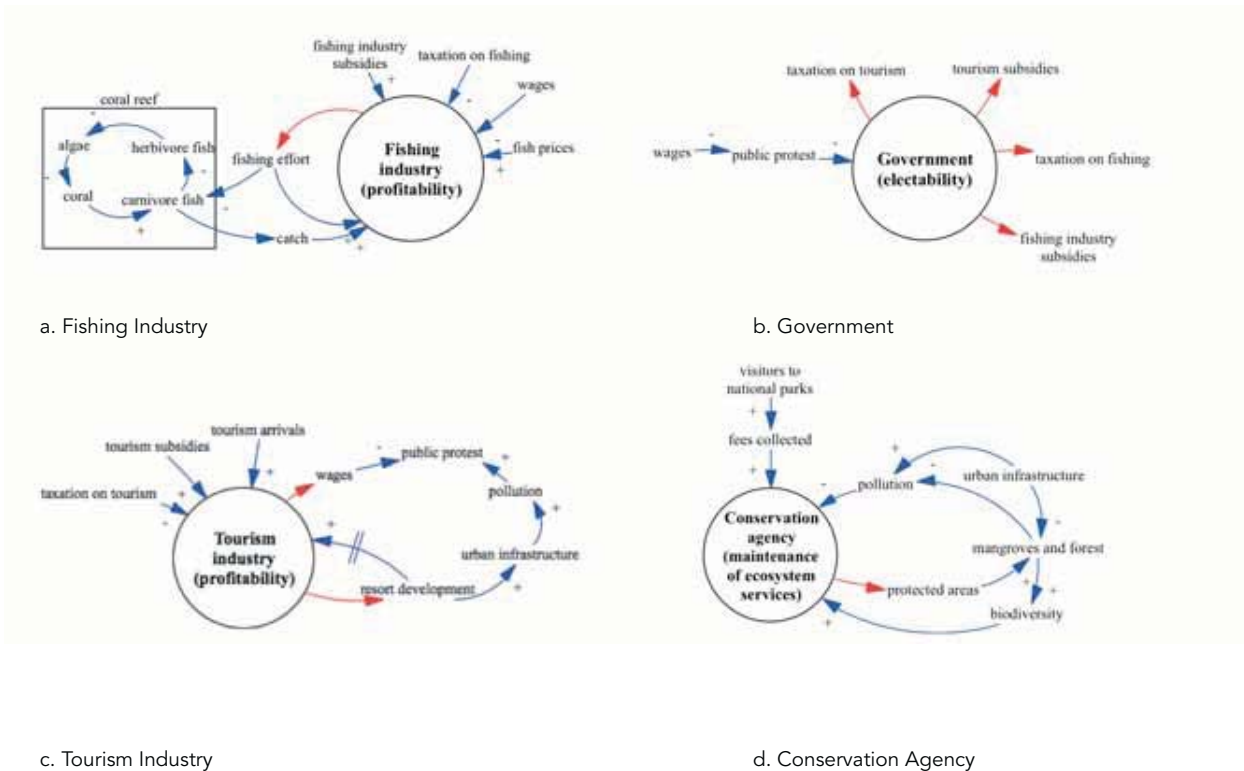


Figure 2. The four roles and their goals, inputs and outputs

The above diagrams illustrate the four roles and their inputs/ outputs, as represented in the SimReef model and role-play game. Positive and negative feedback relationships are marked with +/- signs. Black circles represent the roles discussed in text. Dotted arrows and bold text represent the decisions each role was responsible for (e.g. the Conservation Agency decided the size and location of protected areas).

Every round each group in the role-play game makes decisions about the use of the resources under their control (linked with red arrows in Figures 2 and 3). For example, the tourism role decides the average wage and how many resorts to develop, whilst the fishing role establishes (legal) fishing effort. These decisions then have flow-on environmental and social effects, measured by indicators like 'pollution' and 'public protest'. In turn, these indicators affect the outcomes for the government and the conservation agency. Each group must reach a consensus on their decisions, and negotiate access to funds and approvals through the government. For example, the conservation agency has to obtain permission from the government to establish new protected areas. After reaching consensus, the final decisions are coded into the model. Facilitators then present the results, including whether each group is meeting their established goals.

3. New tools for understanding and managing coral reef systems

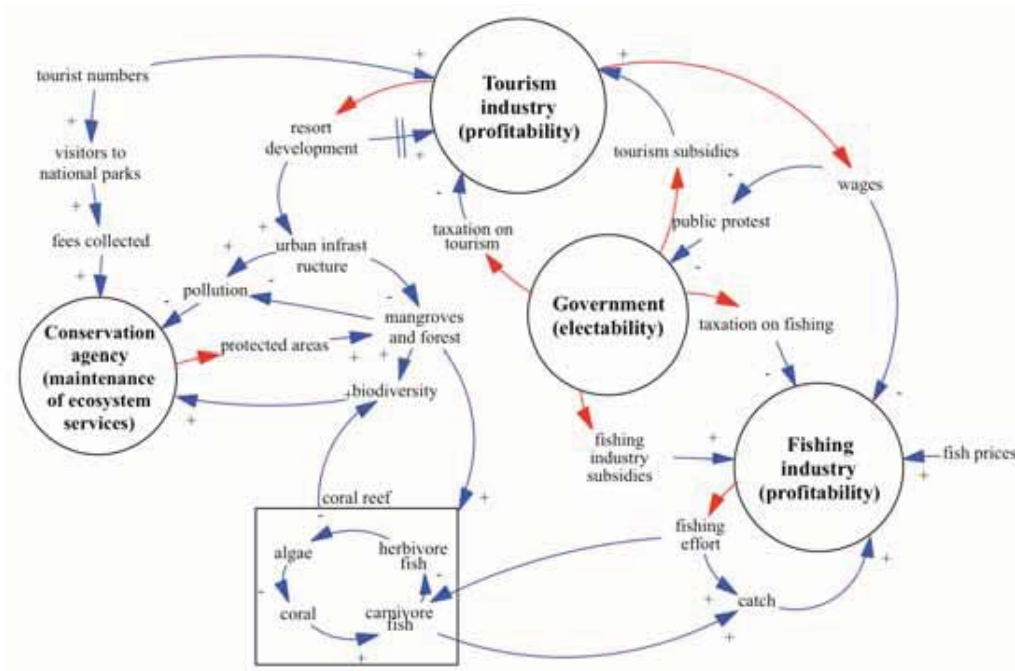


Figure 3. Complete causal loop diagram

The above diagram illustrates the interlinking of the four roles and their inputs/ outputs introduced in figure 2. Positive and negative feedback relationships are marked with +/- signs. Black circles represent the roles discussed in text. Red lines represented the decisions made by each entity

SimReef workshop

SimReef was played at a participatory workshop in Akumal, Quintana Roo, in October 2005. A group of 15 local people participated, representing the federal government's conservation agency, social and marine scientists, a local environmental NGO and an eco-tourism operator. No representatives from the fishing industry were present, although they had been invited. Participants were divided into the four role-play groups, each with a facilitator. Four rounds of the game were played, representing four years. Whilst the model was updated with each round's decisions, the underlying data and assumptions for each of the model's components were presented, so the participants could comment on their perception of the validity of the assumptions, and their recommendations for improving the model. Finally, participants were asked to reflect on the game/model, and its potential for further use as a management tool both in the Quintana Roo context and more generally.

Workshop outcomes

SimReef in Mexico helped to foster relationships and encourage interaction, learning and exchange between researchers and local participants. Introducing fun and play to the participatory context had a particularly positive impact on stakeholder engagement, pointing to some potential for researchers battling stakeholder fatigue.

However, the positive potential of SimReef did not overcome the problems caused by our lack of contact with local stakeholders prior to arriving in Mexico. The outcomes of the workshop were not connected to ongoing projects nor effectively linked to management priorities. Commitment from the individuals and institutions that possess the power to change the behaviours and activities that drive reef degradation is essential. Without this, models and participatory processes in general cannot engage effectively with the structural barriers to improved marine management. These lessons were used to improve design and implementation of the MDSWG's second participatory modeling experiment.

ReefGame, Bolinao, the Philippines

Fishing and reefs in Bolinao

Overfishing is the overwhelming issue for reef management in Bolinao. Falling catches and catch per unit effort are two indicators that target species are close to collapse. Fishing effort needs to be radically reduced if fish stocks are to recover (Meñez et al. 1991; McManus et al. 1992; Licuanan et al. 2006). The burgeoning aquaculture industry, upper-catchment clearing, chemical agriculture and domestic waste streams are also harming the health of the marine ecosystem (Talaue-McManus et al. 2000). Together, these factors mean that the region's growing fisher population is relying on a dwindling resource base that can no longer support the needs of their families. However, limited funds and corruption in the government have meant that little effective management action has been taken (Graham and Sol 2004).

ReefGame coupled model and role play game

ReefGame aims to help fishers understand how overfishing is harming both their livelihoods and the reef, and to start discussions about what could be done. At the same time, we hoped to increase understanding of the fishers' behaviour and livelihood choices as their catches declined.

Unlike SimReef, where users interact directly with the computer interface, ReefGame is primarily a board game. Participants playing in pairs are given a particular fishing identity – with a boat, a family size and ongoing expenses that they have to pay each round. There is also a role for a banker/fish buyer.

Two identical game boards represent a coastal area with an offshore island, made up of sea and land cells and bearing a schematic resemblance to the coast of Bolinao (see figures 4 and 5). Habitat cards are distributed on the sea cells, showing where mangrove, seagrass, coral-dominated reef and algae-dominated reef are located. Designated land cells have livelihood icons, initially one for each of the different activities available (e.g. carpentry and taxi-driving).

Half the participants play around each board. Using both boards means that groups are kept small and different conditions and scenarios can be applied to each. Scenarios include Marine Protected Area implementation, introduction of different livelihoods and migration possibilities, and natural disasters.



Figure 4. Game board showing fisher and habitat tokens



Figure 5. Fishers playing ReefGame

In each round of the game, each pair either goes fishing (by moving their token to any sea cell) or works for a wage in another occupation (the corresponding land cell).

The computer model accompanying ReefGame calculates each pair's catch and income. Fishers receive fish tokens that represent catch biomass. Fish tokens are swapped for money tokens, which are used to track each pair's income (or debt). After players receive their gross earnings, the banker collects family expenses from each player.

ReefGame workshop

Twenty fishers played ReefGame at a one-day participatory workshop in Bolinao, the Philippines in September 2007. We have also used ReefGame as an educational tool in undergraduate and postgraduate workshops at different venues around Australia and the Philippines.

3. New tools for understanding and managing coral reef systems

Workshop outcomes

The Philippines workshop demonstrated that models and games are powerful community education and outreach tools, eliciting rich responses and discussion from participants. Facilitators commented that workshop attendees interacted enthusiastically and naturally with the game and each other. This is in stark contrast to interview and focus groups they had experienced, where 'information extraction' was the sole purpose, creating a stilted one-way interrogation. Participants were also pleased about experiencing something different from the 'typical' workshop setting with butcher's paper and PowerPoint presentations. Most also identified that the workshop had helped them build relationships with peers and learn about reef function and management.

Further research

Together with an extended team based at the University of the Philippines, MDSWG members secured funding from the David and Lucille Packard Foundation through the Ecosystem Based Management (EBM) Tools Network to run participatory modeling workshops in 5 different towns throughout the Philippines in 2010. These workshops will have a strong emphasis on multi-sectoral integration to help find sustainable alternative and supplementary livelihoods for the artisanal fishers who are dependent on reefs. Thus, we will continue the approach initiated with SimReef and continuing with ReefGame in using models and games to improve outcomes of participatory modeling workshops for people and management.

Conclusion

SimReef and ReefGame have very different foci and target audiences, but both were able to elicit creative and interactive responses from key stakeholders. Thus far, gaming has been a valuable tool to build relationships and conduct social research. Moreover, it shows promise as a decision support tool for marine managers. The SimReef workshop demonstrated the dangers of neglecting the traditional concerns of participatory research, particularly local power relationships and the integration of the researchers with the local community and decision-making processes. However, we have drawn a number of important lessons from these experiences, and have incorporated stronger and more direct links to management decisions in our current work.

Acknowledgements

Deborah Cleland would like to thank all participants of SimReef and ReefGame workshops most sincerely for their time and energy. Abbie Trinidad (Conservation International) and Porfirio Alino (Marine Science Institute, University of the Philippines) provided expert advice and support in the development of ReefGame and also facilitated the Bolinao workshop. This work was largely completed as part of Deborah Cleland's honours research, supervised by David Dumaresq, convener of the Human Ecology Program, Fenner School of Environment and Society, ANU. Aspects of this research were presented at the International Coral Reef Symposium in Fort Lauderdale, USA in 2008 and the World Oceans Conference in Manado, Indonesia in 2009. Some material from this paper has also been adapted from a paper by Cleland et al, REEFGAME: exploring the dynamics of subsistence fishing communities, submitted to Simulation and Gaming in September 2009.

References

- Cleland D, Wyborn C (in press) Using visual methods to explore conflicts in land and seascape management. In: Brown VA, Harris J, Smith M (eds) Tackling wicked problems: using the transdisciplinary imagination. Earthscan, London,
- D'Aquino P, Le Page C, Bousquet F, Bah A (2003) Using self-designed Role-Playing Games and Multi-Agent Systems to empower local decision-making process for land use management: The SelfCormas experiment in Senegal. *Journal of Artificial Societies and Social Simulation* 6:<http://jasss.soc.surrey.ac.uk/6/3/5.html>
- Daltabuit M, Vázquez LM, Cisneros H, Ruiz G (2006) El Turismo Costero en la Ecorregión del Sistema Arrefical Mesoamericano. Universidad Nacional Autónoma de México, Cuernavaca, Morelos
- Graham J, Sol N (2004) Rethinking Governance, Social Conflict and Livelihood Choices: Stories from Prieto Diaz, Philippines The Commons in an Age of Global Transition: Challenges, Risks and Opportunities the Tenth Conference of the International Association for the Study of Common Property Oaxaca, Mexico
- Harborne AR, Afzal DC, Andrews MJ (2001) Honduras: Caribbean Coast. *Marine Pollution Bulletin* 42:1221-1235
- Hardin G (1968) The Tragedy of the Commons. *Science* 162:1243-1248
- Iglesias Prieto R (2009) Groundwater pollution and the importance of coral reefs in the protection of the coastal zone The Fifth GEF Biennial International Waters Conference, Cairns, Australia
- Licuanan WY, Aliño P, Campos WL, Castillo G, Juinio-Meñez MA (2006) A Decision Support Model for Determining Sizes of Marine Protected Areas: Biophysical Considerations. *The Philippine Agricultural Scientist* 89:507 - 520
- Lynam T, Bousquet F, Le Page C, D'Aquino P, Barreteau O, Chinembiri F, Mombeshora B (2002) Adapting science to adaptive managers: spidergrams, belief models and multi-agent systems modeling. *Conservation Ecology* 5:<http://www.consecol.org/vol5/iss2/art24>
- McManus JW, Nañola CL, Reyes RB, Kesner KN (1992) Resource ecology of the Bolinao coral reef system International Center for Living Aquatic Resources Management, Manila
- Meñez LAB, McManus LT, Jimenez JF, Rivera CA, Concepcion J, Luna Cz (1991) Survey of the coral reef resources of the Western Lingayen Gulf, Philippines ICLARM
- Pandolfi JM, Jackson JBC, Baron N, Bradbury RH, Guzman HM, Hughes TP, Kappel CV, Micheli F, Ogden JC, Possingham HP, Sala E (2005) Are U.S. Coral Reefs on the Slippery Slope to Slime? *Science* 307:1725-1726
- Siebenhuner B, Barth V (2005) The role of computer modeling in participatory integrated assessments. *Environmental Impact Assessment Review* 25:367-389
- Taluae-McManus L, Clemente RS, Gomez E, Licuanan W, McGlone D, San Diego McGlone ML, Siringan FP, Villanoy CL (2000) Synthesis Report. In: Institute MS (ed) Economic Evaluation and Biogeochemical Modeling of Lingayen Gulf in Support of Management for Sustainable Use