CCRES

Capturing Coral Reef and Related Ecosystem Services Project

SITE REPORT

EL NIDO, PHILIPPINES

NOVEMBER 2018

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CONTENTS

Gleaning on the beach.
Photo: M. Paterson

PILOT SITE

EL NIDO: OUR PILOT SITE IN THE PHILIPPINES

El Nido is a coastal municipality in the north of Palawan in the Philippines. With 18 barangays (the smallest administrative division in the Philippines) and covering 465 square kilometres, the western side of the municipality (Bacuit Bay) has been declared a national managed resource-protected area due to its high marine and terrestrial biodiversity.

Historically, fishing and agriculture have been the main industries in El Nido. Once a boutique tourism location, increasing publicity on the area's dramatic natural beauty and world-class diving in recent years has fuelled the local tourism industry, particularly the backpacker market. El Nido's main town is developing rapidly to cater for increasing tourism. The local population is expanding as immigrants arrive from other areas in the Philippines seeking work in the growing economy.

The area's coral reefs, seagrass beds and mangroves create a rich marine environment. These ecosystems provide El Nido with essential services, including fish to eat and sell, eco-tourism, water filtration and shoreline protection from storms.

El Nido foreshore.
Photo: R. Martinez

LEADERS MEET

CCRES Advisory Board members met with CCRES staff and researchers at El Nido in May 2015 to observe geography, issues and challenges.

▲ **(L to R) Dr Firdaus Agung (Ministry of Marine Affairs and Fisheries, Indonesia), Adrian Ross (PEMSEA), Miledel Quibilan (UPMSI), Dr Zainal Arifin (Indonesian Institute of Sciences), Undersecretary Analiza Teh (DENR), Ms Melanie King (UQ) and Dr Maya Villaluz (WAVES project).**
Photo: G. Sheehan

Pollution, overfishing, unsustainable development and climate change are impacting these ecosystems — and the services they provide. Similar effects are being felt in coastal communities across the Philippines and the East-Asia Pacific.

In 2014, El Nido was chosen as the Capturing Coral Reef and Ecosystem Services (CCRES) project's pilot site in the Philippines. As a fast-growing tourism destination, El Nido provided an exemplar of the pressures faced by coastal communities and the ecosystems on which they depend. El Nido has also been the focus of several research projects by the University of the Philippines Marine Science Institute (UPMSI), our lead agency in the Philippines, so there were existing relationships with potential local partners as well as several data sets to draw upon for the research aspects of the project. As part of the El Nido — Taytay Managed Resource Protected Area (ENTRMPA), environmental values were also clearly recognised by the local stakeholders.

Importantly, there was strong interest in CCRES and support from local partners including the El Nido Local Government, the Palawan Council for Sustainable Development (PCSD), Palawan State University (PSU) and the El Nido Foundation (ENF). Local and national partnerships underpinned the implementation of CCRES. The involvement of local communities, government and businesses was critical to delivering the project's outcomes and ensuring that the tools that were developed were relevant, practical and accurate.

El Nido has an incredibly diverse marine environment – home to 910 fish species, more than 400 species of coral, and eight species of seagrass. It provides nesting habitat to three species of endangered sea turtles (hawksbill, green sea, olive ridley). Large marine vertebrates sighted in the area include dolphins, whales, manta rays, whalesharks and dugongs.

It is also home to over 41,000 people[1], the vast majority of whom depend on the fragile ecosystems for their livelihoods and their food.

CCRES hopes that our work in El Nido will benefit both the natural environment and the people who depend on it in years to come.

[1] National census, 2015

Artisnal fishing catch at El Nido Cove on morning high tide.
Photo: M. Paterson

KNOWLEDGE, NETWORKS, EXPERTISE

The technical expertise, strong networks and informed perspectives of our partners in the Philippines were critical to ensuring the tools developed by the CCRES project are used at and beyond the pilot site.

We would like to thank our partners in the Philippines for their contribution to our work in El Nido. They include:

- Department of Environment and Natural Resources (DENR) through the Biodiversity Management Bureau
- Marine Science Institute (through the Marine Environment & Resources Foundation), University of the Philippines, Diliman (UPMSI)
- Palawan State University (PSU)
- Palawan Council for Sustainable Development (PCSD)
- El Nido Local Government
- El Nido Foundation (ENF)

We would also like to acknowledge the contribution of the Ten Knots Development Corp.

FAST FACTS: EL NIDO

465 km²
bound by three bodies of water: West Philippine Sea, Linapacan Strait, Sulu Sea

16
of its 18 barangays are coastal

Large marine vertebrates sighted: **dolphins, whales, manta rays, whalesharks, dugongs**

Population: approx.
41,606

4.77%
population annual growth rate (primarily immigration)

Main livelihoods: **agriculture, fishing, and tourism**

Number of tourists:
200,000
in 2015
(increasing at 30% per year)

45
genera of hard coral

8
species of seagrass

197
species of fish

El Nido – Taytay Managed Resource Protected Area (ENTMRPA)
90,321 hectares
of primary forest, coral reef, limestone islands and open water

3 major marine habitats are present: **coral reefs, seagrass, mangroves**

Home to 5 of the 7 species of
sea turtle

► **CCRES researchers in action.**
Photo: S. Cabacaba.

THE PROJECT

RESEARCH, TOOLS FOR STRENGTHENING COASTAL MANAGEMENT

The CCRES project is a technical assistance project that seeks to support coastal management across the East Asia-Pacific.

The key question the CCRES project sought to answer is:

How do we assist decision-makers improve the welfare of people who depend upon coral reef-related ecosystems for their food, protection and livelihoods?

The multidisciplinary activities undertaken at El Nido involved leading centres of science, learning and engagement from the Philippines, Australia, Indonesia and the United States.

Based on this research CCRES has developed tools (models, applications, processes, frameworks) for use in marine planning, systems analysis, business development and behaviour change projects.

The tools assist coastal planners, managers and policymakers to make informed decisions that enhance livelihoods and food security, improve community welfare, and sustain coastal ecosystems.

The CCRES project is funded by the Global Environment Facility, the World Bank and the University of Queensland (UQ). These organisations, together with another 15 international, regional, national and local CCRES partners, have provided worldclass expertise in marine planning, systems thinking, business innovation, behaviour change and stakeholder engagement.

FAST FACTS: CCRES

Timing
July 2014 to December 2018

Partners
18 international, regional, national and local institutions

Pilot sites
SELAYAR
EL NIDO
El Nido, Philippines; Selayar, Indonesia

Funders
Global Environment Facility, World Bank and the University of Queensland

People
100+ researchers and advisors

Tools
15 tools (models, processes, frameworks)

► **El Nido Tourism.**
Photo: M. Paterson

ACTIVITIES

RESEARCH SHOWS LINK BETWEEN CORAL REEFS AND PROSPERITY

Ten principle activities were undertaken at El Nido, Palawan in the Philippines, by local, national and international researchers for the CCRES project between 2014 and 2018. These were:

MARINE PLANNING

- *Food Web*
- *Fish SPACE & related research*
  - *Watershed analysis and sedimentation in coasts*
  - *Sedimentation in mangroves and seagrass*
- *Coastal Protection*
- *Understanding the role of governance*
- *Understanding key sectors*

SYSTEMS ANALYSIS

- *Developing tools for systems thinking*

BUSINESS DEVELOPMENT

- *Eco-Biz Challenge*

BEHAVIOUR CHANGE

- *My Future, My Oceans*

The findings from these activities demonstrate a strong link between the condition of coral reefs, fisheries, mangrove forests and seagrass beds, and the livelihoods and welfare of local people.

The key outputs were tools developed and validated in collaboration with local partners and communities.

▶ **El Nido at sunset.**
Photo: R. Martinez

Marine Planning

Activity: Food Web

RESEARCH

Objective

To develop a food web model for coral reefs that accounts for the influence of coral reef structure and health on the dynamics of a coastal community.

Method

Researchers carried out detailed surveys of key reef sites at El Nido. At each site the team collected information on the cover of live corals, versus dead corals, rubble or algae, and structural complexity of reefs, for input into food web models. In addition, they carried out a study to obtain estimates of the growth rates of turf algae across Bacuit Bay.

Fish surveys, turf algae measurements and coral recruit surveys were also carried out to obtain information on the current condition and resilience of reefs in the region.

The results of the surveys were used in a food web modelling framework that in turn informed development of the CCRES reef complexity model *Reef React*, *Fish SPACE* and other tools.

The model is designed to estimate the productivity and carrying capacity of reef fisheries, based on their structural complexity and health.

Model outputs can be used to inform marine spatial planning focussing on maximizing the value of coral reef fisheries in locations where habitat structural complexity and water quality are variable in space, or threatened to varying degrees.

▲ (L to R) Alice Rogers (UQ), Nils Krueck (UQ), Pete Mumby (UQ), Mags Quibilan (UP MSI), George Roff (UQ) between field activities at El Nido.

Timeline

2015 May
Reef health surveys at El Nido looking at crevice abundance, reef fish, coral recruits, turf and macroalgae

2016 February
Field sites revisited for additional measurements

People

Activity leader: Dr Alice Rogers (UQ)

Researchers/facilitators: Prof Peter Mumby and Dr Nils Kruek, George Roff (UQ), Miledel Quibilan, Carolina Castro, Renmar Martinez (UPMSI)

Local partners: UPMSI

▲ **Deploying tiles during reef complexity work at El Nido, Philippines.**
Photo: C. Castro

FINDINGS

Results of the initial El Nido survey reflected known high fishing pressure in the area, demonstrating the relative absence of large-bodied fish. Results also reflected variability between sites and between fish families.

As a result of this activity (and complementary work in Indonesia), detailed models to examine the effects of habitat complexity on the consumption of prey by reef fish have been developed. Smaller fish have more hiding places in a complex reef which can affect the growth rate of predators. When fish can hide effectively, it is harder for predators to access food. The model predictions were tested against known fish assemblages and once validated were used to create a series of scenarios.

The model is now complete for El Nido and will potentially inform the answers to questions such as:

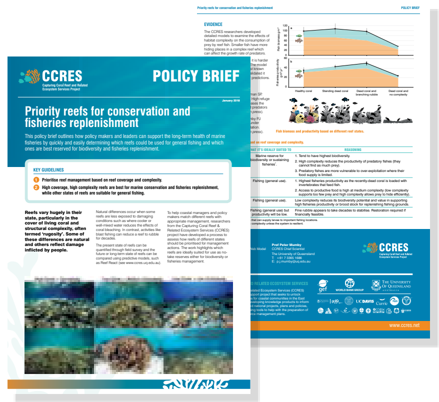
- How much fish production may be lost if XYZ happens?
- How much production can we gain from different management strategies?
- Where should we fish? Where should we protect?
- How much fishing/how many fishers can a particular reef support?
- How might catches (size and type) change over time and in different locations?

Results from the modelling are showing that some habitats support biomass but relatively little productivity (see Figure 1). Analyses have shown that intermediate complexity reefs may provide the best fishing grounds and the healthiest, most complex reefs may be most suited to protection.

OUTPUTS

The outputs from the research were:

- A **policy brief** that outlines how policymakers and leaders can support the long-term health of marine fisheries by quickly and easily determining which reefs could be used for general fishing and which ones are best reserved for biodiversity and fisheries replenishment. Download the policy brief at www.ccres.net.
- Two science publications:
  - Rogers A, Blanchard JL, Newman SP, Dryden CS, Mumby PJ (2018) High refuge availability on coral reefs increases the vulnerability of reef-associated predators to overexploitation. *Ecology* (in press).
  - Rogers A, Blanchard JL, Mumby PJ (2018) Fisheries productivity under progressive coral reef degradation. *Journal of Applied Ecology* (in press).



▲ **A policy brief for coastal planners is one of the outputs from the Food Web activity.**

Coastal managers and policy makers can use the predictive model, *Reef React*, to assess how reefs of different states should be prioritised for management actions. This work highlights which reefs are ideally suited for use as no-take reserves either for biodiversity or fisheries management.

HOW CAN THE RESULTS BE USED?

The aim of the food web modelling framework is to develop a model that can estimate a reef's productivity; that is, how many fish it can support based on its structure and health. This will assist marine spatial planners and coastal resource managers from government and community agencies to estimate the value of coral reef fisheries and their potential to change over time, given different habitat impacts.

THE DATA

The research data is owned and kept by CCRES. Inquiries about the raw data can be made to Prof Peter Mumby (UQ) p.j.mumby@uq.edu.au

For inquiries about the research, findings, outputs, data or technical support, contact Dr Alice Rogers (Victoria University, Wellington, NZ): alice.rogers@vuw.ac.nz

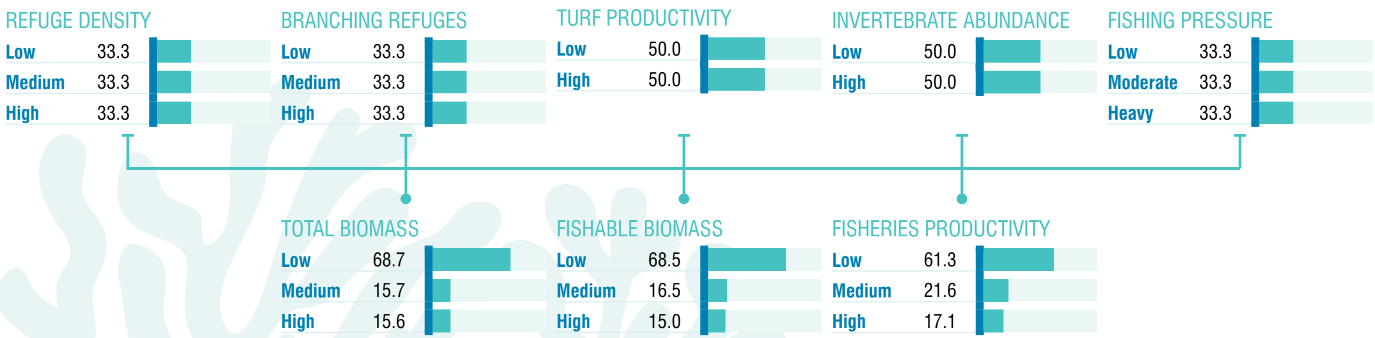


FIGURE 1. Bayesian Belief Network predicting fish biomass and fisheries productivity.

Marine Planning

Activity: Fish SPACE & related research

RESEARCH

Objective

To develop a spatially-explicit tool to support and communicate relevant actions for marine reserve and fisheries management planning and decision-making. The software application shows the effects of decisions on the status of fish stocks and fisheries.

Method

During the development of *Fish SPACE* (Fisheries for Sustaining People's Access through Conservation and Equitable Systems), studies were conducted in El Nido by UPMSI and its partners to develop and gather data for the model. These studies included the ground-truthing of existing habitat maps, development of a connectivity model, and surveys to collect coral reef, reef fish and fisheries data. Complementary research from UPMSI, as well as other activities under the CCRES Project, also supported the project.

Timeline

2014
Conducted ocean current and bathymetry surveys in Lio and Bacuit bays (with the CORVA Project)

2015
Conducted coral reef and reef fish surveys, and fisheries survey

2017–18
Development and improvement of the *Fish SPACE* application

People

Activity leader: Dr Vera Horigue (UPMSI)

Researchers: Chester Balingit, Patrick Pata, Leilani Solera, Anabelle Gammaru, Miledel Quibilan, Prof Porfirio Aliño, Prof Cesar Villanoy (UPMSI); Prof Wilfredo Licuanan (De La Salle University (DLSU))

FINDINGS

Habitat extent and quality

A single habitat map (Figure 2) was created that identified the land, mangrove forests, seagrass beds and coral reefs found in the western side of El Nido, which was identified as the planning region for the model. The habitat map is one of the minimum spatial data inputs of *Fish SPACE*, and serves as the main basis for the development of the planning grid.

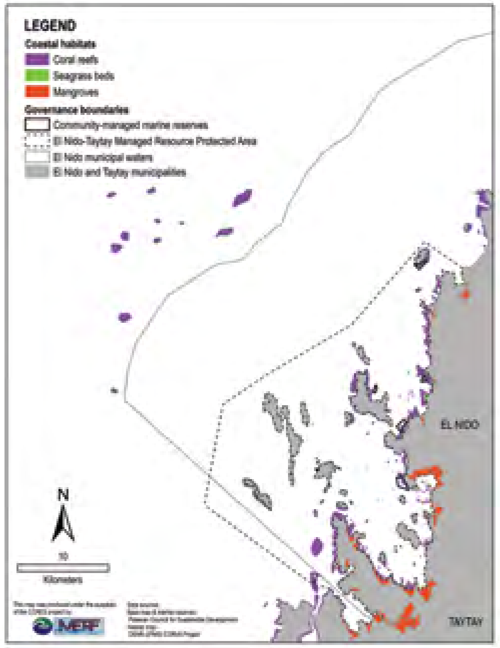


FIGURE 2. Habitats and marine protected areas on the western side of El Nido, Palawan (DENR-UPMSI CORVA Project and PCSD).

Several coral reef areas in El Nido were assessed using research data from rapid surveys of reefs in the country, including sample areas in western El Nido, in 2015 to 2016. Habitat quality data (i.e. % hard coral cover) was extrapolated across the modelling domain and translated onto the reef cells from the habitat grid (Figure 3).

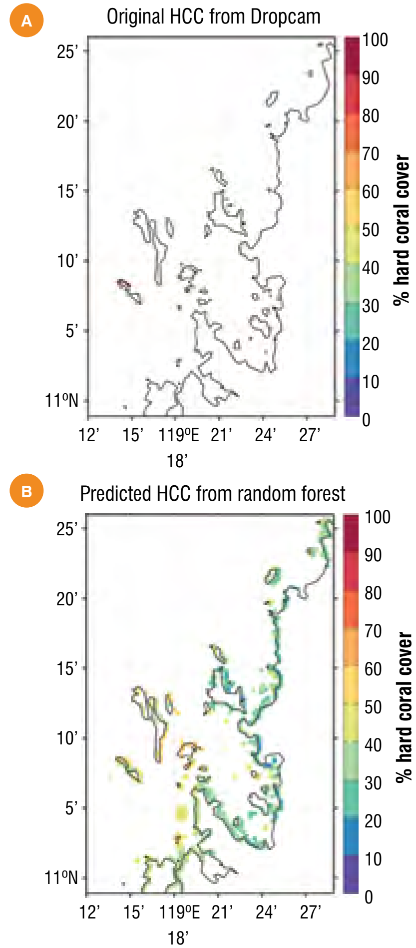


FIGURE 3. A) Reef areas assessed under the DENR-UPMSI CORVA Project; B) Extrapolated hard coral cover fitted to the habitat grid.

Connectivity

In *Fish SPACE*, connectivity is the dispersal and exchange of fish larvae from different reefs. The connectivity model uses information on coral reefs (location and area), hydrodynamics (ocean currents), and fish biology (life history, swimming behavior, etc) to identify in which reef areas fish larvae are located during different seasons of the year. Ocean currents were modelled and then validated using field measurements during the different monsoon seasons, and the data was used to simulate larval dispersal. The strength and patterns of connections between reefs is species- and season-specific, because of the wide range of biological characteristics of the model fish larvae and the spatiotemporal variability of circulation.

Modelled water circulation during the summer months of March to May was generally southwards with a strong westward current north of El Nido, forced by mostly north-easterly winds dominant in this season. Starting June, wind directions shift to a strong Habagat or Southwest Monsoon pattern blowing from the southwest until September, which caused northward currents to be observed in the July 2016 survey. Average circulation patterns observed in June to August did not show the expected northward pattern, but instead showed currents that were generally weaker directed to the southeast.

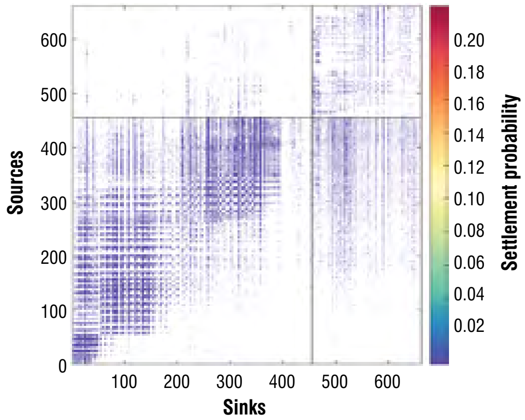


FIGURE 4. Connectivity matrix for the grouper simulations averaged across all seasons. The horizontal and vertical lines mark the division of reefs near the coast and offshore reefs.

The connectivity model (Figure 5) incorporates both the ability of larvae to swim towards the nearest reef, and ocean circulation to transport larvae from the source reef to other reefs. Three model fishes were simulated for El Nido: snapper (maya-maya), grouper (lapu-lapu) and unicorn fish (surahan). These belong to different trophic levels (places in the food chain) and have different early life history characteristics.

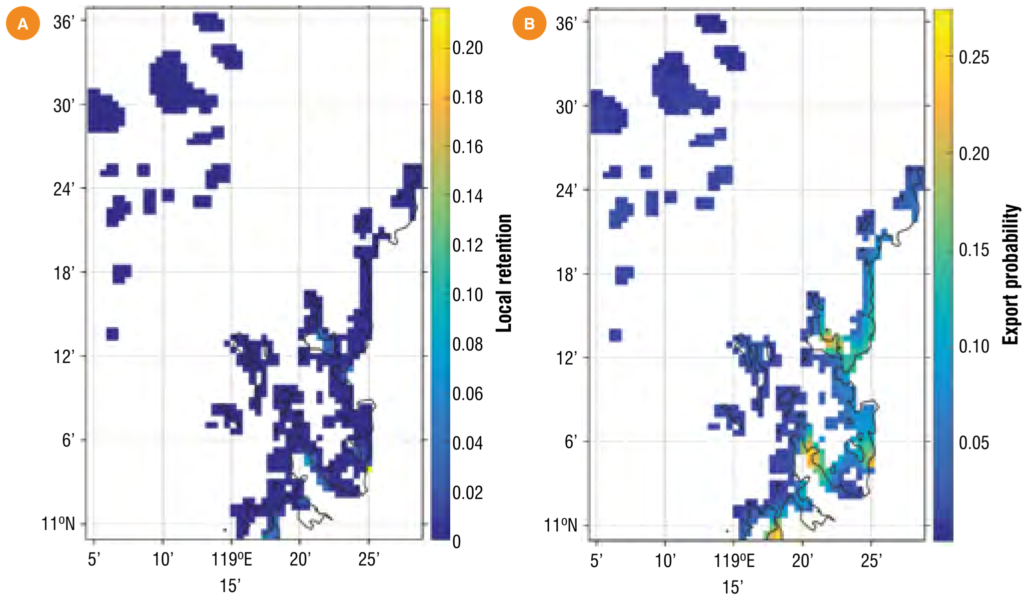


FIGURE 5. Total probability of connections from each reef cell for the grouper simulations averaged across all seasons. (A) shows the local retention back to the natal (birth) reef and (B) shows the export probability or the total probability of connections beyond the natal reef.

Fish

Coral reef fish biomass and carrying capacity were estimated using fish visual census and the food web model (see page 7), respectively. The initial biomass conditions and carrying capacity were estimated for all reef fish species, and predatory and herbivorous fish.

Among the El Nido sites that were sampled, Pinasil, Tres Marias and Twin Rocks had relatively high total fish biomass and carrying capacity values for herbivorous and predator fish combined (Table 1). Depeldet, on the other hand, exhibited low fish biomass as well as a low carrying capacity.

TABLE 1. Total biomass and carrying capacity of fish in sampled sites in El Nido.

SITE	TOTAL BIOMAS (G/SQM)	CARRYING CAPACITY (G/SQM)
Depeldet	**14.8**	**112.0**
Dibuluan	29.8	98.0
Dilumacad	25.0	73.8
East Matinloc	24.2	90.1
Pinasil	47.9	149.9
Tres Marias	**33.1**	**91.4**
Twin Rocks	**34.0**	**87.8**
Mean	29.8	100.4
Standard Deviation	10.3	24.7

Source: (Rogers et al., unpublished dataset)

Fishing activity

Household surveys were conducted in April to May 2015 under a joint study by the University of California Davis and PSU (see page 23). A total of 400 households were surveyed in the entire El Nido municipality, of these 129 households provided complete information on fisheries-related questions. Using the household surveys, the extent of the fishing grounds, distance travelled by fishers, catch rates, and population of fishers targeting coral reef fish species were estimated.

Of the sampled households, 75% (n= 95) were located in the western side of El Nido, while 26% (n=34) of the households were located in the eastern side. Half of the sampled households had family members that were full-time fishers, assuming >100 days of fishing per year. The estimated catch rates of the sampled fishers were 2.96 ± 5.82 kilograms per trip for pelagic species and 0.38 ± 0.75 kilograms per trip for coral reef fish species. Sampled households were also asked to identify the type of fishing gear that they use (see Table 2). Most of the fishers used multiple types of gear, but most fishers stated that they used hook-and-line and fishing nets.

TABLE 2. Gear distribution amongst sampled fishing households.

FISHING GEAR	N
Kawil	41
Lambat palubong	27
Lambat	10
Ganti-ganti/ Taiwan-taiwan	11
Sarangsang	7
Timbog	5
Lambat palutang	5
Pana	4
Panghipon	2
Kitang	1
Bitana	1

Maps showing the fishing docks (i.e. where fishers live and/or dock their boats) and preferred fishing grounds of fishers were digitised and analysed using GIS to define the fishing behaviour of fishers in *Fish SPACE* (Figure 6). From the analysis, fishing grounds ranged between 0.6 square kilometres (km^2) to 150 km^2, with a mode of about 3 km^2. Fishers travelled 0.5 km to 30 km with an average of 10 km, from their dock to their preferred fishing grounds.

OUTPUTS

In the last two years of the project (2017 and 2018), *Fish SPACE* was developed and refined using data from the research described above. It is now available as a spatial planning and communication tool that includes a standalone software application, and accompanying data preparation and user manuals — all of which can be downloaded from the CCRES website (www.ccres.net).

THE DATA

Enquires about the data used to develop *Fish SPACE* may be directed to Dr Cesar Villanoy (UPMSI), cesarv@msi.upd.edu.ph.

A summary report with more detailed results is supplied separately as an annex, or may be requested from UPMSI.

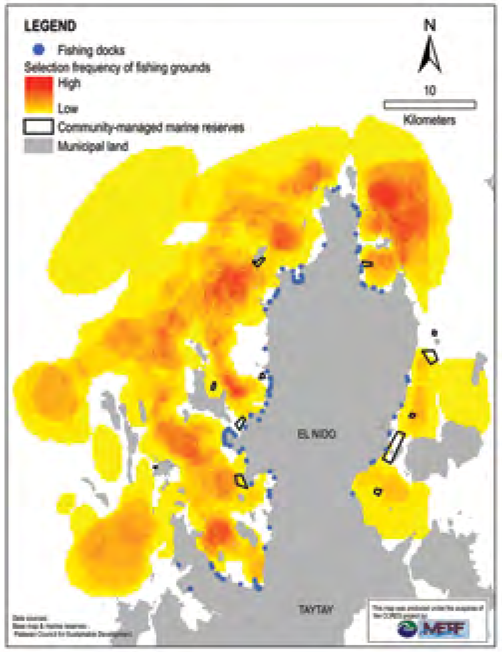


FIGURE 6. Map showing the fishing docks, and preferred fishing grounds of the fishers sampled during the household surveys. Areas that have higher levels of fishing are in red.

FISH SPACE IN ACTION

The coral reefs in El Nido are under mixed management, with a large marine park managed by the national government under the National Integrated Protected Area System (NIPAS) on the western side of the municipality, and small marine reserves (CBMPAs) that are co-managed by the local government and communities located inside the large marine park on the eastern side of the municipality (see Figure 2, page 9).

These existing management schemes were evaluated using *Fish SPACE* to test their performance over 35 years, and to demonstrate how the results may be useful in informing management decisions in fisheries and conservation.

In both scenarios, it was assumed reserves were 'no-take' areas and that fishing activity is constant over time. Both scenarios have cost implications for fishers, in terms of the distance they will have to travel to fish.

In the NIPAS scenario, most fishers will travel great distances to fish for the entire duration, with even more of them doing so towards the end. Apart from the reserve closing off most reef areas near to the shore, closer fishing grounds will eventually be depleted of fish, prompting fishers to target reefs farther offshore.

Under the CBMPAs scenario, fishers have access to a larger area but will also eventually venture farther to fish as fish catch in nearby reefs is depleted.

Fish biomass within reserves would increase more quickly under the NIPAS scenario, and carrying capacity is also attained in a relatively short time. The CBMPAS scenario also shows an increase in fish biomass but only within reserves. Fish biomass in reefs without protection remain low, whereas protection in the NIPAS would support even outside reefs (see Figure 7).

This example demonstrates trade-offs between different management objectives. The extent of protection under NIPAS, which was established in El Nido for the area's unique biodiversity and relatively good reef quality, can support biomass recovery even in neighbouring reefs. On the other hand, access to fishing areas is limited, representing a trade-off to local fishers. Knowledge of such would require planners and decision-makers to complement protection with other management interventions.

Effectiveness of marine reserve designs is ultimately measured against management objectives, whether these are inclined towards conservation, tourism or fisheries.

A fine balance in crafting objectives, to allow for socio-economic and environmentally sustainable considerations that are inclusive and just, is envisioned for El Nido.

Fish SPACE can be used to start a conversation on the potential trade-offs of prioritizing specific objectives and supporting more informed planning and decision-making. Management interventions are not limited to marine spatial planning or to the marine planning region. They also include aspects relating to governance, policy, communication, education and capacity building, and livelihood diversification.

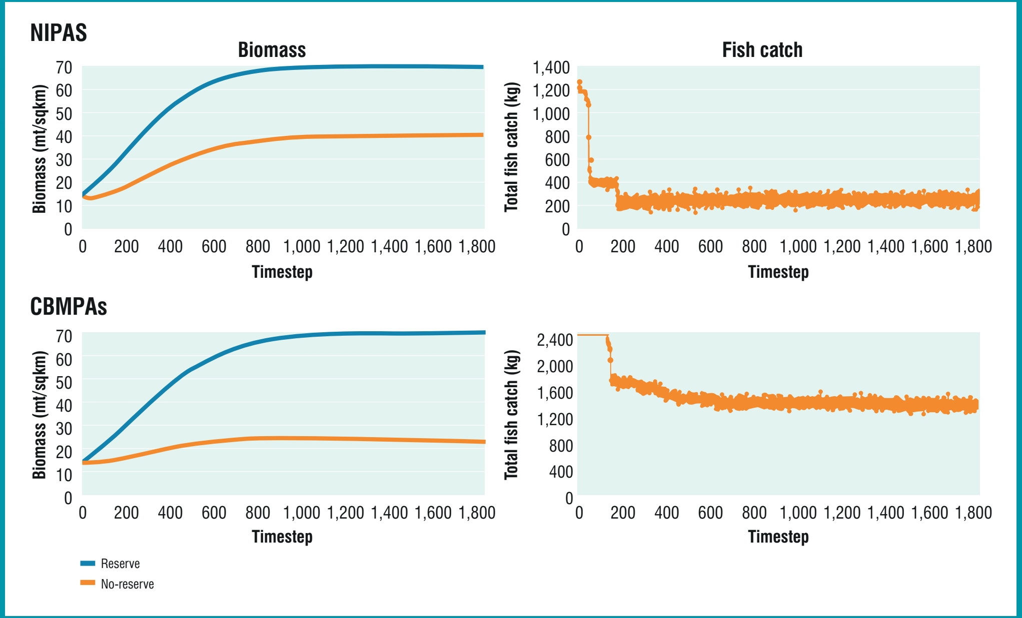


FIGURE 7. Comparing fish biomass and fish catch of both scenarios.

Marine Planning

Activity: Watershed analysis and sedimentation in coasts

RESEARCH

Objective

To quantify the amount of sediment entering El Nido's coastal and marine areas.

Method

To determine the amount of sediment entering Bacuit Bay in El Nido, researchers measured changes in land cover and sediment content in river run-off.

To quantify the land cover changes, the team used LandSat imagery of the area taken between 1989 and 2014, and applied the Normalized Difference Moisture Index (NDMI) to classify vegetation types.

To identify which of El Nido's sub-watersheds contribute most to sediment yield, the researchers used the Soil and Water Assessment Tool (SWAT). Researchers sampled water from four El Nido sub-watersheds from across the Barangays of Barotuan, Bucana, New Ibajay, Pasadena and Manlag, and compared concentration of sedimentation and flow rate across the tributaries.

In the Barangays Manlag and Barotuan, river discharge was measured using water-level sensors. Turbidity was estimated using a combination of light attenuation and suspended sediment data.

River flow was measured with a flow meter, and researchers used the width across banks to determine volumetric discharge.

LandSat data from between 1997 and 2015 was used to analyse the extent of sedimentation and its proximity to coastal areas. The images were used to evaluate plume intensity, and to create a plume frequency map.

Timeline

2016
Gathered calibration data (i.e. flow and discharge rate, sediment load in river runoff) for four watersheds covered by five barangays

People

Activity leader: Bayosa Aya Cariño (UP Institute of Environmental Science and Meteorology)

Researchers: Rene Rollon (UP Institute of Environmental Science and Meteorology); Cesar Villanoy (UPMSI)

◄ **Rural communities at El Nido depend on fisheries for food and livelihood.**
Photo: M. Paterson

▲ **Science in action: Bayosa Aya Cariño measures physical properties such as temperature and salinity, El Nido.**
Photo: L Solera

RESULTS

Land cover change

The total area for forests was lowest in 1989 at 301.8 square kilometres (km^2) (Figure 8). This gradually increased to a high of 350.5 km^2 in 2003. Forest cover then decreased in 2010 and 2014.

Low vegetation was highest in 2014 covering an area of 234.1 km^2. Bare soil was highest in 1989 and 2010 with 90.5 and 84.7 km^2 respectively, and is concentrated on the north east and south west of the island. There was a gradual decrease of mangrove cover from 26.5 km^2 in 1989 to 19.4 km^2 in 2014.

Expansion of low vegetation, and the resulting decrease in forest cover, is seen along the periphery of the island. However, from 2010 to 2014 forest fragmentation occurred in the central area. Preliminary results show that the highest net forest loss was from 2003 to 2010 when 43.7 km^2 was lost.

Sediment contribution of sub-watersheds

Watershed tributaries contribute 254 tons per hectare per year (t/ha/yr) of total eroded sediment. Sediment yield is high during the wet season (i.e. July, August, September) at 48 t/ha/yr; whereas, sediment yield during dry season (i.e. January, February, March) is much lower at 1.1 t/ha/yr. These values are significantly higher than expected, considering that forest and mangrove cover is relatively high in Bacuit Bay watershed, at 55.7%.

Sub-watersheds 16, 17, 18 and 19 located in Barangays Aberawan and Manlag, and sub-watersheds 3, 31, and 32 located in Barangays Barotuan and Bucana had the highest sediment yield of 70 to 90 t/ha (Figure 9). Sub-watershed 31 which had a low forest cover of 1.05 km^2 and bare soil cover of 1.5 km^2 is among these high sediment yielding watersheds.

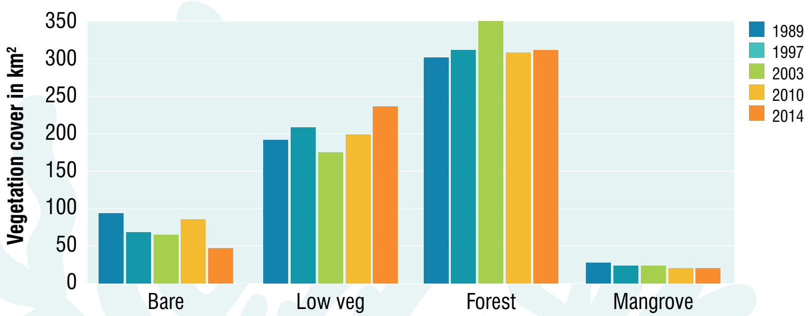


FIGURE 8. Total area for each vegetation type for each time period.

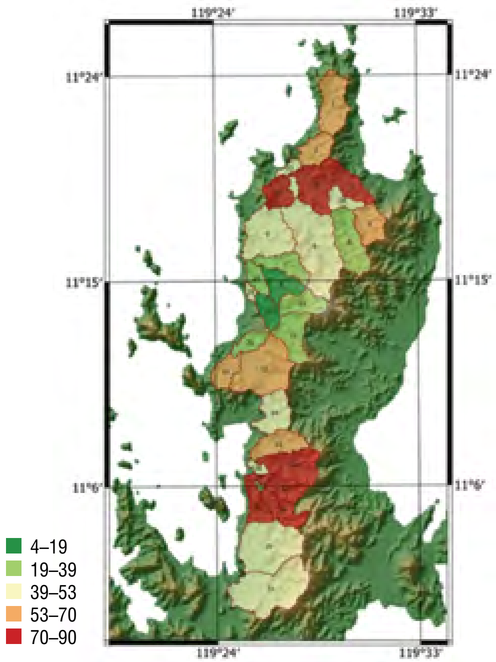


FIGURE 9. Annual sediment yield (ton/ha) of identified sub-watersheds.

Whereas, sub-watershed 9 in Barangay Pasadeña, which had a higher forest cover of 4.8 km^2, had a much lower sediment yield of 4 to 19 t/ha. These findings point to the potential of forests in controlling eroded sediments and mitigating sedimentation.

Sediment yield in Manlalic River

Modelled results of sediments draining from the Manlalic River into Bacuit Bay show higher sediment load for the latter half of the year for all years modelled.

On the other hand, field results show that sediment load and river discharge values follow a general trend, which coincide with some rainfall values in Puerto Princesa, indicating that large weather systems affect both El Nido and Puerto Princesa. However, flood events observed in Manlalic for the month of October do not correspond with rainfall values in Puerto Princesa, indicating that some precipitation events are local to El Nido.

Actual output for sediment yield from the watershed model using the SWAT tool is up to two orders of magnitude greater than the field measurements. It is recommended that SWAT model output values be multiplied by a factor of 10^{-2} to avoid over-estimation of sediment deposits.

Human activities observed in the area, such as gravel washing, could also increase sediment load in rivers. The watershed model can be improved if detailed information of point sources of sediment independent of land cover can be identified, quantified and incorporated in the model.

Sediment plume extent, intensity, and frequency

During the dry season, the sediment plume appears to be more extensive in Bacuit Bay (Figure 10 A), although in the wet season, there appears to be more sediment along the entire western coast of El Nido, with increasing degrees of intensity moving seaward (Figure 10 B).

In Bacuit Bay, areas exposed to high intensity and frequency of the sediment plume correspond to those with poor hard coral cover (Figure 11).

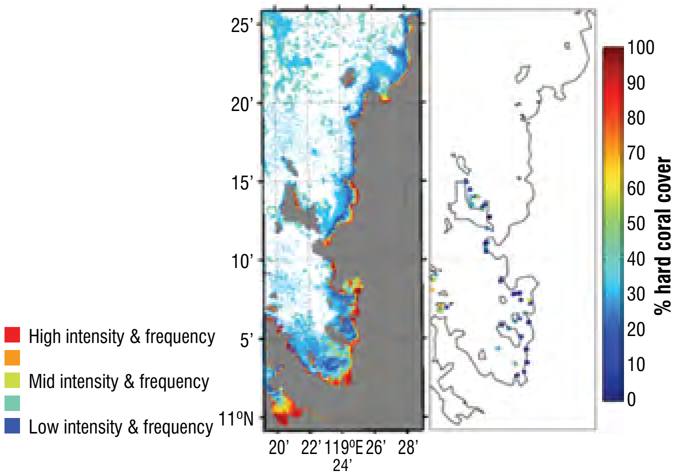
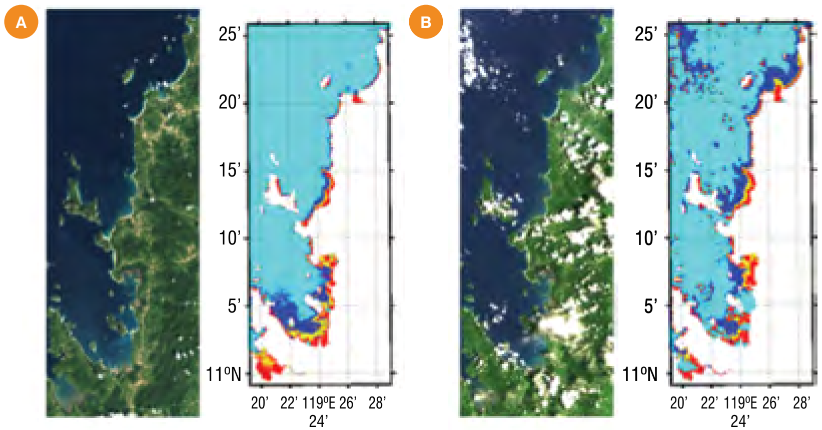


FIGURE 11. The sediment plume (left) and hard coral cover (right).

▲ **Leilani Solera and Patrick Pata (front left) from UPMSI and the research team head out in search of currents at El Nido.**
Photo: A. Gammaru

FIGURE 10. Plume extents for (A) the dry season (February 2003), and (B) the wet season (September 2015).



High intensity
Mid intensity
Low intensity

DATA

For further information, contact Dr Cesar Villanoy (UPMSI), cesarv@msi.upd.edu.ph.

A summary report with more detailed results is supplied separately as an annex, or may be requested from UPMSI.

> **"Because *Fish SPACE* is spatial, people can really see what might happen if they do protect particular areas. That's why I think this work is really meaningful and exciting."**
> Dr Vera Horigue, UPMSI

Marine Planning

Activity: Sedimentation in mangroves and seagrass

RESEARCH

Objective

To understand how effective mangroves and seagrasses are in filtering upland run-off in terms of enhancing the settlement of suspended sediments inside the forests and meadows; and to determine the spatial pattern of sedimentation within mangrove forests and seagrass meadows.

Method

Sedimentation rates were measured in mangroves using sediment plates (traps) deployed in the different forest zones in Manlag and Aberawan in 2014 and 2015, and in Cadlao Island in 2015. Average sedimentation rate in grams per square metre per day (g/sqm/day) was computed for each mangrove zone (i.e. landward, midward, seaward). Age reconstruction and vertical displacement of the hardy seagrass *Enhalus acoroides* (*E. acoroides*) were used to estimate changes in sediment elevation in Manlag and Aberawan. These approaches assisted in understanding the function of mangroves and seagrass in filtering upland runoff and regulating sedimentation, which ultimately contributes to protecting nearby coral reefs.

Researchers also characterized the sites to evaluate how community structure (types of plants) affects the respective rates of sedimentation in mangroves and seagrass beds.

Timeline

2014
Assessed community structure; measured sedimentation rates (NE monsoon); collected seagrass samples

2015
Measured sedimentation rates (transition); collected water samples for Total Suspended Solids

People

Activity leader: Maricar S. Samson (DLSU)

Researchers/support: Giannina Albano (UPMSI), Betty May Villamayor (UP Institute of Environmental Science & Meteorology), Noreen Follosco (UPMSI)

▲ **Sediment captured in the settling disk placed in the mangroves, Manlag, El Nido.**
Photo: G. Albano

▲ **Mangroves along the Philippines coast.**
Photo: G. Sheehan

RESULTS

Mangroves

The mangroves in Aberawan and Manlag are riverine-fringing mangroves while those in Cadlao are fringing. All surveyed sites are dominated by Rhizophora species, with Manlag having the greatest potential extent at 182 hectares.

In terms of zones with highest accumulation, similar patterns were observed across time, but varied across sites. In Aberawan, the middle zone had the highest deposition, ranging from 18.7 to 24.2 g/sqm/day. In Manlag, the seaward zone had the highest volume, ranging from 16.9 to 62.4 g/sqm/day. In Cadlao Island, the smallest in areal extent of the three surveyed areas, the landward zone had a higher volume of accumulated sediment per day (20.7 g/day) (Figure 12).

In Manlag and Aberawan, zones with relatively higher sediment volume appear to correspond with zones with the highest stem density. High stem density has been known to enhance rates of sediment accretion and surface elevation processes.

In Aberawan, the middle zone (1,800 stems per hectare) had a slightly higher density than the landward and seaward zones. On the other hand, in Manlag, the seaward zone had a stem density of 3,600 stems per hectare, relatively higher than the landward and middle zones. However, in Cadlao Island, the results are reversed, with the landward zone having the highest sediment accumulation as well as the lowest density during the time of survey. Here, other factors such as exposure to waves and currents may determine the rate of sedimentation. Nevertheless, of the three areas surveyed, Manlag had the highest sedimentation rate, and the densest mangrove forest.

An additional field activity in March 2015 determined the difference in Total Suspended Solids during low and high tides. Results support previous observations that, during low tide, a higher volume of sediments remains suspended in mangroves (Figure 13).

▲ **UP MSI's Noreen Follosco (second left) and DLSU's Maricar Sampson (far right) with members of the local community at El Nido.**
Photo: G. Albano

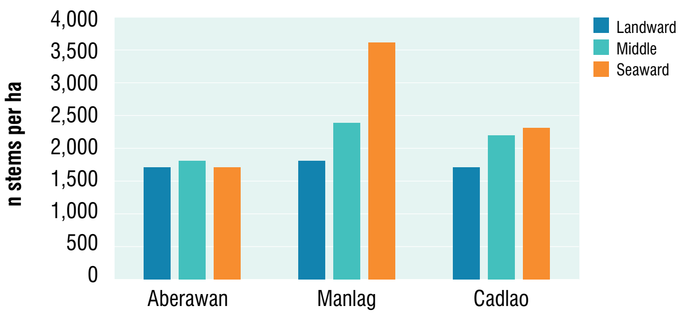


FIGURE 12. Density (n stems per ha) of mangrove forests in Aberawan, Manlag and Cadlao Island surveyed in November 2014.

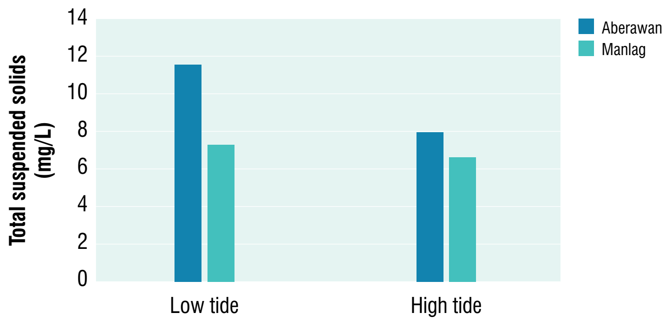


FIGURE 13. Volume of total suspended solids of water samples collected during low and high tide at Aberawan and Manlag, El Nido, Palawan in March 2014.

Seagrass

Analyzing the growth of the *E. acoroides* samples showed an average vertical displacement of 12.2 millimeters per year (mm/year) in Manlag, and 37.3 mm/year in Aberawan, suggesting greater sediment deposition in the latter (Figure 14). The rhizome or subterranean stem of *E. acoroides* differs from other Philippine seagrass species in that it grows horizontally, which may be an important factor in its survival in areas with high sedimentation rate. Such growth further provides for measurements of vertical displacement, which gives an indication of the relative volume of sediment deposited.

FINDINGS

In the areas surveyed in El Nido, apparent threats include upland deforestation for road networks and widespread small-scale mangrove cutting. The present extent of mangrove areas in Manlag and Aberawan may be critical in mitigating the impacts of coastal erosion to adjacent seagrass beds and coral reefs.

The following management interventions may be considered and integrated with ongoing initiatives:

- Establishment of Manlag and Aberawan mangrove forests as ecotourism zones where sustainable nature trails and boating activities can be implemented.
- Strengthen enforcement of the moratorium on mangrove cutting.
- Review upland development against its impact on coastal resources.
- Regulation of activities on seagrass beds such as establishment of fish corrals.

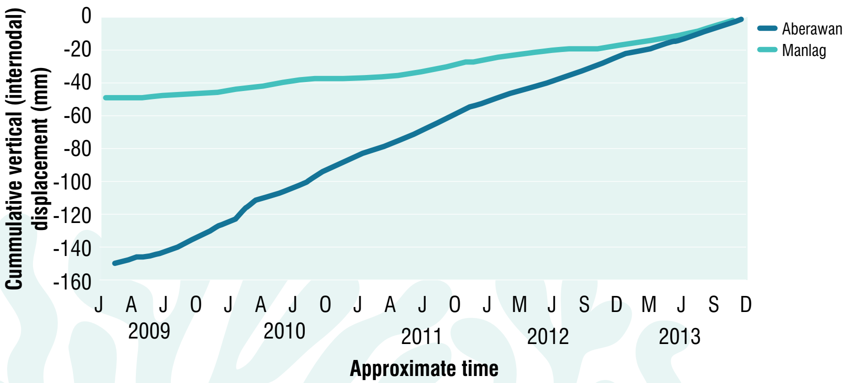


FIGURE 14. Cumulative vertical displacement based on internodal measurements of *Enhalus acoroides* collected in the study sites in November 2014.

▲ **Measuring growth patterns of seagrass (*Thalassia hemprichii*).**
Photo: M. Samson

For further information, contact Dr Cesar Villanoy (UPMSI), cesarv@msi.upd.edu.ph.

A summary report with more detailed results is supplied separately as an annex, or may be requested from UPMSI.

Marine Planning
Activity: Coastal Protection

RESEARCH

Objective

To develop a simple, web-based interface to process and communicate models of coastal ecosystem dynamics, which consider factors like wave conditions and beach erosion, and their influence on reef wellbeing.

Method

Coral reefs serve as natural protective barriers that safeguard communities and infrastructure. CCRES researchers sought to develop a means of quantifying the extent to which reefs protect shorelines, and the potential impact of increased sea levels and wave activity, and subsequent erosion.

FIGURE 15. Predicted shoreline changes at El Nido using a hypothetical scenario.

The physical and biological characteristics of reef system health are complex. The team analyzed the geomorphology (shape and size) of a range of coral reefs to determine the degree of protection they provide coastlines, taking into account reef geometry, reef health, reef-bay configuration and wave height. El Nido was used as a location to demonstrate how the models would work.

The researchers employed Bayesian belief networks (BBNs) – a probabilistic model that uses prior outcomes to predict future occurrences – to communicate their physics-based predictions of the El Nido region's wave activity. In its simplest form, a BBN uses statistics to investigate the inter-relationships between the input variables and the model outputs described by a chosen network.

Timeline

June 2014
Base model for El Nido ready for testing

June 2017
Wave modelling at El Nido completed. Model developed to predict the degree of protection given to beaches by reefs

People

Activity leader: Prof Tom Baldock (School of Civil Engineering, UQ)

Researchers: Dr David Callaghan, Dr Behnam Shabani (School of Civil Engineering, UQ)

OUTPUTS

CCRES has developed the *Coastal Protection* tool including two BBNs (SHORELINE and REEFTOP) to assess the hydrodynamics and sediment dynamics across and behind reefs. REEFTOP is a BBN for assessing wave hydrodynamics and forces on corals in a barrier reef and lagoon system. SHORELINE is a BBN for estimating the wave hydrodynamics and shoreline changes on and behind fringing reefs.

Users can quickly and easily analyze the efficacy of local reefs as defense mechanisms against intensified wave activity, storm surges and erosion — without needing to understand the complex, physics-based and probability models at play. Users simply enter parameters describing the reef (e.g. width, length, wave height and lagoon depth) and alter these parameters to observe different hypothetical outcomes for that reef's future wellbeing.

The *Coastal Protection* BBNs can be applied at any location where the conditions fall within the range of the input states, enabling translation of the models' results to other sites, and enabling the CCRES tool to be linked with other GIS-based ecosystem modelling tools.

The *Coastal Protection* tool can be downloaded from the CCRES website at www.ccres.net together with a user guide.

FINDINGS

To demonstrate how SHORELINE could be applied, it was used on a reef at El Nido where researchers estimated the reef dimensions and the water depth over the reef. They then inputted coral diameter, wave with height, wave period, and wave direction from shore to model the loss of reef structure based on those conditions. Different inputs can then be entered to show their differing effect.

The original and expected new shoreline position were plotted on a satellite image (Figure 15) which shows how the changes in the shoreline calculated by the model would look when applied. The hypothetical example shows the blue line as the original shoreline and the red line where the shoreline would be expected to recede landwards if the parameters used were realised. This information can then be used for coastal planning.

THE DATA

For further information, please contact Prof Tom Baldock (UQ), t.baldock@uq.edu.au. Additional information is supplied separately as an annex.

Marine Planning

Activity: Understanding the role of governance

▲ **Dr Vera Horigue, UPMSI, (centre) talking with stakeholders.**
Photo: N. Follosco

RESEARCH

Objective

To understand the social, economic, and political factors that drive current management activities, and governance of resources in general, in order to support meaningful uptake of CCRES decision-support and other management tools, and the recommendations arising from the use of the tools. Specific objectives were to:

- Evaluate governance structures and processes that underpin management activities.
- Understand the drivers of change that have led to current management practices.
- Recommend strategies to address challenges in marine protected area (MPA) planning, and implementation and spatial planning, in general.

Method

An institutional analysis of protected area policies and implementation was undertaken using an innovation histories workshop with 24 participants from stakeholder organisations, complemented and triangulated with group discussions, semi-structured key informant interviews (formal and informal), observations during meetings, and content analysis of documents (e.g. legislation, project reports). CCRES researchers focussed their analysis on the experiences, roles, functions and interactions of the local, provincial and national government in protected area policy development and implementation in El Nido.

Prior to and after the workshop, researchers interviewed a total of 28 informants from the government (17), non-government organisations and civil society groups (3), private sector (2), and local community members (6). The majority of the informants were living in Palawan, and ranged from 12 to 72 years old.

Timeline

July 2015
Project commenced

November 2015
Conducted initial key informant interviews and the innovation histories workshop

August 2016
Second round of key informant interviews

People

Activity leader: Dr Vera Horigue (UPMSI)

Researchers: Camille De Castro (UPMSI, UP School of Urban and Regional Planning), Michael Pido (PSU), Miledel Quibilan, Annette Menez, and Porfirio Alino (UPMSI)

Local partners: DENR, PCSD staff, El Nido Local Government

FINDINGS

Researchers found that the governance in El Nido is dynamic, having changed tremendously over the past 35 years. The transformation of the government from a centralised to a decentralised system, and implementation of foreign-assisted projects led to changes in management priorities and approaches used. Since the 1980s, the protected areas and other management zones in El Nido have changed, because they were established with different conservation and management objectives.

Originally, the large national park in El Nido was established as a marine turtle sanctuary to protect key nesting and developmental habitats in the 1984. This later changed to consider different uses and priorities, based on the legislation that drove the zoning activities and the participation of various stakeholders. This led to difficulties in implementation and reduced protected area effectiveness, due to the following issues:

1. Financial support from donor-assisted projects waned in the latter years, which limited enforcement activities.
2. The establishment of the large national park marginalized many stakeholders since the beginning, and hence full support of the El Nido locals has never been achieved.
3. Overlapping responsibilities and membership in multiple management boards led by the DENR, PCSD, and the local government resulted in inefficient decision-making and delays in management actions.
4. Economic activities and interests of stakeholders highly influenced policy and decision-making, and thus negated the benefits of multi-sectoral participation in management.

Implementation of large national parks in the Philippines has faced tremendous challenges. Their large size marginalizes and/or displaces many stakeholders. The process by which they have been established lacked community buy-in and engagement. They require more resources (i.e. financial, human resources) to be sustained. The people they require need to have the knowledge and capacity to fulfil their jobs. Similarly, implementation of community-based marine protected areas (CBMPAs) have become challenging because they require consistent financial and government support in order to sustain community engagement and buy-in.

Although these problems are common to protected areas in the Philippines, in the case of El Nido, the opportunities afforded by the donor-assisted projects, and the full mandate of the National Integrated Protected Areas System (NIPAS) Act and the Strategic Environmental Plan (SEP) of Palawan should have been realized to ensure the sustainability of the protected area.

The agreement between the DENR, PCSDS and the El Nido Local Government may be better implemented if the different levels of government are more transparent and coordinate their efforts more.

Researchers found that one of the key factors that influenced the changes in management priorities and approaches used were the structural changes in decision-making. Multi-sectoral participation in decision-making is highly recommended by scholars and environmental advocates, because it has been shown to reduce conflict that can impede acceptance and sustainability of management actions. Multi-sectoral participation, as with decentralization, can also increase government transparency and accountability, because stakeholders are able to engage and interact with government officials more openly. However, we found that the increasing involvement of stakeholders in El Nido introduced more actors with different values, interests, and beliefs that affected goal and priority-setting and consequently effectiveness of protected area management.

Despite these challenges, protected area implementation and other development activities, may be improved in El Nido with the following management strategies:

1. Improve the alignment of priorities and coordination of initiatives.
2. Prioritize board meetings to address joint problems.
3. Develop short-, medium-, and long-term management and development plans based on the priorities identified.
4. Develop a financial scheme to support management initiatives.
5. Higher government levels can institutionalize management decisions through existing laws to ensure sustainability.

OUTPUTS

Researchers developed a timeline from 1980 to 2015 that described key events that shaped the current state of conservation and resource governance in El Nido (see Table 3). Results are used to contextualise management scenarios in *Fish SPACE*.

MORE INFORMATION

For more information on the project, contact Dr Vera Horigue vera.horigue@googlemail.com. A summary report is provided in an annex supplied separately.

▼ **The tourism and hospitality sector is growing rapidly, putting tremendous pressure on marine ecosystem resources at El Nido.**
Photo: M. Paterson

TABLE 3. Key events that shaped the current state of conservation and resource governance in El Nido.

PERIOD		EVENT
PRE-1980s		Fishing boats, trawls, illegal fishing, all operating inside Bacuit Bay
1980	1981–90	Palawan Integrated Area Development Project
	1983–85	Drafting of the Strategic Environmental Plan (SEP) of Palawan Bill
	1984	El Nido declared as a marine turtle sanctuary
	1986	EDSA Revolution
	1988	Road construction connecting El Nido — Taytay — Puerto Princesa caused heavy siltation
		House bill 10945 (SEP Bill) submitted to Congress
	1988–92	WWF Debt for nature swap
	1989	Onset of Coastal Resources Management (CRM) in Palawan
1990	1991	Palawan declared by UNESCO as a Man and Biosphere Reserve
	1991	Enactment of the Local Government Code (*Republic Act 7160*)
	1992	Rio Declaration on Environment and Development
		Andres Soriano Jr. Foundation's CRM Program
		Enactment of the SEP Law (*Republic Act 7611*) and National Integrated Protected Areas System (*Republic Act 7586*) Law
		Commercial logging ban and establishment of the El Nido Marine Reserve
	1994	DENR-PCSD Agreement and establishment of the Environmentally Critical Areas Network board
	1995	Adoption of the General Management Plan and institutionalisation of the protected area management board of El Nido marine reserve
	1995–97	Northern Palawan Sustainable Tourism Development Plan project
	1996	El Nido Resource Management Stakeholders' workshop and implementation of the Integrated Protected Areas Fund (IPAF)
	1998	Severe drought due to El Niño, followed by massive coral reef degradation due to coral bleaching and Typhoon Norming
		Enactment of the Fisheries Code (*Republic Act 8550*)
		Proclamation of El Nido-Taytay Managed Resource Protected Area (El Nido-Taytay park), and renewal of the DENR-PCSD agreement
		Creation of the Palawan province Geographical Information Systems unit
		Inauguration of the Malampaya natural gas project
2000	2000	Establishment of the SEP clearance system
	2000–07	Strategic Environmental Management Program for Northern Palawan Project
	2003	Adoption of the solid-waste management (*Republic Act 9003*) and imposition of a conservation fee as part of the Integrated Protected Areas Fund for the El Nido-Taytay park
	2004	Siltation of Bacuit bay due to the El Nido – Taytay road improvement
		Adoption of the El Nido Comprehensive Land-use Plan
	2004–10	Implementation of the Community-based CRM projects funded by GEF-ACCI, which led to the establishment of nine CMMAs (2006 to 2010), and the Ecotourism Development Fee (2008)
	2005	Illegal fishers caught in Sibaltan
		Adoption of the El Nido ECAN zoning maps
		Tourism was affected by an oil slick that came from outside El Nido
	2007	Enactment of the Special use Agreement for Protected Areas (DENR Administrative Order 2007–17)
		Establishment of the El Nido-Taytay all-weather road and slope establishment
	2009	Titling and fencing of watershed areas
		El Nido locals won case against dredging in Bacuit Bay as part of the port development project of Congressman Alvarez
2010	2010	Integration of the ECAN zones in the proposed 2012 to 2015 Comprehensive Land and Water-use Plan (CLWUP)
	2012	Puerto Princesa Underground River (PPUR) declared as one of the New 7 Wonders of Nature
		Increase in illegal trade of logs, sand, and gravel
	2012–15	Implementation of the enhanced CLWUP
	2013	Construction boom that caused rapid development along beaches, and reduction of water quality in Bacuit Bay
	2014	Massive mangrove clearing for charcoal production and tourism development
		Installation of mooring buoys in the islands and implementation of the coral reef rehabilitation gardening project (DENR partnered with Western Philippines University)
		Implementation of Palawan Sustainable Development Strategies and Action Plan project to assess planning and development approaches in El Nido
		Beaches and watershed areas are occupied by private individuals
	2015	The expanded-NIPAS bill submitted to Congress, to enhance protection of the El Nido-Taytay park and other national parks

Marine Planning

Activity: Understanding key sectors

RESEARCH

Objective

To collect data to help establish the relationships between key economic agents (households, businesses, tourists) to inform the development of CCRES tools.

Method

Training was initially conducted in Puerto Princesa on survey design and surveying methodologies. The team then pre-tested the surveys in the local community and discussed ways to improve the survey and its implementation.

In collaboration with the ENF and El Nido local government officials, the team carried out a series of surveys from April to June, 2015. In order to capture a snapshot of the entire local economy, the key agents in the economy were surveyed. This included households (both fisher and non-fisher), tourists, and major local business sectors.

Approximately 460 households were surveyed all 18 barangays of El Nido, representing 6% of all households. The number of households surveyed in each barangay was weighted by population size, but also stratified to focus on areas where fishing and tourist-related activities are more common, since these are two key sectors in the El Nido economy.

Approximately 433 tourists were surveyed. The primary goal of the tourist surveys was to map where tourists spend their money in order to understand their influence on the local economy. These surveys were focused at points of departure (the airport and bus terminal) in order to obtain the most complete picture of tourists' total expenditures.

Approximately 275 businesses were surveyed focussing on hotels, restaurants, tourism operations, and transportation because these are the primary economic sectors in El Nido that were not covered by the household surveys (household-run businesses predominate in the fishing, agriculture and retail sectors).

Timeline

April–June 2015

People

Activity leaders: Prof Jim Sanchirico, A/Prof Ted Gilliland (University of California, Davis)

Researchers, survey enumerators, support: Prof Ed Taylor (UC Davis); Dante Basaya; Roy Bero; Mark Buncag; Shieng Camacho; Dondon Cayaban; Darlyn Coroña; Ian Davatos; Gianina Decano; Leo Diego; Aynon A Gonzales; Ian Mabitasan; April Marcos; Jun Miraflores; Eva Ponce de Leon; Dr Patrick Regoniel; Unice Roa; Jessa Salvador; Angelou Seneca; Mark Tabangay (PSU)

Local partners: PSU, ENF, El Nido Local Government

▲ El Nido Site coordinator Roy Bero (left) with activity leader Ted Gilliland (second left) with members of the PSU survey team.

FINDINGS

The main industries that El Nido's population participate in are tourism, small-scale fishing and agriculture. The researchers surveyed key economic agents: households, businesses and tourists.

The household surveys focused on households' consumption patterns and production activities and showed that most households derived their income from wage labour (including tourism), followed by household enterprises (small shops), and then fishing and agriculture; however, most households were engaged in more than one of these sectors. For instance, it was found 63% of fishing households were engaged in at least one non-fishing activity. In fishing households, tuna, squid and mackerel accounted for the majority of annual catches, which were harvested across a variety of habitats. Households engaged in agriculture grew a variety of crops, including rice, vegetables, cashew and fruit trees, but of these, rice was the most common by far (approx. 70%).

The business surveys targeted businesses operating in boat tourism; other tourism; fish selling; hotels; restaurants; taxis and transportation; other services; dive operation; and retail. The surveys revealed the average El Nido restaurant spends approximately

9,133 USD a year on direct purchases of fish, and an average boat tourism operation spends 3,830 USD a year on fish. These data indicate that the El Nido fish ecosystem is an important economic driver.

Of the 433 tourists surveyed, approximately 53% were domestic tourists (from the Philippines). The average length of stay in El Nido was 3.4 nights. Almost all tourists (96%) participated in activities related to marine resources (snorkeling, diving, boating, etc.).

Tourist surveys were designed to map tourist expenditure in El Nido. It was found that direct fish purchases by tourists were virtually non-existent, but tourists did funnel money into accommodation, restaurants and bars, and tourism activities like boat tourism, which relies on fish to serve.

OUTPUTS

A unique data set was collected from survey of 460 households and approximately 275 businesses throughout El Nido. The data set informed development of other CCRES tools including the systems analysis tools.

THE DATA

The confidential dataset resides at the University of California, Davis. For inquiries about the research, findings, outputs, data or technical support, contact Prof Jim Sanchirico jsanchirico@ucdavis.edu.

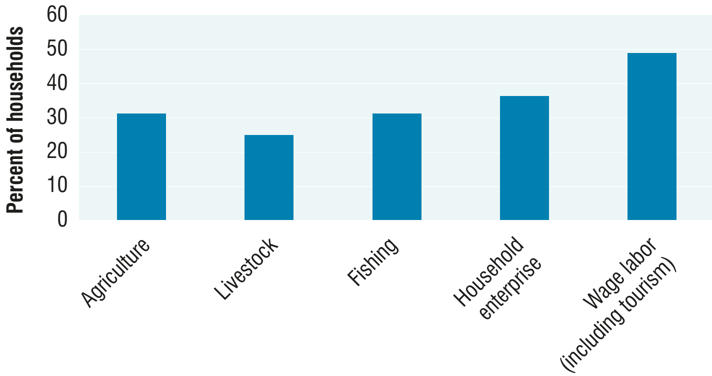


FIGURE 16. Percent of surveyed households engaged in each livelihood activity.

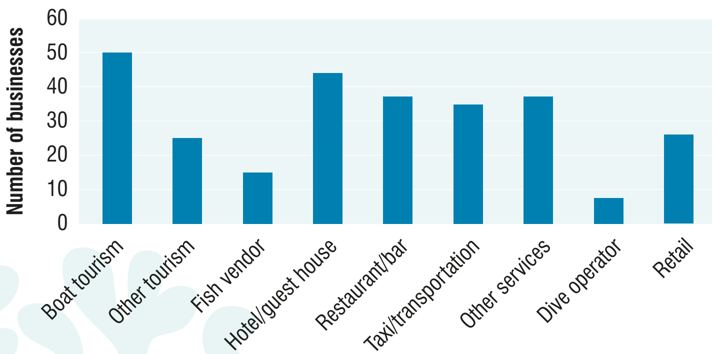


FIGURE 17. Number of business surveyed in the most important sectors of the El Nido economy.

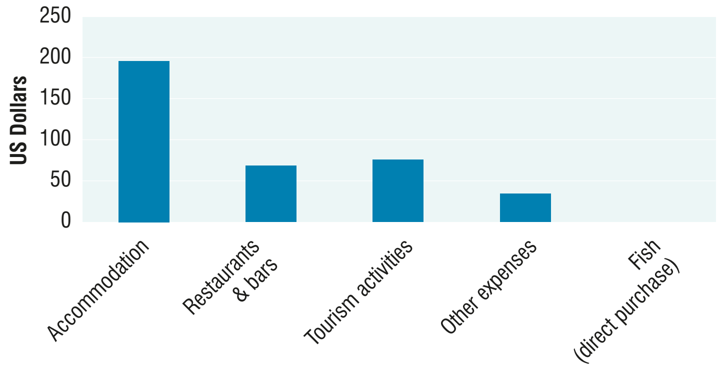


FIGURE 18. Expenditures of an average tourist in El Nido (in U.S. dollars) on a few common goods and services.

▲ **Fish market, El Nido.**
Photo: P. Mumby

Systems Analysis

Activity: Developing tools for systems thinking

RESEARCH

Objective

To use systems thinking to engage coastal communities and assist them to identify coastal resource management problems, preferred future scenarios, and intervention points that will help them achieve desirable outcomes.

Method

Initially, a workshop with local partners (PSU, PCSD and ENF) was held to determine the high priority socio-ecological problems faced by El Nido; where these problems were located; and who CCRES researchers needed to talk to in order to understand these problems.

In El Nido, the primary problems identified were fish catch decline, mangrove loss, water pollution and food insecurity.

A first round of focus groups was conducted in the barangays of El Nido using a beta version of *SESAMME* to explore each of these problems. *SESAMME* (Socio-Ecological Systems App for Mental Model Elicitation) is a group model-building tool used in focus group discussions according to a script that outlines the discussion procedure.

SESAMME, and its associated scripts, are designed to assist group discussions about coastal zone management problems; to capture information about components of these problems (such as resources, activities, pressures and decisions) from participants; and to help visualise how these components interact using icons that are dragged and dropped onto a map. The *SESAMME* maps created by each barangay in the first round of focus groups were then edited to include information gained from other barangays. A second set of focus groups using *SESAMME* was then held in the same barangays to review the maps. This ensured that the maps were as accurate as possible and that learnings were shared between barangays.

SESAMME maps created in this second round of focus groups were combined with other scientific and demographic data and used in the CCRES *System Simulation Model*. The model simulates the behaviour of the coastal system over time, depending on different activities, pressures, resources and decisions. It allows future scenarios to be tested.

In a third round of focus groups, the CCRES *System Simulation Model* was used with participants to assess five possible future scenarios for El Nido — from best case to worst case. The scenarios provided an objective picture of the impact of different decisions and activities on the problems of fish catch decline, mangrove loss, water pollution and food insecurity in their communities.

The focus groups were run according to a script, which is a logical and repeatable process that allows the results of multiple focus group discussions to be compared.

▲ **Dr Russell Richards, UQ, presents *SESAMME*, an iPad app, which was unveiled at the East Asian Seas 2015 Congress at Da Nang, Viet Nam.**
Photo: M. Paterson

► **The SYSTORY app allows creation of different scenarios for coastal ecosystems.**

Overall, this system thinking based process gave communities at El Nido a good understanding of coastal management problems, why they exist, and the potential impact of interventions.

▲ **John Pontillas (PCSD) facilitates talks with municipal and provincial stakeholders at Puerto Princesa.**
Photo: R. Richards

▲ **Eva Ponce de Leon (PSU) facilitates a focus group with residents, and one very tired dog, of Pasadena Barangay, El Nido, on the topic of fish catch decline.**
Photo: C. Smith

The CCRES *System Simulation Model* was subsequently used to build the *SYSTORY* app during 2017. The app allows users to understand and visualise the dynamics of coastal systems, and assess the influence of alternative scenarios on system trajectories over time, in an accessible way that requires no special technical knowledge or training.

Timeline

September 2014
Systems thinking training

April 2015
1st round focus group discussions, El Nido

July 2015
2nd round focus group discussions — training/ planning

October 2015
2nd round focus group discussions, El Nido

November 2015
Municipal focus group discussions Puerto Princesa

May 2016
Workshop to review models; plan for data collection

August 2016
Workshop to finalise models; plan for data collection

April 2017
3rd round focus group discussions — training/ planning

May 2017
El Nido, 3rd round FGDs

People

Component leader: Dr Carl Smith (UQ)

Activity leader: Dr Russell Richards (UQ)

Researchers/facilitators: Roy Bero, Aynon Gonzales, Agustin Miraflores, Patrick Regoniel, Mark Buncag, Gianina Decano, Eva Marie Ponce de Leon, Marissa Pontillas, Maricel Elorde, Ronald Ona and Precious Latras (PSU); Benjamin Adriano, Glenda Cadigal, Grace Palatino, Raul Maximo, John Pontillas, Jesus Bream and Silvino Alcantara (PCSD); Grachelle Dela Cruz, Pattie Lumbania, Lloyd Lumbania, Maius Marcelo, Jose Alferez, Leilani Aliaga and Joey Aliaga (ENF)

Participants: over 1100 community participants attended *SESAMME* focus groups in El Nido, as well as participants from the El Nido local government and Palawan provincial government in a special municipal focus group

Support: UPMSI (coordination) — Noreen Follosco, Miledel Quibilan and Lyn Riveral

Local partners: PCSD, PSU, ENF

THE OUTPUTS

SESAMME

SESAMME is an application (app) for Apple iPhones, iPads, Android phones and tablets, Windows PCs and Apple Mac computers. It is used to assist group discussions about coastal zone management problems (such as fish catch decline) and to capture and visually represent how resources, activities and pressures interact to create the problems identified.

It is a practical resource for governments and NGOs involved in community engagement, and educational institutions teaching courses in systems thinking.

SESAMME can be downloaded from the Apple App Store or the Google Play Store. Supporting scripts are also available on the CCRES website.

System Simulation Model

The *System Simulation Model* is a technical simulation model of the coastal zone built using Stock and Flow modelling software (Stella Architect). It quantifies interactions between activities on land (e.g. farming, urban development), activities on water (e.g. fishing), coastal ecosystems (e.g. coral reefs, mangroves) and coastal resources (e.g. fish). It allows the user to simulate the behaviour of the coastal system over time.

The tool consists of a Stella Architect file, an Excel spreadsheet and the *CCRES System Simulation Model User Guide* which can be downloaded at www.ccres.net.

Fives scenarios were created for each location visited at El Nido — from best case to worst case.

SYSTORY

SYSTORY is an application (app) for Apple iPhones and iPads, Android phones and tablets, and Windows PCs and Apple Mac computers. It helps managers to understand and visualise the dynamics of coastal systems, and assess the influence of alternative scenarios on system trajectories over time.

It has both 'explore' and 'experiment' functions. 'Explore' allows users to explore a story of the system and learn how coastal ecosystems and people interact. 'Experiment' will allow users to run simulations for user-defined scenarios and see how these scenarios affect the behaviour of the system. This can inform policy choices or community engagement around particular issues.

SYSTORY has data pre-loaded for El Nido which enables users to easily explore different possible future scenarios for the island's coastal resources.

SYSTORY can be downloaded on the Apple App Store or the Google Play Store.

THE DATA

As part of the *SESAMME* mapping process, data was captured on coastal zone management problems at El Nido and the components of these problems. This data, together with household survey data from another CCRES project (see page 23) and local demographic data was used to inform the scenario modelling and the development of *SYSTORY*. This data is available in the *System Simulation Model* spreadsheet available on the CCRES website.

For inquiries about the research, data or technical support, contact Dr Carl Smith (UQ), c.smith2@uq.edu.au. Data from the focus group discussions is held by the local partners.

BUILDING CAPACITY

CCRES has built capacity in local partner teams to apply systems thinking and *SESAMME* beyond the project. This is evidenced by:

- ENF using *SESAMME* in a proposed reforestation project
- PCSD using *SESAMME* in marine spatial planning projects
- PSU using *SESAMME* in PhD projects and other research projects
- At least two partner participants integrating systems thinking into their higher degree research as a result of CCRES training

"The enthusiasm, input and testing from our in-country partners in CCRES have been invaluable in taking *SESAMME* from a concept to an engagement tool. *SESAMME* appears to have really connected with the people we have engaged with in our studies in the Philippines and Indonesia."

Dr Russell Richards, UQ

▲ **Dr Patrick Regoniel (PSU) operating *SESAMME* at a focus group discussion, Sibaltan (top).**
Photo: R. Richards

PCSDS mangrove loss team in Bebeladen.
Photo: M. King

Business Development

Activity: Eco-Biz Challenge

RESEARCH

Objective

To identify local entrepreneurs and assist them in starting or expanding businesses that support the local economy, as well as ecosystem services. The *Eco-Biz Challenge* aimed to expand the pool of local talent, knowledge and creativity to find and incubate eco-friendly business ideas, and boost enterprise development. The competition format is designed to identify potential solutions for coastal communities and reward businesses for their ingenuity with the funds to help bring the concept to fruition.

Method

The *Eco-Biz Challenge* invited El Nido community members to submit innovative business ideas that support local livelihoods and protect coastal ecosystems. Creativity workshops were held to inspire El Nido communities and brainstorm business ideas. The business concept had to address criteria which included operating in the local area, employing local residents, and being environmentally sustainable.

Of the 56 *Eco-Biz Challenge* El Nido applicants, CCRES chose 28 semi-finalists. CCRES then ran a three-day business skills workshop with them in Puerto Princesa, and the semi-finalists produced final proposals, from which three winners and a runner-up were selected.

Winners received a one-time equity grant to start or expand their business concepts and mitigate start-up risks. Selection was based on those ideas considered to be viable, where the prize money will make a difference to the business, where the business is likely to be viable in the short to medium term and have a positive environmental impact.

Timeline

August 2017
Eco-Biz Challenge launch in El Nido, local businesses invited to submit ideas

September 2017
Creativity workshops to inspire El Nido communities and brainstorm solutions to pressing problems

2017 October
First commercialisation workshop, Puerto Princesa

2017 November
Eco-Biz semi-finals, second commercialisation workshop, El Nido

2018 January
Eco-Biz finals and prize ceremony, El Nido

People

Facilitators: Assoc Prof Damian Hine, Dr Anya Phelan (UQ); Mariglo Laririt (Ten Knots Development Corp); Noreen Follosco (UPMSI); Eva Marie Ponce de Leon, Gianina Decano (PSU)

Local partners: Ten Knots Development Corp, El Nido Local Government, PSU

Support: UPMSI

▲ **Semi-finalists at the *Eco-Biz Challenge* in the Philippines.**
Photo: L. Izquierdo

OUTCOMES

The three winners, Jonie Fernandez, Michael Magnol and Jovenly Naranjo, and the runner-up, Sonia Yntas, were selected for their inventiveness and the positive impact of their eco-business ideas.

The winning ideas included eco-charcoal (using coconut as an alternative to mangrove wood for cooking); ecotourism in the mangroves; sustainable horticulture (cultivating giant bamboo to reduce logging in native forests); and supplying ornamental native flowers to the tourism industry.

At the *Eco-Biz Challenge* finals El Nido Mayor Nieves Rosento presented each winner with a cheque for PHP 50,000 (approximately AUD$1,500).

A six-month monitoring and mentoring program is underway that will allow CCRES to track the progress of the winners and semi-finalists until the end of the CCRES project in 2018. A couple of the semi-finalists' businesses also received funding and support from local non-government organisations. In this way, CCRES expanded awareness of the nascent entrepreneurs and their businesses, and alerted existing local organisations to new opportunities and pathways to support their local economy and coastal ecosystem simultaneously.

OUTPUTS

The *Eco-Biz Challenge* comprises the central business plan competition, business skills training, and a facilitators' kit containing all materials needed to deliver the competition, including business skills training, logistics, background and material for participants.

The tool is intended to be applicable to diverse, international contexts. It can be used anywhere where communities need to expand the pool of local talent, knowledge and creativity. It is an engaging way to energize community conversation on sustainability issues and boost enterprise development.

Resources for running the *Eco-Biz Challenge* can be downloaded at www.ccres.net.

MORE INFORMATION

For inquiries about the tool or technical support, contact A/Prof Damian Hine d.hine@business.uq.edu.au or Dr Anna Phelan a.phelan@business.uq.edu.au

▲ ***Eco-Biz Challenge*** **business skills workshop, Puerto Princesa.**
Photos: L. Izquierdo

► **Finalist Michael Magno (left) with El Nido Mayor Nieves Rosento, Ms Mariglo Laririt (Ten Knots Development Corp), and A/Prof Damian Hine (UQ).**
Photo: M. King

"All winners had great ideas that are likely to be successful. We can't wait to see that success and the positive effect it can have on the whole municipality of El Nido."

A/Prof Damian Hine, Business Development Component Leader, UQ

Behaviour Change

Activity: My Future, My Oceans

RESEARCH

Objective

The purpose of bringing the program to El Nido was to address local problems and to trial *My Future, My Oceans* in the untested context of the Philippines, using data accumulated to assess and consolidate the tool's versatility and efficacy in new spaces.

Enhancing the philanthropic research and community facilitation skills of local personnel, including barangay leaders, government officials and staff members from Ten Knots Development Corp, as well as a group of students from Georgetown University, Washington DC, attending a Ten Knots summer internship program, were further objectives of this El Nido partnership.

Method

My Future, My Oceans was designed using proven evidence-based behavioural strategies, together with input from local stakeholders and beneficiaries in tailoring the program specifically to their needs.

The activity involved four steps:

1. Scoping potential villages.
2. Engaging and training local staff and personnel (both within Ten Knots Development Corp and the local barangays).
3. Delivering My Future, My Oceans to two barangays.
4. Comprehensively measuring all outcomes at two distinct time points.

At El Nido, the core psychological competencies and behaviours targeted were plastic collection; problem solving skills; checking whether the fish that participants consume are caught safely or by destructive methods; perceived responsibility for the state of the environment; satisfaction with life; and perceived impact of actions on the environment. These measures make up the Sustainable Actions Checklist. A composite score reflects the underlying cognitions, attitudes, behaviours, and social mechanisms necessary to live sustainable lives.

The week-long El Nido trial studied women from two villages — Bebeladan (intervention) and Teneguiban (control). Outcomes were measured directly prior to implementation and directly after.

The cost to roll-out *My Future, My Oceans* in a coastal community in low-resource settings is approximately AUD$2,700 covering most materials and personnel.

Timeline

28 May – 6 June 2018

Intervention: Engaging and training local staff and personnel (through Ten Knots Development Corp and the local barangays).

Evaluation: Comprehensively measuring all behavioural outcomes and program impacts.

◄ **Lloyd Lumbania, El Nido Resorts, facilitates a *My Future, My Oceans* workshop at Bebeladan village, El Nido.**
Photo: P. Bradley

People

Activity leader: Erik Simmons (UQ), Mariglo Laririt (Ten Knots Development Corp)

Trainer: Paula Bradley (PJ Bradley Consulting)

Participants: Nearly 100 women from two villages in El Nido

Support: Ten Knots Development Corp; Georgetown University interns; UPMSI; and local personnel, including barangay leaders, government officials and staff members from Ten Knots Development Corp

THE FINDINGS

Participants improved on the six core psychological competencies and behaviours targeted by the pilot program: perceived plastic collection; problem solving skills; checking whether the fish that participants consumed were caught safely or by destructive methods; perceived responsibility for the state of the environment; life satisfaction; and perceived impact of actions on the environment. This was compared to the control group, which made no changes or improvements on the psychological competencies measured. Psychological competencies are reflective of self-regulatory abilities, sustainable behaviours, and prosocial tendencies that lead to happier, healthier, and flourishing communities.

"*My Future, My Oceans* was created to promote human behaviours that protect coastal ecosystems and the services they provide to local communities It's effective, easy to use and low-cost. This ensures that non-experts, supported with light-touch training and modest investment, are capable of delivering the program for the benefit of those around them."

Erik Simmons, UQ

THE OUTPUTS

The data collected was used to develop *My Future, My Oceans* as a low-cost process of behavioural diagnosis and capacity enhancing intervention for promoting behaviour change. The data also cross-validated *My Future, My Oceans* in a novel, non-Indonesian context.

The *My Future, My Oceans* tool comprises:

- Participant workbook
- Facilitator guidebook
- Project management guidebook complete with an evaluation framework and trainer modules, scripts and slides.

Download the materials from www.ccres.net.

THE DATA

The research data is kept at UQ. For enquiries about the research, findings, outputs, data or technical support, contact Erik Simmons (UQ), e.simmons@uq.edu.au

▲ ***My Future, My Oceans*** **participants at Bebeladan village, El Nido.**
Photo: H. Almasco

► ***My Future, My Oceans*** **workshop at Bebeladan village, El Nido.**
Photo: P. Bradley

TIMELINE

JULY 2014 TO DECEMBER 2018

2014

2015

January
El Nido chosen as the Philippines pilot site

July
CCRES launches in the Philippines

November
Local stakeholders meet with CCRES team to provide insight into socio-ecological problems

November
UPMSI research team explores the efficacy of seagrasses and mangroves in filtering upland runoff in El Nido

February
Philippines partners prepare for El Nido focus group talks on food insecurity, water quality, fisheries and mangroves

March
UPMSI team measure rates of sedimentation in mangroves

April
Surveys conducted with households, tourists, business

April
CCRES partners lead food insecurity group discussions in El Nido's 18 barangays

May
Reef health surveys at El Nido

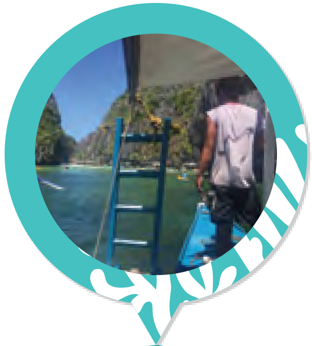
May
CCRES Advisory Board meets at El Nido to observe geography, issues and challenges

September
Business development activity commences with analysis of El Nido businesses

May
El Nido field sites are revisited for additional measurements on crevice abundance, reef fish, coral recruits, turf and macroalgae

2016

2017



2018

July
El Nido ocean currents measured

August
Four major watersheds and their coastal areas examined, sites established at two rivers for longer term measurement of discharge

November
Eco-Biz Challenge scoping with local stakeholders begins

May
El Nido Tools Forum

June
Training for marine reserve design

July
Findings from CCRES research, are presented at a sustainable tourism forum convened by El Nido Resorts

January
El Nido hosts *Eco-Biz Challenge* finals

March
Fish SPACE used to assess coral bleaching damage in El Nido

April
90+ local marine planning experts and coastal managers attend tools training workshops at Tagaytay

May
The *My Future, My Oceans* tool rolls out in the Philippines to improve waste management in El Nido

September
UP MSI provides feedback on *Fish SPACE*-related research to El Nido local government, Protected Area Management Board and others

November
Local stakeholders and community representatives attend closing event

OUR TOOLS

CCRES has developed a suite of innovative tools to help coastal managers, policy-makers and planners to strengthen and sustain their coastal ecosystems and communities. These tools include policy briefs; software programs, models and applications (apps); and toolkits to run processes for business development and behaviour change. They can be used individually to address a specific challenge in coastal development or collectively to build a system-wide solution.

MARINE PLANNING

Marine Protected Areas (MPA) toolbox

The toolbox is designed to help planners and policymakers make informed decisions about the total coverage, placement and local size of MPAs, and encompasses the following tools:

- *MPA placement optimization tool*
- *MPA size optimization tool*
- *Fish SPACE*
- Policy brief: Healthy fisheries through marine reserves
- Policy brief: Priority reefs for conservation and fisheries replenishment
- Educational tool for marine design (pending)

MPA placement optimization tool

The *MPA placement tool* helps users optimize larval dispersal around MPAs in order to achieve flexible management objectives, including both biodiversity conservation and fishery benefits.

MPA size optimization tool

This software helps users optimize decisions on the size of local MPAs by calculating the proportion of the possible maximum number of individuals of each target species that will be effectively protected in MPAs of various conceivable sizes.

Fish SPACE

Fish SPACE assists users to explore the benefits and impacts of different marine reserve network spatial configurations, with fisheries management strategies.

Policy brief: Healthy fisheries through marine reserves

This tool is a set of policy guidelines that can be used to set large-scale marine spatial planning targets, as well as small-scale MPA design.

Policy brief: Priority reefs for conservation and fisheries replenishment

This policy brief guides users on the characteristics of reef areas that are best-suited to marine conservation efforts.

Policy brief: Reduced pathogenic bacteria through seagrass protection

This brief helps policy makers and leaders make informed decisions about managing seagrass, by demonstrating the value of seagrass which can reduce bacteria pathogenic to humans and marine life by up to 50 per cent.

Reef React

Reef React assists users to predict alternate futures for coral reef ecosystems under various climate and human use scenarios to help guide policy and management interventions to reduce negative impacts.

Coastal Protection

Coastal Protection taps into a Bayesian Belief Network (BBN) to evaluate which reefs best protect important coastal infrastructure and communities. Users can apply the *Coastal Protection* model to coral reefs visible on GIS systems like Google Earth.

SYSTEMS ANALYSIS

SESAMME

SESAMME is an app designed to facilitate group discussion about proposed coastal management changes. Available on Apple iOS devices, Windows PC and Android devices, the app draws on past and future trends to visually represent how different coastal zone problems interact with each other.

System Simulation Model

The *System Simulation Model* quantifies interactions between activities on land (such as farming and urban development), activities on water (such as fishing), coastal ecosystems (such as coral reefs and mangroves) and coastal resources (such as fish). It allows the user to simulate the behaviour of the coastal system over time.

SYSTORY

SYSTORY assists users to visualise influencing coastal dynamics and how these forces play out in alternative scenarios. Available on Apple iOS devices, Windows PC and Android devices, the app can be used for policy evaluation, community engagement and teaching.

BUSINESS DEVELOPMENT

Ecosystem-based Business Development (EbBD) Approach for Coastal Communities

The *EbBD Approach* is a process that uses ecosystem services and biodiversity as part of an overall sustainable development strategy, to help support sustainable livelihoods and local economic development in low resource coastal communities.

Eco-Biz Challenge

The *Eco-Biz Challenge* is business plan competition, including business skills training, to encourage businesses that are environmentally and socially sustainable. Local government, NGOs, private sector leaders and educational institutes are encouraged to use the competition to encourage sustainability-focused innovation.

BEHAVIOUR CHANGE

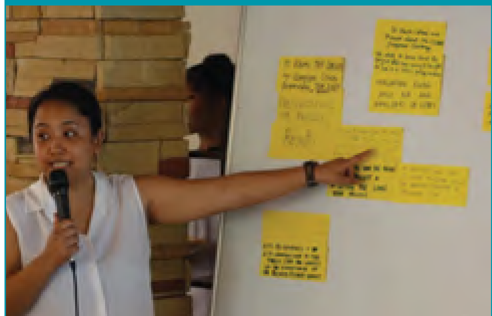
My Future, My Oceans

The *My Future, My Oceans* tool is designed to foster sustainable, environmentally responsible behaviours in low-resource coastal households. The process first assesses current habits and values, then actively engages community members to shift attitudes toward environmental issues.

FishCollab

FishCollab assists governments, communities and NGOs to work together to improve coastal management. It enables users to identify key stakeholders, develop networks, analyse policy, analyse and reduce conflict, and identify opportunities and challenges.

Download the tools at www.ccres.net.



▲ **El Nido Mayor Nieves C. Rosento (top) and CCRES Philippines coordinator Noreen Follosco, at the Tools Forum, El Nido.**
Photos: M. Paterson

EL NIDO TOOLS FORUM

In May 2017, CCRES hosted a forum to show our tools to partners at El Nido.

Local environmental planners, coastal managers, tourism officers, business people and provincial regulators came to see the tools that had been developed based partly on research by CCRES scientists at El Nido.

The event was formally opened by El Nido Mayor Nieves Rosento. Local attendees included representatives from the El Nido Local Government, PCSD, PSU, Protected Area Management Board and Ten Knots Development Corp.

The aim of the forum was to share results of our research at El Nido and to discuss how and when the CCRES tools and knowledge may be used in coastal management and planning at El Nido and elsewhere in the Philippines.

▼ **Potential local end-users at the Tools Forum, El Nido.**
Photo: M. Paterson

THE FUTURE

The goal of the CCRES project is to assist communities and government sustain the services provided by coral reefs, fisheries, mangrove forests and seagrass beds.

This assistance for coastal policy-makers, planners and managers is in the form of a set of technical tools for:

1. Engaging communities in the decision-making process and improved governance.
2. Identifying desirable trajectories for communities and potential obstacles and opportunities.
3. Designing marine plans explicitly to improve reef fisheries productivity and biomass.
4. Factoring in the role of coral reefs in protecting coastal infrastructure into decision-making.
5. Fostering entrepreneurship in marine-related, sustainable business enterprises.
6. Raising awareness of the value of coastal ecosystems to livelihoods and human welfare.
7. Promoting and empowering positive changes in community behaviour.

The tools assist users to sustain coastal ecosystem services (such as food security, tourism, water filtration and coastal protection) that are essential for the health of oceans, people and economies.

Already, they are being used for coastal resource management training and planning across the Philippines (see map page 39).

CCRES is talking with prospective partners in East Asia, the Middle East and the Pacific, and planning for a global rollout of the tools in developing countries post-2018.

The results from the activities at El Nido demonstrate that the tools can be used individually to address a specific challenge in coastal development or collectively to build a system-wide solution.

We hope that the work done at the pilot site of El Nido by our local, national and international partners — with the support and participation of the El Nido community — creates a lasting legacy for El Nido, other coastal communities in the Philippines and beyond.

PROMOTING UPTAKE IN THE PHILIPPINES

In April 2018, over 90 people attended tools training workshops in Tagaytay, Philippines. Representatives from government, NGOs, business, universities and other research institutes — including participants from El Nido — learned about the individual tools and how to use them in coastal planning and management.

A review of post-workshop survey results reveals that 94.5% of attendees at workshops in the Philippines (and Indonesia) expect their organisations to use the tools in their current or future work. Approximately 97% agree or strongly agree that following their involvement with the CCRES project, they see benefits in using information on ecosystem services to support decision-making.

▲ **Prof. Cesar Villanoy and Lyn Riveral, UPMSI, at the CCRES stand, 4th Asia-Pacific Coral Reef Symposium, Cebu.**
Photo: N. Follosco

Videos capturing participants' experiences, an explanation of the tools, and perspectives from project partners in the Philippines are now available on the CCRES YouTube channel.

In June 2018, we had a strong presence at the 4th Asia-Pacific Coral Reef Symposium in Cebu, Philippines, with four people on the program presenting to hundreds of attendees and a trade stand to facilitate discussions about CCRES tools with delegates.

We are also presenting the tools at the Partnerships in Environmental Management for the Seas of East Asia (PEMSEA) East Asian Seas Congress in Iloilo, Philippines in November 2018.

> **"Many delegates were interested in learning more about the tools, and signed up for our newsletter and more updates."**
>
> Noreen Follosco. CCRES Philippines Country Coordinator, at the 4th Asia-Pacific Coral Reef Symposium (APCRS) Cebu, June 2018

Participants, trainers and facilitators at the CCRES tools training workshop in Tagaytay, Philippines, in April 2018.
Photo: G. Bernal

OUR TOOLS IN ACTION

The CCRES tools have already been used in many situations across the Philippines, in El Nido and beyond.

Haribon Foundation, which is a Responsible Partner of the DENR/ UNDP Smart Seas PH Project, has used *Fish SPACE* to evaluate marine reserve design and fisheries management initiatives in Lanuza Bay, Surigao del Sur.

Smart Seas Philippines is using Lanuza Bay as a model site to roll out the MPA design tools in other Marine Key Biodiversity Areas such as the Davao Gulf and the Verde Island Passage.

The **PCSD** and **WWF Palawan** are using *Fish SPACE* and the *MPA Size* and *Placement Optimization Tools* to support MPA design in Cluster 5 in northeastern Palawan, which includes the municipalities of El Nido, Linapacan, Taytay, Dumaran, Roxas and Araceli.

The MPA design tools have been used in **Oriental Mindoro**, **Lanuza Bay**, **Palawan**, and **Batangas**. Local stakeholders used *Fish SPACE* to better understand the trade-offs between biodiversity and fisheries priorities, and the *MPA Size* and *Placement Optimization Tools* to explore different scenarios for individual MPA size and placement to enhance MPA designs.

Organizations such as the **Provincial Agricultural Office of Oriental Mindoro**, **Malampaya Foundation Inc.**, **Smart Seas Philippines**, **Haribon Foundation**, the **Provincial Government Environment & Natural Resources Office of Batangas**, and the **PCSD** have provided counterpart support in the form of local coordination, financing and logistics, and technical resources in using the MPA design tools.

The **Zoological Society of London** working in the Panay and Negros islands, and the **Macajalar Bay Development Alliance** in Misamis Oriental have developed workplans to use the MPA design tools.

The **Protected Area Management Board of the El Nido-Taytay Managed Resource Protected Area** will consider *Fish SPACE* results and associated research in implementing and planning for protection and interventions in the protected area.

The **El Nido local government** and other key stakeholders plan to use *Fish SPACE* results and associated research to facilitate conversations on enhancing local coastal management.

The CCRES tools are also being shared at regional and international conferences attended by government officials, NGOs and community organisations, as well as project managers working on technical projects funded by the **World Bank** and the **Global Environment Facility**.

▲ **Coastal Protection workshop participants, Tagaytay.**
Photo: S. Clayton

◀ **Marine planning training workshop participants at Tagaytay.**
Photo: S. Clayton

WHERE OUR TOOLS ARE BEING USED

Sunset at El Nido.
Photo: A Harvey

ACRONYMS

DLSU	De La Salle University
DENR	Department of Environment and Natural Resources
ENF	El Nido Foundation
PCSD	Palawan Council for Sustainable Development
PSU	Palawan State University
PEMSEA	Partnerships in Environmental Management for the Seas of East Asia
UP	The University of the Philippines
UPMSI	The University of the Philippines Marine Science Institute
UQ	The University of Queensland

Annexes containing further details on the activities, including summary data is supplied separately, or may be requested from the researchers.

◄ **Special thanks to the wonderful staff at UPMSI who facilitated so much of CCRES's work in the Philippines — (L to R) Romelyn 'Lyn' Riveral, Noreen 'Kubi' Follasco and Miledel 'Mags' Quibilan. It could not have been done without you.**

CONNECT WITH US

CAPTURING CORAL REEF AND RELATED ECOSYSTEM SERVICES

Join our community @CCRESnet
ccresnet

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Visit **www.ccres.net**

CCRES
Capturing Coral Reef and Related Ecosystem Services Project

The Capturing Coral Reef and Related Ecosystem Services (CCRES) project is a regional technical support project that unlocks new, sustainable income streams for coastal communities in the East Asia-Pacific region. CCRES has developed knowledge products — which inform the design of global, regional and national projects, plans and policies — and technical models and planning tools which assist users to strengthen community-based coastal resource management.

gef WORLD BANK GROUP THE UNIVERSITY OF QUEENSLAND AUSTRALIA

UCDAVIS Currie UNHAS LIPI CCMRS-I

Front cover: Early morning fishing, El Nido.
Photo: T. Gilliland