Abschlussbericht für das im Rahmen des Paktes für Forschung und Innovation im Leibniz Wettbewerb geförderten Vorhaben

Triple C (Contributing to Coral Commons)

Final Report

Title of Project:

# Triple C

# Contributing to Coral Commons

Leibniz Centre for Tropical Marine Research (ZMT) in cooperation with ZEW & RWI

Reference Number: SAW-2014-ZMT-1 317

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## Contents

Executive Summary ..... 3

Aims of the Project ..... 4

Development of the various subprojects ..... 4

Sub-project 1: Cross-cultural public good experiment (ZEW, Carlo Gallier, Andreas Löschel) .. 4

Sub-project 2: Natural field experiments (ZMT, Katie Nelson, A. Schlüter) ..... 7

Sub-project 3: Spatially explicit econometric modelling (RWI, Colin Vance, Jörg Langbein) ..... 9

Sub-project 4: Ethnographic assessment (ZMT, Jacobs University, Marco Verweij, Abdul Halik, Achim Schlüter) ..... 11

Sub-project 5: Ecological assessment (ZMT, Sonia Bejarano, Sebastian Ferse) ..... 13

Sub-project 6: Synergies and integrating the approach (ZMT, Achim Schlüter, Katie Nelson, Marie Fujitani, Micaela Kulecz) ..... 15

Additional results beyond the sub-projects and follow up activities ..... 17

Proposal writing resulting out of Triple C ..... 17

Academic qualifications obtained with the help of Triple C ..... 18

Concluding appraisal of Triple C ..... 18

List of References ..... 19

List of References produced by Triple C ..... 19

## Executive Summary

Tropical coral reefs provide substantial ecosystem services on a global and local scale: they produce fish, protect shore lines, provide tourism recreation, and host a huge biodiversity. Coral Reefs face unprecedented degradation that stems from various drivers operating at multiple levels. Global stressors include ocean acidification and temperature rise, while local stressors include eutrophication and overfishing. From an economics perspective, coral reefs are common pool resources (CPR), meaning that all would benefit from halting degradation. However, the pursuit of individual benefits, be these from fishing, farming, tourism, or other activities, creates incentives to continue destruction. This project contributed to resolving the crisis of tropical coral reefs by employing different methods from economics, ethnography, and ecology to investigate the factors that determine people's willingness to contribute to solving the coral commons dilemma and by suggesting institutional mechanisms to address the crisis.

The key findings of the project are that the willingness to contribute to the common good of coral reef restoration with either monetary or time donations vary substantially from what normally is observed in the Western world and in our study population of Indonesian people living close to the sea. Monetary contributions have been favoured in comparison to time contributions to the common good (Nelson et al., 2017). This has important implications for organising collective action locally, for example by environmental NGOs. Collective action requires getting people on board. Ethnographic qualitative research in Indonesia has shown that within various forms of public participation one can clearly find preferences for all four types of organisation according to cultural theory, however with an expected higher emphasis on hierarchy (Halik et al., 2018). This shows the importance of participation in local processes of institution building, allowing for clumsy, legitimate solutions (Halik and Verweij, 2018). Those findings are backed up by experimental research in the same geographical area, which shows that particularly in the case of high cultural and religious heterogeneity there is a strong preference for democratic and participatory processes in institution building (Gallier et al., 2018). In a dictator game run in Indonesia, we found differences to what is mostly observed in a Western context: outgroup favouritism (Alt et al., 2018). These findings are based on a student subject pool and therefore might have limited external validity. However, they indicate there is scope to solve the glocal (global and local combined) dilemma of coral destruction. Combining ecological and social data we could show that different protection schemes (local institutional solutions) did not show significantly different effects on the ecological outcome.

The project has given a lot of opportunities to collaborations between the different working groups and therewith between the various Leibniz institutes. This inter-working group collaboration was stronger than anticipated in the project proposal, particularly across institutes,

and led to various joint publications and some joint – although as yet unsuccessful – project applications. It helped to establish a network between Leibniz Institutes from different sections.

## Aims of the Project

The aim of the project was to understand the willingness to contribute to solving the coral reef crisis, using a broad variety of mainly experimental techniques (see project proposal). Each of the different experimental tools used here have their particular advantages and disadvantages and find themselves on a continuum between controllability (leading to internal validity) and external validity, thus being able to expand our findings beyond the experimental setting to a real life situation. The willingness to contribute does not emerge from the experimental situation as such, but it responds to the ecological and social context in which the choice situation is embedded. Therefore, the project consisted of six subprojects distributed across three major knowledge fields, namely ecological, behavioural, and ethnographic, the first of which provided the necessary background on ecosystem processes and the latter two focused on understanding the social contexts. In the following section of this report the major aims, findings, achievements, and unforeseen shortcomings of each subproject will be detailed consecutively.

## Development of the various subprojects

### Sub-project 1: Cross-cultural public good experiment (ZEW, Carlo Gallier, Andreas Löschel)

This subproject designed and tested institutional mechanisms which aim at fostering cooperation in coral reef protection. At the core of the crisis of tropical coral reefs is the fundamental conflict between individual self-interest and social optimality, where rational, self-interested individuals will not act to achieve their common group interest. This conflict is exacerbated by the international dimension of the coral crisis and substantial heterogeneities between all parties involved.

Understanding individuals' cooperative behaviour in international and heterogeneous groups is essential to designing institutions that may increase cooperation for coral reef protection. The starting points for this subproject were the research questions stemming from 1) whether cooperation behaviour differs substantially across individuals from countries and 2) which role heterogeneities play between parties in solving the coral crisis. While the first research question refers to running the same cooperation experiment in a number of different countries and comparing results across locations, the crucial aspect of solving the crisis of tropical coral reefs is that it requires international cooperation. So far little is known about cooperation behaviour in

international groups. Therefore, we did not only investigate cooperation behaviour at the national level, i.e., when agents come from the same country, but also at the international level, i.e., when agents come from different countries.

Designing institutional mechanisms to increase cooperation behaviour between international and heterogeneous parties is crucial for solving the crisis of tropical coral reefs, which involves local as well as global aspects. On the global stage, the crux is that there is no jurisdictional control through a central authority with enforcement capacities comparable to those of the national government within the nation-state. This immediately gives rise to the question whether groups of sovereign agents are able to set themselves institutions and whether they comply with these non-enforceable regulations. Inspired by recent developments in international climate negotiations, we test whether communicating voluntary intensions fosters cooperation in large scale global cooperation problems. In contrast to the global level, on the local level, this subproject examines whether local authorities with respective enforcement capacities may abstain from top-down regulations and use community participation as a vehicle to increase compliance.

In order to study individuals' cooperation behaviour in international groups of heterogeneous parties, a first cooperation experiment is conducted in close collaboration with the United Nations Youth Association Network (UNYANET). Gallier et al. (2017) establish a unique international subject pool with more than 130 participants from more than 50 countries. By conducting the experiment via the Internet, participants from different countries, regions, and time zones are able to participate in the same public goods experiment. By design, participants have the opportunity to increase ambitions beyond a pre-existing level, maintain the current level, or even undo ambitions. The results show that reducing pre-existing ambitions, by taking something out of the public good, appears to be a strong behavioural barrier. Based on this first study, another large scale experiment is designed and conducted in order to explicitly investigate differences in individuals' cooperation behaviour in national and international groups (Gallier et al., MIMEO). With participants recruited from four countries crucial for providing global public goods (China, Germany, India, and the US), this provides the opportunity to study different research questions. First, to analyse whether there are national differences in cooperation behaviour in local groups at the national level across countries. Second, to investigate whether there are differences in cooperation behaviour with local and global others. Finally, this subproject helps us to understand whether the opportunity to communicate voluntary intentions increase cooperation at the local and global level. The results reveal substantial differences in national cooperation behaviour when comparing results across countries. Furthermore, findings also show differences in cooperation behaviour with local and global others. Finally, the results

suggest the tendency that participants do not comply with what they have pledged, this is especially evident in international groups.

With respect to the local aspects of the crisis of tropical coral reefs, three further experimental studies were conducted. The first two studies analyse participants' cooperation behaviour and compliance with decentralized regulations. The first study (Gallier et al., 2018) is described in more detail in sub-project 3. In a follow-up study, Gallier (2017) investigates whether participation has a value per se. The experimental design disentangles to which degree a democratically chosen regulation is driven by self-selection into regulations, information transmitted via democratic participation, and democracy per se. A naïve comparison suggests that the regulation is more effective, if it is democratically chosen than externally imposed. However, democratic participation does not affect participants' contribution behaviour directly, after controlling for self-selection into treatments and the information transmitted by voting. Both studies contribute to the growing economic literature investigating the endogenous formation of institutions to overcome social dilemmas. In order to structure this relatively new research field, Dannenberg and Gallier (MIMEO) review the experimental literature on the choice of institutions and describe what has been learned about the quality and the determinants of institutional choice. A further experiment addresses that local resources like coral reefs are typically managed by a variety of different and heterogeneous fisher groups. Therefore, understanding individual choices in the involvement of group identity provides valuable insights on decision-making. This is assessed in Alt et al., (2018), which finds that participants comply with social norms to different degrees, depending on interactions with in- or out-group members.

The greatest challenge of conducting economic experiments with participants from an international subject pool is to get access to an international pool of participants. Since there is not a clear guideline on how to overcome this challenge, this subproject is based on a successful line of experimental research at ZEW by conducting experiments online via the Internet. This substantially facilitated access to participants in different countries. Since this is an innovative and untested approach, two different recruitment strategies are used in order to minimize the risk of not reaching a critical number of participants. The first strategy relies on a self-established contact to the UNYANET network in order to get access to their international members. The second strategy is based on established contacts to GfK, an international market research company with panel members in a variety of different countries. An unplanned scientific opportunity of conducting the experiment online via the Internet is the possibility to not only focus on national comparisons, by running the experiments in different countries and comparing results across locations, but also to investigate international cooperation, by combining participants from different countries in the same experiment.

## Sub-project 2: Natural field experiments (ZMT, Katie Nelson, A. Schlüter)

The natural field experiments aimed to address the determinants of individuals' willingness to contribute to solving the CPR dilemma facing coral reefs globally. This sub-project conducted four field experiments in Indonesia and two experiments in Germany. The experiments in Indonesia were conducted with fishermen from Wakatobi, Southeast Sulawesi; students and the general public from Bogor, Java; and tourists on Gili Trawangan, Lombok. Experiments in Germany were conducted with students from Bremen. Participants in the experiments were exposed to different treatments to donate for coral reef restoration.

Proximate stressors such as destructive fishing are key drivers damaging coral reef public goods. Conservation strategies that marshal local action and are tailored to the preferences of the target group are thus needed to sustain coral resources. The field experiments conducted with fishermen in Wakatobi, Indonesia aimed to test economic theory regarding preferences for giving time and money to environmental and other charitable causes. Each participant was subjected to one of four treatments: monetary donation, monetary donation match, volunteer time donation, and volunteer time donation match. Contrasting with theory, we find that participants give significantly more when donating money compared to time when they are of equal value. We also find that matching donations increases the percent of people giving but does not increase the amount donated. This research furthers our understanding of what motivates resource users in a developing country to contribute to the provision of marine public goods (Nelson et al., 2018c).

Using data collected from the same study population, we examined the effect of social and psychographic characteristics on giving to marine public goods. This study used an incentivized task to elicit preferences for the distribution of wealth between oneself and an anonymous other. Participants were classified into categories based on preferences for benevolence, egalitarianism, own-money-maximization, and malevolence. The data show that these intrinsic characteristics, such as preferences for equality, are a significant predictor of donation behaviour. Practical application of these results would call for conservation marketing practices to develop targeted messages that emphasize social norms, promote cooperative values, and consider the needs of resource-users in the design of local conservation campaigns and goals (Nelson et al., 2018b).

We conducted a follow-up to the study donating time and money with students at the Bogor Agricultural University (IPB). Over 300 students participated in a task to benefit a local marine conservation organization and were given the opportunity to either donate some of their earnings or to donate additional time to the organization to help conserve coral reefs in Indonesia. The results of this study are in line with theory showing that there are no differences

in the amounts of time and money given to charity when the values are equivalent. When the donation values are matched by a third party, more people chose to go with the match-option only in the case of monetary donations but not in the case of time donations. Therefore, we conclude that matching has a crowding-in effect on the external margin (the likelihood that an individual makes a donation) for monetary donations but has no effect on the external margin for time donations. Alternatively, matching greatly affects the intensive margin (the amount given conditional on making a gift) for time donations but not for monetary donations. These are interesting and valuable findings given that matching is effective in different ways for gifts of time and money. If the goal is to increase the base of donors, then matching monetary gifts is the best way to do this. If the goal is to increase the value of donations to the charity, then announcing matches to volunteer time is the best way to achieve this.

We conducted experimental research to elicit conservation action with coral reef tourists in Indonesia. Through this experiment, we solicited voluntary user fees from tourists visiting a marine reserve in Indonesia. Contributions supported the local conservation organization to provide public good services such as keeping the island clean, providing recycling services, and protecting the fragile coral ecosystem. Real donations were solicited under four treatment conditions: control (write-in amount), default opt-in, default opt-out, and reference levels. Results revealed that tourists are willing to donate to coastal conservation and that there is a significantly higher propensity to donate in all treatment conditions compared to the open-ended condition. The default opt-out conditions garnered the highest rate of donations at 75% and 62% respectively for the lower and higher set amounts. The mean donation amount was largest in the higher default opt-out condition. Our results suggest that the optimal method of requesting voluntary donations is a set default amount requiring users to opt-out if they do not wish to donate. Implementing a default opt-out eco-donation targeting all types of visitors represents a significant source of funding and illustrates the potential for donations to finance land and sea conservation efforts, an important avenue for future investigation in many interconnected systems that have been historically governed and financed separately (Nelson et al., 2018a, forthcoming).

Awareness of the problem is the primary step in the behaviour change process. We were interested to experimentally test the effects of message frames and media types in raising awareness for coral reef conservation. We conducted cross-cultural studies with students, tourists, and the general public in Indonesia and Germany. We used a 2x2 experimental research design. We tested innovative technology using virtual reality headsets with 360 degree video footage and compared this to traditional ‘flat’ video footage. We combined the media type with positive/gain messaging compared to a negative/loss message frame. This experiment included over 1000 participants representing more than 40 different countries. Our results show that all

the treatment conditions result in a significant increase in pro-environmental behaviour compared to the control - no media communication. The virtual reality medium increases pro-environmental behaviour but this effect is observed at a statistically significant level only in the reef tourist population. The effect of the virtual reality medium is strongest in combination with the negative/loss message framing which is consistent with Prospect theory in economics.

We encountered challenges in carrying out the proposed method of administering the field experiments via a web-based donation instrument, but we have efficiently and effectively addressed these challenges. In 2014 PhD student, Katie Nelson, attended the 'The Science of Philanthropy Institute' annual conference to liaise with influential behavioral scientists (i.e. John List, Michael Price, Catherine Eckl, and many others) engaged in philanthropy to discuss research design and platforms to conduct the research. Meetings were also held at the Washington DC headquarters of The Nature Conservancy and World Wildlife Fund – both potential research partners. Both of the institutes stated proprietary and sensitive information on their donation websites and were not comfortable working with researchers to engage in experimental field testing of different donation request messages using their donor base. Although web-based experiments have the potential to reach a large number of people, the ratio of active donors to site visits is much lower than more traditional face-to-face fundraising campaigns. After the discovery that fundraising on behalf of conservation organizations through purchased e-mail lists or marketing companies (such as GfK Verein) would yield very low donation rates (around 5,000:1), we shifted the donation vehicle to smaller-scale, yet more efficient and more direct methods of fundraising experiments, such as local campaigns and locally organized activities.

### Sub-project 3: Spatially explicit econometric modelling (RWI, Colin Vance, Jörg Langbein)

As originally conceptualized, the aim of this work package was to estimate spatially explicit econometric models of land cover change that linked agricultural and fishing activities to reef ecosystem degradation. With the commencement of our work, we decided to reframe this aim to focus specifically on activities in fishing communities, recognizing that available resources would not be sufficient to additionally include surveys of farming communities. In line with the Triple-C's overarching goal to investigate different institutional mechanisms for harnessing people's willingness to contribute to solving the coral commons dilemma, our focus shifted to understanding the incentives underpinning fish extraction in the absence of clearly defined property rights. This shift opened unanticipated scientific opportunities leading to an ongoing collaboration with practitioners in resource conservation and subsequent research endeavors.

Early on in the project, it was realized that our research goals closely meshed with the activities of Rare, a US-based conservation NGO whose main charge is coral reef protection. Rare's work focuses on the establishment of Territorial Use Rights for Fisheries (TURFs). TURFs represent an

integrated approach to fisheries management that couple conservation with economic development goals by bestowing local fishers with exclusive access to their fishing grounds in the form of territorial use rights. Prior to beginning data collection, Triple-C initiated a dialogue with Rare that led to the signing of a Memorandum of Understanding (MoU) in 2015. The MoU specified a collaborative effort under which the Triple-C project surveyed households in regions where Rare was in the planning phase of establishing TURFs.

By establishing exclusive access privileges, TURFs are intended to align the self-interest of individual fishers with the collective stewardship of the fishery. To inform this process, Triple-C designed an experiment to understand how fishers reach a decision on the extraction rate in a region where TURFs were planned but not yet implemented. We explicitly framed the experiment as extraction from a common pool fishery for Indonesian fishers. Our experimental design employs a common-pool resource (CPR) game that introduces treatments corresponding to alternative strategies for encouraging cooperative behavior.

Such experiments, in which investigators study the behavior of subjects in a laboratory-like setting, is an increasingly employed method in the social sciences. Real rewards are built into the game to ensure that participants have an incentive to behave in their own best interest. The main virtue of behavioral experiments lies in the ability to hold fixed the influence of confounding factors, which creates ceteris paribus observations that allow testing a hypothesized cause-effect relationship with data from a single point in time. Their main vice is that this experimental control typically compromises realism, calling into question whether the observed behavior can be extrapolated to non-experimental settings.

Field experiments, as applied here, is a particular type of experimental approach that attempts to mitigate this shortcoming and improve external validity. Rather than recruiting subjects from the university classroom, field experiments recruit subjects from the field. Moreover, the experimental design is framed around goods and a social context with which the subjects have immediate familiarity in their everyday lives (Harrison & List, 2004). Although field experiments are widely recognized to afford a more realistic framework for understanding human behavior, their uptake in conservation science has been sluggish (Nelson et al., 2017; Reddy et al., 2017).

Through the collaboration with Rare, the Triple C project has attempted to fill this void. The Triple-C team designed the common pool resource game (CPR), and worked jointly with Rare in developing a supplemental household questionnaire. Fieldwork took place between October and November 2015. During the survey, Rare provided logistical support to a RWI-commissioned and supervised team of enumerators from the University of Indonesia.

The CPR was implemented with the aim of evaluating alternative decision processes for determining maximum catch rates in TURFs. Conducted in three sites where Rare is active, Bunaken, Mola and Liya, and three comparison sites in Sulawesi, the game involved groupings of five fishers selecting a desired level of harvesting activity varying between one and eight hours per day, with payoffs calibrated such that each player's dominant strategy is to select the maximum harvesting level. The game was implemented with randomly assigned treatments to explore whether the extraction decision varies according to three non-binding recommendations originating from (1) a democratic process, (2) a group leader or (3) an external source that recommends a socially optimal extraction level.

As elaborated in Gallier, Langbein, and Vance (2018), three key findings emerge:

1) Non-binding recommendations originating from both a democratic decision process and an external source increase cooperation among fishers in one of the three sites - Bunaken
2) The absence of this effect in two of the sites, however, shows that caution is warranted in generalizing this conclusion to other sites in which TURFs are being considered.
3) The degree of individual non-compliance with the recommendation was highest for the external treatment, while it was of a negligible magnitude for the leadership and democracy treatments. This suggests that people are more likely to comply with targets arrived at by the group than those recommended by an external source.

From a policy perspective, the low compliance but high extraction reduction of the external treatment together with the high compliance but somewhat lower extraction reduction of the democracy treatment suggests some promise for coupling external advocacy of the social optimum with a community-based democratic decision process, particularly when enforcement is costly.

The work between Rare and RWI has continued beyond the Triple-C project. A follow-up survey materialized two years later in 2017, when Rare commissioned RWI to oversee data collection from the same households as those interviewed in 2015. Rare and RWI are currently working jointly on the development of a standardized global survey instrument to monitor changes in household welfare in sites where Rare is working around the world.

### Sub-project 4: Ethnographic assessment (ZMT, Jacobs University, Marco Verweij, Abdul Halik, Achim Schlüter)

The aim of the sub-project 4 was to assess the willingness to contribute to solving the coral dilemma on a local level with the help of ethnographic qualitative data. This component was added to the project because experiments can produce "thin" description and can prove

hypotheses, but have difficulties to understand results. Ethnographies provide "thick" description which helps us to understand coral reef conservation at the local level under the particular cultural conditions of Indonesia. The project mainly used Cultural Theory of Mary Douglas to enlighten the understanding of people at the local level of coral reef conservation. An ethnographic study requires one to be deeply immersed into the culture investigated. Therefore, we have been happy to recruit Abdul Halik from Indonesia, who grew up on Sulawesi, where field work took place.

The first paper analyses Marine Protected Areas using the theoretical lens of cultural theory. Marine Protected Areas are the main important local policy tool to provide coral reef protection. From a local perspective, the global factors contributing to coral destruction have to be taken as external factors, with no power at all to influence those. From the local perspective it is about solving the local collective action problem and therewith engaging jointly in protecting the reefs. Putting 10% of the marine space under protection by 2020 is an important policy goal on the Convention of Biological Diversity agenda. However, the problem is that particularly in the marine realm many of the protected areas just exist as paper parks (Weber de Morais, Schlüter, & Verweij, 2015; World Bank, 2006). This holds also true for Indonesia (Ferse, Glaser, Neil, & Schwerdtner Máñez, 2014). Therefore, it is very timely to look at this policy issue in more detail. Local communities investigated in the project rely centrally on those reefs for their livelihoods, might it be for fishing, might it be for tourism activities or might it be for coastal protection. How do you classify the different types of Marine Protected Areas existing? For which type of Marine Protected Area would theory predict that it is more likely to solve the collective action problem and protection takes place in a sustainable, long lasting way? Analysing the different Marine Protected Area types carefully with the help of a Cultural Theory lens it becomes clear that protection regimes, using a co-management approach as a messy management regime, are much more able to provide the clumsy solutions required for long term sustainable management. Cultural Theory assumes that in any policy arena one might find people aiming at the four different forms of organisation, which all have their particular perspective on nature, its vulnerabilities and strengths. The four types of organisation are egalitarianism, hierarchy, individualism and fatalism. Only policies that manage to consider those fundamental, deeply ingrained understandings of nature will be successful in the long run (Halik et al., 2018), as they consider the fundamental desires of the entire community.

The second paper (Halik and Verweij, 2018) then takes Cultural Theory to Sulawesi (Indonesia) and operationalizes in a qualitative manner about what the different understandings of nature would mean on the ground. What type of statements used by stakeholders in a marine coastal environment would represent, for example, fatalism or hierarchy? Once this is solved, the paper is able to bridge the gap between qualitative and quantitative data by coding qualitative data and

identifying the relative distribution of world views in the particular environment. Knowing Indonesian culture one might assume that hierarchy is a preferred form of organisation. The data shows that Indonesia has indeed a higher proportion of world views preferring hierarchy. However, it also shows that all four types are present. It can be also shown that individuals have to different degrees and in different areas of life those various worldviews incorporated. Therefore, indeed it seems a requirement to find poly-rational solutions to the environmental problems faced due to coral reef destruction.

The third study of this subproject (Halik et al., draft paper)tests three different forms of deliberation, namely Focus Groups, Musyawarah (a traditional adapted form of Indonesian process of deliberation) and Planning Cells to understand if those deliberation mechanisms are able to produce recommendations that contain the four different ways of life proposed by Cultural Theory. The initial hypothesis was that Planning Cells are particularly suitable to produce diversified recommendations, as the method incorporated the recommendations of cultural theory. The results show that each of the three methods is able to produce diversified recommendations. From this perspective it confirms the hypothesis of Cultural Theory that those four types will emerge if various people discuss and deliberate together. However, as one might expect in an Indonesian context, particularly recommendations favouring hierarchical or egalitarian solutions to the conservation problem have been particularly prominent.

Using those deliberative methods in conservation planning requires a lot of time. Organising a proper Planning Cell requires, for example, two days. Despite the fact of perfect connections into the field with the help of Abdul Halik (networks play a crucial role), we realised that the willingness to participate is limited, if the exercise takes place in a purely academic setting without any direct tangible benefit for the participant. Initially it was planned that this sub-project 4 only uses qualitative ethnographic data. However, due to the particular interest of Abdul Halik, the sub-project also employed quantitative data and bridged somehow the gap to the more experimentally oriented sub-projects. Particularly the third paper aims at using a quasi-experimental approach to test a qualitative phenomenon, which is the different understandings of nature resulting in different types of recommendations on how to conserve coral reefs.

### Sub-project 5: Ecological assessment (ZMT, Sonia Bejarano, Sebastian Ferse)

Sub-project 5 used two complementary approaches to improve our understanding of coral reef ecosystem processes and drivers of change in Indonesia. First, a field study was designed to quantify the levels of a key ecosystem function in response to varying environmental conditions (i.e. water turbidity and benthic topographic complexity). Second, through a partnership established with the Wildlife Conservation Society – Indonesia (WCS) Triple C scientists gained access to comprehensive monitoring datasets spanning fin fisheries catches and underwater

benthic and fish community assessments. These datasets were extensively analysed to investigate whether the strictness of the management regulations applied on coral reefs moderate the temporal trajectory of fish communities.

Specifically, our field study focused on quantifying levels of carnivorous predation, a key regulatory ecosystem function that had received considerably less attention than others coral reef (e.g. herbivory). We asked whether predation risk influences the sheltering behaviour of small-bodied fishes (e.g. damselfishes). Predation risk was assumed to be a function of predator abundance, level of predatory activity, and environmental moderators such as water turbidity and benthic rugosity. We hypothesised that under high predation risk, mutualistic damselfish would remain closely sheltered within their host coral, and under low predation risk they would venture further away from it, with important implications for the mutualistic relationship. We conducted our observations in Kepulauan Seribu (also known as the Thousand Islands National Park) off the coast of Jakarta, using stationary high-definition video cameras to record fish feeding and sheltering behaviours, and standard fish census techniques to quantify fish abundance. We found that the smallest of damselfish (< 2 cm) sheltered most closely to their host corals under high water turbidity. Contrary to our expectations, sheltering behaviour was either weakest where predator activity was highest (for large damselfish) or unaffected by predator activity (for small damselfish). We expanded on a number of ecological explanations for this observation and suggest that a type of cooperative behaviour common in birds and other marine animals, (i.e. sentinel behaviour) occurs also in damselfish. This study comprised the core of the Masters' thesis of Robin Gauff (supervised by Sebastian Ferse and Sonia Bejarano) and were published in the journal Environmental Biology of Fishes.

Our data analysis effort based on the cooperation between Triple C and WCS Indonesia focused specifically on Karimunjawa National Park (Central Java) and on five fish functional groups that contribute complementary facets of coral reef herbivory. We asked whether areas subject to restrictive fishing regulations sustained higher biomass and functional redundancy over seven years, compared to areas where moderate and permissive regulations apply. We tracked changes in predator biomass, food availability, and fishing practices that could influence herbivore trajectories. Biomass of scrapers-excavators, grazers-detritivores, and algal farmers doubled in 2012 compared to 2006-2009, and remained high in 2013 across levels of management restrictiveness. We discard that this biomass build-up resulted from predator depletion or increased food availability but demonstrate that it emerged in response to a park-wide cessation of muroami fishing. The biomass build-up was accompanied by a modest increase in functional redundancy within the scraping-excavating function. While this implies a recovery of mechanisms responsible for the removal of algal turfs and detritus, restoring other facets of herbivory (e.g. macroalgal consumption) may require more time. Muroami fishing stopped here due to an

increase in the cost-benefit ratio per journey, which paved the way for a ban on muroami fishing that met minimal resistance. Similar windows of opportunity may emerge elsewhere in which gear-based regulations can be issued to supplement zoning plans that are insufficiently complied with. Compliance with the muroami ban might remain high given its harmful effects on fishers' health and physical reef structure, but may require vigilance. This study was undertaken as part of the post-doctoral research of Sonia Bejarano, and a manuscript presenting these results is currently undergoing peer-review in the Journal Ecological Applications. One more manuscript based on WCS-Indonesia is in preparation. It is focused on shallow reefs in Aceh (Northern Sumatra) affected by the global mass coral bleaching event in 2010. With this paper we aim to test whether areas subject to the most restrictive fishing regulations loss less live cover from 2009-2011 compared to those that have been less restrictively regulated. We anticipate that strictly regulated areas guarded the highest levels of pre-bleaching herbivore functional diversity, redundancy and complementarity thus facilitating post-bleaching recovery.

### Sub-project 6: Synergies and integrating the approach (ZMT, Achim Schlüter, Katie Nelson, Marie Fujitani, Micaela Kulecz)

The aim of Triple C was to experimentally test in a cross cultural perspective the possibility to solve the collective dilemma arising from coral reef destruction. One of the early conclusions of Triple C was that this requires, first, the development of new experiments, which are modelling the resource closer to reality (Brandt et al., 2012). Most often static common pool resource experiments or public good experiments are used to mimic the collective dilemma underlying the coral reef crisis. However, in real life the resources are dynamic in nature and the state of the resource in t+1 is dependent on the extraction in t. Second, it was clear that understanding the coral dilemma, which is nested on global and local level, requires an online experimental tool for investigation. Due to those two reasons an online dynamic common pool resources extraction experiments (OGUMI) was developed (Brandt et al., 2017). Since then this tool has been used in various experimental settings in the class and in the field.

Rather early on our main Indonesian partners in the project (namely Luky Adrianto & Eva Anggraini from IPB Bogor University) mentioned that they would get additional benefit (apart from the scientific cooperation), if Triple C could engage into teaching activities at IPB. Therefore, we organised in 2017 and 2018 each a one-day lecture (about 60 participants), once on environmental experimental economics and once on the investigation of common pool resource dilemmas in a marine setting. Those lectures were both times followed by a week-long seminar, where we trained students to run experiments. With this learning by doing approach, we conductedv various experiments with students from IPB and the general public. This course resulted in a first published joint paper (Alt et al., 2018), described in more detail in sub-project

1. A second and a third paper, of which the results are described in sub-project 2 have not been finalised yet, but will be submitted in 2019.

During the project intensive research in WAKATOBI was done (SP2,3,4). To complement, on the one hand, the experimental research with more in-depth qualitative information and, on the other hand, to also focus on an additional aspect of coral destruction, Eva Anggraini conducted an interview based study on marine litter and the associated collective action problems with it. It resulted into a joint paper draft, where she is the lead author (Anggraini et al., draft paper).

Apart from fundamental research results, the conclusions of the Triple C project are also of huge relevance for policy makes. E.g. sub-project 1 emphasises the role of outgroup cooperation. Sub-project 2 provides particular insights for NGOs, who aim to raise funds for coral reef conservation. Sub-project 3 and 4 investigate further the role of democratic and participatory decision making in conservation activities, results that are important for Government and Non-Government Organisation in the conservation sector. Sub-project 5 is measuring the ecological impact of different degrees of marine protection. Due to those policy lessons one can draw from Triple C we organised in 2017 a discussion and dissemination event at the Bogor Convention Centre, where scientists and practitioners alike (government organisation from various ministries, NGOs: RARE, The Nature Conservancy, Wildlife Conservation Society, World Wildlife Fund) reflected on the potential outcomes (and future joint activities).

Through the project funds, a professional quality coral reef 3D conservation film entitled 'Coral Reefs: Life below the Surface' was produced and translated into 3 languages: German, English, and Bahasa Indonesian. The initial aim of the film (see the explanation within the project natural field experiments) was to investigate further avenues (2D, vs. 3D.; positive vs. negative framing) to increase the willingness to contribute to solving the coral crisis. However, apart from this scientific benefit the video is successfully used as tool to increase awareness and ocean literacy at many opportunities for ZMT. The video has been featured in Tauchen magazine and has received awards at several international film festivals. It has been largely used in various outreach events of the ZMT (e.g. Forschungsmeile, Meerwissen etc.).
One of the important goals of ZMT and therefore also for Triple C was to engage in intensive collaboration and the use of synergies between natural and social sciences. Out of the puzzling results on donation behavior in Indonesia from sub-project 2 and the cultural comparative research done in sub-project 1 the idea was developed to run an online cross cultural donation experiment using Clickworkers (an online working platform). In this cooperation between the ZEW, the ZMT and the Wildlife Conservation Society online workers from Indonesia and Germany have to classify google images of the Indonesian coast into those containing so called grazing halos and those not containing them. Grazing halos are important indicators of reef degradation.

Therefore, the information produced is of value from a coral reef ecologist perspective. After the task the online workers have the opportunity to donate some of their earnings or to continue the task instead and donate time. The development and planning of the experiment took longer than expected, therefore, the experiment will only be run at the beginning of 2019. Obviously, Triple C has come to an end and those activities are financed by internal funding of ZMT. However, the experiment is collaborative outcome of Triple C, has been partly financed by this project, and is therefore mentioned here.

Another effort in synthesizing the conclusions from Triple C was the joint writing of a paper submitted to Marine Policy with the title: "Coral reefs and the slow emergence of institutional structures for a glocal land and sea-based collective dilemma." (Schlüter et al., under revision). It requires major revision, but will be resubmitted in January.

## Additional results beyond the sub-projects and follow up activities

### Proposal writing resulting out of Triple C

Out of the Triple C project various joint or individual project applications emerged. It is important to mention here that Katherine Nelson played a particular crucial role in this area of activity, being a central promoter of them. The various project applications are briefly described below:

**Corals: A 'Glocal' Challenge: Co-Glocal** (Volkswagen Stiftung: Europe and Global Challenges; 840.000 €) – not funded: joint application between ZMT, ZEW, IPB and other partners, which builds directly on the experience and results of Triple C.

**Coral conservation using Virtual Reality** (BMBF; 10.000 €) – funded: the purpose of the application was to finance activities and hardware purchase related to the virtual reality experiments described in sub-project 2.

**Sustaining coral reef ecotourism: Building capacity for informal conservation** (Rufford Foundation, ~10.000 €) – not funded: the aim was to provide additional funding for the experiment done on Gili Island in joint cooperation with the local NGO.

**Making coral reef conservation work: Social networks and fundraising behavior on the Gili Islands, Indonesia** (Waitt Foundation, ~10.000€) – funded: the money helped financing the investigation done in sub-project 2.

**Supporting community cooperation in economic and environmental development (SUCCEED) of sustainable waste management for small islands and coastal municipalities** (EUAid) – concept note, not funded: the project was a collaboration between ZMT and the Gili Eco-Trust, the main civil society partner for the work on Gili Islands.

**Reefscape: Ecosystem design for artificial coral reefs** (ZMT core budget, 150.000 €) – not funded: a joint collaboration between the working group of institutional and behavioural economics and reef systems.

**COMPASS: Comparing Aquaculture Systems Sustainability** (BMBF, 660.000 €) – easy AZA to be submitted: proposal jointly submitted between ZMT and the IPB Bogor to analyse the transformation of aquaculture systems in Indonesia. The content does not relate to Triple C, but the network stems from it.

**BeSMART: Behavior-centered planning for sustainable management of reef tourism** (DFG Middle East Collaboration, 457.000 €) – pending: the project is a collaboration between the ZMT and Michelle Portmann (Technion Haifa), using and experimental approach similar to the one used in sub-project 2, this project aims to understand how to make reef tourists behave in a more sustainable way (would provide 3 years Post-Doc funding for Katie Nelson).

**Interdependent cooperation challenges** (working title) – to be submitted in March 2019 to the SAW Pakt, a joint proposal under the lead of ZEW comprising partners from RWI and ZMT

### Academic qualifications obtained with the help of Triple C

Within the Triple C project four students aimed to graduate for their PhD. Three of them have been successful until today (Dr. Carlo Gallier, ZEW; Dr. Jörg Langbein, RWI; Katie Nelson, ZMT). The forth, Abdul Halik (ZMT), has two papers accepted and the third paper is close to submission. Abdul Halik started immediately after his 3 years of funding ended a highly competitive job with WWF South East Asia in Singapore. This has substantially slowed down the process to finish his PhD. However, it is very likely that he will succeed in 2019. Mr. Robin Gauff from Pier and Marie Curie University Paris (France) successfully completed his Master Thesis within Triple C.

## Concluding appraisal of Triple C

Triple C allowed us to understand further the particular difficulties of nested collective action problems, which have a local and a global dimension. Understanding those phenomena is of outmost and urgent importance. The funding of the Triple C project led to a collaboration between a section E institute (ZMT) and two section B institutes (RWI, ZEW) within the Leibniz Association, which otherwise would not have materialised and which has converged into a longer lasting collaboration. The initial aim of Triple C was more restricted to the creation of fundamental knowledge. However, due to the intensive collaborations with NGOs namely RARE International and the Gili Ecotrust, we did not only manage to create fundamental knowledge, but also to concretely solve current sustainability challenges on the ground (e.g. the concrete

amount of tourists' willingness to pay for coral reef conservation on Gili Islands, so that a fee could be implemented).

The scientific output so far published has been published in journals leading their field, like Conservation Letters, Ecological Economics or Games. There are many findings coming out of Triple C that exist in draft versions or are until now published in working papers and still need to be published in peer reviewed journals. Production processes are very long. Looking at the project proposals submitted within the context of ZMT a benefit stream lasting far beyond Triple C can be expected.

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