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Proposal	
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Corals reefs in Indonesia - the case study of Spermonde Archipelago

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Abstract

Indonesian coral reefs belong to the speciest richest in the world. However, currently they are experiencing a widespread degradation as a reaction to changing climate and pollution and also because of overexploitation and destructive fishing methods. The continuous changes in environmental conditions severely undermine the resilience of coral reefs and the capacity to resist additional disturbances. Coral reefs in Indonesia and the ecosystem services they provide are crucial for the livelihood of coastal communities and an important source of income. The resulting intensive use of reef resources triggers severe threats to ecological reef functions. This may lead to phase-shifts from coral dominated to algae dominated states, effecting biodiversity in general and specifically fish population numbers and other valuable resources.

In this situation the analyses of coral reef developments necessarily includes incorporating social processes even more if management aspects are to be considered. Feedbacks between between social and ecological dynamics are specific for regions and depend on a variety of social and economic factors.

The Spermonde Archipelago is a typical example for Indonesia. In a situation of an increasing population on the islands and fast coastal urbanisation, intensive fishing on differing targets with a large number of techniques drive considerable changes in the marine community. Furthermore, the archipelago is located in one of the largest fisheries of the South-east Asian region, and is thus often driven by world-market demands additionally to local needs. The presentation will give an overview of the research done in the Spermonde Archipelago during the last decade and place it in the context of regional coral reef developments.

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Proposal	
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Non-random variability in functional composition of coral reef fish communities along an environmental gradient

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Abstract

Changes in the coral reef complex can affect predator-prey relationships, resource availability and niche utilisation in the associated fish community, which may be reflected in changes and decreased stability of the functional traits present in a community. This is because particular traits may be favoured by a changing environment, or by habitat degradation, while others are selected against, and because degradation can relax the association between fishes and benthic habitat. We characterised six important ecological traits for fish species occurring at seven sites across a disturbed coral reef archipelago in Indonesia, where reefs have been exposed to eutrophication and destructive fishing practices for decades. Functional diversity was assessed using two complementary indices (FRic and RaoQ), correlated to important environmental factors (live coral cover, rugosity and distance from shore), and examined for both a change in their mean, and temporal and spatial variability. Furthermore, variability in individual traits was examined to identify which traits are most affected by habitat change. Increases in the general reef health indicators, live coral cover and rugosity (correlated with distance from the mainland), were associated with decreases in the variability of functional diversity and with community-level changes in the abundance of several traits (notably home range size, maximum length, microalgae, detritus and small invertebrate feeding and reproductive turnover). A decrease in coral cover increased variability of RaoQ while rugosity and distance both inversely affected variability of FRic, however averages for these indices did not reveal particular patterns associated with the environment. These results suggest that increased degradation of coral reefs is associated with increased variability in fish community functional composition resulting from selective impacts on specific traits, thereby affecting the functional response of these communities to increasing perturbations.

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Proposal	
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Controls of benthic algae in the coral reef system, Spermonde Archipelago, Indonesia

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Abstract: Coral reefs are threatened by local factors such as eutrophication and overfishing that can lead to phase shifts from coral to algae dominance. This may be particularly the case in highly populated coastal areas such as the Spermonde Archipelago, Indonesia, that is heavily impacted by coastal pollution and overfishing. We hypothesized that here, reefs closer to shore would be dominated by macroalgae due to high levels of nutrient inputs available for macroalgal growth compounded with lower fish abundance that release grazing pressure. Initial water quality, benthic and pelagic surveys confirmed significantly lower water quality closer to shore, and this coincided with lower coral cover and herbivorous fish biomass. Surprisingly, we found low macroalgal cover growing on the reefs, despite their presence on back-reef flats. Turf algae were dominant closer to shore. Subsequently, two experiments were conducted along the spatial gradient to identify bottom-up and top-down controls of the algal communities. Firstly, benthic settlement tiles were deployed in caged and uncaged treatments, and secondly, rates of herbivory were examined through short-term feeding assays. No macroalgae were found growing on the tiles even under grazer exclusion, but turf algae were dominant. Feeding assays showed a high rate of herbivory of transplanted macroalgae by herbivorous fish. The lack of macroalgae in our experimental sites run contrary to many recent grazer exclusion studies, however this might in-part be accounted for in the high level of taxonomic and functional diversity found within the herbivorous consumer group. In light of these results, we discuss the drivers and mechanisms leading to the lack of macroalgal blooms in this system, and highlight the importance of turf algae, a phenomenon which is becoming increasingly documented in the Indo-Pacific region.

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Proposal	
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Understanding the dynamics of seagrass ecosystems and plankton in a tropical barrier reef and lagoon ecosystem

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Abstract

Together with Coral reefs and mangrove forests, seagrass meadows rank amongst the most important ecosystem components of tropical coastlines. The highly productive seagrasses support large biomasses of fishes and invertebrates, and are the preferred food item of iconic endangered species like green turtles and dugongs. Southeast Asia has the greatest diversity of seagrasses worldwide, and a substantial part of the global seagrass area. In spite of that, seagrasses in the region remain poorly studied. Research conducted in the Spermonde archipelago by scientists of the AWI in collaboration with representatives of Hasanuddin University Makassar aimed to fill some of the knowledge gaps on Southeast Asian seagrass ecosystems. In the first phase of the project the impact of seaweed farming on the productivity of the seagrass meadow below was adressed. The second focus was on the ecological role of synaptid holothurians, burrowing axiid shrimp and siganid fishes in the meadows. The biodiversity of gobiid fishes and plankton was also studied. In the second phase the main focus was on seagrass distribution, the impact of water motion and water depth on the composition of multispecies meadows, the controlling effect of callianassid shrimp and the diversity and diet of fish communities. Pinnid bivalves, macrobenthos diversity and plankton processes were the subject of further studies. In the third phase an in-situ carbon dioxide enrichment experiment was conducted, and the magnitude and fate of river inputs into the Spermonde lagoon was measured. In all three phases, capacity building was done through jointly supervised final theses and lectures in the “Marine Ecology Special Training Course”. Seventeen German and ten Indonesian students wrote their thesis within the project. A total of four PhD, 15 master and eight bachelor theses were completed.

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Proposal	
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Connectivity of coral reefs in Indonesia I: concordant genetic population structure of reef fauna indicates restricted gene flow across the Indo-Malay Archipelago

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The world's greatest diversity of marine shallow water species can be found in the Indo-Malay Archipelago (IMA). This high diversity can be explained by several theories, which fall into three main categories: centre-of-evolutionary-radiation from where new species disperse, centre-of-overlap of the Indian and Pacific Oceans biota, and centre-of-accumulation of species that originated in peripheral areas. Genetic studies on several taxa have shown a phylogenetic break between the Indian and Pacific Ocean, supporting the view of speciation in separated ocean basins. However, even though increasing, detailed studies on the genetic population structure of marine biota in the centre of marine biodiversity are still rather rare, such information is important to understand evolutionary and ecological processes in the IMA. This presentation aims to provide a status quo of what is known about the genetic structure of coral reef biota in the IMA, which general pattern can be observed, and which conclusions can be drawn regarding the evolution of species in the region. Recent studies have shown a complex genetic population structure in many species, which can be attributed to the geological history and prevailing current regimes in the IMA. The genetic population structures are characterised by restricted gene flow between some sites and panmixia between others. The major observed genetic differentiation between the Indian Ocean and Western Pacific is most probably due to historical isolation by sea level changes, whereas current oceanographic conditions facilitate connectivity along the Indonesian Throughflow on the one hand and separation at sometimes very small scales on the other hand. These factors cause vicariance between populations, which can lead to allopatric speciation, suggesting that the Indo-Malay Archipelago is a centre-of-evolutionary-radiation.

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Connectivity of coral reefs in Indonesia II: small scale population patterns of reef organisms in the Spermonde Archipelago

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For the effective conservation of the coral reef ecosystem and the sustainable use of marine resources, profound knowledge of the genetic diversity of the reef organisms and the connectivity between populations is crucial. As base for all biodiversity, the genetic diversity plays a major role in the adaptability of organisms to changing environmental conditions and has therefore an influence on the resilience of the ecosystem as a whole. The connectivity between populations ensures the maintenance of diversity and the replenishment of local stocks.

To study the genetic diversity and connectivity between reefs of the different shelf areas in the Spermonde Archipelago, population genetic analyses of selected reef organisms were performed by using mitochondrial control region and micosatellite markers. Vertebrate (clown anemonefish) and invertebrate species (sea squirt, coral) were studied to find potential general patterns within the region.

The genetic population structures revealed restrictions in gene flow in the clown anemone fish (*Amphiprion ocellaris*), especially between reefs of the innershelf and midshelf area indicating very localized small-scale genetic exchange and high self-recruitment. The outershelf reefs show higher connectivity, even though geographic distances are larger. The filter-feeding sessile sea squirt *Polycarpa aurata* features restrictions in gene flow with geographic distance being the major factor for differentiation. The coral species *Acropora tenuis* is forming two major genetic groups, one containing the innershelf and one the outershelf reefs. The results underline that there are restrictions in gene flow even on very small geographic scales in all studied organisms, but no general picture of connectivity. Possibly, biological factors, like larval behaviour and constitution might play a role in the formation of the connectivity patterns.

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Barcoding of grouper species in Spermonde Archipelago, South Sulawesi

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Abstract

Indonesia's groupers are marketed in the international marine live trade with high price. This leads to over exploitation due to illegal fishing. The illegally fished specimens cannot be identified properly due to time limitation provided by fisherman during sampling, in order to avoid that the fish die. Molecular identification, which is also known as DNA barcoding, allows to identify any living organisms with high precision. Such information is a prerequisite for management. Cytochrome C oxidase I (COI) is a standard marker for molecular identification of animals. The objective of the project is to identify grouper species harvested in the Spermonde Archipelago. The amplified COI fragments were sequenced using the big-dye terminator method. All sequences were edited manually using the softeware BioEdit (ver. 7.0.4.1). A multiple sequences alignment was done using ClustalW as implemented in BioEdit (ver. 7.0.4.1). The orthology to previous published sequences available in the barcoding database BOLD (http://boldsystems.org) and GenBank were also verified. To support this result, a phylogenetic tree was reconstructed with the help of the programme MEGA (v. 4.0) using teh *neighbour joining* (NJ) method with 1000 non-parametric bootstrap replicates. A total of 28 sequences were obtained during the study. Molecular identification proved that only one sequences matched well (99.8%) in the BOLD data base with *Epinephelus ongus*. The remaining 27 sequences were blasted to the data available in GenBank and proved that the sequences were homologous with *Epinephelus* and *Plectropomus*. The genus *Epinephelus* consist of eight individuals of *Epinephelus ongus*, while the genus *Plectropomus* consist of one individual of *Plectropomus maculatus*, and 18 individuals of *Plectropomus leopardus*, with sequences similarities ranges from 97 % up to 98 %. The most exploited species was *Plectropomus leopardus*. The result of molecular identification was also supported by analysis of the phylogeny, which showed that all sequences form three different clades with high bootstrap supports.

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Linking fishers' perceptions of the reef to their fishing activities: a case study from Spermonde Archipelago, South-Sulawesi

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Abstract

In what way do perceptions about the state of the reef ecosystem they depend on correlate with or even affect the behavior of fisherfolk towards that reef? We examine this question with data collected in two socio-economic surveys conducted in Spermonde Archipelago in September 2012 and February 2013. Approximately 20 team members from UNHAS and ZMT visited six islands (*Langkai, Bonetambung, Lumu-Lumu, Polewali, Baranglompo, Karangrang, Lanyukang*) for two ten-day periods. Data was collected in interviews with 157 fishermen on local fishing methods, environmental perceptions, social capital and social positions (*punggawa*, *sawi, mandiri*).

Our results revealed that the interviewed fishers currently employ around 20 different fishing techniques in Spermonde reef fisheries, of which some are seasonal and some year-round, and some fishermen use diving and thus get a regular visual impression of the reef. We therefore compare the perceptions of diving and non-diving fishermen, fishers' perception in relation to their social status, and the drivers of illegal and unsustainable versus legal and more sustainable fishing techniques.

While this article is still work in progress, preliminary results have shown that no clear division is possible between divers' and non-divers' knowledge based on their stated fishing method. Knowledge of the underwater environment hold by both divers and non-divers seems to have a similarly solid base. Moreover, 99% of all interviewed fishers did not see destroyed reefs as a major driver of fish availability, while 100% of those fishers engaged in less destructive, more selective fishing techniques (FAD, kedo-kedo, rawe, hand and line) stated that the perceived decrease in target species availability is linked to the fishing techniques they use. The social status seems to be unimportant for reef perceptions. With this article we intend to open the way for further needed studies on the links between perceptions and behavior.

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A user-friendly simulation model to assist in the local management of coral reefs exposed to multiple stressors

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Abstract

Community-based conservation has emerged as a promising alternative for management in places like Indonesia where overexploitation of marine resources in a decentralized manner make enforcement difficult. In this situation, management needs to incorporate community goals in order to be successful. Involving marine resource users in the decision-making process in important, as is developing case specific management strategies. We present a decision-support tool for local managers to explore the possible outcomes of management scenarios. We developed an ecological model of a local coral reef of an area up to 1km^2 with a user-friendly and visual interface. The two-dimensional grid model is spatially explicit and contains 4 benthic groups and 3 fish groups. The effects of environmental variables on reef dynamics (nutrients and water temperature) can be simulated through different scenario settings, and ecological processes such as benthic competition and trophic interactions are represented. Users can upload a bathymetric greyscale map of their reef of interest and select its initial conditions in terms of benthic cover and fish abundances at different depth ranges. Fishing management strategies such as gear and depth selectivity or fleet restrictions can be configured in the user menu to run the simulations and obtain the benthic cover and fish abundances resulting from different management approaches. We hope that this program will be used by managers to inform their decisions and foster ecological understanding and sustainable management of coral reefs.