Kalimantan Tides

Lessons learned from Dutch-Indonesian research cooperation in 'the Asian Amazon'

Edwin de Jong & Machiel van Zanten

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Contents

Foreword

Indonesia and the Netherlands share a long and fruitful history of scientific cooperation. Joint research projects have been conducted on a wide variety of themes, such as agriculture, a bio-based economy, biodiversity, coastal and marine issues, infectious diseases, socioeconomics, cultural and historical developments and global change. Often, this bilateral cooperation has evolved into cutting-edge scientific research of major strategic and societal importance, not only for both countries but also for the world at large.

The bilateral scientific cooperation over the past decade has coincided with a change in science policy in Indonesia. Universities have become increasingly independent institutes, changing from teaching to research organisations. The growing awareness in Indonesia that investing in science and technology is essential for development has led to significant increases in budgets for education and research, including international scientific cooperation and postdoctoral job opportunities.

Apart from scientific quality and originality, the 'triple bottom line' (People, Planet, Profit), public-private partnerships and the Millennium Development Goals have become increasingly important criteria in the scientific cooperation between Indonesia and the Netherlands. At the same time, a strong public appeal to scientific communities worldwide to deliver objective knowledge related to solving burning issues - such as climate change, energy security, pandemic threats, religious tensions and socioeconomic shifts - requires further international cooperation, and a shift towards researching issues relevant to society and the environment. These changes resonate with new initiatives in the Netherlands on science for society and science to meet global challenges.
By capitalising on the existing time-honoured networks of exchange, cooperation and mutual trust, and by setting up new research groups and partnerships, Indonesia and the Netherlands are now in a strong position to take further advantage of the scientific, human, natural and other resources available in both countries.

This booklet provides an overview of the major Dutch-Indonesian research programmes currently being undertaken in Kalimantan. It aims to inform scientists, policymakers and the wider public about ongoing research in Kalimantan and, at the same time, pays tribute to the breadth of issues that are being addressed by joint, often multidisciplinary, research teams.

The result is an insightful reflection on the results that have thus far been achieved through the manifold efforts of the Royal Netherlands Academy of Arts and Sciences (KNAW), the Netherlands Organisation for Scientific Research (NWO) and other Dutch organisations in collaboration with Indonesian partners, most notably the agency for the Assessment and Application of Technology (BPPT), the Indonesian Institute of Sciences (LIPI), the Indonesian Ministry of Science and Technology (RISKTEK), the Directorate General of Higher Education (DIKTI) and the Indonesian Academy of Sciences (AIPI).

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Kudat
Sulu Sea
Mount Kinabalu
Kota Kinabalu
Sandakan
South China Sea
Bandar Seri Begawan
BRUNEI
Sabah
MALAYSIA
Bintulu
Celebes Sea
Sibu
Sarawak
Paloh
Kuching
East
Kalimantan
West
Kalimantan
INDONESIA
Pontianak
Samarinda
Telukbatang
Central
Kalimantan
Palangkaraya
Kendawangan
Makassar Strait
South
Kalimantan
Banjarmasin
Karimata Strait
Java Sea

Kalimantan - ‘the Asian Amazon’

Covering almost three-quarters of the island of Borneo – the third largest island in the world – Indonesian Kalimantan is host to some of the richest and most diverse ecosystems on this planet. As Malcolm MacDonald already noted in 1956, ‘nowhere on earth is natural vegetation more lavish’. The great river and lake systems, dense rainforests, swampy coastal areas fringed with mangrove forests and mountainous interior are home to a great variety of flora and fauna. Its ecosystem forms a vital link in the global carbon dioxide and oxygen cycles. The cultural diversity of Kalimantan is also distinct and varied. There are tens of ethnic groups, indigenous Dayak and Malayu groups as well as large migrant communities, making the population of this island one of the most varied of human groupings.

Despite their ecological value, Kalimantan’s natural resources have been rigorously exploited since the late 1970s at a rate hardly paralleled in human history. Today, nearly 70 percent of the rain forests have been cleared through logging and mining followed by oil palm plantation development, devastating forest fires and controversial transmigrant settlement schemes. Alongside a significant reduction in biodiversity and a rise in carbon emissions, the rapid ecological degradation has had dire consequences for local communities and livelihoods that depend on the natural environment. Urgent societal problems that pose formidable challenges to poverty reduction include ethnic conflicts, a weak economy, deforestation, a risk of flooding and fire, overfishing, pollution, health problems and an increase in vector-transmitted infectious diseases. New modes of economic exploitation, such as more intensive forms of agriculture and fishing methods, and advanced ways of mining are further increasing the pressure on this already fragile ecosystem.

Given the enormous size of Kalimantan, its ecological and cultural diversity that are of great scientific interest, and its rapidly changing nature that provides a window on change and continuity along the economic, political and social dimensions of human-environment interactions, but also urgently needing to be investigated to support sustainable development, it is highly surprising that research in Kalimantan remains marginal and fragmented. In Indonesia in general, and Kalimantan in particular, there is a mounting call by policymakers for greater insight into the deteriorating ecosystems of Kalimantan, where struggles over natural resources take place between autonomous local governments, national and international businesses, non-governmental organisations (NGOs) and local communities.

Although the focus of some researchers is moving slightly towards Kalimantan, the majority stay in the ‘comfort zones’ of the islands of Java, Bali and Sumatra. Moreover, the research projects and programmes that do arise tend to be short-term and on an ad-hoc basis with a lack of overall cooperation. As a consequence, the data gained on Kalimantan are rarely exchanged either between or within the various groups of researchers that come from different disciplinary backgrounds and countries, most prominently Indonesia, Australia, the United Kingdom and the Netherlands.

On 24th November 2009, the Radboud University organised a small seminar in Nijmegen, entitled 'The Mahakam Drama: ecological change, human adaptation, and governance in East Kalimantan's waterways'. This reflected that, in the past few years, an increasing number of Dutch and Indonesian scholars have been working on changes in ecology, human livelihoods and governance in the rivers, deltas and lakes of the largest river system of East-Kalimantan, the Mahakam. Nevertheless, many of these initiatives remain somewhat scattered and isolated in their separate academic, NGO or policy domains. It is rare for researchers, NGO representatives and policymakers to come together to share insights and ideas. At this seminar, we aimed to inform one another about recent research findings and work-in-progress on aqua-ecological change, human livelihoods and adaptation, and water management models in the Mahakam River basin.

It was shocking to find out how little participants knew about each other's research projects and findings. It was again concluded that there is an urgent need for a good information system about current and past research in Kalimantan, one that serves both the academic and the public sector such as NGOs and government institutes, in Indonesia, in the Netherlands and in other countries involved. The Governor of East Kalimantan informed us that he is in dire need of scientific underpinning to gain the supportive power and money he needs from national and international NGOs and governments to implement a sustainable policy on the protection of the ancient forests and wildlife and, through that, the aquatic ecosystem of East Kalimantan. Furthermore, for a better understanding of the interrelationships between many aspects of the natural and socioeconomic systems in Kalimantan, these mono-disciplinary studies have to be connected and this requires better coordination and an exchange of information.

This booklet is a first attempt to inform scientists, policymakers and the wider public about on-going research in Kalimantan by providing an overview of the major Dutch-Indonesian research programmes that are currently being undertaken in the region on the one hand, and by sketching some exemplary cases on the other. It is also a call to enhance scientific cooperation and intensify scientific research in Kalimantan, and to accelerate actions that will protect what remains of the rich natural biodiversity. As was stated by a representative of the Royal Netherlands Academy of Arts and Sciences (KNAW), 'Kalimantan is and will remain a special area of interest and we should now maintain the momentum by bringing the thorough findings of researchers on the on-going ecological degradation, as well as the possible solutions for a way out, to the attention of a broad audience, both in the Netherlands and in Indonesia.'

Research in a frontier zone

Since the Dutch period, research in Kalimantan has been rather marginal, individually based and regionally scattered. The launching of the Indonesian-Netherlands Programme for coastal zones research in East Kalimantan (EKP) in 2002 marked the beginning of an increasing scientific interest in the region, and a concentration of Dutch research at specific locations in East Kalimantan, most notably the Mahakam Delta and Berau area. At that time, Indonesian scientists were becoming aware of the great potential of well-developed large river deltas for societal and economic development. Alongside Sumatra and Irian Jaya, Kalimantan hosts the largest rivers in Indonesia. The Indonesian Institute of Sciences (LIPI), together with its partners in the Indonesian Consortium on Coastal and Marine Research (ICoMAR), have identified East Kalimantan, in particular the Mahakam Delta, as one of its priority areas for marine and coastal research in Indonesia.

East Kalimantan is one of the largest and least populated provinces of Indonesia. Thanks to its abundant natural resources, it is also one of the richest regions in the archipelago, surpassed only by those of the industrialised, heavily populated provinces of Jakarta, West, Central and East Java. East Kalimantan's riches originate from industries linked to its natural resources. Largely covered in primary forest, the province was opened up to logging companies as far back as colonial times. Nevertheless, the province largely remained a colonial backwater until the discovery of extensive oil and coal reserves in its coastal areas. After Indonesian independence, technical developments in natural resource extraction techniques enabled the expansion of coal mining and gas and oil extraction into multi-million dollar industries involving international companies. The easily accessible forests were also heavily logged, with the province's largest rivers providing an excellent transport infrastructure. From the 1970s onwards, this expanding logging industry, controlled by the political and military elite, took hold of East Kalimantan's extensive forests and, when the availability of prime logging concessions decreased from the 1980s onwards, plantations came to the fore. In colonial times, the first small-scale rubber plantations had been laid out on land opened up in the wake of logging activities. Whereas rubber remained a local product, it was especially palm oil that was seen as a promising future for Indonesia. Extensive palm oil plantations were developed in logged and cleared forest sites throughout the coastal areas. To a lesser extent, and generally more recently, plantations to produce wood pulp and ironwood have been introduced.

Human pressure has increased strongly since the mid-1990s and will continue to increase in the future due to upland deforestation, intensification of land use and exploitation of natural resources (coal, gold and nickel mining), expanding industrialisation and population growth. East Kalimantan is generally known in Indonesia for having an ethnic Dayak population but its sparsely populated lands and economic potential have for centuries attracted migrants from other parts of Indonesia and have, since independence, been the destination of various government-sponsored transmigration programmes. RESCOPAR programme manager Roel Bosma (Wageningen University) commented: "Kalimantan is a frontier zone, a bit like the Wild West. People just take land that is available and do whatever they want with it. Sometimes it is regulated, sometimes it is not".

While no single ethnic group has an absolute majority in the province, all the migrant groups together decisively outnumber the indigenous population. Roughly speaking, most of the migrant population live in the coastal areas and the cities, while various areas in the hinterland have a distinct Dayak minority. In other parts, the Dayak form sizeable minorities within a mixed population.

It is in this large, resource rich and ethnically diverse, hinterland that the rivers of Kalimantan stretch out for up to more than 400 km. Since the Tertiary period, these rivers have developed large delta systems and they continue to do so today, varying from river-dominated strongly prograding deltas such as the Mahakam Delta to more tidally dominated estuarine systems like the Berau area. The deltas of the Mahakam and Berau Rivers differ strongly in morphology and environmental dynamics, resulting in different ecosystems with different variabilities (including coral reefs, seagrass beds, mangrove forests etc.) which are to a large extent related to different tolerance limits and responses to abiotic factors such as sediment load (turbidity), nutrient availability, currents and tides.

Since the launch of the East Kalimantan Programme, the coastal areas of the Mahakam Delta and Berau Estuary, plus upstream areas and adjacent parts of the shelves, have become the regional focus of the involved EKP researchers, and also for subsequent Dutch-Indonesian research projects and programmes up until today.

East Kalimantan deltas: a living laboratory

Although the geographical region of Dutch-Indonesian research in Kalimantan has been narrowed considerably to two coastal areas in East Kalimantan, the deltas host a variety of issues worthy of investigating by physical, biological and socioeconomic scientists (e.g. resource use, land use change, social conflicts, water pollution, climate change, the impact of these issues on the coastal (eco-) system and anthropogenetic and natural processes, multi-hazard risk mapping and assessment). Or, as Jan Sopaheluwakan from the Indonesian Institute of Science once put it: “Indonesia is a living laboratory for Dutch scientists”. Most of these issues have been investigated within the East Kalimantan Programme. It is partly geological, focusing on sedimentation characteristics, but also has biological aspects as scientists look at the impact of the changes on the flora and fauna of the delta. As programme coordinator Salomon Kroonenberg (Delft University of Technology) correctly observed: “And then there is also the socioeconomic aspect: what do the changes mean for the people and what kinds of laws and regulations play a part?”

The Mahakam Delta is a typical example of a mixed fluvial-tidal delta with an almost perfect separation between fluvial and tidal sediment pathways. Primeval mangrove forests play an important role in this delta: they slow the tidal flow, stabilise tidal channels and attenuate wave energy. However, between 1980 and 2000, almost 70 percent of the mangrove swamps were converted into shrimp ponds. This conversion has had dramatic consequences for both sediment and ecosystem dynamics.

The mechanisms that have been going on for decades in the Mahakam Delta have only just started in the Berau Estuary. The region is still relatively pristine and there are fewer economic activities. However, land, forest and reef degradation, changes in hydrological and fluvial regimes, sedimentation and water pollution all now threaten the sustainability of this ecosystem.

There is a worldwide shift in aquatic food production from fisheries to aquaculture. As a result, more and more mangrove forests are turned into pond areas. For example, in 2008 ponds occupied 40 percent of the Berau delta, whereas the corresponding figure was only 4 percent in 1996. As Kroonenberg observes: "It is interesting to see how far the degradation process in the Berau region has gone, if we can stop the conversion of mangrove forests into shrimp ponds and learn from the mistakes that were made in the Mahakam Delta."

In 2006 Wageningen University launched the 'Rebuilding Resilience of Coastal Populations and Aquatic Resources' (RESCOPAR) research programme that focuses on the Berau delta and makes comparisons with developments in a similar type of delta in the Ca Mau and Bac Lieu provinces of Vietnam. "RESCOPAR aims to contribute to an improved understanding of the sustainability of the livelihoods in coastal zones of tropical deltas where people practice shrimp culture and fisheries", says programme manager Roel Bosma (Wageningen University). He continues: "We hope to find livelihoods that are resilient, that are more sustainable in the long term than what we see nowadays."

The destruction of mangrove areas has a negative effect on fishery catches in the near-shore seas, which in turn stimulates further advancement of the shrimp industry. At the same time, the productivity of shrimp ponds is declining as a result of acidification, pollution and infectious diseases such as the white spot shrimp virus. As a consequence, Indonesian fish farmers ab*andon* their ponds within 5 to 15 years and move away to open up new culture areas.

The shrimp farmers are not the only ones who are concerned. Fishermen, who depend on catches in near-shore seas, complain that the advancing shrimp culture threatens their livelihoods. Over the past five years, 75 percent of fishermen have reported a drop in income.

The RESCOPAR projects are grouped in four interdisciplinary research themes: aquatic eco-systems, culture systems, livelihoods and governance. As Bosma notes: "The decision-making process is very important to the use and management of the ponds and mangroves. From the very start we actively involved local governments in our research. We explained what our plans were and we have already twice communicated our progress to them. We thus try to gain better access to the people and to make sure our recommendations will have a real impact."

A recently started research project 'Sliding from greasy land?' focuses also on the Berau area but on a completely different theme. This project, coordinated by Paul Burgers and Annelies Zoomers (Utrecht University), studies the consequences of the rapid expansion of oil palm plantations for sustainable development and, more specifically, for rural development planning.

'Sliding from greasy land' is one of the projects of the Agriculture beyond Food (AbF) programme. The world faces an enormous increase in demand for biomass for purposes other than food. This demand poses threats and offers opportunities for the agricultural sector. AbF, which focuses on Indonesia, aims to develop a solid, scientifically well-founded innovative programme on the development of biofuels and bioproducts.

"Bioenergy is hot, and Indonesia is well on its way to becoming a superpower in the field of bioenergy", says programme coordinator Huub Löffler (Wageningen University). "The Indonesian government actively stimulates this development and allocates considerable funds to promote the sustainable production and use of biofuels." Indonesia focuses on four commodities for the production of biofuels: oil palm and jatropha for the production of biodiesel, cassava and sugar cane for the production of ethanol.

The socioeconomic and environmental consequences of Indonesia's biofuel production are huge and not yet well understood. The development of biofuel leads, for instance, to changes in land use. Enormous areas of land are used for jatropha cultivation, forests are cleared to make way for oil palm plantations, and cassava and sugar cane cultivation competes with food production.

Studying the 'Threatened Lake of the Year 2008'

One of Kalimantan's largest wetlands is situated between 180 and 350 km from the mouth of the Mahakam, the so-called 'Middle Mahakam Lakes and Wetlands area (MMLW)'. The MMLW is a subsiding area in which about thirty shallow lakes are connected to the meandering Mahakam River by small tie channels. The lakes modulate the river discharge, by either feeding or draining the river, and thus prevent extreme floods or low flow conditions.

Coordinated by Ton Hoitink (Wageningen University), some researchers within EKP have been studying the hydraulic interactions between the channels, lakes and aquifers and the sediment distribution at the lowland river junctions in the MMLW. Using a so-called Horizontal Acoustic Doppler Current Profiler (H-ADCP), an instrument that continuously monitors flow velocity, the researchers were able to produce a more accurate estimate of river discharges than with the conventional rating curve technique. The researchers also explored the added value of the H-ADCP data in a rainfall-runoff model driven by satellite rainfall estimates from the Tropical Rainfall Measuring Mission (TRMM). They found that continuous discharge measurements gave an added value by providing accurate discharge estimates for calibrating and evaluating a rainfall-runoff model driven by TRMM rainfall estimates.

The MMLW is also of great ecological value due to its unique features such as shallow lakes, freshwater swamps and mangrove forests, and the existence of rare and endangered species including birds, monkeys, reptiles and the freshwater Irrawaddy dolphin. It contains up to 500 million tonnes of peat carbon and is a major breeding ground for freshwater fish, giving it a high economic value for the fishing industry. Alongside fishing, the fertile grounds of the lake and lakesides are used in the dry season to grow rice and other crops, and the forests and mangrove swamps provide abundant products for local consumption.

However, since the early 1980s, the Mahakam wetland ecosystem has been increasingly threatened by a variety of factors, all of which are related to humans, such as deforestation, forest fires, mining, mono-cropping, pollution, population pressure and overfishing. In 2008, the Global Nature Fund (GNF), an international foundation for the protection of the environment and nature, tried to draw attention to the dramatic situation of various wetlands in Indonesia by proclaiming the MMLW to be the 'Threatened Lake of the Year 2008'.

The research project 'Adapting to Water Change' aimed at understanding the complex interrelationships between aquatic-ecological and cultural systems under conditions of rapid hydrological and ecological change. It studied the perceptions and experiences of water-dependent communities with changing water quantity and quality and linked these to the actual changes taking place in the aquatic system. As a second step, the consequences of changing water quality and quantity on human livelihoods and the processes of social-ecological resilience, on environmental innovation, and on the formation of new livelihoods have been studied.

'Adapting to Water Change' was financed by the NWO Research Council on Earth and Life Sciences (ALW) and the NWO Foundation for the Advancement of Tropical Research (WOTRO) under the umbrella of the 'NWO Water Programme'. The research by Edwin de Jong (Radboud University of Nijmegen) and Gerben Nooteboom (University of Amsterdam) is fairly unique in the sense that it relates physical water measurements and changes over time to data on livelihood constitution and on people's perceptions of aquatic change and resource depletion.

The water measurements show that the quality of the water is decreasing while changes in water quantity make the water supply unreliable, often leading to extreme floods. Given the decentralisation of government power, with new regional legislation that is often not in line with central government rules and laws, conflicts over access to water are increasing, not only between government officials or companies and the local fishermen, but also between and within local communities.

Confronted with the harsh reality of a changing and declining aquatic resource base, local water-dependent communities are forced to change their livelihood strategies. It would be wrong, however, to regard these communities as mere victims of environmental destruction: they are also creative actors, actively interpreting and altering their environment. Unlike most natural ecological systems, human livelihoods are both exploitative and adaptive and should be seen as self-learning systems able to adapt to new conditions and even 'innovate' in the process of establishing new livelihoods. This innovation can be positive, but also individually or collectively destructive in the use of new exploitative techniques. Nevertheless, the capabilities for adaptation should not be overrated since there is no shared definition and understanding of the problem.

Moving further away from the deltas

A little south of the Mahakam Delta, one finds Pasir - the southernmost district of the province of East Kalimantan. Pasir is comprised of a flat coastal plain and a mountainous, forested hinterland known as Gunung Lumut. Oil palm plantations and mining dominate the coastal area of this region and provide work for migrants from throughout Indonesia. In the mountains, where communities of subsistence farmers live in villages typically comprising a small number of extended families, legal and illegal logging and *ladang* (slash-and-burn farming) are the main economic activities. Local customs and border agreements between communities, rather than national laws or government policies, regulate access to land. The mountain communities saw the New Order's unilateral management of logging and mining projects in Gunung Lumut as dictatorial and unjust, leaving them suspicious of all government initiatives and the national law. As a result, official regulations are implemented along the coast, where the district government is based, but have less influence in

the mountains. Following implementation of administrative decentralisation in Indonesia, the popular influence on governance has increased, especially at the *kabupaten* (district) level, where 'local ways' have become a hot topic in the political discourse.

Laurens Bakker (Radboud University of Nijmegen) conducted socio-legal research on what constitutes these local ways in Paser, and to whom they belong. Can they be reconciled with national laws? Considering land tenure, where district regulations and grassroots practices often differ, it was found that both government and society are looking to tradition, national law and Pasir identity to redefine authority over land. Bakker's project 'Who owns the Land? Looking for Law and Power in Reformasi East Kalimantan' was part of the 'Indonesian-Netherlands Studies of Decentralisation of the Indonesian 'Rechtsstaat' and its impact on 'Agraria' (Indira) research project'. This socio-legal research project, which ended on September 1st, 2008, sought to analyse and understand the development of regional autonomy in post-Suharto Indonesia. Indira was part of the Royal Dutch Academy of Sciences' programme 'Indonesia in Transition' that focuses on recent social and political change in Indonesia.

Although the vast majority of the Dutch-Indonesian research in Kalimantan is conducted in East Kalimantan, some projects have now started on the other side of the island, in the coastal regions of West Kalimantan. The research programme 'In search of Middle Indonesia' is a wide-ranging attempt to relocate the focus of the social science research agenda in Indonesia: away from the 'commanding heights' of society, the state and the economy, and towards understanding the underestimated middle reaches. In accordance with its objective of getting away from the mainstream, one of the projects within the programme 'Youth, identity and work in Pontianak' has been conducted in West Kalimantan. It focuses on the commonly observed 'youth paradoxes' in Indonesia, from both youth and adult perspectives, and investigates whether these paradoxes apply to Pontianak, the capital city of West Kalimantan.

'In Search of Middle Indonesia' is a joint Netherlands-Indonesia research consortium, funded through a grant from the Royal Netherlands Academy of Sciences (KNAW) under its SPIN programme (Indonesia-Netherlands Cooperation Programme).

The shift of focus from the inner to the outer islands of Indonesia certainly boosted Dutch-Indonesian research cooperation in Kalimantan, both in scale and in intensity. However, this upswing coincided with the narrowing of the geographical boundaries of these research initiatives to virtually only the coastal region of the province of East Kalimantan. This is not that surprising given the fact that this region was identified as a priority area for marine and coastal research in Indonesia since most economic activities take place in the deltas of large rivers that have great potential for societal and economic development.

In the years that followed, a considerable number of Dutch-Indonesian research projects have been conducted in this coastal region on a variety of themes within the geological, biological, ecological, morphological and socioeconomic disciplines. As the science boxes show, this research cooperation has resulted in insights that are sometimes surprising and highly relevant both the scientific world and for policymakers.

Scienceboxes

The holocene development of the mixed tidal-fluvial Mahakam Delta

With a rising sea level, the Mahakam Delta has prograded 40 km seaward over the last 5,000 years. It is hardly influenced by waves, with most of the sediment transport being induced by tidal currents and fluvial discharge, resulting in a distinct network of distributary and tidal channels. Fluvial deposition is essentially limited to the 43 channels of the main fluvial distributaries and the bars at their mouths. Tidal deposition predominates in the inter-distributary delta plain areas. In order to better characterise the Holocene outbuilding, researchers Rory Dalman, Duddy Ranawijaya, Tine Missiaen and Salomon Kroonenberg have carried out a large survey of high-resolution subsurface echo soundings and core samplings in the upper 25 metres of the delta.

The Mahakam Delta is unique in that fluvial and tidal depositional regimes are virtually separate. This is because the Mahakam River has no sudden peak discharges into the delta. Runoff peaks do occur in the upstream part of the drainage basin, but these are buffered by the huge lakes in the lower course of the river and do not reach the delta. As a result, the delta is never flooded, and therefore fluvial and tidal channels can persist separately. Another consequence of the absence of delta floods is that avulsions are rare: the fluvial channels are extremely stable, and rarely change course, unlike many other deltas in the world. A second mechanism that inhibits avulsions is the extremely strong bank stability, which inhibits levee breakthrough.

The only significant sedimentary connection between the fluvial and tidal realms is indirect, through the sea-delta interface. Mud and silt carried to the sea by the river are transported back landwards into the inter-distributary delta plain areas along highly sinuous tidal channels which have no connection to the fluvial distributaries. Therefore, very little mixing between fluvial and tidal sediment fluxes occurs.

The seismic and core data show great differences between the inner and the outer parts of the tidal plain of the main fluvial distributaries. In the inner part, the channels cut deeply into the underlying delta front sediments and form laterally heterogeneous crosscutting silt and clay deposits. The outer, tide-dominated, delta plain shows a much more homogeneous sedimentary architecture. This seems to be a distinctive feature of tide-dominated tropical deltas.

Between 5,000 and 2,000 years ago, the northern fluvial distributaries of the Mahakam Delta were the most active, but around 2,000 years ago the southern distributaries became dominant. The tide-dominated delta plain was filled in and its deposits continuously reworked. The tide-dominated

delta plain deposits remain relatively intact due to lateral migration being inhibited and the lack of avulsions in the fluvial channels of the delta. Although there do seem to be changes in the relative dominance of the sediment supply between fluvial distributaries, the basic delta pattern has remained largely unchanged.

Discharge regimes, morphometry and tides in the Mahakam Delta channel network

Many of the world's lowland rivers are influenced by tidal motion. River-tide interaction originates from frictional effects due to variable tidal amplitudes which generate non-steady gradients in the sub-tidal water level. In lowland rivers, the region of influence of low-frequency surface level variations potentially reaches further inland than the point of tidal influence. This study, conducted by Maximiliano Sassi and Ton Hoitink (Wageningen University), investigates the mechanism of river-tide interaction and its consequence on the division of river discharge in the Mahakam Delta.

Relationships between water discharge and the geometric properties of a channel - such as mean depth, surface width and surface slope - are known as Hydraulic Geometry (HG) relations. HG relations are of fundamental importance to water management in delta channel networks, and have an interesting relationship with their geomorphological evolution. Tidal rivers are comparatively more complex than alluvial ones because their channels must accommodate the tidal motion as well as the river discharge. The river and the tide not only coexist in the same channel, they also interact with each other. A systematic variation in the tidal range may lead to a cyclic variation in the water discharge distribution at bifurcations, affecting the HG relations. This research aims to extend the HG concept to the situation of river deltas affected by tides.

In the Mahakam Delta, bifurcations are responsible for the distribution of water and for sediment discharge, contributing to both the short-term sediment dispersal, and the mid- to long-term morphological development. Flow and morphology at tidally influenced bifurcations depend on upstream as well as downstream conditions, thus creating a feedback mechanism along the delta.

The researchers found that the channel geometry of the fluvial distributary network scaled with the bifurcation order. Unlike in the case of river deltas, the bifurcation order does not fully explain bifurcate branch length or bifurcate width ratio. Tidal channels attached to the fluvial network demonstrate converging widths with intrinsic wavelengths decreasing as one moves landwards, and possible indications of ebb/flood transitions in sediment transport. The results may help in understanding the morphological evolution of delta channel networks affected by tides, thus improving idealised models of delta evolution.

Large-scale deforestation increases the rates of suspended sediment discharge (SSD) into tropical rivers, which leads to the silting up of delta channels and the degradation of fluvial, estuarine and coastal ecosystems. Traditionally, methods to continuously monitor and quantify SSDs have been virtually non-existent. Recent developments, however, have offered the possibility of monitoring water discharges continuously by horizontally deploying an Acoustic Doppler Current Profiler (H-ADCP).

The researchers have developed a method to obtain year-round estimates of SSD in the Mahakam River and its main distributary channels. Continuous, fixed-station measurements of flow velocity

and turbidity were taken with an H-ADCP and an optical backscatter sensor (OBS) spanning more than six months. At several sites in the river and its distributary channels, boat-based surveys were carried out to collect simultaneous vertical profile measurements with an ADCP, an OBS and a Laser In-Situ Scattering and Transmissometer (LISST).

Each of the later sets of measurements covered a full tidal cycle. The mass concentration was determined from about one hundred water samples, which allowed the researchers to investigate the ADCP backscatter response to variations in suspended mass concentration, and changes in particle size distributions as inferred from the LISST data.

The new method enables one to obtain continuous estimates of SSD, and of the division of SSD among the main distributary channels. The method combines complementary acoustic and optical methods, based on different measurement principles, to monitor suspended sediment concentration.

Stakeholder interests and the potential for sustainable coastal management through rights regulation practices in the context of decentralisation in the Mahakam Delta, East Kalimantan

How have formal and informal rules regulated natural resource use in the Mahakam Delta? How have the rules been made, and to what extent have they been effectively implemented? What are the socio-legal requirements in terms of property rights for sustainable coastal management in the context of decentralisation? These are the main questions addressed in this research project, conducted by Rikardo Simarmata and Myrna Safitri (University of Leiden).

Since the late 1960s, Indonesian central and local governments have been practicing a policy of territorial zoning in the governing of natural resource use in the Mahakam Delta. The zoning of certain areas through various technical means, followed by exercising state jurisdiction over territorialised areas by creating regulations to delineate how and by whom the resource can be used, is a key instrument of what has been termed a 'territorial strategy'.

In the late 1960s, part of the Mahakam Delta was declared a State Mining Zone. In 1983, the entire delta area was also declared a State Forest Zone. Following those two demarcations as state property, both the Ministry of Energy and Mineral Resources and the Ministry of Forestry have applied state laws and regulations to the use of resources in the Mahakam Delta. An important provision of these laws and regulations is that no use of natural resources in the area shall be undertaken without an official licence, either from one of the two ministries or from the provincial or district governments. A second key provision states that the use of resources shall protect the forest and the environment from destruction and degradation.

In practice however, resource use in the Mahakam Delta fails to comply with these two provisions. Several resource tenure rights have been granted by central and local authorities, but these are often not in full accordance with existing laws and regulations.

As a result, coastal resource use continues to occur with little or no compliance with existing laws and regulations. Two primary conditions facilitate such non-compliance: a lack of legal implementation and law enforcement, and administrative conflict over authority over forest management within the process of decentralisation. These two conditions have led to an 'administrative culture of justification'. Not only do local government officials justify the rights they award to resource users, they also justify the failure to implement and enforce existing laws and regulations.

The conclusion must therefore be that the policy of territorial zoning does not meet its goals. Most resource use occurs without official permits or licences, and the ecology of the Mahakam Delta has been significantly degraded. Since the formal resource tenure system has proven to be ineffective in practice, local government officers, particularly street-level bureaucrats, have created or continued an alternative system of actual resource tenure based on their perception of 'understanding' or reasonableness. The term 'understanding' is used to mean the justifications given by local government officers to explain why they provide and formalise use rights in the delta. In practice, rather than legal reasons, local government officers mainly use non-legal arguments in granting and 'legalising' use rights.

Due to the near absence of central or regional state regulations on the ground, resource use in the Mahakam Delta is mostly governed by local arrangements originating from the interactions between local government officers and resource users. This local-level, unregulated formalisation of existing resource use practices has conspired to facilitate the on-going resource use and development in the Mahakam Delta, without effective compliance with existing laws or minimum standards for sustainable management.

Water and sediment distribution at lowland river junctions: the Mahakam Lakes region

River junctions are nodal points where river channels combine or split. Over recent decades much research has focused on channel junctions in braided rivers. These are morphologically highly dynamic alluvial environments, which typically occur in steep upstream river reaches. Physical analyses of channel junctions in lowland rivers are relatively rare. In particular, the bifurcation processes controlling water and sediment distribution over lowland distributaries are not well understood.

This project, conducted by Bart Vermeulen and Ton Hoitink (both from Wageningen University), aims to analyse river junctions in the Mahakam Lakes region, an extremely flat area that seldom exceeds 10 m above mean sea level. As a result of the gentle bed gradient, the Mahakam River meanders with a tendency to anastomose. On both sides, the Mahakam is connected to a total of about thirty shallow lakes which modulate the water discharge. The lakes alternately feed and drain the Mahakam, preventing both extreme floods and low flow conditions. During periods of high upstream discharge, water flows into the lakes. When the discharge rate is low, the lakes flow into and fill the downstream part of the river. The lakes thus act like a buffer so that the downstream part of the river receives a relatively constant inflow.

The Mahakam River has an awkward morphology. Some of its bends have a particularly sharp curvature resulting in recirculating flow at the inner and/or outer sides of the bend. Such bends usually develop in relatively small streams with a small gradient slope and mainly in systems dominated by suspended loads.

The remarkable morphology of the Mahakam River is caused by the resilience of its banks, caused specifically by the iron and manganese content in the soil. During an extensive fieldwork campaign, the researchers carried out a bathymetric survey along a 360 km stretch of the Mahakam, and made a spectacular discovery: the river has scour holes OF up to 50 m deep. The researchers found as many as thirty such deep scours, some of them four times the average river depth. These scours are almost always associated with high curvature bends. A cross-correlation of curvature and depth shows that the scours are generally found a river width back from the point of highest curvature.

A numerical model is now being used in order to uncover further details of the flow and this may eventually lead to an explanation of the origins of these bends and the concomitant scours. Some preliminary results confirm the strong topographic steering of the flow, but further refinements are needed to explain the formation of these bends.

Rainfall-runoff modelling of a large, tropical poorly-gauged basin – The Mahakam River, Kalimantan

The middle Mahakam region is a subsiding area, where there are about thirty shallow lakes which are connected to the meandering Mahakam River through small tie channels. The lakes modulate the river discharge by alternately feeding and draining the Mahakam River, thus preventing extreme floods or low flow conditions. This modelling project has three goals: understanding the dynamics of the liquid discharge of the central reaches of the Mahakam River; understanding the hydrology of the largest peat dome in the middle Mahakam region; and determining the dominant hydrological mechanisms controlling floods and droughts in the area.

Rainfall-runoff models rely on rating curves to obtain the discharge estimates required in model calibration and evaluation. The rating curve technique involves some uncertainties because it is based on several individual measurements which are then interpolated throughout the year using a stage-discharge relationship. To improve the knowledge, researchers Hidayat and Ton Hoitink installed a so-called Horizontal Acoustic Doppler Current Profiler (H-ADCP), an instrument that continuously monitors flow velocity. This technique delivers much more accurate estimates of discharge than the conventional rating curve technique. The H-ADCP technique was applied in the Mahakam River at a station located 300 kilometres from the river mouth in the Mahakam Delta.

The researchers then explored the added value of using H-ADCP data in a rainfall-runoff model driven by satellite rainfall estimates from the Tropical Rainfall Measuring Mission (TRMM). Both HBV (Hydrologiska Byrans Vattenbalansavdelning) and VIC (Variable Infiltration Capacity) models were used in modelling rainfall runoff for the Mahakam catchment area upstream of Melak.

It appeared that a steady-flow rating curve was not able to accurately reproduce the actual discharge values beyond the upper limit of the measured discharge at Melak. As such, continuous discharge measurements did give an added value by providing accurate discharge estimates for calibrating and evaluating a rainfall-runoff model driven by TRMM rainfall estimates.

An interesting aspect of this project is that the researchers are now using the same method in the Netherlands. Based on the results in Indonesia, Rijkswaterstaat has outsourced a project to the researchers to see how the new H-ADCP technique works in the Netherlands.

The researchers have further explored the use of radar images for observing the dynamics of the Mahakam River floodplain, by incorporating field water level measurements. Water level measurements were made along the river, in the lakes and at two peatland locations using arrays of pressure transducers. The first peatland area was part of the Mahakam floodplain, representing those open peat areas dominated by shrub and reed. The second area represents forest-covered peatland.

A land use/land cover map was available from a previous analysis of PALSAR imagery. To analyse radar backscatter behaviour for different land cover types, several regions of interest were selected based on the land cover classes. A number of land cover classes (medium shrub, high shrub, fern/grass and secondary forest) were found to be sensitive to flooding, whereas in some other classes (peat forest, riverine forest and tree plantation) backscatter signatures remained almost unchanged with flood inundation.

Correlations between water level and radar backscatter were used to distinguish between three types of flooding signal: flooding of low vegetation, flooding of high vegetation, and the boundary shift of lakes. An analysis of the relationship between radar backscatter and water levels was carried out in each of the regions of interest. For lakes and shrub-covered peatland, where the range of water level variations was high, a good water level-backscatter correlation was obtained. In forest-covered peatland, where the range of water level variation was small, water level-backscatter correlations were poor.

Adapting to water change

What are the consequences of changes in water quality and quantity of the Middle Mahakam Lakes and Wetlands area for water-related livelihoods; and what processes of adaptation, interpretation and innovation take place as a result of these changes? These were the central issues in the ‘Adapting to Water Change’ research project, conducted by Gerben Nooteboom (University of Amsterdam) and Edwin de Jong (Radboud University, Nijmegen) (the Netherlands).

The Mahakam Wetland, one of Kalimantan’s largest wetlands, is traversed by the Mahakam River, and forms an important water catchment area and control system for the natural regulation of the river. The wetland is of great ecological value with its shallow lakes, freshwater swamps and mangrove forests, plus rare and species including birds, monkeys, reptiles and the endangered freshwater Irrawaddy dolphin.

Local populations in the Mahakam Wetland have been hit hard by ecological deterioration: surrounding forests have been felled, lakes are silting up, roads have been built, population figures are rising rapidly and, in recent decades, open coal mines and oil palm plantations have been established on a large scale. These changes dramatically affect the availability and sustainability of resources and resource use.

Changes in water quality
The water quality near two research villages (Enggelam on Lake Melingtang and Muara Ohong on Lake Jempang) has deteriorated profoundly. The water is now very acid, akin to swamp conditions, with very low oxygen levels. This makes it difficult for fish to survive and certainly to reproduce.

Villagers' perceptions of a changing environment
Members of indigenous communities are generally aware of even minor signs of climate change and can clearly point to the effects of changes in aquatic systems. The most striking changes mentioned by the people of Muara Ohong are the increased number of floods and the decrease in their predictability, closely followed by a decline in the number of fish species, the amount of fish caught and a deteriorating water quality. Many villagers blame the mining companies, plantation enterprises and logging activities.

Livelihood adaptation
Several changes can be observed in the livelihoods of fishermen living around the three major lakes in the Middle Mahakam area. Generally, there is a trend towards less sustainable livelihoods strategies, such as fish cage production. There is also a shift to catching cheaper and smaller species of fish, and an increase in lakeside agriculture. In some areas, conflicts arise over resources, techniques and fishing areas, and between established villagers and outsiders. Although incomes have remained relatively stable, investments and inputs have increased to maintain these incomes: people work longer, fish further out into the lake, use larger nets, use less sustainable techniques and collectively risk exhausting the rivers and lake areas. The prospects of sustaining existing livelihoods are not very positive and, since few alternatives are available, conflicts are likely to increase.

However, it would be wrong to view the local communities as mere victims of environmental destruction: they are also creative actors who interpret and alter their environment. Unlike most natural ecological systems, human livelihoods are self-learning systems able to adapt to new conditions and even 'innovate' in the process of establishing new livelihoods. Nevertheless, adaptation capabilities should not be overrated since a shared definition and understanding of the problem is lacking.

Making a living in the coastal frontier of Berau, Indonesia

The coastal area of Berau is rich in shrimps and fish that significantly contribute to the livelihoods of small-scale fishermen. Over the last two decades, Marine Protected Areas (MPAs) have been established throughout Indonesia to strengthen biodiversity conservation and to provide a more sustainable basis for fisheries resource management. The Berau region of northeast Kalimantan was declared an MPA in 2005 by the district head, with strong support from international NGOs such as The Nature Conservancy (TNC) and the World Wildlife Fund

(WWF). To control access to the area, the local government has developed *Pokmaswas*, village-based groups for local coastal surveillance. Their official objective is to combat illegal fishing and reduce conflicts over accessing local fishing grounds.

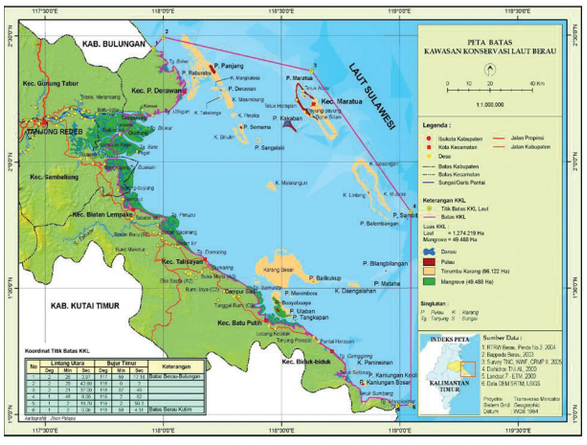
This research project, which is part of the RESCOPAR Programme, started in 2007; with fieldwork carried out between 2008 and 2010 in coastal villages of the Berau delta. In-depth interviews with key social actors were held, and focus group discussions and household surveys were carried out. The general aim of the project is to describe the everyday lives in capture fisheries and coastal aquaculture in Berau. PhD researcher Bambang Gunawan (Mulawarman University, Samarinda) under the supervision of Professor Leontine Visser, Chair of Rural Development Sociology at Wageningen University, is attempting to unravel the interactions between the various social actors in the area. These actors include fishermen/pond farmers, outsider fishermen (*andon*), bosses, village heads and local leaders, local organisations (*Pokmaswas*), external entrepreneurs, district government staff and shrimp traders. By carefully following people's everyday fishing practices in the Berau MPA, insights are gained into the knowledge and interests of the local actors - factors that are often regarded as irrelevant to national and international policymaking.

The *andon* issue is a case in point. Access by distinct actors - outsiders and local fishermen - to fishing grounds has led to social and governance conflicts. *Andon* come from outside the area to fish, and then depart to sell the fish in their home region. The local government understands that the *andon* are a threat to local fishermen. However, the government benefits from *andon* through their contribution to regional income through access permits. Regional economic profit makes it difficult to force them out of the area, so the government in effect legitimises their illegal access to the MPA. In other words, the political economy of the decentralised government regards outsiders' access to fishing grounds within the park boundaries as 'illegal but licit'. Physically closing the boundaries of the MPA, as is advocated in conservation policy, thus would have little effect because of the governmental permeability of the social boundaries: although the area is protected, people can still enter and fish.

To find out how local practices contribute to the functioning of *Pokmaswas* in controlling fishery resources and the interplay among actors involved in fisheries at the village level, a case study was conducted in the coastal villages of the Berau delta applying an actor-oriented approach. Villagers involved in *Pokmaswas* are currently becoming new elites by creating a political network, with access to local government, for the purpose of raising regional income by controlling outsider fishermen who enter the Berau waters. They thus seem to be supporting the political economy of the district government, rather than the causes of their fellow villagers. The socially embedded *Pokmaswas* institution thus threatens local trust as it both excludes local fishermen, who still use the prohibited mini-trawls, and allows access by the *andon* or 'illegal outsiders'.

Fuelling conflicts: overcoming asymmetry between global interests in Berau, Indonesia

Since the decentralised management of land and resources took effect in 2000, there have been dramatic changes in land use in the Berau district of Indonesia. Forest areas have declined significantly and the 'logged over forest' has increased. The area given over to oil palms and tree


PETA BATAS
KAWASAN KONSERVASI LAUT BERAU
KAB. BULUNGAN
KAB. KUTAI TIMUR
LAUT SULAWESI
TANJUNG REDEB
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Kec. P. Derawan
Kec. Maratua
Kec. Sambaliung
Kec. Biatan Lempake
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plantations has more than doubled, and will certainly increase further. Paul Burgers (Utrecht University) and Rizki Pandu Permana have studied the social and economic aspects of these developments for the local government and local communities. This research is part of the Integrated River Basin Management Project - Berau, and is part of the KNAW-funded East Kalimantan Programme.

A further dramatic increase in land conversion processes is caused by the large-scale open-pit coal mining. Interviews with the local planning agency (BAPPEDA) revealed that, in many cases, forest area is reclassified as non-forest land. Then it can be used for other purposes such as mining. This process cannot be halted as mining has first priority in Indonesian politics: any land use must make way for mining.

These developments have had a huge impact on the people of Berau. There is, for example, an increasing conflict between the communities of the villages of Tumbit Dayak and Tumbit Melayu and the mining company PT Berau Coal. Not only is the mining company operating on what is considered to be customary forest land, the open-pit mining, in combination with the blasting methods used in quarrying, has a negative effect on the livelihoods of surrounding villages. The forest areas are cleared and replaced by open pits for the extraction of coal. Local people have stated that the yields from their cocoa and banana plantations are decreasing because the dust created hampers flowering and pollination. The enormous blasts also often uproot their cash-crop trees.

These mining developments could in theory also have positive aspects such as employment generation and hence poverty alleviation. This is, however, rarely the reality. In practice, small-scale tree farming practices require almost three times as much labour. In addition, open-pit mining is a very capital-intensive industry and provides little low-skilled employment for the local people.

Logging operations are also widespread in Berau. Many logging companies are active in ancestral and sacred areas, and in the farming area adjoining the upper part of the Segah River. This has caused numerous conflicts with the indigenous Dayak, who have developed forest-derived livelihood systems. The logging company operating there was blamed for its application of poor forestry practices: neglecting reforestation obligations and blocking the river with logs, rather than providing a new bridge, for road access. Areas used for shifting cultivation have also been logged, directly conflicting with the food security of the Dayak communities. Previously, during the regeneration of secondary forest following a shift in cultivation, local people would support the regeneration by planting useful species in the regenerating forest. The now heavily degraded primary and secondary forests are no longer a haven for food and cash crops. One reason is that the logged primary forest is now targeted for illegal logging, one of the few remaining options open to the local people to sustain their livelihoods. This further degrades the forest areas.

Conclusion

Although local governments can play an important role in acting as a mediator between the local communities and national or global interests, there is still asymmetry between the various levels. Even though the research showed that local communities do have very sound reasons and solutions to balance and adjust some of the asymmetry, the ultimate managers of the forest, the local communities, have no influence. There is, however, enough common ground to balance and adjust some of this asymmetry. What should prove important will be the fact that local governments are able to set up active forms of participation involving local communities, rather than the passive participatory approaches that are currently implemented. Building the capacity of local governments in terms of integrated planning is urgently needed. There is a major task for policymakers, for NGOs and for pressure groups to incorporate development-oriented objectives into investment deals involving foreign land investments in forested areas.

Seagrass systems and turtle grazing: biophysical feedbacks and interactive effects and feedback with eutrophication

Two PhD projects - conducted by Achmad Adhitya and Marjolijn Christianen, and supervised by Tjeerd Bouma - aim to explore and analyse whether nonlinear feedback relationships within seagrass ecosystems explain sudden and irreversible shifts from vegetated seagrass meadow to a bare situation. The overriding hypothesis is that nutrient load, sediment load (affecting light transmission and seabed composition), hydrodynamics and seagrass grazing are the most important drivers that push the seagrass ecosystem into a different functional state.
These important drivers are being studied in pristine Indonesian seagrass meadows in the Berau delta, East Kalimantan, and in the laboratory. The first PhD project focuses on the biophysical feedback loop between hydrodynamics and grazed seagrass that is known to influence both sediment trapping and sediment stability within a meadow and, for bare sediments, also affect seston (microorganism) exchange between column water and pore water. The second project focuses on the ecological interactions between high nutrient loads (eutrophication), seagrass and intensive turtle grazing which may protect seagrass meadows from overgrowth by epiphytes, increasing critical loads.

Hydrodynamics and spatial heterogeneity in seagrasses

Although spatial heterogeneity is a natural phenomenon, little is known about the effect of heterogeneity in seagrass density on hydrodynamic parameters. The researchers have studied this topic in a series of experiments in a race track flume. For example, in one experiment, spatial heterogeneity was created by placing four boards with contrasting shoot densities in different patterns. The results show that canopy flux - which is an indicator of the supply of resources such as nutrients, dissolved gasses and sediment - shifted from high density (HD) to low density (LD) seagrass patches. Considering the canopy flux, the TKE and the Reynold stress values, seen as driving factors in increasing vital resources such as nutrients and dissolved gasses to seagrass meadows, the researchers conclude that hydrodynamic processes favour the growth of LD patches over HD patches in larger spatial patch arrangements, thereby causing heterogeneous seagrass meadows to, over time, become more homogenous.

Effects of sediment and nutrient loading on seagrasses

Seagrass losses are accelerating worldwide, and recovery is non-existent or slow. The researchers compared the seagrass meadow properties over a gradient with varying river influences. Results show that the abiotic properties of a water column and of pore water are unsuitable as indicators of increased river sediment and nutrient loading, whereas sediment properties can be used to a limited extent. Seagrass meadows did, however, strongly respond to higher sediment and nutrient loads by decreasing seagrass cover, the standing stock, the number of seagrass species and by changing species composition. The discrepancy between the strong nutrient response in seagrasses and the lack of response in the water column and the pore water shows that it is vital to make a distinction between nutrient loads (fluxes) and concentrations. This study has also identified and confirmed the early-warning indicator qualities of static seagrass system variables. It is advised that tissue nutrient concentrations be included in the monitoring list of seagrass-watch manuals.

Grazing increases seagrass tolerance

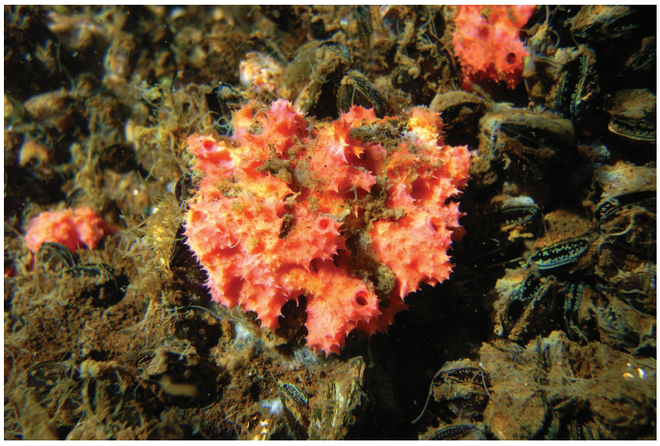
The endangered green turtle (*Chelonia mydas*) plays a pivotal role in coastal systems. Their populations have, however, declined dramatically as a result of over-harvesting and loss of foraging habitat. The researchers investigated the interaction effects of nutrient addition and of simulated green turtle grazing on seagrass and epiphyte productivity, on seagrass biomass and on nutrient contents in enclosures at a pristine seagrass site in Kalimantan, Indonesia.

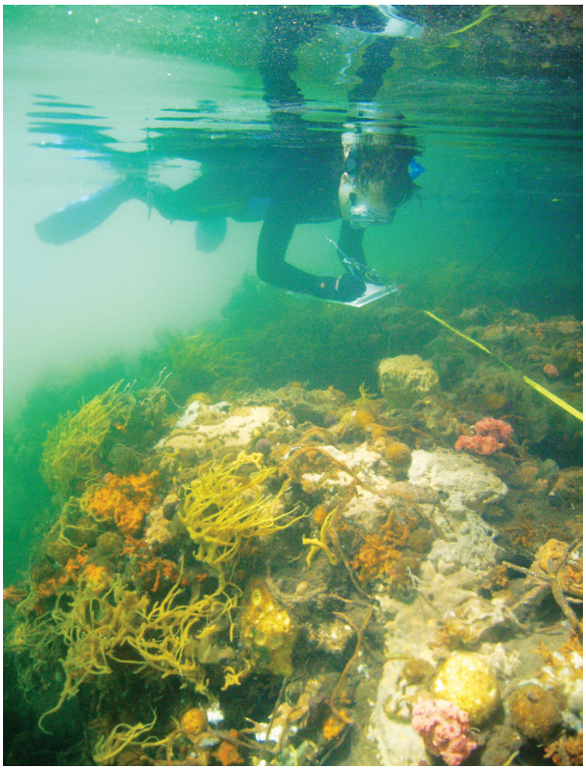
In tropical seagrass systems with high green turtle grazing pressure, the grazing alleviates the negative effects of eutrophication by stimulating seagrass production and a concomitant nutrient uptake, by increasing the export of nutrients and by the indirect prevention of low below-ground biomass. The turtles not only drive the structure and the functioning of their foraging grounds, they also increase the resilience of seagrass ecosystems to eutrophication by removing excess nutrients.

Reef sponges in Kalimantan

The coral reefs of Indonesia are amongst the most diverse but also the most threatened in the world. Proper conservation, restoration and management of these reefs require accurate baseline studies of the constituent species and environmental conditions under which these species thrive. Most reef surveys take place in areas that have already experienced massive biodiversity losses and shifts in composition as a result of historical disturbances. However, it is also important to study the few remaining relatively undisturbed areas, such as the Berau delta. Nicole J. de Voogd and Leontine E. Becking (both of the National Museum of Natural History, Leiden, Netherlands) and Daniel F. R. Cleary (Universidade de Aveiro, Portugal) have studied the habitat structure (including the cover of branching coral, massive coral, sand or rubble), abiotic environmental variables (such as temperature, salinity and pH) and the composition and abundance of larger reef sponges in the Derawan Islands of East Kalimantan, Indonesia.

The combination of terrestrial-based pollution and other disturbance such as blast fishing appear to have had an adverse effect on the reefs. The average live coral cover across investigated sites and depths was just under 30 percent, which can hardly be considered pristine. The combined mean cover of rubble and dead coral exceeded 40 percent and was thus well above the live coral cover. Of the 36 transects, only 4 had more than 50 percent live coral cover and would thus fall into the 'good' category definition of Gomez and Yap (1988); 15 transects had less than 25 percent live coral cover and would be classified as 'poor'.





Various factors may be responsible for the high rubble cover. On the furthest offshore islands, the rubble is almost certainly the result of illegal blast fishing. Inshore, the rubble may be the remnant vestiges of coral reefs that died in the more distant past.

In contrast to corals, sponges appeared to be thriving in the Derawan Islands. A total of 168 sponge species or morphospecies were identified. The most common of these were *Stelletta clavosa, Lamellodysidea herbacea, Niphates sp., Ircinia ramosa* and *Petrosia nigricans*. There were 38 (22 percent) 'unique' species (i.e. only found in one transect) and a large number of singletons (26 species) were observed, indicating that the actual diversity will be higher than that recorded. Many of these species have never been recorded in Indonesia, or have not yet been described.

The researchers found the highest number of species in those inshore reefs that already had depauperate coral communities. The individual sponges also tended to be larger at these sites. This was in marked contrast to findings elsewhere in Indonesia (Northwest Java, Southwest Sulawesi) where, for all the taxa sampled, all the inshore communities were depauperate.

The researchers found a highly significant relationship between the variation in sponge species composition and a set of spatial, environmental and habitat structure variables in the area. Sponge diversity and abundance are notably higher than in other reefs within the Indonesian Archipelago.

Conclusions and recommendations

Moving beyond the state-of-the-art

As Kathy MacKinnon and others already noted in their 1996 book *The Ecology of Kalimantan*: 'If future developments in Kalimantan are to be carried out in a way least damaging to biodiversity and the environment, planners and regional developers will need access to a broad base of ecological information. Kalimantan universities, environmental study centres and research institutes have a key role to play in this research.' In defining the state-of-the-art, they developed a list of topics that needed further investigation including the effects of (re)logging on plant and animal communities, effects of watershed disturbance, changing morphology of rivers and deltas, mangrove ecology, fisheries research and the effects of deforestation and industrialisation on natural resources.

In the years that followed, a considerable number of Dutch-Indonesian research projects have been conducted in Kalimantan on these various themes. As the science boxes show, this research cooperation has resulted in insights that are sometimes surprising and highly relevant for both the scientific world and for policymakers. Study of the above themes, which are generally related to the physical sciences, is today still highly important. However, since then, we have also come to recognise that this is not the full story: we also need to include the disparate and under-researched economic and socio-cultural dimensions. We need to move further beyond the state-of-the-art in future Kalimantan research.

Neoliberalist views imbue many aspects of life in Kalimantan and greatly influence the way various people, organisations, government institutions and firms value 'nature' and natural resources in Kalimantan. Ecosystems in Kalimantan or, more importantly, the degradation of these systems can no longer be understood without studying the main cause, which is often economic. In standard economic thinking, ecological degradation is considered to be an economic benefit. For instance, the costs of logging in virgin tropical forests, or the pollution of water, are ignored or externalised. This is elsewhere a standard practice; such as in the CO_2 reduction strategies of western countries.

Further, as a consequence of the decentralisation policies launched by the Indonesian government in 2001, conditions for accessing Kalimantan's resources and the actors in the arena have changed completely. State institutions and their resources are now used by a greater number of actors for private ends, and certain former functions of the central state, such as taxation and policing natural resources, were transferred to informal networks of mafia-types and private security agencies, sometimes closely related to the police. This chaotic mode of domination is a new form of state in which the coercive apparatus of the state transcends the boundaries between the legal and illegal, the formal and informal, the legitimate and illegitimate and the public and private. In effect, such an apparatus includes both governmental and non-governmental organisations and practices. In order to understand how access to natural resources in Kalimantan is regulated, and the ways in which resources are prone to exploitation or have conservation potential, socio-cultural research is needed on the new balance of power between the holders of high office in government institutions on the one hand and members of networks of influence on the other.

Moreover, research activities in Kalimantan need to be applied on a larger scale. For example, if a research project is water based, one cannot really understand downstream effects without paying attention to upstream changes. Similarly, any analysis of alternative ways to improve policymaking and governance surrounding river basins soon runs into the upstream-downstream dilemma. The people, firms, organisations and communities that cause the problems upstream have no internal drive to seek a solution or cooperate. They will only do so if they are forced to, or if they 'need' their 'neighbours' downstream for other reasons (social, political, economic). For this reason, we need to look beyond the boundaries of East Kalimantan and link the results with research that focuses on the sources of the various water circulations or the causes of degradation in ecosystems in the inner terrain of Kalimantan, or compare it with research in similar settings in West or South Kalimantan.

Finally, research initiatives in Kalimantan should be scaled up in a sense that local issues are no longer locally defined or determined. In Kalimantan, it is especially European, North American, Australian and Chinese mining, oil, gas and plantation companies that play the major roles in exploiting natural resources. Often, their valuation of 'nature' is defined by their home context. This might explain the unsustainable operations of Chinese companies. In the name of corporate social responsibility, some companies are forced by consumers in their home countries to address the ecological problems in Kalimantan. These companies do not only have rights and obligations in Kalimantan but far beyond. Another change is that, since the fall of Suharto, national and international NGOs have entered the arena and access and mobilise an extensive network of people and organisations at the grassroots level. In the political field, they have become the fourth or fifth power (alongside the legislative, executive and judiciary – and currently also the media). In Reformasi Indonesia, the new position of national and international NGOs, as participants in decision making over natural resource management and legislation, requires them to redefine their objectives, strategies and responsibilities.

A final word

In 2005, Lowenhaupt Tsing noted in her study on Kalimantan's rain forests that instead of either segregating nonhumans from nature and "throwing out the libraries on history and culture or taking nature for granted as resources for human use, we might want to look at how species and populations slip in and out of markets, in and out of cultural attention, and in and out of a whole spectrum of not-yet-fully-described interactions between humans and nonhumans." Within the various research programmes there is already a strong ambition to pay attention to humans alongside nonhumans but, in practice, the human dimension still plays a minor role in most research programmes related to Kalimantan. Moreover, we need to go one step further, by, as Lowenhaupt Tsing suggests, not only including the human dimension but also studying the interactions between humans and nonhumans. More multidisciplinary research in Kalimantan is needed: to clarify the relationships between changes, on a variety of spatial and temporal scales, in the ecological systems and the socio-political arena and cultural and economic discourses and practices; and to assess the potential and observed effectiveness of conservation initiatives or, as they are now often referred to, ecosystem services.

To achieve this, a new all-embracing research programme (with a range of disciplines and region-wide actors) should be developed with a comparative model from the outset through which projects depart from a common analytical framework. This should be a joint effort of Dutch, Indonesian and other universities and research institutes and should involves scientists from a broad spectrum of disciplines. Results should be coordinated and communicated among scientists, and also to policymakers and the wider public.

A first initiative towards such a comprehensive undertaking has been taken with the organisation of the 6th Open Science Meeting on the 28th and 29th November 2011 in Jakarta. The Open Science Meeting is an initiative within the Scientific Programme Indonesia-Netherlands (SPIN), and aims to further strengthen the collaboration between scientists and Indonesian policymakers and NGOs so as to stimulate the exchange of information and identify the central issues that urgently need further investigation in Indonesia. By focussing on 'Kalimantan Tides' on the second day, it is also a real attempt to ensure that we move beyond the state-of the-art in future Kalimantan research.

Colophon

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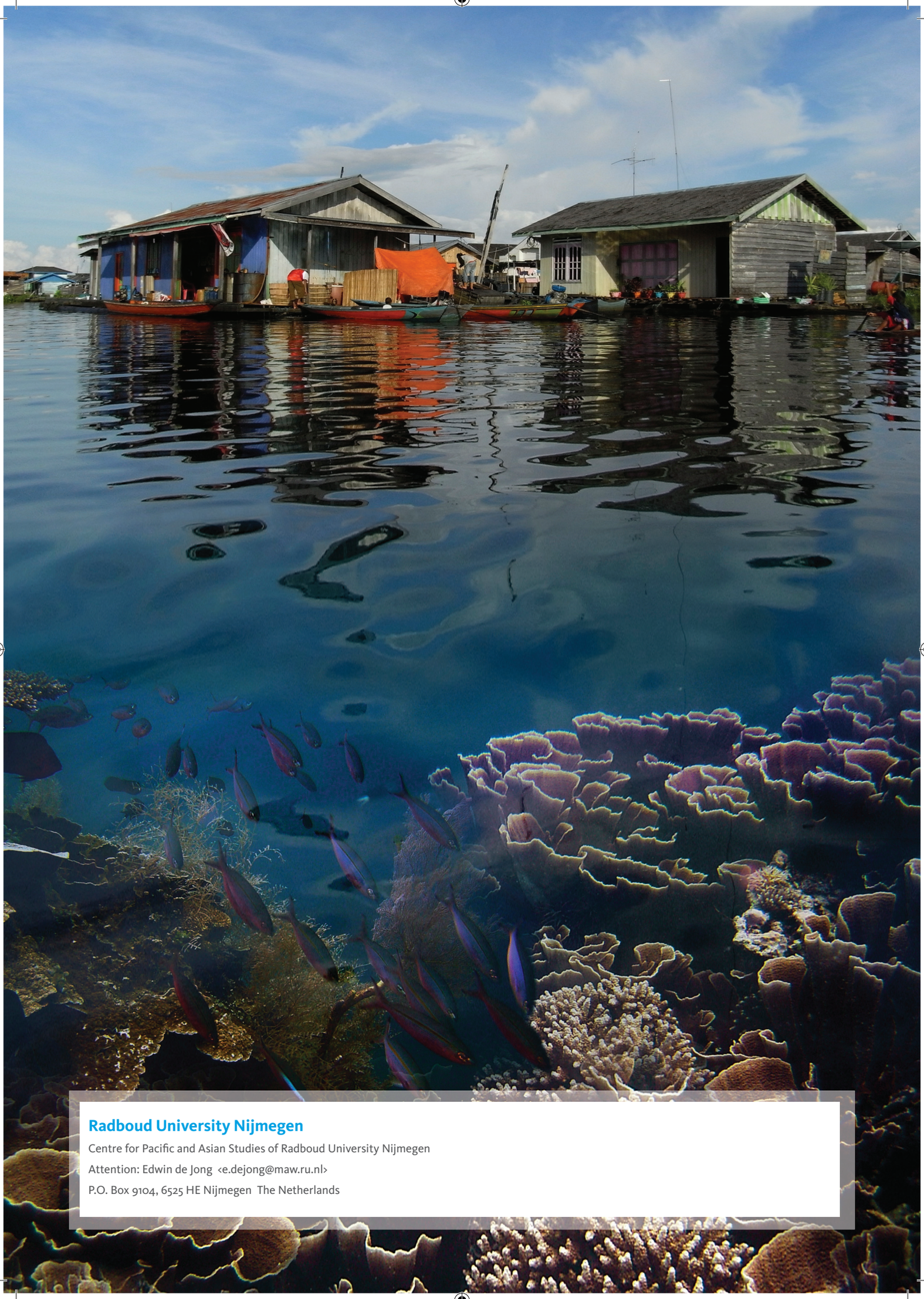

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