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CONTESTED AQUACULTURE DEVELOPMENT IN THE PROTECTED MANGROVE FORESTS OF THE KAPUAS ESTUARY, WEST KALIMANTAN

KONFLIKTGELADENE AQUAKULTURENTWICKLUNG IN DEN MANGROVENWÄLDERN DES KAPUAS-ÄSTUARS, WEST KALIMANTAN

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SUMMARY

Indonesia comprises more mangroves than any other country, but also exhibits some of the highest mangrove loss rates worldwide. Most of these mangrove losses are caused by aquaculture development. Monetary valuation of the numerous ecosystem services of mangroves may contribute to their conservation. However, our analysis of mangrove to aquaculture conversions in West Kalimantan demonstrates that socio-political structures and networks and related patterns of political and economic domination and marginalisation are more fundamental determinants of mangrove loss or conservation and hence deserve more scholarly and political attention. The conversion of 1,800 ha of legally protected mangrove forest in the Kapuas estuary into brackish aquaculture was pushed by non-local aquaculture operators, village representatives, state officials, and fisheries authorities. Bonded by entrepreneurial interests, corruption, power, and political goals, this 'aquaculture alliance' has struggled against the forest authorities' mangrove conservation goals. The majority of the politically marginalised local residents, many of whom depend on the mangroves, do not benefit from the development but are deprived of some of their resources. Networks of power and hierarchies avert rebellion. The environmental transformations both are determined by and reveal an entrenched social order marked by problematic power relations and inequity.

Keywords: mangrove forests, deforestation, mangrove conservation, aquaculture, capture fisheries, conflicts over natural resources, environmental governance, political ecology, land use and land cover change, remote sensing, Indonesia

ZUSAMMENFASSUNG

Indonesien ist das mangrovenreichste Land der Erde, weist jedoch gleichzeitig eine der höchsten Abholzungsraten weltweit auf. Die wichtigste Ursache dafür ist die Aquakulturentwicklung. Eine Quantifizierung der vielfältigen Ökosystemdienstleistungen von Mangroven kann zu deren besseren Schutz beitragen. Unsere Analyse der Aquakulturentwicklung in West Kalimantan zeigt jedoch, dass sozial-politische Strukturen und Netzwerke sowie damit verbundene Konstellationen politischer und ökonomischer Vorherrschaft und Marginalisierung grundlegendere Determinanten für den Schutz oder die Zerstörung von Mangroven darstellen und daher größerer wissenschaftlicher und politischer Aufmerksamkeit bedürfen. Die Umwandlung von 1.800 ha geschützter Mangrovenwälder im Kapuas-Ästuar in Brackwasseraquakulturen wurde von auswärtigen Investoren, einigen Dorf- und Staatsrepräsentanten und den Fischereibehörden vorangetrieben. Diese durch ökonomische Interessen, Korruption und politische Macht verbundenen Akteure kämpfen gegen die für den Schutz der Mangrovenwälder zuständigen Forstbehörden für eine Legalisierung der Aquakulturen. Die politisch marginalisierte Lokalbevölkerung, die vielfach von den Ressourcen und Ökosystemdienstleistungen der Mangroven abhängt, profitiert nicht von der Aquakulturentwicklung und wird stattdessen eines Teils ihrer Ressourcen beraubt. Entsprechende Widerstände werden durch machtdurchdrungene Netzwerke und Hierarchien unterdrückt. Die Umwelttransformationen im Kapuas-Ästuar sind das Ergebnis von und Teil einer durch problematische Machtstrukturen und tief verwurzelte Ungerechtigkeit charakterisierten gesellschaftlichen Ordnung.

Schlüsselworte: Mangroven, Entwaldung, Mangrovenwaldschutz, Aquakultur, Fischerei, Konflikte um Naturressourcen, Umwelt-Governance, Politische Ökologie, Landnutzungswandel, Fernerkundung, Indonesien

1 INTRODUCTION

With an extent of almost 3.2 million hectares, Indonesia comprises about one fifth of the world's mangrove area (Spalding et al. 2010). The country not only ranks first in terms of mangrove coverage but also exhibits the highest level of mangrove biodiversity worldwide (FAO 2007a; Spalding et al. 2010). At the same time, Indonesia sets records in terms of mangrove destruction. While on the global scale the total mangrove area declined by 20% between 1980 and 2005, the mangrove area of Indonesia declined by 31% during the same period (data from FAO 2007a). And in contrast to declining mangrove deforestation rates on the global scale, mangrove destruction in Indonesia has accelerated during the past decade. While globally, the average annual mangrove loss rates declined from 1.04% in the 1980s to 0.66% between 2000 and 2005, the average annual rates of mangrove loss in Indonesia, after declining from 1.8% (1980s) to 1.0% (1990s), considerably increased to 1.6% between 2000 and 2005 (data from FAO 2007a). This is by far the highest mangrove loss rate of any country in Asia. These figures only document mangrove loss and do not include mangrove degradation. Of the total mangrove area still remaining in Indonesia, more than half is degraded (FAO 2007b).

The causes of mangrove conversions in Indonesia as well as worldwide are certainly not well summarised with "[h]igh population pressure in coastal areas", as the Food and Agriculture Organization of the United Nations states in the executive summary of its assessment of the world's mangroves (FAO 2007a: ix). Given that mangrove conversions are often driven by non-local actors, economic and political elites, and broader socio-political structures and processes, notions about 'high population pressure' appear to be not only superficial but misleading. A country report in a related working paper provides a somewhat more differentiated and more realistic picture of the major direct drivers of mangrove deforestation in Indonesia, citing "unsustainable aquaculture development" as the main cause for mangrove losses and "overexploitation […] through intensive logging" as a secondary cause (FAO 2007b: 40).

Development of aquaculture, particularly of shrimp aquaculture, has been one of the main drivers of mangrove conversion in Indonesia and worldwide (Adger & Luttrell 2000; Spalding et al. 2010). Hamilton (2013), who analysed changes in mangrove cover in 56 major estuaries of Indonesia, Brazil, Bangladesh, India, Thailand, Vietnam, Ecuador, and China, found that 52% of the total historic mangrove coverage of these estuaries was lost, and that 54% of these mangrove losses were caused by aquaculture development. Across the nine analysed estuarine mangrove areas in Indonesia, the situation was even more extreme, with 61% of the historic mangrove cover being lost between the early 1970s and 2005-10, and aquaculture development accounted for 79% of this loss (ibid.).

The total brackish aquaculture area in Indonesia, almost three fourths of which is used for shrimp farming, increased from about 458,000 to 749,000 ha between 2002 and 2011 (BPS 2012). In light of the political support and development goals of the Indonesian Ministry of Marine Affairs and Fisheries, which proposes no less than 2.96 million ha as the potential area for brackish aquaculture (KKP 2013), the aquaculture boom, and hence mangrove conversions, are set to continue unabated in Indonesia.

Aquaculture development not only provides economic benefits, but can be accompanied by substantial environmental and social costs, including, among others, the loss of wetland habitats and nursery areas; the depletion of wild fish and reduced catch yields due to the loss of nursery and feeding grounds and the collection of wild broodstock and feed fish for fishmeal; eutrophication; effluents containing antibiotics and chemicals; introduction of exotic species; spread of diseases; hydrological changes and salt water intrusion; and the loss of or deprivation of access to resources previously used by local residents (Bailey 1988; Bosma & Verdegem 2011; Dewalt et al. 1996; Naylor et al. 2000; Páez-Osuna 2001; Primavera 2006; Thornton et al. 2003). Furthermore, brackish aquaculture ponds excavated in mangrove soils often fail due to the development of acid sulfate soils (Bosma et al. 2012; Choong et al. 1990; Northcote & Hartman 2004), contributing to a "boom-and-bust pattern" (Rönnbäck 1999: 237), especially in shrimp aquaculture, with high income generation in the first years and a rapid decline thereafter. In semi-intensive and intensive ponds, shrimps are usually cultured no longer than five to ten years, before the farmer abandons the pond and moves on to construct a new one (Rönnbäck 1999; also see Bailey 1988).

With the conversion of mangroves into aquaculture ponds, the numerous ecosystem services provided by mangroves (summarised in Table 1) are lost.

Many mangrove ecosystem services are difficult to quantify and convert into monetary values. The resulting undervaluation of mangroves has been seen as a major driving force for their conversion (see, for example, Rönnbäck 1999). However, we argue that even complete quantification and monetisation of all mangrove ecosystem services seems unlikely to considerably slow down mangrove destruction, since the existence of a societal consensus with all actors collaborating to maximise total economic or, more broadly, societal gains from the natural resources and potentials of a region cannot be assumed. In reality, various socio-political structures and processes, the roles, economic interests and political alliances of a few influential actors and related patterns of political inclusion and exclusion may largely determine the pace and patterns of mangrove conversion. Already a quarter of a century ago, Bailey (1988) critiqued the widespread expropriation of community resources by aquaculture investors and the roles of networks and bribery. Similarly, Armitage (2002) found that aquaculture development in Banawa, Central Sulawesi, was "organized and controlled by relatively few well-connected district and regional officials and entrepreneurs" (p. 211). He noted that instead of restricting access to mangrove forest ecosystems, government staff granted permits for aquaculture development based on self-interest. However, the roles of political structures and processes and of particular actors, and, as noted by Adger & Luttrell (2000), the roles of property rights, questions of access to resources and the distribution of the impacts of mangrove conversion tend to be under-emphasised in literature on mangrove management and degradation.

Based on our research in West Kalimantan we suggest that understanding the causes and implications of mangrove conversion and aquaculture development requires a combined analysis of the spatial and temporal physical dynamics, the roles of and alliances between the main actors involved, related political and administrative processes, the (potential) effects of the transformations, and the parties affected. All these aspects or dimensions of the transformation have to be seen as embedded in the context of overall societal structures. Such a Political

Ecology analysis not only reveals the underlying causes and dynamics of mangrove conversion and aquaculture development, but can also provide insight into the socio-political fabric of a region and into overall modes of governance, as we will show in the following

Tab.1: *Ecosystem functions and services of mangroves (modified and compiled after Adger & Lutrell 2000; Alongi 2008; Armitage 2002; Blasco et al. 1996; Choong et al. 1990; Dutrieux 1991; Jennerjahn & Ittekkot 2002; Kaplowitz & Hoehn 2001; Long & Skewes 1996; MacKinnon 1996; Northcote & Hartman 2004; Ruitenbeek 1992; Rönnbäck 1999)*

Ecosystem functions and services of mangroves			
Biological	*Physical*	*Chemical*	*Social and economical*
habitat for fish, crustaceans (crabs, shrimps), bivalves (cockles, mussels, oysters), and gastropods (snails, slugs)	trapping sediments; promoting sedimentation	water quality maintenance; water purification; groundwater recharge	fish, crustaceans, molluscs and other fauna (including off-shore fisheries)
feeding ground	shoreline protection; buffer against wind and waves; reduce coastal erosion	chemical buffer; pollutants filter	timber for construction; fuel wood; charcoal; wood chips
breeding, spawning and nursery area	protection of freshwater areas from intrusion of seawater	export of organic matter and nutrients	source of industrial raw materials: pulp, paper, textiles, medicine, alcohol, sugar, honey, sweetmeats from propagules, glue, wax, and cosmetics
refuge habitat and shelter from predators for marine species		storage and recycling of organic matter, nutrients and pollutants	tannin for dying of fishing nets
protection area for young terrestrial fauna such as birds and bats		influence on local and global climate, globally relevant contribution to (marine) carbon sequestration	scientific and educational information
reservoirs of biomass and genetic materials		provide oxygen and absorb carbon dioxide	tourism and recreation

2 RESEARCH APPROACH, METHODS AND STUDY AREA

Political Ecology, which "combines the concerns of ecology and a broadly defined political economy" (Blaikie & Brookfield 1987: 17), seeks to understand the sources, circumstances and ramifications of environmental change (Bryant 1992). It links environmental dynamics and varied societal interpretations thereof with questions of access to and control over resources, the roles and interests of the actors, socio-political structures, and power relations, and (often unequal) distributions of the benefits and negative effects of environmental transformations (see, for example, Blaikie 1985; Bryant & Bailey 1997; Peluso 1992; Paulson & Gezon 2004; Zimmerer & Bassett 2003).

Taking a similar methodological approach as described in Lukas (2014), we used a Political Ecology perspective and combined an analysis of satellite images and historical maps with social-scientific research methods to investigate the spatial and temporal dynamics of (illegal) aquaculture development in the protected mangrove forests of the Kapuas estuary in West Kalimantan, and explored the drivers of these transformations, related political struggles, their environmental and social effects, and resulting conflicts and injustices. In doing so, we paid particular attention to the roles and interests of the various actors and their narratives about the transformations. We started our inquiry with an analysis of bio-physical changes using satellite images and historical maps. Using a political ecology perspective with social-scientific inquiry we then linked the observed environmental transformations with socio-political structures and processes (as in Lukas 2014).

Based on a series of Landsat images taken between 1973 and 2014, we identified land cover changes throughout the Kapuas estuary region. The satellite images were acquired from the U.S. Geological Survey and the Geo-Informatics and Space Technology Development Agency (GISTDA) in Bangkok, Thailand. They were georeferenced based on recent topographic maps. Land cover changes were identified through visual interpretation of false colour composites generated from the green, red and near infrared bands. GPS-facilitated land use and land cover mapping and secondary spatial data acquired from governmental authorities supported the satellite image analysis. To further expand the temporal scale of analysis into the past, historical maps from 1925 and 1932 were acquired from the collections of the Royal Tropical Institute at Amsterdam and the National Archives at Jakarta, scanned, georeferenced and checked for accuracy. Our social-scientific inquiry mainly comprised semi-structured interviews with representatives of governmental and non-governmental organizations at sub-district, district and province levels, with aquaculture pond owners, representatives of fishermen unions and with affected local residents. In addition, we collected secondary data from various governmental and non-governmental organizations.

The research presented here was part of a larger research endeavour exploring and linking environmental and social-political transformations in the Kapuas estuary region and throughout the entire Kapuas watershed (Lukas et al. 2012). The Kapuas estuary region (Figure 1) is located at the equator and was once covered with mangrove forests along the sea and peat swamp forests further inland. Most of the area belongs to the district of Kubu Raya, which split from the provincial city of Pontianak in 2007.

Almost the entire estuary region has been and is being rapidly transformed by transmigration programmes, oil palm plantation development and the expansion of brackish aquaculture. The latter involves the clearance of protected and / or communally used mangrove forests along the coast. These mangrove forests, their associated ecosystems and their ecological and socio-economic relevance as well as the development of brackish aquaculture replacing the mangrove forests have barely been documented to date. For the whole of Kalimantan, Spalding et al. (2010) recorded high mangrove loss rates. They estimated that "[p]robably more than 65 per cent of the original mangrove area of Kalimantan has been lost" (p. 108).

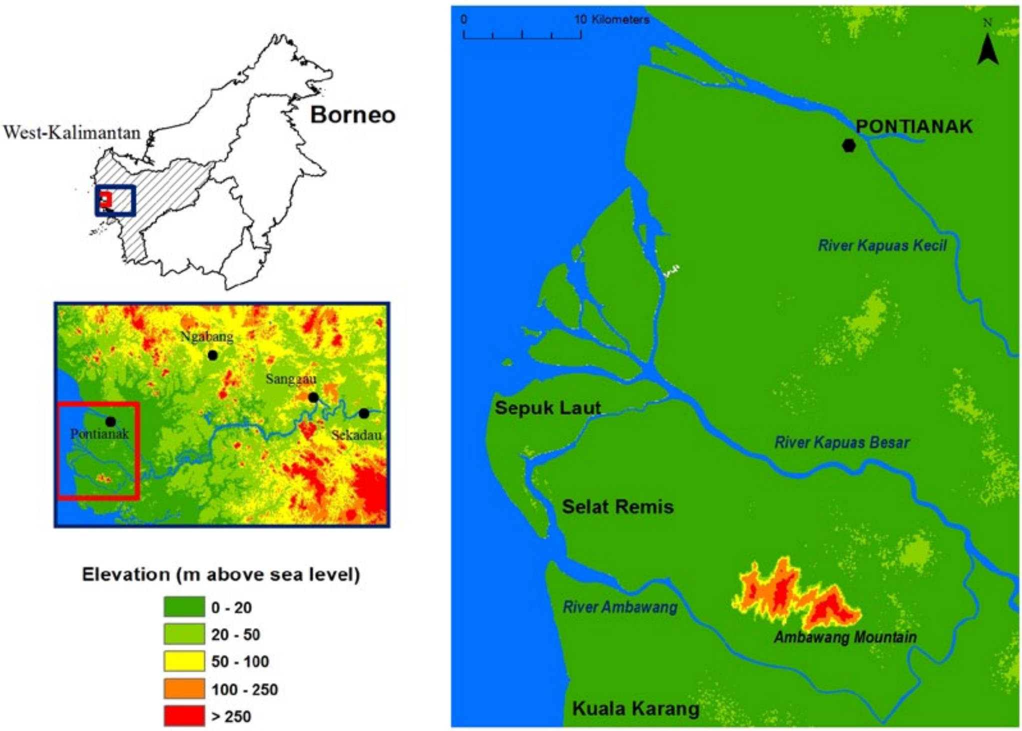

Fig.1: *The Kapuas estuary region with the Small Kapuas River ('Kapuas Kecil'), flowing through the province capital Pontianak in the north, the Big Kapuas River ('Kapuas Besar') with a number of distributaries, and the Ambawang River in the south. Data sources: SRTM (remotely sensed elevation data), U.S. Geological Survey (hydrology), Regional Planning and Development Board of Kubu Raya (administrative units).*

And Rahman et al. (2013) documented mangrove conversions in the Mahakam Delta, once one of the largest mangrove areas in Kalimantan. They found that 75% of the mangrove area had been deforested by 2010 for aquaculture development. The mangrove conversions in the Kapuas estuary have to our knowledge not yet been documented.

3 SPATIAL AND TEMPORAL DYNAMICS OF RAPID AQUACULTURE EXPANSION IN PROTECTED MANGROVE FORESTS

In the early 1990s, there were only very few small aquaculture ponds situated within the area of the present district of Kubu Raya. According to a representative of the provincial Agency of Marine Affairs and Fisheries, these ponds had first started to be established by transmigrants from Java, who introduced aquaculture in the Kapuas estuary region, based on their knowledge and experiences from Java. The operators of the small ponds produced fish mainly for self-consumption and their neighbours, supplementing their main incomes derived from agriculture or capture fisheries (World Bank 1992). Landsat images of the area from the 1990s show no signs of any brackish aquaculture ponds in the Kapuas estuary. The few existing ponds were obviously either too small to be detected in the satellite images or were situated outside of our research area.

Tab.2: *Area of protected mangrove forest converted into aquaculture ponds in the Kapuas estuary region between 2002 and 2014 (based on our analysis of Landsat images) and future aquaculture area proposed by the District Authorities of Marine Affairs and Fisheries*

Year	Sepuk Laut	Selat Remis	Kuala Karang	Total
2002	46	-	-	46
2007	495	111	-	606
2011	943	203	127	1,273
2014	1,445	225	127	1,797
Goal of District Authorities of Marine Affairs and Fisheries	*1,600*	*1,500*	*500*	*3,600*

The first larger brackish aquaculture ponds can be detected in Landsat images at the end of 2000. Since then, aquaculture development has rapidly transformed large parts of the island of Sepuk Laut and the neighbouring area of Selat Remis (Figure 2). By 2011, 943 ha of protected mangrove forests in Sepuk Laut and 203 ha of protected mangrove forest in Selat Remis had been converted into aquaculture ponds (see Figure 2 and Table 2). In 2011, an additional 127 ha of protected mangrove forest was converted into aquaculture ponds south

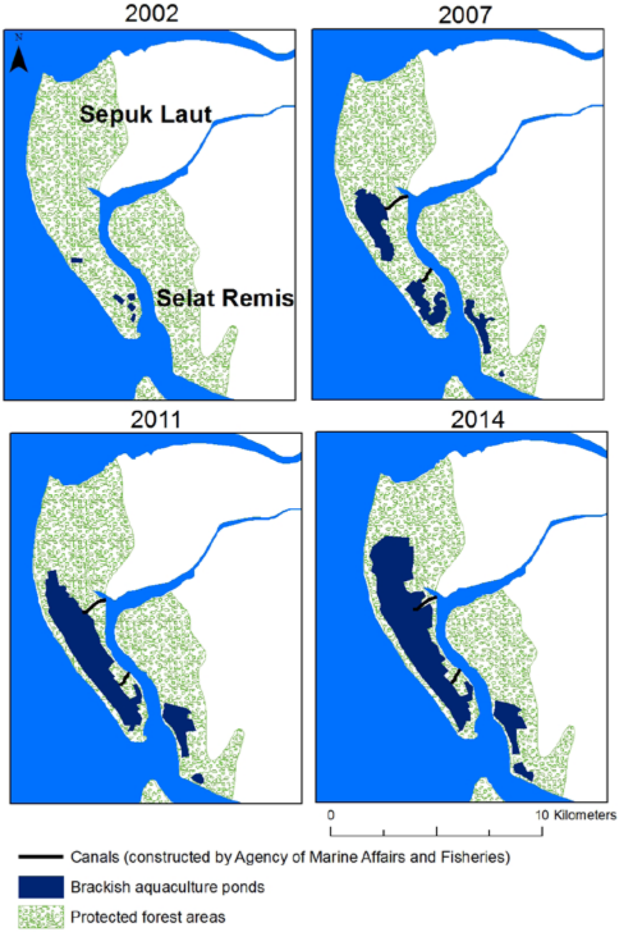

Fig.2: *Aquaculture development on Sepuk Laut Island and in Selat Remis in the Kapuas estuary between 2002 and 2014 (based on an analysis of Landsat images, provided by the U.S. Geological Survey)*

of the Kapuas estuary in Kuala Karang (Figure 3), causing social conflicts. Since the time of our field research, the brackish aquaculture area on Sepuk Laut Island has further expanded. It now covers an area of 1,445 ha (see Figure 2).

Data of the aquaculture areas received from the provincial Authority of Marine Affairs and Fisheries from 2011 (Table 3) roughly corresponds to the size of the aquaculture areas detected in the satellite images in Sepuk Laut, but clearly underestimates the area converted into aquaculture ponds in Selat Remis and Kuala Karang (cf. Tables 2 and 3). However, the data complements the results of our satellite image analysis by providing a picture of the approximate number of ponds and pond operators. Accordingly, in 2011 a total of 116 aquaculture farmers owned 172 ponds, covering a total area of 1,098 ha on Sepuk Laut Island, in Selat Remis and Kuala Karang (Table 3).

Indonesian forest areas, including mangrove forests, are legally classified into protected, production and conversion forests. These forest classes are incorporated in spatial planning documents. In protected forests, logging is illegal. An overlay of the aquaculture areas detected in the satellite images with the protected forest areas reveals that all aquaculture ponds established in the Kapuas estuary region between the end of 2000 and 2014 replaced <u>protected</u> mangrove forests (see Figures 2 & 3).

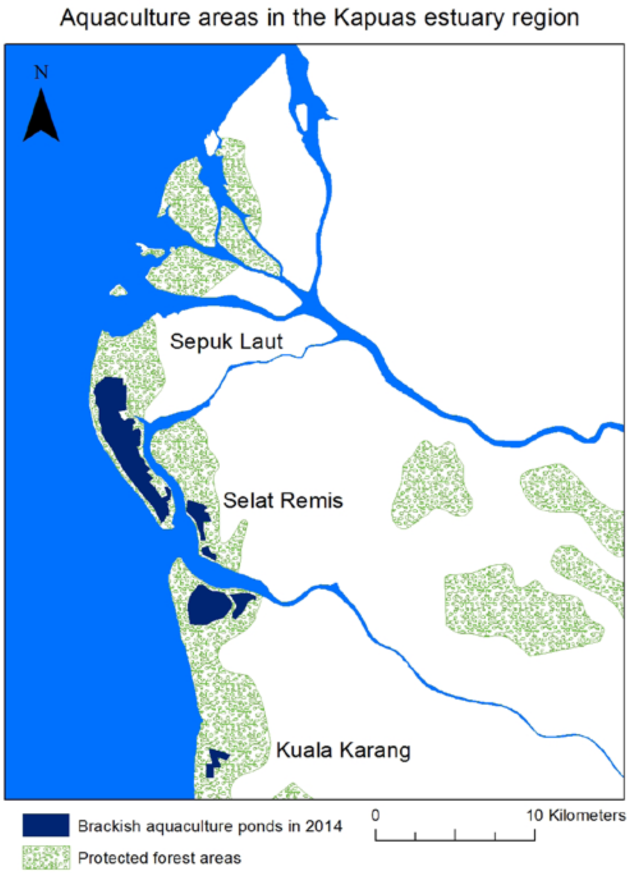

Fig.3: *Total area of brackish aquaculture ponds established in the protected mangrove forests of the Kapuas estuary region as of February 2014 (based on an analysis of Landsat images, provided by the U.S. Geological Survey)*

Tab.3: *Status of aquaculture development in the Kapuas estuary region, based on data from the provincial Authority of Marine Affairs and Fisheries (Dinas Kelautan dan Perikanan Kalimantan Barat 2011)*

Location	Total area (ha)	Number of ponds	Number of farmers	Main species	Other species
Sepuk Laut	976	136	107	Milkfish	Giant tiger shrimp
Selat Remis	62	24	6	Giant tiger shrimp	Milkfish
Kuala Karang	60	12	3	Giant tiger shrimp	Milkfish
Total	1,098	172	116		

The establishment of many of the aquaculture ponds also violates regulations regarding coastal green belts. To protect coastlines from erosion and preserve the function of mangroves as nursery grounds, greenbelt policies started to be formulated in Indonesia in 1975 with a decree by the Director General for Fisheries (Instruction No. Hl/4/2/18/1975), designating coastal green belts of 400 m width (Burbridge & Koesoebiono 1982; Choong et al. 1990; Wibisono & Suryadiputra 2006). Subsequent Joint Ministerial Decrees from 1984 (No. KB 550/246/KPTS/4/1984 and No. 082/KPTSII/1984) which designated protected green belts of 200 m width were superseded in 1990 by Presidential Decree No. 32/1990 which stipulates a mangrove green belt with a width measuring at least 130 times the average tidal range. However, since the decentralisation of political power in 2004, greenbelt regulations have become "a matter of interpretation" and are partly not enforced at the provincial and district level (BAPPENAS & Partners for Water Programme 2013: 3). Based on the assumption of an obligatory mangrove and peat swamp forest green belt of 400 m, Figure 4 depicts the aquaculture pond areas that not only illegally replaced protected mangrove forest, but also violate green belt regulations. In fact, the regional Authority for Marine Affairs and Fisheries, as indicated in interviews and in written correspondence with other authorities (Letter 523.1/229/DKP-E, Dinas Perikanan dan Kelautan Kubu Raya, 2010), assumes an obligatory green belt of no less than 500 m width along the coast.

4 THE 'AQUACULTURE ALLIANCE' AND ITS STRUGGLES FOR EX-POST LEGALISATION

In trying to understand the political processes related to the conversion of legally protected mangrove forests into aquaculture ponds, our research approach combining remote sensing with social-scientific political ecology inspired inquiry proved particularly fruitful. The results not only reveal insights into the actor coalitions causing, promoting and justifying the rapid development of aquaculture development, but also contrast some actors' political framings of the dynamics of aquaculture development with the actual transformations detected in satellite images. The findings not only document but have the potential to influence the course of the on-going political struggle.

The rapid conversion of vast mangrove forest areas into aquaculture ponds has not only led to conflicts with and between local residents (as will be shown below), but involves controversial political struggles that have reached the national level, with the Ministry of Forestry and the Ministry of Marine Affairs and Fisheries in disagreement over the legal and political handling of the land conversions.

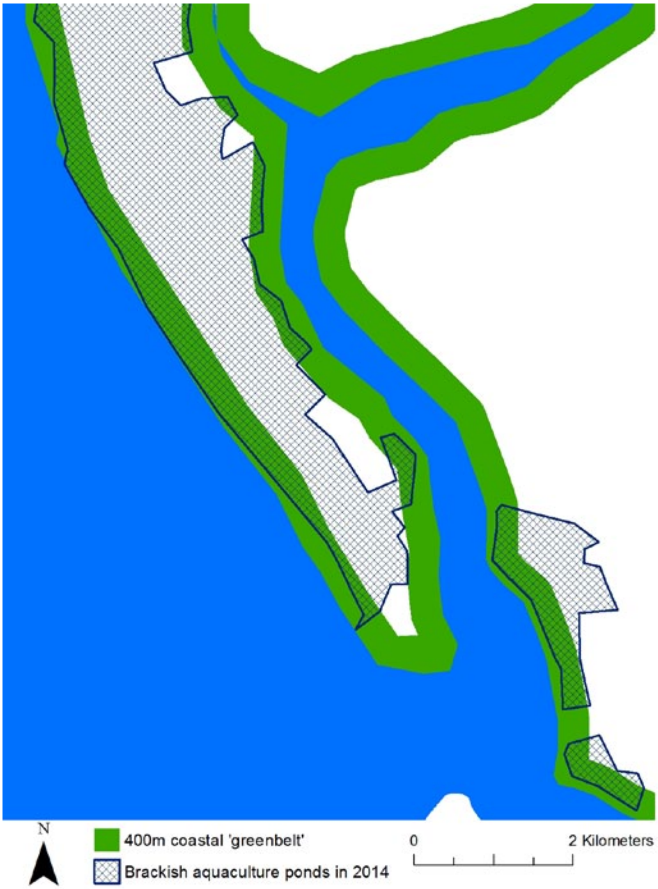

Fig.4: *Violations of the coastal buffer zone in Sepuk Laut and Selat Remis, based on the analysis of Landsat images and the assumption of an obligatory mangrove and peat swamp forest green belt of 400 m.*

Disagreements between fisheries and forestry authorities are not uncommon in Indonesia and date back to the 1970s, when both departments were still under the Ministry of Agriculture. The Department of Forestry sought to re-establish former mangrove areas used for brackish water fishponds, while the Department of Fishery viewed only the mangroves directly along the shoreline as necessary (Burbridge & Koesoebiono 1982). Accordingly, the greenbelt regulation was introduced by the Directorate General of Fisheries in 1975. Until today, the division of responsibilities and modes of collaboration between fisheries and forestry authorities are not clearly defined, so that confusion and conflicts continue to emerge.

Most of the aquaculture ponds on Sepuk Laut Island are based on new land that has been created through sedimentation over the course of the 20th century (see Figure 5). Newly formed land is usually classified as state land in Indonesia, though political struggles over new land in other areas, including the Segara Anakan lagoon on Java's south coast, show that regulations are partly unclear and contradictory (J. Heyde, personal communication). Regarding Sepuk Laut Island, a representative of the Regional Planning and Development Board at district level explained that new land that is situated within a distance of 4 km from a village becomes the property of the local community. If the new land is located more than 4 km away from a village, it is under the authority of the state. If the surrounding area is protected forest, the new land also has the status of protected forest.

In August 2000, the Ministry of Forestry declared large mangrove areas on Sepuk Laut Island and in Selat Remis as protected forest (see Figures 2 & 3, Ministerial Decree No. 259/KPTS-II). The aquaculture farmers whom we interviewed were aware of the fact that they had established their ponds in protected mangrove forests. But they also knew that they had a strong ally with the Agency of Marine Affairs and Fisheries, which supports aquaculture development in the area. The provincial and district-level authorities provided the aquaculture farmers with contacts to hatcheries and labour agencies, and in 2007 they even established new navigation channels in the protected mangrove forest of Sepuk Laut Island to improve access to and support the further development of aquaculture ponds. In 2000, when the first ponds were constructed at the southern end of Sepuk Laut Island, no channels were visible yet in the satellite images. The Landsat image from 2007 shows two channels leading directly to the hotspots of aquaculture development, where several ponds were established close to each other (see Figures 2 & 3). These drivers and patterns of mangrove conversion in Sepuk Laut Island are comparable to the drivers and patterns of peat swamp forest clearance in Kubu Raya, which initially advances along the drainage and navigation channels (as was also noted by Nakagami & Chakraborty 2009).

The strong support of the Authorities for Marine Affairs and Fisheries for aquaculture development in legally protected mangrove forests of the Kapuas estuary seems surprising, but broadly conforms to findings from other parts of Indonesia. In his case study in Sulawesi, Armitage (2002) noted that the provincial Fishery Department pushed coastal aquaculture development and recommended additional infrastructure construction without taking into consideration biophysical conditions including soil suitability, longer-term impacts on coastal fisheries, and increasing regional concerns about mangrove forest decline.

However, the large-scale conversion of protected mangrove forests in the Kapuas estuary has met opposition and led to political and legal struggles. Revealing some of the dynamics of these struggles not only helps to better understand the environmental transformations in the estuary but provides some insight into related social conflicts and the arena of regional political actors.

Confronted with the forest authorities' opposition to the conversion of protected mangrove forests (Department of Forestry 2008), the Authorities of Marine Affairs and Fisheries defended the aquaculture operators by strategically narrating historical events in a particular sequence and by claiming that mainly the 'local communities' would benefit from the development. According to the narrative of representatives of the provincial Authority of Marine Affairs and Fisheries, the forestry authorities assigned the coastal areas as protected forest in 2000, although local community members had practiced aquaculture farming in these areas long before. They stated that aquaculture ponds had already been established more than 30 years ago when fish stocks started to be depleted in the 1970s. They explained that transmigrants who were moved into the Kapuas estuary from Java, introduced the aquaculture techniques. "Together with community members we started further aquaculture projects in recent years to create new opportunities and jobs for the fishermen." (Interview with a representative of the provincial Authority of Marine Affairs and Fisheries, 2012-03-02).

A similar story was narrated by a representative of the Sub-District Authority of Marine Affairs and Fisheries in Sungai Kakap, but with differing dates. According to him, aquaculture development in the Kapuas estuary started in 1998, two years before the Ministry of Forestry decided to declare most of the affected area as protected forest. He pointed out that "it will be difficult to change what the community has long been doing. Because the gasoline prices went up, many fishermen sold their boats and work in the aquaculture business now. They made many efforts to construct the ponds before the regulation about the land status changed." (Interview with representative of Sub-District Authority of Marine Affairs and Fisheries in Sungai Kakap, 2012-04-17). Narrating the same version of historical events, a representative of the District Authority of Marine Affairs and Fisheries of Kubu Raya explained that if the aquaculture farmers have clear proof that their ponds existed before 2000, when the areas were designated protected forest, their land will immediately be excluded from the protected forest area.

Contrary to the narratives told by the Authorities of Marine Affairs and Fisheries at the province, district and sub-district levels, our analysis of satellite images shows that the first brackish aquaculture ponds on Sepuk Laut Island were established at the end of 2000. In line with the results of the satellite image analysis, our interviews with aquaculture farmers revealed that the first brackish aquaculture pond on Sepuk Laut Island was established by a migrant from Makassar, South Sulawesi, in September 2000 and hence after the areas had been declared protected forest. Our series of satellite images impressively documents the rapid development of aquaculture thereafter (Figure 2). Our interviews with aquaculture farmers and local residents in Sepuk Laut and Kuala Karang also contradict the claim of the Authorities of Marine Affairs and Fisheries that the aquaculture development is mainly driven by, implemented in collaboration with and for the benefit of local residents. Instead, by far most of the aquaculture ponds are owned and operated by migrants who moved into the area from South Sulawesi or outsiders who live around Pontianak, while only a few ponds are owned by people from the local communities.

Additional insight into the emergence of the coalition of actors pushing and benefitting from aquaculture development in the Kapuas estuary was provided during an interview with a representative of the local police: "A local NGO reported some cases of illegal aquaculture ponds on Sepuk Laut Island to the Forestry Department in 2002. The forestry authorities forwarded the news to the governor of West Kalimantan, who was planning to visit the area at that time. The governor saw that Sepuk Laut was suitable for aquaculture business and invested himself. Then the development just really started and new canals were built. Again, the local NGO reported the cases – now covering more than 50 illegal ponds. The Ministry of Forestry had to react and went to court." (Interview, 2012-04-17). In 2003, the former Governor joined the harvest with aquaculture farmers at Dabong in order to show them his support (Masyarakat Nelayan Dabong 2010).

To sum up, combining information provided by different respondents and findings from our analysis of satellite images, the following sequence of events provides a plausible, though certainly by far not complete, summary of the course of events driving aquaculture development in the Kapuas estuary: (1) The coastal areas were designated protected forest by the Ministry of Forestry in 2000. (2) Subsequently, migrants from South Sulawesi set up the first aquaculture ponds on Sepuk Laut Island. (3) An NGO reported the cases of illegal aquaculture development to the forest authorities. (4) One or several representatives of the province of West Kalimantan thereupon became aware of the economic potential of aquaculture in the area and themselves invested in aquaculture ponds. (5) The province, district and sub-district authorities of Marine Affairs and Fisheries intensified material and provided political support for aquaculture development. (6) Massive aquaculture development has since then led to the rapid clearance of large areas of protected mangrove forest in the Kapuas estuary, triggering social conflicts and posing environmental challenges, which will be discussed below.

While the 'aquaculture alliance', comprising the aquaculture operators, the Fisheries Authorities on different levels, and representatives of the state, had already irreversibly transformed the social-ecological landscape of the Kapuas estuary, i.e. had created a fait accompli, political and legal struggles over these transformations reached national level authorities and were still ongoing at the time of our research in 2012.

The case of the aquaculture ponds in the Kapuas estuary and the power struggle between the forestry and fisheries authorities went to the Indonesian Constitutional Court in 2009. According to information from the Authorities of Marine Affairs and Fisheries, 58 people were summoned to court in order to be questioned about the illegal conversions of protected mangrove forest. Half of the aquaculture farmers were allegedly not able to attend because of the high travel costs, and the other half reportedly could not afford a lawyer. At the time of our field research in 2012, the court case was still under investigation. For the time being, the aquaculture farmers were allowed to continue their practices (Masyarakat Nelayan Dabong 2010), and as recent satellite images show, the aquaculture pond area has been further increased on the cost of protected mangrove forests between 2011 and 2014 (see Figure 2).

Independent of the court case, the province and district Authorities of Marine Affairs and Fisheries continued their effort towards an ex-post legalisation of the already existing aquaculture ponds and for further aquaculture development. In 2010, they sent a proposal to revise the spatial plans of Kubu Raya to the Regional Planning and Development Board. The proposal aims at excluding the current as well as potential future aquaculture areas in Sepuk Laut, Selat Remis and Kuala Karang from the protected forest area. In their letter the fisheries authorities argue that "it is an urgent matter to fight for, because it concerns the livelihoods of many people" (Letter 523.1/229/DKP-E, District Authority of Marine Affairs and Fisheries Kubu Raya 2010). The authors of the letter also acknowledge that "for environmental conservation, prevention and anticipation of natural disasters, the forest area along the coast has to be at least 500 m wide. For areas vulnerable to erosion, even a minimum of 1000 m of forest should be maintained" (ibid.). Interestingly, this statement contradicts with the proposal to exclude the aquaculture areas from the protected forest, because with the southern part of Sepuk Laut Island being only 1-3 km wide, barely any aquaculture would be possible with a 500-1,000 m wide greenbelt. On the contrary, the proposal shows that the Authorities of Marine Affairs and Fisheries anticipate and are planning to push additional aquaculture development on a large scale. The proposal suggests excluding an area of 1,600 ha from the protected forest area on Sepuk Laut Island alone, and an additional 1,500 ha in Selat Remis and 500 ha in Kuala Karang. This would open the possibility for a doubling of the current aquaculture area to a total of 3,600 ha (see Table 2).

The provincial forest authorities seem to have started backing down, but it remains open whether the entire proposal by the fisheries authorities will be approved. A representative of the forest authority stated that 400 ha of protected forests might shift into another land use category in the upcoming spatial plan. But final decisions will be made by the national Ministry of Forestry in Jakarta. Kubu Raya's Regional Planning and Development Board was at the time of research still waiting for a decision at the national level to be incorporated into the upcoming spatial plan for the period 2012-2032.

While the 'aquaculture alliance' and the forest authorities struggle with opposing interests over the legal status of the land, local residents are often not sure 'which side' they should take. In case the legal status of the land surrounding their villages is changed from protected forest to conversion forest, more investors from outside might rush into their territory, aiming to convert more land into aquaculture ponds or plantation estates. If the legal status of the land surrounding their villages remains protected forest, local residents run the risk that their own resource uses might be considered illegal. "How can we make our daily living if we are not allowed to touch our resources?" (Interview with a resident of Sepuk Laut, 2012-04-17).

Conflicts between the forest authorities' mangrove protection policies and local residents, who claimed rights over the areas, some of which had already been converted from mangroves into fish ponds or agricultural uses, are nothing new in Indonesia (see, for example, Burbridge & Koesoebiono 1982). However, the conflict over the brackish aquaculture ponds in the Kapuas estuary is of a different nature, with recent large-scale conversions of mangrove areas, taking place after the areas had been declared protected forest and mainly driven by migrants who moved into the area from South Sulawesi and outsiders who live around Pontianak rather than by local residents. The case of aquaculture development in Sepuk Laut Island, where investors backed by the Authorities of Marine Affairs and Fisheries have converted large areas of protected mangrove forest over a period of 14 years, drastically exposes the weakness of law enforcement, the large room to manoeuvre that some actors enjoy, and the importance of the right political connections.

5 FORMATION AND EROSION OF NEW LAND

The conversion of mangrove forests to aquaculture pond areas might alter coastal erosion and sedimentation processes on the island of Sepuk Laut. Since the 1920s, coastal sedimentation has substantially enlarged the island and created the land that is presently the basis for the aquaculture ponds. Our reconstruction of historical shorelines, based on a historical topographical map and a series of satellite images, documents the sedimentation process since 1925 (Figure 5, Table 4). Mangroves have undoubtedly played an important role in the formation of the new land areas. Though mangroves are not capable of 'building up land', they colonize newly deposited and unstable sediments, thereby consolidating them and promoting further sedimentation. Mangrove roots break the wave and wind energy and slow down abrasion processes (Blasco et al. 1996; Northcote & Hartman 2004). The logging of mangroves for aquaculture development likely contributes to reduced coastal sedimentation and increased abrasion in parts of the island. Residents of the village of Sepuk Laut described recently increased coastal abrasion along the west coast as a major issue. The village is situated at the island's west coast, north of the aquaculture ponds. Many residents, most of whom do not benefit from the aquaculture development, collect crabs and mussels in the mangrove forests throughout the island and catch fish along the entire coast. They are thus aware of recently increased abrasion. A village representative of Sepuk Laut pointed out:

"Abrasion is a real problem for our island. We have to face two seasons with strong winds: southern sea winds from July to September and northern sea winds from February until April. For coastal protection we tried to plant mangrove trees, but the wind and the tides were too strong. Now we try to make a net out of coconut fibre, which can be fixed underwater with stones. Then we can plant mangroves successfully behind the net, because they

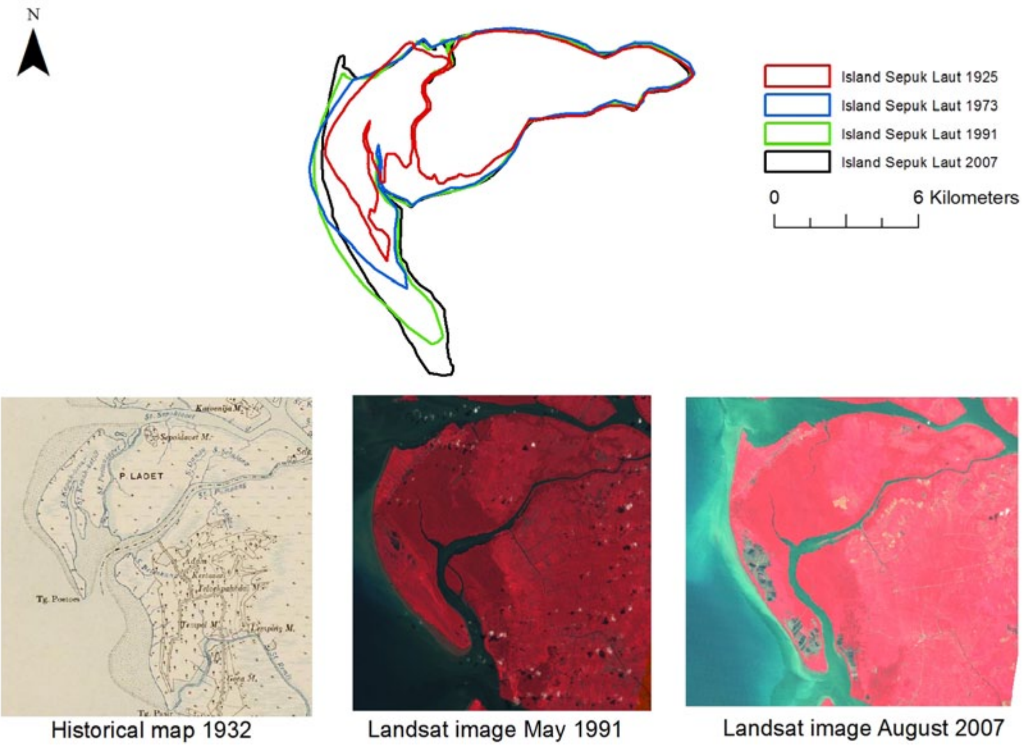

Fig.5: *Coastline changes on Sepuk Laut Island between 1925 and 2011, based on (1) a historical topographical map, scale 1:50,000, prepared under the direction of the U.S. Army in 1942, photolithographed and reprinted from a Dutch map dated 1925; and (2) Landsat images from 1973, 1991 and 2007, provided by the U.S. Geological Survey*

are protected. The net will be around 4 km long and costs us about Rp. 200-300 millions [ca. € 16,000- 24,000].” (Interview, 2012-04-17).

Our analysis of shoreline changes confirms the residents’ observations. During the period 1991-2007, abrasion has, in contrast to the previous periods analysed, for the first time exceeded sedimentation along large parts of the island’s west coast (see Figure 5).

While some aquaculture ponds at the west coast have already begun to be affected by abrasion, the operators of many ponds in the southern part of the island still observed sedimentation. Although sedimentation blocks the navigation channels, the aquaculture farmers in the south described mainly positive aspects of sedimentation, pointing out that the deposition of sediments protects the fish and shrimp ponds from offshore-hazards such as oil spills. As one aquaculture farmer stated “bad things cannot reach my pond.” (Aquaculture farmer, 2012-04-05).

Tab.4: *Area of Sepuk Laut island (calculations based on historical map and Landsat images, see Figure 5)*

	1925	1973	1991	2007
Area in ha	5555	7164	7786	7936

Before final conclusions can be drawn, further research should elaborate the linkages between mangrove deforestation, aquaculture development and coastal abrasion and sedimentation processes in the Kapuas estuary region. If it is true that the mangrove conversions lead to accelerated coastal abrasion, then the ‘aquaculture alliance’ has not only deprived many local residents of the mangrove forests that they had previously used for collecting crabs and mussels, but has even started to undermine the very basis of parts of the island.

The following sections will shed light on the aquaculture production techniques and related environmental and economic challenges and social conflicts linked to the brackish aquaculture developments.

6 PRODUCTION TECHNIQUES AND THEIR SUSTAINABILITY

Plans for aquaculture development in the Kapuas estuary had already been proposed before the first Bugis from South Sulawesi initiated brackish aquaculture on a larger scale. The Integrated Swamp Development Project (ISDP), which aimed at upgrading the infrastructure of transmigration and swamp development schemes in the provinces of Riau, Jambi and West Kalimantan and which was implemented in the 1990s by the Directorate of Swamps under the Ministry of Public Works and funded by the World Bank, included an aquaculture component. According to a related project document "[a]quaculture is not widely practiced in any of the ISDP schemes. Poor soil and water quality, the farmers' insufficient knowledge, experience and skill, inadequate capital and management, and shortage of labour and fish fry are the causes" (Directorate of Swamps 1992: 19). The aquaculture component of the project was planned to comprise technical support, extension and training programmes, and the strengthening of the aquaculture support system. It was planned to establish demonstration ponds and offer training in pond construction in order to avoid the formation of acid sulfate soils (ibid.). These goals were never achieved in the Kapuas estuary.

The aquaculture farmers interviewed in Sepuk Laut Island established their ponds on their own and did not receive any training, neither from a project initiative such as the ISDP, nor from the Department of Marine Affairs and Fisheries. The migrant from Sulawesi who opened the first pond on Sepuk Laut Island in 2000 had learned his aquafarming skills from friends in his hometown Makassar. Other aquaculture farmers subsequently learned most of their skills from people who had already established ponds on Sepuk Laut Island. Some pond owners hired experienced but 'cheap' aquaculture workers from Java.

Most aquaculture farmers cultivate milkfish (Ikan Bandeng, *Chanos chanos*) and giant tiger shrimp (Udang Windu, *Penaeus monodon*). These species also occur naturally in the coastal waters close to the mangrove forests. Milkfish is produced for local consumption, while shrimps are destined for export markets and, according to the aquaculture operators interviewed, sold via traders to Singapore. In the 1970s, milkfish was still the main species in Indonesian aquaculture, and shrimps only a by-product (Djajadiredja & Purnomo 1972). But due to high market prices for shrimp, aquaculture farmers in many parts of Indonesia have shifted from milkfish to shrimp production. Hence, the goal of generating cash incomes and foreign exchange has replaced the previous aim to produce domestic protein as the main driver of aquaculture development (Choong et al. 1990; Yusuf 1995). During the Asian economic crisis in the late 1990s, shrimp prices remained relatively high, which pushed further expansion of aquaculture farms (Bosma et al. 2012). The shrimp farmers interviewed in Sepuk Laut Island received Rp. 62,000-122,000 (ca. € 5-10) per kg, depending on the size of the shrimps.

Establishing an aquaculture pond requires substantial investment. An aquaculture farmer on Sepuk Laut Island summed up costs of Rp. 70 million (ca. € 5,600) for a pond of 5-6 ha, including costs for land clearing. Additional costs incurred for receiving the permits and related bribes, for infrastructure (e.g. transportation, office, feed warehouse), raw material (e.g. fish and shrimp fry, feed, pesticides), and labour. Total expenditure can amount up to Rp. 300 million (ca. € 24,000).

Aquaculture systems can be differentiated into extensive, semi-intensive, and intensive farming. In extensive systems, fish and shrimp seed are collected in mangroves or trapped in the ponds through open sluice gates during high tide (Armitage 2002; Froese & Pauly 2012). Additional feed is applied to supplement natural nutrients. Water renewal in the ponds depends mainly on tidal fluctuations; in some cases small pumps may be installed. Maximum yields range between 400 and 800 kg per ha per year (Yusuf 1995). In semi-intensive systems productivity is raised with fertilizers, pesticides and special feed. Two harvests per year are possible and total yields range between 1 and 2 tons per ha per year (Yusuf 1995). Aeration is needed to assure sufficient oxygen content (Choong et al. 1990). Oxygen is consumed during decomposition, and toxic amounts of ammonia and nitrite can be released. To avoid oxygen depletion and massive fish kill, production can be limited to a certain amount of fish, the water can be exchanged regularly or the pond can be aerated artificially (Bosma & Verdegem 2011). Intensive aquaculture farming systems are 'technologized', often with concrete pond bottoms to ease harvest and a number of aerators providing for sufficient oxygen levels. With high quality feed, pesticides and antibiotics, production can reach 5-10 tons of shrimp per ha (Yusuf 1995). The aquaculture ponds in the Kapuas estuary combine

Fig.6: *Newly constructed aquaculture ponds in Kuala Karang (S. Karstens, 2012)*

characteristics of extensive and semi-intensive systems (Figure 6). Fish eggs and shrimp larvae are bought from Java. Usually the farmers apply pesticides and fertilizers. But for water renewal, most farmers in the Kapuas estuary depend on tidal fluctuations – a characteristic of extensive systems.

Fig.7: *Sluice gate of an aquaculture pond on Sepuk Laut Island (S. Karstens, 2012)*

Fish and shrimp are harvested 2-3 times per year, at night when the animals are active. Sluice gates are opened, so the water flows out, and fish and shrimp can be caught with simple nets hung over the gates (Figure 7). About ten workers are needed to hold the nets and collect the remaining fish on the dry pond ground. The workers either receive a share of the revenue or fixed wages of Rp. 100,000 (ca € 8) per person per night, which is above standard wages in the fishery sector in West Kalimantan (BKPM & JICA 2005) and above the wages for workers paid by oil palm and logging companies.

Aquaculture production in the Kapuas estuary is affected by seasonality. During the rainy season, the amount of freshwater in the ponds becomes so high that milkfish and shrimp would not survive. Consequently, the ponds are drained (Figure 8). Only aquaculture farmers who have installed pumps are not affected by seasonality because they simply pump out the surplus of freshwater during the rainy season (Interviews with aquaculture farmers, March-April 2012).

Seasonality not only limits productivity, but "[e]xcessive fluctuations in abiotic factors like oxygen, salinity, and temperature may […] increase stress and susceptibility to disease" (Kautsky et al. 2000: 145). When first signs of diseases appear, shrimp and fish are harvested immediately. They will be relatively small and hence less valuable, but early harvest can prevent a complete harvest failure.

After each harvest, the grounds of the ponds are treated with pesticides. Thiodan, better known as Endosulfan, an organochlorine insecticide and acaricide, is used to eliminate predators before new fish and shrimp fry are stocked. Due to its toxicity and bioaccumulation potential, Endosulfan has been banned in over 80 countries (Umweltbundesamt 2011). In April 2011, a global prohibition for the production and use of Endosulfan was agreed upon in the frame of the Stockholm Convention (Baier 2012). Previously, the fish and shrimp farmers on Sepuk Laut had used Akodan, which contains 35% of Endosulfan, but regarded its effects as too weak.

Fig.8: *Drained aquaculture pond on Sepuk Laut Island (March 2012). During the rainy season the amount of freshwater becomes too high. Therefore many ponds are drained (M.C. Lukas, 2012).*

One of the biggest problems regarding the conversion of mangroves into agricultural land or aquaculture ponds is the development of acid sulfate soils. Mangrove soils are composed of marine alluvial sediments which have been transported and deposited by rivers or the sea. The substrate in mangrove areas is a combination of sand, silt and clay, rich in organic detrital matter. Dissolved calcium originating from shells or, if present, from coral reefs, make the brackish water around mangroves slightly alkaline, but mangrove soils are nevertheless acidic. The acidity results from sulfur-reducing bacteria (Northcote & Hartman 2004). Mangrove soils usually contain large amounts of iron sulfur present as pyrite. The formation of pyrite requires a source of sulfur (usually present in seawater), anaerobic conditions, energy supply for bacteria (organic matter from mangroves), a supply of iron (terrestrial sediments), tidal flushing to wash out reaction products, and temperatures above 10°C (Queensland Department of Environment and Resource Management 2012). When potential acid sulfate soils are drained and exposed to air, the oxidation process releases sulfuric acid. The problem is exacerbated when the produced acid attacks fine clay particles and leads to a release of soluble forms of aluminium, sometimes manganese and other heavy metals. The high concentration of soluble salts lowers the nutrient availability and the uptake of fertilizers. Phosphate sticks to ferric and aluminium ions and is no longer available to the nutrient cycle. Coconut trees can be cultivated on acid sulfate soils, but for other utilisations of mangrove soils to succeed, liming is necessary to reduce acidity (Choong et al. 1990; MacKinnon 1996). To reverse the formation of acid sulfate soils only in the top soil would require application of 100-150 million tons of lime per ha in the first year and 20-30 million tons per ha in the following four years (Directorate of Swamps 1992). Even transporting soil from another location would be more cost effective. Without ploughing and liming, also shrimp and fish production in ponds constructed in acid sulfate soils will rapidly decline after three to five years (Bosma et al. 2012).

To prevent the development of acid sulfate soils, the aquaculture farmers in the Kapuas estuary apply Trisodium Phosphate (TSP) to the pond ground after every harvest. If too much TSP is applied, a “green fungus” will develop once the pond is refilled with water (Interviews with aquaculture farmers, April 2012). Phosphate promotes algae growth and can lead to eutrophication (see Figure 9).

In addition, approximately 50kg of Lodan, a fertilizer containing calcium, magnesium, nitrogen, potassium, and aluminum sulfate, is applied per hectare per year. Aluminum sulfate is used to reduce sediment-turbidity, so that light can penetrate deep into the ponds. It is a flocculating agent, which causes particles in suspension to coagulate into larger particles and precipitate (Wilkinson 1998). Aluminum sulfate is acid forming and may substantially lower total alkalinity and pH to levels that are toxic for fish and shrimps (Wilkinson 1998). As aquaculture farmers in the Kapuas estuary already have to deal with problems of acid sulfate development, the choice of a fertilizer containing aluminum sulfate seems inappropriate.

Fig.9: *Application of Trisodium Phosphate* ***to prevent the formation of acid sulfate soils can lead to eutrophication of aquaculture ponds. Pond in the southern part of Sepuk Laut Island (S. Karstens, 2012)***

According to the provincial Authority of Marine Affairs and Fisheries, aquaculture ponds in the Kapuas estuary are threatened by mercury and zinc. While mercury obviously originates from gold mining upstream (see Adijaya & Takao 2004; Subanri 2008), the increasing amounts of zinc could not be explained yet. Although evidence is missing, the increasing zinc levels in the water of the Kapuas estuary might be linked to fertiliser application in palm oil plantations on peat soils. The main fertilizer ('Peat-Kay'), of which 8kg are applied per tree per year (Interview with representative of palm oil company, 2012-04-25), contains zinc (Agrifert Malaysia 2007). Part of the zinc content might be washed out and via the river network eventually reach the aquaculture ponds in the estuary. However, final conclusions can only be drawn based on additional research.

Under the potential threat of law enforcement and after a number of newspapers and internet sources published critical reports about aquaculture development in the Kapuas estuary (see e.g. Department of Forestry 2008), linking it to illegal land grabbing in the protected mangrove forest, the aquaculture farmers' union encouraged the planting of mangrove trees around the ponds. An aquaculture farmer noted that "the head of our aquaculture union

Fig.10: *Under the potential threat of law enforcement and following critical reports in pubic media, the aquaculture farmers' union encouraged mangrove reforestation around the ponds, resulting in the planting of a few Rhizophora trees around ponds and along the navigation channel (S. Karstens / M.C. Lukas, 2012).*

told us that it looked too naked around our ponds" (Interview, 2012-04-05). Some of the farmers hence planted a few *Rhizophora* trees around their ponds (Figure 10). Two farmers stated that they were also willing to try mixed aquaculture-mangrove systems, though they were aware that the system would not be suitable for milkfish.

7 AQUACULTURE DEVELOPMENT ON THE COST OF CAPTURE FISHERIES?

There is a broad, widely undisputed political consensus among fisheries authorities and beyond that aquaculture development is a good strategy to boost food production, improve livelihoods and promote economic development. Brackish aquaculture development became a political priority in Indonesia already in the 1980s (Yusuf 1995). Armitage (2002: 210), based on his case study in Sulawesi, noted that "aquaculture production systems are considered by regional and district officials to be economically efficient and congruent with broader economic development goals."

A study on investment opportunities in Kalimantan, conducted in collaboration of the Indonesian Investment Coordinating Board and Japan's International Cooperation Agency (BKPM & JICA 2005), identified fisheries in addition to Aloe Vera farming and quartz sand exploitation as most promising in Kubu Raya. According to the report, the brackish water areas along the coast of West Kalimantan, comprising a total of 26,704 ha, have "a great

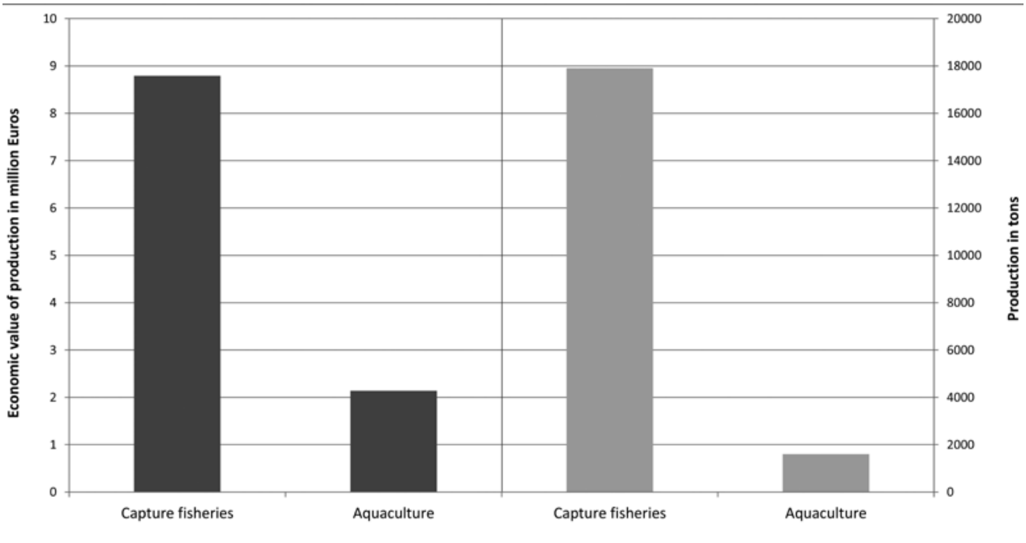

Fig.11: *Fishery production in Kubu Raya in 2011 (Data from BPS Kabupaten Kubu Raya 2012)*

potential in shrimp aquaculture" (BKPM & JICA 2005: 27). For the district of Kubu Raya, the study identified an area of 10,935 ha as suitable for shrimp farming (BKPM & JICA 2005). By 2011, 'only' about one fifth of this area, i.e. between 2,000 and 2,500 ha, including aquaculture ponds outside of our study area in the southern part of the district, had already been utilised. The report also notes that "[b]rackish water aquaculture needs professional staff […]. Investors should hire professional staffs from Java" (BKPM & JICA 2005: 27).

Referring to the Kapuas estuary region, representatives of the fisheries authorities at different administrative levels argued that aquaculture was necessary to promote economic development, to compensate declining coastal fisheries and to provide alternative livelihoods that are less vulnerable to rising fuel prices. However, based on research results from other parts of the world and indications from our preliminary research, the question arises whether the aquaculture development in the Kapuas estuary region undermines the potential of capture fisheries, and hence, whether a minority of aquaculture operators, mainly comprising non-local individuals, undermines the livelihood basis of the majority of the coastal residents, who depend on coastal fisheries and resources from the mangrove forests.

Most residents in the coastal zone of the district Kubu Raya base their livelihoods on fishing. Capture fisheries contributed 92% of the total production and generated 81% of the total revenue from the fishery sector in Kubu Raya in 2011 (Figure 11; BPS Kabupaten Kubu Raya 2012). However, while aquaculture production has increased, production from capture fisheries has declined over time,. The most valuable species are marine shrimp, which accounted for 95% of the fishery export value in West Kalimantan in 2005 (BKPM & JICA 2005). Between 2001 and 2003, over 90% of the shrimps came from capture fisheries, while only a small amount was cultured in brackish aquaculture ponds. But during the same period, cultivated shrimp production increased by 4.4% annually, whereas the amount of captured shrimp decreased by 5.5% annually (BKPM & JICA 2005).

The political narrative of the Authorities of Marine Affairs and Fisheries (2011), who argue that declining capture fisheries catches and high operational costs due to rising fuel costs triggered rapid aquaculture development in Kubu Raya, not only neglects the fact that aquaculture operators and coastal fishers are different social groups, but also disregards the possibility of linkages between capture fisheries, mangrove ecosystems and aquaculture development.

Mangroves provide habitat and serve as breeding and nursery areas for many fish, crustaceans (crabs and shrimps), bivalves (cockles, mussels, and oysters), and gastropods (snails and slugs). Milkfish (Chanos chanos), grouper (Epiniphelus spp), kakap (Latin name unknown) and eels (Anguilliformes) are important fish species and sources of high quality protein in the Kapuas estuary region. Some of these fish depend directly on healthy mangrove ecosystems;

others live in the adjacent coastal waters which receive nutritional input from the mangroves. Mangroves are open ecosystems where organic and inorganic nutrients from terrestrial sources are transformed into dissolved and particulate matter that can be used in the estuary or exported into the open sea to enter the offshore food chain (Dutrieux 1991; Nordhaus et al. 2005). Crustaceans in the Kapuas estuary which depend on healthy mangrove ecosystems during their life cycle are giant tiger shrimps (Penaeus monodon), sand shrimps (Metapenaeus spp.), and mangrove crabs (Scylla serrata).Prawns are trapped in triangle nets all over the Kapuas estuary (Figure 12). A good season for catching prawn is October to December, when strong winds add to the regular tide and push these species into the nets. Combining information from various interviews and statistics, Table 5 lists the major fish and shrimp species that are commonly caught by fishers in the coastal waters of Kubu Raya. During the stormy season it is too dangerous to go out fishing on the open sea with traditional boats; therefore the fishermen depend on catching prawns in the river nets or collecting crabs in the mangrove forests (Interview with head of the fishers' union, 2012-04-20).

Tab.5: *Fish and shrimp species caught by local fishers in the Kapuas estuary (Data based on interviews with members of fishers' unions, village heads and a representative of the Authority of Marine Affairs and Fisheries; BPS Kabupaten Kubu Raya 2012). Habitat: blue = open sea; green = coastal waters; brown = freshwater; * = species associated with mangroves*

Scientific name	English name	Indonesian name	Total production Kubu Raya 2011 (in tons)	Total value 2011		Selling price	
				in million Rp.	in €	in Rp./kg	in €/kg
Scomberomorus	Narrow-barred Spanish mackerel	Ikan Tenggiri	446	14,278	1,145,631	40,000	3,21
		Ikan Titip				10,000	0,80
Ilisha pristigastroides	Javan Ilisha	Ikan Puput				20,000	1,60
Ariidae	Catfish	Ikan Manyung					
Pampus argenteus	Silver pomfret	Ikan Bawal	32	1,113	89,304		
Trichiurus lepturus	Largehead hairtail	Ikan Layur	960	2,688	215,678		
Anguilliformes spp.*	Eel*	Ikan Malong*					
Platophyrs ocellatus	Eyed flunder	Ikan Sebelah	19	66	5,296		
Batoidea spp.	Ray	Ikan Sinar					
Chanos chanos*	Milkfish*	Ikan Bandeng*					
		Ikan Mayong				7,000 – 15,000	0,56 - 1,2
		Ikan Gulama					
		Ikan Kakap*	5	185	14,844		
Epiniphelus spp*	Grouper*	Kerapu*	36	789	63,307		
Macrobrachium rosenbergii	Giant river prawn	Udang Galah	33	835	66,998		
		Udang Wangkang				65,000	5,22
Penaeus monodon*	Giant tiger shrimps*	Udang Windu*					
Metapenaeus spp.*	Sand shrimps*	Udang Dogol*	514	11,843	950,253	35,000	2,81
		Udang The	1,379	3,448	276,659		

In terms of economic value, shrimps are the most valuable fishery resource associated with mangroves and "[p]ositive correlations between offshore yield of shrimps and the amount of mangrove forest in the nursery area have been demonstrated throughout the tropics"

Fig.12: *Giant river prawn, Macrobrachium rosenbergii (12-1) and prawn net in the Kapuas estuary (12-2) (S. Karstens, 2012)*

(Rönnbäck 1999: 245). Shrimp are temporary residents of mangrove areas. Pelagic shrimp larvae drift into estuaries where mangrove forests become their nursery areas and the larvae subsist on detritus. Reaching the sub-adult to adult stages, the shrimp return to the open sea where they start breeding. A cycle offshore-estuary-offshore is formed (Choong et al. 1990).

With the clearance of large mangrove areas for brackish aquaculture development in the Kapuas estuary region, the various ecosystem services associated with mangroves, including their function as breeding and nursery ground, are lost. The negative effects on the diversity and abundance of marine life in coastal waters and related impacts on coastal fisheries can be immense. Whitten et al. (1987, quoted in MacKinnon 1996: 515) estimated the hidden costs behind the conversion of mangroves into aquaculture ponds. He found that "the average coastal fish pond in Sumatra produces 287 kg of fish/ha but that the loss of 1 ha of mangrove to aquaculture leads to a net loss of offshore shrimp and fish of approximately 480 kg/ha/year". While the pond owner might gain (in the beginning), the overall economic win diminishes, and local fishers have to carry the consequences.

But the clear-cutting of the mangrove forests in Sepuk Laut Island may have negative impacts not only on the coastal fisheries, but also on aquaculture production itself. With unsustainable aquaculture practices, the pond operators might undermine their own basis of production. Apart from the problem of acid sulfate soils and negative effects of pesticides, the loss of the mangrove forests and their ecosystem services (Table 6) may undermine the productivity and profitability of aquaculture, and the resulting reliance on more external inputs may have additional environmental impacts.

Tab.6: *Ecosystem services of mangroves for aquaculture and capture fisheries (modified and extended after Rönnbäck 1999: 23)*

for capture fisheries		for aquaculture
Food abundance		Storm and flood protection
Predation refuge		
Lateral trapping		Erosion control
Outwelling	**Ecosystem services of mangroves**	Sediment trapping
Stabilizing salinity		Nutrient input
Lowering turbidity		Naturally occurring shrimp larvae
Filtering pollutants		

Apart from the negative effects of mangrove clearance, research in other areas has shown that the gathering of wild shrimp larva for aquaculture ponds contributed to declining capture fisheries (see Dewalt et al. 1996; Primavera 2006). This is not the case in the Kapuas estuary where aquaculture operators (at least those interviewed) buy their larvae from hatcheries and do not collect them. However, the overall environmental and economic performance of shrimp production in aquaculture as compared to captured shrimp further deteriorates if one takes into account that about 2.8 tons of wild fish processed into fishmeal are used to produce 1 ton of shrimp in aquacultures (Naylor et al. 2000; also see Hannesson 2003; Kautsky et al. 2000; Natale et al. 2012).

Precise data regarding the degradation of mangrove forests and declining capture fisheries does not yet exist for Kubu Raya. A survey which integrates (1) changes in mangrove area, (2) changes in capture fisheries, and (3) fishery effort, including time spend offshore, modifications of fishing gear, changes in territory or shipping distances, and number of fishermen (see Ruitenbeek 1992), would support the identification of linkages between the condition of mangrove forests and coastal fisheries. The head of the fishers' union in Sepuk Laut stated that mangrove degradation would especially affect the naturally occurring giant tiger shrimps, because they use the mangrove forests as nursery areas. A village representative of Sepuk Laut noted that fishers nowadays have to go further out to catch the same amount of fish and shrimp as in previous years, because the flushing of waste water from the aquaculture ponds affects the coastal waters. Fact is that the pond waste water contains pesticides like Thiodan and Akodan, which are highly toxic.

8 DISPARITIES AND CONFLICTS BETWEEN WINNERS AND LOSERS

Both the coastal landscape of the Kapuas estuary region and the revenues of fisheries production in Kubu Raya are increasingly dominated by brackish aquaculture. The benefits and negative impacts of this transformation are unequally distributed within society. Mangrove forests, a common property used by many local residents and an important basis for coastal fisheries, are being converted into aquaculture ponds and privatized. Complex multi-resource ecosystems are being transformed into simplified single-use-systems benefitting only a small number of people (cf. Bailey 1985, quoted in Adger & Luttrell 2000; Armitage 2002).

About four fifths of the male residents of the village of Sepuk Laut are fishermen (Interview with head of the fishers' union, 2012-04-17), depending on coastal fisheries that in turn partly depend on the mangrove forests. In addition, many residents directly use(d) resources of the mangrove forests, such as crabs and mussels, throughout the island. The rapid development of aquaculture undermines their resource base and possibly contributes to the threat of coastal erosion.

Contrasting with the argument of the fisheries authorities that an ex-post legalisation of the aquaculture ponds "is an urgent matter […], because it concerns the livelihoods of many people" (Letter 523.1/229/DKP-E, District Authority of Marine Affairs and Fisheries Kubu Raya 2010), the number of people driving and benefiting from aquaculture development is actually comparatively small. In 2011, the almost 1,000 ha of brackish aquacultures on Sepuk Laut Island were managed by only 107 operators, while about 1,100 local fishers depended on capture fisheries. Consequently, a large number of local fishers might be impaired by the activities of a small number of non-local aquaculture operators. According to interviews with aquaculture operators, around 45% of the investors are non-local Chinese, 40% are migrants mainly from Sulawesi with few from Java, and 15% are Malay. The great majority of the local residents does not benefit from the development, either directly or indirectly via taxes. A village representative of Sepuk Laut stated that "[t]he aquaculture ponds are only beneficial to some people, but the others do not get anything. The Department for Fisheries does not allow us to collect taxes from pond owners." (Interview, 2012-04-17). Taxes are paid directly to the state authorities, who push the development, and not to the local communities. The pond owners are not big companies, but most of them are also not local community members as narrated in interviews with representatives of the fisheries authorities. Discussing the distribution of the benefits and costs of wetland conversions, Adger & Luttrell (2000) argued that former users of coastal wetland resources should be compensated after the land conversion, not only on a short-term basis but over the longer term with new employment options. However, the aquaculture farms in the Kapuas estuary are not labour-intensive and will hardly meet these criteria. Usually, labourers are needed only at the time of harvest.

In Kuala Karang, the conversion of 127 ha of mangrove forest in close proximity to the village into aquaculture ponds by outsiders between 2008 and 2011 provoked protests by local residents and led to a climate of conflict within the village. Local residents desperately complained about the loss and privatisation of mangrove forests, a common property used for collecting crabs, shells, honey and fire wood, with the acknowledgement of and support from the village head.

Most of the residents of Kuala Karang are fishermen. Due to coastal abrasion, in this area obviously mainly a natural process, and salt water intrusion, farming is not possible anymore. Based on memories from their childhood or information from their parents, residents recounted that in the 1950-60s villagers still cultivated coconuts, vegetables and rice around Kuala Karang. Conforming to the information received from the residents, a topographical map from 1973 depicts agricultural land use in the area of Kuala Karang. Due to coastal abrasion and salt water intrusion, rice cultivation had to be gradually abandoned, and hence most residents turned to fishing in the 1970s. In the 1980s, the coconut trees also disappeared, and since then, mangroves, which previously only grew along the water channels,

Fig.13: *Protected mangrove forests that had been used by local residents for collecting crabs, shells, honey and fire wood have been privatised and converted into aquaculture ponds by non-local investors with support from the village head (M.C. Lukas, 2012)*

have colonised the entire area around the village. According to the village head, these mangrove areas were declared protected forest in 2002. However, the villagers could continue using resources from the mangrove forests. Most of them depend on coastal fisheries and the mangrove forests to a great extent. "The water is very rich in nutrients and fishermen do not have to go out far to catch a lot of fish. But the fishermen depend on the monsoon climate and cannot go out during stormy weather. During that time mainly the women are collecting crabs and shells from the mangrove forests." (Member of a students' association, Tanjungpura University, 2012-03-23). Some families are not engaged in fishing and completely depend on mangrove resources.

After the conversion of 127 ha of mangrove forests into brackish aquaculture ponds, a conflict within the village emerged between residents on the one hand and the aquaculture pond owners with their supporters on the other hand. While the sea continuously advances towards the village from the west, eroding about 3-5 m of land every year, establishment of brackish aquaculture has deprived the villagers of some of their mangrove resources north and south of the village (Figure 13). The village head pointed out that the remaining mangrove area was still large enough for gathering crabs and mussels, but a village resident explained that the mangrove areas converted into aquaculture ponds had been the best sites. Furthermore, some residents noted that the establishment of the ponds had accelerated salt water intrusion into an area inland of the ponds, which had been the only area where freshwater had still been available.

With support from the village head, the five aquaculture ponds were set up by four investors who live near Pontianak. Barely any local residents benefit from the development. Once the mangrove forest was cleared and the ponds established, labour requirements for the management of the ponds are minimal. Protesting against the sale of their resources, a large group of residents plundered the aquaculture ponds. Since then the aquaculture pond owners have employed security personal – people from Pontianak and from Java – who are guarding the ponds on a permanent basis (Figure 14). At the time of harvest, state police forces are present. Pointing to power structures, a resident noted that it was difficult to openly speak about the conflict. Residents staged a protest in front of the office of the district head (Bupati) in Kubu Raya. They hoped that no ex-post legalisation would be granted for the ponds.

The village head, who does not depend on coastal resources but who owns a swallow bird house and was said to be involved in gambling and the local lottery, shared a very different perspective regarding the aquaculture ponds. He explained that the investments from outside should serve as an example for the local residents. Realizing the potential of aquaculture, local residents could then follow the example on a smaller scale. The village head also noted that the economic situation of the local residents was not bad, and that incomes from fishing were fairly high with daily net-revenues of Rp. 70,000-80,000 (€ 5.88-6.72) on average days and Rp. 300,000 (€ 25.19) on good days, but that education, the lack of management

Fig.14: *Guard-house: The aquaculture pond operators employ security personal and deploy the police at the time of harvest to prevent local residents from protesting against the disappropriation of their resources by plundering (M.C. Lukas, 2012)*

skills, and ideas what to do with the money were the major constraints. Whether many local residents of Kuala Karang will follow the example and set up their own aquaculture ponds, whether more investors from Pontianak and elsewhere will convert further mangrove areas around Kuala Karang into brackish aquaculture or whether residents of Kuala Karang will, in whatever way, hinder aquaculture production and further investments, remains to be seen.

9 CONCLUSION

Substantial portions of the social-ecological landscape of the Kapuas estuary region have been transformed by rapid aquaculture development during the past 14 years. The conversion of to date about 1,800 ha of legally protected mangrove forest has been driven by less than 200 mainly non-local aquaculture operators and a few village heads and state representatives and has been supported by the fisheries authorities. Bonded by entrepreneurial interests, corruption, power, and political goals for aquaculture development, this influential 'aquaculture alliance' has struggled against the forest authorities' mangrove conservation goals and for an ex-post legalisation of the fait accompli. Related efforts to revise spatial plans and a lawsuit filed by the forest authorities have not come to any conclusion for years, but during this period, the brackish aquaculture area has been further expanded at the cost of mangroves that are legally protected and that had been used by local residents. While non-local investors and a few local elites benefit from the aquaculture development, which barely provides any job opportunities, the majority of the local residents who depend on capture fisheries and resources from the mangroves are deprived of some of their resources.

The results of our combined analysis of the spatial and temporal dynamics of environmental transformations, the roles of different actors, related political struggles, and social conflicts on the ground represent a strong, albeit only case study-based, plea against generalised, misleading notions of population pressure as driver of mangrove conversion. In the Kapuas estuary, and this is certainly not a special case, it is rather the other way around: Mangrove conversion through aquaculture development benefits non-local actors and puts additional pressures on local populations and natural resources. Our findings also expose the fisheries authorities' arguments that *the aquaculture development is allegedly mainly driven by, implemented in collaboration with and for the benefit of local residents and that aquaculture was necessary to promote economic development, to compensate declining coastal fisheries and to provide alternative livelihoods* as strategic political narratives that are in fact completely wrong. If the loss of mangrove forests is justified by the need for economic development, the central question to be asked is: <u>Whose</u> economic development? <u>Whose</u> economic necessities?

The social-political pattern of aquaculture development in the Kapuas estuary region has both created and reflects a sharp disparity and imbalance of power between beneficiaries and those affected by negative impacts, between a minority comprising investors from outside, local leaders and representatives from government and the majority of the local residents. In case of rebellion, as the situation of Kuala Karang demonstrates, networks of power, linking investors, village heads, police and security personal, help to restore or maintain entrenched social order (cf. Lukas 2013). Aquaculture development creates new social constellations and conflicts which are crucial to investigate, but its analysis also provides insight into broader socio-political structures and overall modes of governance. In the context of the analysed actor constellations and conflicts, it does not appear surprising that the fisheries authorities view the following aspects as major constraints for a successful development of Kubu Raya's coastal zone: lack of control (offices, staff and speed boats), lack of knowledge in the communities how to preserve natural resources, and abrasion due to natural disasters or illegal logging by community members (Dinas Kelautan dan Perikanan Kalimantan Barat 2011). One-sided blaming of uneducated local residents' resource uses for environmental issues while supporting the conversion of 1,800 ha of protected mangrove forests by outsiders reflects the social order and the entanglement of political power, economic interests and problematic informal networks with 'environmental governance'.

Knowledge and quantification of the numerous ecosystem services of mangroves, particularly their linkages with coastal fisheries and their influence on sedimentation and abrasion processes, could undoubtedly support better informed decisions. However, more importantly, a knowledge-based consideration and optimisation of the various options of mangrove protection, utilisation and conversion requires a less corrupt political arena with key actors taking into account factors beyond personal and short-term gains, with stronger institutions limiting the pervasive roles of informal networks of power, and a breaking up of entrenched hierarchical patterns of repression and marginalisation.

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