Draft manuscript

Sources of livelihood resilience in post-Tsunami Aceh: property rights, collective action and environmental service provision[1]

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Abstract
The December 2004 Tsunami will stay with at least one generation of people as a symbol of human vulnerability to 'natural' disasters, and of an unheard-of global response to support the recovery of livelihoods of the survivors. As 'resilience' can only be really observed in the face of strong shocks, the ongoing recovery phase offers an opportunity to learn from the various contributing sources of resilience at the scale of individuals, household economies and society, as well as the challenges to balance public goods and private interests that have contributed to the exposure of large numbers of people, over and beyond what was strictly unavoidable. This paper will draw on the iNRM working group for western Aceh that arose in response to the Tsunami and on a specific study of the shrimp ponds along the northern coast of Aceh, where conversion of mangrove had opened up the coast and exposed people.

1. Introduction

The Indian Ocean earthquake of December 25 2004 triggered a series of gigantic waves (tsunami) that killed large numbers of people and devastated coastal communities and their productive resources, including large areas of brackish water aquaculture (*tambak*) in Aceh Province. A few weeks after the Tsunami, the

[1] Data and information regarding brackish-water aquaculture (*tambak*) presented in this paper, based on 21 days field survey (2-21 December 2005) in north-east coast of the Province of Nanggroe Aceh Darussalam, part of The Ford Foundation funded project on ***Integrated Natural Resource Management and Livelihood Paradigms in Recovery from the Tsunami in Aceh*****:** Study on Socio-Economic Aspects of *Tambak* Production in Aceh. The status of the study now is in progress: report writing.

main international agencies involved in relief activities adopted a 'livelihood analysis' framework as a basis for the transition rescue/relief to rehabilitation phase.

The framework has allowed for the emergence of an integrated perspective on how the impacts on lives, security, infrastructure and local institutions interacted with the impacts on 'natural capital', including the coastal vegetation, the marine resources, the soils and livestock. Figure 1 highlights a number of examples in each of the five 'asset' categories.

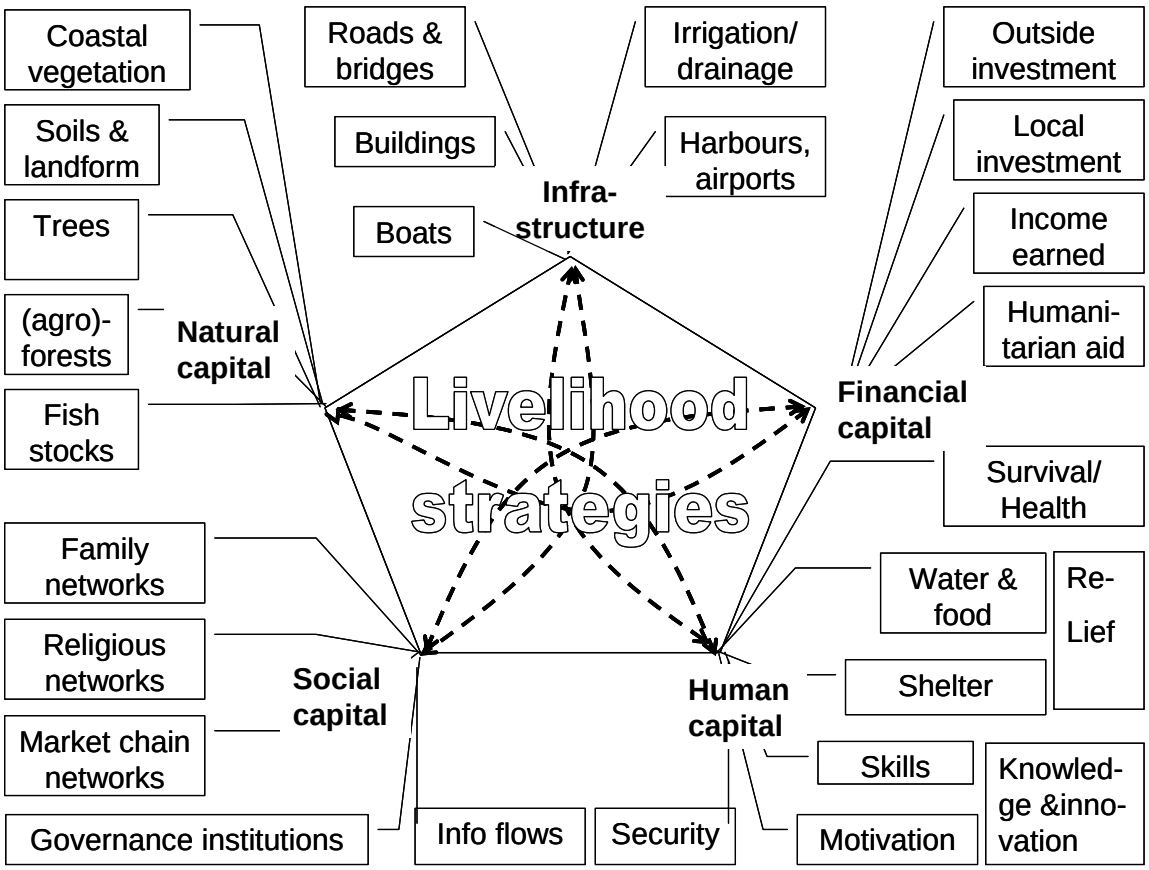


Figure 1. Sources of impact and resilience across the five capital types, adapted from Bebbington (1999) and discussed in the Meulaboh workshop December 20055

In subsequent analysis, it has become clear that the 'resilience' or ability to bounce back of the various components of the overall system is not directly linked to the

severity of the impact, and that some of the initial concerns, luckily, did not materialize (or were in fact avoided by the human response), while other aspects are slower to recover.

Most components of the '***natural capital***' have in fact bounced back faster than envisaged/feared. This may be linked to the fact that on a timescale that is relevant for the formation of the landscape and the evolution of the biota, the 2004 Tsunami was not unique. On most of the flooded soils salt sea water did not penetrate far during the flooding, as the soil was close to saturation when the floods came, and the salt (sodium chloride) that did get into the soil was leached out in a few months, given the high rainfall of the area. In fact, many of the soils increased their fertility with the marine silt deposits, although elsewhere soils were decapitated or submerged due to land subsidence after the earthquake. A number of peat 'lenses' in the coastal plain proved to be tolerant of the flood, and provided shelter to the people using this zone for rubber agroforests. The immediate impacts on the trees in the coastal zone varied with tree type, tree size (exposure of the canopy to the waves determined the force exerted, the strength of the root systems the forces withstood), surrounding vegetation and location. Tree mortality after the flooding did not follow patterns expected on the basis of salinity tolerance; for example, according to existing databases rambutan (*Nephelium lappaceum*) is supposed to be more tolerant than rubber (*Hevea brasiliensis*), but in fact it suffered a high mortality, while the rubber trees that were not knocked over by the waves, lost their leaves, 'wintered' and recovered in a few months time. A number of palm species with economic value proved to be tolerant and resilient. The west coast of Aceh did not have much mangroves before the Tsunami, as the coast is too exposed. Only in the mouth of a number of rivers were mangroves present, and they withstood most of the wave impact. The role of these mangroves for the coastal fish populations is currently under study.

The Tsunami impacts on ***physical infrastructure*** were dramatic, and the greatly reduced accessibility of the area substantially increased the human impact of the Tsunami, while making the rescue & relief phase of the response more difficult.

Sections of coastal roads disappeared, bridges were washed out, airstrips covered by mud and harbours destroyed. Recovery of infrastructure is not based on 'inherent resilience', as is the case for natural capital, but is fully dependent on human effort. Immediate effects of the loss of infrastructure was that prominent activities that were part of local livelihood strategies lost key parts of the chain. While the soil and trees of the rubber agroforests were resilient and many of the tappers/farmers survived, the road access to the processing factories was not, and recovery is a slow process.

The impacts on ***human capital***, for obvious reasons, received the most immediate attention. Beyond rescue and relief, however, the recovery of livelihood options requires a combination of skills, motivation and access to up-to-date information and knowledge. Resilience of livelihoods does not necessarily imply a return to the conditions before the disturbance – shifts to equivalent or better opportunities may well be part of the response. However, the psychological level of stress hampers the ability to envisage plausible futures and innovate accordingly.

Social capital in the coastal zone of Aceh has been an important base of resilience,, especially the family and religious networks that absorbed survivors. The (re)emergence of traditional resource management institutions such as the 'Panglima Laut' ('sea captains') has been relevant especially for channeling the perspectives of the fishermen, the equivalent organizations for land-based activities have been les visible. The recovery of Aceh took a dramatically positive turn with the peace accord that ended decades of conflict. The peace that ensued opens up new economic opportunities – as well as environmental threats to the remaining forests of the inland areas that had so far been 'protected by civil war'.

An important dimension of social capital in the form of formal local governance systems has been less resilient than hoped for. The direct loss of lives in many of the agencies has caused a delayed ability to return to the capacity at pre-Tsunami level, which was below the standards for the rest of Sumatra, partly in response to the internal conflicts. The outside agencies that stepped into the vacuum were effective at the rescue & relief level, but faced more challenges where long term

recovery is involved. Substantial 'confusion' over the desirability and feasibility of a wide zone of protective coastal vegetation -- although the realization that mangroves only occupy a specific landscape niche emerged relatively fast. However, the lack of clarity of whether 30, 50, 500 or 2000 m of the coastline should/would be kept free from houses has been an obstacle to progress. The absence of decision making at the relevant scales as well as the lack of reliable information to base decisions on has been (and continues to be) an obstacle. The fact that the coastline itself, the basis for any zonation, has changed raises questions on prior rights and public responsibilities.

Finally, the immediate ***financial*** loss was no worry to the international insurance companies (in contrast to the hurricane Katrina damage in the USA) or financial markets (again in contrast with Katrina's effect on oil prices), because the affected areas were still relatively poorly connected to the global economy. The largely emotional response of the rest of the world providing humanitarian aid as well as investments in economic recovery, lead to a situation where financial capital was not a constraint – but the related processes of governance and the challenges of converting financial capital into enhancement of the other capital types was.

Overall resilience of a system is potentially limited by the resilience of the most vulnerable subsystem and the opportunities for changes in system configuration. The governance part of the social capital as well as the market access part of the economic chains to derive value from local tree crops have probably been the weakest part of the chains.

We'll have a closer look now at the roles of the various capitals in the conversion of mangroves to shrimp/fish ponds along Aceh's north coast, at the additional exposure of people to the Tsunami waves that this caused – and the opportunities that recovery of the shrimp ponds can play in local livelihood strategies.

2. Brackish-water pond study

The December 2004 Tsunami brought Aceh and its coastal zone to the forefront of public interest in discussions on environment and development. Conversion of mangrove forest to shrimp/fish ponds in the 1980s almost certainly increased the death toll from the Tsunami. The devastation was unprecedented in recorded human history. After the emergency relief phase, when clean water, food and shelter were available and the wounded had received care, the discussion started on sustainable livelihood options along the coast – but also on the 'causes' of the human damage and the role of the fish/shrimp ponds. ICRAF and other CGIAR centres operating in the Tsunami affected countries responded in a number of ways. One of its project activities is a study on socio-economic aspect of brackish-water pond aquaculture in Aceh.

The objective of the study was to clarify the social, economic and legal issues that relate to the development of *tambak*s in the mangrove zone, as a contribution to the debate on rehabilitation strategies. The study used rapid assessment methods to try and construct farm budgets for the operation of *tambak*s, focusing on 'returns to land' and 'returns to labour'. It involved all Tsunami affected parts of the north and east coast of Aceh – with a gradient in impact by the Tsunami from Banda Aceh eastwards. A number of villages was selected for detailed survey. Hence, the study observed a gradient where all *tambak* areas were destroyed by the Tsunami close to Banda Aceh while damage was about 50% in Aceh Utara and Loksheumawhe where our survey ended.

2.1. Post Tsunami: A lament for the brackish-water pond in Aceh Province

Most of physical capital supporting *tambak* production that was developed in decades was washed away. An assessment carried out by FAO (Philip and Budiman, 2005: 34-37) weeks after the natural disaster, noted that 20.429 ha or 42.9% of *tambak* in the province, with varies of damage, lost its production

capacity[2]. About 1,000 ha of *tambak* were permanently inundated due to the change of coastal line inward, and 7,300 ha were severely damaged. Those which were only inundated during the time of Tsunami, was not clear whether they were not losing their yields. Regarding infrastructure, 810 km (66.8%) of irrigation channels and 193 units (out of 223) hatcheries severely damage.

Some of the damage is repairable, whereas some *tambak* that have been completely lost, never been able to be restored. The damage to the *tambak* from Tsunami includes: (1) structural damage such as destruction of dykes, damage to irrigation channels, water gates and loss of associated infrastructure (huts, pumps, machinery), and (2) sedimentation caused by deposition of debris, silt, sand and mud into ponds and irrigation canals. It needs to note that silting up as a result of sand and debris by the Tsunami, widespread along the north-east coasts, filling even ponds without structural damage. Damage to the embankments is relatively easy to repair. *Tambak* that were silted up will require more effort to repair. Where as *tambak* that situated between settlements were also filled with debris from the buildings; restoring *tambak* belong to this case is the most difficult to restore.

Thousand of shrimp/fish farmers lost their income as well as their working capital. Sudden lost of working capital, brought about serious impact to the availability financial capital in the community. Quick assessment done in December 2005 in 12 villages in the six regencies with largest brackish-water pond area in the province (Banda Aceh, Aceh Besar, Pidie, Bireun, Lhok Seumawe, and Aceh Utara) found out that 92% *tambak* farmers rely on *toke* who provide working capital and serve as marketing agent. By the disaster, *toke* also lost their capital. Almost nothing left for them to recover quickly from setbacks. It appears, that *tambak* farmers whose ponds were damaged are not be able to restore their *tambak* themselves. The helps from out side, government and/or international donors, is needed for *tambak* rehabilitation in Tsunami affected area. Besides, the nature of this physical capital is different with what fishermen have; a damage pond cannot

[2] Brackish-water farming contributes highly significant to overall fisheries values in Aceh; 32% of total fishery value. MAFF/World Bank figures give the fishery sector of Aceh a value of Rp 1.59 trillion, or US$176.67 million(Philip and Budiman, 2005: 2)

generate cash in a short period of time. Restoring ponds take some time; at least need six month to restore the physical structure (depend on the level of damage) and only six months after *tambak* ready for cultivation, the yield can be harvested. This means they will be slower to return to work than the fishers and rice farmers, some of whom were able to start work one month after the Tsunami.

2.2. Tracing back to brackish-water pond development

Brackish water aquaculture in Aceh, in local term called *neuheun,* started in traditional earthen ponds systems that depended on tidal water exchange for wild seed supply and maintenance of water quality. It started in Kecamatan Jeunib and Samalanga of Kabupaten Bireun and Kecamatan Seunedon and Baktiya Barat of Kabupaten Aceh Utara in second half of 1940's by *Ulee Balang*. It then spread toward north along the eastern coast of the province. Brackish-water pond establishment along the north-east coast grew rapidly in the late 1970s (Figure 1), inline with the development of semi-intensive shrimp farming, evolving to the deliberate stocking of wild or hatchery fry in ever increasing densities supported by feed and water management inputs to increase yields. The growth of the brackish-water in the 1980s partly contributed to the lost of mangrove area in the province.

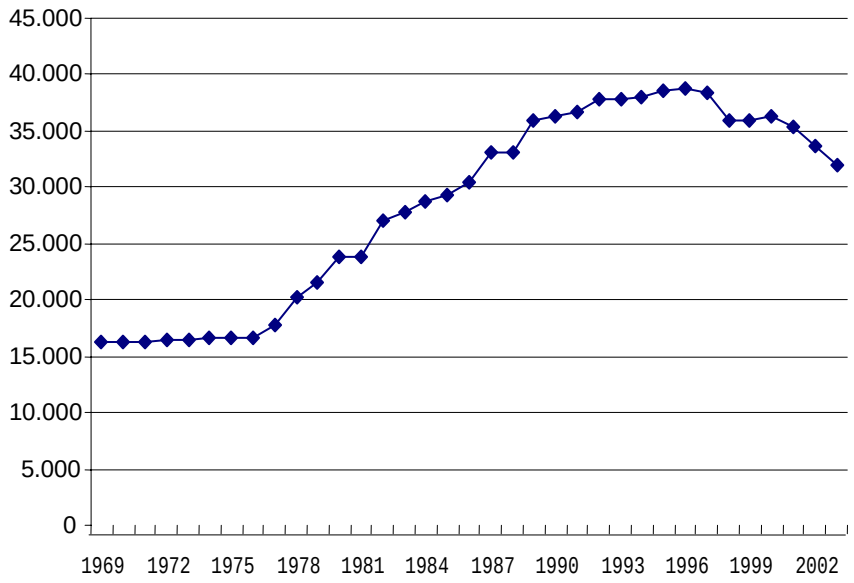


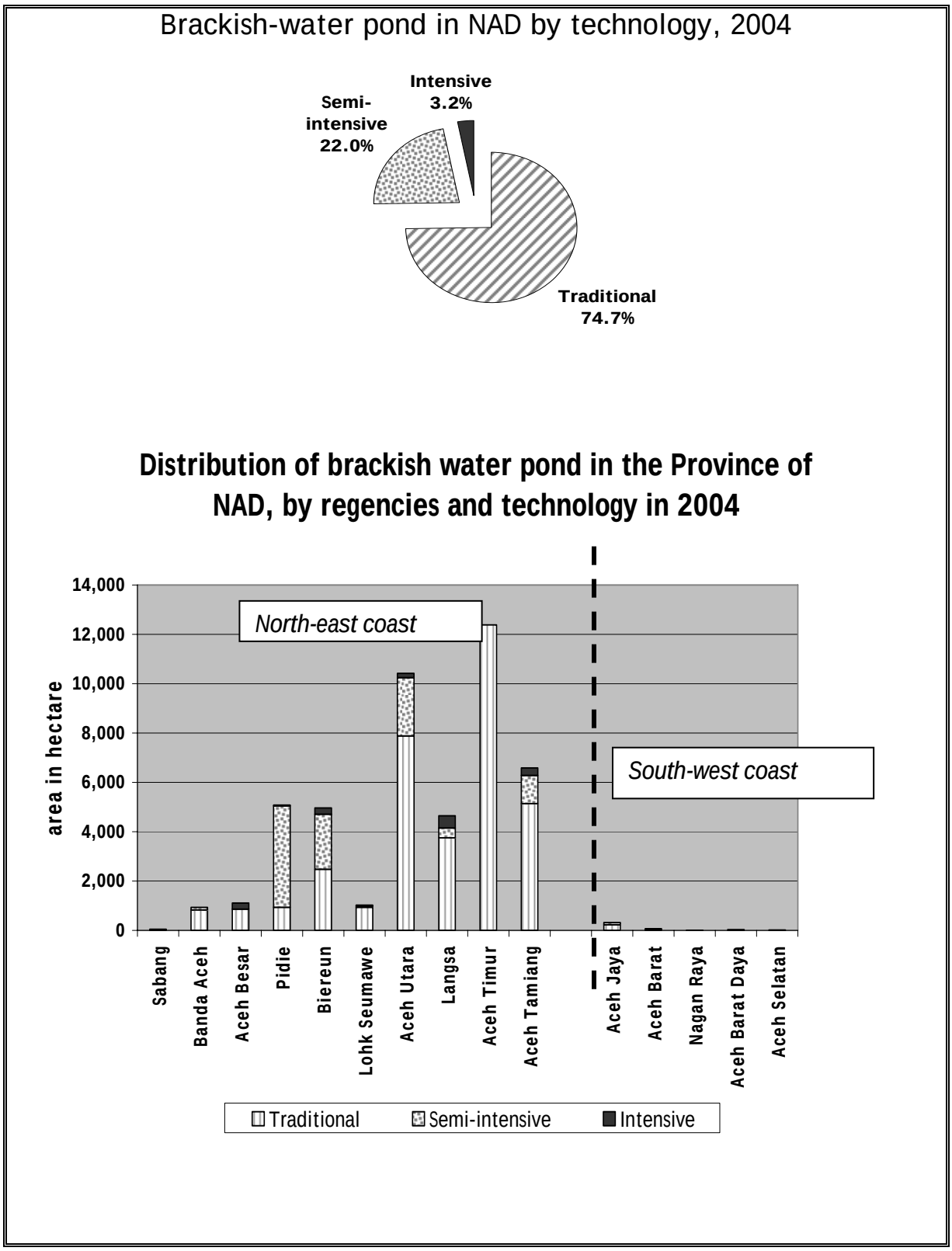
Figure 1. Brackish water pond area in Aceh 1968 -2003 (in hectare)

The development of aquaculture ponds in north-east Aceh is particularly interesting to note. The majority of the brackish-water ponds in Bireun, Pidie, Aceh Utara, and Lhokseumawe are converted paddy fields. Ponds in other areas like Banda Aceh, Aceh Besar are usually built in mangrove forest with a substrate of mud. Extensive conversion of mangrove forest for shrimp farming in Aceh, began in early 1960's, when a Medan based investor provided credit scheme for shrimp culture to groups of 40 farmers. The response was very positive; mangrove conversion for shrimp cultures were took place extensively along the north-east coast. By a license (*surat izin menggarap*) issued by village head (*keuchik*), those who did not have land could use any land available in the village, mostly converting mangrove forest. The deal was that the yield must go to the investor and the price was decided by the investor.

Shrimp culture boom in Southeast Asia that took place between 1970 to 1990s (Primavera, 1997) constitute driving factor of the development of brackish-water pond in Aceh, both area extent and the adoption more intensive technology, with the expense of mangrove forest lost. Intensive shrimp farming development contributed to the lost of mangrove forest. As it is well known that the average operational life of a shrimp pond is two to three years, as chemical feeds and fertilizers coupled with pesticides (used in aquaculture) deteriorate water quality to the point of not being able to raise healthy shrimp. At this point operation shrimp ponds were usually abandoned as investors move on to clear new areas of mangrove forest. It is quite understandable that the presence of intensive shrimp culture, were very dynamic in nature depend on the world price.

The most recent statistical data on brackish water pond of Aceh prior Tsunami, as visualized in Figure 2, shows interesting figures. Shrimp and milkfish farms in Aceh are mainly operated as traditional (74.7%), with low input farming systems in polyculture and monoculture situated along the north-east coast. There are 22% (of the total) are semi-intensive farming, mostly found in Bierun and Pidie, and only 3.2% intensive shrimp farms. The number of intensive and semi-

intensive shrimp farms has started developing over the past 5 years on the west coast of Aceh. However, total farm areas along west coast are still very low.



Sources : Dinas Perikanan Propinsi NAD

Figure 2. Status of brackish water pond in Aceh

Observation in several places in Lhok Seumawe, Bireun and Pidie found some damaged aerators, indicating that the aquaculture ponds had been operating intensively at the time the Tsunami. It is unfortunate that the study in December 2005 was not able to collect information and data on the number of tambak that already abandoned prior the time of Tsunami.

With regard to property right issue, not all *tambak* were established on privately owned land. By comparing the data on *tambak* area derived from village level to the land status data of the Potensi Desa 2003, it is estimated that 19.8% of the *tambak* area in the 12 villages under study established on non-private land. Looking at the land status of the privately owned land, it is noted that in the 12 selected villages only 36.5% of the privately owned land hold land certificate. The land with this kind of secured land title mostly found in the urban area closed to Banda Aceh (Tibang and Lambaro skep, 99.5% and 44.9% respectively) and Pidie (Baroh Lancok, 43.9%). Whilst in rural area, the number of private land equipped with land certificate is very low, less than 15%. It does matter to develop a sustainable strategic livelihood in the future; hence vulnerable to eviction.

2.3. Brackish-water pond rehabilitation – a year after the Tsunami

Post Tsunami *tambak* rehabilitation is considered as a strategic intervention with two reasons. Firstly, it certainly will relief the livelihood of thousands of people living in coastal area that rely on *tambak* aquaculture. Study in 12 villages noted that there were 2,722 households relied their livelihood on 1,433 ha *tambak*, mostly practicing traditional systems; meaning, per hectare *tambak* serves nearly two households. Secondly, it is the best time for coastal area rehabilitation that was already somehow deteriorated before the Tsunami hit the province, due to

development of shrimp aquaculture by converting mangrove forest, and could be also urban development.

The efforts to restore this physical capital, however, vary depended on the level of damage. Referring to FAO mission (Philip dan Budiman, 2005: 35) there are four level of physical damage : (1) complete loss of ponds; estimate figures is 5% of the total damage, (2) heavily damage (greater then 50% of embankment and infrastructures loss resulting in loss of the physical structure of the *tambak* and associated infrastructure); estimated 35.6% of the total damage, (3) moderate damage (partial loss of embankment and its associated infrastructures; 25% to-50%); estimate figures is 25.1% of the total, and (4) Minor or light damage to dykes (<20% dykes destroyed, or eroded) and associated infrastructure; 28.7% of the total tambak damage. It probably can be added with the "no damage but lost of its working capital" categories, due to flooding, although no records we made in this regards

The presence of international aid agencies for Aceh recovery seems to be very helpful in tambak rehabilitation. As a matter of fact that a year after the Tsunami hit the province, some patches of damage *tambak* have been restored by international organizations working together with national partner, although still very little. The rehabilitation started from the lighter damage tambak like in Biereun and Lhok Semauwe, while the heavier damage tambak started quite recently in September 2005, and was implemented relatively small area. No hard data can be referred regarding the progress of this effort. The estimate is less then 15% of the tambak have been restored. Observation in December 2005, found interesting phenomenon on the rehabilitation efforts.

Firstly, very few tambak that already been restored was optimally used, mostly because of lack of working capital available. Some were returned to do cultivate shrimp, but failed due to water quality. This was then under mitigation of Loka *Budidaya Air Payau* of Ujung Batee. In Kuala Meuraksa of Kecamatan Blang Mangat, groups of youngsters already running grouper nursing, based on order from trader from Medan. They nurse grouper from fry to three-inch fingerling for

two months, and sell it to the investors. A group of three youngsters could worth Rp 5 million to Rp 7.5 million, or return to labor of grouper nursing approximately Rp 61,250 per person day. The economic of scale of this activity was 10,000 tail of fry per group and assuming 70% survival rate. The return to labor was relatively higher then agricultural labor wage rate.

Secondly, restoring tambak with unclear land status. There was an example of restoring severely damage tambak area in Lamnga and Gampong Baru of Kecamatan Merjid Raya, by an international aid agency (NGO) that faced problem of land status. Although already included in the work plan that was developed with the community, the NGO staff leave some parcels of tambak untouched, just because the staff realize later that those lands have been part of mangrove area rehabilitation (under NAD-Nias Rehabilitation and Reconstruction Board). Inevitably the tension between group of farmers running the tambak mentioned above, and the NGO staff is occurred. Similar case could happen elsewhere if the land status is unclear. As there is an estimate that 19.8% of tambak were established on non-private land. Besides, larger proportion of private land have no land title deed.

Thirdly, problem in rehabilitating tambak on sandy soil close to shoreline. Rehabilitating tambak on sandy soil close to shoreline is problematic. The existence of tambak close to shoreline is actually against the old *adat* rule, saying that 200 meters (150 *depa*) from the shore line must free from any cultivation activities that disturb fishermen activities. It's been no longer practiced, as tambak provide more income for coastal communities and also vulnerable to tide wave. Case of Meunasah Lancok, Kecamatan Samalanga is an example. Only few weeks after been rehabilitated, blocks of sandy tambak collapsed its embankment and the pond were flattened by the sand in a single hit of relatively high tide. The tambak was rehabilitated by an international aid agency, by spending about a month of rented back hoe to restore the embankment and cleaning the sediment of this sandy brackish water pond. Waste of resources is the first impression one might have,

because reconstructing a sandy tambak needs more efforts than it is in more solid grounded tambak.

Fourthly, gender related issue in restoring tambak. Many Acehnese perceived that tambak farming is masculine type of activities. Efforts to provide more opportunity and role for women in tambak rehabilitation in a village of Pidie, initiated by an Italian NGO, were failed and the NGO gained protest from the community.

A year after tsunami, tambak rehabilitation seems to be very slow. The four phenomena listed above and considering the nature of this physical capital that need some time to recover from disaster, give us the answer why the efforts seems to be very slow. More than that, any tambak rehabilitation should consider the balance between the use economic potential of coastal resources and environmental problem might occur in the future of exploiting this coastal resources. The conflict between public and private interest should be internalized into rehabilitation process. Multilevel social networks are crucial for developing social capital and for supporting the legal, political, and financial frameworks that enhance sources of social and ecological resilience (Dietz etal, 2003)

2.4. Financial assessment of brackish-water pond rehabilitation

Two questions will be addressed in the financial perspectives of tambak rehabilitation : (1) how much brackish-water pond worth and (2) how does the brackish water pond contribute to the livelihoods of community surroundings. The first question includes how much the cost (cost of establishment that will include rehabilitation cost) and how much the returns (return to land and return to labor), whilst the second question will deal with employment generation in brackish water pond operation and its establishment.

Table 1 presents financial estimates of brackish-water pond rehabilitation in north-east coast of Aceh. Based on the data collected from several tambak

rehabilitation actitivites in some villages, cost of tambak rehabilitation per hectare is estimated varies between Rp. 5.89 million and Rp 32.41 million depend on the level of damage and the method used; capital intensive (using back hoe) or labour intensive (done manually). Labour intensive will never work to reconstruct severely damage tambak, while other level damage can do both. Tamabk rehabilitation using back hoe is relatively faster than it is done manually. Both methods employ unskilled labour that available locally, and it is actually also employment opportunity for local community.

Table1. Estimate of rehabilitation cost, required working capital and profitability

Financial parameters of tambak rehabilitation	Level of damage due to tsunami				
	Severely damage (capital intensive)	**Medium damage**		**Minor damage**	
		capital intensive	labor Intensive	capital intensive	labor Intensive
Estimate of rehabilitation cost (Rp 000)	32,414	20,917	12,366	12,373	5,886
Labour requirements					
– professional labour (ps-d)	9	5	0	3	0
– skilled labour (ps-d)	51	41	48	33	42
– unskilled labour (ps-d)	25	21	96	17	22
Number of labour employ	85	66	144	52	64
Cost components (%)					
– Back hoe services	57.4%	48.6%	0.0%	46.1%	0.0%
– Gasoline	12.3%	10.4%	0.0%	9.9%	0.0%
– Tool and Material					
• Water gate	8.6%	12.0%	22.2%	10.8%	22.5%
• Hut	7.7%	12.1%	20.0%	11.6%	24.1%
– Labor cost	14.1%	16.9%	57.7%	21.6%	53.4%

Source: Study on Socio-economic of tambak in Aceh

Ex ante financial assessment on the brackish water pond production after reconstruction, were carried based on the December 2005 prices. The assessment is summarized in Table 2. Traditional systems which is practiced by the largest tambak operator in the province, is still profitable under 15% discount rate, and it is

assume that survival rate for shrimp fry and milk fish is 48% and 70% respectively. Initial capital is ranging between about Rp 18.5 million and Rp 45 million per hectare (cost of establishment and working capital). In normal condition those amount oh money is affordable. But in situation like in Aceh at present, it is not affordable for smallholder shrimp/fish farmer. Return to labour (which converts the surplus to a wage after accounting for purchased inputs and discounting for the cost of capital and no surplus is attributed to land) is a bit higher than average agricultural wage rate. It is still attractive for farmers to engage.

Table 2: Financial assessment of tambak production: required working capital and profitability (11 years production scenario)

Tambak Technology	Scale of Operation	Financial parameters	Level of damage due to tsunami				
			Severely damage (Capital intensive)	Medium damage		Minor damage	
				Capital intensive	Labor Intensive	Capital intensive	Labor Intensive
Traditional	- area : 0.5 – 1 ha, continues cultivation - brood stock density : o shrimp fry 20,000/ha o milk fish 1000/ha	**Rehabilitation cost (Rp 000/ha)**	32,414	20,917	12,366	12,373	5,886
		Working capital required (Rp 000/ha)	12,624	12,624	12,624	12,624	12,624
		Profitability					
		NPV (discount rate 15%)	3,011	13,009	20,445	20,319	19,133
		IRR	17.7%	32.0%	58.7%	58.5%	103.7%
		Return to labour (Rp/ps-day)	36,449	41,302	44,487	44,948	44,308
Semi intensive	- area : 0.5 – 2ha, continues cultivation - brood stock density : o shrimp fry 60,000/ha	**Rehabilitation cost (Rp 000/ha)**	32,414	20,917	12,366	12,373	5,886
		Working capital required (Rp 000/ha)	26,770	26,770	26,770	26,770	26,770
		Profitability					
		NPV (discount rate 15%)	62,740	72,737	80,173	68,757	85,808
		IRR	58.0%	86.0%	132.2%	116.5%	219.9%
		Return to labour (Rp/ps-day)	60,721	64,994	66,868	63,611	70,512
Intensive	- area : 2 ha < , fallow rotation. - brood stock density o shrimp fry 140,000/ha	**Rehabilitation cost (Rp 000/ha)**	32,764	20,967	12,616	12,744	6,436
		Working capital required (Rp 000/ha)	51,320	51,320	51,320	51,320	51,320
		Profitability					
		NPV (discount rate 15%)	222,989	233,247	240,509	240,398	245,883
		IRR	274%	403%	585%	582%	858%
		Return to labour (Rp/ps-day)	143,193	149,711	147,964	154,479	156,150

Note:
Net Present Value (NPV) measures return to land; positive NPV means the systems are profitable. Internal rate of return (IRR) is an alternative measure of profitability, which is the discount rate that brings NPV to zero; using it makes the same point with greater clarity. Returns to labour is the wage rate sets NPV equal to zero. This calculation converts the surplus to a wage after accounting for purchased inputs and discounting for the cost of capital; no surplus is attributed to land.

At the other extreme, tambak with intensive systems require more initial capital ranging from Rp. 57.86 million to Rp 84.1 million. It provide the highest profitability, although it assumed that it has only seven years effective out of 11 years production scenario. No wonder if this system is very attractive for many investors as the IRR is tremendously high. But all of those calculation has not internalized the social cost of the mangrove lost, the environmental and social damage where problems of pollution, public health risks and salinization caused by intensive shrimp farming are in stark contrast to the values of communal ownership, coastal protection and domestic food supply intrinsic to intact mangroves (Primavera 1993). These values need to be monetized to provide more comprehensive information to national governments and international funding organizations, which have been working on tambak rehabilitation programme in Aceh. Institutions that protect local communities and the environment from short term profit-makers must be developed and supported and their rules must be enforced. (Primavera 1999)

How does the brackish water pond contribute to local community? Using labour requirement we may estimate the employment generation of a hectare of tambak may provide. Table 3 presents the estimates of labour requirement. From employment generation point of view, brackish-water aquaculture is a good option for employment generation with reasonable better return to labour than other agricultural wage rate in rural area. As seen in the table, brackish-water aquaculture requires 395 – 813 person-days per hectare per year for its operational, depend on the technology. Intensive systems require more labour than traditional. It seem the intensive system would provide more employment for local community. It is not always happen in reality. Experience in Aceh, as long as tambak operators is not from local community, very little local labour would be employed. Some time it creates tension between local communities and the migrant labourer working the intensive shrimp farming. This another issue of an intensive shrimp culture, as also happen elsewhere.

Table 3: Labour requirements of tambak production : person-day/ha/year (11 years production scenario)

Tambak Technology	Labor requirement	Level of damage due to tsunami				
		Severely damage	Medium damage		Minor damage	
			Capital intensive	Labor Intensive	Capital intensive	Labor Intensive
Traditional	**Establishment phase**	85	66	144	52	64
	Operational phase					
	– professional labour					
	– skilled labor	9	9	9	9	9
	– unskilled labor	386	386	386	386	386
	Sum	479	461	539	447	459
Semi-intensive	**Establishment phase**	85	66	144	52	64
	Operational phase					
	– professional labour		0	0	0	0
	– skilled labor	201	201	201	201	201
	– unskilled labor	504	504	504	504	504
	Sum	789	771	849	757	769
Itensive	**Establishment phase**	92	73	155	58	75
	Operational phase					
	– professional labour	2	2	2	2	2
	– skilled labor	334	334	334	334	334
	– unskilled labor	477	477	477	477	477
	Sum	903	885	967	870	887

Source: Study on Socio-economic of tambak in Aceh

3. Conclusion and recommendation

The resilience of coastal societies is more tightly linked to larger-scale processes today than in the past: economic linkages and the globalization of trade in commodities, and might be just recently to more and ecological services. As we might note that the growth shrimp culture in Aceh was also part of the Asian shrimp industry.

The capacity of coastal ecosystems to regenerate after disasters and to continue to produce resources and services for human livelihoods can no longer be taken for granted; rather, socio-ecological resilience must be understood at broader scales and actively managed and nurtured. Incentives for generating ecological

knowledge and translating it into information that can be used in governance are essential. (Adger etal, 2005).

Socio-ecological resilience can be understood on the basis of the interactions and differential inherent resilience between the different types of capital. While soils and trees can regenerate without the sense of 'trauma' that adds complexity to the resilience of 'human capital', infrastructure is fully dependent on human, social and financial capital interactions for recovery. The sensitivity of the market-based livelihoods to physical infrastructure in west Aceh, has become evident to all rubber growers in the area.

The 'human causation' part of the Tsunami impact has received a lot of attention for the city of Banda Aceh that lost its protective mangroves in the 1980's due to conversion to urban use. Attention to the 'human causation' is in line with the general tendency that the judged seriousness of an environmental loss is a matter of what caused it (Brown et al., 2005). The effects on the rest of the coast are more difficult to quantify, but still important in the debate. The social cost of past conversion of the mangroves to *tambak*s had previously been estimated as primarily based on the value of open-sea fisheries (*ref* Turner, 1977?).

Although estimates indicated that the 'social value' of intact mangrove was much higher than the 'private value' of converted mangrove, there was no mechanism to make the relevant benefit transfers to those who had the right to convert to make them reconsider their decisions. Part of the Tsunami damage can thus be seen as the result of institutional failure to internalize externalities.

SBd/

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