FARM LEVEL PROBLEMS IN IRRIGATED AGRICULTURE OF INDONESIA

A DISSERTATION

Submitted in partial fulfillment of the requirements for the award of the degree of

MASTER OF TECHNOLOGY

in

IRRIGATION WATER MANAGEMENT

By

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Candidate's Declaration

I Hereby declare that the work presented in this thesis entitled "Farm Level Problems In Irrigated Agriculture Of Indonesia" in authentic record of my own work carried out during the academic year 2010/2011 and is a partial fulfilment for the award of the Master of Technology Degree (M.Tech.) in Irrigation Water Management (IWM), in the Department of Water Resources Development and Management (WRD&M), Indian Institute of Technology Roorkee (IITR), Uttarakhand, India. This thesis work was supervised my DR. S.K. Tripathi, Professor WRD&M, IITR. This thesis or any matter embodied within this dissertation has not been submitted for the award of any other degree or diploma.

Place : Roorkee

Date :

(Fauzan)

This is to certify that the statement presented by the above candidate is true and correct to best of my knowledge.

(DR. S.K.Tripathi)
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Fauzan

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Abstract

The December 2004 tsunami caused great devastation to a wide area, including agriculture land along the east and west coasts of the Nanggroe Aceh Darussalam (NAD)/Aceh province, Indonesia. Tsunami-damage agriculture land by can be classified into three groups: light, medium and heavy damage. From 2005-2006, rehabilitation of agriculture land was focused on light to medium damage land, with heavily damage land to be use rehabilitated later. Major problem encountered in the rehabilitation of agriculture land were thick sand/mud/silt deposit, farm level problem, highly salinity level, economic problem, high Specific Absorption Rate (SAR) values, blocked drainage, damaged irrigation channels and traumatised farmer.

As the rehabilitation and reconstruction process proceed, rice field have been gradually cultivated by farmer. Rice productivity in rehabilitated fields along the east coast, considered a lightly damaged area, has reached 5-6 ton per hectare (average productivity in the area before tsunami was 4.5 ton per ha), meanwhile, productivity of rice in the western coast, considered heavily damage area, is 3-4 ton per ha. Successful cultivation of most of the damage agriculture land is due to strong effort and commitment for all stakeholders involved in the rehabilitation such as United Nations, NGO's, BRR and Local Government.

Thus it can be concluded that tsunami 2004 in Indonesia (Aceh province) was a curse to agriculture but with hard work of the farmers and support of the donor agencies and Indonesian government this has become boon to the farmer. This is expected to further improve when the irrigation system in the process of modernization become fully operational.

Key words: Aceh, Aceh rice field rehabilitation, tsunami damaged agriculture land, rice field productivity.

CHAPTER I
INTRODUCTION

INTRODUCTION

Water is important for human and plant life on the earth. It plays a decisive role in the sustainable livelihoods of rural people. Approximately 40 percent of the world's food supply is produced on the irrigated land (Johnson III 1995). Improvement in access to water serves as a powerful tool to diversify livelihoods and reduce exposure for small producers. Irrigation water creates options for extended production across the year, increases yields and outputs, and creates employment opportunities. Increased household income may be spent locally thus helping to stimulate the rural economy. For the last two decades, an ever-increasing number of countries around the world have been turning over the management authority for irrigation systems from government agencies to farmers or other non-governmental organizations. This phenomenon is generally referred to as management transfer or devolution.

Water is precious resource. Only 2.5 percent of the world water is not salty, and of two- third is locked up in the form of ice caps and glaciers. Due to the continuous hydrological cycle, about two-third of remaining water is lost to evaporation while, some 20 percent of the remaining potentially useable water is in areas to remote for human access. After deducting all the quantities of water which can not be utilized by the human beings (for example excess water during the monsoon or the flood water), only 0.08 percent of the total water on the planet is actually utilized by the mankind (Lashari *et al.* 2003).

Agriculture is the largest consumer of water. Ever increasing population of the earth is putting more pressure on the agriculture sector to meet the demands of the increased population, especially food requirements. Irrigation water, the single most important input for the agriculture sector, is even under more stress as compared to other inputs due to limited supplies. Need for improvement in efficiency and productivity of irrigation water has become one of the key issues for the irrigation as well of the agriculture sector. It has been observed that the state owned irrigation systems have not been performing well and are deteriorating day by day, especially in developing countries due to financial, managerial and socio-political factors (Haq 1998).

Literature and world experiences on irrigated agriculture have clearly indicated that without integrated approach of water resources that includes irrigation, drainage and environment, the agricultural productivity and sustainability would not be possible in the developing countries. The linkages and coordination among all stakeholders of irrigated agriculture is the most important institutional intervention. The irrigation and drainage sector plays a vital role in the food supply as well as in the economy of Indonesia.

Agriculture And The Economy Of Indonesia

Roughly 60 percent of Indonesia's population relies on agriculture for their income. The archipelago is favoured with regions with excellent soils and rainfall and is a key producer of a wide variety of tropical food. Indonesia is the leading producer of palm oil globally, and has substantial land area that could be brought under cultivation for new oil palm plantations. In addition, production of coffee, cocoa, a wide range of tropical spices, rubber and forest products contribute to Indonesia's export earnings. Rice production of over 50 million tons (paddy basis) annually is substantial, but not enough to meet local consumption.

Indonesian agriculture features both plantation and small holder production modes. Palm oil, rubber and sugar exhibit both types of production, while most other crops, such as rice, soybeans, corn, fruits and vegetables are largely the province of small holder agriculture. Small holders typically farm very small plots, averaging 0.3 hectares, and the tropical climate usually allow for multiple crops annually, so long as irrigation is available.

For animal protein, Indonesia relies on a spectrum of producers, from large integrated poultry farms to small backyard producers. For beef, roughly 500,000 head of cattle are imported and fed out annually, almost all from Australia. Commercial milk production is confined to a few dairies, as the tropical environment is not generally supportive for dairy operations.

Indonesia imports a wide variety of feed ingredients for the poultry and aquaculture sectors including soybean meal, Distiller's Dry Grain's (DDG's), Meat and Bone Meal (MBM). There are no commercial soybean crushing operations in country, although a few small full-fat crushers produce meal, principally from soybeans that are not suitable for direct human consumption.

Agricultural Policy Overview Of Indonesia

The one goal of Indonesia's agricultural policy, continuously raised since the inception of the Soeharto New Order regime in 1966 is, self sufficiency. In Indonesia to this day, self sufficiency means self sufficiency in rice production. In terms of agricultural policy, all other goals are secondary compared to rice self sufficiency. This goal has been so pervasively discussed over the two generations since 1966 that it percolated out of the government offices where it was first vetted to reside with the man on the street. While the goal is elusive, progress toward the goal is impressive.

East, Central and West Java, the three most populous Indonesian Provinces with a combined population of over 100 million produce almost 30 million metric tons of rice annually, plus substantial volumes of corn and other food crops. With a land area approximately equal to that of the State of Pennsylvania, and an estimated population density an order of magnitude more than the Keystone State, it is a remarkable statement of the basic productivity of the agricultural resource base of the island in general, and these three provinces especially. This is especially the case as the average land holding is estimated by provincial officials at a mere 0.3 hectares.

Total rice production on the whole of the island of Java in 1965 was only 4.9 million tons, indicating more than a six-fold increase in production since 1965. Over the same period per capita rice consumption rose over 50 percent, from an estimated 85 kilograms to 140 kilograms annually, while Indonesia's population increased 140 percent to 240 million. Substantial gains in rice production on Java, Indonesia's most productive rice farming zone, were largely offset by population and per capita consumption increases. Self sufficiency as an Indonesia agricultural policy goal is not unique to rice. Ministry of Agriculture officials frequently mention this goal with respect to corn, animal proteins and other crops, although the main thrust remains rice.

The adoption of a transparent body of regulation for biotechnology is a low priority for the GOI. Revised food labelling (only "packaged" food) regulation is expected similarly. A committee approach is being used, although it appears that the two committees (i.e., biosafety, food safety) have the same members, just a different meeting venue. Meanwhile, trans national corporations working in the arena of transgenic seed development complain quietly about a lack of leadership and direction that stymies their progress. At present, there are no imported or locally developed commercial transgenic seed varieties approved for planting in Indonesia.

The Effects of Tsunami on the livelihood of Aceh, Indonesia

Aceh is a province of Indonesia located at the north western portion of Sumatra. The province has about 5,5 million ha land area with a population of about 4.3 million (data before the Tsunami). The predominant soil found in the province is Inceptisols (66.2%) followed by Ultisols (11.7%), and Entisols (8.3%). Entisols formed from marine sediments were found mainly on the coastal line both on the west and east coasts of Aceh. The Ultisols were found mainly in the mountain and plateau areas. The Inceptisols lied mostly in areas between Entisols and Ultisols.

A massive earthquake on December, 26th 2004 followed by Tsunami has devastated the coastal regions of Aceh province and Nias, a small island in North Sumatra province, Indonesia. The west coast of Aceh experienced more devastation than the east coast. The Tsunami reached as far as 7 km inland in the west coast and up to 4 km in the east coast. The Government of Indonesia (GOI) through the Minister of State for National Development Planning announced on January 19, 2005 that the disaster caused more than 100,000 people deaths, more than 132,000 missed, and more than 340,000 are becoming refugees. The infrastructure damages include 1.3 million homes and buildings, 8 ports, 85% of the water and 92% of the sanitation systems, 120 km of roads, and 18 bridges. The estimated total damages and losses is US$ 4.5 billion (Bappenas, 2005).

The recovery processes would be significantly complex and costly. Building bridges, roads, or temporary housing for the refuges could be done in a few months with the joint efforts of national and international communities. However, the socio economic issues such as land ownership, relocation of household, child development concern, credit availability for farmers, and rehabilitation of soil condition may take long and complex development processes. The GOI has set up three phases of recovery. The 3 phases include emergency phase, rehabilitation phase, and reconstruction phase. The emergency phase (6 month) focused on saving the survivors as soon as possible and provide them with the minimal need for living. The rehabilitation phase would take 6 – 18 months with the focus on rebuilding local governments, reconstructing buildings and offices, making the community ready to move to the reconstruction process, and rehabilitating agricultural land. The reconstruction phase would take years to be completed.

The Effects of Tsunami on Farmland in Aceh, Indonesia

The Indonesian Soil Research Institute is conducting remote sensing data analyses to study the extent and intensity of damages on agricultural land due to Tsunami. The analyses was conducted by comparing data generated from satellite images (Landsat TM-5 and Landsat 7), before and after the Tsunami. Those data were then cross checked with tabular data obtained from the Ministry of Agriculture for the Aceh province. Figures 1 and 2 show satellite images used for the analyses.

Figure 1: Ikonos satelite images of Lho Nga Aceh Besar before and 3 days after the Tsunami.

Before Tsunami	3 days After Tsunami

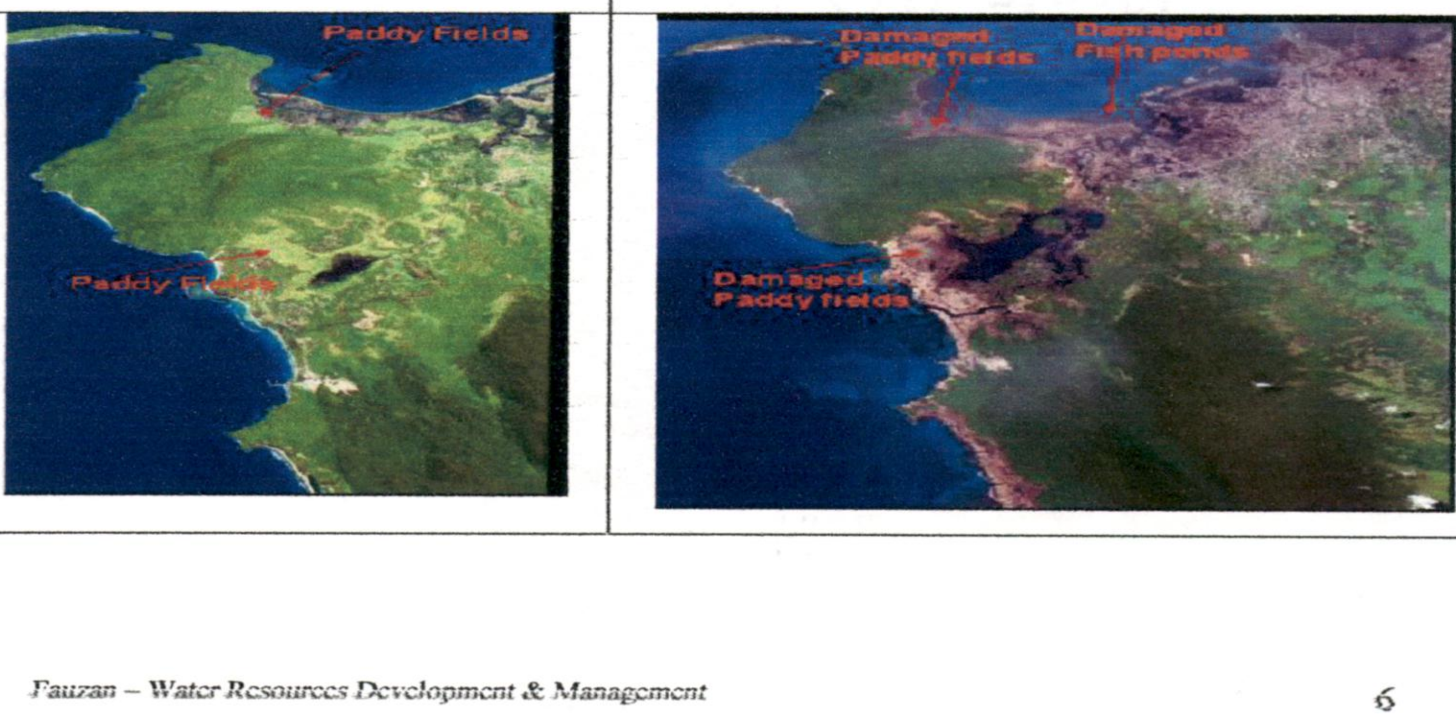
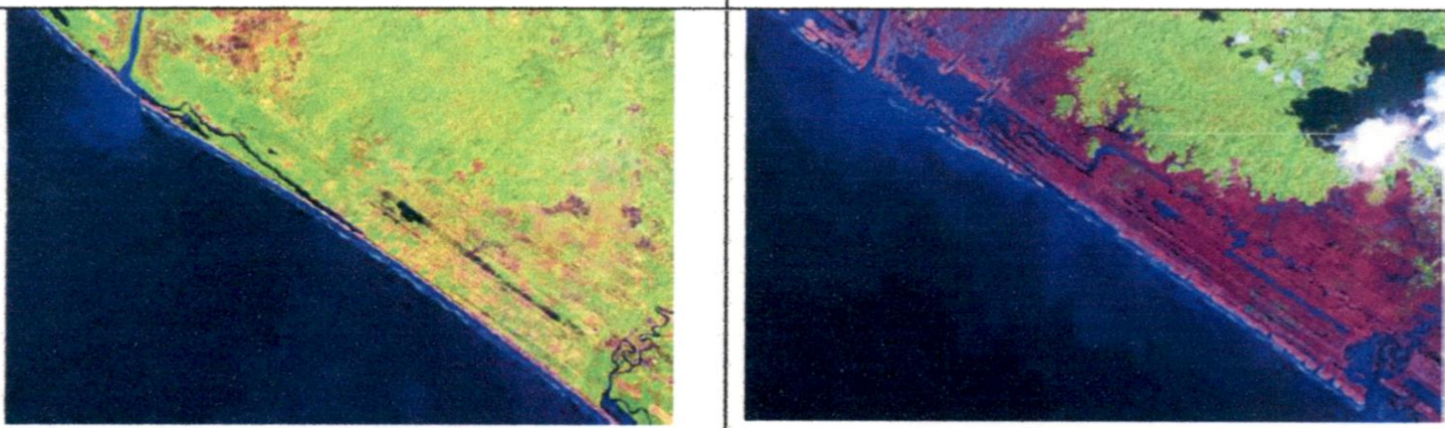


Figure 2: Landsat TM 7 of north Meulaboh, Aceh Barat before and after the Tsunami.

Before	After



The results indicated that around 8.6% out of 336,000 ha of agricultural land were damaged by Tsunami. The damaged paddy fields were found mainly in Aceh Barat (6107 ha), Aceh Barat Daya (4520 ha), Aceh Jaya (4159 ha), and Aceh Pidie (4023 ha; Table 3), the first three districts are located in the west coast of Aceh.

Prior to Tsunami, the province was expected to produce 1.5 million ton of rice from 380 thousands ha of paddy field, 190 thousands ha of them were irrigated. Paddy field were found mainly in the east coast, while in the west cost estate crops such as oil palm were found to dominate the agricultural activities. Since larger area of paddy field were found mainly in the east coast as compared to the west coast (Figure 3).

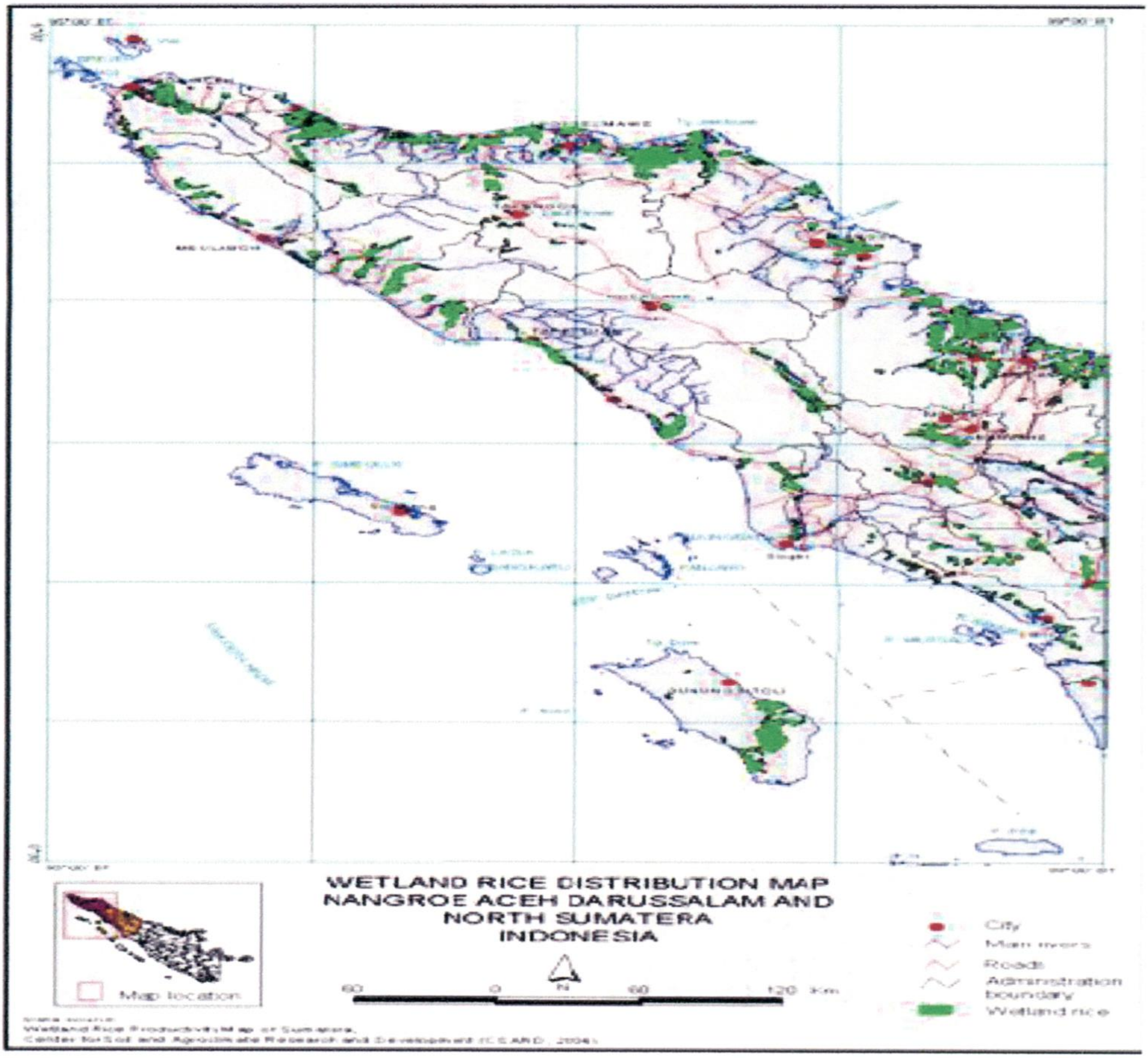


Figure 3: Wet land rice distribution in Aceh and North Sumatra.

The total paddy fields damaged by the Tsunami is approximately less than 10% of the total paddy field area in the province before the Tsunami. However, the loss of rice production could be significant. If the provincial average of soil productivity for rice is 4.2 ton/ha, then the potential loss of rice production from Aceh is at least 120,000 ton rice per planting season. Rehabilitating the Tsunami affected agriculture lands, both the paddy field and other crops land, would restore not only the food security of rural areas but also the livelihood of local farmers.

At least four major forms of damage, some areas sustaining a combination of more than one forms, to farmlands have been identified:

1) changes in landscape,

2) deposition of mud transported from the sea and coastline,

3) infiltration of sea water into the soil profile, and

4) deposition of debris on soil surface.

The waves stripped out the land surface along the coastline to, at some areas in the west cost, at least 1000 m inland leaving some of the formerly agricultural land areas to permanently inundated with sea water. The areas are no longer suitable for agricultural activities, however, it can be used as a waves protection area by planting with mangroves.

The Tsunami sent not only sea water but also mud from the sea and coastline to as far as 3-5 km inland in the east coast and 5-7 km in the west coast. As the water receded, the materials sunk and capped the soil surface with mud and debris. Field observation indicated that the finer materials deposited farther inland to the extent of the water's path. The depth of the deposited materials varied from 1 cm at the area closer to the coast line to >20 cm at the area closer to the end of water's path. These materials have grey to light green colour and it is very hard when dry indicating a high clay and some cementing agent contents. The clay content of deposited mud varied from 7.8% to 42.8% depended on the source of materials (Table 1). Figures 4 and 5 show paddy field covered with mud to as high as 40 cm and dry land covered with 20 cm mud, respectively.

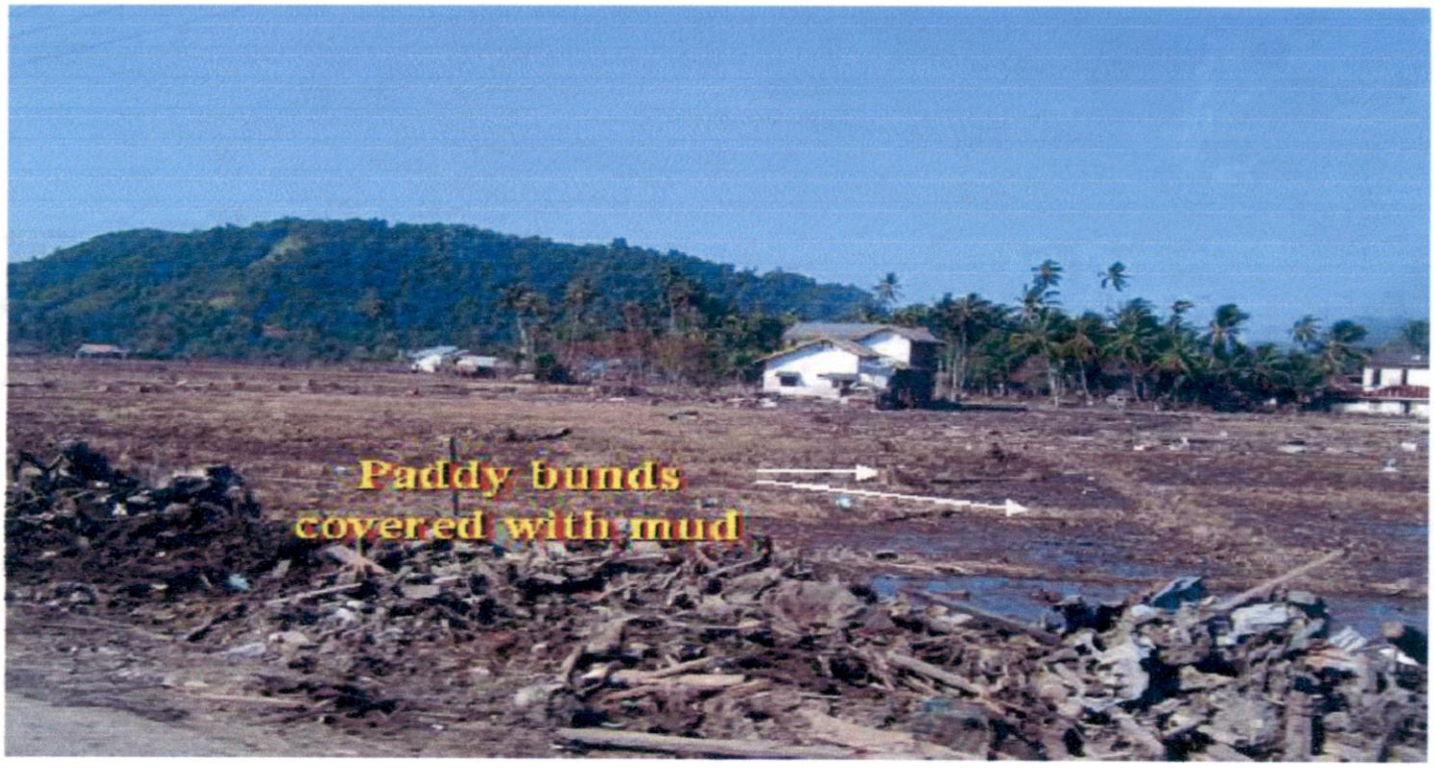


Figure 4: Paddy field under mud cover in Lho Nga 30 days after the Tsunami.

Figure 5: Dry land covered with 20 cm mud in Banda Aceh 30 days after the tsunami.

Table 1: Characteristics of deposited mud measured on 26-29 Januari 2005 in Aceh Besar

Village	Sand Content (%)	Clay Content (%)	Mud Thickness (cm)	Soil EC (dS/m)	Salt Content (ppm)
Lamcot. Aceh Besar	52.8	7.8	10 - 20	60.86	31.280
Kenene. Aceh Besar	26.2	42.8	15 - 25	84.19	46.268
Lampineung. Aceh Besar	12.3	42.3	15 - 25	80.11	44.116
Tanjung. Aceh Besar	47.2	24.8	2 - 5	38.95	20.140
Mire. Aceh Besar	6.2	41.9	2 - 5	19.8	9,804

The electrical conductivity of the deposited materials was 19.8-84.2 (dS/m) (Table 1) a level far exceeding most crop tolerable level of 2-3 dS/m. Dried mud on the soil surface forms a hard pan or crust that restrict infiltration of rainfall causing a significant amount of runoff but less fresh water infiltrated into the soil to leach out the toxic materials.

CHAPTER II
DESCRIPTION OF PROJECT AREA

DESCRIPTION OF PROJECT AREA

Geographic Location

The Krueng (Kr = River) Aceh basin is located in the northern tip of Aceh Province (Figure 6 and Annexures) and cover a total area of roughly 1752 km^2 (3.1% 0f Aceh Province)[1] ([1]=Bakosurtanal Topographic Map, PERMEN PU 11A, 2006). In 2007, the population in basin was an estimated 398,000 million people (9,4% of total Aceh)[2] ([2]=Aceh Dalam Angka, BAPPEDA Aceh, 2008). The basin enjoy the tropical monsoon climate with an average annual rainfall ranging from 1,250 mm in the north-west corner of the basin to more than 2,700 mm in the south-east.

The basin cover relatively narrow zone comprising of an upper region (> 500 m+ sea level) consisting of mountain terrain, a middle region consisting of a mixture of hilly terrain (50-500 m+) and dissected plains (< 50 m+). The lower part of these plain consist predominantly of alluvial soils.

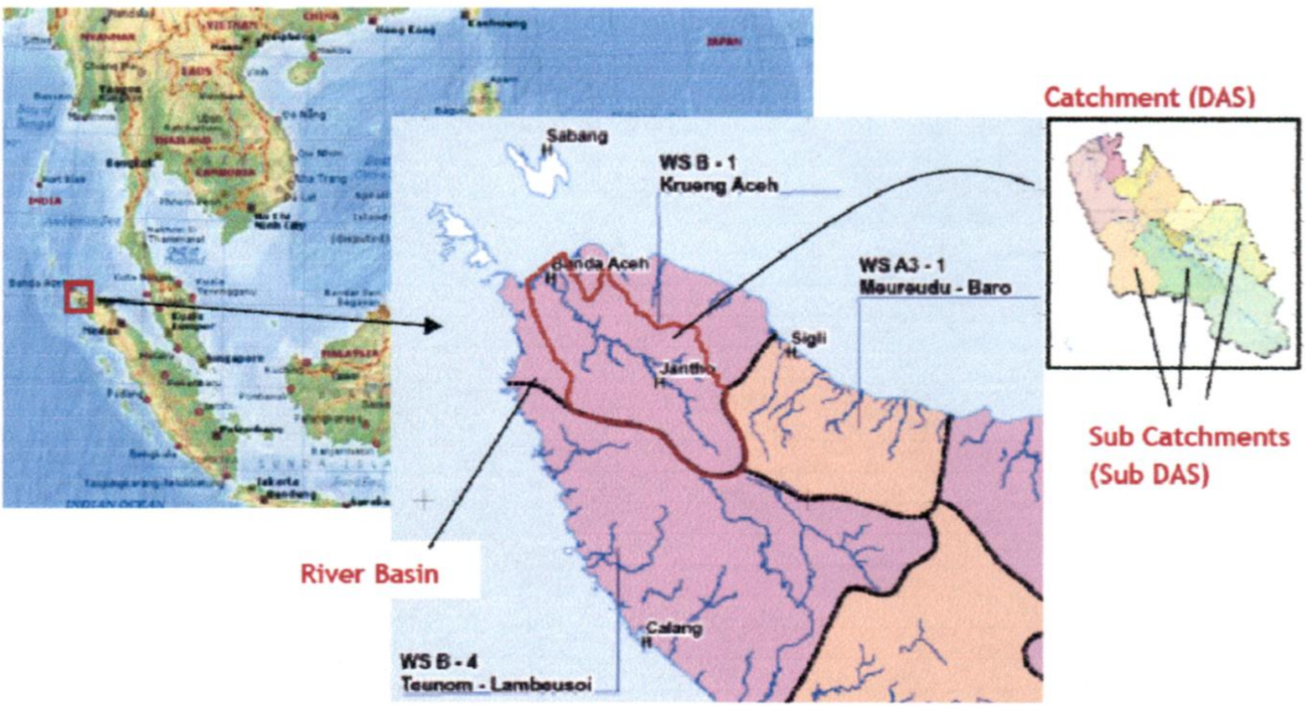


Figure 6: Location Kr. Aceh Basin

The basin's main river, the Kr. Aceh, has its headwaters in the Barisan Mountain in the South-East of the basin at an elevation of 1,000 m, after it drop to the 50 m contour lines near Seulimeum (Kr Aceh Weir), which marks the start of the alluvial plain. Here the river (referred as the Kr. Inong) join one of its major tributaries, the Kr. Agam and flow as the Kr. Aceh in the north-west direction to its outlet in the Indian Ocean at Banda Aceh.

Table 2: Summary rivers

Catchments/ DAS	No. Rivers				Length Rivers (km)				
	1st	2nd	3rd	4th	1st	2nd	3rd	4th	5th
Kr Aceh	1	20	70	11	64	269	403	72	1
	102				807				

Note : River section from junction Kr. Inong – Kr. Agam to sea

Other major tributaries downstream of Seulimeum are the Kr. Keumiru (Keliling Reservoir), the Kr. Jreu (Kr. Jreu weir, Kr. Lam Kareung weir) and the Kr. Leubok (Leubok reservoir). These rivers referred to as 2nd order. There are a total of 20 second order rivers and 70 third order rivers that drain into the Kr. Aceh (Table 3) and table Kr. Aceh characteristic (Table 3).

Table 3: Kr. Aceh Characteristic

Name of the river			Krueng Aceh
Length Latitude and Longitude		(Km)	113.00 North : 05^{0} 24' 47.2" East : 95^{0} 26' 45.5"
Width	Downstream	(M)	60.00
	Midstream	(M)	57.00
	Upstream	(M)	51.00
Flow	Max	M3/Sec	85.20
	Min	M3/Sec	10.38
	Average	M3/Sec	19.10
Water Resources		M3/Year	602,337,600.00
Slope (I)	Downstream	(m)	0.00412
	Midstream	(m)	0.00433
	Upstream	(m)	0.00474

Drainage Basin Area		(Km2)	1,752.00
Est. Gauging Equip			ARR & AWLR
Irrigated Area		(Ha)	D.I. Krueng Aceh
Irrigated Width		(Ha)	7,384.00
Flood Plain		(Ha)	2,100.00
Remark's			Sedimentation in River mouth

Krueng Aceh covers the area of 1752 sq.km, consist of ten sub-catchments, normally Kr. Inong. Kr Agam, Kr. Keumireu, Alue Lhok II, Lamkabeu, Alue Bhitak, Kr. Lebuee, Kr. Jreu, Kr. Lingka, Banda Aceh Right and Banda Aceh Left See the figure.

The catchments bordered by mountainous area. On west side there are some peaks along Bukit Barisan Mountain: Gle (Gle = Mountain) Raja (1660 m+), Gle Lemo (1670 m+), Cuplet Bulat (1951 m+), and Gle Mendeun (1589 m+). On east side there are: Seulawah Agam (1810 m+) and Gle Seukeun (1647 m+). Kr. Aceh catchments length is about 74 km and about 24 km wide.

Figure 7: Schematic Diagram Of Sub-Catchments In Krueng Aceh

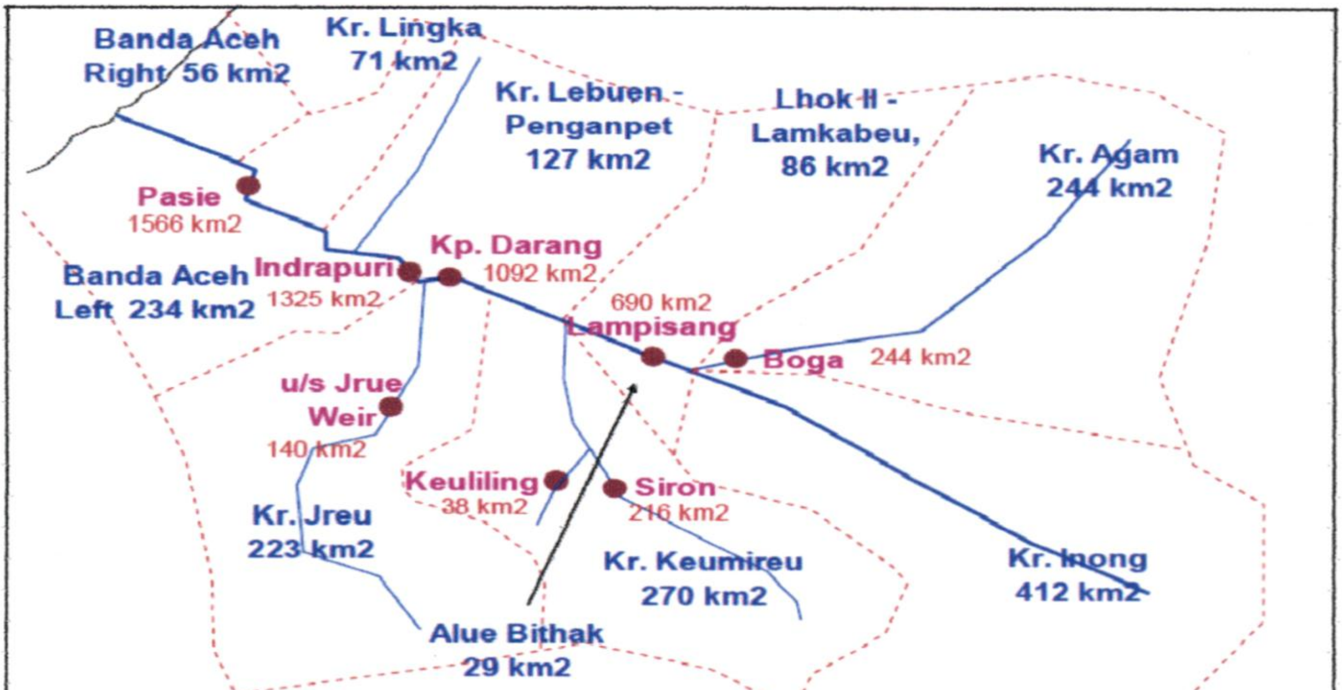


Table 4: Sub-catchments In Kr. Aceh

No	Sub-Catchments	Size (km2)	No	Sub-Catchments	Size (km2)
1	Kr. Inong	417 km^2	2	Kr Agam	244 km^2
3	Kr. Keumireu	270 km^2	4	Lhok II, Lamkabeu	86 km^2
5	Alue Bhitak	29 km^2	6	Kr. Lebuen-Penganpet	127 km^2
7	Kr. Jreu	223 km^2	8	Kr. Lingka	71 km^2
9	Banda Aceh Left	234 km^2	10	Banda Aceh Right	56 km^2
				TOTAL	1752 km^2

Catchments area of Kr. Aceh at the weir is 625 km^2 and at Kampung (Kp = Vilage) Lampisang 690 km^2. the catchments size at Kp. Darang is 1092 km^2, while at Indrapuri is 1325 km^2. Entering Banda Aceh at Pasi Village (Sta AWLR D) the catchments area is 1566 km^2.

The catchments of Kr. Jrue at the AWLR station (upstream of the weir) is 160 km^2. Kr. Keumireu at Kp. Siron has catchments size of 216 km^2. Kr. Agam at Boga has catchments of 244 km^2.

Will be analysis further in sub-section, there are four technical irrigation schemes in Kr. Aceh catchments, these are:

- Kr. Aceh irrigation scheme, 7450 ha, along the Kr. Aceh, mostly on the right bank.
- Kr. Jrue irrigation scheme, 2350 ha, along the Kr. Aceh left bank.
- Keuliling irrigation scheme, 1440 ha, downstream of Keuliling and outer side of Kr. Jrue scheme.
- Lebok irrigation scheme, 515 ha. Along Kr. Leubok.

These technical irrigation scheme cover the area of about 11755 ha out of village and simple irrigation schemes. The existing irrigation schemes spread over the middle of catchments, 27 km long and 11 km wide started from Seulimeum to Banda

Aceh. Most of those irrigation schemes are located in the plain/dissected plain area on both side of the Kr. Aceh river, it occupies about 7 % of the catchments.

Soil Preparation

Soil preparation include all mechanical measure to loosen, turn or mix the soil, such as ploughing, tilling, digging, hoeing, harrowing, etc. careful soil cultivation can improve the soil capacity to retain water, its aeration, capacity of infiltration, warming up, evaporation etc. but soil cultivation can also harm the soil fertility as its accelerated erosion and decomposition of humus. There is not one right way to cultivate the soil, but a range of option. Depending on the cropping system and soil type, appropriate soil cultivation pattern must be developed

Create good growing condition for plants, there are many reason for cultivating the soil. The most important ones are to:

- Loosen the soil to facilitate the penetration of plant roots.
- Improve the aeration (nitrogen and oxygen from the air).
- Encourage the activity of the soil organisms.
- Increase infiltration of water.
- Reduce evaporation.
- Destroy or control weeds and soil pest.
- Incorporate crop residues and manures into the soil.
- Prepare the site for seeds and sidings.
- Repair soil compaction caused by previous activities.

Minimum Disturbance

Any soil cultivation activity has a more or less destructive impact on soil structure. In tropical soil, regular tillage accelerated decomposition of organic matter which can lead to nutrient looses. The mixing of soil layers can severally harm certain soil organism. Soil after tillage is very prone to soil erosion if left uncovered before the onset of heavy rains.

Zero tillage system on the other side help to built up a natural soil structure with a crumbly top soil rich in organic matter and full of soil organism. Nutrient looses are reduced to a minimum as there is no sudden decomposition of organic matter and nutrient are caught by a dense net-work of plant roots. Soil erosion won't be a problem as long as there is a permanent plant cover or sufficient input of organic material. Last but not least, farmers can save a lot of labour.

Thus, each organic farmer will have to assess the soil cultivation practice which is most suitable for his condition. Zero-tillage can be used only in few crops, mainly perennial. To minimize the negative impact of soil cultivation while benefiting from its advantages, the organic farmer should aim on reducing the number of intervention to the minimum and chose methods that conserve the natural qualities of the soil.

Soil Compaction

If soil in cultivated in wet condition or burdened with heavy machinery, there is a risk of soil compaction which results in suppressed root grow, reduce aeration and water logging.

Where soil compaction is a potential problem, farmers should be aware of the following aspect:

- The of soil compaction is highest when the soil structures is disturbed in wet conditions.
- Do not drive vehicles on your land soon after rains.
- Ploughing of wet soil can lead to a smearing of the plough sole.
- Soil rich in send are less prone to soil compaction than soil rich took place.
- High content of soil organic matter reduce the risk of soil compaction.
- It is very difficult to restore a good soil structure once soil compaction took place.
- Deep tillage in dry condition and the cultivation of deep rooted plain can help to repair soil compaction.

Salinity of Soils

The seawater composed of salt, mainly in the form of NaCl. Other forms include a combination of basic cautions (K, Ca, Mg) and sulfate, bicarbonate, and chlorine anions. The seawater that flooded the agriculture land, in some areas lasted for several days, had a chance to infiltrate into the soil profile and increase the salinity of soil or deteriorate soil structure due to high sodium content. A preliminary study has been conducted to evaluate the effects of Tsunami on soil salinity. Two transects were chosen, called Darussalam and Lhok Nga transects. On each transect five points of observation were selected based on the level damages as indicated on the satellite images.

Figures 8 and 9 show the soil EC (Electrical Conductivity) and ESP (Exchangeable Sodium Percentage, the percentage of sodium relative to the sum of potassium, calcium, magnesium, aluminium and hydrogen on the exchange site) of top soil (0 – 10 cm) and sub soil (10 – 20 cm) of original soil 30 days after the

Tsunami. The EC for soil removed from Lhok Nga transect were much higher than the soil from Darussalam transect.

Figure 8a: The Electrical conductivity (EC) and Exchangeable Sodium Percentage ESP of soil collected from the Darussalam transect.

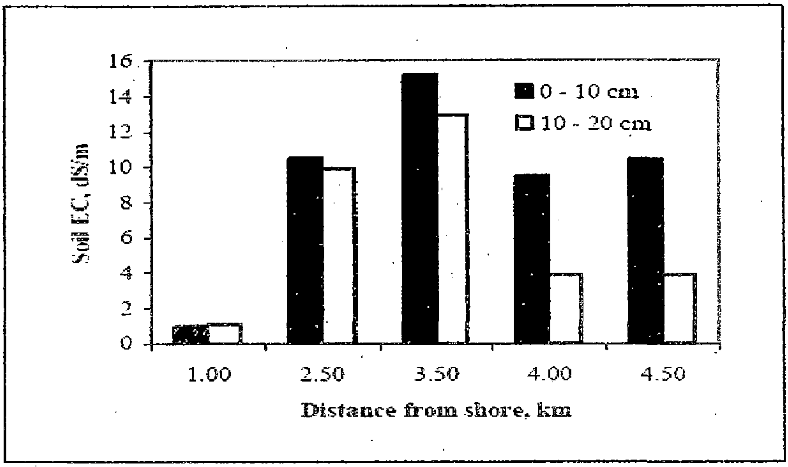


Figure 8b: The exchangeable sodium percentage (ESP) of soil collected from the Darussalam transect.

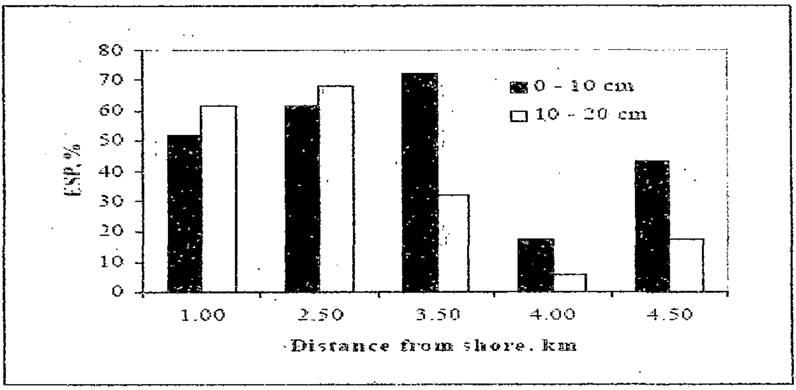


Figure 9a. The Electrical conductivity (EC) of soil collected from the Lhok Nga transect.

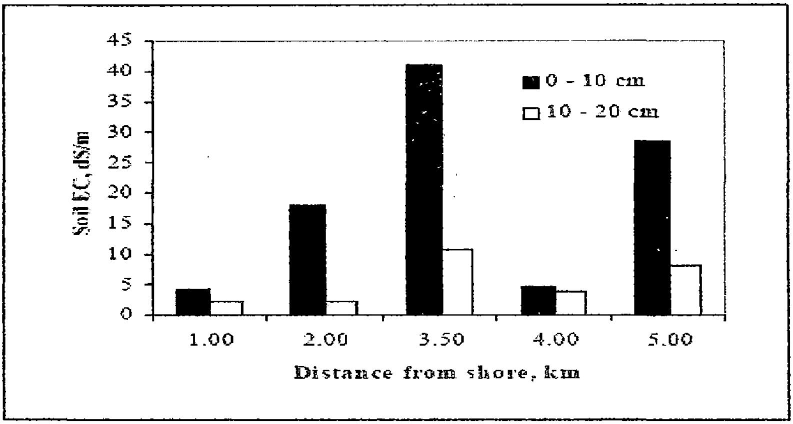
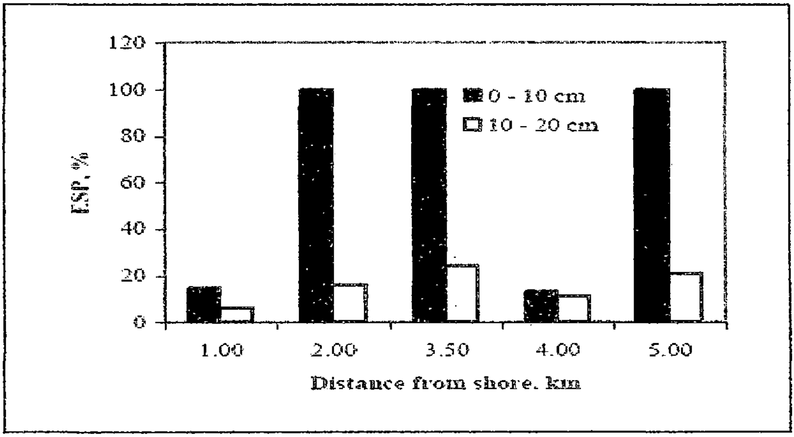


Figure 9b: The exchangeable sodium percentage (ESP) of soil collected from the Lhok Nga transect.



Soil samples collected from Lhok Nga transect were from paddy field and dry land from Darussalam transect. The paddy field tended to hold deposited mud inside the bunds, therefore, increased the chance to elevate soil salinity, while in the dry land the mud has been washed away by the rain.

There is a tendency that the EC for the top soils has been elevated from <1 dS/m for not affected soils to as high as 40.97 dS/m and to a lesser degree of increase for the subsoil. According to the information given by the local farmers, there has been 3 times of rainfall since the tsunami. The rainfall may have enhanced the infiltration of salt materials into deeper soil to increase the salinity for both the top and subsoil.

Soil salinity is an important growth-limiting factor for most non-halophytic plants. Salts inhibit plant growth by osmotic stress, nutritional imbalance, and specific ion toxicity (Cornillon and Palloix, 1997; Gunes et al., 1996). High levels of sodium on the exchange complex as indicated by the ESP value greater than 15 may deteriorate soil structure which in turn reduce plant growth (Ben-Hur et al., 1998).

Another problem facing the recovery process of agriculture is the widespread of debris on the farmland. The debris consisted of concrete cement, wrecked cars, and many other materials that need efforts to clean out from the farmland.

A preliminary recommendation has been released to the Ministry of Agriculture- Indonesia by the Indonesian Soil Research Institute-Bogor on dealing with the elevated soil salinity on dry land and wet land rice. The recommendation is based on the thickness of mud deposited on the field. (Table 5) indicates the management recommendation that can be applied to the field before planting seeds. The recommendation is subject to modification after more data is collected.

Table 5. Preliminary recommendation for rehabilitating the soil from salinity problems based on land use and mud thickness.

Land Use	Mud Thickness (cm)	Alternative Technology
Dry Land	< 5	Deep tillage to incorporate the mud with soil.
	5 – 15	1. Establish a simple/ditch irrigation to wash out the salts from the field. 2. Deep tillage (20-40 cm) to enhance percolation. 3. Apply more organic fertilizer to enrich soil organic Matter
	> 15	1. Restore/improve irrigation canals to wash out salts from the field. 2. Deep tillage (20-40 cm) to enhance percolation 3. Introduce salt tolerance crops. 4. Apply more organic fertilizer to enrich soil organic matter.
Paddy Field	< 5	Tillage to incorporate mud with the soil, then planted with rice after cleaning up the debris.
	5 – 15	1. Restore irrigation canals to wash out salts from the field. 2. Remove debris from the field. 3. Apply deep tillage (20-30 cm) to incorporate mud with the soil. 4. Apply more organic fertilizer to enrich soil organic matter.
	> 15	1. Establish/restore irrigation canals to wash out salts from the field 2. Remove debris from the field 3. Apply deep tillage to incorporate mud with the soil 4. Introduce salt tolerance crops. 5. Apply more organic fertilizer.

Drinking Water Supply

Before the disaster, only about 9 per cent of the total population in Aceh Province and 24 per cent in North Sumatra Province had access to piped water supply. Self provided and community based systems served the bulk of the population, mainly based on wells and springs. Sanitation across rural and urban areas was provided mainly by septic tanks and pit latrines. It is assumed that septic tank management was marginal, and sewage treatment plants partly operational before the disaster. Rural water systems have been badly affected by the disaster, with many thousands of wells and boreholes damaged, destroyed or contaminated an estimated 60,000 wells and 15,000 hand pumps. In these cases, urgent needs are for replacement, cleaning and disinfection. Mobile water supply has been a strong focus of the relief effort, through the action of relief actors (UN, NGOs and the military) in support of local government and GOI (Govermen Of Indonesia) efforts. UNICEF (United Nations Educational, Scientific and Cultural Organization) reports that no more than 20 per cent of the construction of latrines and water supplies in the spontaneous IDPs (Internal Displaced Peoples) settlements meets minimum SPHERE (Humanitarian Charter and Minimum Standards in Disaster Response) standards, with clear risks to human health and the environment. Sanitation systems have been flooded and destroyed by the tsunami, with the contents in many cases mixing with the tsunami waters. Risks include the passage of water-borne diseases, gastric complaints, typhoid and cholera. Standing water left by the tsunami in Banda Aceh has been tested by the MoE (Ministry of Environment), and consistent with sewage contamination. This can probably be extrapolated to other population centres, where water quality was also problematic prior to the tsunami. There are some 465 irrigation schemes, covering 335,084 hectares in Aceh. All 28,000 hectares of coastal irrigation schemes were significantly impacted by the tsunami. Additional damage to flood protection dykes and related infrastructure is also apparent.

Weather Condition In Indonesia

Being situated between two continents and two oceans, Indonesia is characterized by high temperature, high humidity and abundant rainfall. The daily mean temperature ranges between 22 °C and 31 °C. The mean annual temperature at level is somewhat above 26 °C and the mean humidity is 80%.

At Bandung, 730 m above the sea level, the mean annual temperature is 21 °C. At each rise of 1,000 m, the decrease in temperature is between 5.5 °C to 6 °C. Because of its position astride the Equator, Indonesia has no real seasons.

However, the period from September to March can be called the rainy season and that from April to August the dry season. The rain is typically tropical-frontal and convectional. Most of it falls with great intensity and thunder. In Java the mountains receive very large amounts of rain, the mean exceeding 4,000 mm on the windward slopes.

Sumatera and the western half of Java tend to have good rain all the year around with no determinate dry season. The eastern part of Java has less rain and a relatively pronounced dry season from July to October. In these islands the rainfall decreases eastwards to less than 1,000 mm; in the driest district the dry season is longer. This the only part of Indonesia with marked dry season. Most of Kalimantan has heavy rainfall throughout the year with totals exceeding 2,500 mm in the middle and north, 2,000 to 2,500 mm in the lowlands of the south and east, and 4,000 mm in the mountains. There is rally no dry season. Thus, nearly everywhere in Indonesia, the total yearly rainfall is high; it exceeds the potential evapotranspiration and surplus water is available. Rainfall varies widely between 700 and 7,000 mm per year (average rainfall for the whole country being about 2,600 mm), while actual evapotranspiration is generally within the range of 1,200 to 1,400 mm per year which can be considered constant all over Indonesia, apart from its decrease with altitude and the supply limits in dry seasons.

Weather Condition In Study Area

Temperature is very important and influences both pH and specific conductance readings. It is also an indicator of pollution. Polluted discharges either increase or decrease temperatures in water bodies. Extreme changes in temperature along a reach of a river is an indicator that a discharge of other waters may be occurring. These waters could be a groundwater discharge in the form of a spring, the inflow of a tributary or a pollution source. There are no standards for temperature for drinking water in Indonesia. For the Krueng Aceh system, waters ranged between 22.6 °C in the headwaters of Krueng Inong to 27.2 °C for the Krueng Agam just before it enters the Krueng Aceh. From Point 17 to Point 26, the main stem of the Krueng Aceh ranges from 25.6 °C at Point 17 to 26.8 °C at Point 25 (Peunayong Bridge). Higher temperatures with higher conductivities in the Krueng Agam and at the Peunayong Bridge deserve a closer look otherwise the changes in temperature are in general within a few degrees.

Water Management Organization Group

Government regulation (PP) No. 22 of 1982 on Water Management, and following PP No. 23 of 1982 on Irrigation expand the management and planning functions and the implementation methodology originally defined in the Law 11/1974. Under Regulation No. 22/1982 the rights to drinking water for every person and their livestock are set out a basic prior right as long as due care and attention are paid to the surrounding environment, without the need for any permit. The rights to water for all other uses however are said to require a permit. Authority to issue permits was lodged with Ministry of Public Works (MPW) together with the authority to prioritise the use of water by category and coordinate its overall management. PP No. 22/1982 also states that the authority and functions of the Ministry may be delegated to the regions through the Minister's office.

The two main regulations regarding Irrigation and Maintenance Policy (IMP) are President Instruction (INPRES) No. 2/1984 on 'Guidance to Water Users Associations (WUAs)', Irrigation Operation and Maintenance Policy (1987), an INPRES No. 42/1989 on 'System of Turnover of Small Scale Irrigation System and Management Authority to WUAs'. These were the basic regulation which provided guidelines for the establishment of WUAs in tertiary unit or village irrigation area; the introduction of efficient the operation and maintenance, special maintenance and Irrigation Service Fee (ISF); and the turnover of responsibility for operation and maintenance to WUAs of small scale schemes. Irrigation schemes were divided into three categories depending on their condition and management responsibility : A, B, and C.

This concerns the hand over of responsibility for the operation and maintenance of irrigation schemes from the government to the WUAs, starting with irrigation schemes smaller than 500 ha. Initially the program targeted irrigation schemes were grouped together into large block and turned over to WUAs en-masse. There was, however, usually a considerable delay before turnover was actually carried out, due to lack of coordination (central, provincial, and district/kabupaten levels) and too many procedure for processing program.

In 1992 important legislation was released from the Ministry of Home Affairs (MOHA). Two MOHA regulations on irrigation Service Fees No. 6/1992 and No. 19/1992 indicated the government's determination to raise revenue from the water users to provide funds for maintenance above the tertiary turnouts and place more responsibility on the farmers to care for the supply system.

Responsibility for the collection of the ISF was placed on the local revenue service (DISPENDA) whose task was to rise the revenue directly from the WUAs. The amount to be collected complicated issue, as it was individually assessed by Chief of District (Bupati), having, in the theory, taken regard of a number of location specific factors, such as the socio-economic condition of the area, the condition of the existing water supply and the actual calculated requirement. Following an initial and expensive three-years attempt to implement the law it has now been abandoned under the latest Autonomy for local government, Law No. 25 of 1999, Fiscal Balance Central to Region Government.

During the same period a new MOHA regulation, No. 12 of 1992 on the Establishment and Development of Water Users Associations was released. This regulation is based on number or previous laws regarding village structure and responsibilities and classic President Instruction No. 2/1984 on Guidance to the Water Users Association. The MOHA regulation was released to improve and clarify the status of WUAs; that it was really time to enforce the regulation of WUAs, one of which is the obligation to pay service fee for maintenance.

International Bank for Reconstruction and Development (IBRD) and World Bank had independently concluded that further assistance was required to support the development of reform in water resources sector, and recommended a program that closely matched the (National Planning Agency, Indonesia) BAPPENAS agenda. Consequently a USD 300 million Water Sector Adjustment Loan (WATSAL) was proposed by the World Bank, conditional on specific indicators being achieved within an agreed time frame. A Policy Matrix was developed jointly by WB and BAPPENAS; following this, the WATSAL task force was established by decree issued by Minister of Planning (November 1998).

Further to this, owing to the multi-ministerial involvement in the reform, a Presidential Decree was issued on 9/1/99 creating a Coordination Team from nine concerned Minister whose duties were based on the following principles;

- Management would be based on beneficial and sustainable principles for the welfare
- of the nation and its living environment,
- Consideration should be given to all habitat conservation and environmentally
- sustainable needs for all natural resources and living creatures,
- Where possible, corporate basin management organizations such as State Owned Enterprises (SOEs) and regional owned enterprises (BUMD) should be utilized,
- Public, community and NGO participation in basin management institution should be promoted.

The specific aspects to be reviewed and requiring reformed policies were:

1) improved water pollution control regulation,
2) Irrigation Management Policy Reform,

3) ISF reviewed in terms of self financing capacity,
4) WUAs Empowerment, and
5) Curtailment of the million hectare swampland / peat-land (Gambut) project expenditures.

These aspects and the various issues they encompass were used to define the reform objectives, address policy, legislative, and institutional\ readjustments focusing on food security, sustainable water use, and improved water related environments. These consideration were defined in the four part WATSAL program.

Minister Decree No. 179/1996 issued by the Ministry of Home Affairs proscribes the organizational structure, the status, task and function of a number of Training Centre (Balai) to be established under the Java loan program in all provinces of Java. It establishes that the Balai as Technical Implementation Unit (UPTD) under the Provincial Public Works Service, Provincial Water Resources Development Service (PSDA). A program of support for establishment of these Balai is currently being undertaken by the Basin Water Resources Management Project (BWRM), which is operating under the Java loan (IBRD, ADB, JBIC) supporting WATSAL.
The task and function of these Balai will vary according to the need of the basin(s) that within their management. It is envisaged, however, that they should have the capability of managing the resource base of all water related aspects, from coastal zone management to watershed management, according to the specific need. An institutional guideline to determine the task, function and operation is due to be produced to assist the administration of these offices. Some Balai are situated with the River Basin Management Authority areas (PJT 1 and PJT 2) and their operational procedure will be, necessary, have to be reviewed as part of the overall WATSAL agenda.

Capacity strengthening under the WATSAL agenda is vital for the proper functioning of these Balai and institutional coordination, through Director Water Regulator System Committee (Panitia Pelaksana Tata Pengaturan Air = PPTPA) to Water Regulator System Committee (Panitia Tata Pengaturan Air = PTPA), is necessary to maintain effective purpose and function. The devolution of irrigation management to the district levels through the imposition of Law 22/1999 will require the Provincial Service Office (Dinas Provinsi) and Branch Service Office (Dinas Kabupaten) to examine their institutional roles and responsibilities. Criteria need to be developed to determine the relating of Balai to PPTPA and to PTPA and share of responsibility in the execution of the workload. The division of assets, infrastructure for operation and maintenance, jurisdiction in water resources management and coordination of management all need critical examination.

CHAPTER III
METHODOLOGY

The study employ both qualitative and quantitative method to collect primary information from the sites. The method use were household surveys, Focus Group Discussion (FGD) and direct observation. Secondary observation basically in historical rainfall and crop production data covering to the study site were accessed and utilised. Most of the information was collected through household survey using a structured questionnaire where the individual household are the sampling unit. FGD provided general information common to the community to further supplement the study.

The direct observation was carried out in both the study site frequently in order to triangular, justify and validate the responses obtained from the household survey and FGD. It was important to monitor on-farm rice varietal diversity and its distribution in crop growing season.

The Questionnaire and Survey

A structured questionnaire constituting both open and close ended question was developed to acquire information required for each study objective (Annexures). The questionnaire had four sections. The first focused on the demographic and socio-economic information such as age, sex, education, occupation, family size, food security and income source. The second section captured the information regarding resources such as land and its types, varietal diversity and its abundant. The third section explored farmers perception of rainfall variation during rice growing season and its effect on rice production and food security. This section also ranked vulnerability of rice varieties and landraces particular in relation to abnormal rainfall events. The final section about farmers adaptations, knowledge and practices.

To enhance the validity to questionnaire, it was pre-tested with non-respondent outside the sample frame close to the mid-hill site with the purpose identifying how farmers understand and respond to each question asked. Finally, the questionnaire was translated into local Indonesian to Simeulues vernacular language to facilitate better understanding by the respondents.

The survey was conducted at the end of December in mid-hill and during second week of January in plain. Personnel trained in survey work were employed as survey assistant and were further oriented before conducting the survey. The survey participants were informed individually three days before to allow them to allocated time. The survey assistant under the supervision of researcher administrated household survey through face to face interview techniques at both sites.

Focus Group Discussion

Focus Group Discussion (FGD) is a qualitative study method that require a small homogenous group of experienced people to discuss a study topic (McCallister, 1998). It is an exploratory research tool and is extensively use by researchers to generate quantitative data and triangulate findings (Morgan, 1997).

In this study, FGD was used a to draw information from the study site related to varieatal dynamic, rainfall related stress events as well as its locally perceived effects on food security. The discussion was led by the researchers with the use of checklist prepared. Four experienced persons including at least one female from each participating group were invited to participate in each FGD

Figure 10 : Researchers conducting household survey in plain (left) and focus group discussion in mid-hill study site (right). (Photo : Fauzan)

The participating community people provide the requested information based on their recall on past and present experiences on the study topic in each FGD. There FGDs were organized in each study site during the entire study period. The first was before the survey in august to discuss general facts about the study site and the participation.

The second was during the time of the household survey to conduct historical time line analysis on rainfall change, its dynamic effect on production and food security. Timeline analysis is a qualitative research tool that facilitated trend analysis, situation assessment and future prediction (Barry, 1997).

The basic idea of time line analysis in this study was to recall the major rainfall related stress events of the past and present of the past have had an effect on rice crop, its diversity and other aspect in the society. Finally, the third FGD was a general discussion after one month of survey to validate and share some of the preliminary findings with the participants.

Sample Size

A representative sample of 10 distributaries and 360 farm households were selected for collecting primary information from the field and secondary information from the Former Organizations (FOs) and irrigation department offices. The distributaries and farmers were taken from all the districts which fall in the area of Krueng Aceh Irrigation i.e. reform area.

Questionnaire Development

A comprehensive questionnaire was constructed and pre-tested in order to make necessary changes regarding variation in situation across different selected distributaries. After necessary amendments, the final version of the questionnaire was developed. The questionnaire consisted of four modules arranged as follows.

- Basic information module:

This module was designed to gather information about the household, such as household members, their ages, schooling, sources of income, employment, non-farm income, area owned, and area rented-in, area rented-out and land rent in the area.

- Irrigation infrastructure module:

This module gathered information on sources of irrigation water, number of irrigations, type of outlets, cultivated area, operation and maintenance of irrigation infrastructure and overall condition of the distributaries.

- Agricultural production module:

This module obtained information on the farming situation before and after the implementation of the irrigation management, cost and value of agricultural production

- Retrospective questions module

This module was designed to obtain historical information over the last four years (before and after Irrigation Management Transfer (IMT)) on availability of surface water, water delivery problems at their turn, percentage of ground water used, quality of ground water, crop yields, and production of major crops and irrigation related problems.

The questionnaire was carefully edited to frame the questions to suit the local context, in so far as units of measurement, local connotations, or other common usage of phrases or words were concerned. This made the questionnaire easier to understand by the respondents.

Pre-Testing Of The Questionnaire

Keeping in view the objectives of the study, pre-testing was under taken. Information such as the clarity of the questions, length of time required to complete a questionnaire, quality of the answers, relevancy of the questions and logistical requirements were gathered during the pre-testing period. A general review of the questionnaire was conducted and necessary changes based on pre-testing were incorporated.

Data Sources And Collection

Two types of data were collected.

- Primary data
- Secondary data

Primary Data Collection

For collection of primary data, respondents were interviewed personally at their farms. Although questionnaire was constructed in English, yet the questions were asked in their local language (Aceh) for the convenience of interviewees to get the required information with maximum accuracy. While interviewing, researcher tried his best to maintain informal and friendly atmosphere in order to obtain the data from the respondents. Records of irrigation activities and transaction records for the years 2004-05 and 2006-07 growing seasons were also collected. Fieldwork in the community was the ultimate focus of study as farmers were the most important stakeholders in the process.

Secondary Data Collection

Various secondary data sets were also collected in order to support the results on primary data set. Pre-IMT data for two years (2003 and 2004) was collected from the Aceh Besar Irrigation Department (ABID). Data included assessment of water charges, collection of water charges, O&M expenditures, non-development expenditures, Head-Tail equity in water distribution and disputes reported from Head and Tail end reaches. Information regarding design discharge of distributary at the Head was also collected. Post-Irrigation Management Transfer (IMT) data for the last two years (2005 and 2006) was collected from the Former Organizations (FOs) working in the field

In this research, selected distributaries in the Krueng Aceh Irrigation were examined and assessed for their physical and economic performance before and after management transfer. The research work was based on:

a) Literature Review,

b) Interviews with different stake holders including

(i) FO representatives particularly President and members of management committee

(ii) Officials of Aceh Besar Irrigation Department (ABID) and Aceh Besar Irrigation and Drainage Authority (ABIDA)

(iii) Farmers of the study area

(iv) Irrigation management experts from different walks of life

Literature review contributed towards the understanding of the existing irrigation system and the proposed institutional reforms. Interviews with the Former Organization (FO) representatives and relevant people from the government and relevant institutions enhanced the understandings of the irrigation system management and broadened the vision regarding the irrigation reforms.

Data Entry

The questionnaires were edited every day before moving on to the next day. In this way a quality data of 10 distributaries and about 360 respondents was collected. For data entry, a format was prepared on the Microsoft Excel work sheet. It was also required to convert data recorded in different units in the questionnaire to standard units prior to entering in the database. All the data was carefully entered.

Cleaning And Organization Of Data

Cleaning is the integral part of the data management process before using it in the final analysis. The entered data was examined for errors or bad entry, missing values and zeros. Errors identified were immediately corrected. The data were also examined cell by cell to detect any error. The data base in Excel was converted into Statistical Package for Social Scientists (SPSS) format and further cleaning was undertaken. Tables were generated for all variables and were examined for outliers, errors in coding, as well as other errors. Variables with such errors were sorted and the case number identified and doubtful cases were verified by checking back with the questionnaire. Subsequently each data file was examined by individual row or column to detect any error across variables or within a variable.

Indicators For Performance Measurement

Following is a list of indicators that were used to assess the outcome and impacts of Irrigation Management Transfer (IMT) in the study area. The rationale for adopting IMT is that it would improve quality and efficiency of irrigation system, to improve Head-Tail equity, better financial and physical sustainability of irrigation systems, and increased productivity and profitability of irrigated agriculture. A well defined set of indicators was carefully recorded.

Table 6: Broader Category of Indicators Used at Various Levels in the Study

Broad category of indicators	Level of study	Indicators
Physical indicators	At both levels	Condition of the system, water delivery, ground water contribution
Institutional Indicators	At level first	Presence of new institutions, working of new institutions, user participation, impact of new institutions, dispute settlement

Productivity indicators	At level two	cropping intensity and pattern, cropped area, GVP, gross Margin, net income of farm
Sustainability Indicators	At both levels	O&M expenditure, water charges collection, operational expenditures
Socio-economic Indicators	At both level	Age, education, income level
Equity	At level first	Delivery performance ratio, Head-Tail equity
Institutional Indicators	At Second level	Capacity building and training of FO representatives. dispute settlement

Source: Hussain and Biltonen 2001

Few of the above indicators are explained below while others (average yield, gross value product, average cost of production, variable cost of production, gross margins, loan assessment, loan collection, per hectare O&M expenditures, per hectare salary expenditures) are self explanatory.

1. Equity In Water Delivery

a. Delivery Performance Ratio (DPR):

$$\text{DPR (H)} = \frac{\text{Observed discharge at Head}}{\text{Sanctioned discharge at Head}}$$

The ratio should be closer to 1.

$$\text{DPR (T)} = \frac{\text{Observed discharge at Tail}}{\text{Sanctioned discharge at Tail}}$$

Ideally the ratio should be closer to 1.

b. Head-Tail Equity: $= \dfrac{\text{DPR at Head}}{\text{DPR at Tail}}$

c. Tail End Supply Ratio (TSR):

$$TSR = \frac{\text{No. of days sufficient water supply reached at the end of the distributary}}{\text{Total number of days.}}$$

Ideally the ratio should be closer to 1.

d. Head-Tail Equity in output

2. Financial Sustainability

a. Loan collection performance:

$$= \frac{\text{Total amount of loan collected in a year}}{\text{Total amount of loan assessed in a year}}$$

b. Gap between loan assessment and Actual collection

3. Operation And Maintenance (O&M)

a. O&M expenditures per acre of CCA

4. Institutional/Capacity Building

a. Trainings obtained by the FO Executive Body

b. Conducted regular General Body meetings

c. Conducted regular Executive Body meetings

d. Participation rate in General Body meetings

e. Participation rate in Executive Body meetings

f. Preparation of Annual Development and Maintenance Plan

5. Dispute Settlement

$$\text{Ratio of disputes:} = \frac{\text{Total Number of disputes settled}}{\text{Total Number of disputes registered}}$$

6. Productivity

a. Out put per unit area at Head, Middle and Tail (Rp. Per ha):

$$= \frac{\text{Total annual value of agricultural production}}{\text{Total command area}}$$

b. Out put per unit irrigated area (Rp. Per ha):

$$= \frac{\text{Total value of agricultural production}}{\text{Total annual irrigated cropped area}}$$

c. Cropping Intensity:

$$= \frac{\text{Gross cultivated area in a year}}{\text{Gross cultureable area}}$$

CHAPTER IV
OBSERVATION

OBSERVATION

Economic Conditions In Aceh

Aceh's GDP in 2003 was approximately US$4.5 billion, about 2% of the GDP of Indonesia. While the Acehnese economy has generally benefited from the

Table 7: GDP with and without Oil Gas (billion rupiah), Aceh 2000-2004

Year	GDP (with oil & gas) (Rp. bn.)	GDP (without oil & gas) (Rp. bn.)	Growth (%) (with oil & gas)	Growth (%) (without oil & gas)
2000	35,883	19,259	--	--
2001	32,565	19,136	-9.3	-0.6
2002	39,961	20,426	22.7	6.9
2003	42,239	21,204	5.7	3.7
2004	39,664	21,778	-6.1	2.7

Note: Based on 2000 constant prices. 2004 data are preliminary figures.

Source: Bappeda Aceh (2005)

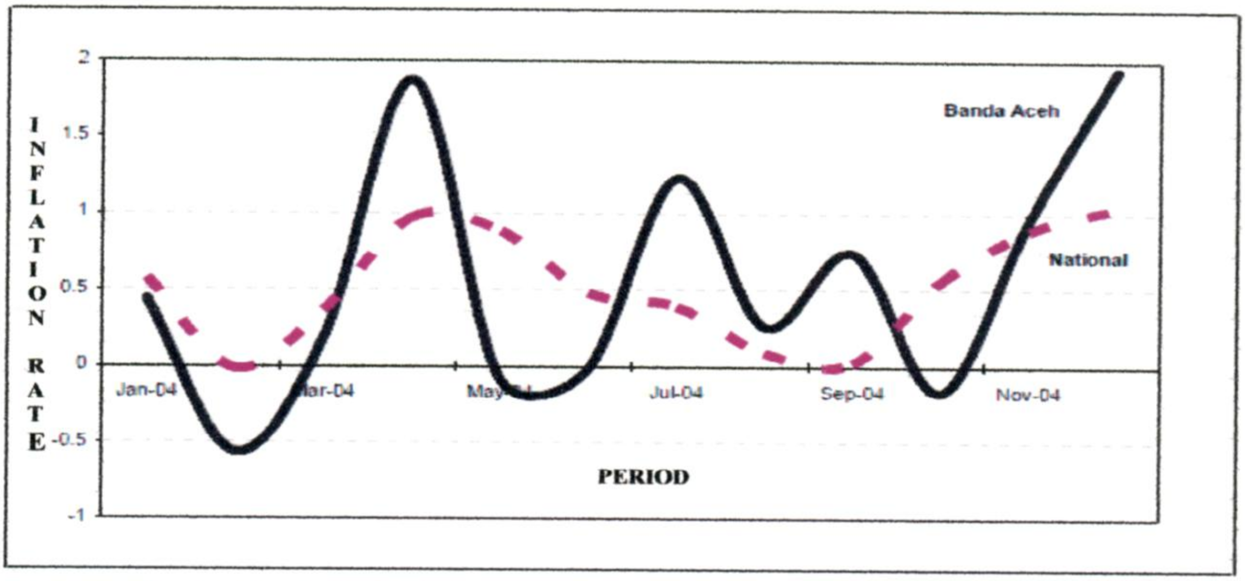
regional oil and gas industry, in 2004 the local energy sector contracted somewhat, contributing to negative growth in the province (Table 7). The agriculture sector, which makes up around 32% of regional GDP, also plays a key role in the local economy. Agriculture absorbs almost 50 per cent of labour in Aceh. Other major sectors of employment are trade (21%) and public services (18%) (Bappeda Aceh, 2005).

In the early 2000s Aceh's exports to other parts of Indonesia were small, around 8 per cent of regional output. About 26% of Aceh's output was exported abroad and 66 per cent was consumed within the province. Imports from other parts of Indonesia and from abroad were a small part, about 6% and 4%

respectively, of the total material inputs needed for Aceh's productive sectors (Athukorala and Resosudarmo, 2005).

Regional inflation (as measured in the provincial capital of Aceh Besar) was moderate in the period just before the tsunami (Figure 11).

Figure 11: Monthly Rates of Inflation (%), Aceh Besar, prior to December 2004 Earthquake and Tsunami



Source: Bappeda Aceh (2005)

Aceh's population was around 4.1 million in 2003. Although, on paper, Acehnese GDP per capita (almost US$1,100) was among the highest in Indonesia because of the statistical boost to measured production provided by the oil and gas sector, in fact many local areas in Aceh did not receive noticeable benefits from the enclave energy sector and were quite underdeveloped. Indeed, before the tsunami the Ministry for the Development of Least Developed Regions had classified eleven districts in Aceh (around half of the total in the province) as "least developed districts". In 2003 it was estimated that the percentage of poor people in Aceh was almost 30 per cent (almost 20 % and 34 % in urban and in rural areas, respectively), while the figure for Indonesia as a whole was around 17% (14% and 20% in urban and rural areas, respectively). Aceh was among the five provinces with the highest percentage of poor people (BPS, 2005). The long-term socio-political conflict was widely believed to be one of the major causes for the lack of development in the province (Soesastro and Ace, 2005).

The Indonesian national decentralisation program which became effective in 2001 brought dramatic changes to the public revenue and expenditure patterns in Aceh. Regional government spending in 2004 was double that in 1999. However, the bulk of the expenditure was still for routine administrative expenses (such as salaries and building maintenance) (World Bank, 2003 and 2006b; Bappeda Aceh, 2005).

Economic Impacts

The World Bank's assessment of the total damage caused by the Aceh tsunami was US$4.45 billion, almost equal to Aceh's GDP in 2003[3]. Of this total, 60% was estimated to be physical damage and 40% was from losses of income flows through the economy. Almost 80% of total damage and losses was borne by the private sector while the rest was borne by the public sector (World Bank, 2005). The Institute for Economic and Social Research (LPEM) at the Faculty of Economics, University of Indonesia, estimated the total damage in Aceh to be slightly higher than the World Bank's estimate at US$4.6 billion (LPEM, 2005).

According to the World Bank, Aceh's GDP in 2005 could contract by 7%–28% of the 2004 level (World Bank, 2005). LPEM (2005) arrived at a slightly lower estimate than the World Bank's upper estimate (22%).

[3] The World Bank's estimate was based on a standard assessment technique developed by the United Nations Economic Commission for Latin America and the Caribbean (ECLAC, 2003)

The oil and gas industry in Aceh escaped the tsunami virtually unharmed. The most seriously affected sector in terms of both the number of casualties and capital destroyed was agriculture, particularly fisheries. (Soesastro and Ace, 2005).

According to information gathered by the Ministry of Marine Affairs and Fisheries, by mid-January 2005 approximately 55000 fishermen and aquaculture workers were confirmed dead (approximately one-half of the total number of fishermen in Aceh) and around 14000 are still missing. The UN Food and Agriculture Organization of the United Nations (FAO) reported that 40%–60%of coastal aquaculture ponds along coastal Aceh and between 36000 and 48000 hectares of brackish-water aquaculture ponds (which mainly produced shrimp and milkfish) were seriously damaged. It is estimated that about 65%–70%of the small-scale fishing fleet and associated gear was destroyed in Aceh (FAO, 2005a).

In Aceh about 30,000 hectares of rice fields—around 10% of the area under rice cultivation in the province—were badly affected. Soil salinity problems were the main concern. Fortunately, because of humid conditions, salt-polluted arable land was cleaned by rainfall and by irrigation water relatively quickly. A survey carried out by FAO in early 2005 indicated that salt deposited in more than two-thirds of the affected agricultural land was leached out within a few months allowing planting to resume in April and May 2005. It was estimated that only 9000 hectares could no longer be used for farming (China View, 31 March 2005; FAO, 2005b).

The impact of the decline in Aceh's GDP on Indonesia's overall economic performance is expected to be small. Both the World Bank and the LPEM estimated that Indonesia's GDP growth in 2005 was expected to be no more than around half a per cent less than the pre-tsunami growth forecast (World Bank, 2005; LPEM, 2005). An increase in poverty is probably the most serious economic problem caused by the tsunami and earthquake. In 2004, the Indonesian Central Agency of Statistics calculated that almost 30% of people in Aceh were living below the poverty line. LPEM predicted that this figure could grow to around 50 per cent.

Agricultural Sector

Rice is the major food crop for farming and staple food for the people of Aceh. Paddy cropping pattern and seasonal production are mainly determined by irrigation system and rainfall. Rainfall varies considerably, with generally more rainfall on the west coast than the east coast. In drier areas, there is only one crop per year without irrigation, but 2-3 crops with irrigation. Overall, the east coast has better irrigation facilities than those on the west coast.

Based on the pattern of the monsoon winds, there are two main seasons in a year, referred to as "wet" and "dry" seasons. The wet season normally runs from October to March and produces some 60% of the annual rice crop and half of the annual maize, soybean and groundnut crops. The dry season covers the period of April to September when the remainder of the annual crop is produced.

Total wetland area in Aceh before the tsunami was around 391000 hectares, with paddy harvested area increasing in the last decade from 300000 hectares in 1990 to 370000 hectares in 2004. Many coastal rice growing areas were devastated by seawater inundation and marine deposits. The total damaged/lost paddy land was estimated at 37500 hectares (equivalent to some 60000 ha of harvested area), accounting for some 16% of paddy land. Among the total damaged/lost land, 18.9% was lightly damaged, 26.7% moderately damaged, and 46.7% highly damaged. Some 2900 or 7.7% was totally lost to the seas or have become completely unsuitable for farming (Table 7). Based on FAO, normal agricultural production started immediately in lightly damaged field, but it required simple interventions in moderately damaged area and more complex interventions in heavily damaged area.

Almost everywhere along the west coast and Simeulue, the direct effects of the earthquake and the tsunami on agricultural land were both more extensive and more severe, with most damaged paddy-fields categorized as being severely damaged; while on the east coast, damage is more limited to the estuarine areas of Pidie, Bireuen, Aceh Utara, and Aceh Timur, with most paddy-field damage categorized as light or moderate.

On the west coast, the February/March harvest – lost to the tsunami in affected area represents a greater share of annual paddy production. Many rural communities in the affected areas lost not only most of their farm assets, but also important agricultural infrastructure such as drainage and irrigation systems, rice mills, processing plants, agricultural markets, trader shops, research and training institutions, and government extension services.

Recovery Status In Aceh (Nanggroe Aceh Darussalam = N.A.D)

(Table 8) provides a summary of the rehabilitation progress so far as well as the prospects for 2006 for the rice fields in Aceh. Almost one year after the tsunami, more than 90% of lightly damaged and more than 80% of the moderately damaged paddy fields have been cleaned and restored for 2005/06 main wet season starting from October/November, primarily through cash for work programmes. Most of both categories of affected paddy fields had one harvest since the tsunami, with unexpectedly good yield on the east coast. However, some of the severely damaged paddy fields need major rehabilitation including recovery of irrigation infrastructures and removal of sediments from drainage systems or creeks mouths which is expected to up to 5 years; some 3 000 ha is lost permanently. Some areas may be planted with rice, but other areas may be more suitable for aquaculture or planting of salt-tolerant tree crops, particularly in the low areas near the sea.

The deterioration of soil fertility due to the salt pollution of agricultural fields was a major concern during our March Mission. However, surveys and research by FAO and Australian Centre for International Agricultural Research (ACIAR) in collaboration with the Indonesian Soil Research Institute in Bogor and Balai Pengkajian Teknologi Pertanian (BPTD: Assessment Institute for Agriculture Technology) in Banda Aceh suggest that soil salinity is no longer a major threat to crop production in areas that have good irrigation facilities or those that receive good annual rainfall in the west.

Based on a FAO survey, heavy precipitation along the severely damaged west coast in the spring had already leached out most of the contaminated lands. Along the drier east coast, farmers and local government officials interview also confirmed that the fields with salt contamination were well-watered by rain and the situation has returned to normal. However, crop failures had been reported in low-lying areas near tidal creeks due to much more extensive inundation with seawater. Farmers on the east coast reported that they have unexpectedly good yield (5.5 tonnes/ha) from the lightly damaged fields. The farmers also attribute the good harvest to the seeds, fertilizer, tools, and hand-tractors provided by FAO, government and other organizations.

Table 8: Rehabilitation Progress in 2005 and Prospect for 2006: Paddy Fields in NAD

Damage by Degree	Area Damaged (ha)/	Rehabilitation and Production in 2005			Prospects for Rehabilitation and Production in 2006		
		Rehabilitated	Production	Assistance received	Rehabilitation	Production	Assistance Needs
Minor damage	7 070	>90% as normal	1 harvest in irrigated area; good yield	seeds, fertilizer, hand tractor, thresher, water pump, Cash for work	100% recovery	Normal	Seeds, fertilizer, fuel
Moderate	10 000	>80% cultivated, but irrigation system not recovered	1 harvest in irrigated area with salt tolerant rice varieties; normal yield	Same as above	>90% recovery in cultivation and irrigation system	Normal with change of cropping pattern	Cash for Irrigation system, seeds, fertilizer, fuel
Severe	17 500	>50% cultivated, irrigation system not repaired	Most areas no harvest	Same as above	>70% recovery in cultivation and irrigation system	Some area for paddy, some for aquacultur e or tree crops	Cash for Irrigation system, Support to diversificat ion, inputs
Lost	2 900						
Total	37 500						

Source: BRR and Mission's assessment.

Comparison Of Performance Indicators

To achieve the objectives of the study and to assess the performance of the system in terms of improving water delivery, O&M of the system, equity in water distribution and overall management of the system and agricultural and economic productivity, data were collected separately from primary sources (farming households in the study area) and secondary sources (office record of FOs, ABID, ABIDA and other published material).The present chapter is divided in to three parts. The first part covers the socio-economic profile of the respondents in the study area. The second part is based on the comparison of indicators developed from primary data and the third part is based on the comparison of indicators developed from secondary data. These indicators have been used in different studies such as Hussain and Biltonen (2001), Hussain *et al.* (2003) and Molden *et al.* (2007)

Socio-Economic Profile Of The Respondents Across The Study Area

Apart from the direct measurement of the variables in the study, other basic characteristics like, family size, sources of income of the respondents, education, tenancy status and land distribution also provides information on the impact of irrigation reforms in the study area. As it was observed that a large family size with low education level has more tendencies to work on the farmland as compared to an educated family of the same size. Various indicators were analyzed under the following categories:

- Socio-economic indicators
- Agricultural indicators

Social Indicators

Family Size In The Study Area

Family size represents the number of total family members (male and female) of the respondent. A large number of farm household in the study area were averaged 6 family members. About 11 percent of the respondents had family members total 7 or more. About 23 percent of the respondents fall in the category of those having family members from 2 to 4. About 28 percent of the respondents in the study area had 6 family members. Thus (Table 9) shows a heterogeneous family structure as observed in the study area.

Table 9: Structure and Family Size of the Respondents in the Study Area

Family Size	No. of Respondents	Percentage (%)
2 to 4 family members	82	22.7
5 family members	59	16.5
6 family members	102	28.4
7 family members	78	21.6
7 and above members	39	10.8
Total	360	100

Sources Of Income

Farming is profitable business if it is managed scientifically/technically using balanced inputs. In the study area, it was found that most of the farmers were growing major crops (maize, rice and sugarcane). Due to financial constraints, they were unable to use the recommended inputs and hence they were not getting expected yields. It was also evident that for large proportion of farmers in the study area agriculture was the only source of income. However, there were few farmers who were jointly managing farmland along with the other economic activities. More than 80% of the farmers were engaged in agriculture for their livelihood. Only 7.50% of the respondents were either doing government or private sector service. Some 2.66% of farmers were poultry farmers and 4.55% were shopkeepers. A small percentage of farmers (about 0.45%) were also getting remittances from abroad. It was also found that there were some farmers who were also doing labour along with agriculture. This group of farmers represented about three percent of the total respondents.

Table 10: Source of Income of the Respondents in the Study Area

Source of Income	No. of Respondents	Percentage (%)
Agriculture only	293	81.35
Agriculture +Job	27	7.50
Agriculture + Poultry Farming	10	2.66
Agriculture +Shop keeping	16	4.55
Agriculture +Remittances	2	0.45
Agriculture +Labour	9	2.45
Agriculture +Others	3	1.04
Total	360	100

Educational Status Of The Respondents

(Table 11) shows that 58% of the farmers in the study area were either illiterate or under middle school level. When the respondents were asked about their low level of education, they revealed that they got the household farming in inheritance from their forefathers. For such respondents, agriculture was the only source of income, and due to their limited resources they remained unable to get desired education. On the other hand, only 1.6% of the respondents were those whom have completed 14 years or above schooling. Out of the total sampled respondents 7.45% completed 10 years of schooling. It was observed that majority of the educated farmers were also engaged in other economic activities at local level. Thus it is clear from the above discussion that most of the farmers in the study area were not equipped with education. Similar pattern of educational qualification was found in FOs. The results of the study also showed that a majority of the farmers were illiterate. Such farmers represented 58% of the total respondents in the study area. While interviewing such farmers, it was observed that they were laggard in adopting modern agricultural techniques. It was also found that only 6% of the farmers had higher school education.

Table 11: Educational Qualification of the Respondents in the Study Area

Qualification of the Respondents	No. of Respondents	Percentage (%)
B.A and above	6	1.6
Intermediate (Higher Secondary)	20	5.53
Matriculation (Secondary level)	27	7.45
Middle (8 years of schooling)	100	27.65
Illiterate	207	57.77
Total	360	100

Agricultural Indicators

Land Distribution

Land is unevenly distributed among the farmers in the study area. The number of farms in different farm household classes varied during different time intervals. Land is being fragmented in to smaller units due to our prevailing inherited land distribution system. Over population has been one of the more apparent causes of this variation especially as the farm sizes were decreasing. (Table 12) shows that a significant proportion of the farmers in the study area were operating less than 5 ha of land. Land holding in the study area was mostly in the range of 3 to 5 ha. Similarly, about 80% of the farmers owned land in the range of 3 to 5 ha in lower canal Krueng Aceh (East) irrigation system of Krueng Aceh. About 0.6% of the farmers were operating farm area more than 100 ha, showing a merger proportion. On the other hand, thus heterogeneity was found regarding the landholdings of the farmer.

Table 12: Landholding of the Respondents in the Study Area

Farmer Classes	No. of Respondents	Percentage (%)
Less than 5 acres	157	43.6
5 to 12.5 acres	135	37.5
12.51 to 25 acres	59	16.4
25.01 to 100 acres	7	1.9
More than 100 acres	2	0.6
Total	360	100.0

Farming Experience

Experience of farm household in agriculture has also implications on agricultural productivity. About 4% of the farmers had less than 5 years of experience in agriculture. Such farmers were engaged in other economic activities in addition to agriculture. It was found that about 13% of the farmers had more than 36 years of experience in farming. They were able to get more productivity of crops by timely sowing of crops, avoid flood irrigation hence saving water and balanced use of fertilizers on account of their experience. A large majority of respondents were doing agriculture for the last 16 to 35 years. (Table 13) given below shows the farming experience of the respondents in the study area.

Table 13: Farming Experience of the Respondents in the Study Area

Farming Experience	No. of Respondents	Percentage (%)
Less than 5 years	13	3.5
6 to 15 years	83	23.0
16 to 25 years	100	27.7
26 to 35 years	120	33.55
36 years and above	44	12.25
Total	360	100

Comparison of Indicators Developed from Primary Data Sources

Primary data were obtained from farming households in the study area as per sampling scheme discussed in Chapter 3. Primary data were collected for two years. Year 2004 represents pre-tsunami period and year 2006 present post-tsunami period. Year 2005 was transition period so it was not included in pre and post-tsunami period. The primary information comprised of opinions of the farmers regarding their perception about reduction in water delivery problems at their turns, provision of allocated quantity of water, improvement in quantity of water supplied after reforms and particularly at Tail end reaches and improvement in operation and maintenance of the distributary after irrigation management transfer were collected and analyzed. Data about average yield of major crops, gross margin and cost of production of major crops like maize, sugarcane and rice were collected from the farmers in the field and then empirically examined.

Opinion of the Farmers Regarding O&M and Quantity of Irrigation Water

Irrigation water availability by design was less than its demand through out the study area. Therefore, most of the farmers were concerned and look for ways and means to increase their water availability. Farmers' perception about increased water availability and FOs management are presented in the (Table 14). It also shows the perception of the farmers regarding reduction in water delivery problems, provision of allocated quantity of water at their turns, improvement in quantity of water supplied after irrigation reforms and particularly at the Tail reaches and improvement in O&M of the distributary.

When respondents were asked about irrigation reforms and their impact in reduction of water delivery problems after the irrigation reforms, 53% of them in Kr.Lingka division were of the view that their problems regarding water delivery had been reduced and FOs were performing better under ABIDA Act, 1997. However farmers in Kr.Keumirue divisions were more satisfied with the performance of the new system. About 90% of the respondents perceived that water delivery problems have been considerably reduced after irrigation management transfer. They justified their opinion with the comments that after reforms, farmers were involved in the decision making process and they were in a better position to solve their own problems. Similar trend was observed in Kr.Jreu and Kr.Labeun pengapet canal divisions.

When the respondents were asked about their opinion regarding the provision of allocated quantity of water at their turns after the reforms, 70% of the respondents agreed that they were getting the allocated quantity of water at their turns. However, they reported that time required to irrigate one ha by surface irrigation water was insufficient. They reported that government allocated 24 to 30 minutes for irrigating one acre by canal water whereas, practically it took 120 to 180 minutes to irrigate one acre. 30% of the respondents in Kr.Lingka division were not agreed with the above statement. Similarly, majority of the respondents in Kr.Jreu, Kr.Labeun pengapet and Kr.Keumirue canal divisions agreed that they found improvement in water delivery at the Tail end reaches. However, 10% of respondents in Kr.Jreu, 10% in Kr.Labeun pengapet and 6% respondents in Kr.Keumirue canal division reported no change in water supply at the Tail ends after irrigation reforms. The reason they mentioned was that the new institution (ABIDA) would not be able to provide water according to demand because of shortage of supply at the rim station.

Similarly majority of the respondents in Kr.Lingka (60%), Kr.Jreu (70%), Kr.Labeun Pengapet (54%) and Kr.Keumirue (77%) canal division agreed that they found improvement in operation and maintenance of the distributaries after irrigation management transfer. Another important opinion recorded was about the improvement in quantity of water supplied to the farmers. It was observed that majority of the farmers were of opinion that there was an improvement in quantity of water supplied. The percentages given in the "No" column shows the respondents who described the present water quantity supplied to them as worse than the pre-reform period. As it is indicated from (Table 14) that majority of the farmers termed the present water supplies better than the previous system.

Table 14: Opinion of the Farmers Regarding O&M and Quantity of Irrigation Water

Variables under study	Kr.Lingka			Kr.Jreu			Kr.Labeun pengapet			Kr.Keumirue		
	Yes (%)	No (%)	No Change (%)	Yes (%)	No (%)	No Change (%)	Yes (%)	No (%)	No Change (%)	Yes (%)	No (%)	No Change (%)
Reduction in water delivery problems	47	53	-	56	44	-	66	34	-	90	10	-
Provision of allocated quantity of water	70	20	10	68	22	10	63	17	20	32	30	38
Improvement in quantity of water supplied after reforms	66	34	-	60	13	27	63	22	15	79	10	11
After reforms improvement in quantity of water supplied to Tail ends	70	30	-	73	17	10	70	20	10	94	6	6
After reforms improvement in O&M of the distributary	60	20	20	70	15	15	54	15	31	77	17	6
After reforms improvement in quality of construction works	66	33	1	46	8	46	51	14	35	44	16	40

Farmers' Perception on Reduction in Water Theft Cases

Irrigation water theft has been a chronic problem in the Krueng Aceh irrigation system and was root cause of many problems associated with conflicts and inefficient water utilization. Farmer Organizations (FOs) were able to institutionalize a number of measures that could lead to substantial reduction in water stealing. (Table 15) shows that there were 43% of the farmers who reported that water theft had almost been controlled (theft cases reduced but comparatively at lower pace) after handing over the irrigation system to the farmers. At the Middle reach of the distributary 48% of the farmers gave their opinion that water theft decreased after Irrigation Management Transfer (IMT). Most of the farmers at the Tail end were of the opinion that either water theft increased (10%) or was same (10%). According to them there was no significant change in the extent of water theft after change in management. Only the form of water theft changed. Earlier there was open theft but now there was disguised theft of canal water. Only 7% of the farmers reported that water theft increased but the percentage of those farmers who reported that water theft decreased after irrigation management transfer, totalled 31%.

Table 15: Opinion of the Farmers Regarding Cases of Water Theft

Cases of water theft	Head (%)	Middle (%)	Tail (%)	Total (%)
Increased	5	6	10	7
Decreased	15	48	35	33
Controlled	55	34	40	43
Same	20	6	10	12
Do not know	5	6	5	5

Average Yield Of Major Crops Across The System In Pre and Post-Tsunami Period Per ha

Maize, rice and sugarcane were the major crops grown in the study area. (Table 16) shows the average yield of major crops across the Krueng Aceh Irrigation system in pre and post-tsunami period. The results of the study showed a wide variation in yield across farms and distributaries. It is evident from (Table 16) given below that the irrigation reforms have positive impacts on crop yields across the study area. In Lingka canal division maize and sugarcane were the two major crops. Average yield was 31.1 and 35 per ha respectively before and after irrigation management transfer. It is revealed that after reforms, the increase in maize yield was about 13% which was highest increase in the Krueng Aceh Irrigation system. The other canal divisions also showed increasing trend in yield of maize but at slower rate as compared to Lingka division. This substantial increase in maize yield in Lingka division was attributed to suitable soil conditions and fertility of the soil. Agronomic factors like land preparation, timing of crop sowing, variety and quality of seed, timing of application of inputs and quality of land and adequacy of irrigation of water contributed significantly to increase in production of maize in the Lingka canal division. It was also found that farmers found sufficient time for sowing of maize after harvesting of rice, which resulted in their higher yield (Early sowing of maize produced high yield). It was also observed that some times farmers keep their land fallow which conserves the fertility of the soil and resultantly more crop yield.

The percent increase in average yield of maize was recorded as 12%, 8% and 6% in Kr.Jreu, Kr. Lebuen Pengapet and Krueng Keumireu divisions, respectively. Lowest percent increase was found in Kr.Keumireu division. This lower yield was due to reason that farmers usually habitual of late sowing of maize after harvesting of rice in this area (Cisadane rice is sown in this area which is a late variety). The irrigation management transfer also affected positively the average increase in sugarcane yield after IMT. In the post-reform period average yield rose in all canal divisions but percent increase in yield of sugarcane was more in Kr.Lingka division (7%) and Kr.Jreu division (7%) as compared to other canal divisions. Whereas, change in sugarcane yield was about 4% and 3% in Kr.Labuen Pengapet and Kr.Keumireu canal divisions respectively. This increase in sugarcane in Kr.Lingka and Kr.Jreu was due to tendency of farmers and their experience in sugarcane production. In Kr.Keumireu canal division, increase in sugarcane yield was lower i.e. 3% but the farmers of this division were already getting maximum yield of sugarcane crop before IMT and after IMT, therefore showing nominal increase in both the periods. Rice was grown more or less in all canal divisions in Krueng Aceh irrigation system of the Aceh Besar. The average rice yield in the study area before IMT was 31.4 per ha which rose to 35.5 per ha after IMT, thus showing 13% increase after irrigation management transfer. Kr.Keumireu canal division showed 22% increase in rice yield. Rice is water loving crop that requires plenty water from sowing up to maturity of crop. An increase in yield of rice in Kr.Keumireu division showed that there was more availability of surface water after IMT. Kr.Keumireu division is located at the Tail of main canal where there was shortage of water before the management transfer. Thus increase in rice yield on an average basis showed that there was improvement in water supply situation at the Tail of the canal.

While collecting data from the field, it was observed that some farmers were getting more yields of crops and others operate at low performance level. The difference in crop productivity across the systems and across the various categories of farmers (small, medium and large farmers) was attributed to number of factors, which included: land and irrigation water related factors such as location of distributary with respect to main canal, location of watercourse with respect to distributary and location of the farm with respect to watercourse. Overall condition of the watercourse i.e. lined or unlined, also significantly contributed towards surface water availability to the farmers. A comparison of average yield of maize, sugarcane and rice is shown in (Figures 12, 13 and 14) respectively. These Figures given below show the yield difference of the said crops in pre and post-reform period of management change.

Table 16: Average Yield of Major Crops Across the System (Q/ha)

Canal Division	Maize			Sugarcane			Rice		
	Post-reform Period	Pre-reform period	% change	Post-reform Period	Pre-reform period	% change	Post reform period	Pre-reform Period	% change
Kr.Lingka	31.1	35	13	560	597	7	32	35	9
Kr.Jreu	30.4	34.1	12	569	606	7	31.1	35	13
Kr.Labeun pengapet	33.6	36.4	8	612	636	4	32.1	35.2	10
Kr.Keumirue	34.8	36.7	6	618	637	3	30.3	37	22
Overall	32.4	35.5	10	590	619	5	31.4	35.5	13

Average Gross Value Product (GVP) of Major Crops Across the System in Pre and Post-reform Period (Rupiah. Q/ha)

Average Gross Value Product of the major crops was calculated on per acre basis using the real prices (calculated by using GDP deflator for the year 2001-02).

GVP depicts the income of the farmer for the specific crop. (Table 17) shows that GVP of the farmers calculated for three major crops (maize, rice and sugarcane) of the system increased by 4% for maize crop in the year 2006 (pre reform period) as compared to the year 2004 (post reform period). While average percentage in GVP for sugarcane increased about 15% in pre-reform periods. Most significant increase was in rice crop that showed an increase of 43% across the system. This increase in GVP was attributed to high increase in prices of rice output. Overall increase in maize crop was 4% which was lowest among other crops studied in the area. It shows that there was an actual decline in real price of maize output received by the majority of the farmers in year 2006 as compared to year 2004. Rice crop showed the maximum increase in real GVP i.e. 43% while the increase in average rice yield was about 13% depicting that there was an increase in real price of rice in the year 2006 as compared to year 2004.

Figure 12: Average Yield (Q/ha) of Maize Crop Across the System in Pre and Post Tsunami Period

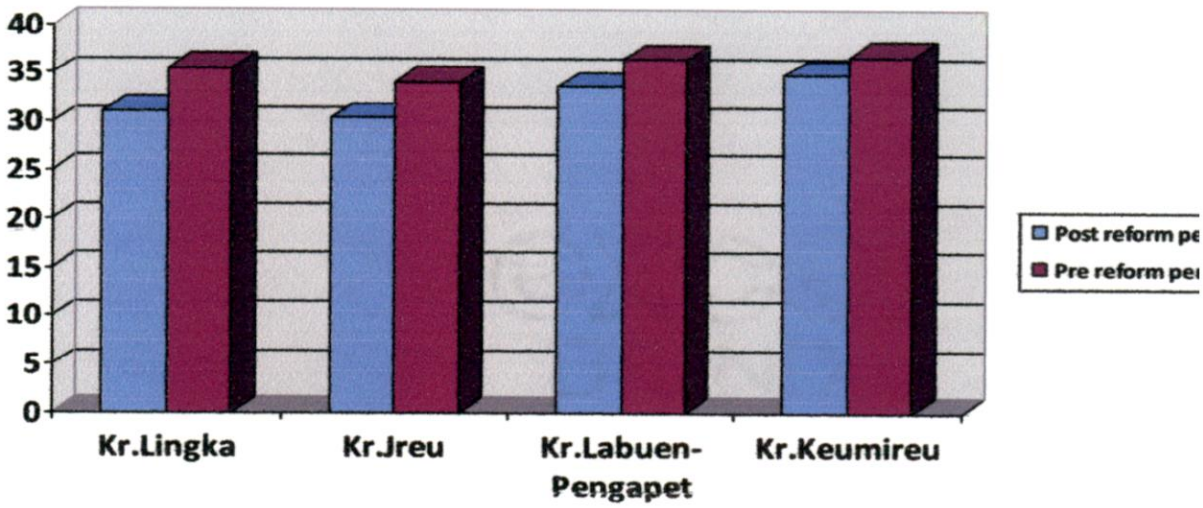


Figure 13: Average Yield (Q/ha) of Sugarcane Crop Across the System in Pre and Post Tsunami Period

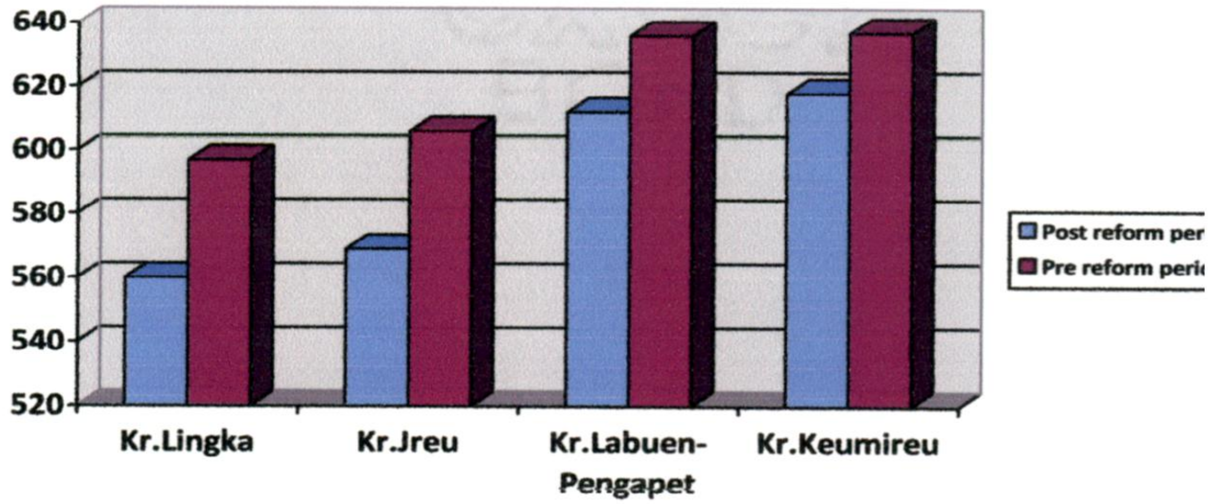
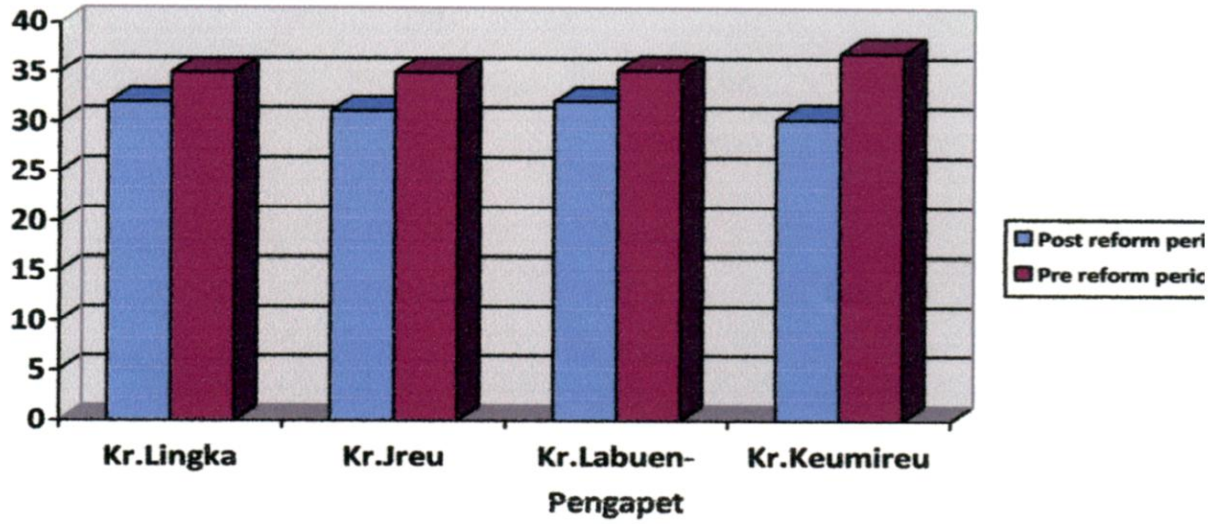


Figure 14: Average Yield (Q/ha) of Rice Crop Across the System in Pre and Post Tsunami Period



One interesting point is that percent increase in GVP of rice in Kr.Keumireu division was about 61% which was highest among all the crops and canal divisions. While discussion with the farmers in the field, it was found that this high increase in GVP of rice was on account of two factors: one was the availability of sufficient quantity of water after irrigation reforms and other was higher prices of output paid to the farmers.

Table 17: Average Gross Value Product (GVP) of Major Crops Across the System (Rp. Q/ha) 1 Rupee = 180 Rp

Canal Division	Maize			Sugarcane			Rice		
	Post Tsunami Period	Pre-Tsunami Period	% Change	Post Tsunami Period	Pre Tsunami Period	% Change	Post Tsunami Period	Pre Tsunami Period	% Change
Kr.Lingka	11612	12430	7	26179	30561	17	5914	8260	40
Kr.Jreu	11348	12034	6	26600	31074	17	5828	8250	42
Kr.Labeun pengapet	12583	12896	2	28796	32618	13	6821	9118	34
Kr.Keumirue	13015	13102	0.7	29101	32645	12	5611	9049	61
Overall	12148	12616	4	27669	317245	15	6044	8669	43

Note: Real prices of output are taken by using GDP deflator for the year 2001-02.

The Indian Ocean tsunami that followed a magnitude 9.0 earthquake on the 26 December 2004 claimed more than 283000 lives and destroyed crops, buildings and infrastructure in low-lying coastal areas around the Indian Ocean. On the west coast of Sumatra the tsunami waves were up to 10 m in height and swept several kilometres inland, reducing the population of some villages by up to 80%. On the east coast of Sumatra the wave heights varied from 2-6 m, population losses were generally lower (15-20%), and infrastructure damage was less.

Restoring Cropping And R&D Capacity In Aceh And Nias

In response to the tsunami the world witnessed one of the largest humanitarian emergency relief and recovery aid operations of recent times. The Australian Centre for International Agricultural Research and Ausaid commissioned NSW DPI and Indonesian R&D agencies to help farmers restore cropping in areas affected by the tsunami in Sumatra and Nias. The project also aimed to rebuild the R&D capacity of the Indonesian governments agricultural technology evaluation and extension agency in Aceh (BPTP NAD) and district extension services. The project also assessed impacts of the tsunami on the soils in South Nias. Since May 2005 the project has trained Aceh research and extension staff to rapidly assess soil salinity and fertility changes, identify constraints that affected crops after the tsunami, demonstrate improved agronomic management not currently used by farmers in Aceh, and facilitate information exchange between government organisations, NGOs and farmers.

This paper describes some of the problems that farmers experienced after the tsunami and strategies developed with the agricultural research and extension agencies in Indonesia to address these problems.

Relocation Of farmers During The Emergency Phase

In the first few months after the tsunami NGOs were the main providers of emergency aid in rural areas. They provided food, drinking water, medical aid, temporary shelters in camps, cash for work projects to remove debris and repair damaged infrastructure, and agricultural inputs such as seed, fertilisers and tools. Consequently many farmers on the east coast of Sumatra and in Nias were able to put in crops less than 4 months after the tsunami. However farming activity took longer to resume on the west coast where tsunami damage was more severe. As well, relocation of farmers into emergency relief camps sometimes made it difficult for them to access and farm their land.

Landscape And Soil Impacts

The force of the tsunami changed the shape of coastal landforms, disrupted drainage networks and moved large amounts of soil and debris across the floodplain (Figure 15). Near Banda Aceh, the coastline moved up to 4 km inland. Coastal estuaries were reshaped and coastal lakes were lost to the sea while new ones were created. Soils close to the coast were eroded by high velocity flows and coastal sands were transported inland and deposited on heavier alluvial soils. In some areas the tsunami also transported saline marine sediments and deposited these over the floodplain alluviums. The marine sediments contained significant amounts of iron and sulphur (Table 17) and formed iron oxides as they dried (Figure 16). On the west coast peat materials from coastal swamps were washed inland and deposited on sandy soils.

Figure 15: The tsunami left large amounts of debris and saline water on farm land.

The tsunami event in Sumatra occurred after the start of the wet season, so most of the floodplain was under flooded rice paddies. The fresh water in the paddies may have limited the infiltration of saline water. Interviews with farmers revealed that land was inundated with sea water for a few hours to many weeks, depending on local elevation and the connectivity of drainage lines. Areas closer to the coast were generally inundated for longer because the landscape changes were greater and there was less capacity for surface water to drain away.

Figure 16: The project team inspects soil with iron oxide crust formed after oxidation of deposited marine sediment.

Soil salinity levels were assessed using the electromagnetic induction technique (EM38). Results showed that soil salinity was often higher where farmers reported longer inundation times. Research and extension staff were equipped with EM38 instruments and trained to interpret the measurements in relation to expected crop growth (Figure 17).

Figure 17: Aceh staff assess soil salinity across a salt affect peanut crop 8 months after the tsunami. Note the bare saline patches in the crop.

Farmers removed tsunami sediments from their fields or cultivated them into the soil. The marine deposits were highly saline, sodic and had low porosity (Table 18, Figure 18) compared with the underlying alluvial clay soil. However the deposits also had a high caution exchange capacity and high amount of plant available phosphorus (Table 18). The deposition of these marine sediments varied across the floodplain with deeper deposits often occurring near half the inundation distance from the coast.

Figure 18: Marine derived tsunami sediment. Note the iron oxide stains and massive structure.

Table 18: Chemical analysis of marine-derived mud deposited by the tsunami

Soil	Salinity EC1:5 dS/m	Cation exchange capacity cmol(+)/kg	Exchangeable sodium percentage	Iron % (total)	Sulphur % (total)	Colwell Phosphorous mg/kg
Deposited tsunami mud	6.3	59	38	4	1.2	69
Under lying soil	0.89	38	19	3.8	0.078	34

Impacts On Crops

Rice, peanuts, soybeans and corn are the major field crops in the coastal area of Sumatra. Crop failures and high losses were common in the first year after the tsunami. The reasons for crop failure included high soil salinity, flooding and water logging of non-rice crops due to high rainfall and lack of drainage, and insufficient water supply to finish irrigated crops.

Farmers had no previous experience of growing their crops in saline soils. Many of the early rice crops appeared to grow well during the vegetative stages but yielded less than 50% of pre-tsunami levels due to a high proportion of empty grain. Field observations indicated lack of grain filling was higher in areas of the rice paddy that had little through circulation of water. This effect has also been observed in Australia where rice is grown on saline soils and is managed by ensuring there are no blind rice bays through which surface water cannot flow. In areas where there was a reliable irrigation supply Aceh farmers were advised to allow through-flow of surface water to avoid salinity stress in rice. However, this strategy could not be used where the irrigation system was not operational. In these areas the only option was to avoid farming the most saline land.

Farmers generally had access to fertiliser through aid donors and tended to apply high amounts in an attempt to maximise yields. However, the quality of seed provided by donors was often poor which mean that fertilisers were not efficiently utilised. High crop losses due to increased activity of rats and feral pigs were also reported in interviews with local farmers due to lack of labour to control them.

Figure 19: There was no irrigation water to flush these water in these rice bays, resulting in stressed rice seedlings.

Salinity avoidance was critical in the first 12 months after the tsunami and is still relevant in small pockets of poorly drained or tidal land. Leaching of salts was greatly enhanced heavy rain and flooding in the wet season. There was considerable expectation that salt tolerant crop varieties could be used for an interim period after the tsunami. However there was not enough seed available, and there was concern that the varieties were not suitable for the region. There was not enough time to verify the benefits of salt-tolerant varieties before farmers established crops in the first few months of 2005 NDC2. Consequently this strategy had little tangible outcome in the short term. In the long term planting of salt-tolerant varieties may help farmers to use saline coastal land that is common throughout Indonesia. There is also considerable scope to improve soil fertility in Aceh through better management of nutrients and soil structure.

CHAPTER V
RESULT AND DISCUSSION

RESULT AND DISCUSSION

This chapter reveals the outcomes of this research that has been performed to know the farmer's knowledge about recommended practices, adoption of recommended practices, constraints in the adoption of recommended practices and the effectiveness of various information sources in the adoption of new agricultural practices.

Tsunami-affected agricultural land can be divided into three categories, i.e . light damage, medium damage, and heavy damage. Light damage land identified by sediment of less than 10cm thickness, no mud, no silt and no eroded land. Medium damage land identified by sediment between 10 and 20 cm thickness, less than 50% debris and mud on the land, and some eroded land. Heavily damage land identified by sediment greater than 20cm, more than 50% land covered by debris and mud, and heavy erosion. There is also agricultural and permanently loss due to the erosive forces of the tsunami.

Damaged agriculture land located on the eastern coast of Aceh, fell into the light damage category. District that has lightly damage land are listed in the (Table 19). Damaged agriculture land on the west coast was categories as light (class A), medium (class B) and heavy (class C), as listed in (table 19)

Table 19: Lightly damage agricultural land (t ha) in eastern coast of Aceh

No	District	Damage to agriculture land		
		Rice paddy	Gardens	Field
		ha		
1	Pidie	1.859	4.704	3.072
2	Bireuen	2.118	2.750	567
3	Aceh Utara	1.224	-	612
4	Kota lhokseumawe	-	-	-
5	Aceh Timur	2.119	-	-
Total		7.320	7.454	4.251

(Table 20) show that most land damage on the west coast, fell into the medium damage category. The amount of light, medium and heavy damage land in western coastal area are 1760 ha, 55615 ha and 1285 ha respectively. Some example of damage classed as medium and heavy on the West Coast are shown in (figures 20 and 21). the thickness of sediment and debris are the main reason for this classification. Distribution of sediment thickness on damaged land in several district can be seen in (table 21)

Table 20: Level of land (ha) damage on west coast Aceh

No	District	Sub District	Damage Class/ha			Total
			A	B	C	
1	Aceh Besar	Peukan Bada	120	160	30	310
		Lhok Nga	220	680	230	1130
		Lhoong	490	500	210	1200
		Baitulsalam	100	250	120	470
Sub Total			930	1590	590	3110
Percent (%)			29.9	51.1	19.0	100
2	Aceh Jaya	Jaya	150	620	-	770
		Samponiet	-	140	180	320
		Teunom	-	840	100	940
		Panga	-	200	-	200
		Krueng Sabe	-	260	-	260
Sub Total			150	2060	280	2490
Percent (%)			6.0	82.7	11.2	100
3	Aceh Barat	Meurebo	235	20	85	340
		Sama Tiga	370	890	330	1590
		Arongan Lambalek	75	1055	-	1130
Sub Total			680	1965	415	3060
Percent (%)			22.2	64.2	13.6	100
Grand Total			1760	5615	1285	8660
Percent (%)			20.3	64.8	14.8	100

Source :Anonymous, 2006

A = Light Damage, B = Medium Damage, C = Heavy Damage

Figure 20: Medium damage (Class B) showing extensive deposit of sediment at Lhoong, Aceh Besar, 2006

Figure 21: Heavy damage (Class C) with sediment > 30 cm deep and extensive debris at Lhoong, Aceh Besar, 2006

Table 21: Level of land (ha) Distribution of sediment thickness on damaged land in several district on west coast Aceh

No	District	Sub District	Sediment thickness and size (ha)			Total
			0-5 cm	6-20 cm	20-30 cm	
1	Aceh Besar	Peukan Bada	120	160	30	310
		Lhok Nga	220	580	230	1030
		Lhoong	490	600	210	1300
		Baitulsalam	100	350	120	470
Sub Total			930	1690	590	3110
Percent (%)			29.9	54.3	15.8	100
2	Aceh Jaya	Jaya	150	620	-	770
		Samponiet	-	140	180	320
		Teunom	-	940	-	940
		Panga	-	200	-	200
		Krueng Sabe	-	260	-	260
Sub Total			150	2160	180	2490
Percent (%)			6.0	86.7	7.2	100
3	Aceh Barat	Meurebo	235	105	-	340
		Sama Tiga	910	430	250	1590
		Arongan Lambalek	330	500	300	1130
Sub Total			1475	1035	550	3060
Percent (%)			48.2	33.8	18.0	100
Grand Total			2555	4885	1120	8660
Percent (%)			29.5	56.4	14.1	100

Source :Anonymous, 2006

A = Light Damage, B = Medium Damage, C = Heavy Damage

In 2005-2006, Bureau Reconstruction and Rehabilitation (BRR) focused their activities on rehabilitation of agricultural land with light and medium damage. Most of this land has been recovered and is under cultivation. In 2007 and 2008, BRR (agriculture) together with other stakeholder (UNs and NGOs) started to rehabilitate agricultural land categorised as heavy damage.

Rehabilitation activities complete by BRR (agriculture) together wit UNs and NGOs include:

1. Cleaning of land by cash for work program
2. Providing seed
3. Providing fertilizer

4. Ploughing of land
5. Providing farm equipment and machinery
6. Rehabilitation of irrigation channel and drainage
7. Sediment removal from heavily damage land

The last two activities were started in 2007 and late 2007/early 2008 respectively. All activities implemented by stakeholders and coordinated by BRR (agriculture) have showed good result in the field. In general, most of lightly-damage agriculture land has been rehabilitated, recovered and brought back into livelihood activities for the villages. Field observation on the east coast of Aceh combined with report from extension agencies and farmer show that average rice field productivity range between 5 to 9 ton per hectare. (Before the tsunami average rice productivity in Aceh is about 4.5 ton per hectare). On the other land, observation and report from the west coast indicated that most land categorized as medium and heavy damage has yet to fully recover. Paddy field productivity is only 2.5 to 4 ton per hectare. This is mainly caused by:

1. Irrigation and drainage channels not yet function optimally,
2. Paddy field in this area consist most of peat soil,
3. Many field are submerged under water for most of the year,
4. Post-tsunami, farmer motivation to cultivated their paddy filed is still low.

Up to now, BRR (agriculture sector) has rehabilitated 46484 hectare of agriculture land: 13961 hectare paddy field, 2450 hectare dry land, and 27029 hectare community plantation. Furthermore, agricultural land rehabilitation conducted by NGOs has rehabilitated about 25661 hectare (based on NGOs report received by data and information centre, BRR). However, there is still a lack of detail on what kind of and has been cleared and what type activities are involved in the rehabilitation process conducted by NGOs.

Table 22: Paddy productivity on damaged land in eastern coast of Aceh

No	Sub district	Class Damage	Productivity (t/ha)	
			2006	2007
1	Trienggadeng	Linght	6.4 - 10.2	6.5 -10.5
2	Simpang Tiga	Linght	6.6 - 8.3	6.8 - 8.5
3	Kembang Tanjong	Linght	6.6 - 7.0	6.9 - 7.2
4	Pante Raja	Linght	6.0 - 6.4	6.2 - 6.7
5	Meuredu	Linght	7.0 - 7.4	7.1 - 7.6
6	Ulim	Linght	6.2 - 8.8	6.5 - 8.9
7	Pidie	Linght	5.9 - 6.2	6.0 - 6.5
8	Muara Tiga	Linght	6.4 - 7.0	6.5 - 7.2

Source : BRR food crops implementing agency report

Table 23: Paddy productivity on damage land in western coast of Aceh.

No	District	Sub District	Class Damage	Productivity (t/ha)	
				2006	3007
1	Aceh Besar	Peukan Bada	Light	3.0-4.0	3.5-4.5
			Medium	2.5-3.0	3.0-4.0
		Lhok Nga	Light	3.0-3.7	4.0-4.5
			Medium	nd	3.5-4.0
		Lhoong	Light	3.0-3.5	3.5-4.2
			Medium	nd	4.2-4.0
		Baitussalam	Light	3.0-3.5	4.0-4.5
			Medium	nd	3.0-4.0
2	Aceh Jaya	Jaya	Light	2.0-3.5	3.5-3.7
			Medium	nd	2.0-3.5
		Sampoinit	Light	2.0-3.5	3.5-4.0
			Medium	nd	2.0-3.5
		Teunom	Light	3.6-4.0	4.0-4.3
			Medium	nd	3.0-3.4
		Panga	Light	3.5-4.0	3.7-4.2
			Medium	nd	3.1-3.3
		Krueng Sabe	Light	3.5-4.0	4.0-4.5
			Medium	2.0-3.0	3.0-3.5
3	Aceh Barat	Meurebo	Light	2.0-2.5	3.5-4.5
			Medium	nd	2.0-2.5
		Sama Tiga	Light	2.0-2.5	2.5-3.0
			Medium	nd	2.0-2.5
		AronganLambalek	Light	2.0-2.5	2.5-3.0
			Medium	nd	nd

Source: Agriculture extension agency reports and information, nd = no data

Field observation in June2008 showed that besides lightly damaged land, some of medium damaged agricultural land in Aceh Besar has been recovered as potential rice field such as, Lhoong Sub District, Aceh Besar (Figure 22).

Damage rice field in Lhoong (mostly inceptisols–mineral soil), have been cultivated at least there times since 2006. Only some of medium damage rice field in Aceh Barat and Nagan Raya has been rehabilitated and cultivated. Several constraints faced in rehabilitation of heavily damage land in the western coastal areas are:

1. Most rice field are on peat soil,
2. Irrigation channel are still blocked,
3. Weed regrowth (bak raboo) was very fast on peat soil, so that farmers needed extra efforts to clear the field, and
4. in some areas irrigation channels are not available, so that the rice crops is completely dependant on rainfall.

Figure 22: Land returned to rice cropping in Lampisang, Lhoknga, Aceh Besar, 2007

Farm a soil chemistry point of view, rice field categories as light damage do not have salinity problems anymore. Leaching either conducted by purpose with irrigation or from rainfall has resulted in significant decrease in soil salinity and soil pH has recovered to about normal (6-7)

The next step, suggested, to be taken is the rehabilitation of the remaining medium and heavy damage land in the west coast. The rehabilitation should be focused on reparation of drainage canals and removal of sediments, because these two important activities have not progressed satisfactory. Field observation showed that in peat soil and rain fed paddy field, rehabilitation of drainage canals is crucial to agriculture recovery. Furthermore, the tsunami sediment also needs to be remove from the top soil surface, especially the sand, so that farmer can use and cultivated their paddy field again. Several stakeholders, such as UNDP and other NGOs have started the removal of sediment from paddy field on the west coast. We believe that these activities will be successful.

Combating the regrowth of weed on peat soil is a key obstacle to recommencing cultivation, this extra task has discouraged farmers and they have become hesitate to cultivate their land.

Discussion

This study showed that majority of respondents that faced production constraints due to irregular and shortage in irrigation system and non availability of lined water courses. The result showed that majority of respondents faced production constraints in lack of inputs. Similarly, Bhatia, *et al.* (1994) suggested that protection measures, fertilizer applications and seed rate were urgently needed for the adoption of improved sugarcane production technology. In the same way as Saccharum (1996) found that mechanical operations, varieties, fertilizer applications and insecticide/pesticide caused of development crop production. With this Kuntohartono and Roesmanto (2001) had also described that poor quality of planting material, water shortage, high pest disease and weed infestation effect on sugarcane production. Results from this study were also similar to the work of Khan (1965) which stated that high prices of fertilizers and implements unawareness of improved agriculture practices lack of irrigational supply water were the problems of growers and Jelani (1966) stated that the hindrance which fell in the way of farmers were unavailability of production requisites such as seed, fertilizer, scarcity of irrigation water.

Overall 2005/06 Food Production And Supply Situation In Aceh 2005/06

Paddy Production And Supply Situation In Aceh

Forecast Of Paddy Production In 2005

Most affected areas lost the 2004/05 main season paddy crops (planted in October2004 and harvested mostly from February to April 2005). The secondary crop is relatively small in affected areas, and paddy was planted in the area with irrigation schemes. During the mission's field visits in the province, team members observed the standing crop in the coastal areas and discussed with local government officials and farmers who were working in the field for paddy harvesting. The yield is estimated to be close to normal.

In non-affected areas, few changes are expected for dry season paddy production. The profitability of paddy production in Aceh has been reported as very good. A ban on imports of rice, which was imposed by the central government in order to protect farmers prices and income for paddy production in early 2004 (except for a brief period immediately following the tsunami disaster), was extended to the end of 2005. However, the Ministry of Trade recently lifted the rice import ban by issuing an official license for Bulog to import 70050 tonnes of rice from Vietnam due to low stock and high price in the country. The paddy and rice prices at the farm gate have been good (wet paddy at Rp.1 330/kg and dry paddy at Rp.1740/kg). Rice prices have largely been determined by private traders and rice millers operating in an open local market situation.

Rainfall/irrigation conditions and input supply are normal in non-affected areas. As shown in (Table 24), the Mission estimates 2005 aggregate paddy production in NAD at 1.43 million tonnes, some 7.5 percent below that in the previous year (1.552 million tonnes). This would result in reduction in rice production of about 75000 tonnes. The new estimated paddy output is lower than that forecast in March Mission (1.47 million tonnes), reflecting the lowered harvested area estimated by government. The major reduction, compared to the previous year, takes place in the western costal districts, including Aceh Jaya, Nagan Raya and Aceh Barat Data.

Table 24: Paddy Area and Production in Aceh

District	Area (Ha)				Production (MT)			
	2003	2004	2005	Percent	2003	2004	2005	Percent
	A	B	C	Cx2/ (A+B)	A	B	C	Cx2/ (A+B)
Sabang	34	10	39	177	3	21	86	183
Banda Aceh	174	312	19	8	664	1 183	73	8
Aceh Besar	37 334	40 979	36 202	92	161 711	176 600	157 459	93
Pidle	40 953	42 897	42 428	101	178 882	186 433	185 372	101
Bireuen	40 675	31 849	33 111	91	175 157	136 828	142 766	92
Aceh Utara	43 639	47 602	45 128	99	188 679	205 129	195 143	99
Lhokseumawe	1 417	1 473	914	63	5 430	5 684	2 582	46
Aceh Tengah	11 725	12 085	12 000	101	43 884	44 191	44 607	101
Aceh Timur	30 477	36 504	32 867	98	128 960	153 538	139 029	98
Langsa	2 273	1 732	2 157	108	8 766	6 627	8 376	109
Aceh Tamiang	21 943	18 060	20 622	103	91 920	75 691	87 133	104
Aceh Jaya	13 342	13 302	4 906	37	54 514	54 089	20 056	37
Aceh Barat	17 079	23 580	19 380	95	70 115	96 543	76 194	91
Nagan Raya	29 506	26 511	21 382	76	122 384	109 660	79 327	68

Simeulue	8 456	7 334	627	8	32 445	27 749	2 383	8
Aceh Selatan	14 153	17 018	17 600	113	59 610	71 274	74 406	114
Aceh Singkil	4 613	4 950	4 981	104	17 038	17 478	16 612	96
Aceh Barat Daya	22 253	11 267	13 730	82	93 781	46 600	57 832	82
Aceh Tenggara	13 909	17 937	21 269	134	57 296	73 237	87 628	134
Gayo Lues	13 681	15 566	14 000	96	56 227	63 527	57 568	96
NAD	367 636	370 968	343 362	93	1 547 536	1 552 082	1 434 632	93

Source: 2003 and 2004 data are from BPS; 2005 area and production are estimated by this mission based on the information provided by MOA of Aceh Province.

Rice Supply/Demand Balance In 2005/06 (April/March)

The Mission's forecast of the rice supply/demand balance for 2005/06 by district is summarized in (Table 25). The rice surplus in 2005/06 is estimated at some 200 000 tonnes, slightly lower from a normal year[4]. Therefore, in spite of local crop losses, overall food availability even in the affected areas is more than adequate to cover food needs. Given the relatively large rice supply available in the region, 200000 tonnes, the average surplus for the previous two years would be about 275000 tonnes, assuming that the local consumption was about the same, it is recommended to pursue local purchases whenever possible in order to meet food aid requirements in the province to prevent domestic food market distortions and protect paddy farmers interest. The estimated balance is based on the following assumptions: population to grow at annual rate of 1.26%; half of missing persons due to earthquake and tsunami actually died in the disaster; and a milling rate of 65% from paddy to rice. Requirement levels from past years are assumed as: for food consumption 150 kg/caput of rice, feed and seed use 40 kg/ha, post-harvest losses 7%, and buffer stock 5% of consumption.

[4] Rice surplus for previous years is not calculated explicitly since the production figures for 2003 and 2004 have been revised. However, given that the drop in rice production in 2005/06 marketing year is calculated at about 75000 tonnes and the surplus of about

Table 25: Rice supply and demand balance (tonnes) in marketing year 2005/06 (April/March), by district

District	Production	Food Use	Total Use	Balance
Sabang	56	3 767	3 975	-3 919
Banda Aceh	47	28 610	30 480	-30 039
Aceh Besar	102 348	8 753	30 894	82 569
Pidie	120 492	78 874	96 789	23 729
Bireuen	92 798	55 405	68 510	24 312
Aceh Utara	126 843	80 103	98 503	28 374
Lhokseumawe	1 678	25 707	27 170	-25 490
Aceh Tengah	28 995	41 906	47 282	-18 287
Aceh Timur	90 369	51 009	63 736	26 633
Langsa	5 444	18 864	20 370	-14 926
Aceh Tamiang	56 636	34 609	41 816	14 820
Aceh Jaya	13 036	11 247	14 399	-969
Aceh Barat	49 526	27 596	34 369	15 478
Nagan Raya	51 563	21 932	28 614	22 953
Simeulue	1 549	9 088	10 480	-8 931
Aceh Selatan	48 364	30 400	37 036	11 331
Aceh Singkil	10 798	19 189	22 047	-11 249
Aceh Barat Daya	37 591	17 743	23 815	13 776
Aceh Tenggara	56 958	23 191	29 295	27 663
Gayo Lues	37 419	10 220	15 253	22 166
NAD	932 511	598 213	744 835	199 995

Source: Estimated by this Mission.

The Impact Of Food-Aid On Food Market

Food Aid did not provide a disincentive to farmers in the rice production areas in the eastern part of Aceh (Pidie, Bireun, Aceh Utara and other unaffected regions). This was indicated by the relatively the stable price of rice at the farm-gate, which was ranging from Rp.1300 – Rp.1600 [5] / kg of dried paddy during April-May 2005. Food aid has, however, been a disincentive to the traders, as indicated by the decline of trade volume and profit margin. It should be mentioned that the decline in traders business it not exclusively a result of food-aid but also because of damage in transportation infrastructure and fuel price hike.

[5] currency: 1 Rupes = 180 Rupiah

Rice, fish and other food items are community trade not only with in Aceh but also to North Sumatera. Rice and paddy are transported from surplus areas such as Pidie, Aceh Utara and Aceh Timur on the west coast to various cities especially Medan, Banda Aceh, Meulaboh and Tapak Tuan. The disaster hampered the flow of rice to and from the west coast. In Banda Aceh, in particular, the damage to main market places (Pasar Aceh and Peunayong) has moved the main trading places to Pasar Lambaro, Ketapang, Neusu and Ulee Kareng. The effect of the tsunami on the rice trade in the east coast areas, however, is relatively small.

Food market, including rice, are relatively competitive. A lot of trades are involved and marketing areas are quite extensive. The more open the transportation system, information and the price signals allows goods to flow to other regions, easily resulting in smaller price deferential between regions. After the disaster, almost everything changed dramatically. The flow of goods, especially from the west coast, has been hampered. Hence, the west coast trades has shifted from various cities from in Aceh to Medan. It also negatively effected the east coast trade. Some traders have gone bankrupt, and food price in the western regions increased, though only temporally.

The marketing cost has increase since the disaster happened in Aceh. The increased coast was not only due to the increase in the price of fuel and wages, but also because of longer delivery times, particularly along the west coast. The increase in marketing cost for destination of Banda Aceh and Medan is relatively small but to the main markets on the west coast has in creased by up to 50%.

Markets are working sluggishly because of:

1. the shrinking market destination (Banda Aceh and regions in the west cost),

2. The number of traders has decline significantly, especially in the destination markets,
3. Traders do not want to take high risk by maintaining large stoke and
4. Most of the food aid is in the form of rice.

The price rice rocketed to Rp.10000-Rp.12000/kg in Banda Aceh and Meulaboh within three weeks of the tsunami. That was the critical period. After this period, the rice price was relatively stable (Rp.2800-Rp3000 per kg). Bulog's market operation and WFP food-aid program played an important role in stabilizing the price. In addition, the rice market in Aceh is open to inflow of rice from other markets (e.g. Medan)

Other food price after the tsunami were: sugar (Rp.4000-Rp.6000 per kg), wheat flour (Rp.3600-Rp.4500 per kg), edible oil-crude coconut (Rp.4500-Rp.6000 per kg). Only Bimoly (branded cooking oil) and tiger shrimp tended to increase because of high demand from higher income group.

The Impact Of Food –Aid On Consumption Patterns

Food aid was able to stabilized the frequency of intake, which experienced a decline during the first 2-3 weeks after the tsunami. Canned fish, however, is not preferred from offish for local people. Internally Displaced Persons (IDPs) were reported to have relatively sufficient stoke of rice (20-40 kg/household). Many of them sold part of their rice stoke to obtain cash for the purchase of other daily needs such as sugar, kerosene, fresh fish and other non-food items. This happened because some IDPs did not receive regular living allowance. In addition, the cash for work program could not absorb all the unemployed IDPs.

Before the tsunami, the sources of rice and fish for household consumption in rural areas was primarily from self-production and the Government's Raskin Program (for rice), while other food product were bought from local market. After the tsunami, since most household in the affected areas are IDPs, most of the food was in the form of food-aid received from the Government and WFP.

The food aid basket comprises rice, fortified noodles, cooking oil, canned fish and biscuit. The consumption of the other food was reported to be very limited. It must be mentioned that the food aid contributed to stabilizing the frequently of the staple food consumption in the affected areas in Aceh.

Wages In The Affected Areas

Compared to wages rates in surrounding regions (North Sumatera, Riau, West Sumatera). Aceh's rate is slightly higher. In the three province mentioned above, the wages ranging between Rp.20000-Rp.30000/day in agriculture, Rp.30000-Rp.40000/day for unskilled non-agriculture labour, and Rp.40000-Rp.50000/day for skilled non-agriculture labour. If significantly higher wages are paid under reconstruction activities in Aceh, it might create regional imbalance, if continued for a long period and lead to marked distortion and artificial inflation.

After the tsunami, the unemployment in Aceh increased by more than 150%, from 206000 (4.8%) to 528000 people (13.3%). Wages in agriculture sector both for skilled and un-skilled labour were not significantly different in western and eastern areas (Rp.40000-Rp.50000/day). But for fisheries sector, wages in western areas (Rp.75000-Rp.150000/day)were higher than those in eastern areas (Rp.50000-Rp.100000/day).

Wages in the non-agricultural sector in western areas (Rp.40000-Rp.80000/day) were also slightly higher than those in eastern areas (Rp.30000-Rp.75000/day), for both skilled and un-skilled labour. This wage rate (found at the time when the survey was conducted) is the same as the prevailing rate before the tsunami. There was a significant temporary increase in the wage rate during the 1-2 mouths following the tsunami when the debris clearing process was at the peak. At the time, labour was paid on a piece based (borongan) system, of approximately Rp.1-2 million to clear a damage house/building.

The wage rate paid under the Cash for Work Program (Padat Karya) were relatively the same as the labour market wage rate in the non-agriculture sector, i.e. Rp.30000-Rp.40000/ day. This wage rate is not different between western and eastern areas. There is no strong evidence that the Padat Karya Program in the affected areas attracted labour from unaffected areas. Labour mobility from the unaffected to the affected areas occurred the temporary in the 1-2 months after the tsunami, especially during the period of clearing.

CHAPTER VI
SUMMARY AND CONCLUSION

SUMMARY AND CONCLUSION

The study entitled "Farm Level Problems In Irrigated Agriculture Of Indonesia" is summarized below:

- Aceh is the north western province of Sumatera island in Indonesia it way badly affected by tsunami in 2004, about 40% of the land area of the province was inundated by sea water causing large damage to agriculture production, life and properly.
- Majority of the farmer are small and marginal in the region and have their livelihood based on agriculture, fish culture, sea water culture and animal husbandry due to unprecedented flooding the good land became saline land.
- Rescue operation, government policy and donation, for various activities were initiated to help people in the rural area, the program of land reclamation irrigation system improvement were required and agriculture technology was extended. All these taken together helped improving the little damage lands within a year. Average productivity of rice jumped to 6.0t/ha from 4.0t/ha. Moderately damage lands could be reclaimed within 5 years. Severely damage lands could not be reclaimed even today.
- Irrigation system was fully damage restructuring and modernization process in under way.

CONCLUSION

Thus it can be concluded that tsunami 2004 in Indonesia (Aceh province) was a curse to agriculture but with hard work of the farmers and support of the donor agencies and Indonesian government this has become boon to the farmer. This is expected to further improve when the irrigation system in the process of modernization become fully operational.

References

Achmad Rachman, Fahmuddin Agus. 2004. - Tsunami impacts on farming in Aceh and Nias. Indonesian Soils research Institute (ISRI), Indonesia

Athukorala, P. and B. P. Resosudarmo (2005). "The Indian Ocean Tsunami: Economic Impact, Disaster Management and Lessons", Asian Economic Papers, 4(1): 1-39.

Bappeda Aceh (2005). Pembangunan Propinsi Aceh Pasca Bencana Alam. Banda Aceh: Bappeda Propinsi Aceh.

Bappenas. 2005. www.bappenas.go.id

Barry, C.A. 1997 The Research Activity Timeline: A Qualitative Tool For Information Research. *LIAR* 19: 153-179

Ben-Hur, M., M. Agassi, R. Keren, and J. Zhang. 1998. Compaction, aging and raindrop impact effect on hydraulic properties of saline and sodic Vertisols. Soil Scie. Soc. Am. J. 62:1377-1383.

BPS (Badan Pusat Statistik) (2005). Statistik Indonesia 2005. Jakarta: BPS.

BPS, Bappenas, UNFPA, CIDA, AusAID, and NZAid (2005a). Penduduk and Kependudukan Aceh Pasca Gempa dan Tsunami: Hasil Sensus Penduduk Nanggroe Aceh Darussalam 2005. Jakarta: BPS.

BPS, Bappenas, UNFPA, CIDA, AusAID, and NZAid (2005b). Penduduk and Kependudukan Nias Pasca Gempa dan Tsunami: Hasil Sensus Penduduk Nias 2005. Jakarta: BPS.

BPS Kabupaten Nias (2005). Kabupaten Nias dalam Angka 2004. Gunungsitoli: BPS Kabupaten Nias.

Cornillon, P., and A. Palloix. 1997. Influence of sodium chloride on the growth and mineral nutrition of pepper cultivars. J. Plant Nutr. 20:1085-1094.

FAO (Food and Agriculture Organization of the United Nations) (2005a). "Impact of the Tsunami on Fisheries, Aquaculture and Coastal Lives". Last accessed online, 11 October 2006, at: FTP.FAO.org/FI/Document/tsunami

FAO (Food and Agriculture Organization of the United Nations) (2005b). "Soil Salinity Problems are Limited in Tsunami Affected Countries. Planting Could Resume in Many Areas, but Farmers are Still Facing Other Constraints". Last accessed online, 11 October 2006, at: http://www.fao.org/tsunami/stories/

Gunes, A., A. Inal, and M. Alpaslan. 1996. Effect of salinity on stomatal resistance, proline, and mineral composition of pepper. J. Plant Nutr. 19:389-396.

Haq, A.U., and B.A. Shahid.1997. —Public, Private or Participatory? Reforming Irrigation Management in Pakistan‖ *Journal of the International Commission on Irrigation Drainage (ICID)* 46 (1): 37-48.

Haq, A. U. 1998. —Managing irrigation for environmentally sustainable agriculture in Pakistan‖. A Case study of the Punjab Irrigation Department. Report No. C-12, Pakistan National Programme, International Irrigation Management Institute, Lahore, Pakistan

Hussain, I; and E. Biltonen. 2001.—Pro-poor intervention strategies in irrigated agriculture in Asia: Issues and Options‖. International Water Management Institute, Colombo, Sri Lanka.

Hussain, I., Wijerathna, D., Arif, S.S., Murtiningrum, Mawarni, A. and Suparmi (2006). "Irrigation, Productivity and Poverty Linkages in Irrigation Systems in Java, Indonesia." Water Resource Management 20: 313 - 335.

ICID (International Commission On Irrigation And Drainage), 1998. – Irrigation & Drainage in the World – A Global Review

IFOAM (International Federation Of Organics Agriculture Movement) – Training Manual On Organic Agriculture In The Tropics

Johnson III, S.H.; S. Mark, and J. Trava. 1997. —Participatory Irrigation Management: Benefits and second generation problems‖. Economic Development Institute of the World Bank, Washington, D.C.

Lashari, B., Y. Memon and N.A. Memon. 2003 —Iinstitutional reforms in irrigation sector of Pakistan: An approach towards integrated water resource management‖. Paper presented at the 9th International Drainage Workshop, The Netherlands.

LPEM (Institute for Economics and Social Research) (2005). "Perhitungan Kebutuhan Dana Pembangunan kembali Aceh". LPEM Internal Report, Jakarta.

McCallister, S. 1998. Focus Group Discussion: A Tool For Learning And Organizing. http://www.millenniumassessment.org/docs/1263/136005.html [accessed 10 January 2011]

Molden. D; M. Burton and M.G. Bos.2007. —Performance assessment, irrigation service delivery and poverty reduction: Benefits of improved system management‖. *Journal of Irrigation and Drainage* 56: 307-320.

Morgan, D.L. 1997. Focus Group A Qualitative Research. Second Edition. London, *SAGE Publication.* UK

Peter Slavich , Malem McLeod, Natalie Moore, Gavin Tinning, Rebecca Lines-Kelly .2004. - Tsunami impacts on farming in Aceh and Nias, Indonesia NSW Department of Primary Industries (NSW DPI), Australia

Prama Yufdy. 2004. - Tsunami impacts on farming in Aceh and Nias . Assessment Institute for Agriculture Technology (BPTP SUMUT) Indonesia

Soesastro, H. and R. Ace (2005). "Survey of Recent Developments", Bulletin of Indonesia Economic Studies, 41(1): 5–34.

T Iskandar .2004. - Tsunami impacts on farming in Aceh and Nias.Assessment Institute for Agriculture Technology (BPTP NAD) Indonesia

World Bank (2003), "Decentralizing Indonesia: A Regional Public Expenditure Review", Report No. 26191–IND, Poverty Reduction and Economic Management Unit, East Asia and Pacific Region.

World Bank (2005). Indonesia. Preliminary Damage and Loss Assessment: The December 26, 2004 Natural Disaster. Jakarta: The World Bank.

World Bank (2006a). GAM Reintegration Needs Assessment. Jakarta: The World Bank.

World Bank (2006b). Aceh Public Expenditure Analysis: Spending for Reconstruction and Poverty Reduction. Jakarta: The World Bank.

List of Abbreviations

ABID	: Aceh Besar Irrigation Department
ABIDA	: Aceh Besar Irrigation and Drainage Authority
ACIAR	: Australian Centre for International Agricultural Research
ADB	: Asian Development Bank
Ausaid	: Australian Agency for International Development
AWLR	: Automatic Water Level Recorder
Bakosurtanal	: National Coordinator for Survey and Mapping Agency /
	: Badan Koordinasi Survei dan Pemetaan Nasional
Balai	: Training Centre
BAPPEDA	: Regional body for planning and development
Bappenas	: National Development Planning Agency
Borongan	: Labour was paid on a piece based
BPS	: Indonesian Central Statistics Agency / Badan Pusat Statistik
BPTP	: Assessment Institute for Agriculture Technology /
	: Balai Pengkajian Teknologi Pertanian
BRR	: Bureau Reconstruction and Rehabilitation /
	: Badan Rehabilitasi and Rekonstruksi
Bulog	: Indonesian National Logistics Agency /
	: Badan Urusan Logistik
BUMD	: Regional Owned Enterprises
BUMN	: State Owned Enterprises
Bupati	: Chief of District
BWRM	: Basin Water Resources Management Project

DDGs	: Distiller's Dry Grains
DISPENDA	: Local revenue service
DPR	: Delivery Performance Ratio
DPTP&H	: Department of Agriculture Service for Food and. Horticultural Crops/
	: Dinas Pertanian Tanaman Pangan Dan Holtikultura
dS/m	: deciSiemens per metre
EC	: Electrical Conductivity
EM38	: Electromagnetic induction sensors
ESP	: Exchangeable Sodium Percentage
FAO	: Food Agriculture Organization
FGD	: Focus Group Discussion
FO's	: Former Organizations
GOI	: Government Of Indonesia
GVP	: Gross Value Products
GDP	: Gross Domestic Product
IBRD	: International Bank for Reconstruction and Development
IDPs	: Internal Displaced Peoples
IMP	: Irrigation and Maintenance Policy
IMT	: Irrigation Management Transfer
Inpres	: President Instruction
ISF	: Irrigation Service Fee
JBIC	: Japan Bank for International Cooperation
KTPP	: CO Coordinators Supervise Community Organizers /
	: Ketua Tenaga Pembimbing Petani

LPEM	: Institute for Economic and Social Research /
	: Lembaga Pemberdayaan Ekonomi Masyarakat
MBM	: Meat and Bone Meal
MoE	: Ministry of Environment
MoHA	: Ministry of Home Affairs
MPW	: Ministry of Public Works
MRC	: Mesh Reinforced concrete
NAD	: The Other One Province In Indonesia /
	: Provinsi Naggroe Aceh Darussalam
NGOs	: Non Government Organizations
NSIASP	: Northern Sumatera Irrigated Agriculture Sector Project
NSW DPI	: New South Wales Department of Primary Industri
O&M	: Operation and Maintenance
Padat Karya	: Cash For Work Program
Permen	: Ministry of regulations
Pesantren	: Islamic Educational Foundation
PJT	: Practical Job Training
PP	: Government regulation / Peraturan Pemerintah
ppm	: Parts Per Million
PPTPA	: Director Water Regulator System Committee /
	: Panitia Pelaksana Tata Pengaturan Air
PPTA	: Water Regulator System Committee /
	: Panitia Tata Pengaturan Air

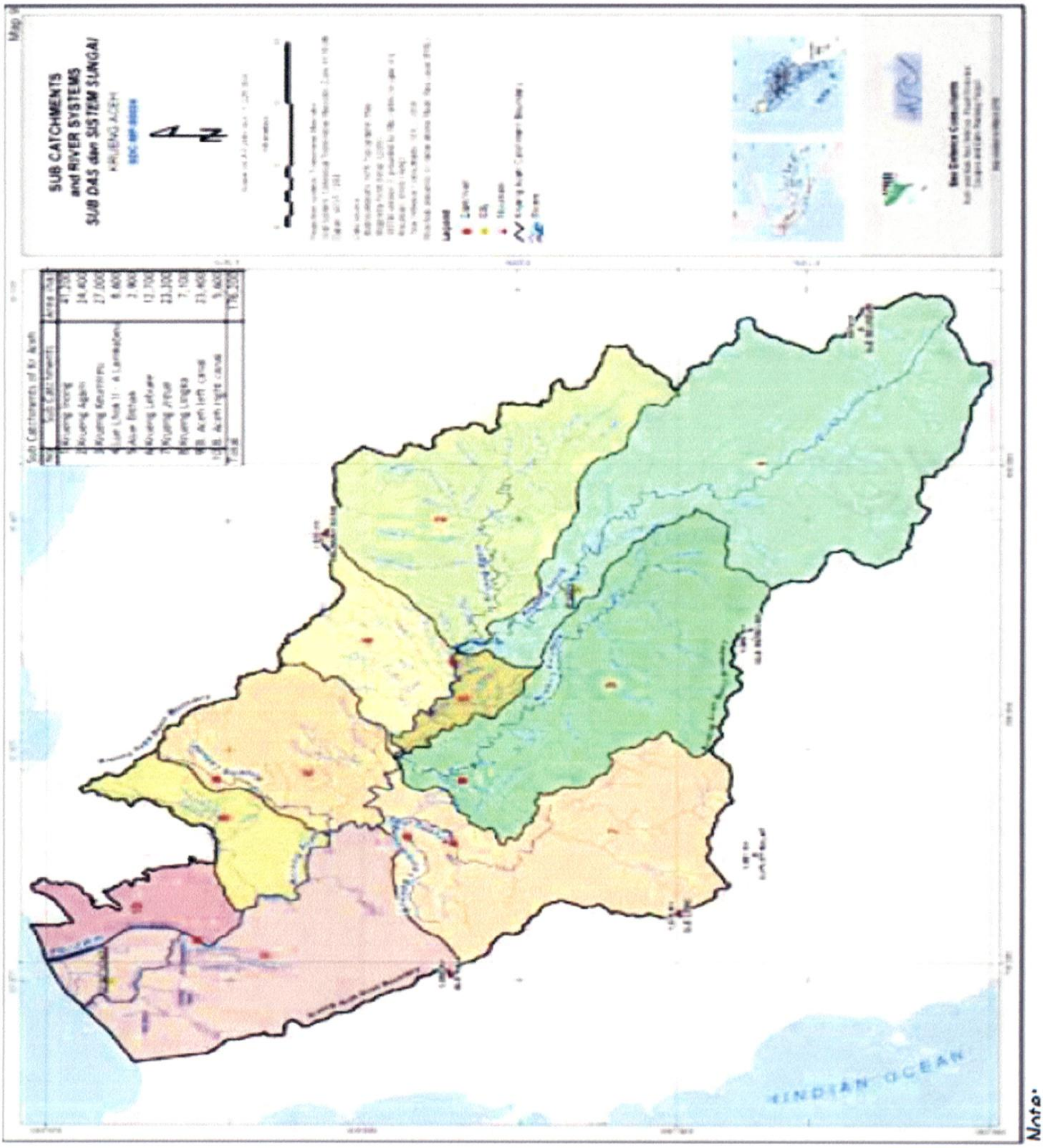
PSDA	: Provincial Water Resources Development Service
R&D	: Research And Development
SPHERE	: Humanitarian Charter and Minimum Standards in Disaster Response
SPSS	: Statistical Package for Social Scientists
SUSENAS	: National Socio-Economic Survey /
	: Survey Ekonomi-Sosial Nasional
TSR	: Tail End Supply Ratio
TPP	: Supervise Community Organizers / Tenaga Pembimbing Petani
UN	: United Nations
UNICEF	: United Nations Educational, Scientific and Cultural Organization
UNDP	: United Nations Development Programme
UPTD	: Regional Technical Implementation Unit /
	: Unit Pelaksana Teknis Daerah
WATSAL	: Water Sector Adjustment Loan
WB	: World Bank
WFP	: World Food Programme
WUA's	: Water Users Associations

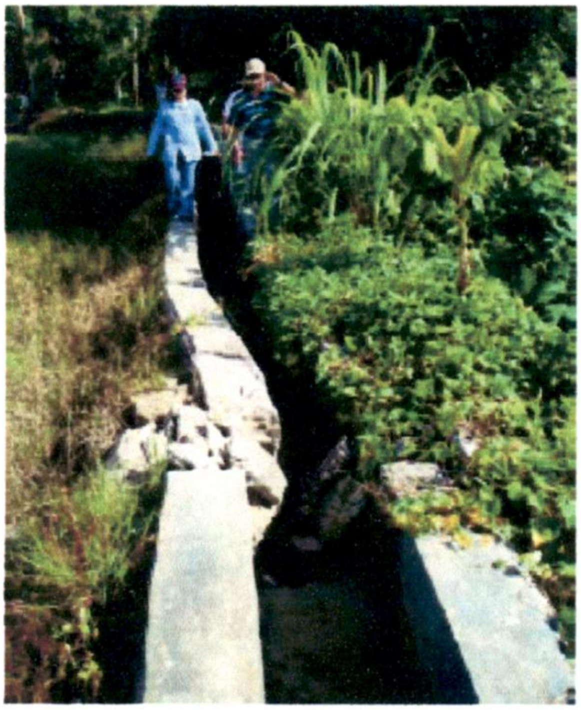
Key Informants

List of key informants in the study sites.

SN	Name	Gender	Study Site
1	Naskah Bin Khamar	Male	Kr.Lingka
2	Musfian	Male	Kr.Lingka
3	Kusmayadi	Male	Kr.Lingka
4	Rika Mahyona	Female	Kr.Lingka
5	Renita	Female	Kr.Lingka
6	Malahayati	Female	Kr.Lingka
7	Fahrial	Male	Kr.Lingka
8	Mumun Ikhwan	Male	Kr.Jreu
9	Harris R Dahlan	Male	Kr.Jreu
10	Rahmaini	Female	Kr.Jreu
11	Asdiana	Female	Kr.Jreu
12	Linda Purnama	Female	Kr.Jreu
13	Boy Afriansyah	Male	Kr.Jreu
14	Hasrizal HB	Male	Kr.Jreu
15	Mukhrizal	Male	Kr.Labuen
16	Fitriani	Female	Kr.Labuen
17	Srikandi	Female	Kr.Labuen
18	Asranita	Female	Kr.Labuen
19	Abuslan	Male	Kr.Labuen
20	Ali Hasmi	Male	Kr.Labuen
21	Budiman	Male	Kr.Labuen
22	Dewi	Female	Kr.Kemumireu
23	Lena Marlina	Female	Kr.Kemumireu
24	Lina Diana	Female	Kr.Kemumireu
25	Syauki	Male	Kr.Kemumireu
26	Nayan Sahputra	Male	Kr.Kemumireu
27	Muhammad Ali	Male	Kr.Kemumireu
28	Junidar Salim	Female	Kr.Kemumireu
29	Raudatul Jannah	Female	Kr.Kemumireu
30	Syamsidar	Female	Kr.Kemumireu

Figure : Sub Catchments And River system

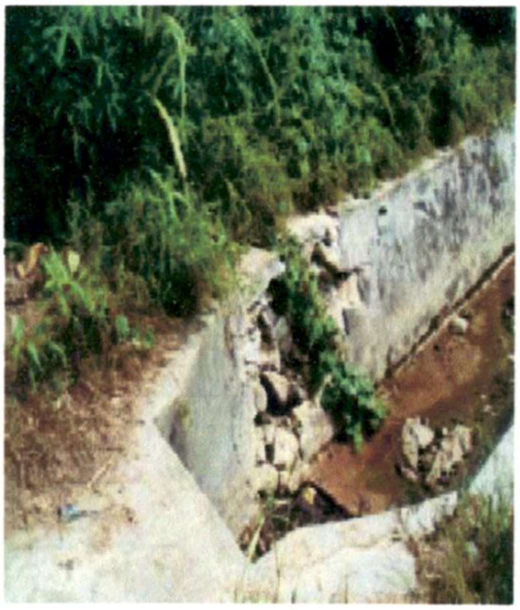
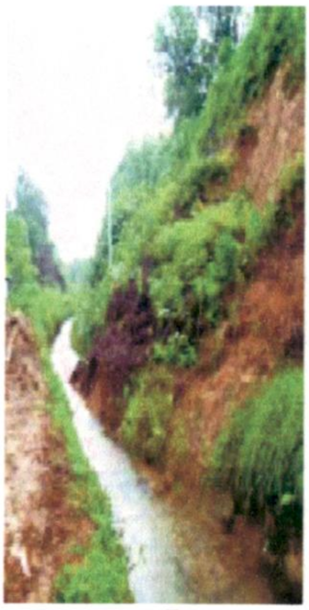
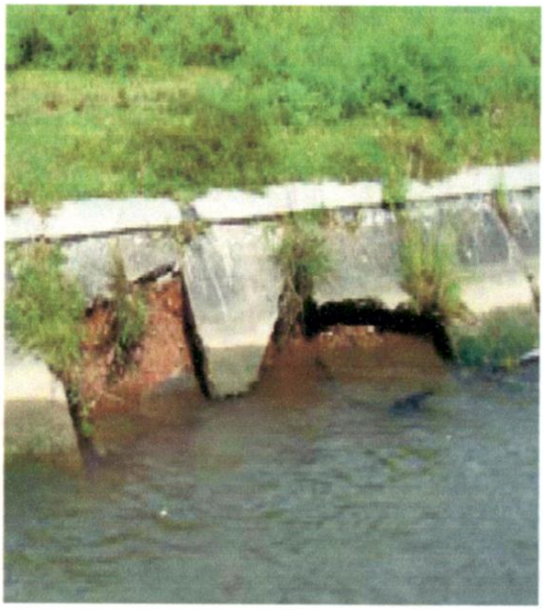





A B

Figure A: Cracking and displacement of masonry flume lining in Aceh was widespread

Figure B: Section of masonry flume toppled over

A B C

Figure A: Cracking of lining at join with off take out late

Figure B: Earthquake make step cuts above canal unstable

Figure C: Failure of pre cast slab canal by uplift pressure on poor quality concrete

A

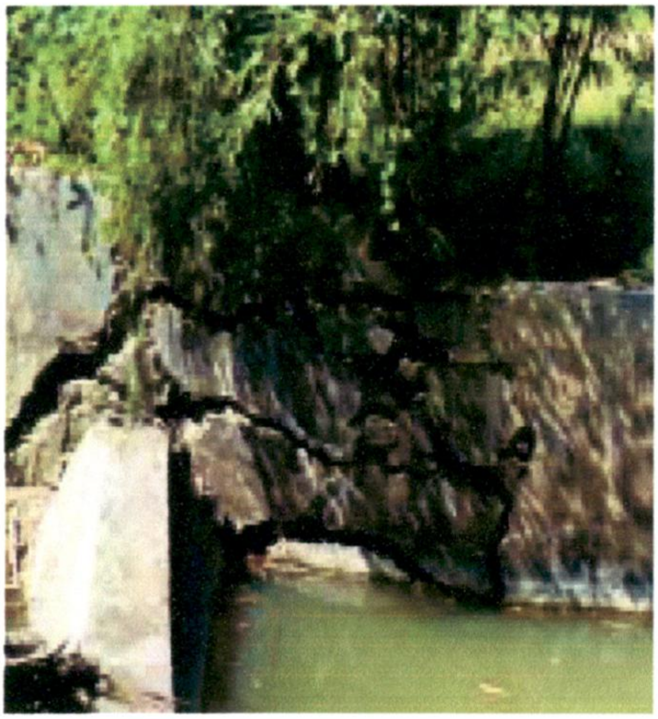
B

Figure A&B: Earthquake damage to Moafoa weir and canal in Aceh

A

B

Figure A: Tsunami damage to rice and coconut plantation.
Figure B: Tsunami damage to Geunteut weir irrigation.



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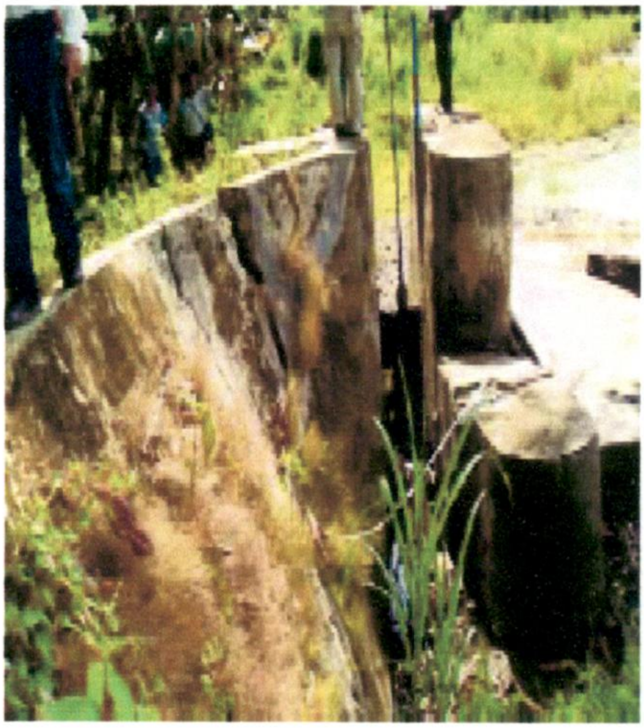
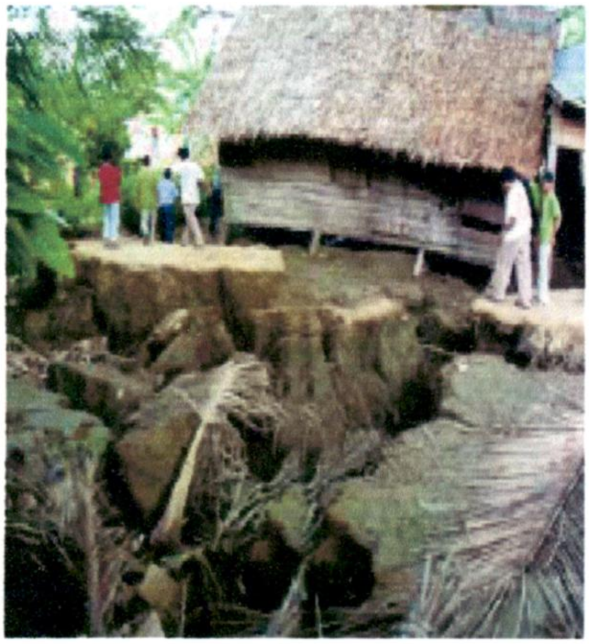


B

C

Figure A&B : Damage to masonry abutment and scour gate peirs
Figure C : Damage to masonry weir block



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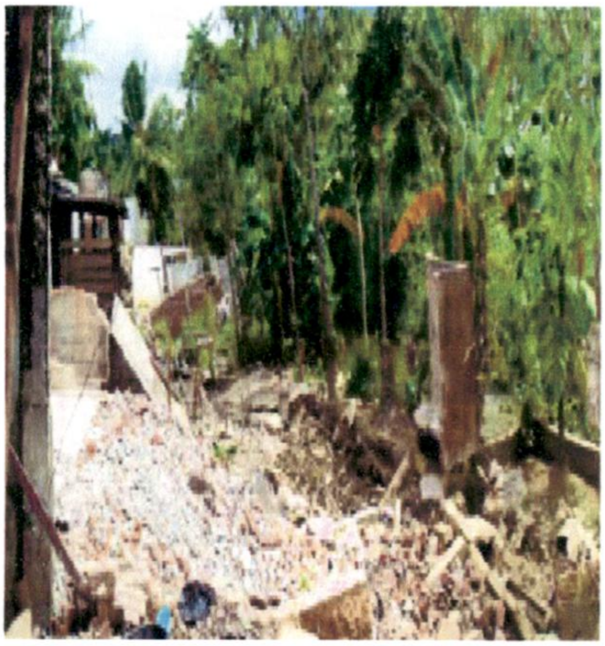
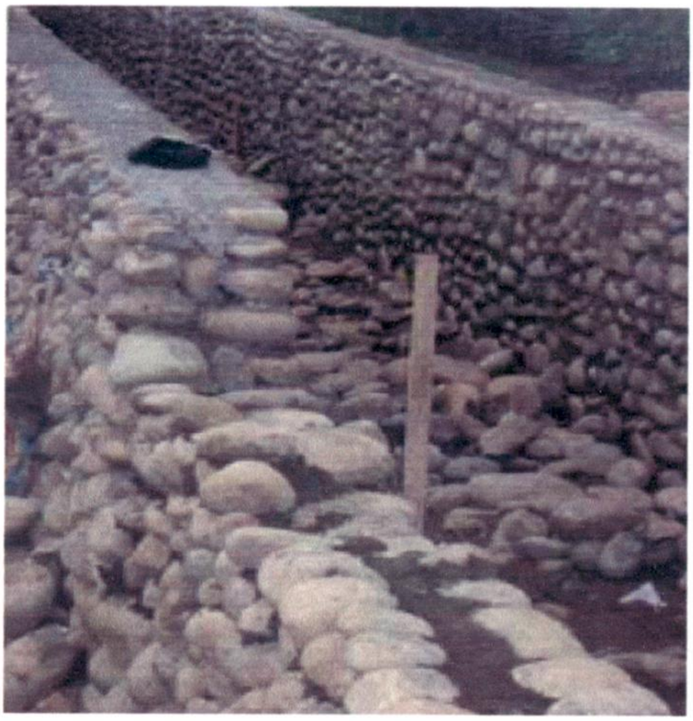


B

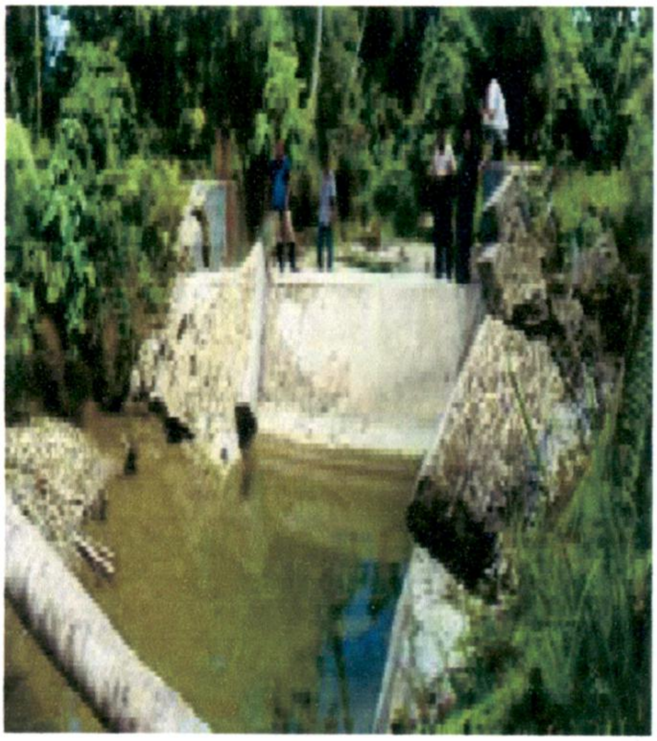
Figure A&B: Liquefaction cracks on soft alluvial floodplains and landslips into river.



A

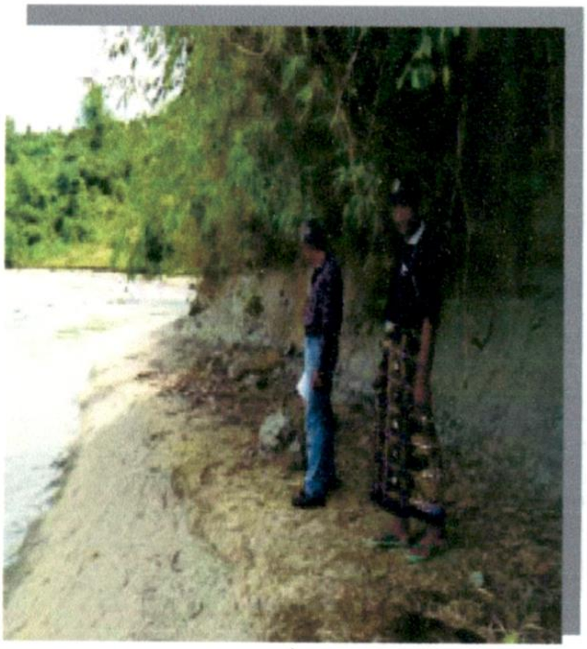
Figure A: Masonry wall under construction with rounded stones weak mortar on NSIASP, Meuredu irrigation system.

A



B

Figure A: Moafoa weir rebuilt with reinforced concrete abutments.
Figure B: Previous damage to Moafoa weir.

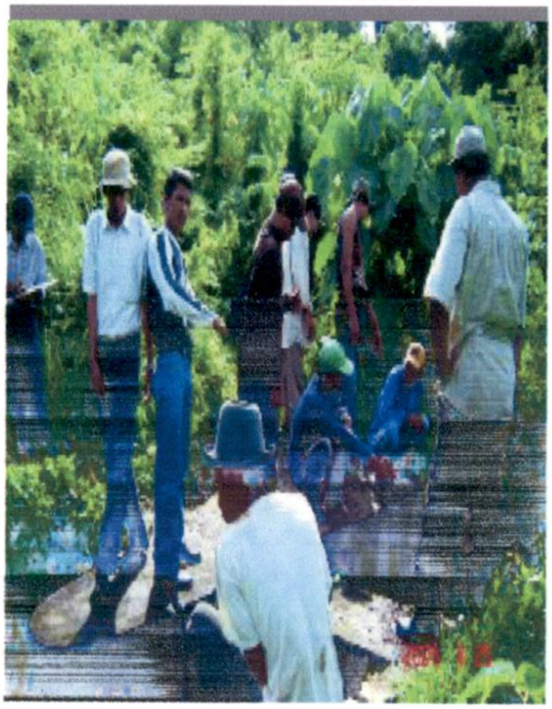


A

B

Figure A: Supervise Community Organizers (TPP) training season
Figure B: Specialist technical input with key WUA members.

A



B

Figure A: Technical assistance in constructing MRC canal lining.
Figure B: Walkthrough exercise and discussion on structure condition and function

A

Figure A. Crop destruction due to salinity

A

Figure A. Landscape de-surfacing due to erosion and sedimentation

A

Figure A. Salt precipitation and sediment cracking in Krueng Aceh, Aceh Besar

A

Figure A. Trash and debris in Lhok Nga, Aceh Besar

A

B

Figure A&B: Died Fish and snake due to strong salinity.

A

B

Figure A: Irrigation infrastructure damage
Figure B: Salinity in the field irrigation canal

A

Figure A: Community Plenary Meeting assessing existing problems, identification of existing local institution (DI Indrapuri, Aceh Besar)

A

Figure A: A member of Water User Association (WUA) in DI Alue Ubay, Aceh Utara is actively constructing their own secondary canals. Usually, the Secondary canal is constructed by professional contractors

A

Figure A: A Field Staff of B & V Consultant , Koordinator Tenaga Pendamping Petani (KTPP), is providing a technical assistance to the members of WUAs during the construction in DI Indrapuri, Aceh Besar.

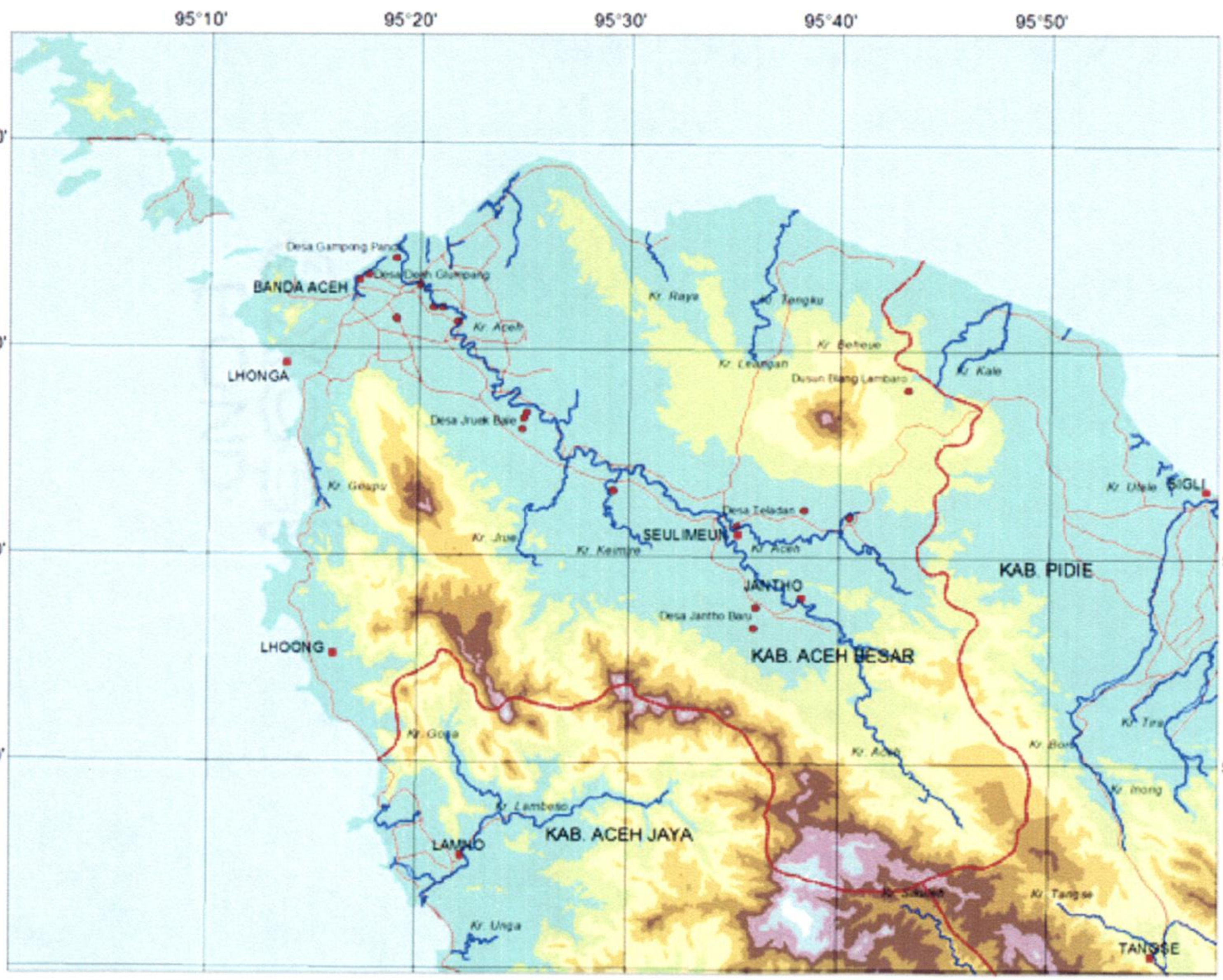
A

Figure A: Four WUA's members in Krueng Aceh Irrigation, Aceh Besar is "gotong royong" using a concrete mixer to prepare required materials needed to complete construction of tertiary canals.

A

Figure A: Water User Association (WUAs) are able to construct high quality secondary canals, instead of tertiary ones. (Indrapuri Irrigation, Aceh Besar)

Kabupaten Aceh Besar



U
B T
S

0 5 10 15 20 Km

- Village
- Town
- District Boundary
- River
- Road

Elevation

- 0 - 250
- 250 - 500
- 500 - 750
- 750 - 1000
- 1000 - 1250
- 1250 - 1500
- 1500 - 1750
- 1750 - 2000
- 2000 - 2250
- 2250 - 2300

Spesifikasi Peta
Sistem koordinat UTM zone 46N

Sumber Peta
Peta Topografi skala 1:50.000

PETA TOPOGRAFI KABUPATEN ACEH BESAR / TOPOGRAPHY MAP OF ACEH BESAR DISTRICT

Skala 1 : 250.000 pada ukuran A1/ 1 : 250.000 Scale in A1 size

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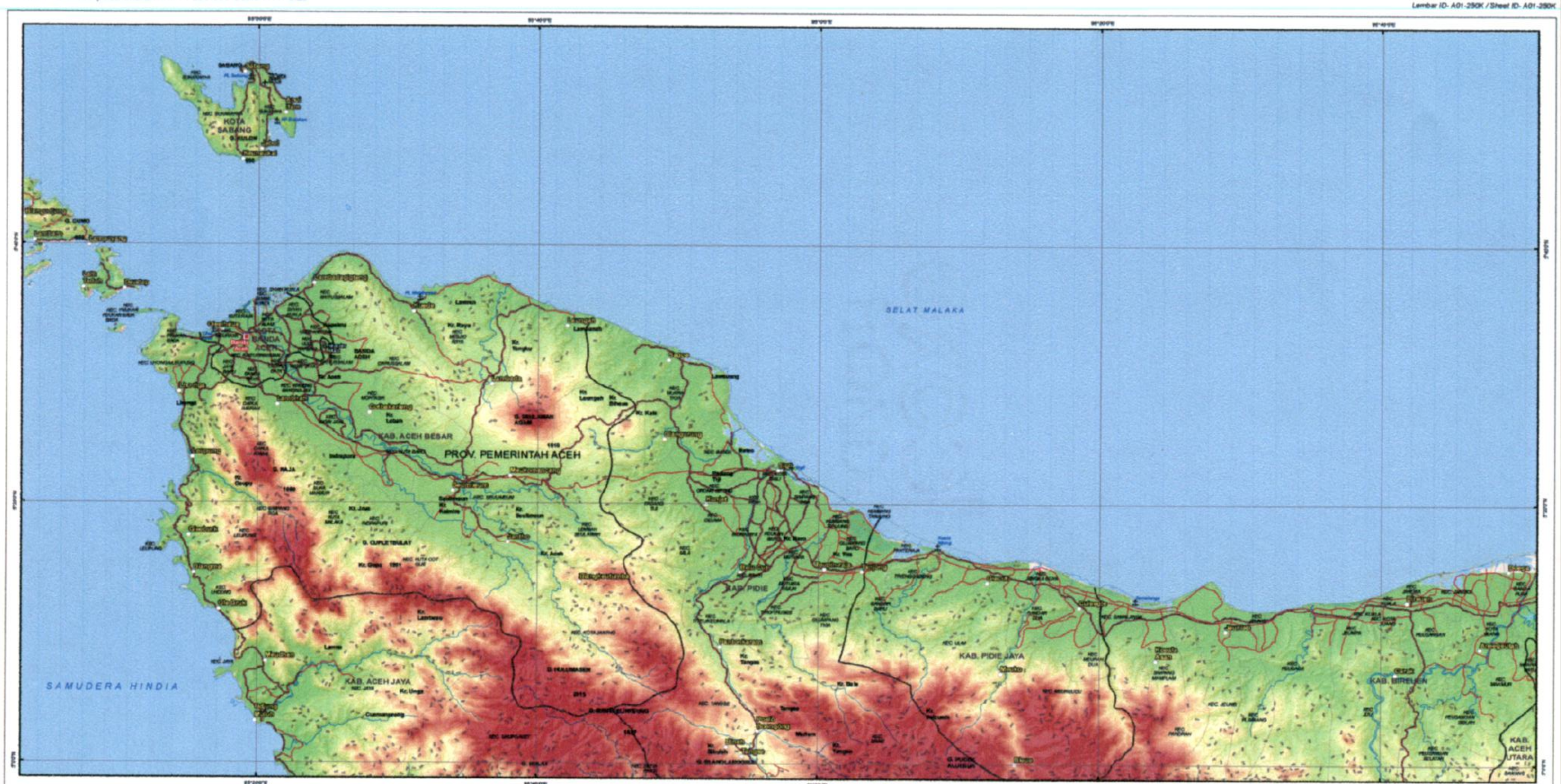

Legenda / Legend

Batas Administrasi / Administrative Boundary
- Ibu Kota Provinsi / Province Capital
- Kota / Town
- Batas Provinsi / Province Boundary
- Batas Kabupaten / District Boundary
- Batas Kecamatan / Sub District Boundary
- Garis Pantai / Coast Line

Jaringan Jalan / Road Network
- Jalan Utama / Major Road
- Jalan Kolektor / Collector Road
- Jalan Lokal / Local Road
- Jalan Setapak / Step Road
- Jalan Kereta Api / Rail Way
- Jalan Lori / Lorry Road

Transportasi / Transportation
- Bandara / Airport
- Pelabuhan / Port

Topografi / Topography
Ketinggian (mdpal) / High (m above sea level)
- High : > 1000
- Low : < 200
- Garis Kontur / Contour Line

Hidrologi / Hydrology
- Sungai / River
- Danau / Lake

Informasi Kartografi / Cartographic Information

Proyeksi Lokal / Local Projection :
UTM, Zone 46 North

Proyeksi Geografi / Geographic projection :
Lintang - Bujur / Latitude - Longitude

Datum Unit : WGS - 84

Unit Grid / Grid Unit :
Lintang - Bujur dengan interval antar grid 0.3 derajat /
Lat - Long with interval 0.3 degree

Skala / Scale :
1 : 250.000 pada ukuran A1 / 1 : 250.000 at A1 size
1 cm di peta sama dengan 2,5 km di lapangan /
1 cm equals with 2,5 km in the field

Satuan tinggi dalam meter / High unit in meters
Selang kontur 100 meter / Contour interval of 100 meters

Sumber data / Data Source

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SRTM 30 M

- Peta dasar / base map :
Peta dasar digital Bakosurtanal Skala 1 : 250.000/
Digital Basemap. Bakosurtanal 1 : 250.000 Scale

- Batas administrasi/administrative boundary :
BPS 2006

- Kota, pelabuhan dan bandara / town, port, and airport :
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Dibuat oleh / produce by :

BADAN NASIONAL PENANGGULANGAN BENCANA
(B N P B)
Jl. Ir. H. Juanda 36, Jakarta 10120 Indonesia
Telp. 021 345.8400, Fax. 021 345.8500

Provincial Capital

Other Towns

District Boundaries

Note: Simeulue, Sabang, Lhokseumawe, and Langsa all have district status.

Note: Map boundaries and locations are approximate. Geographic features and their names do not imply official endorsement or recognition by the UN.