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Sea Level Rise in South Kalimantan, Indonesia - An Economic Analysis of Adaptation Strategies in Agriculture

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This EEPSEA study from Indonesia finds that building dikes would be the best strategy to protect farmland from rising sea levels that are being caused by climate change. In Indonesia there is considerable concern about the impact this problem will have on large areas of re-claimed coastal swampland in South Kalimantan – land which is already experiencing freshwater salination due to rises in sea level. It is thought that over 150,000 ha of this land, which is currently being farmed for rice and other food crops, are at risk, and that this will jeopardize the livelihoods of many thousands of farmers and their communities.

To help decide what is the best response to this unfolding crisis, two researchers from Lambung Mangkurat University look at different strategies that the government could take to respond to the problem – one of these is building dikes, the other relocating farmers to new agricultural areas inland. The researchers find that building dikes to protect farmland is a more cost-effective response.

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May, 2009

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The Economy and Environment Program for Southeast Asia (EEPSEA) was established in May 1993 to support research and training in environmental and resource economics. Its objective is to enhance local capacity to undertake the economic analysis of environmental problems and policies. It uses a networking approach, involving courses, meetings, technical support, access to literature and opportunities for comparative research. Member countries are Thailand, Malaysia, Indonesia, the Philippines, Vietnam, Cambodia, Lao PDR, China, and Papua New Guinea.

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LIST OF ABBREVIATIONS

IPCC	Intergovernmental Panel on Climate Change
SLR	Sea level rise
GDRP	Gross domestic regional product
IDR	Indonesian rupiah
FGDs	Focus group discussions
GIS	Geographic information system
HH	Households
CBA	Cost-benefit analysis
NPV	Net present value
OCC	Opportunity cost of capital
SDR	Social discount rate

SEA LEVEL RISE IN SOUTH KALIMANTAN, INDONESIA – AN ECONOMIC ANALYSIS OF ADAPTATION STRATEGIES IN AGRICULTURE

Akhmad R. Saidy and Yusuf Azis

EXECUTIVE SUMMARY

The economic importance of the Indonesian coast is significant as a large tidal swampland near the coastal areas has been reclaimed for agricultural purposes. Twenty-five years of swamp reclamation has succeeded in 89,036 ha of swampland in the province of South Kalimantan being reclaimed for agriculture, mainly of rice. These new agricultural areas are now, however, at risk due to sea level rise (SLR). A household survey was carried out to determine the awareness level of farmers of SLR and its effect on the agricultural lands. Out of the total number of 1,222 respondents, only 35% understood SLR and its effects on their rice fields. This indicates a strong need for information dissemination on the SLR issue to farmers in the coastal areas.

The geographic information system (GIS) was employed to predict agricultural loss caused by a 0.5–1.0 m SLR. Out of the 13 regencies in South Kalimantan Province, six regencies—Banjar, Banjarmasin, Barito Kuala, Kotabaru, Tanah Bumbu, and Tanah Laut—had agricultural areas that were impacted by SLR. The results of the analysis also revealed that Barito Kuala would experience the largest loss in agricultural production from just a 0.5-m SLR, amounting to IDR 630.26 billion.

Another objective of this research was to conduct economic assessments of agricultural adaptation to SLR in South Kalimantan Province, namely the construction of farm dikes and establishing new agricultural areas. The results of the cost-benefit analysis showed that farm-dike installation had positive net present values (NPVs) while the establishment of new agricultural areas produced negative NPVs. This implies that farm-dike establishment is more a worthwhile adaptation strategy for agriculture in response to a SLR of one meter compared to the establishment of new agricultural areas.

1.0 INTRODUCTION

Coastal areas in Indonesia perform essential environmental and economic functions. Big rivers such as the Barito, Kapuas and Mahakam in Kalimantan and the Musi in Sumatera allow tidal water entering inland to form tidal swamplands. These sites represent a total area of over 20 million ha (Nedeco-Euroconsult 1984). Tidal swamplands represent a huge reservoir of water, organic carbon and nitrogen. Under undisturbed conditions, tidal swamplands are covered by forests that maintain the biodiversity of the area and provide habitats for wildlife. Forests growing in tidal swamplands also yield a number of important products such as timber and bark, and around 10% of Indonesia's export of forest products is obtained from these areas (Rieley and Setiadi 1997). Due to pressure for land, a large area of tidal swampland in Indonesia has been being reclaimed for agricultural purposes.

The Indonesian government introduced the Tidal Swampland Development Project in the 1960s in order to achieve rice self-sufficiency. Under the project, four ministries (Ministry of Public Works, Ministry of Internal Affairs, Ministry of Agriculture, and Ministry of Transmigration) were appointed to plan and execute a program known as the "Project on Paddy Field Development on Tidal Swamps through Transmigration". Twenty-five years of swamp development has succeeded in 89,036 ha of swampland in the province of South Kalimantan being reclaimed for rice cultivation (Ministry of Settlement and Regional Infrastructure 2006). Rice production in the reclaimed tidal swampland accounted for 38% of total rice production in the Province of South Kalimantan in 2005 (Statistics Board of South Kalimantan Province 2006).

As noted by the Intergovernmental Panel on Climate Change (IPCC 2007), continued growth of greenhouse gas emissions and the associated global warming will exacerbate climate change. Climate change will have many negative effects, including greater frequency of heat waves; increased intensity of storms, floods and droughts; and rising sea levels. Sea level rise (SLR) poses a particularly big threat to countries with heavy population concentrations and economic activity in coastal regions. SLR will increase the susceptibility of coastal populations and ecosystems through the permanent inundation of low-lying regions, amplification of episodic flooding events, and increased beach erosion and saline intrusion (Mclean 2001). The coastline will retreat hundreds of meters inland, causing the loss of tidal swamplands. Freshwater sources will be affected due to salinization of surface and underground water bodies by the sea water. Ultimately, SLR will lead to the displacement of millions of people, significant damage to property and infrastructure, and a considerable loss of coastal ecosystems by the end of the 21st century (Nicholls and Lowe 2004).

Several measures should be taken to reduce the risk of loss of life or damage in order to maintain economic activity in coastal areas. Proposals to maintain the economic and environmental viability in coastal areas include protection through hard structures such as dikes and sea walls, but this will be costly. For example, investment in and the maintenance of coastal defense structures as well as the monitoring of beach and dune pollution in Belgium cost about 25 million Euros (Lebbe and Meir 2000). In addition, Kojima (2004) estimated that 115 billion USD would be needed to protect port-related facilities alone against a 1.0-m SLR in Japan.

The establishment of coastal protective structures as an adaptation option has been largely neglected in Indonesia because this would be very expensive as the country's coastline is approximately 81,000 km long. Lau (2005) reported that the cost for a 500-km dike to prevent losses from a 1.0-m SLR for the North China Plain was estimated at 370 million USD. While no hard structures have been built in Indonesia for coastal protection, farm-dikes established by the Ministry of Settlement and Regional Infrastructure in collaboration with the Ministry of Agriculture could reduce the impact of the SLR on reclaimed tidal swamplands.

Water management determines the success of agricultural management in swamplands; therefore, fiber flap-gates are frequently installed farm dikes that form part of the drainage systems in the reclaimed swamplands to control water flow in rainy and dry seasons (Susanto et al. 1999). Based on its function to control water flow from and to rice fields in the reclaimed swamplands, the installation of flap-gates could be used to reduce the impact of SLR on agricultural areas. An alternative option is to establish new agricultural areas inland which are not affected by SLR. The Indonesian

government has substantial experience in relocating people under its transmigration program but it has no information on the costs and benefits of farm-dike establishment and the establishment of new agricultural areas.

The general objective of this research was to predict the economic impacts of adaptation strategies in agriculture in response to SLR in the Province of South Kalimantan, Indonesia. The specific objectives were:

1. To determine the level of awareness of farmers of the issue of SLR and its effects on their agricultural lands.
2. To predict the agricultural losses that will result from a SLR of one meter if no adaptation is done.
3. To estimate the costs and benefits of the protection of agricultural areas in coastal areas through farm-dike establishment.
4. To estimate the costs and benefits of the establishment of new agricultural areas inland.

2.0 BACKGROUND OF THE STUDY

This section provides a brief discussion of the socio-economic characteristics of the province of South Kalimantan and the area of reclaimed swamplands in it.

2.1 Brief Description of South Kalimantan Province

The province of South Kalimantan lies in the island of Kalimantan (Borneo) with an area of 3,766,000 ha, situated between latitude $1^{o}21'$south to $4^{o}10'$ south and longitude $114^{o}19'$ east to $116^{o}33'$ east. Lowland areas in this province account for 1,140,140 ha, with 763,207 ha potentially available for agricultural reclamation. The province is surrounded by the provinces of East Kalimantan and part of Central Kalimantan in the north, the Java Sea in the south, the province of Central Kalimantan in the west, and the Makassar Straits in the east (Figure 1).

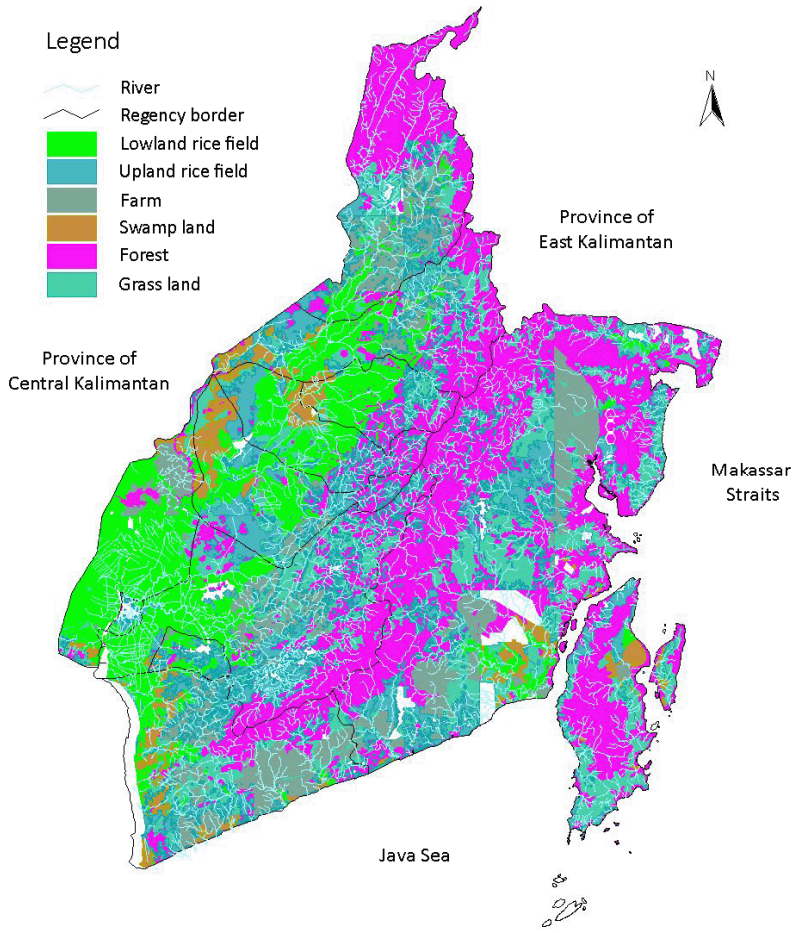

Figure 1. Land use in South Kalimantan Province

Three sectors contributed the most to the gross regional domestic product (GDRP) of South Kalimantan Province. These were agriculture; mining; and trade, restaurants and hotels. Agriculture contributed IDR 7,849,541.92 million or 22.77%. This is the largest contribution among sectors. A breakdown of the GDRP of South Kalimantan Province is given in Table 1.

Table 1. Gross regional domestic product of South Kalimantan in 2006 (million IDR)

No.	Sector	Value Added (IDR)	%
1	Agriculture	7,849,541.92	22.77
2	Mining	7,336,238.42	21.28
3	Trade, restaurants and hotels	5,060,494.91	14.68
4	Manufacturing	4,161,349.39	12.07
5	Social and community services	3,285,867.89	9.53
6	Transport and communication	2,952,625.19	8.57
7	Construction	2,218,685.04	6.44
8	Finance, dwelling, building rental and business services	1,428,842.63	4.15
9	Electricity and water supply	175,583.18	0.51
	Total	34,469,228.57	100.00

Source: Statistics Board of South Kalimantan Province (2007)

The total population of the province of South Kalimantan in 2006 was 3,345,784 (Statistics Board of South Kalimantan Province 2007) while total employment in the province reached 1,821,597 (55.44%). Among the nine sectors recorded as sources of employment, agriculture had 852,775 people or 46.81% of the total employed population. This implies that the agriculture sector is still dominant in the province. Other key employment sectors include trade, restaurants and hotels (22.11%); social and community services (10.76%); and manufacturing (8.31%). The sectoral employment statistics of the province are shown in Table 2.

Table 2. Employment in South Kalimantan Province (2006)

No.	Sector	Number (people)	%
1	Agriculture	852,775	46.82
2	Trade, restaurants and hotels	402,795	22.11
3	Social and community services	196,023	10.76
4	Manufacturing	151,390	8.31
5	Transport and communication	83,984	4.61
6	Mining	57,022	3.13
7	Construction	53,742	2.95
8	Finance, building rental and business services	17,853	0.98
9	Electricity and water supply	6,012	0.33
	Total	1,821,597	100.00

Source: Statistics Board of South Kalimantan Province (2007)

2.2 Reclaimed Swamplands for Agriculture in South Kalimantan Province

Agricultural areas in South Kalimantan Province can be categorized into two groups: upland and lowland areas. Lowland agricultural areas are generally located in the western part of the province (Figure 1) and situated in reclaimed swamplands (tidal and non-tidal swamplands). This study focused on agricultural areas in reclaimed tidal swamplands because these are the areas that will be most impacted by SLR.

Table 3. Reclaimed swampland areas for agriculture in South Kalimantan Province

No.	Regency	Tidal Swamplands		Non-Tidal Swamplands		Total	
		ha	%	ha	%	ha	%
1	Balangan	-	-	-	-	-	-
2	Banjar	5,970	6.71	24,886	24.83	30,856	16.30
3	Banjarbaru	-	-	-	-	-	-
4	Banjarmasin	-	-	-	-	-	-
5	Barito Kuala	75,766	85.10	2,500	2.49	78,266	41.35
6	Hulu Sungai Selatan	-	-	10,705	10.68	10,705	5.66
7	Hulu Sungai Tengah	-	-	6,020	6.01	6,020	3.18
8	Hulu Sungai Utara	-	-	19,598	19.55	19,598	10.35
9	Kotabaru	-	-	13,753	13.72	13,753	7.27
10	Tabalong	-	-	4,187	4.18	4,187	2.21
11	Tanah Bumbu	-	-	-	-	-	-
12	Tanah Laut	7,300	8.20	2,108	2.10	9,408	4.97
13	Tapin	-	-	16,485	16.45	16,485	8.71
	Total	89,036	100.00	100,242	100.00	189,278	100.00

Source : Swampland Development Project (2007)

The reclamation of swamplands for agriculture has been conducted in only three regencies; Kabupaten Tanah Laut, Kabupaten Banjar, and Kabupaten Barito Kuala, covering a total area of 89,036 ha. These lands are frequently flooded every year; therefore, most the common agricultural crop in these areas is rice. Production of rice in these three regencies from 1997-2006 reached 38-49% of the total rice production in South Kalimantan, indicating the significant role of these regencies in the provision of food for the province.

3.0 RESEARCH METHODS

3.1 Farmers' Awareness of Sea Level Rise

3.1.1 Focus group discussions

Two focus group discussions (FGDs) were carried out before the household survey. The first was with government agencies, namely, the agricultural regional offices of South Kalimantan Province, Kabupaten Banjar, Kabupaten Barito Kuala, and Kabupaten Tanah Laut; the Settlement and Regional Infrastructure Regional Office of South Kalimantan Province; and the Transmigration Regional Office of South Kalimantan Province. The aim of the first FGD was to inform the regional offices of the objectives of the study. The FGD provided a forum in which to discuss the current status of agriculture in the reclaimed swamplands of South Kalimantan, the programs and activities that were being implemented to maintain agricultural productivity, and any problems that were encountered.

The second FGD was attended by 12 farmers from different districts (*kecamatan*) in South Kalimantan Province. The participants were recruited through agricultural field officers. There were representatives from the three regencies that had the largest proportion of reclaimed swamplands in the province. This FGD served as a venue to discuss the objectives of this study with the farmers and to determine their level of awareness of SLR.

3.1.2 Recruitment and training of enumerators

Twelve final-year students and fresh graduates from the Study Program of Agribusiness, Faculty of Agriculture Lambung Mangkurat University, were recruited as enumerators and attended training on how to conduct the household survey. The training of enumerators comprised classroom lectures and (pre-test) field activities.

3.1.3 Farmer-household survey

The composition of the sample for the farmer-household survey involved a three-stage process. The Statistics Board of South Kalimantan Province and its Agricultural Regional Office generated the sample for the household survey. The first stage involved the selection of four regencies (*kabupaten*) that had the largest rice production in the province while the second stage focused on the selection of districts situated in coastal areas in each regency. The third stage was to select villages in each district where the household survey would be carried out.

Four regencies: Barito Kuala, Tanah Laut, Banjar, and Tapin were selected from the 13 regencies in South Kalimantan. These regencies had the largest rice production in the province. Tapin was later dropped as it was not situated in a coastal area.

The questionnaire for the household survey had four parts and was administered through personal interviews. The first part asked the respondents for background information, particularly on their education and income. The second part assessed the farmer's assets which were at risk of loss from SLR. The third part of the questionnaire

was applicable only to farmers who lived and worked in agricultural areas with farm-dike establishment or in new established agricultural areas. It focused on the costs and benefits of each farming activity carried out by the local farmers. The fourth section asked about the farmer's knowledge/awareness of SLR. During the interview, the interviewer showed photos and discussed what SLR was and what its causes were.

Interviews were carried out in the afternoon to increase the likelihood that the heads of the households would be available. The research team visited the chairperson of each village before conducting interviews to obtain his support and cooperation and to ensure security.

3.2 Agricultural Loss Caused by Sea Level Rise (Base Case)

Geographic information system (GIS) software was employed to determine the total agricultural area affected by SLR. The GIS was used to overlay land-use data with the inundation areas projected for a 1.0-m SLR. The land-use data that showed rice fields, crop farms, forests, grasslands, and settlement areas was obtained from the National Agency for Survey and Mapping. Inundation areas were derived from a combination of contour line data and data on tidal flooding areas. Contour line data was supplied by the National Agency for Survey and Mapping whilst data on tidal flooding areas was provided by the Research Institute for Agricultural Swampland (this included specific swamp areas based on distance from the coastline).

Estimates of agricultural loss due to SLR were made through identification and quantification of agricultural activity in the impacted areas. Rice fields, fish/shrimp ponds, fruit farming, and animal husbandry in each regency were considered as agricultural activities which would be impacted by SLR. The agricultural productivity of each regency was taken into account as each regency had slightly different levels of agricultural productivity. Secondary data on agricultural productivity and the prices of agricultural products was supplied by the Agricultural Regional Office of South Kalimantan.

SLR could impact rice production in two ways. Firstly, sea water containing high concentrations of salt would enter the rice fields. This would jeopardize the growth of the plants. The effects of high concentration of salt on rice growth have been reported in several studies (for example, Saidy, Purnomo and Osaki 2004; Asch and Woperies 2001; Khan et al. 1997). Saidy, Purnomo and Osaki (2004) reported that an increase in salt concentration to 2 dSm^{-1} in rice fields of South Kalimantan Province could lead to a reduction in growth of the rice crop of up to 60-70%. Higher SLR would result in more adverse reductions. Secondly, SLR will seriously reduce the availability of oxygen for growth of the rice crop if it is 45 cm or more as the water will then submerge most of the field. Our study found that there would be a 100% loss in rice production at 45 cm SLR.

Based on these two mechanisms, we assumed that the losses in rice production over a period of 66 years would be as follows:

- 10% loss in rice production for Years 1-5
- 20% loss in rice production for Years 6-10
- 35% loss in rice production for Years 11-15

- 50% loss in rice production for Years 16-20
- 70% loss in rice production for Years 21-25
- 95% loss in rice production for Years 26-30
- 100% loss in rice production for Years 31-66

However, the loss in fruit and fish/shrimp production was assumed to begin when the sea level rose *beyond* 45 and 40 cm, respectively. Fruits were mostly cultivated in raised beds 45-50 cm higher than rice fields. Therefore, the loss in fruit production was assumed to take place when SLR exceeded 45 cm. Fish/shrimp ponds are generally protected by a 40-75 cm concrete bank (Hanafie 2007); thus, the production of fish/shrimp was assumed to be affected when SLR exceeded 40 cm. The expected losses in fruit and fish/shrimp production were assumed to be as follows:

- 0% loss in fruit and fish/shrimp production for Years 1-30
- 50% loss in fruit and fish/shrimp production for Years 31-40
- 70% loss in fruit and fish/shrimp production for Years 41-50
- 90% loss in fruit and fish/shrimp production for Years 51-60
- 100% loss in fruit and fish/shrimp production for Years 61-66

The determination of the time frame for the effects of SLR to manifest in the study areas was a crucial issue in our analysis. Nurmaulia et al. (2005), using satellite data of altimetric topex (1992-2002), reported that the most suitable predicted mean SLR was 15 mm per year in the Java Sea. Therefore, a SLR of 0.5 m in the study areas will occur in 2039, while a 1.0-m SLR will occur in 2072.

Based on data provided by the Agricultural Regional Office of South Kalimantan (2007) and the Statistics Board of South Kalimantan (2006), we made the following assumptions in our calculations:

- The area of rice fields that will be affected by SLR (based on the GIS model) in South Kalimantan Province is 157,973 ha with an average productivity of 3.34 tonnes per hectare per year.
- Fruit farms areas that will be affected by SLR total 1,843 ha with an average productivity of 32.60 tonnes per hectare per year.
- Fish/Shrimp ponds that will be affected by SLR total 809 ha with an average productivity of 12 tonnes per hectare per year.
- The number of inhabitants in the areas expected to be impacted by SLR is 394,935 with an average household size of 5. Therefore, the total number of households (HH) is taken as 78,987.

3.3. Assessing the Costs and Benefits of the Farm-Dike Establishment Project

A Cost-Benefit Analysis (CBA) was employed in this study to assess the economic viability of farm-dike establishment to protect agricultural areas from SLR impacts. From an economic perspective, the assessment of this investment was conducted for reclaimed agricultural areas with and without farm-dike establishment to reflect the true welfare change attributable to the proposed farm-dike establishment project.

The CBA was conducted based on the following assumptions:

- Dikes can protect agricultural land (rice fields, fruit and shrimp farms) from SLR and maintain land productivity
- Dike construction will be conducted for all the impacted agricultural areas (157,973 ha) and the construction will take place in five-year stages, starting with 15,000 ha in Year 1 (2007), another 15,000 ha in Year 6 every five years for up to 157,973 ha and thereafter, for replacement (see lifespans below)[1].
- The lifespan of a dike is 50 years.
- The lifespan of a flap-gate is 15 years.
- Dike and gate construction or replacement will be done during the dry season so that the dikes and gates can be used in the same year (during the rainy season) to protect the agricultural land.

Benefits were expressed as incremental or additional benefits (benefit value is the difference between current benefits and benefits in previous years). These benefits were estimated from the loss of net returns for rice fields, fruit farms, and shrimp farms which would be avoided with the project and the residual value of the dikes at the end of the project.

Costs were expressed as incremental or additional costs (current costs less past costs). These costs were estimated from the costs that would be incurred in the project, namely for construction, procurement, installation, and maintenance.

The difference between the benefits and costs are the net benefits. The lifetime of the project was set at 66 years[2] and the prices used in the analysis were set at 2007 constant prices. The streams of net benefits from Year 1 (Year 2007) to Year 66 of the project (Year 2072) were discounted by an 8% discount rate. The sum of the discounted net benefits is the net present value (NPV) of the project.

3.4 Assessing the Costs and Benefits of the Relocation Project

A CBA was also employed for assessing the economic viability of relocating the households that would be impacted by SLR to newly established agricultural areas in adapting to the impacts of SLR. Similar to that of farm-dike establishment, the assessment of this investment was based on comparing the scenarios with and without

[1] Appendix 4 shows the stages of dike and gate construction and replacement.

[2] This research focused on adaptation strategies for a 1.0-m SLR. Based on our data that SLR in this area was 15 mm per year and assuming the rate to be constant, we estimated that a 1.0-m SLR would be reached in the 66th year. Therefore, the lifespan of the project was set at 66 years.

the establishment of new agricultural areas to reflect the true welfare change attributable to the proposed project.

The assumptions in this estimation were:

- The opportunity cost of land used for the relocation project was zero because the land was owned by the government and it was idle land (not cultivated).
- The fertility of the new agricultural areas was similar to that of previous agricultural lands and the total area of agricultural land that would be developed for relocation was equal to that which would be affected by a 1.0-m SLR.
- Each household will receive two hectares of agricultural land; therefore, 15,000 ha of agricultural land will be provided to 7,500 households every five years for up to 157,973 ha.
- New rice fields, housing and other infrastructure construction will take place in five-year stages, starting with 15,000 ha for rice fields and 7,500 houses in Year 1 (2007), then Year 6, and so on until Year 51 (7,953 ha)[3].
- New fruit farms (1,843 ha) and fish/shrimp ponds (809 ha) would be established in the first year of relocation (2007).
- The lifespan of the rice fields, fruits farms, shrimp ponds, and housing and other infrastructure is 66 years.
- The first rice and shrimp harvests will take place in the third year (a year after relocation) and the first fruit harvest will occur three years after relocation.

Benefits were expressed as incremental or additional benefits. The benefits of the establishment of new agricultural areas were estimated from the loss of net returns from the rice fields, fruit farms and shrimp-pond farms which would be avoided with the project and the residual values of rice fields, housing and other infrastructure at the end of the project.

Costs were expressed as incremental or additional costs. The costs of establishment of new agricultural areas were estimated from the costs that would be incurred in conducting the project, especially for the construction of houses and the rice fields/new agricultural areas, and transporting people from the impacted areas to the new agricultural areas.

The differences between the benefits and costs are the net benefits. The lifetime of the project was set at 66 years and 2007 constant prices were used in the analysis. The streams of net benefits from Year 1 (2007) to Year 66 of the project (2072) were discounted at a rate of 8%. The sum of the discounted net benefits is the NPV of the project.

3.5 Choosing the Discount Rate

The discount rate used for calculating the NPV had to be decided. In economic analysis using efficiency prices, there are two rates that are commonly chosen and a third that is sometimes proposed. The first discount rate is the opportunity cost of capital (OCC). Although this rate is good as a theoretical definition, it is difficult to

[3] Appendix 8 shows the stages of the establishment of new agricultural areas in the relocation project.

apply in practice. In most developing countries, it is assumed to be somewhere from 8–15% in real terms. A common choice is 12% (Gittinger 1992).

A second discount rate is the borrowing rate the nation must pay to finance the project. This is most commonly proposed when the country expects to borrow from abroad to fund investment projects. In this case, the World Bank suggests using from 3–8% (Gittinger 1992).

A third rate sometimes proposed is the social time preference rate or social discount rate (SDR). It is usually felt that society has a longer time horizon, so its discount rate would be lower. This implies that a lower discount rate should be used for public projects compared to private projects. If the project has inter-generational impacts and there is no reason to believe that it will crowd out private investment, then the discount rates used will be 3.5% (for Years 0-50) and 2.5% (for Years 51-100) (Boardman et al. 2006).

This study used a discount rate of 8%, the highest discount rate suggested by the World Bank (Gittinger 1992). Furthermore, in order to test how sensitive the CBA results were to the changes in discount rates, sensitivity analyses were carried out for discount rates of 12% and 16%.

4.0 FARMERS' AWARENESS OF SEA LEVEL RISE

4.1 Socio-economic Characteristics of the Respondents

The farmer-household survey was conducted in three regencies: Barito Kuala (Kecamatan/Districts of Mandastana, Belawang and Rantau Badauh); Banjar (Kecamatan/District of Aluh-Aluh); and Tanah Laut (Kecamatan/District of Kurau). The distribution of the respondents by district and village is given in Table 4. The highest number of respondents came from Danda Jaya Village (180 respondents) whilst the Karang Bunga Village had the smallest number of respondents (32 respondents).

Table 4. Distribution of respondents by district and village

District/Village	Number of respondents	
	Number	%
Kecamatan Kurau		
Sungai Rasau	66	5.40
Kurau Utara	60	4.91
Padang Luas	60	4.91
Tambak Karya	62	5.07
Bawah Layung	60	4.91
Sungai Bakau	60	4.91
Tambak Sarinah	60	4.91
Kecamatan Aluh-Aluh		
Bunipah	62	5.07
Simpang Warga	56	4.58
Simpang Warga Dalam	86	7.04
Pemurus	80	6.55
Aluh-Aluh Kecil	80	6.55
Aluh-Aluh Besar	56	4.58
Kecamatan Mandastana		
Karang Bunga	32	2.62
Karang Indah	60	4.91
Kecamatan Belawang		
Karang Dukuh	52	4.26
Karang Buah	50	4.09
Kecamatan Rantau Badauh		
Danda Jaya	180	14.73
Total	1,222	100.00

Table 5 describes the socio-economic characteristics of the respondents. The mean age was 42.7 years. The youngest respondent was 18 years old whilst the oldest was 81 years old (only heads of families or respondents who were at least 18 years old were selected). The average number of years of farming experience was 17 years. Of the total, 79% of the respondents were male while 21% were female.

Table 5. The socio-economic characteristics of the respondents

No.	Characteristics	Respondents	
		Number	%
1	**Age (years)**		
	Mean	42.7	n/a
	Standard Deviation	11.5	n/a
	Minimum	18	n/a
	Maximum	81	n/a
2	**Gender**		
	Female	258	21.11
	Male	964	78.89
3	**Educational Attainment**		
	No formal schooling	76	6.22
	Elementary school graduate	652	53.36
	Junior high school graduate	292	23.90
	Senior high school graduate	176	14.40
	College graduate	26	2.13
4	**Income (IDR/month)**		
	Mean	1,188,501	n/a
	Standard Deviation	1,313,451	n/a
	Minimum	560,667	n/a
	Maximum	11,366,833	n/a
5	**Experience in farming (year)**		
	Mean	17	n/a
	Standard Deviation	10	n/a
	Minimum	4	n/a
	Maximum	50	n/a

Data regarding educational attainments showed that most of the respondents had attended school. Only seventy-six respondents (6%) had no formal schooling. Many of the respondents had finished elementary school (53%) while 2% of the respondents had finished college. The mean income of the respondents was IDR 1,188,501 per month. The lowest income of the respondents was IDR 560,667 per month while the highest income was IDR 11,366,833 per month.

4.2 Awareness of Sea Level Rise

Among others things, this study sought to evaluate the level of farmers' awareness of SLR. Out of the total number of 1,222 respondents, 35% knew what SLR was and its effects on their rice fields (Table 6). Most farmers who were aware of SLR had obtained information on it and its effect on agricultural land from the mass media (newspapers and television) (59%) while the remaining had obtained information from neighbors, extension officers, and other sources.

Table 6 shows that when the farmers were asked about changes in the surface levels of rivers around their rice fields, 25% of them said they had observed no change. Most of the farmers (75%) had, however, observed a consistent increase or decrease, or fluctuating changes. For these farmers, 45% and 41% of them considered that the changes were related to variations in season and the effects of SLR, respectively.

Table 6. Awareness of SLR and observation of changes in the river surface level

No.	Questions	Response	Respondents	
			Number	%
1	Awareness of sea level rise	Aware	428	35.02
		Not aware	794	64.98
		Total	1,222	100.00
2	Source of information on the SLR	Neighbors	46	10.75
		Extension officer	30	7.01
		Mass media	252	58.88
		Others	100	23.36
		Total	428	100.00
3	Current river surface level compared to several years ago	No changes	300	24.55
		Increase	752	61.54
		Decrease	102	8.35
		Fluctuation	68	5.56
		Total	1,222	100.00
4	Cause of changes in river surface level	Changes in season	413	44.84
		Deforestation	62	6.71
		Sea level rise	379	41.08
		Others	68	7.36
		Total	922	100.00

Before asking questions on appropriate adaptation strategies and who should be responsible for their implementation in reducing the impacts of SLR on agriculture, the interviewers explained the effects of SLR on the agricultural sector/lands and showed some pictures of and calculations on such effects. Table 7 shows that 71% of the respondents preferred to protect their rice fields from the impacts of SLR. Only 9% chose to introduce a new rice variety, convert rice fields to fish/shrimp ponds, and relocate to new rice lands.

Table 7 also indicates that the farmers think that the government should be responsible for implementation of the strategies (42%), followed by the private sector (32%). Only 18% of the respondents said that the implementation of the adaptation strategies for reducing the impacts of SLR on rice fields should be carried out among the government, private sector and farmers.

Table 7. Responses of farmers to questions on appropriate adaptation strategies and who should be responsible for their implementation

No.	Questions	Response	Respondents	
			Number	%
1	Appropriate adaptation strategies to reduce the impacts of SLR	Introducing a new rice variety	42	3.44
		Change rice field to fish/shrimp pond	16	1.31
		Protection of rice field	864	70.70
		Relocation to new rice field	54	4.42
		Others	246	20.13
		Total	1,222	100.00
2	Responsibility for implementation of the adaptation strategies	Government	514	42.06
		Private sector	392	32.08
		Farmers	2	0.16
		Collaboration among the government, private sector, and farmers	226	18.49
		Others	88	7.20
		Total	1,222	100.00

5.0 AGRICULTURAL LOSS CAUSED BY SEA LEVEL RISE (BASE CASE)

Table 8 and Figure 2 show agricultural areas for each regency that will be affected by different magnitudes of SLR if no action is taken to reclaim coastal swamplands. Out of the 13 regencies in South Kalimantan Province, six coastal regencies (Banjar, Banjarmasin, Barito Kuala, Kotabaru, Tanah Bumbu, and Tanah Laut) had agricultural areas that will be impacted by SLR.

Table 8. Percentage of agricultural areas projected to be impacted by SLR in South Kalimantan Province

No.	Regency	Agricultural areas (ha)	Agricultural areas affected by SLR (%)	
			0.5 m	1.0 m
1	Balangan	20,548.00	-	-
2	Banjar	68,792.10	14.26	52.08
3	Banjarbaru	0.00	-	-
4	Banjarmasin	2,470.90	2.34	74.95
5	Barito Kuala	121,521.67	60.68	68.15
6	Hulu Sungai Selatan	40,245.00	-	-
7	Hulu Sungai Tengah	27,201.00	-	-
8	Hulu Sungai Utara	10,849.00	-	-
9	Kotabaru	17,362.31	78.37	78.37
10	Tabalong	27,031.00	-	-
11	Tanah Bumbu	16,840.80	28.02	63.33
12	Tanah Laut	33,287.10	5.25	39.67
13	Tapin	55,772.00	-	-
Total		441,920.88	23.46	35.76

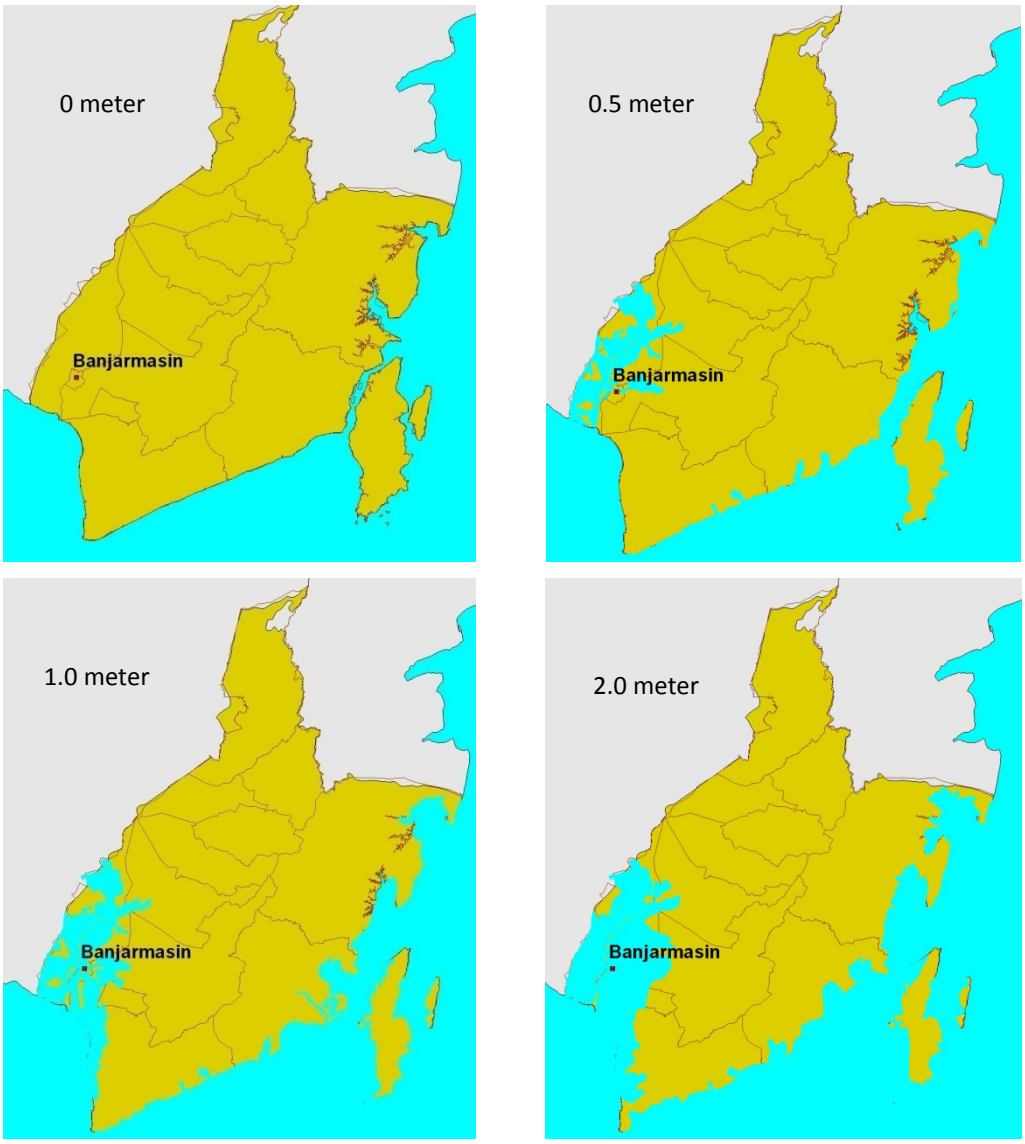

Figure 2. Inundation zone in South Kalimantan Province for different SLR scenarios

As shown in Figure 3, four regencies: Banjarmasin, Barito Kuala, Kotabaru and Tanah Bumbu will be the most seriously impacted by SLR. Up to 60% of agricultural areas in these regencies will be impacted by a 1.0-m SLR. Most impacted will be Barito Kuala where 68% of 121,522 ha of agricultural land will be affected. At the provincial level, 36% of the agricultural areas in South Kalimantan Province will be affected by a SLR of one meter.

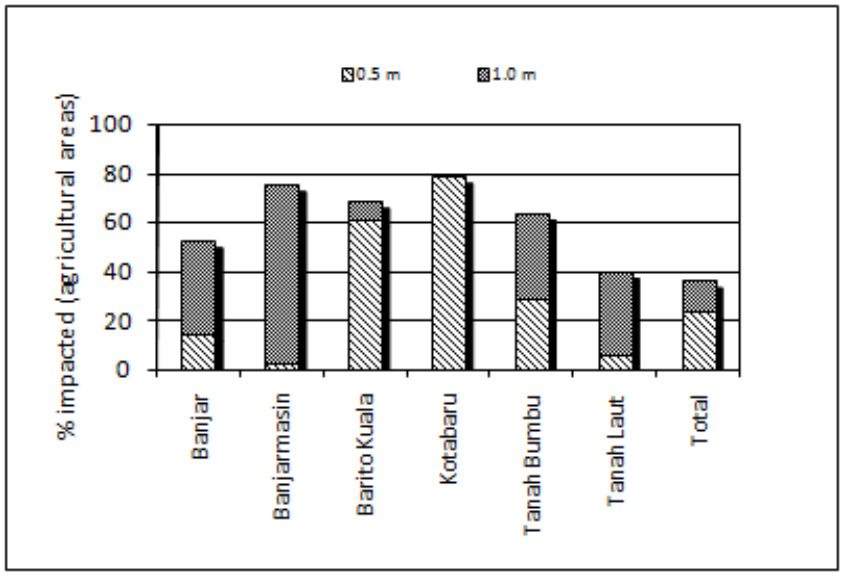

Figure 3. Percentage of agricultural areas projected to be impacted by SLR in six regencies in South Kalimantan Province (hectares)

In order to estimate the loss in agricultural production resulting from SLR, it was essential to calculate the total area of agriculture affected. Three types of agricultural activities: rice fields, fish/shrimp ponds, and fruit cultivation, were found in the impacted regencies. Animal husbandry was excluded as this activity was only found in small areas in the swamplands and was generally carried out in upland areas that would not be impacted by SLR. Areas of rice fields, fish/shrimp ponds, and fruit farms affected by SLR each year, as estimated by the GIS analysis, are described in Appendix 1. On the assumption that the sea level in these areas would increase by 15 mm per year starting from 2007, a 0.5-m SLR will occur in the year 2039 and a 1.0-m SLR will occur in 2072. We also estimated the areas impacted by SLR for each agricultural activity in each impacted regency (Table 9).

Table 9. Areas projected to be impacted by SLR in six regencies in South Kalimantan Province, by agricultural activity (hectares)

No.	Regency	Rice/Rice fields	Fish/Shrimp ponds	Fruit farms
0.5-m SLR				
1	Banjar	9,809.76	6.77	141.09
2	Banjarmasin	57.82	0.19	-
3	Barito Kuala	73,739.35	18.29	361.83
4	Kotabaru	13,606.84	65.42	-
5	Tanah Bumbu	4,718.79	27.03	-
6	Tanah Laut	1,747.58	72.42	-
	Total	103,680.14	190.12	502.92
1.0-m SLR				
1	Banjar	35,826.93	49.25	515.28
2	Banjarmasin	1,851.94	1.31	-
3	Barito Kuala	82,817.02	38.01	406.37
4	Kotabaru	13,606.84	130.36	-
5	Tanah Bumbu	10,665.28	58.2	-
6	Tanah Laut	13,204.99	147.07	-
	Total	157,973.00	424.2	921.65

The estimation of agricultural product loss (total net loss) impacted by SLR in South Kalimantan Province is described in Appendix 2 while the losses for the three types of agricultural products in each regency is described in Figure 4 and Table 10. The total net loss in agricultural production in the province reached IDR 910.65 billion with a 0.5-m SLR and IDR 1,506.42 billion with a 1.0-m SLR.

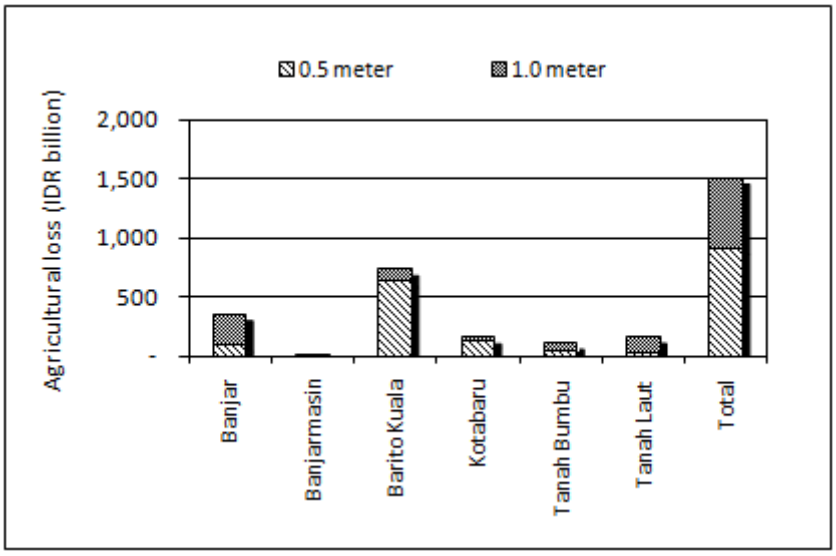

Figure 4. Projected net losses in agricultural production due to SLR in South Kalimantan Province

Table 10. Projected net losses in agricultural production due to SLR in South Kalimantan Province, by agricultural activity (billion IDR)

No.	Regency	Rice/Rice fields	Fish/Shrimp ponds	Fruit farms	Total
0.5 m SLR					
1	Banjar	81.91	1.02	4.60	87.53
2	Banjarmasin	0.48	-	-	0.48
3	Barito Kuala	615.72	2.74	11.80	630.26
4	Kotabaru	113.62	9.81	-	123.43
5	Tanah Bumbu	39.40	4.06	-	43.46
6	Tanah Laut	14.59	10.89	-	25.48
	Total	865.73	28.52	16.40	910.65
1.0 m SLR					
1	Banjar	299.15	14.77	33.60	347.53
2	Banjarmasin	15.46	0.39	-	15.86
3	Barito Kuala	691.52	11.40	26.50	729.42
4	Kotabaru	113.62	39.11	-	152.72
5	Tanah Bumbu	89.06	17.46	-	106.51
6	Tanah Laut	110.26	44.12	-	154.38
	Total	1,319.07	127.26	60.09	1,506.42

The results revealed that Barito Kuala would experience the largest loss in agricultural production (Table 10 and Figure 4). Even with a 0.5-m SLR, IDR 630.26 billion in agricultural production in Barito Kuala would be lost. This would reach IDR 729.42 billion under the 1.0-meter SLR scenario. The second largest loss— IDR 87.53 billion and IDR 347.53 billion with 0.5 m and 1.0 m SLR, respectively—would occur in Banjar. However, Banjarmasin and Tanah Bumbu where almost 75% of the agricultural areas would be impacted by a 1.0-m SLR, would only lose IDR 15.86 billion and IDR 106.51 billion respectively.

6.0 PROTECTION OF AGRICULTURAL AREAS BY FARM-DIKE ESTABLISHMENT

6.1 The Incremental Benefits of the Farm-dike Establishment Project

The benefit assessment of farm-dike establishment in relation to reducing the impacts of SLR on agricultural areas was made by estimating the loss of net returns from rice fields, fish/shrimp ponds, and fruit farms that could be avoided by the installation of farm-dikes and the scrap value of the farm-dikes at the end of the project.

Agricultural benefits in a case such as this would generally be measured by changes in net returns corresponding to changes in crop yields as a result of changes in agricultural areas with and without farm-dike establishment. However, in this analysis it was logical to assume that the costs of production per unit of planted area (including those of agricultural management and technology employed) with and without farm-dike establishment would remain same.

Fish/shrimp ponds are generally constructed with dikes to prevent sea/flood water from entering the ponds. The height of the dikes is normally 40-75 cm.

Therefore, the construction of dikes will benefit fish/shrimp ponds. Fruit trees are generally planted in raised bed soils. It is reasonably assumed that the installation of farm-dikes will prevent rotting of the tree roots due to SLR.

Another benefit considered in this analysis was the residual value of the farm-dikes (and gates) at the end of the project, which is the value of the farm-dikes (and gates) installed from 2057 (AFTER 50 YRS FROM 2007) to 2072. These farm-dikes (and gates) would still have economic value at the end of the project because their full lifespans are 50 years and 15 years respectively. The incremental benefits of farm-dike installation for rice fields, fish/shrimp ponds, and fruit farms, and the residual values of the project (2007-2072) are given in Appendix 3 and summarized in Figure 5. The total incremental benefit would be IDR 50,440.65 billion with the highest contribution from rice fields (IDR 46,540.21 billion).

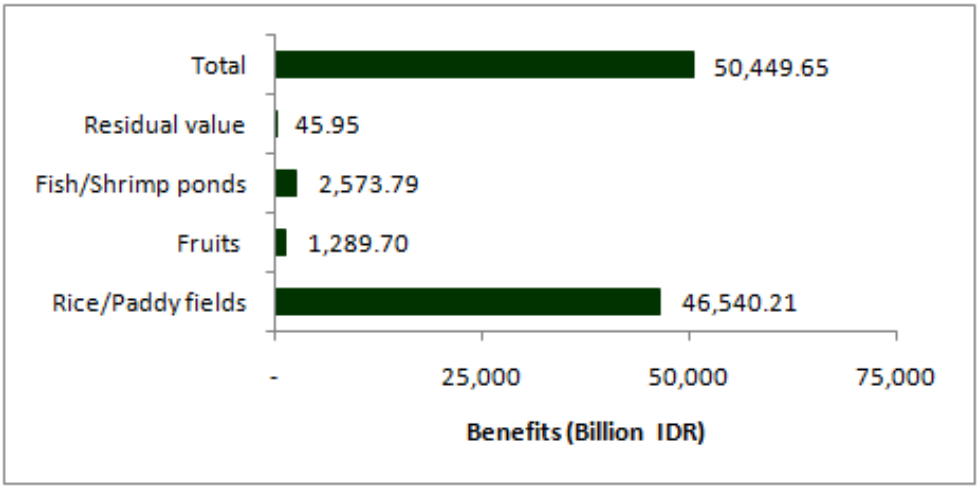

Figure 5. The incremental benefits of the farm-dike establishment project in South Kalimantan Province

6.2 The Incremental Costs of the Farm-dike Establishment Project

All reclaimed tidal swamplands have generally been installed with drainage canals. These canals drain off excess water and irrigate dry agricultural areas. In order to improve land productivity, the Ministry of Settlement and Regional Infrastructure installed flap-gates in farm-dikes to better control the water flow. Farm-dikes with flap-gates have been shown to be successful in draining off excess surface and groundwater, providing flood protection, preventing salt intrusion, and controlling water quality (Susanto 2003).

The cost of agricultural protection by farm-dike establishment is the cost of the investment. Just as for benefits, the cost analysis was based on incremental costs in comparing agricultural areas with and without farm-dike establishment. The estimation of the costs of farm-dike establishment is given in Appendix 4. Each farm-dike can be used for 50 years, after which it should be replaced with a new one while the lifespan of a gate is 15 years. Therefore, the incremental costs incurred each year is the total costs of the operation and maintenance of the farm-dikes (and gates) for each year, their

procurement costs (material preparation, construction, transportation and installation), and the costs of replacing them after 50 years (for the farm dikes) and 15 years (for the gates). The breakdown of the project costs, expressed in 2007 constant prices, is shown Appendix 5 and summarized in Figure 6. The total incremental cost for the project (2007-2072) would be IDR 355.58 billion.

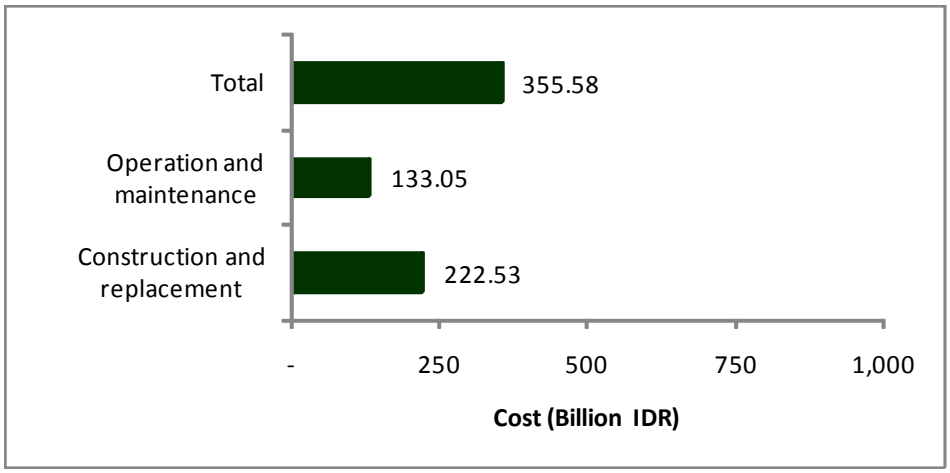

Figure 6. The incremental costs of the farm-dike establishment project in 2007 constant prices

6.3 The Net Benefits and Net Present Values of the Farm-dike Establishment Project

The stream of net benefits is the difference between the total incremental benefits gained and the total incremental costs incurred each year during the project period (2007-2072). The total net benefits resulting from farm-dike establishment to reduce the effect of a 1.0-m SLR on agricultural areas in South Kalimantan Province during the project period was found to be approximately IDR 50,094.06 million (Appendix 6). From a benefit-cost perspective, this is satisfactory as the benefits gained outweigh the costs incurred, thereby increasing social welfare. After the stream of net benefits was calculated, the NPVs at different discount rates were calculated (Table 11).

Table 11. Net present values of the farm-dike establishment project

Discount rate	NPV (billion IDR)
NPV at 8%	2,654.80
NPV at 12%	1,000.17
NPV at 16%	476.50

Table 11 shows that the NPV for the protection of agricultural areas by farm-dike construction at a discount rate of 8% is greater than zero. This implies that the protection project is economically feasible. When sensitivity analyses were conducted using higher discount rates of 12% and 16%, the project was still found to be

economically sound although the NPV decreased drastically at these higher discount rates. This implies that this project is sensitive to changes in discount rate.

7.0 RELOCATION TO NEW AGRICULTURAL AREAS

7.1 The Incremental Benefits of the Relocation Project

As discussed in the previous section, the benefits gained from the relocation to new agricultural areas were expressed as incremental or additional benefits. These benefits were estimated from the loss of net returns from rice farms, fruit farms, and fish/shrimp ponds that would be avoided by the relocation and the residual value of housing and other infrastructure in the relocation areas. Details of the benefits of the agricultural relocation project are listed in Appendix 7 and summarized in Figure 7.

The incremental benefit from rice fields in 2007 was found to be a loss of IDR 1,315.61 billion but this changed to a positive value of IDR 1,319.07 billion for the year 2072. The total incremental benefit that would accrue from the new rice fields during the project period from 2007 to 2072 was projected to be IDR 13,585.91 billion while the total incremental benefit from the new fruits farms was IDR 688.88 billion and the total incremental benefit from the new fish/shrimp ponds was IDR 2,088.39 billion. A further benefit from the relocation to new agricultural areas was the residual values of rice fields, housing and infrastructure which totaled IDR 943.42 billion. In general, the total incremental benefit from the relocation to new agricultural areas for the project period was IDR 17,306.60 billion (Appendix 7).

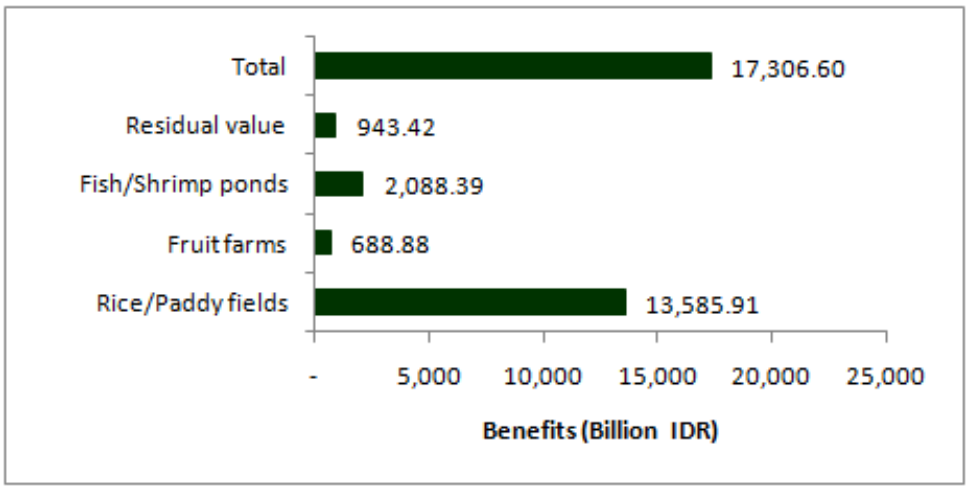

Figure 7. The incremental benefits of the relocation project in South Kalimantan Province

7.2 The Incremental Costs of the Relocation Project

The establishment of new agricultural areas inland in response to the impact of SLR on coastal agricultural lands has not yet been conducted by the Indonesian government. However, the government has extensive experience in relocating people from high density areas to new areas in its transmigration program. The objective of this program is to increase the wealth of the relocated people through agricultural

development in the new areas. The program first commenced in November 1905 where 155 households from Kedu Karesidenan/Regency in Central Java were relocated to Tanjung Karang Kabupaten/Regency in the province of Lampung to establish new agricultural areas there. The number of households that were transmigrated from high density areas in Java to Sumatera, Kalimantan, Sulawesi, Maluku, Nusa Tenggara, and Irian reached 2,055,999 in 2005 (Ministry of Manpower and Transmigration of the Republic of Indonesia 2006).

Agricultural lands were established by the government in the new areas in which each household was given two hectares of agricultural areas and supported with living expenses for two to three years. In addition, the government also provided housing, and water treatment and public facilities such as offices, churches, mosques, storage facilities, and health centers. In addition, infrastructure such as roads, bridges, and drainage canals were also constructed by the government.

The costs of relocation to new agricultural areas were the economic costs associated with the investment. Just as for the estimation of the incremental benefits, the cost analysis was based on incremental costs in a comparison between agricultural areas with and without the relocation project. The analysis took into account the capital costs of establishing the new rice fields, fruit farms, and fish/shrimp ponds; constructing houses and other infrastructure; living costs; and transportation costs.

We assumed that the total area of the new agricultural areas was equal to the agricultural areas impacted by SLR and that the relocation would be conducted in several stages. On the further assumption that each household would receive two hectares of agricultural land, a relocation of 7,500 households every five years would require the establishment of 15,000 ha of new agricultural area up when 157,973 ha is reached. Fish/shrimp ponds and fruit farms will presumably be established at the beginning of the relocation project. The stages of the relocation project are described in Appendix 8. Based on data in the Appendix 8 and the assumptions given in Section 3.4, the incremental costs of the relocation project were calculated and the results are given in Appendix 9. The total incremental costs of the project for the period 2007 to 2072 are minus IDR 18,717.29 billion (Appendix 9).

7.3 Net Benefits and Net Present Values of the Relocation Project

The stream of net benefits is the difference between the total incremental benefits gained and the total incremental costs incurred in each year of the project period (2007-2072). The total net incremental benefit resulting from the relocation to new agricultural areas due to a 1.0-m SLR in South Kalimantan was found to be IDR 36,023.89 billion (Appendix 10).

After estimating the stream of net benefits, the discount rate was used to calculate the NPV. The NPVs for the relocation project at different discount rates (8%, 12% and 16%) are given in Table 12.

Table 12. Net present values of the relocation project

Discount rate (%)	NPV (billion IDR)
NPV (8%)	-2,284.55
NPV (12%)	-2,579.61
NPV (16%)	-2,299.97

Table 12 shows that the NPV for the relocation project at the discount rate of 8% is less than zero. This implies that the relocation project is not economically feasible. When sensitivity analyses were conducted using higher discount rates of 12% and 16%, the project was still found to be economically unviable. However, the NPVs did not fall drastically at these higher rates; this implies that the project is not sensitive to the changes in the discount rate.

A comparison between the NPVs of the two projects—the protection of agricultural areas using farm-dikes and the establishment of new agricultural areas—showed that the first project was more viable as a strategy to adapt to a 1.0-m SLR.

8.0 CONCLUSIONS AND POLICY IMPLICATIONS

This study focused on the province of South Kalimantan which is experiencing the salination of its freshwater due to SLR, especially during the dry season. This problem is impacting not only water consumers but also agricultural areas in tidal swamplands by the coast. However, most of the farmers in the province are not aware of the impact of SLR on their agricultural lands. The results of the household survey showed that out of the total number of 1,222 respondents, only 35% understood SLR and its effects on their farms. This indicates that there should be better dissemination of information on SLR to farmers in the coastal areas as their understanding of the issue is essential in the implementation of adaptation strategies.

The results of this study also provide estimates of agricultural loss in South Kalimantan Province due to SLR. Out of the 13 regencies in the province, six (Banjar, Banjarmasin, Barito Kuala, Kotabaru, Tanah Bumbu, and Tanah Laut) had agricultural areas that would be impacted by SLR. Barito Kuala would experience the largest loss, IDR 630.26 billion, in agricultural production with just a 0.5-m SLR. This would reach IDR 729.42 billion with a 1.0-m SLR. The total loss in agricultural production in the province would reach 19.19% with a 1.0-m SLR. This information should be valuable to the government in designing the right policies to ensure food security and national stability.

Another objective of this research was to conduct economic assessments on adaptation to SLR impacts in South Kalimantan Province by investing in farm-dikes and new agricultural areas. The expected project period was 66 years, from 2007 to 2072, as a 1.0-m SLR was estimated to be reached in 2072. The total incremental benefits were approximated at IDR 50,449.65 billion for farm-dike establishment and IDR 17,306.60 billion for the relocation to new agricultural areas. On the other hand, the total incremental costs accounted for IDR 355.58 billion for farm-dike establishment and minus IDR 18,717.29 billion for the establishment of new

agricultural areas. All in all, the farm-dike establishment project produced a higher incremental net benefit than the relocation one.

The results of the CBA showed that farm-dike installation had positive NPVs whereas the establishment of new agricultural areas produced negative NPVs. This implies that farm-dike establishment is a more economically viable adaptation strategy in response to a SLR of one meter compared to the establishment of new agricultural areas. The unsatisfactory results of the CBA for the relocation project may stem from the fact that all the relevant impacts may not have been fully accounted for, such as those on human health and other environmental impacts.

On economic grounds, the negative NPVs for the relocation project imply that it may not be necessary to establish new agricultural areas to replace those impacted by SLR. It also highlights the importance of doing a CBA to guide policy-makers in deciding on which adaptation strategies to implement and avoiding cost-ineffective options. Aside from the CBA approach, it may also be worthwhile using other cost effectiveness criteria, like the least cost option and the highest ratio between total agricultural areas saved and total costs, in assessing adaptation proposals.

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APPENDICES

Appendix 1. Areas of rice fields, fish/shrimp ponds, and fruit farms affected by SLR as estimated by the GIS for each year of the project period (2007-2072) (hectares)

No.	Year	Rice fields	Fruit farms	Fish/Shrimp ponds
1	2007	4,146.82	20.12	5.76
2	2008	7,257.23	35.21	10.08
3	2009	10,367.63	50.29	14.40
4	2010	13,478.04	65.38	18.72
5	2011	16,588.44	80.47	23.04
6	2012	19,698.84	95.56	27.65
7	2013	22,809.25	110.64	31.69
8	2014	25,919.65	125.73	37.45
9	2015	29,030.06	140.82	40.33
10	2016	32,140.46	155.91	44.94
11	2017	35,250.86	170.99	48.97
12	2018	38,361.27	186.08	54.73
13	2019	41,471.67	201.17	57.61
14	2020	44,582.07	216.26	63.37
15	2021	47,692.48	231.35	72.01
16	2022	50,802.88	246.43	80.65
17	2023	53,913.29	261.52	89.30
18	2024	57,023.69	276.61	97.94
19	2025	60,134.09	291.70	106.58
20	2026	63,244.50	306.78	112.34
21	2027	66,354.90	321.87	118.10
22	2028	69,465.31	336.96	123.86
23	2029	72,575.71	352.05	129.62
24	2030	75,686.11	367.13	135.38
25	2031	78,796.52	382.22	141.15
26	2032	81,906.92	397.31	149.79
27	2033	85,017.33	412.40	155.55
28	2034	88,127.73	427.49	161.31
29	2035	91,238.13	442.57	167.07
30	2036	94,348.54	457.66	172.83
31	2037	97,458.94	472.75	178.59
32	2038	100,569.34	487.84	184.35
33	2039	103,680.14	502.92	190.12
34	2040	105,851.84	519.67	197.21
35	2041	107,480.63	532.23	204.31
36	2042	109,109.42	544.79	211.40
37	2043	110,738.20	557.35	218.50
38	2044	112,366.99	569.91	225.59
39	2045	113,995.77	582.48	232.69
40	2046	115,624.56	595.04	239.78
41	2047	117,253.35	607.60	246.88
42	2048	118,882.13	620.16	253.97
43	2049	120,510.92	632.72	261.07
44	2050	122,139.70	645.29	268.16
45	2051	123,768.49	657.85	275.26

Appendix 1 (continued)

No.	Year	Rice fields	Fruit farms	Fish/Shrimp ponds
46	2052	125,397.28	670.41	282.35
47	2053	127,026.06	682.97	289.44
48	2054	128,654.85	695.53	296.54
49	2055	130,283.64	708.10	303.64
50	2056	131,912.42	720.66	310.73
51	2057	133,541.21	733.22	317.83
52	2058	135,169.99	745.78	324.93
53	2059	136,798.78	758.34	332.02
54	2060	138,427.57	770.91	339.11
55	2061	140,056.35	783.47	346.21
56	2062	141,685.14	796.03	353.31
57	2063	143,313.92	808.59	360.40
58	2064	144,942.71	821.16	367.49
59	2065	146,571.50	833.72	374.59
60	2066	148,200.28	846.28	381.69
61	2067	149,829.07	858.84	388.78
62	2068	151,457.85	871.40	395.78
63	2069	153,086.64	883.97	402.88
64	2070	154,715.43	896.53	409.97
65	2071	156,344.21	909.09	417.08
66	2072	157,973.00	921.65	424.20

Appendix 2. Benefits, costs, net benefits and net losses in agricultural production caused by SLR in South Kalimantan Province (base case) (billion IDR)

Year	Benefits	Costs	Net benefits	Net losses
2007	1,678.48	982.20	696.28	3.46
2008	1,675.88	982.20	693.68	6.06
2009	1,673.28	982.20	691.08	8.66
2010	1,670.68	982.20	688.49	11.25
2011	1,668.09	982.20	685.89	13.85
2012	1,649.04	982.20	666.84	32.90
2013	1,643.85	982.20	661.65	38.09
2014	1,638.65	982.20	656.45	43.29
2015	1,633.46	982.20	651.26	48.48
2016	1,628.26	982.20	646.07	53.67
2017	1,578.92	982.20	596.72	103.02
2018	1,569.83	982.20	587.63	112.11
2019	1,560.74	982.20	578.54	121.20
2020	1,551.65	982.20	569.45	130.29
2021	1,542.56	982.20	560.36	139.38
2022	1,469.84	982.20	487.64	212.10
2023	1,456.85	982.20	474.65	225.09
2024	1,443.86	982.20	461.67	238.07
2025	1,430.88	982.20	448.68	251.06
2026	1,417.89	982.20	435.69	264.05
2027	1,294.09	982.20	311.90	387.84
2028	1,275.91	982.20	293.72	406.02
2029	1,257.73	982.20	275.53	424.21
2030	1,239.55	982.20	257.35	442.39
2031	1,221.37	982.20	239.17	460.57
2032	1,032.21	982.20	50.01	649.73
2033	1,007.54	982.20	25.34	674.40
2034	982.86	982.20	0.67	699.07
2035	958.19	982.20	(24.01)*	723.75
2036	933.52	982.20	(48.68)	748.42
2037	825.96	982.20	(156.24)	855.98
2038	798.63	982.20	(183.57)	883.31
2039	771.30	982.20	(210.90)	910.64
2040	751.55	982.20	(230.64)	930.38
2041	736.48	982.20	(245.72)	945.46
2042	721.41	982.20	(260.79)	960.53
2043	706.33	982.20	(275.87)	975.61
2044	691.26	982.20	(290.94)	990.68
2045	676.18	982.20	(306.02)	1,005.76
2046	661.11	982.20	(321.09)	1,020.83
2047	623.30	982.20	(358.90)	1,058.64
2048	607.64	982.20	(374.56)	1,074.30
2049	591.97	982.20	(390.23)	1,089.97
2050	576.31	982.20	(405.89)	1,105.63
2051	560.64	982.20	(421.55)	1,121.29

Appendix 2 (continued)

Year	Benefits	Costs	Net Benefits	Net Losses
2052	544.98	982.20	(437.22)	1,136.96
2053	529.32	982.20	(452.88)	1,152.62
2054	513.65	982.20	(468.54)	1,168.28
2055	497.99	982.20	(484.21)	1,183.95
2056	482.33	982.20	(499.87)	1,199.61
2057	438.03	982.20	(544.17)	1,243.91
2058	421.78	982.20	(560.42)	1,260.16
2059	405.52	982.20	(576.67)	1,276.41
2060	389.27	982.20	(592.93)	1,292.67
2061	373.02	982.20	(609.18)	1,308.92
2062	356.76	982.20	(625.43)	1,325.17
2063	340.51	982.20	(641.69)	1,341.43
2064	324.26	982.20	(657.94)	1,357.68
2065	308.01	982.20	(674.19)	1,373.93
2066	291.75	982.20	(690.45)	1,390.19
2067	258.24	982.20	(723.96)	1,423.70
2068	241.72	982.20	(740.48)	1,440.22
2069	225.17	982.20	(757.03)	1,456.77
2070	208.62	982.20	(773.58)	1,473.32
2071	192.07	982.20	(790.13)	1,489.87
2072	175.51	982.20	(806.68)	1,506.42
Total	60,604.22	64,825.08	(4,220.86)	50,403.69

Notes:

(1) * Figures in parenthesis are negative values.

(2) Net benefits = benefits – costs; Net losses = total loss – net benefits

Appendix 3. Incremental benefits of the farm-dike establishment project in South Kalimantan Province (billion IDR)

No.	Year	Incremental Benefits				
		Rice fields	Fruit farms	Fish/Shrimp ponds	Residual values	Total
1	2007	3.46	0.00	0.00	0.00	3.46
2	2008	6.06	0.00	0.00	0.00	6.06
3	2009	8.66	0.00	0.00	0.00	8.66
4	2010	11.25	0.00	0.00	0.00	11.25
5	2011	13.85	0.00	0.00	0.00	13.85
6	2012	32.90	0.00	0.00	0.00	32.90
7	2013	38.09	0.00	0.00	0.00	38.09
8	2014	43.29	0.00	0.00	0.00	43.29
9	2015	48.48	0.00	0.00	0.00	48.48
10	2016	53.67	0.00	0.00	0.00	53.67
11	2017	103.02	0.00	0.00	0.00	103.02
12	2018	112.11	0.00	0.00	0.00	112.11
13	2019	121.20	0.00	0.00	0.00	121.20
14	2020	130.29	0.00	0.00	0.00	130.29
15	2021	139.38	0.00	0.00	0.00	139.38
16	2022	212.10	0.00	0.00	0.00	212.10
17	2023	225.09	0.00	0.00	0.00	225.09
18	2024	238.07	0.00	0.00	0.00	238.07
19	2025	251.06	0.00	0.00	0.00	251.06
20	2026	264.05	0.00	0.00	0.00	264.05
21	2027	387.84	0.00	0.00	0.00	387.84
22	2028	406.02	0.00	0.00	0.00	406.02
23	2029	424.21	0.00	0.00	0.00	424.21
24	2030	442.39	0.00	0.00	0.00	442.39
25	2031	460.57	0.00	0.00	0.00	460.57
26	2032	649.73	0.00	0.00	0.00	649.73
27	2033	674.40	0.00	0.00	0.00	674.40
28	2034	699.07	0.00	0.00	0.00	699.07
29	2035	723.75	0.00	0.00	0.00	723.75
30	2036	748.42	0.00	0.00	0.00	748.42
31	2037	813.78	15.41	26.79	0.00	855.98
32	2038	839.75	15.90	27.65	0.00	883.31
33	2039	865.73	16.40	28.52	0.00	910.64
34	2040	883.86	16.94	29.58	0.00	930.38
35	2041	897.46	17.35	30.65	0.00	945.46
36	2042	911.06	17.76	31.71	0.00	960.53
37	2043	924.66	18.17	32.77	0.00	975.61
38	2044	938.26	18.58	33.84	0.00	990.68
39	2045	951.86	18.99	34.90	0.00	1,005.76
40	2046	965.47	19.40	35.97	0.00	1,020.83
41	2047	979.07	27.73	51.84	0.00	1,058.64
42	2048	992.67	28.30	53.33	0.00	1,074.30

Appendix 3 (continued)

No.	Year	Incremental Benefits				
		Rice fields	**Fruit farms**	**Fish/Shrimp ponds**	**Residual values**	**Total**
43	2049	1,006.27	28.88	54.82	0.00	1,089.97
44	2050	1,019.87	29.45	56.31	0.00	1,105.63
45	2051	1,033.47	30.02	57.80	0.00	1,121.29
46	2052	1,047.07	30.60	59.29	0.00	1,136.96
47	2053	1,060.67	31.17	60.78	0.00	1,152.62
48	2054	1,074.27	31.74	62.27	0.00	1,168.28
49	2055	1,087.87	32.32	63.76	0.00	1,183.95
50	2056	1,101.47	32.89	65.25	0.00	1,199.61
51	2057	1,115.07	43.03	85.81	0.00	1,243.91
52	2058	1,128.67	43.76	87.73	0.00	1,260.16
53	2059	1,142.27	44.50	89.64	0.00	1,276.41
54	2060	1,155.87	45.24	91.56	0.00	1,292.67
55	2061	1,169.47	45.97	93.48	0.00	1,308.92
56	2062	1,183.07	46.71	95.39	0.00	1,325.17
57	2063	1,196.67	47.45	97.31	0.00	1,341.43
58	2064	1,210.27	48.19	99.22	0.00	1,357.68
59	2065	1,223.87	48.92	101.14	0.00	1,373.93
60	2066	1,237.47	49.66	103.05	0.00	1,390.19
61	2067	1,251.07	56.00	116.63	0.00	1,423.70
62	2068	1,264.67	56.82	118.73	0.00	1,440.22
63	2069	1,278.27	57.63	120.86	0.00	1,456.77
64	2070	1,291.87	58.45	122.99	0.00	1,473.32
65	2071	1,305.47	59.27	125.12	0.00	1,489.87
66	2072	1,319.07	60.09	127.26	45.95	1,552.37
Total		46,540.21	1,289.70	2,573.79	45.95	50,449.65

Appendix 4. Stages of the farm-dike establishment project in South Kalimantan Province (hectares)

No.	Year	Dike construction	Gate construction	Dike replacement	Gate replacement
1	2007	15,000	15,000	0	0
2	2008	0	0	0	0
3	2009	0	0	0	0
4	2010	0	0	0	0
5	2011	0	0	0	0
6	2012	15,000	15,000	0	0
7	2013	0	0	0	0
8	2014	0	0	0	0
9	2015	0	0	0	0
10	2016	0	0	0	0
11	2017	15,000	15,000	0	0
12	2018	0	0	0	0
13	2019	0	0	0	0
14	2020	0	0	0	0
15	2021	0	0	0	0
16	2022	15,000	15,000	0	15,000
17	2023	0	0	0	0
18	2024	0	0	0	0
19	2025	0	0	0	0
20	2026	0	0	0	0
21	2027	15,000	15,000	0	15,000
22	2028	0	0	0	0
23	2029	0	0	0	0
24	2030	0	0	0	0
25	2031	0	0	0	0
26	2032	15,000	15,000	0	15,000
27	2033	0	0	0	0
28	2034	0	0	0	0
29	2035	0	0	0	0
30	2036	0	0	0	0
31	2037	15,000	15,000	0	30,000
32	2038	0	0	0	0
33	2039	0	0	0	0
34	2040	0	0	0	0
35	2041	0	0	0	0
36	2042	15,000	15,000	0	30,000
37	2043	0	0	0	0
38	2044	0	0	0	0
39	2045	0	0	0	0
40	2046	0	0	0	0
41	2047	15,000	15,000	0	30,000
42	2048	0	0	0	0
43	2049	0	0	0	0
44	2050	0	0	0	0
45	2051	0	0	0	0

Appendix 4 (continued)

No.	Year	Dike construction	Gate construction	Dike replacement	Gate replacement
46	2052	15,000	15,000	0	45,000
47	2053	0	0	0	0
48	2054	0	0	0	0
49	2055	0	0	0	0
50	2056	0	0	0	0
51	2057	7,973	7,973	15,000	60,000
52	2058	0	0	0	0
53	2059	0	0	0	0
54	2060	0	0	0	0
55	2061	0	0	0	0
56	2062	0	0	15,000	60,000
57	2063	0	0	0	0
58	2064	0	0	0	0
59	2065	0	0	0	0
60	2066	0	0	0	0
61	2067	0	0	15,000	75,000
62	2068	0	0	0	0
63	2069	0	0	0	0
64	2070	0	0	0	0
65	2071	0	0	0	0
66	2072	0	0	15,000	75,000

Note: The lifespan of the farm-dikes is 50 years each and the lifespan of the gates is 15 years each.

Appendix 5. Incremental costs of the farm-dike establishment project in South Kalimantan Province (billion IDR)

No.	Year	Incremental Costs		
		Construction & replacement	Operation and maintenance	Total
1	2007	10.59	0.30	10.89
2	2008	0.00	0.30	0.30
3	2009	0.00	0.30	0.30
4	2010	0.00	0.30	0.30
5	2011	0.00	0.30	0.30
6	2012	10.59	0.60	11.19
7	2013	0.00	0.60	0.60
8	2014	0.00	0.60	0.60
9	2015	0.00	0.60	0.60
10	2016	0.00	0.60	0.60
11	2017	10.59	0.90	11.49
12	2018	0.00	0.90	0.90
13	2019	0.00	0.90	0.90
14	2020	0.00	0.90	0.90
15	2021	0.00	0.90	0.90
16	2022	13.23	1.20	14.43
17	2023	0.00	1.20	1.20
18	2024	0.00	1.20	1.20
19	2025	0.00	1.20	1.20
20	2026	0.00	1.20	1.20
21	2027	13.23	1.50	14.73
22	2028	0.00	1.50	1.50
23	2029	0.00	1.50	1.50
24	2030	0.00	1.50	1.50
25	2031	0.00	1.50	1.50
26	2032	13.23	1.80	15.03
27	2033	0.00	1.80	1.80
28	2034	0.00	1.80	1.80
29	2035	0.00	1.80	1.80
30	2036	0.00	1.80	1.80
31	2037	15.87	2.10	17.97
32	2038	0.00	2.10	2.10
33	2039	0.00	2.10	2.10
34	2040	0.00	2.10	2.10
35	2041	0.00	2.10	2.10
36	2042	15.87	2.40	18.27
37	2043	0.00	2.40	2.40
38	2044	0.00	2.40	2.40
39	2045	0.00	2.40	2.40
40	2046	0.00	2.40	2.40
41	2047	15.87	2.70	18.57
42	2048	0.00	2.70	2.70
43	2049	0.00	2.70	2.70
44	2050	0.00	2.70	2.70

Appendix 5 (continued)

No.	Year	Incremental Costs		
		Construction & replacement	Operation and maintenance	Total
45	2051	0.00	2.70	2.70
46	2052	18.51	3.00	21.51
47	2053	0.00	3.00	3.00
48	2054	0.00	3.00	3.00
49	2055	0.00	3.00	3.00
50	2056	0.00	3.00	3.00
51	2057	24.14	3.16	27.30
52	2058	0.00	3.16	3.16
53	2059	0.00	3.16	3.16
54	2060	0.00	3.16	3.16
55	2061	0.00	3.16	3.16
56	2062	18.51	3.16	21.67
57	2063	0.00	3.16	3.16
58	2064	0.00	3.16	3.16
59	2065	0.00	3.16	3.16
60	2066	0.00	3.16	3.16
61	2067	21.15	3.16	24.31
62	2068	0.00	3.16	3.16
63	2069	0.00	3.16	3.16
64	2070	0.00	3.16	3.16
65	2071	0.00	3.16	3.16
66	2072	21.15	3.16	24.31
	Total	222.53	133.05	355.58

Appendix 6. Streams of incremental benefits, incremental costs and incremental net benefits of the farm-dike establishment project (billion IDR)

No.	Year	Incremental benefits	Incremental costs	Incremental net benefits
1	2007	3.46	10.89	-7.43
2	2008	6.06	0.30	5.76
3	2009	8.66	0.30	8.36
4	2010	11.25	0.30	10.95
5	2011	13.85	0.30	13.55
6	2012	32.90	11.19	21.71
7	2013	38.09	0.60	37.49
8	2014	43.29	0.60	42.69
9	2015	48.48	0.60	47.88
10	2016	53.67	0.60	53.07
11	2017	103.02	11.49	91.53
12	2018	112.11	0.90	111.21
13	2019	121.20	0.90	120.30
14	2020	130.29	0.90	129.39
15	2021	139.38	0.90	138.48
16	2022	212.10	14.43	197.67
17	2023	225.09	1.20	223.89
18	2024	238.07	1.20	236.87
19	2025	251.06	1.20	249.86
20	2026	264.05	1.20	262.85
21	2027	387.84	14.73	373.11
22	2028	406.02	1.50	404.52
23	2029	424.21	1.50	422.71
24	2030	442.39	1.50	440.89
25	2031	460.57	1.50	459.07
26	2032	649.73	15.03	634.70
27	2033	674.40	1.80	672.60
28	2034	699.07	1.80	697.27
29	2035	723.75	1.80	721.95
30	2036	748.42	1.80	746.62
31	2037	855.98	17.97	838.01
32	2038	883.31	2.10	881.21
33	2039	910.64	2.10	908.54
34	2040	930.38	2.10	928.28
35	2041	945.46	2.10	943.36
36	2042	960.53	18.27	942.26
37	2043	975.61	2.40	973.21
38	2044	990.68	2.40	988.28
39	2045	1,005.76	2.40	1,003.36
40	2046	1,020.83	2.40	1,018.43
41	2047	1,058.64	18.57	1,040.07
42	2048	1,074.30	2.70	1,071.60
43	2049	1,089.97	2.70	1,087.27
44	2050	1,105.63	2.70	1,102.93

Appendix 6 (continued)

No.	Year	Incremental benefits	Incremental costs	Incremental net benefits
45	2051	1,121.29	2.70	1,118.59
46	2052	1,136.96	21.51	1,115.45
47	2053	1,152.62	3.00	1,149.62
48	2054	1,168.28	3.00	1,165.28
49	2055	1,183.95	3.00	1,180.95
50	2056	1,199.61	3.00	1,196.61
51	2057	1,243.91	27.30	1,216.61
52	2058	1,260.16	3.16	1,257.00
53	2059	1,276.41	3.16	1,273.25
54	2060	1,292.67	3.16	1,289.51
55	2061	1,308.92	3.16	1,305.76
56	2062	1,325.17	21.67	1,303.50
57	2063	1,341.43	3.16	1,338.27
58	2064	1,357.68	3.16	1,354.52
59	2065	1,373.93	3.16	1,370.77
60	2066	1,390.19	3.16	1,387.03
61	2067	1,423.70	24.31	1,399.39
62	2068	1,440.22	3.16	1,437.06
63	2069	1,456.77	3.16	1,453.61
64	2070	1,473.32	3.16	1,470.16
65	2071	1,489.87	3.16	1,486.71
66	2072	1,552.37	24.31	1,528.06
	Total	50,449.65	355.58	50,094.06
NPV (8%) (billion IDR)				2,654.80
NPV (12%) (billion IDR)				1,000.17
NPV (16%) (billion IDR)				476.50

Appendix 7. Incremental benefits of the relocation project in South Kalimantan Province (billion IDR)

No.	Year	Incremental Benefits				
		Rice fields	Fruit farms	Fish/Shrimp ponds	Residual values	Total
1	2,007	-1,315.61	-120.16	-242.70	0.00	-1,678.48
2	2,008	-1,313.01	-120.16	-242.70	0.00	-1,675.88
3	2,009	-1,185.17	-120.16	0.00	0.00	-1,305.33
4	2,010	-1,182.57	-120.16	0.00	0.00	-1,302.73
5	2,011	-1,179.97	-120.16	0.00	0.00	-1,300.14
6	2,012	-1,160.93	0.00	0.00	0.00	-1,160.93
7	2,013	-1,030.48	0.00	0.00	0.00	-1,030.48
8	2,014	-1,025.29	0.00	0.00	0.00	-1,025.29
9	2,015	-1,020.09	0.00	0.00	0.00	-1,020.09
10	2,016	-1,014.90	0.00	0.00	0.00	-1,014.90
11	2,017	-965.55	0.00	0.00	0.00	-965.55
12	2,018	-831.21	0.00	0.00	0.00	-831.21
13	2,019	-822.12	0.00	0.00	0.00	-822.12
14	2,020	-813.03	0.00	0.00	0.00	-813.03
15	2,021	-803.94	0.00	0.00	0.00	-803.94
16	2,022	-731.22	0.00	0.00	0.00	-731.22
17	2,023	-592.99	0.00	0.00	0.00	-592.99
18	2,024	-580.00	0.00	0.00	0.00	-580.00
19	2,025	-567.01	0.00	0.00	0.00	-567.01
20	2,026	-554.03	0.00	0.00	0.00	-554.03
21	2,027	-430.23	0.00	0.00	0.00	-430.23
22	2,028	-286.80	0.00	0.00	0.00	-286.80
23	2,029	-268.62	0.00	0.00	0.00	-268.62
24	2,030	-250.44	0.00	0.00	0.00	-250.44
25	2,031	-232.26	0.00	0.00	0.00	-232.26
26	2,032	-43.10	0.00	0.00	0.00	-43.10
27	2,033	106.83	0.00	0.00	0.00	106.83
28	2,034	131.50	0.00	0.00	0.00	131.50
29	2,035	156.17	0.00	0.00	0.00	156.17
30	2,036	180.85	0.00	0.00	0.00	180.85
31	2,037	246.21	15.41	26.79	0.00	288.41
32	2,038	397.43	15.90	27.65	0.00	440.99
33	2,039	423.40	16.40	28.52	0.00	468.32
34	2,040	441.54	16.94	29.58	0.00	488.06
35	2,041	455.14	17.35	30.65	0.00	503.14
36	2,042	468.74	17.76	31.71	0.00	518.21
37	2,043	607.59	18.17	32.77	0.00	658.53
38	2,044	621.19	18.58	33.84	0.00	673.61
39	2,045	634.79	18.99	34.90	0.00	688.68
40	2,046	648.39	19.40	35.97	0.00	703.76
41	2,047	661.99	27.73	51.84	0.00	741.57
42	2,048	800.84	28.30	53.33	0.00	882.48
43	2,049	814.44	28.88	54.82	0.00	898.14

Appendix 7 (continued)

No.	Year	Incremental Benefits				
		Rice fields	Fruit farms	Fish/Shrimp ponds	Residual values	Total
44	2,050	828.04	29.45	56.31	0.00	913.81
45	2,051	841.64	30.02	57.80	0.00	929.47
46	2,052	855.24	30.60	59.29	0.00	945.13
47	2,053	994.09	31.17	60.78	0.00	1,086.05
48	2,054	1,007.69	31.74	62.27	0.00	1,101.71
49	2,055	1,021.29	32.32	63.76	0.00	1,117.37
50	2,056	1,034.89	32.89	65.25	0.00	1,133.04
51	2,057	1,048.49	43.03	85.81	0.00	1,177.33
52	2,058	1,128.67	43.76	87.73	0.00	1,260.16
53	2,059	1,142.27	44.50	89.64	0.00	1,276.41
54	2,060	1,155.87	45.24	91.56	0.00	1,292.67
55	2,061	1,169.47	45.97	93.48	0.00	1,308.92
56	2,062	1,183.07	46.71	95.39	0.00	1,325.17
57	2,063	1,196.67	47.45	97.31	0.00	1,341.43
58	2,064	1,210.27	48.19	99.22	0.00	1,357.68
59	2,065	1,223.87	48.92	101.14	0.00	1,373.93
60	2,066	1,237.47	49.66	103.05	0.00	1,390.19
61	2,067	1,251.07	56.00	116.63	0.00	1,423.70
62	2,068	1,264.67	56.82	118.73	0.00	1,440.22
63	2,069	1,278.27	57.63	120.86	0.00	1,456.77
64	2,070	1,291.87	58.45	122.99	0.00	1,473.32
65	2,071	1,305.47	59.27	125.12	0.00	1,489.87
66	2,072	1,319.07	60.09	127.26	943.42	2,449.85
	Total	13,585.91	688.88	2,088.39	943.42	17,306.60

Appendix 8. Stages of the relocation project in South Kalimantan Province

No.	Year	Rice field establishment (ha)	Fruits farm establishment (ha)	Fish/Shrimp pond establishment (ha)	Housing + other construction (HH)
1	2007	15,000	1,843	809	7,500
2	2008	0	0	0	0
3	2009	0	0	0	0
4	2010	0	0	0	0
5	2011	0	0	0	0
6	2012	15,000	0	0	7,500
7	2013	0	0	0	0
8	2014	0	0	0	0
9	2015	0	0	0	0
10	2016	0	0	0	0
11	2017	15,000	0	0	7,500
12	2018	0	0	0	0
13	2019	0	0	0	0
14	2020	0	0	0	0
15	2021	0	0	0	0
16	2022	15,000	0	0	7,500
17	2023	0	0	0	0
18	2024	0	0	0	0
19	2025	0	0	0	0
20	2026	0	0	0	0
21	2027	15,000	0	0	7,500
22	2028	0	0	0	0
23	2029	0	0	0	0
24	2030	0	0	0	0
25	2031	0	0	0	0
26	2032	15,000	0	0	7,500
27	2033	0	0	0	0
28	2034	0	0	0	0
29	2035	0	0	0	0
30	2036	0	0	0	0
31	2037	15,000	0	0	7,500
32	2038	0	0	0	0
33	2039	0	0	0	0
34	2040	0	0	0	0
35	2041	0	0	0	0
36	2042	15,000	0	0	7,500
37	2043	0	0	0	0
38	2044	0	0	0	0
39	2045	0	0	0	0
40	2046	0	0	0	0
41	2047	15,000	0	0	7,500
42	2048	0	0	0	0
43	2049	0	0	0	0
44	2050	0	0	0	0
45	2051	0	0	0	0
46	2052	15,000	0	0	7,500

Appendix 8 (continued)

No.	Year	Rice field establishment (ha)	Fruit farm establishment (ha)	Fish/Shrimp pond establishment (ha)	Housing + other construction (HH)
47	2053	0	0	0	0
48	2054	0	0	0	0
49	2055	0	0	0	0
50	2056	0	0	0	0
51	2057	7,973	0	0	3,987
52	2058	0	0	0	0
53	2059	0	0	0	0
54	2060	0	0	0	0
55	2061	0	0	0	0
56	2062	0	0	0	0
57	2063	0	0	0	0
58	2064	0	0	0	0
59	2065	0	0	0	0
60	2066	0	0	0	0
61	2067	0	0	0	0
62	2068	0	0	0	0
63	2069	0	0	0	0
64	2070	0	0	0	0
65	2071	0	0	0	0
66	2072	0	0	0	0

Appendix 9. Costs of the relocation project in South Kalimantan Province (billion IDR)

No.	Year	Total costs of the relocation project	Total costs of the base case	Incremental costs
1	2007	266.09	982.20	-716.11
2	2008	52.50	982.20	-929.70
3	2009	212.90	982.20	-769.29
4	2010	212.90	982.20	-769.29
5	2011	212.90	982.20	-769.29
6	2012	512.90	982.20	-469.29
7	2013	293.62	982.20	-688.58
8	2014	293.62	982.20	-688.58
9	2015	293.62	982.20	-688.58
10	2016	293.62	982.20	-688.58
11	2017	593.62	982.20	-388.58
12	2018	374.33	982.20	-607.87
13	2019	374.33	982.20	-607.87
14	2020	374.33	982.20	-607.87
15	2021	374.33	982.20	-607.87
16	2022	621.83	982.20	-360.37
17	2023	455.04	982.20	-527.16
18	2024	455.04	982.20	-527.16
19	2025	455.04	982.20	-527.16
20	2026	455.04	982.20	-527.16
21	2027	702.54	982.20	-279.66
22	2028	535.75	982.20	-446.45
23	2029	535.75	982.20	-446.45
24	2030	535.75	982.20	-446.45
25	2031	535.75	982.20	-446.45
26	2032	783.25	982.20	-198.95
27	2033	616.46	982.20	-365.74
28	2034	616.46	982.20	-365.74
29	2035	616.46	982.20	-365.74
30	2036	616.46	982.20	-365.74
31	2037	863.96	982.20	-118.24
32	2038	697.17	982.20	-285.03
33	2039	697.17	982.20	-285.03
34	2040	697.17	982.20	-285.03
35	2041	697.17	982.20	-285.03
36	2042	944.67	982.20	-37.53
37	2043	777.88	982.20	-204.32
38	2044	777.88	982.20	-204.32
39	2045	777.88	982.20	-204.32
40	2046	777.88	982.20	-204.32
41	2047	1025.38	982.20	43.18
42	2048	858.59	982.20	-123.61
43	2049	858.59	982.20	-123.61

Appendix 9 (continued)

No.	Year	Total costs of the relocation project	Total costs of the base case	Incremental costs
44	2050	858.59	982.20	-123.61
45	2051	858.59	982.20	-123.61
46	2052	1106.09	982.20	123.89
47	2053	939.30	982.20	-42.90
48	2054	939.30	982.20	-42.90
49	2055	939.30	982.20	-42.90
50	2056	939.30	982.20	-42.90
51	2057	1070.87	982.20	88.67
52	2058	982.20	982.20	0.00
53	2059	982.20	982.20	0.00
54	2060	982.20	982.20	0.00
55	2061	982.20	982.20	0.00
56	2062	982.20	982.20	0.00
57	2063	982.20	982.20	0.00
58	2064	982.20	982.20	0.00
59	2065	982.20	982.20	0.00
60	2066	982.20	982.20	0.00
61	2067	982.20	982.20	0.00
62	2068	982.20	982.20	0.00
63	2069	982.20	982.20	0.00
64	2070	982.20	982.20	0.00
65	2071	982.20	982.20	0.00
66	2072	982.20	982.20	0.00
	Total	46,107.79	64,825.08	-18,717.29

Appendix 10. Streams of incremental benefits, incremental costs and incremental net benefits of the relocation project in South Kalimantan Province (billion IDR)

No.	Year	Incremental benefits	Incremental costs	Incremental net benefits
1	2007	-1,678.48	-716.11	-962.36
2	2008	-1,675.88	-929.70	-746.18
3	2009	-1,305.33	-769.29	-536.04
4	2010	-1,302.73	-769.29	-533.44
5	2011	-1,300.14	-769.29	-530.84
6	2012	-1,160.93	-469.29	-691.63
7	2013	-1,030.48	-688.58	-341.90
8	2014	-1,025.29	-688.58	-336.71
9	2015	-1,020.09	-688.58	-331.51
10	2016	-1,014.90	-688.58	-326.32
11	2017	-965.55	-388.58	-576.97
12	2018	-831.21	-607.87	-223.34
13	2019	-822.12	-607.87	-214.25
14	2020	-813.03	-607.87	-205.16
15	2021	-803.94	-607.87	-196.07
16	2022	-731.22	-360.37	-370.85
17	2023	-592.99	-527.16	-65.82
18	2024	-580.00	-527.16	-52.84
19	2025	-567.01	-527.16	-39.85
20	2026	-554.03	-527.16	-26.87
21	2027	-430.23	-279.66	-150.57
22	2028	-286.80	-446.45	159.65
23	2029	-268.62	-446.45	177.83
24	2030	-250.44	-446.45	196.01
25	2031	-232.26	-446.45	214.19
26	2032	-43.10	-198.95	155.85
27	2033	106.83	-365.74	472.57
28	2034	131.50	-365.74	497.24
29	2035	156.17	-365.74	521.91
30	2036	180.85	-365.74	546.59
31	2037	288.41	-118.24	406.65
32	2038	440.99	-285.03	726.02
33	2039	468.32	-285.03	753.35
34	2040	488.06	-285.03	773.09
35	2041	503.14	-285.03	788.17
36	2042	518.21	-37.53	555.74
37	2043	658.53	-204.32	862.85
38	2044	673.61	-204.32	877.93
39	2045	688.68	-204.32	893.00
40	2046	703.76	-204.32	908.08
41	2047	741.57	43.18	698.39
42	2048	882.48	-123.61	1,006.09
43	2049	898.14	-123.61	1,021.75

Appendix 10 (continued)

No.	Year	Incremental benefits	Incremental costs	Incremental net benefits
44	2050	913.81	-123.61	1,037.42
45	2051	929.47	-123.61	1,053.08
46	2052	945.13	123.89	821.24
47	2053	1,086.05	-42.90	1,128.95
48	2054	1,101.71	-42.90	1,144.61
49	2055	1,117.37	-42.90	1,160.27
50	2056	1,133.04	-42.90	1,175.94
51	2057	1,177.33	88.67	1,088.67
52	2058	1,260.16	0.00	1,260.16
53	2059	1,276.41	0.00	1,276.41
54	2060	1,292.67	0.00	1,292.67
55	2061	1,308.92	0.00	1,308.92
56	2062	1,325.17	0.00	1,325.17
57	2063	1,341.43	0.00	1,341.43
58	2064	1,357.68	0.00	1,357.68
59	2065	1,373.93	0.00	1,373.93
60	2066	1,390.19	0.00	1,390.19
61	2067	1,423.70	0.00	1,423.70
62	2068	1,440.22	0.00	1,440.22
63	2069	1,456.77	0.00	1,456.77
64	2070	1,473.32	0.00	1,473.32
65	2071	1,489.87	0.00	1,489.87
66	2072	2,449.85	0.00	2,449.85
	Total	17,306.60	-18,717.29	36,023.89
NPV (8%) (billion IDR)				-2,284.55
NPV (12%) (billion IDR)				-2,579.61
NPV (16%) (billion IDR)				-2,299.97