POLICY BRIEF

INDONESIA: COSTS OF CLIMATE CHANGE 2050

May 2016

This document was produced for the United States Agency for International Development. It was prepared by Chemonics for the ATLAS Task Order.

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This document and the associated spreadsheet may be accessed online through https://www.climatelinks.org/projects/atlas

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Prepared for:

United States Agency for International Development
Climate Change Adaptation Thought Leadership, and Assessments (ATLAS)

Prepared by:

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CONTENTS

LIST OF FIGURES AND TABLES

EXECUTIVE SUMMARY

Climate change is a growing concern throughout the world, as each year shows new records for high temperatures and the new "worst storm ever." For Indonesia, with its more than 17,000 islands and an economy highly dependent on natural resources, understanding the implications of this change in the global environment is essential. With the government's strong national focus on poverty reduction, it is crucial to analyze the economic impacts of climate change to ensure that efforts to lift the population out of poverty are designed in a way that accounts for climate impacts.

This study adds to the rich and growing body of analytical information supporting strong and decisive action to address climate change risk. It provides information about projected climate change and associated economic costs for policy makers to consider as an integral part of sectoral planning, budget allocation and information dissemination within the government and to the public.

The study presents an estimate of the costs that will be imposed by climate change in the year 2050 in three areas: agriculture, health, and gradual sea level rise (SLR). The estimate is only for 2050, it is not cumulative, so the increasing costs imposed in years leading up to that date are not included. Within these areas, key impacts examined include: the change in value of soybeans, corn, sugarcane, and rice; economic losses associated with dengue fever and malaria; and the change in value of homes, offices, industrial areas, fields, and aquaculture facilities that will be flooded as the sea level rises. These are considered with respect to expected changes in temperature, rainfall, and gradual SLR in 2050, and valued at the most recently available present market values.

These estimates represent one projection among many possibilities for major aspects of the Indonesian economy and society, and while they do not capture all sectors and potential impacts, they provide a useful snapshot of likely climate change risks. The climate change scenario used is an average of all international climate models for middle-of-the-road assumptions about greenhouse gas emissions. The four crops account for a significant share of the value of food crops, while the two diseases include those expected to be most affected by climate change. The accompanying technical report provides details on all parameters and calculations, which are available in the separate study spreadsheets.

This study provides insights into the possible future without adaptation. It conveys evidence to aid decision-makers as they weigh the risks of climate change and integrate climate risk management into their development efforts. International and Indonesian policy analysts and decision makers in government, civil society, and the private sector can use this information to inform decisions related to policy, planning, technical assistance, and budgeting and identify issues for more detailed analysis that will refine the understanding of the economic implications of climate change and the need for adaptation.

Findings:

- The total costs imposed on Indonesia in 2050 by climate change in these three areas of impact are estimated at 132 trillion Indonesian rupiahs which, at present prices, would be 1.4 per cent of today's Indonesian economy as measured by GDP. The greatest financial impact of climate change will be due to decreased agricultural output, which accounts for 53 percent of this cost. Health impacts account for 34 percent, while gradual SLR accounts for 13 percent of the projected costs.

- The overall negative impacts of climate change will fall disproportionately on Jakarta, the capital, which will experience 25 percent of the total projected costs through the combined effects of dengue fever and SLR. Jawa Timur, Jawa Tengah, and Jawa Barat provinces account for 19 percent, 15 percent, and 9.5 percent of total costs, respectively; these losses are overwhelmingly agricultural.

- Not all impacts are negative under the parameters used in this study. While total agricultural impacts are negative nationwide, the value of agricultural output is expected to rise in some provinces due to increased rainfall which could, under favorable conditions and with other measures, lead to more production of certain crops. This effect is most pronounced in Lampung and Gorontalo provinces.

- In per capita terms, Lampung and Gorontalo provinces are potentially the biggest beneficiaries; the effect is more pronounced in Gorontalo because of its small population. Jakarta will see the biggest losses in per capita terms, along with Sulawesi Utara and Papua Barat provinces, both of whose small populations mean that their losses fall more heavily on each resident than would be apparent from their total provincial loss.

- Most costs imposed by health impacts come from an increase in dengue fever, typically an urban disease. More than half of that impact will occur in Jakarta, where the incidence of the disease is expected to grow rapidly.

- Effects of SLR will be felt nationwide, but the greatest costs imposed by gradual rise will occur primarily in Jakarta due to the high property values of the capital region.

Recommendations:

- In general, the GOI should discuss these results with provincial authorities to inform local planning and budgeting. Climate change will have implications for agriculture, health, infrastructure, and general development in both expenditures and revenues.

- When considering adaptation strategies for these sectors the benefits and costs of various actions should be considered in the context of the projected costs shown here.

- In each province, policy makers and agriculture interests should look for opportunities to benefit from climate change, encouraging growth of crops that will do well under the new conditions and investing in water control and irrigation infrastructure to take advantage of where rainfall may decrease or increase. This study alone may not be sufficient to say that policy makers should immediately encourage corn production in Lampung and Gorontalo provinces, but at both the national and provincial level, understanding where the opportunities will emerge is important, especially given that the climate will not change equally everywhere.

- The responsible authorities should plan now to avoid or alleviate the clear significant negative consequences for Jakarta associated with dengue fever. Similarly, in many provinces the conditions for malaria will worsen and authorities should be planning or initiating programs for this. More research should be carried out on links between disease and climate, including not only of the expected increased incidence but also of the possibility that some changes in climate may actually hinder the spread of certain diseases in some locations. More detailed research on malaria along the lines of the study used to analyze dengue fever would be particularly important.

- Actions against gradual SLR must be chosen carefully: The study shows negative effects of SLR nationwide, but the costs foreseen are almost all incurred in urban areas where property is much more valuable and adaptation will be most costly. Both policy makers and private investors working on shoreline development should be extremely interested in this. It is unlikely that large-scale protective infrastructure would be cost-effective anywhere except possibly in Jakarta or other very large and economically valuable urban areas. Such a cost-benefit analysis was done before the decision was made to build the National Capital Integrated Coastal Development (NCICD) sea wall for Jakarta that is now under construction.

- Extreme storms and weather pose a great economic threat: Analysis of the probability of extreme storms in different parts of the country would be very valuable in identifying the costs they will impose and setting priorities for investments in adaptation. To the extent that the fields of climatology and oceanography can shed light on this issue, investments in further research will be essential. Policy makers must order more detailed analysis of the impacts of extreme storms on large urban areas, particularly Jakarta. In particular, work that can consider the macroeconomic or multiplier implications of the loss of key urban infrastructure will be essential to set priorities for investments in adaptation or strategies to minimize the harm caused by such storms. The private sector must anticipate these problems as well; every company whose business relies on transportation through the harbor or airport should create plans for continuity of its operations in the face of such extreme storms.

- To identify optimal implementable policy responses much more information is needed on certain aspects. In particular, more work is crucial on links between climate change and agricultural yields given the huge monetary impacts involved. The wide range of impacts on

agriculture found here are dependent on a single piece of research. It is essential for Indonesia to invest in more research on links between climate and agriculture, considering a wider range of crops and more areas of the country. Moreover, the research and this study point to the varying effects in different locations; a more comprehensive understanding of this geographic variation across this vast country would be valuable to design provincial or local adaptation responses.

- Work on the probability of extreme storms and the costs they would impose in different parts of the country is also very important, particularly the macroeconomic implications of flooding on nationally important transportation infrastructure in Jakarta. More generally, flooding and drought have direct costs and multiplier effects throughout the economy and these should be studied.

- Indonesia cannot wait until 2050 to act: This study projects the situation in 2050 in specific areas of impact under specific parameters. As climate change is gradual, it may be assumed that the conditions described for 2050 will evolve between now and then, and that Indonesia will increasingly and inexorably experience the costs and benefits each year. This means that policy makers should not wait until the future to implement changes that either lessen or take advantage of the impacts.

1. INTRODUCTION

This study contributes to a growing body of knowledge for planning appropriate climate change adaptation. It develops an estimate of the costs that will be imposed by climate change if Indonesia does not make a concerted effort to protect itself through effective adaptation. It focuses on three areas of impact: agriculture, health, and gradual rise in the oceans that surround the Indonesian archipelago. These areas were chosen based on their importance to the country, the need to limit the scope of the work to be able to produce results in a useful timeframe, and the expectation that they would be sufficiently controllable to address in a study that builds on work carried out by other researchers. The purpose of the study is to provide a comparative analysis of climate impacts across selected sectors in all provinces in Indonesia to raise awareness about the significance of climate change, and to provide information useful for priority-setting and integrating climate risk reduction into the country's development.

The study calculates the costs that can be anticipated in the year 2050 due to decreased output, direct expenditures, illness, and forgone income from properties that will flood as the sea level rises.[1] It works with data available at the provincial level, which means it is possible to compare the estimated impacts both across areas of impact and across provinces or regions of the country.

Most studies of the impacts of climate change focus on several issues:

- Identifying how climate change will affect different areas of activity;
- Identifying how climate change will affect specific locations, ranging in scale from individual villages to the country as a whole;
- Quantifying the vulnerability of the country to climate change impacts, typically using subjective indicators or indices of vulnerability based at least in part on residents' assessments of which problems are the most serious;
- Identifying strategies to head off those impacts or adapt to them;
- Calculating the costs of those adaptation strategies.

This study differs from other assessments in two key ways:

- It quantifies the impacts of climate change in monetary terms.
- It does not consider adaptation strategies or the cost of adaptation.

[1] Those interested in the technical details of this study may access both the spreadsheets developed for the study and the technical report describing the methodology online at https://www.climatelinks.org/projects/atlas.

The approach of this study is offered as a complement to, rather than a replacement for other approaches. The use of monetary values and the focus on costs of climate change, rather than costs of adaptation, are useful for several reasons. First, while monetary values certainly do not capture everything of importance to humans, they offer a standard, relatively objective unit of measure that permits comparison of impacts across both places and areas of impact. The availability of a wide range of published provincial data in Indonesia on agriculture, health, aquaculture, and other topics makes it possible to compare impacts in ways that should help both national and provincial governments set priorities for adaptation.

WHY MONETARY VALUE?

Use of monetary value of impacts as a common metric across sectors and provinces (or other subnational spatial area) makes it possible to compare impacts of climate change across provinces and sectors, and with the costs of adaptation in each province and sector.

Second, in a context where public officials manage scarce resources, the use of monetary valuation provides an understanding of what will be lost if they do not factor adaptation into their plans. While this study is not a comprehensive cost-benefit analysis of climate change impacts – such an analysis goes well beyond the scope of this work – it does shed light on the costs that will be incurred if Indonesia does not invest in adaptation.

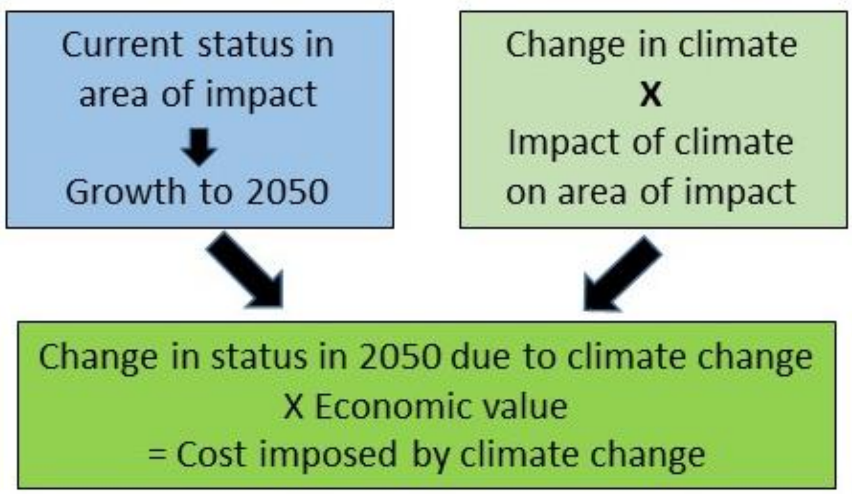
2. METHODOLOGY

The broad approach to this study involves combining data and analytical results from a number of other fields in a kind of "chain" to predict how climate change will affect the areas of interest.

This is done in several steps:

- Identify the impacts of climate change on the country based on global models of the impacts, and focused on temperature, rainfall, and SLR. The temperature and rainfall predictions used are the output of international climate models whose results for Indonesia are available online for public use.[2] The predictions of SLR are the outcome of Indonesian modeling work, generously shared by Dr. Ibnu Sofian of Badan Informasi Geospasial.

Figure 1. Overall approach of the study



- In the areas of focus, locate information on the present situation on the ground: how much agricultural production, how many cases of disease, how many people living in areas at risk from coastal flooding, what infrastructure is at risk of coastal flooding, et cetera. Data on these topics come from the Indonesia Statistical Yearbooks, statistical reports of the Ministry of Agriculture and the Ministry of Marine Affairs and Fisheries, Ministry of Health studies, and other specialized studies. The base year for these data is 2012. Analysis was done for 33 rather than the current 34 provinces, as separate data were not yet available for Kalimantan Utara in 2012, then still part of Kalimantan Timur.
- By searching the relevant analytical literature, identify studies that shed light on how changes in temperature or rainfall will affect the areas of focus. This is the most challenging part of the study, because it concerns how climate change affects very complex physical

[2] Temperature predictions come from www.climatewizard.org, and rainfall predictions from www.worldclim.org. For more detail see the technical report.

and biological systems, such as the ecosystem in which an anopheles mosquito transmits disease, or the complex currents and winds surrounding Indonesia's 17,000 islands.

- Combine predictions of change in the climate with predictions of how that change will affect agriculture, health, or other issues, to predict the specific changes that will occur in Indonesia in 2050. How will agricultural output change? How will the number of cases of disease evolve? What will be flooded? Impacts directly related to population, particularly in the case of health, are based on projections of the 2050 population of each province.
- Use current price data to put a monetary value on the changes attributable to climate change. All monetary values in the study are expressed in 2012 Indonesian rupiahs (Rp), which had an average exchange rate of Rp 9,300 to US$1 in 2012.

As this methodology suggests, this study does not involve new primary data collection or original research. Its strength is that it brings together the data collection and research done by others, integrating their results into a single framework that can be used to (1) develop monetary estimates of the impacts of climate change, and (2) compare those values across areas of impact and across provinces.

3. RESULTS: AGRICULTURE

The analysis of agriculture focuses on five crops: soybeans, corn, sugarcane/sugar, irrigated rice, and rainfed rice. The analysis relies on a study carried out at Bogor Agricultural University by Handoko and Syaukat (2008) that looked at how yields of these five crops will vary in response to changes in temperature and rainfall in several provinces of Indonesia.[3] Both the Handoko and Syaukat study and the present one look at how climate change will affect existing crops. As the Handoko and Syaukat work did not include the possible new opportunities in agriculture that may arise from crops better suited to new climate conditions, this study could not incorporate those opportunities either. Figure 2 shows the value of production of the five study crops in 2012.

Figure 2. Value of production of study crops in 2012
(in millions of rupiahs)

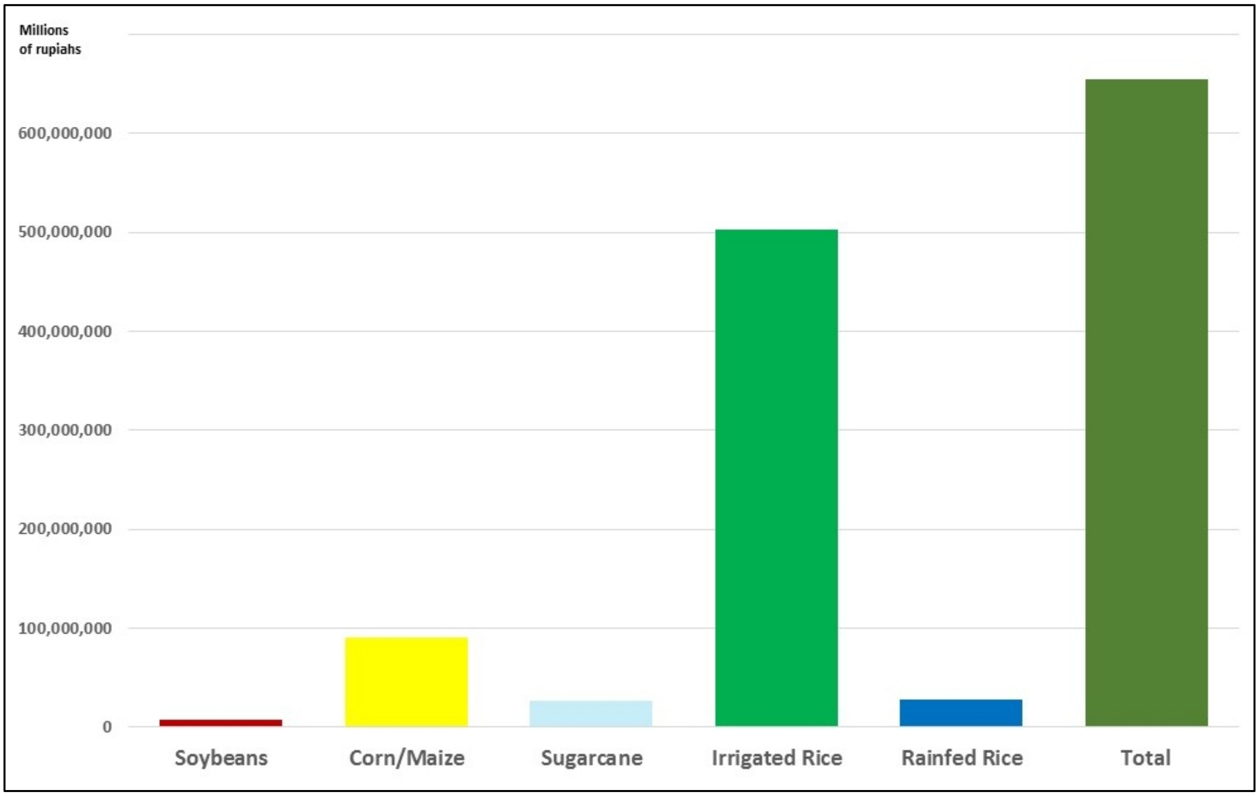


Figure 3 shows the overall impacts of climate change on the value of agricultural output by crop. These are the only crops for which the Handoko and Syaukat (2008) work finds that, other factors being held equal, rainfall will affect yields. The study does not take into account other factors such as the timing or intensity of the rainfall. This chart shows clearly that climate change will lead to a decrease in the overall value of agricultural output but significant

[3] Handoko, Yon Sugiarto, & Syaukat, Yusman. (2008). Keterkaitan Perubahan Iklim dan Produksi Pangan Strategis: Telaah Kebijakan Independen dalam Bidang Perdagangan dan Pembangunan. SEAMEO-BIOTROP and Kemitraan, Bogor – Indonesia.

percentage increases in the value of corn and rainfed rice. The increase in the value of corn could be more than 25 percent and the increase in the value of rainfed rice could be nearly 50 percent but the decrease in irrigated rice value of roughly 20 percent is from a much larger base of production. The increased rainfall in some provinces is sufficient to outweigh the negative effects on yield from temperature rise and make the overall impact on the value of corn and rainfed rice positive.

Figure 3. Impact of climate change on the value of crops in 2050
(in millions of rupiahs)

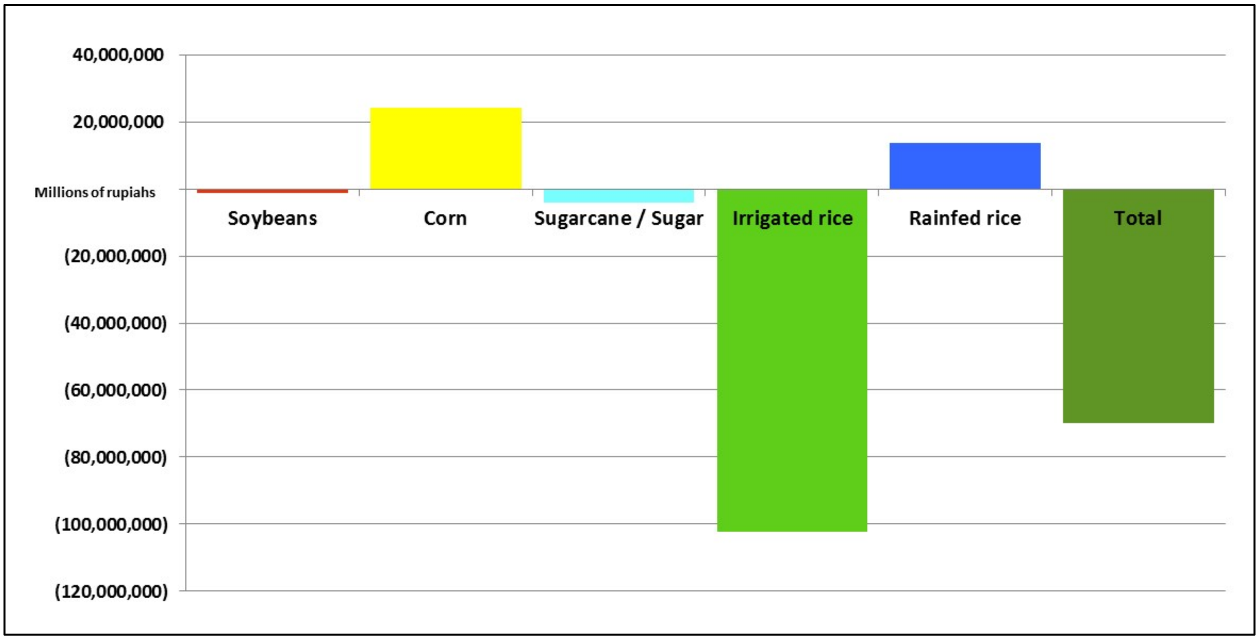
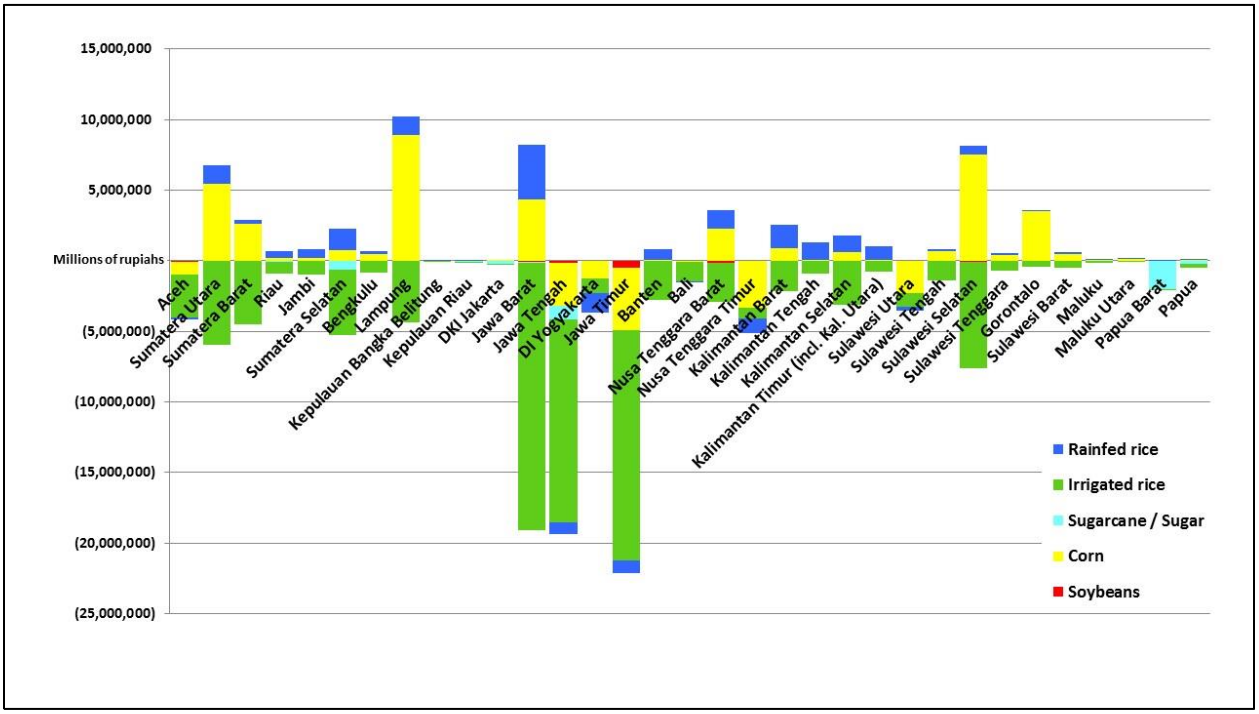


Figure 4 shows the impacts of climate change on agriculture by province and by crop. Table 1 provides the data underlying this figure. The yellow and darker blue areas show the change in value of corn and rainfed rice, respectively, while the turquoise, green, and red areas represent sugarcane, corn, and soybeans. Where rainfall will rise with climate change, the impacts on corn and rainfed rice are positive; in provinces where rainfall will drop, those impacts are negative. The other three crops, unaffected by rainfall, always drop in output and value due to higher temperatures. Where the increased value of corn and rainfed rice exceeds the declines in the other three crops, the net impact on the province is positive. This is the case in 11 out of 33 provinces. In two provinces, Lampung and Gorontalo, the difference is significant: more than Rp 5 trillion in Lampung and more than Rp 3 trillion in Gorontalo.

It will be important to understand better the wide variation in agricultural impacts of climate change in order to design adaptation strategies. In provinces where rainfall is expected to rise, farmers may consider shifting to corn, rainfed rice, or other rainfed crops whose yields may be higher than in the past. In areas with increased rainfall, the need to make use of existing irrigation systems may also decrease though increasing irregularity would still require it.

Figure 4. Impact of climate change on value of crops by province in 2050
(in millions of rupiahs)



It is important to note that the Handoko and Syaukat (2008) study on which this work is based (and on which Indonesia's Climate Change Roadmap is based) is the only research available to date on the impacts of climate change on agricultural output in Indonesia. Their coefficients are based on changes in yield within a modest range of changes in rainfall and temperature, so the changes anticipated due to climate change in 2050 are much greater than what can be predicted with these coefficients. If their coefficients were applied here, some crop yields would triple or even quadruple with increases in rainfall, while others would – mathematically at least – be negative due to higher temperature or less rain. To prevent such anomalies, this study constrains changes in yield to 100 percent. That is, yield can go down to zero or increase by 100 percent (double), but cannot go beyond those boundaries in this present study.

This variation in impacts, and the fact that only one research study to date has explicitly addressed the impacts of climate change on agriculture in Indonesia, makes additional research on these issues essential. Agriculture is too important to both economic well-being and food security for policy decisions to be based on only a single study. Additional research into how climate patterns affect agricultural output nationally in all areas, rather than only in selected provinces, and considering more carefully which crops may do better or worse under the new conditions, is essential to designing effective adaptation strategies.

Table 1. Change in value of agricultural output in 2050 due to climate change
(in millions of rupiahs)

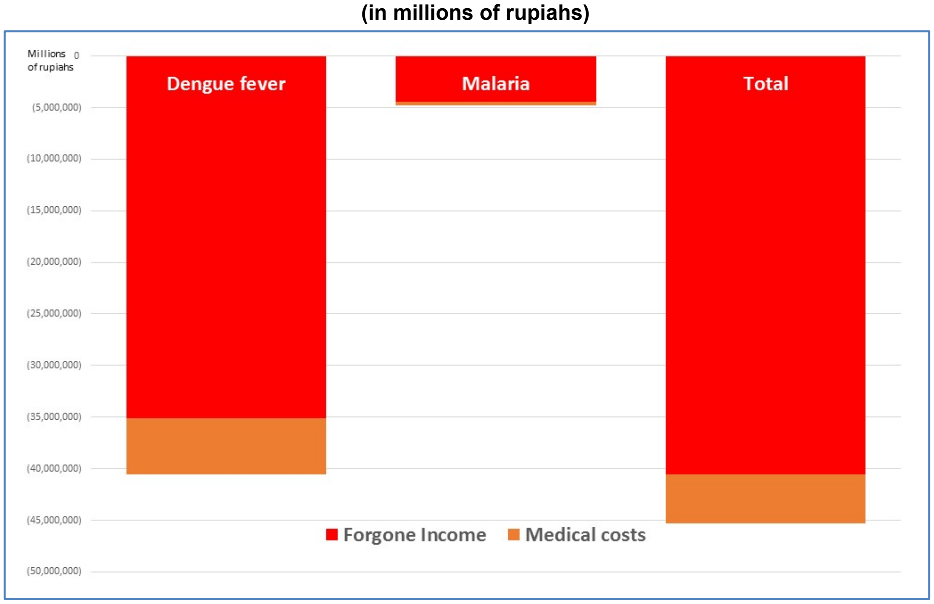
Province	Soybeans	Corn/Maize	Sugarcane / Sugar	Irrigated rice	Rainfed rice	Total, Agriculture
Aceh	(93,616.8)	(909,905.6)	-	(3,018,110.8)	(125,293.8)	(4,146,926.9)
Sumatera Utara	(11,909.9)	5,438,312.9	-	(5,958,230.1)	1,300,382.4	768,555.3
Sumatera Barat	(1,939.3)	2,619,863.7	-	(4,525,805.3)	253,473.0	(1,654,407.9)
Riau	(7,849.8)	174,090.9	(63,287.3)	(829,781.8)	503,239.1	(223,588.8)
Jambi	(8,325.1)	161,149.6	-	(973,569.7)	665,934.1	(154,811.1)
Sumatera Selatan	(18,819.9)	763,597.9	(631,086.6)	(4,592,855.1)	1,483,735.7	(2,995,428.0)
Bengkulu	(5,706.5)	458,640.5	-	(819,672.7)	217,371.9	(149,366.8)
Lampung	(17,032.9)	8,916,072.3	-	(4,374,994.6)	1,319,848.8	5,843,893.7
Kepulauan Bangka Belitung	(15.9)	4,833.1	-	(30,263.8)	67,119.5	41,673.0
Kepulauan Riau	(21.6)	1,260.1	(82,190.6)	(1,882.8)	37.2	(82,797.6)
DKI Jakarta	-	106.1	(225,020.2)	(17,000.5)	-	(241,914.6)
Jawa Barat	(104,042.5)	4,313,762.6	(12,993.6)	(18,969,628.2)	3,928,711.6	(10,844,190.1)
Jawa Tengah	(175,773.4)	(3,037,258.8)	(930,292.8)	(14,414,499.4)	(782,340.1)	(19,340,164.5)
DI Yogyakarta	(41,163.1)	(1,234,752.6)	-	(1,000,724.7)	(1,409,045.0)	(3,685,685.3)
Jawa Timur	(462,368.0)	(4,429,238.1)	-	(16,325,581.7)	(889,598.4)	(22,106,786.3)
Banten	(13,123.0)	80,173.4	-	(2,784,266.4)	755,909.6	(1,961,306.4)
Bali	(8,742.7)	(85,098.4)	-	(1,339,424.3)	(1,979.0)	(1,435,244.4)
Nusa Tenggara Barat	(153,211.2)	2,236,253.8	-	(2,728,641.6)	1,365,709.5	720,110.5
Nusa Tenggara Timur	(3,396.6)	(3,354,005.7)	-	(741,175.4)	(1,040,338.4)	(5,138,916.1)
Kalimantan Barat	(3,970.7)	856,690.3	-	(2,140,918.7)	1,673,435.8	385,236.6
Kalimantan Tengah	(3,647.4)	41,634.6	-	(881,216.5)	1,240,883.2	397,653.9
Kalimantan Selatan	(8,990.0)	590,291.8	-	(3,129,798.6)	1,210,177.2	(1,338,319.6)
Kalimantan Timur (incl. Kal. Utara)	(3,017.2)	46,590.8	-	(753,743.3)	1,007,599.3	297,429.6
Sulawesi Utara	(10,711.1)	(2,253,758.3)	(26,574.2)	(935,468.3)	(286,433.2)	(3,512,945.1)
Sulawesi Tengah	(18,128.9)	674,675.0	-	(1,365,382.6)	126,834.4	(582,002.2)
Sulawesi Selatan	(57,427.2)	7,490,557.9	(26,062.9)	(7,498,829.0)	621,187.4	529,426.2
Sulawesi Tenggara	(7,115.4)	372,150.2	-	(695,164.4)	181,476.8	(148,652.8)
Gorontalo	(5,911.2)	3,538,186.1	-	(450,993.0)	30,800.1	3,112,081.9
Sulawesi Barat	(4,827.1)	502,063.3	-	(489,746.1)	105,143.9	112,634.0
Maluku	(1,364.5)	78,543.2	-	(114,226.1)	26,145.1	(10,902.3)
Maluku Utara	(3,459.8)	131,438.2	-	(99,864.7)	87,316.7	115,430.4
Papua Barat	(1,160.3)	17,838.1	(2,031,006.7)	(58,918.4)	22,692.8	(2,050,554.4)
Papua	(7,704.3)	56,886.5	(218,387.8)	(253,978.1)	63,976.3	(359,207.5)
Indonesia	**(1,264,493.1)**	**24,261,645.3**	**(4,246,902.6)**	**(102,314,356.6)**	**13,724,113.6**	**(69,839,993.5)**

4. RESULTS: HEALTH

The analysis of health impacts focused on dengue fever and malaria because there are plausible ways to establish quantitative links between changes in weather and changes in the probability of these two diseases. The Indonesia Climate Change Roadmap also considered diarrheal diseases. However, the quantitative approach here depends on estimates of the probability of change in disease incidence from gradual climate change. Changes that result primarily from extreme storms are not available and could not be included in this work.

For each of the two diseases, the study looked at forgone income due to illness or premature death and at direct medical expenditure. Estimates of years of life lost to illness – the World Health Organization's so-called disability-adjusted life-years or DALYs – are multiplied by 2012 provincial income per capita to estimate forgone incomes.
Figure 5 shows the overall costs imposed by climate change impacts associated with the incidence of dengue fever and malaria. As the graph shows, dengue fever imposes far greater costs than malaria. Most costs for both diseases are due to forgone income, with direct medical expenditures accounting for only a small amount.

Figure 5. Costs of dengue fever and malaria in 2050
(in millions of rupiahs)



(Note on representing the health costs in tables, figures and charts in this report: While expenditures may in themselves be considered positive, to be able to add them to the forgone income – a negative – and to the changes in value for agriculture and losses from SLR, we have chosen to show all health costs as negative.)

Figure 6 shows the allocation of health-related costs by province. Jakarta incurs the highest costs by far. This is entirely from dengue fever; Ministry of Health figures show that Jakarta has no malaria at all. The high cost of dengue fever in Jakarta is the result of several underlying factors. First, the disease is already a significant and growing problem in Jakarta as it thrives in urban areas. Second, the study on which this analysis is based, which looks at the impact of weather on the incidence of dengue fever in different provinces of Indonesia, finds that changes in rainfall and temperature will have much greater impacts on dengue fever in Jakarta than

elsewhere in the country.[4] Third, per capita incomes in Jakarta are much higher than in most of the rest of the country, so a single lost year of working life has more impact on total costs than it would elsewhere.

Figure 6. Losses in 2050 from health impacts by province
(in millions of rupiahs)

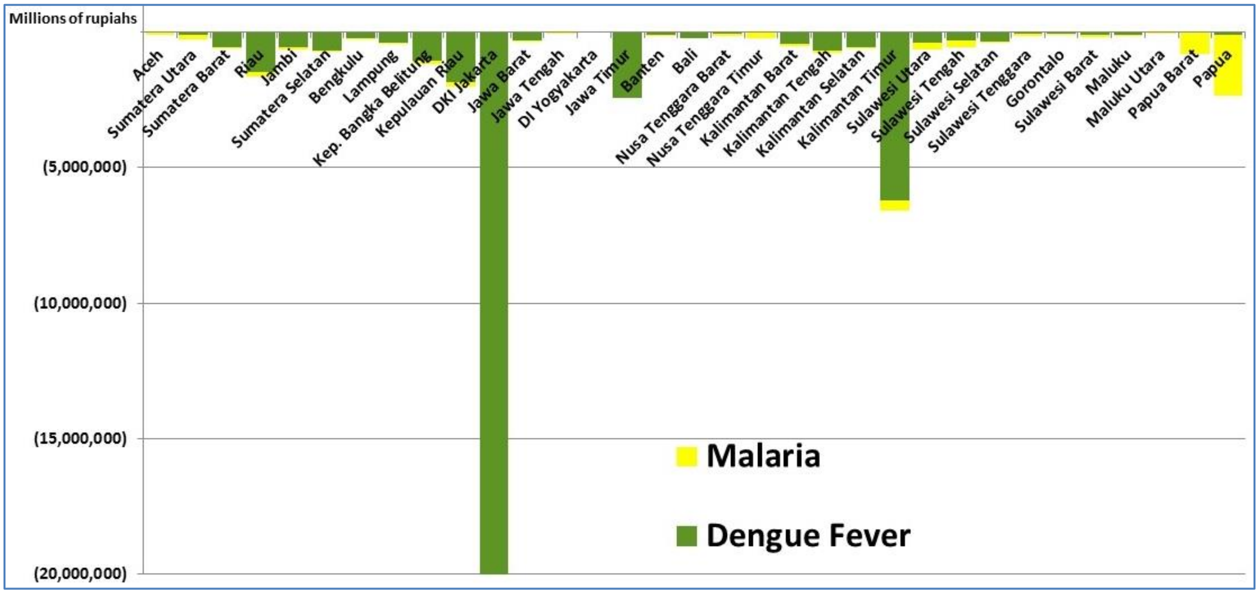


Table 2 provides the data underlying Figure 6. In the table, one can see that dengue fever will actually decline, with resulting economic benefits, in three provinces: Java Tengah, DI Yogyakarta, and Nusa Tenggara Timur. In those provinces, rainfall is expected to decrease with climate change, leading to a decrease in dengue fever. Rainfall is also projected to decrease in Aceh, but the coefficient for the impact of change in rainfall in Aceh is only one-eighth that of the other three provinces (0.001, compared with 0.008). In Aceh, therefore, the decrease in dengue fever resulting from a drop in rainfall is outweighed by the increase resulting from the rise in temperature.

The costs imposed by malaria are much lower than those associated with dengue fever. The analysis of changes in the incidence of malaria is based on standard figures for the temperature and rainfall conditions suitable for transmission of the disease. The study calculated current "person months" of suitability for malaria under historic weather patterns and those projected for 2050 in each province, and based on that, the increase in DALY rates, forgone income, and medical expenditures in 2050. Although a few provinces showed decreases in the length of the malaria season due to less rainfall, in all provinces the incidence of disease and associated costs are expected to rise by 2050. The exceptions are those provinces where at present there is no malaria, despite suitable temperature and weather conditions. As such, no data are shown for these provinces in the malaria column of Table 2. The highest costs by far are in Papua Barat and Papua, which have a very high incidence of the disease at present, combined with

[4] Arcari, Paula, Tapper, Nigel & Pfueller, Sharron. (2007). Regional Variability in Relationships between Climate and Dengue/DHF in Indonesia. *Singapore Journal of Tropical Geography*, 28, 251-272.

fairly high income per capita. Nusa Tenggarah Timur also has a very high incidence of the disease, but because per capita income is much lower, the costs imposed by malaria will be considerably lower than those in Papua Barat and Papua.

Table 2. Costs imposed by climate change in 2050 due to health impacts
(in millions of rupiahs)

PROVINCE	DENGUE FEVER	MALARIA	TOTAL HEALTH
Aceh	(10,958)	(72,365)	(83,323)
Sumatera Utara	(123,887)	(158,506)	(282,393)
Sumatera Barat	(575,372)	(4,084)	(579,456)
Riau	(1,472,666)	(152,836)	(1,625,502)
Jambi	(564,172)	(65,311)	(629,483)
Sumatera Selatan	(706,043)	(24,496)	(730,538)
Bengkulu	(208,282)	(52,176)	(260,458)
Lampung	(403,540)	(14,894)	(418,434)
Kepulauan Bangka Belitung	(1,047,218)	(154,415)	(1,201,633)
Kepulauan Riau	(1,847,984)	(171,239)	(2,019,223)
DKI Jakarta	(20,155,714)	-	(20,155,714)
Jawa Barat	(300,656)	(39,115)	(339,772)
Jawa Tengah	12,417	(30,348)	(17,932)
DI Yogyakarta	17,078	-	17,078
Jawa Timur	(2,444,143)	-	(2,444,143)
Banten	(106,609)	(4,977)	(111,586)
Bali	(228,619)	-	(228,619)
Nusa Tenggara Barat	(52,063)	(74,928)	(126,991)
Nusa Tenggara Timur	24,981	(236,556)	(211,575)
Kalimantan Barat	(428,345)	(76,900)	(505,244)
Kalimantan Tengah	(677,068)	(92,597)	(769,665)
Kalimantan Selatan	(542,753)	(22,773)	(565,526)
Kalimantan Timur	(6,231,726)	(354,673)	(6,586,399)
Sulawesi Utara	(393,226)	(256,941)	(650,167)
Sulawesi Tengah	(309,733)	(256,648)	(566,382)
Sulawesi Selatan	(350,963)	(38,763)	(389,726)
Sulawesi Tenggara	(81,561)	(66,822)	(148,383)
Gorontola	(47,970)	(54,337)	(102,307)
Sulawesi Barat	(85,123)	(116,643)	(201,766)
Maluku	(107,151)	(40,280)	(147,431)
Maluku Utara	(4,599)	(25,536)	(30,135)
Papua Barat	(10,091)	(803,583)	(813,674)
Papua	(91,787)	(2,264,535)	(2,356,322)
Total	**(39,555,542.5)**	**(5,727,279.2)**	**(45,282,821.7)**

While the overall monetary impacts of health problems are much lower than those of agriculture, these are still major costs and represent significant negative effects on the quality of life or on life itself. These results suggest that more research on empirical links between rainfall, temperature, and the incidence of malaria across Indonesia, analogous to the Arcari, Tapper, and Pfueller (2007) work on dengue fever, may be useful to better understand the implications of climate change for disease, as this is important information for preparing the country's public health services to address the impacts of climate change.

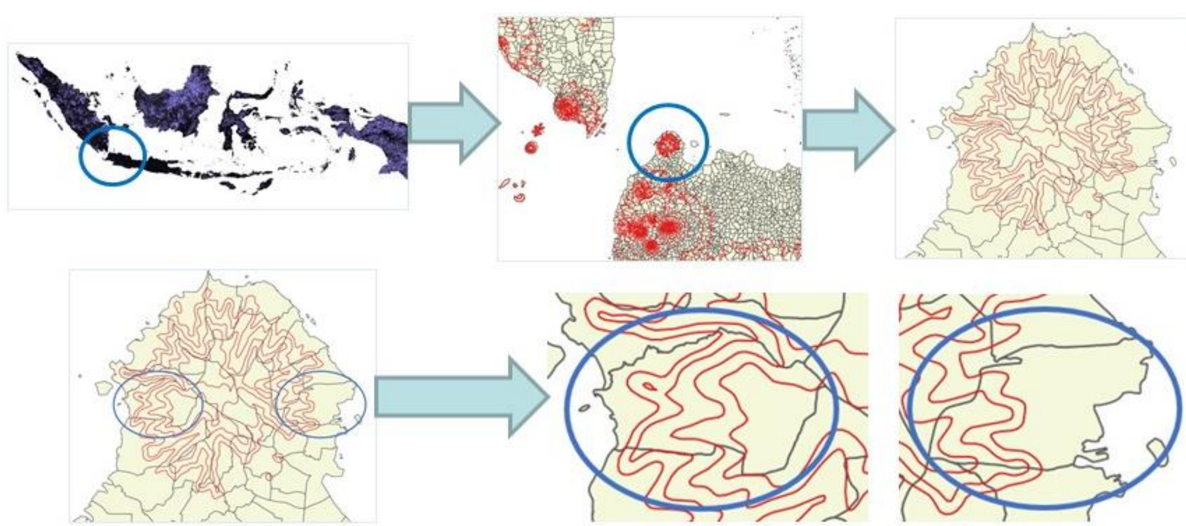
5. RESULTS: SEA LEVEL RISE

The analysis of coastal impacts focuses on long-term gradual sea level rise (SLR) and how it will affect coastal property and economic activity. It includes estimates of forgone earnings from agriculture, forgone earnings from aquaculture, and forgone annual value of industrial, office, and residential properties submerged. It was not possible to estimate the losses due to extreme storms because no information is available on the probability of such storms of any given magnitude in different parts of Indonesia. The study does not assess the macroeconomic or multiplier implications of lost roads, ports, or other key infrastructure, as this goes beyond the scope of this rapid assessment. Both of these issues are very important, and will probably impose greater costs than gradual SLR, however, they should be the subject of separate study.

The analysis of losses in agriculture and aquaculture due to SLR is fairly straightforward. The area expected to flood by 2050 was mapped and overlaid with land use/land cover data for Indonesia. This enabled a calculation of how much agricultural land, rice paddy, and brackish ponds used for aquaculture would be lost due to the flooding. Using data on incomes from crops, rice, and brackish-pond aquaculture, the total income lost in 2050 due to flooding was calculated.

Figure 7. Analyzing sea level rise in a Geographic Information System (GIS)

This image shows the progression of spatial analysis in a geographic information system from country to province to local level. Contour lines along the coast can be used to determine what would be flooded with a certain rise in sea level. The village on the right has much more land closer to sea level than does the one on the left and therefore would lose more land to sea level rise.

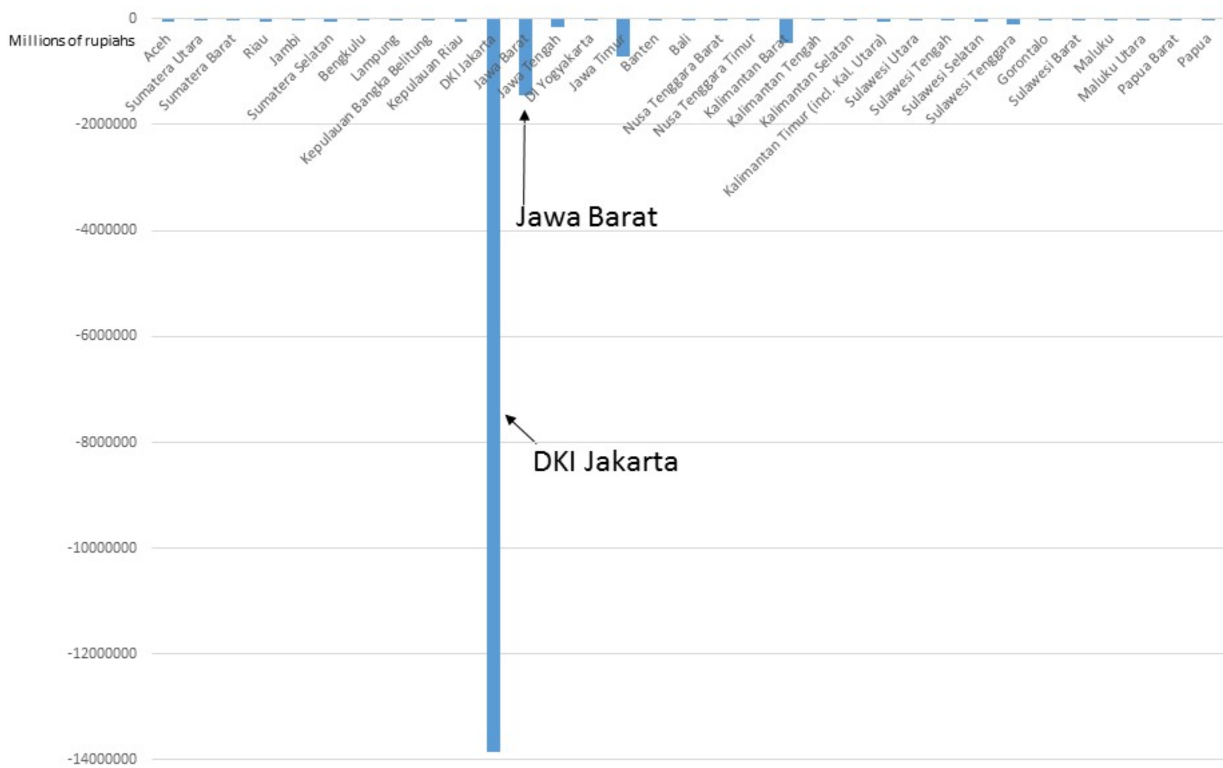


The analysis of losses of urban property and rural homes is much more complex, because of the challenge of determining what kinds of property might be flooded and what those properties will be worth. For urban properties, the data used were from Colliers International, a global real

estate company that publishes reports on Jakarta and Surabaya (a port city on the Indonesian island of Java).[5] As a proxy for the value of rural homes, the compensation paid for homes lost in the Aceh tsunami of 2004 was used. By relating property values to population density, the research team estimated a per-hectare value for residential, industrial, and office properties and calculated the value of flooded land in each province. This was then converted from a capital value to a forgone income stream in 2050, so that these results could be compared with the losses from agriculture and aquaculture.

Figure 8 shows the results of these calculations; the underlying data are shown in Table 3. Not surprisingly, the lost income from urban properties accounts for most losses due to SLR: Rp 14,406,695 million out of a total of Rp 17,198,244 million, or 84 percent. Equally unsurprising is that property losses in Jakarta account for Rp 13,844,737 million, or 96 percent of the urban property losses and 81 percent of all losses due to SLR. Jawa Barat, which is projected to be entirely urban by 2050, comes a very distant second in losses of property income, at Rp 375,123 million.

Figure 8. Losses in 2050 from sea level rise, by province
(in millions of rupiahs)



5 http://www.colliers.com/en-gb/asia

Perhaps more surprising is that office values exceed residential or industrial ones. The Colliers data show office prices (rental or purchase) to be somewhat higher than residential prices and much higher than industrial prices, which is one factor in this result. It is probably also due to assumptions made in the analysis concerning the share of each property type in the flooded area, the heights of different kinds of buildings, and percent of land per hectare covered with marketable space.

After property losses, the biggest losses from flooding come from decreased production of rice. This reflects the importance of rice in land use and the importance of paddy in coastal areas flooded – more than six times the share of other cropped land. The only land categories that have greater representation in the flooded area are those necessarily by the sea: salt flats and brackish ponds.

As already mentioned, coastal flooding relates to both extreme storms and long-term SLR. Gradual SLR to 2050 is predictable, but extreme storms may impose high costs and destroy properties near the coast before 2050. From an adaptation perspective, of course, the problem is that the timing, magnitude, and location of extreme events are difficult to predict, and the probability of one occurring in any specific place at any given time is assumed to be low.

If it is not possible to estimate the probability of an extreme storm in any given place, one way to analyze possible impacts is simply to determine what would flood in a storm surge of a given height, without knowing how likely it actually is. Knowing what will flood, it is possible to estimate both direct losses and, if the models can be built, indirect losses through economic multiplier effects. This would give the loss from one storm. To prioritize the choice of areas for investment in adaptation and assess how much investment is appropriate, however, it would be valuable to know how likely it is that a storm surge of a given height would actually occur in different parts of the country. Even not knowing how likely a storm is to occur, knowing what would be lost would still provide a very useful base for policy choices.

Table 3. Value of losses in 2050 due to sea level rise
(in millions of rupiahs)

PROVINCE	AGRICULTURE		AQUACULTURE		SETTLEMENTS				TOTAL
	Crops	Rice	Brackish ponds	Paddy	Urban residence	Urban industrial	Urban office	Rural homes	
Aceh	(74)	(29,278)	(13,156)	(15)	(274)	(169)	(489)	(3,848)	(47,302)
Sumatera Utara	(1,301)	(24,720)	(141)	(65)	(484)	(299)	(864)	(997)	(28,872)
Sumatera Barat	(253)	(5,874)	-	(16)	(252)	(156)	(450)	(310)	(7,313)
Riau	(118)	(26,899)	-	-	(2,909)	(1,796)	(5,190)	(12,777)	(49,689)
Jambi	(46)	(34,568)	-	(1)	(411)	(253)	(732)	(2,716)	(38,728)
Sumatera Selatan	(250)	(44,144)	(250)	(130)	(2,492)	(1,538)	(4,445)	(10,669)	(63,918)
Bengkulu	(20)	-	-	-	(24)	(15)	(42)	(30)	(131)
Lampung	(451)	(717)	(1,072)	(0)	(364)	(225)	(650)	(1,787)	(5,265)
Kep, Bangka Belitung	(1)	(45)	-	-	(85)	(53)	(152)	(184)	(520)
Kepulauan Riau	(105)	-	-	-	(13,891)	(8,574)	(24,780)	(7,127)	(54,478)
DKI Jakarta	(2)	-	-	-	(4,070,699)	(2,512,518)	(7,261,520)	-	(13,844,738)
Jawa Barat	(368)	(752,743)	(313,481)	(1,746)	(110,295)	(68,077)	(196,751)	-	(1,443,460)
Jawa Tengah	(9,771)	(60,866)	(63,258)	(24)	(3,043)	(1,878)	(5,429)	(8,839)	(153,108)
DI Yogyakarta	(3)	(224)	-	(0)	-	-	-	(7)	(234)
Jawa Timur	(147,217)	(395,432)	(82,550)	(277)	(19,030)	(11,746)	(33,947)	(21,139)	(711,339)
Banten	(49)	(1,038)	(4,601)	(0)	(2,538)	(1,567)	(4,528)	(301)	(14,623)
Bali	(45)	(686)	-	(0)	(1,372)	(847)	(2,448)	(61)	(5,459)
NT Barat	(4,779)	-	(55)	-	(793)	(489)	(1,414)	(2,585)	(10,114)
NT Timur	(159)	(5)	(9)	(0)	(145)	(90)	(259)	(494)	(1,161)
Kalimantan Barat	(5)	(411,478)	(55,628)	-	(78)	(48)	(140)	(547)	(467,924)
Kalimantan Tengah	-	-	(3,269)	-	(35)	(22)	(63)	(1,270)	(4,659)
Kalimantan Selatan	(35)	-	(41)	-	(334)	(206)	(596)	(3,078)	(4,291)
Kalimantan Timur	(1)	(7,124)	(30,700)	(0)	(840)	(518)	(1,498)	(1,444)	(42,127)
Sulawesi Utara	(219)	(33)	(80)	(1)	(553)	(341)	(986)	(586)	(2,799)
Sulawesi Tengah	(97)	(5,981)	(10,173)	(0)	(312)	(193)	(557)	(2,759)	(20,073)
Sulawesi Selatan	(723)	(1,474)	(51,700)	(1)	(718)	(443)	(1,281)	(691)	(57,032)
Sulawesi Tenggara	(293)	(37,615)	(53,711)	(1)	(2,669)	(1,647)	(4,760)	(3,089)	(103,783)
Gorontalo	(1,097)	(139)	(312)	(1)	(74)	(45)	(131)	(267)	(2,066)
Sulawesi Barat	(100)	(2,040)	(135)	-	-	-	-	(144)	(2,419)
Maluku	(59)	-	-	-	(625)	(386)	(1,115)	(2,657)	(4,842)
Maluku Utara	(386)	-	-	-	(300)	(185)	(535)	(1,317)	(2,724)
Papua Barat	(8)	-	-	-	(241)	(149)	(430)	(1,169)	(1,998)
Papua	(1)	(0)	-	-	(46)	(28)	(81)	(899)	(1,055)
Indonesia	**(168,036)**	**(1,843,123)**	**(684,322)**	**(2,278)**	**(4,235,929)**	**(2,614,501)**	**(7,556,265)**	**(93,789)**	**(17,198,244)**

6. COMPARISON ACROSS PROVINCES

The impacts of climate change vary substantially across provinces. Figures 9 and 10 show that variation, comparing total and per capita impacts at the provincial level, respectively. Table 4 provides the data underlying these figures, enabling one to see more detail. The figures make it very clear which provinces are most positively affected – Lampung and Gorontalo – and which are most harmed: Jakarta and other provinces on Java Island. These figures also clearly show how much agriculture dominates the impact in all provinces except Jakarta. On the other hand, Figure 11 shows the per cent gain and loss versus prevailing incomes. Clearly, the same size loss in rupiahs to a person in the poorest provinces is more devastating than the same rupiahs lost in a province with a high income such as Jakarta. Finally, Figure 12 shows the total impact per province versus the entire 2013 budget (revenue) of each provincial government. The average of these is about 2/3 which would be a significant sum.

The harm to Jakarta accounts for more than 25 percent of total costs nationwide. As Figure 9 shows, this is in part because of the financial losses from SLR, since its property values are the highest in the country. It also bears most of the burden of dengue fever (a greater cost), both because the disease flourishes in densely-populated urban areas and because the resulting forgone incomes are the highest in the country.

In all areas of the country, more detailed analysis is needed to identify priorities for investments to prevent harm from extreme storms. This should be a priority in Indonesian work to establish priorities for climate change adaptation. Future analysis of the impacts of extreme storms must consider not only the direct loss of property but also the repercussions of those losses for the country as a whole. Economic research has shown that some impacts, such as flooding of the international airport in Jakarta, would impose costs far beyond the investments required to prevent them.

Jawa Timur, Jawa Tengah, and Jawa Barat account for 19 percent, 15 percent, and 9.5 percent of total costs, respectively. In these provinces, most losses are in agriculture, particularly due to decreased yields from irrigated rice. Portions of Jawa Barat close to Jakarta will certainly lose property of significant value due to SLR; however, since results cannot be disaggregated at a sub-provincial level, this effect cannot be identified separately.

Two provinces could be significant economic beneficiaries of climate change, based on this analysis: Lampung and Gorontalo. In both cases, this is the result of increased corn output and, to a lesser extent, increased output of rainfed rice, combined with low losses in other areas of impact. As a result, the net impact is significantly positive there.

The differences between total impact and impact per capita in some provinces, notably Gorontalo (positive) and Nusa Tenggara Timur (negative), are the result of their relatively small projected populations in 2050. Similarly, Jakarta has a large potential loss but it is smaller per capita because of the large population and small relative to the per capita income which is high.

Figure 9. Total impacts of climate change by province
(in millions of rupiahs)

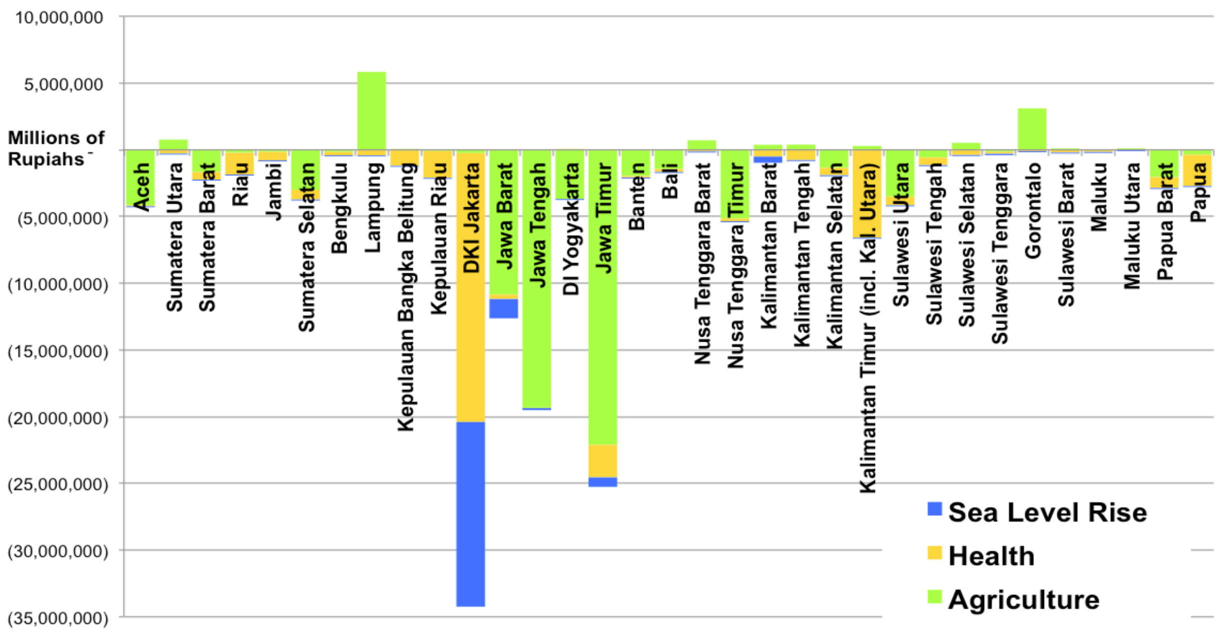


Figure 10. Per capita impacts of climate change by province
(in rupiahs)

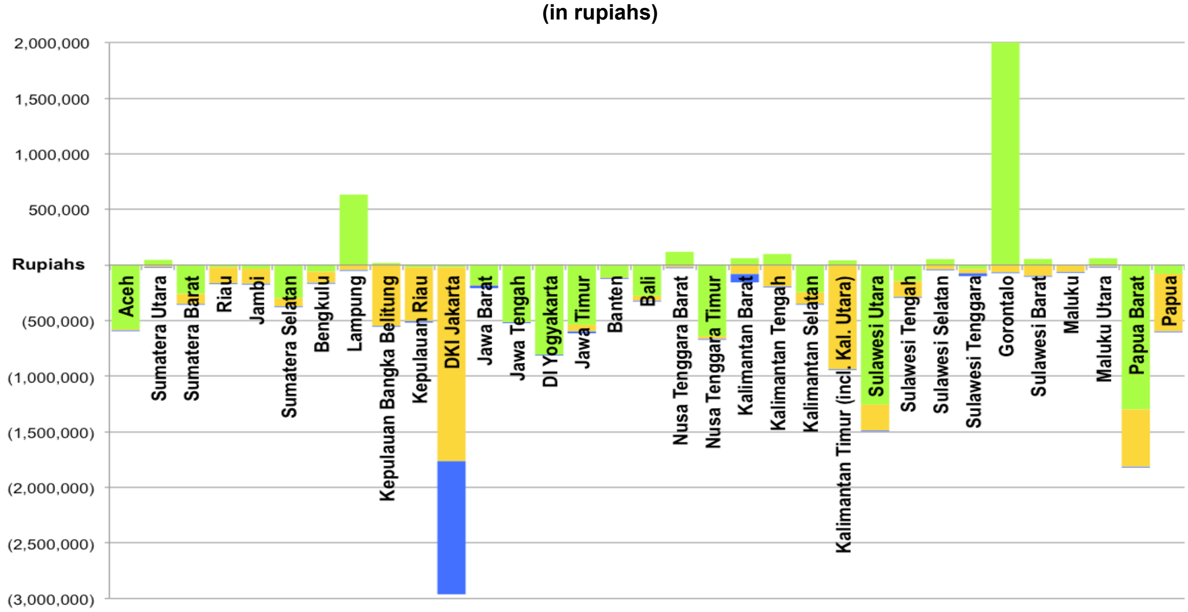


Figure 11. Percent gains and losses in income per capita by province
(in percent)

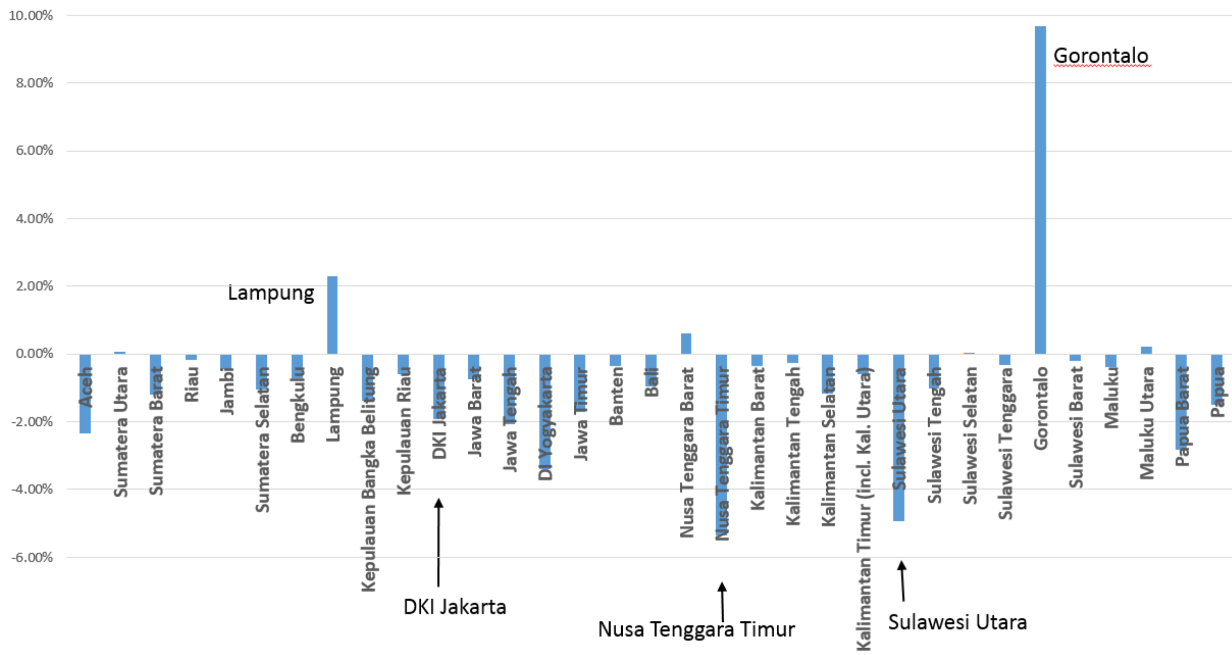


Figure 12. Impact of climate change compared to provincial budget revenues
(in percent)

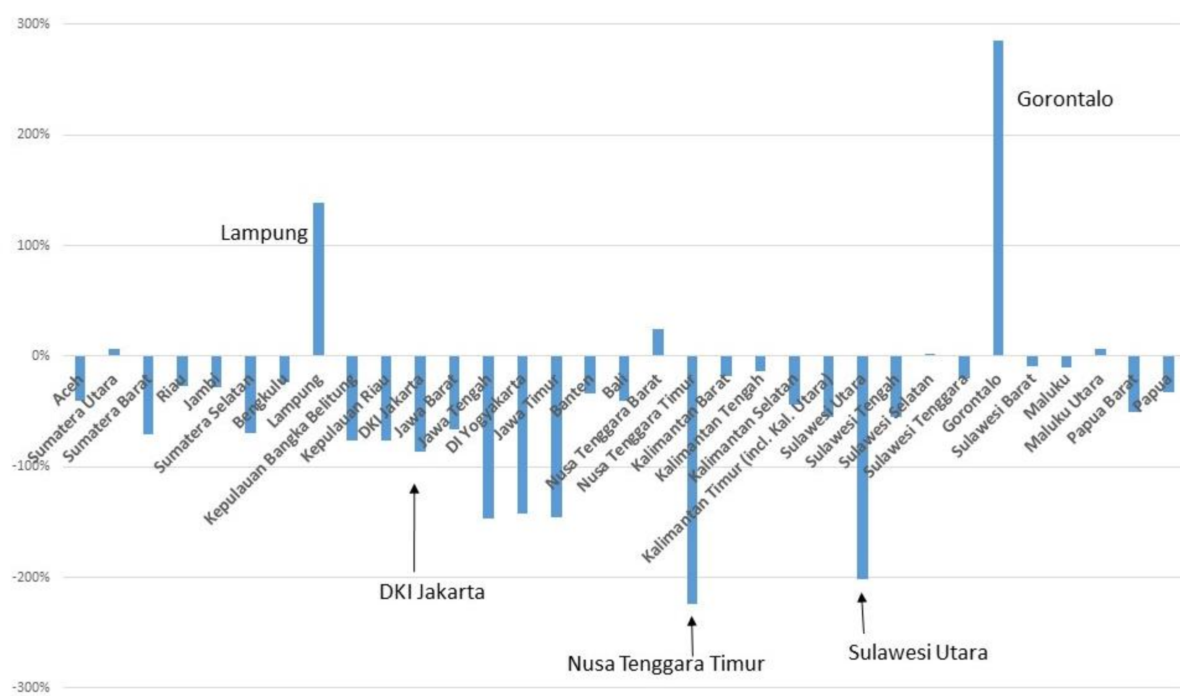


Table 4. Total and per capita monetary impacts of climate change in 2050 by province

	Total (millions of rupiahs)				Per capita (rupiahs)			
Province	**Agriculture**	**Health**	**Sea Level Rise**	**Total Impacts**	**Agriculture**	**Health**	**Sea Level Rise**	**Total Impacts**
Aceh	-4,146,927	-83,323	-47,302	-4,277,552	-576,386	-11,581	-6,575	-594,542
Sumatera Utara	768,555	-282,393	-28,872	457,291	46,706	-17,161	-1,755	27,790
Sumatera Barat	-1,654,408	-579,456	-7,313	-2,241,177	-259,411	-90,859	-1,147	-351,416
Riau	-223,589	-1,625,502	-49,689	-1,898,780	-19,863	-144,401	-4,414	-168,678
Jambi	-154,811	-629,483	-38,728	-823,022	-33,177	-134,904	-8,300	-176,381
Sumatera Selatan	-2,995,428	-730,538	-63,918	-3,789,884	-299,029	-72,928	-6,381	-378,338
Bengkulu	-149,367	-260,458	-131	-409,956	-58,687	-102,335	-51	-161,073
Lampung	5,843,894	-418,434	-5,265	5,420,194	634,340	-45,420	-572	588,349
Kepulauan Bangka Belitung	41,673	-1,201,633	-520	-1,160,480	18,994	-547,677	-237	-528,921
Kepulauan Riau	-82,798	-2,019,223	-54,478	-2,156,499	-19,895	-485,183	-13,090	-518,168
DKI Jakarta	-241,915	-20,155,714	-13,844,738	-34,242,367	-20,925	-1,743,414	-1,197,532	-2,961,870
Jawa Barat	-10,844,190	-339,772	-1,443,460	-12,627,421	-179,261	-5,617	-23,861	-208,739
Jawa Tengah	-19,340,164	-17,932	-153,108	-19,511,204	-513,999	-477	-4,069	-518,544
DI Yogyakarta	-3,685,685	17,078	-234	-3,668,841	-806,565	3,737	-51	-802,879
Jawa Timur	-22,106,786	-2,444,143	-711,339	-25,262,268	-537,514	-59,428	-17,296	-614,238
Banten	-1,961,306	-111,586	-14,623	-2,087,515	-110,417	-6,282	-823	-117,522
Bali	-1,435,244	-228,619	-5,459	-1,669,322	-276,985	-44,121	-1,053	-322,159
Nusa Tenggara Barat	720,110	-126,991	-10,114	583,006	118,759	-20,943	-1,668	96,148
Nusa Tenggara Timur	-5,138,916	-211,575	-1,161	-5,351,652	-638,386	-26,283	-144	-664,813
Kalimantan Barat	385,237	-505,244	-467,924	-587,932	61,896	-81,178	-75,181	-94,463
Kalimantan Tengah	397,654	-769,665	-4,659	-376,670	99,690	-192,951	-1,168	-94,429
Kalimantan Selatan	-1,338,320	-565,526	-4,291	-1,908,137	-245,911	-103,913	-788	-350,613
Kalimantan Timur (incl. Kal. Utara)	297,430	-6,586,399	-42,127	-6,331,096	42,333	-937,446	-5,996	-901,109
Sulawesi Utara	-3,512,945	-650,167	-2,799	-4,165,911	-1,256,385	-232,528	-1,001	-1,489,914
Sulawesi Tengah	-582,002	-566,382	-20,073	-1,168,457	-145,992	-142,074	-5,035	-293,101
Sulawesi Selatan	529,426	-389,726	-57,032	82,669	53,512	-39,392	-5,764	8,356
Sulawesi Tenggara	-148,653	-148,383	-103,783	-400,819	-37,157	-37,090	-25,942	-100,189
Gorontalo	3,112,082	-102,307	-2,066	3,007,709	2,019,447	-66,388	-1,341	1,951,719
Sulawesi Barat	112,634	-201,766	-2,419	-91,551	54,699	-97,985	-1,175	-44,460
Maluku	-10,902	-147,431	-4,842	-163,175	-4,320	-58,415	-1,918	-64,653
Maluku Utara	115,430	-30,135	-2,724	82,572	61,047	-15,937	-1,441	43,669
Papua Barat	-2,050,554	-813,674	-1,998	-2,866,226	-1,299,195	-515,529	-1,266	-1,815,989
Papua	-359,207	-2,356,322	-1,055	-2,716,584	-79,011	-518,292	-232	-597,535
Indonesia	**-69,839,993**	**-45,282,822**	**-17,198,244**	**-132,321,059**	**-215,545**	**-139,755**	**-53,078**	**-408,378**

7. FINDINGS AND RECOMMENDATIONS

Agriculture, health, and sea level rise are three areas of impact that represent major aspects of the Indonesian economy and society. The five crops studied account for a significant share of the value of food crops, while the two diseases analyzed are those expected to be most affected by climate change. The climate change scenario used is an average of all international climate models for middle-of-the-road assumptions about greenhouse gas emissions. Although this study presents only one projection of the impacts of climate change among many possibilities, and hence is neither comprehensive nor exact, it provides valid insight into the possible future and valuable direction for further analysis.

Findings:

- The total costs imposed on Indonesia in 2050 by climate change in these three areas of impact are estimated at 132 trillion Indonesian rupiahs which, at present prices, would be 1.4 per cent of today's Indonesian economy as measured by GDP. The greatest financial impact of climate change will be due to decreased agricultural output, which accounts for 53 percent of this cost. Health impacts account for 34 percent, while gradual SLR accounts for 13 percent of the projected costs.

- The overall negative impacts of climate change will fall disproportionately on Jakarta, the capital, which will experience 25 percent of the total projected costs through the combined effects of dengue fever and SLR. Jawa Timur, Jawa Tengah, and Jawa Barat provinces account for 19 percent, 15 percent, and 9.5 percent of total costs, respectively; these losses are overwhelmingly agricultural.

- Not all impacts are negative. While total agricultural impacts are negative nationwide, the value of agricultural output is expected to rise in some provinces due to increased rainfall which could, under favorable conditions and with other measures, lead to more production of certain crops. This effect is most pronounced in Lampung and Gorontalo provinces.

- In per capita terms, Lampung and Gorontalo provinces are potentially the biggest beneficiaries; the effect is more pronounced in Gorontalo because of its small population. Jakarta will see the biggest losses in per capita terms, along with Sulawesi Utara and Papua Barat provinces, both of whose small populations mean that their losses fall more heavily on each resident than would be apparent from their total provincial loss.

- Most costs imposed by health impacts come from an increase in dengue fever, typically an urban disease. More than half of that impact will occur in Jakarta, where the incidence of the disease is expected to grow rapidly.

- Effects of SLR will be felt nationwide, but the greatest costs imposed by gradual rise will occur primarily in Jakarta due to the high property values of the capital region.

Recommendations:

- In general, the GOI should discuss these results with provincial authorities to inform local planning and budgeting. Climate change will have implications for agriculture, health, infrastructure, and general development in both expenditures and revenues.

- When considering adaptation strategies for these sectors the benefits and costs of various actions should be considered in the context of the costs shown here.

- In each province, policy makers and agriculture interests should look for opportunities to benefit from climate change, encouraging growth of crops that will do well under the new conditions and investing in water control and irrigation infrastructure to take advantage of where rainfall may increase. This study alone may not be sufficient to say that policy makers should immediately encourage corn production in Lampung and Gorontalo provinces, but at both the national and provincial level, understanding where the opportunities will emerge is important, especially given that the climate will not change equally everywhere.

- The responsible authorities should plan now to avoid or alleviate the clear significant negative consequences for Jakarta associated with dengue fever. Similarly, in many provinces the conditions for malaria will worsen and authorities should be planning or initiating programs for this. More research should be carried out on links between disease and climate, including not only of the expected increased incidence but also of the possibility that some changes in climate may actually hinder the spread of certain diseases in some locations. More detailed research on malaria along the lines of the study used to analyze dengue fever would be particularly important.

- Actions against gradual SLR must be chosen carefully: The study shows negative effects of SLR nationwide, but the costs foreseen are almost all incurred in urban areas where property is much more valuable and adaptation will be most costly. Both policy makers and private investors working on shoreline development should be extremely interested in this. It is unlikely that large-scale protective infrastructure would be cost-effective anywhere except possibly in Jakarta or other very large and economically valuable urban areas. Such a cost-benefit analysis was done before the decision was made to build the National Capital Integrated Coastal Development (NCICD) sea wall for Jakarta that is now under construction.

- Extreme storms and weather pose a great economic threat: Analysis of the probability of extreme storms in different parts of the country would be very valuable in identifying the costs they will impose and setting priorities for investments in adaptation. To the extent that the fields of climatology and oceanography can shed light on this issue, investments in

further research will be essential. Policy makers must order more detailed analysis of the impacts of extreme storms on large urban areas, particularly Jakarta. In particular, work that can consider the macroeconomic or multiplier implications of the loss of key urban infrastructure will be essential to set priorities for investments in adaptation or strategies to minimize the harm caused by such storms. The private sector must anticipate these problems as well; every company whose business relies on transportation through the harbor or airport should create plans for continuity of its operations in the face of such extreme storms.

- To identify optimal implementable policy responses much more information is needed on certain aspects. In particular, more work is crucial on links between climate change and agricultural yields given the huge monetary impacts involved. The wide range of impacts on agriculture found here are dependent on a single piece of research. It is essential for Indonesia to invest in more research on links between climate and agriculture, considering a wider range of crops and more areas of the country. Moreover, the research and this study point to the varying effects in different locations; a more comprehensive understanding of this geographic variation across this vast country would be valuable to design provincial or local adaptation responses.

- Work on the probability of extreme storms and the costs they would impose in different parts of the country is also very important, particularly the macroeconomic implications of flooding on nationally important transportation infrastructure in Jakarta. More generally, flooding and drought have direct costs and multiplier effects throughout the economy and these should be studied.

- Indonesia cannot wait until 2050 to act: This study projects the situation in 2050 in specific areas of impact under specific parameters. As climate change is gradual, it may be assumed that the conditions described for 2050 will evolve between now and then, and that Indonesia will increasingly and inexorably experience the costs and benefits each year. This means that policy makers should not wait until the future to implement changes that either lessen or take advantage of the impacts.

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