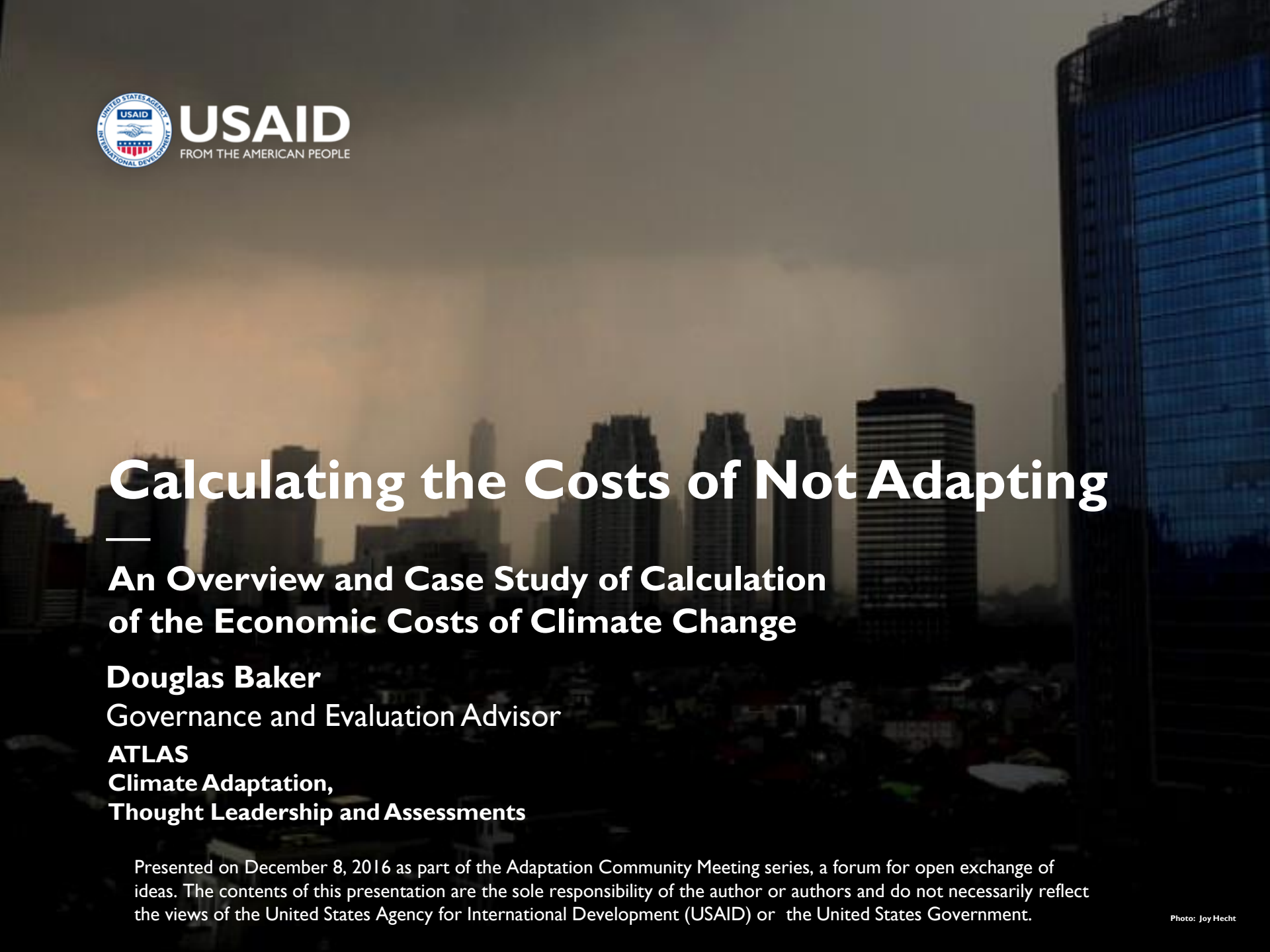

USAID
FROM THE AMERICAN PEOPLE

Calculating the Costs of Not Adapting

An Overview and Case Study of Calculation of the Economic Costs of Climate Change

Douglas Baker
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ATLAS
Climate Adaptation,
Thought Leadership and Assessments

Presented on December 8, 2016 as part of the Adaptation Community Meeting series, a forum for open exchange of ideas.

Photo: Joy Hecht

PRESENTATION TODAY

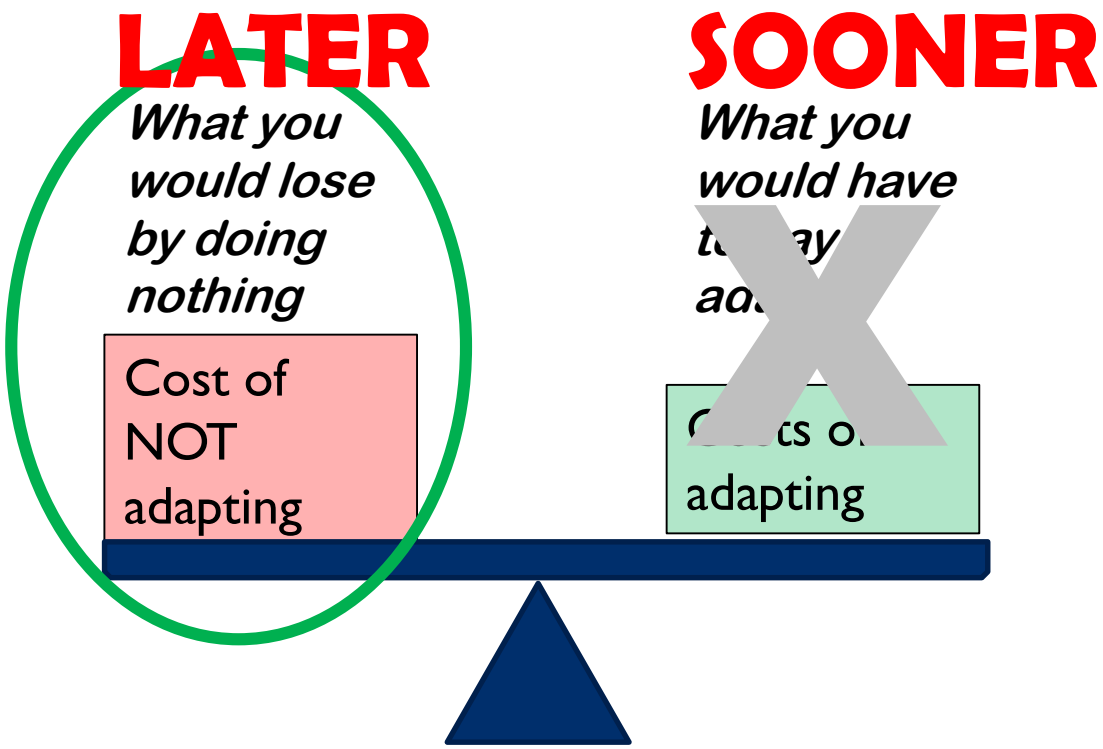
Part One Economic Cost of Climate Change Basic Questions:

What do we mean by ECCC?
What is Economic Cost vs Other Costs?
Why would we want to calculate this?
Where have these studies been done?
How does one do these calculations?
What does it all mean?
Who would do these studies?
Who would use this information?

Part Two ATLAS Case Study:

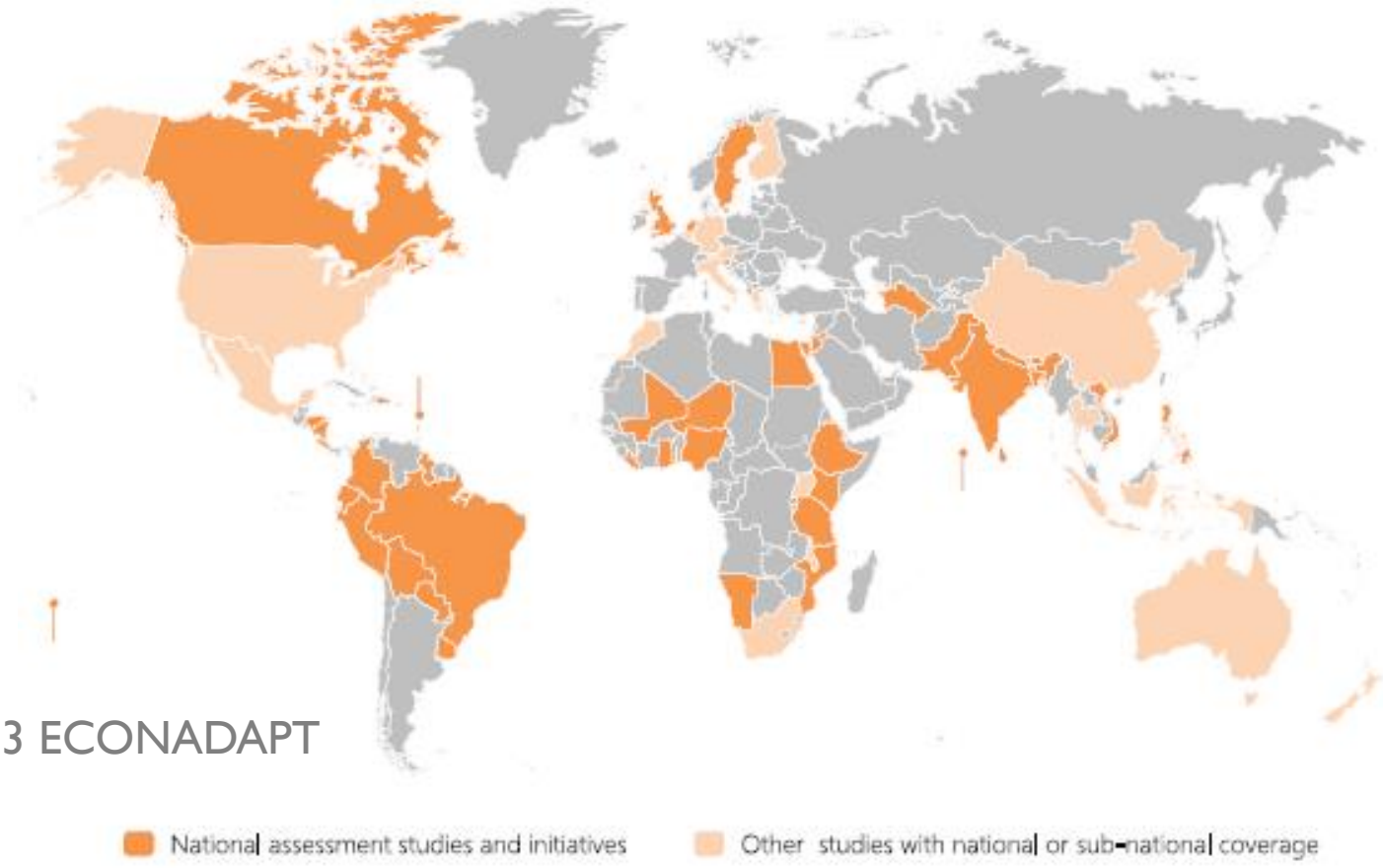
Economic Assessment of Climate Risk in Indonesia

CALCULATING COSTS OF CLIMATE CHANGE BEFORE THE COSTS OF ADAPTATION

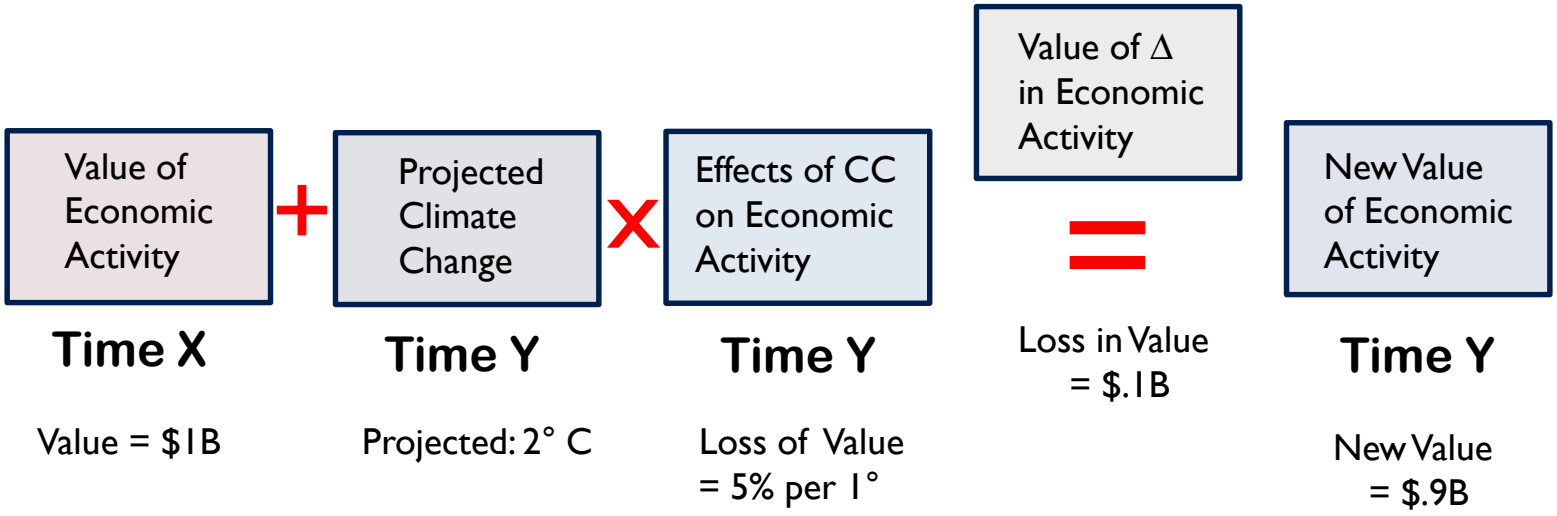


WHERE HAVE THESE STUDIES BEEN DONE?

Both developed and developing countries or regions



WHAT IS INVOLVED IN CALCULATING ECCC?



But it is not that simple with many sectors, many products, many effects, and many changes, all happening over time!

WHAT DATA ARE NEEDED FOR CALCULATING?

Value of Economic Activity

- GDP by sectors: agriculture, manufacturing, fishing, tourism, raw materials
- Value of sales and trends
- Population and projected change

+

Projected Climate Change

- IPCC projections of physical conditions according to emissions scenarios
- Studies typically choose a "middle-of-the-road" scenario though some also do "worst-case scenario"
- "Downscaled" as much as possible given cost and accuracy of data

X

Effects of CC on Economic Activity

- Effect of change in temperature or in rainfall on crops or other natural resources
- Effect of change on other natural resources related to tourism.
- Effect of sea level rise on coastal communities and activities

=

Value of Δ in Economic Activity

- Actual application of likely effect to each economic activity
- Assume certain likely changes such as population but not assume breakthroughs
- Check against the *Real World*

WHAT WOULD BE AN EXAMPLE?

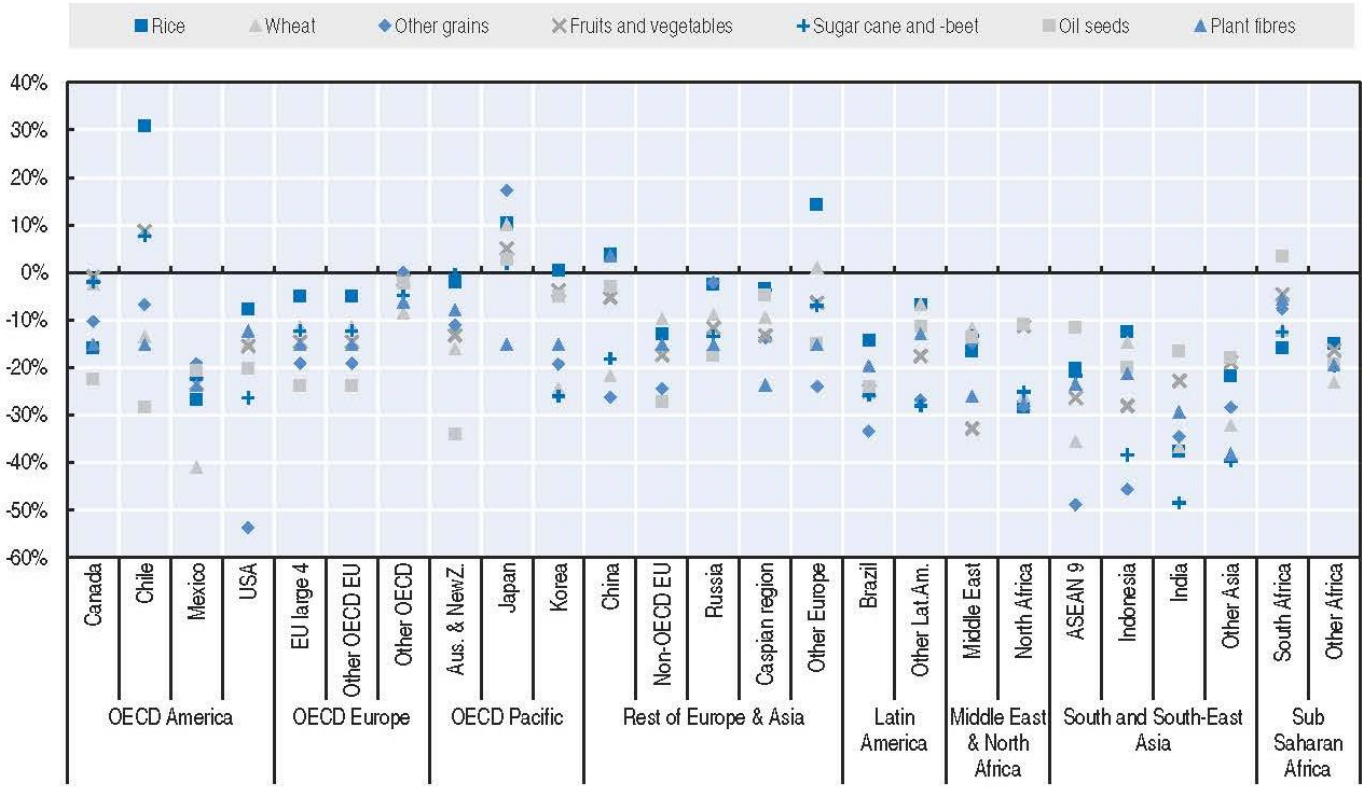
Value of Economic Activity + Projected Climate Change x Effects of CC on Economic Activity

In Agriculture, Value = Yield x Price

The Economic Consequences of Climate Change OECD 2015

Figure 1.2. **Impacts of climate change on crop yields in the central projection**

Percentage change in yields in 2050 relative to current climate



Source: IMPACT model, based on the AgMIP study (Von Lampe et al., 2014).

StatLink http://dx.doi.org/10.1787/888933275901

WHAT KINDS OF ECCC HAVE BEEN DONE?

Market and Non-Market

The Economic Consequences of Climate Change OECD 2015

Table 1.1. **Categories of climate impacts considered in this study**

AGRICULTURE	Changes in crop yields (incl. cropland productivity and water stress)	Modelled
	Livestock mortality and morbidity from heat and cold exposure	Qualitatively
	Changes in pasture- and rangeland productivity	Stand-alone
	Changes in aquaculture productivity	Qualitatively
	Changes in fisheries catches	Modelled
COASTAL ZONES	Loss of land and capital from sea level rise	Modelled
	Non-market impacts in coastal zones	Qualitatively
EXTREME EVENTS	Mortality, land and capital damages from hurricanes	Modelled
	Mortality, land and capital damages from floods	Stand-alone
HEALTH	Mortality from heat exposure (incl. heatwaves)	Stand-alone
	Morbidity from heat and cold exposure (incl. heatwaves)	Modelled
	Mortality and morbidity from infectious diseases, cardiovascular and respiratory diseases	Modelled
ENERGY DEMAND	Changes in energy demand for cooling and heating	Modelled
TOURISM DEMAND	Changes in tourism flows and services	Modelled
ECOSYSTEMS	Loss of ecosystems and biodiversity	Stand-alone
	Changes in forest plantation yields	Qualitatively
WATER STRESS	Changes in energy supply	Qualitatively
	Changes in availability of drinking water to end users (incl. households)	Qualitatively
HUMAN SECURITY	Civil conflict	Qualitatively
	Human migration	Qualitatively
TIPPING POINTS	Large scale disruptive events	Stand-alone

Note: "Modelled" implies that the impact is captured (at least partially) in the main modelling framework; "stand-alone" refers to a quantitative assessment outside the main modelling framework, and "qualitatively" implies only a qualitative assessment was possible in this report.
Source: Own compilation.

Costing the Impacts of Climate Change in the UK: Implementation Guidelines Final Report

Marketed goods or services:
- **coastal** zones
- **water** resources
- **agriculture**
- buildings and **infrastructure**.

Non-marketed goods or services:
- habitats and biodiversity
- human **health**
- recreation and amenity
- cultural objects
- leisure and working time
- non-use benefits.

Which Sectors are Common?

The Mozambique EACC study selected four sectors believed to be vulnerable to climate change: (1) **agriculture**, which employs over 70 percent of the population; (2) **energy**, particularly hydropower generation, which is dependent on water runoff; (3) transport **infrastructure**, notably roads; and (4) **coastal** areas, which do not conform to a "sector" but characterize specific geographical areas vulnerable to floods and storm surges directly and indirectly related to sea level rise.

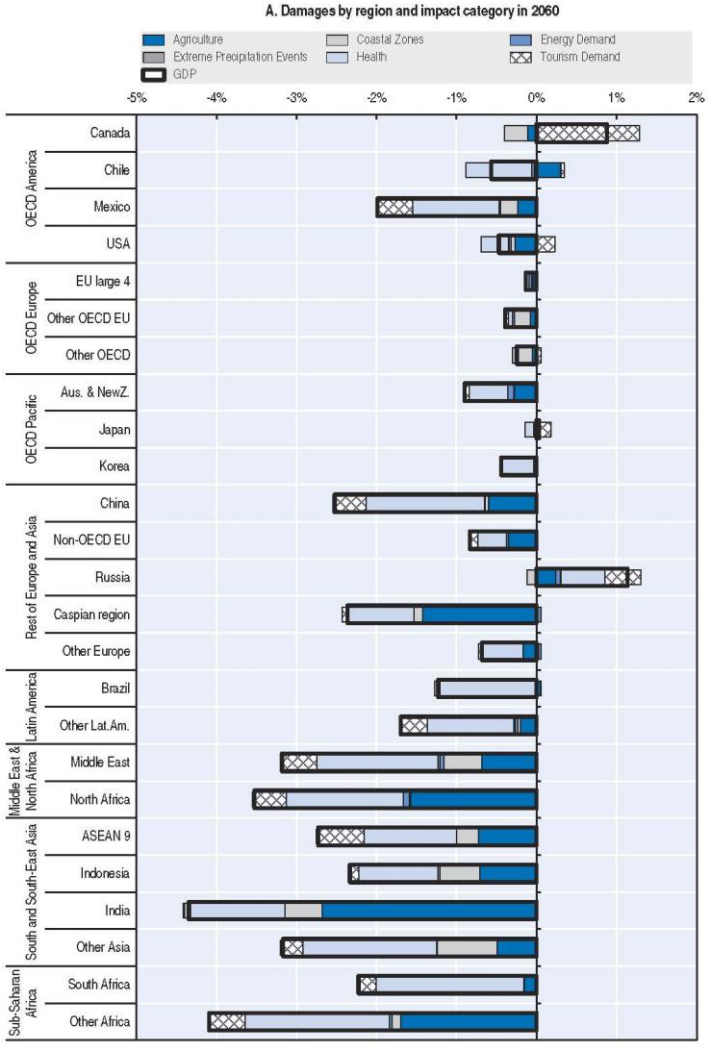
WHAT HAVE BEEN SOME RESULTS FOUND?

WHAT HAVE BEEN SOME RESULTS FOUND?

The Economic Consequences of Climate Change OECD 2015

Figure 2.10. **Damages from selected climate change impacts, central projection**

Percentage change in GDP in 2060 w.r.t. no-damage baseline



ADB in 2010 review of SE Asia found: Indonesia, Philippines, Thailand, and Viet Nam—are projected to suffer an **annual** mean loss of **2.2% of gross domestic product (GDP) by 2100**, if market impact only (mainly related to agriculture and coastal zones) are considered.

Mean impact could be dramatically worse, equivalent to **5.7% of GDP** each year by 2100, if non-market impact (mainly related to health and ecosystems) is included; and **6.7%** if catastrophic risks are also considered.

ADB Economics Of Climate Change In The Pacific 2013 found:

Economic impact could be alarmingly high. Assuming the world does not deviate from its business-as-usual scenario, the total cost of climate change in the Pacific will continue to grow prohibitively high over the long term, reaching 12.7% of annual GDP equivalent by 2100

SUMMARY OF CHARACTERISTICS OF STUDIES

DESIGN:

- Limited in coverage of sectors typically agriculture, health, labor or certain services such as water supply. Market goods and services more easily calculated than non-market values
- Acknowledged high level of uncertainty due to both uncertainty of what will happen climatically and of how activities will react. More confidence in results for ~2050 than for beyond

RESULTS:

- Every region will see losses with these lowest (or even some sector gains) in most temperate areas and losses “especially large” in Africa and Asia (which also have largest population and fastest growth)
- Generally, agriculture will have the largest losses from lower yields. Losses to sea level rise will continue to increase
- Losses of 1% to 12+% in specific unusual cases (Pacific Islands) with most in the 2-4% range by 2050-60, then increasing.

UNCERTAINTIES:

- Do not take into account specific adaptation investments or changes in practices such as changing crops
- Do not take into account high-impact singular or extreme events which are projected to increase
- Do not take into account other human costs such as migration

MEANWHILE, IN THE REAL WORLD

Example of ECCC Case Study for Indonesia done by ATLAS

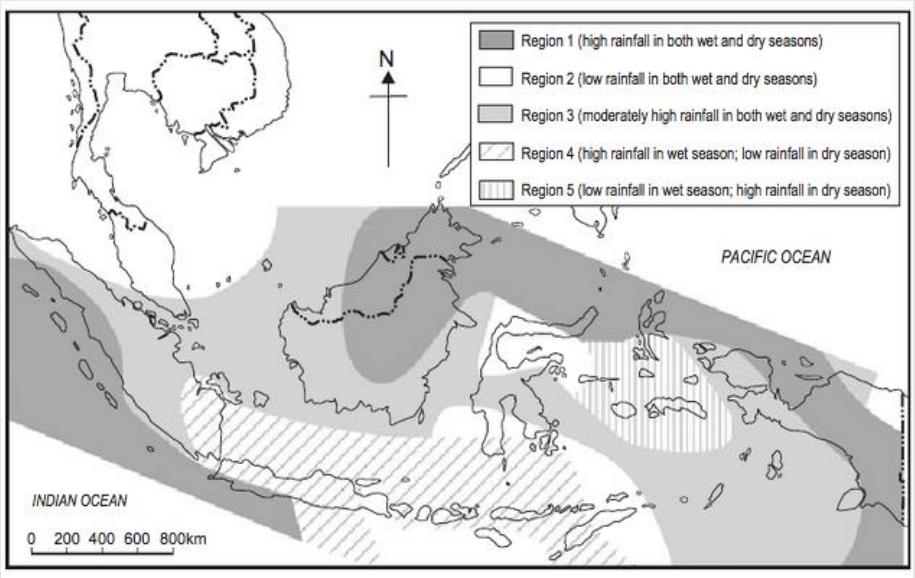
Economic Assessment of Climate Risk in Indonesia: Final Results

ASSESSMENT OVERVIEW

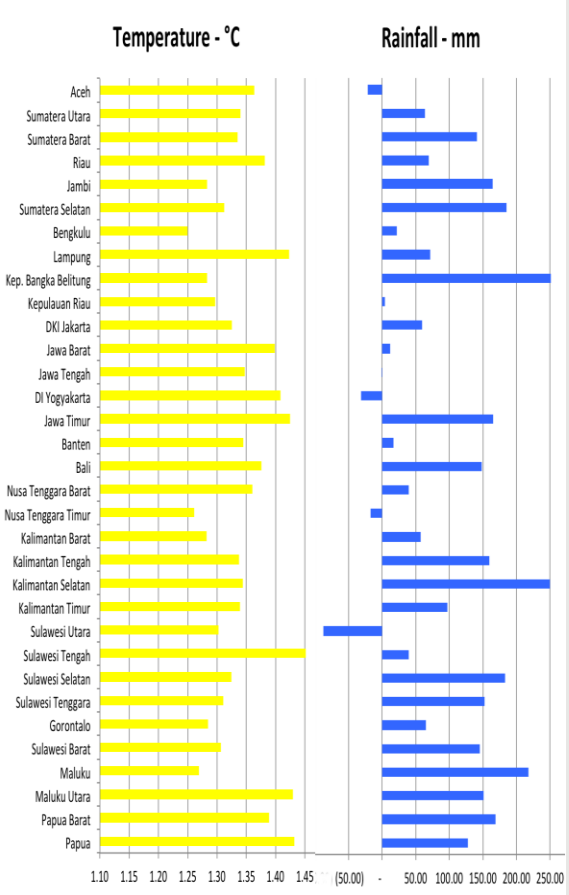
- Study estimates the costs imposed on Indonesia by climate change in the absence of adaptation
- Covers impacts expected **<u>in the year 2050</u>** (***not cumulative*** to 2050) with baseline data for prices and population and land use in 2012 and 2013
- Considers one IPCC climate scenario, a1b, which is a "middle of the range" projection
- Covers impact on only three areas of major importance: **agriculture, health, and coastal impacts**
- Covers the whole country, disaggregated at the provincial level

CLIMATE VARIATION ACROSS PROVINCES

Current climate can vary even on each island

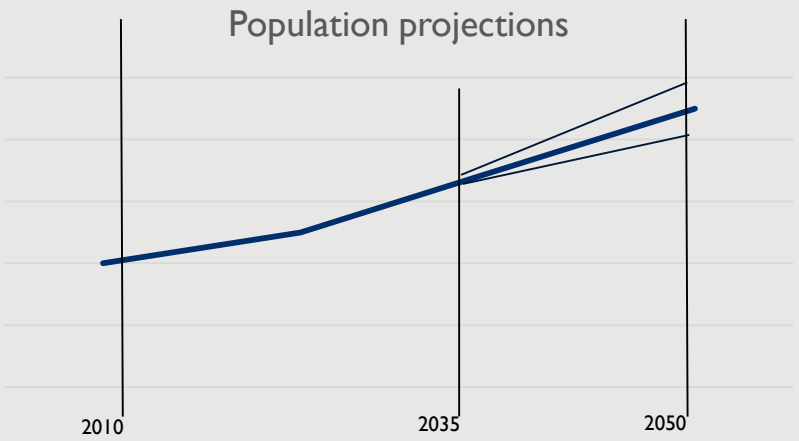


Future projected changes also vary



POPULATION PROJECTIONS

- Started with 2010 census data by kabupaten, including rural/urban breakdown and Indonesian population projections to 2035 by province.
- We then estimated population to 2050 by province, with rural/urban breakdown.

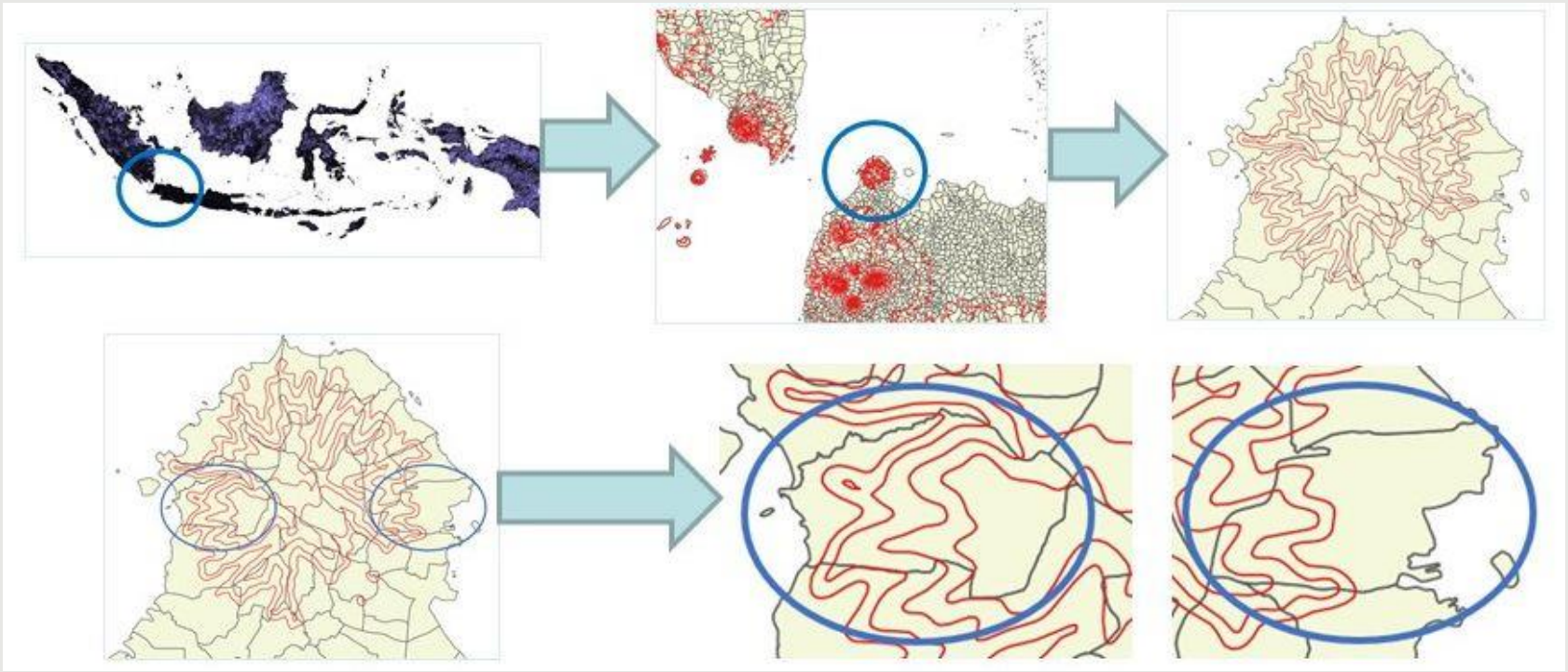


GRADUAL SEA LEVEL RISE: RESEARCH METHODS

- Sea level rise is projected to average **33 cms (~1 ft)** by 2050.
- Digital elevation data used to determine **which land will be flooded**.
- Flooded area overlaid with **land use/land cover map** to determine **what kinds of activity will be flooded**: agriculture, aquaculture, and settled areas.
- Economic impact is based on forgone income or use of property ***in 2050*** for land flooded ***up to and including 2050.***
- Analysis **does not include extreme storms**, as sufficiently detailed projections about their extent or probability are not available. It also **does not include macroeconomic impacts or economic multipliers** of flooded infrastructure.

GRADUAL SEA LEVEL RISE: SPATIAL ANALYSIS

ANALYZING SEA LEVEL RISE IN GIS

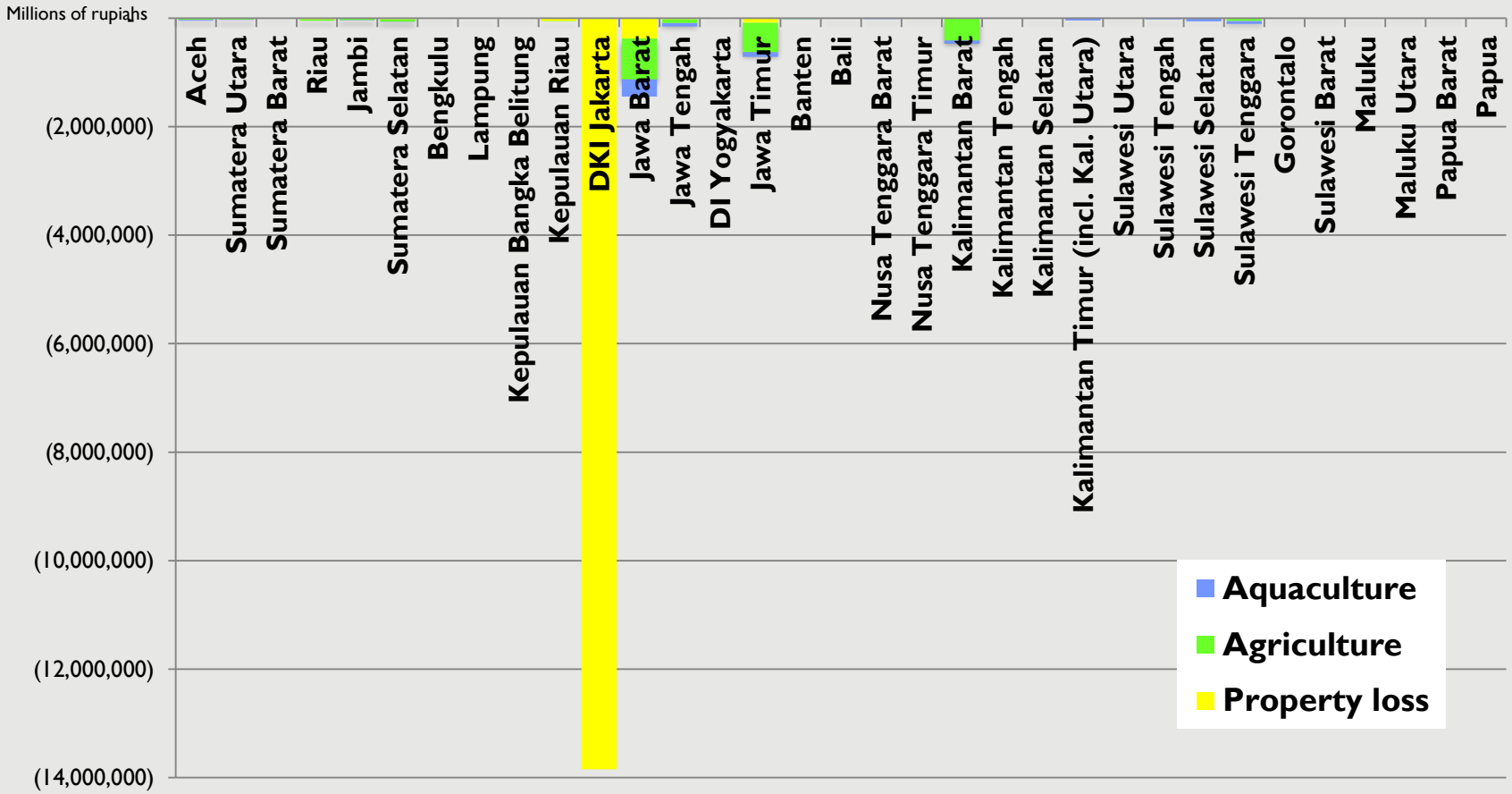


Contour lines along the coast can be used to determine what would be flooded with a certain rise in sea level. The village on the right has much more land closer to sea level than does the one on the left and therefore would lose more land to sea level rise.

COST OF GRADUAL SEA LEVEL RISE: DISCUSSION

- **Lost income from urban properties** accounts for 14,400,000 out of 17,200,000 million rupiahs, or 84% of total loss.
- **Office space** losses account for 52% of urban property loss; residences and industrial land account for 29% and 18%, respectively.
- **Agriculture and aquaculture** account for about 12% and 4%, respectively, of total losses due to SLR.
- Almost all **cost is incurred in Jakarta**, with Jawa Barat a very distant second.
- Analysis of SLR **does not include macroeconomic impacts** from multiplier effects of flooding of key infrastructure in Jakarta.

COST OF SEA LEVEL RISE BY PROVINCE IN 2050



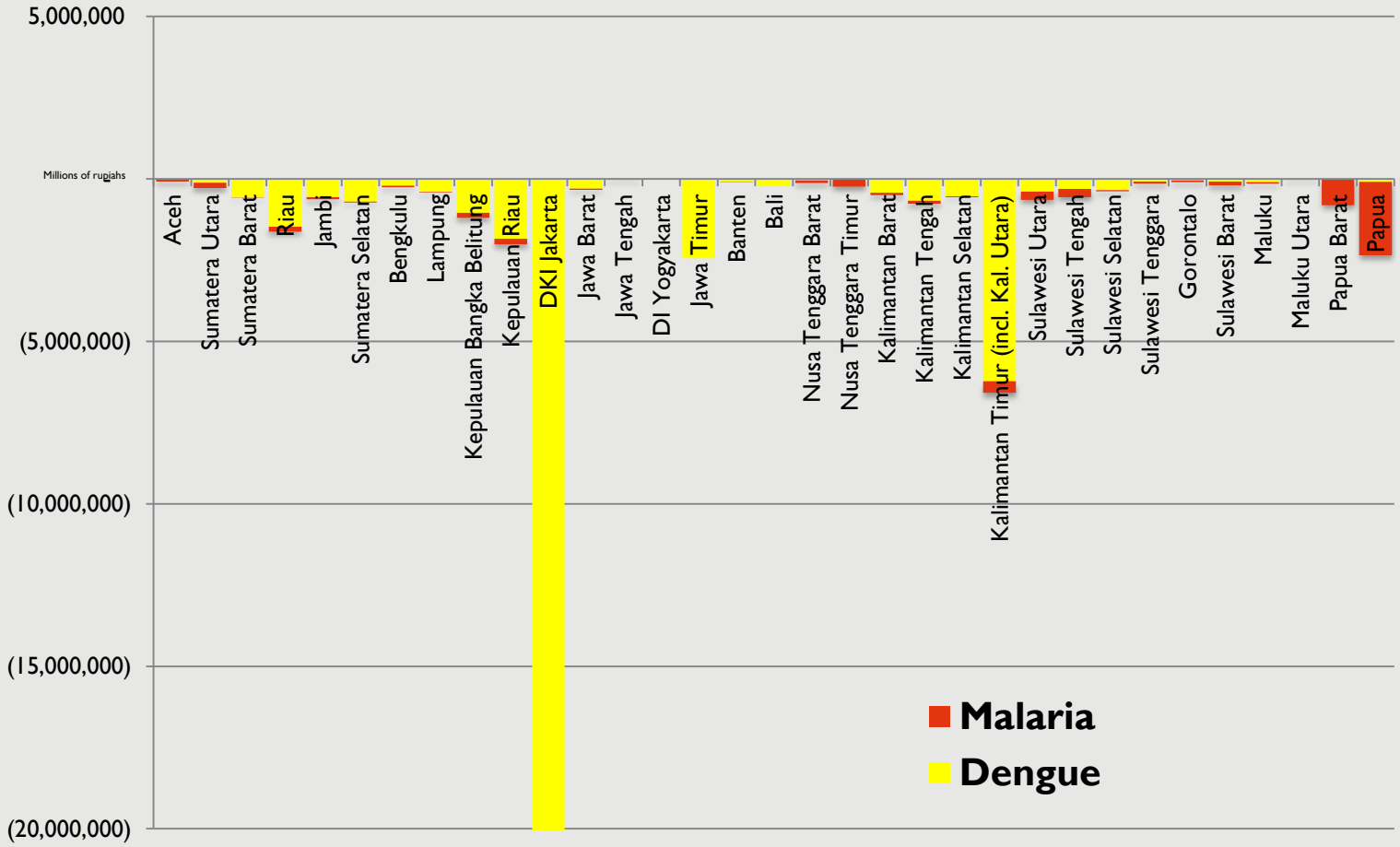
HEALTH: RESEARCH METHODS

- Focus is on **malaria and dengue fever**, diseases expected to be most influenced by climate change.
- Analysis is in terms of "**disability-adjusted life-years**" (DALYs), the international metric for incidence of disease.
- **Dengue fever analysis** is based on a research study of how temperature and rainfall influence disease incidence in eight representative Indonesian provinces.
- **Malaria analysis** is based on how many months per year temperature and rainfall conditions are suitable for malaria, and changes in annual person-months of exposure.
- **Provincial DALY data are projected to 2050** to estimate future impact of the disease.
- **DALYs are valued** based on gross provincial product per capita.

COSTS FOR HEALTH: DISCUSSION

- **Dengue fever accounts for most of the cost** at 40,000,000 million rupiahs, compared with 5,700,000 for malaria – due to both high rates and high incomes where it is prevalent: urban areas.
- **51% of dengue cost and 45% of total health cost is in Jakarta** (20,155,714 million rupiahs).
- Dengue fever will **decrease where rainfall drops**; Java Tengah, DKI Yogyakarta, and Nusa Tenggara Timur.
- Impact of **malaria highest in Papua and Papua Barat** – due to high current rates.

IMPACT OF DENGUE AND MALARIA BY PROVINCE IN 2050



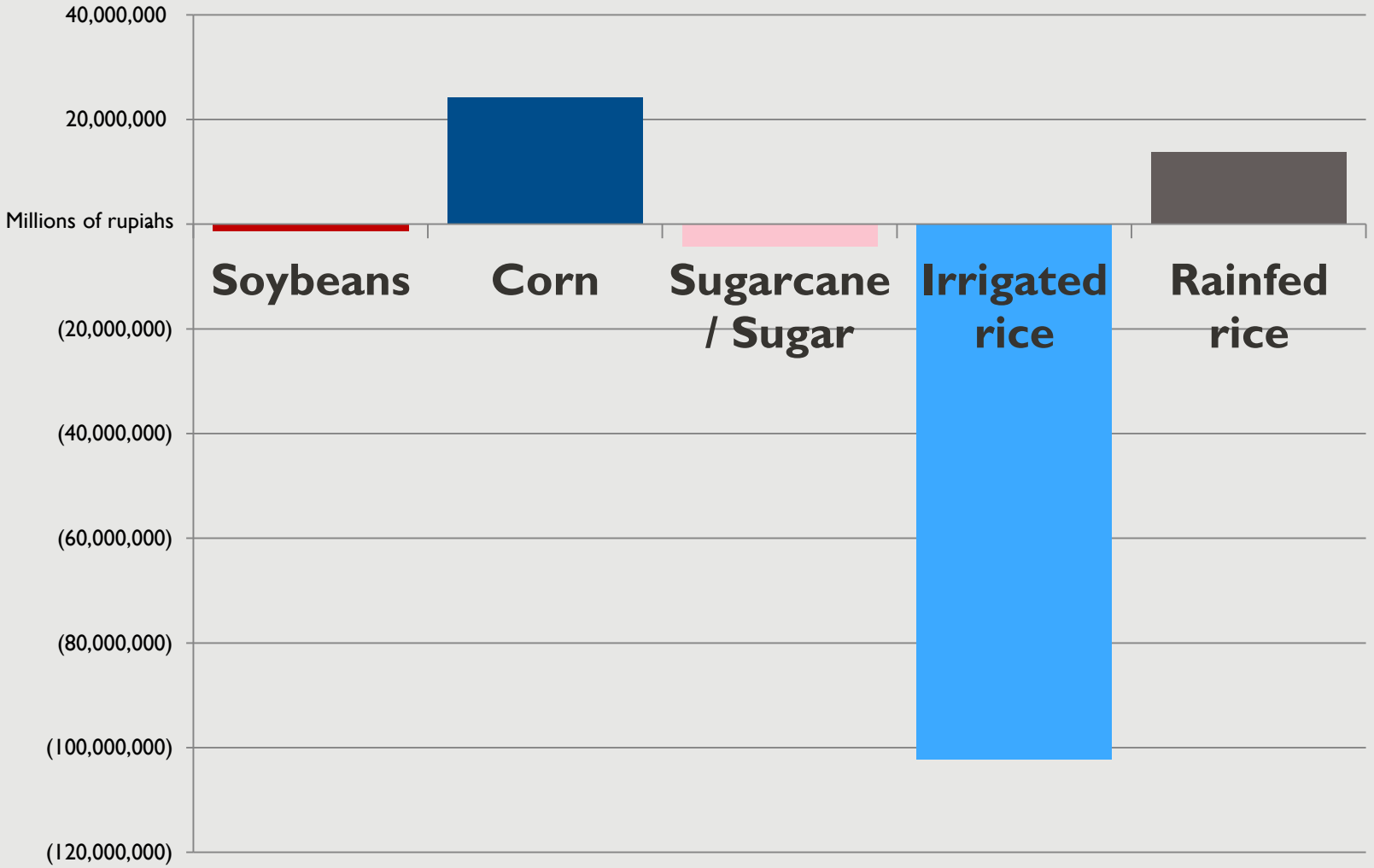
AGRICULTURE: RESEARCH METHODS

- Focus on **soybeans, maize, rainfed and irrigated rice, sugarcane** – among the most important food crops in the country and the only ones for which a model is available showing impact of climate change.
- Analysis incorporates **changes in yield due to changes in temperature and rainfall**.
- Analysis assumes that **area cultivated with each crop is unchanged**, and **does not incorporate other changes in cultivation** due to new agricultural suitability patterns.
- Economic value of changes in output is calculated using **current prices**.
- Analysis has been carried out at the **provincial level**; making inter-provincial comparisons possible.

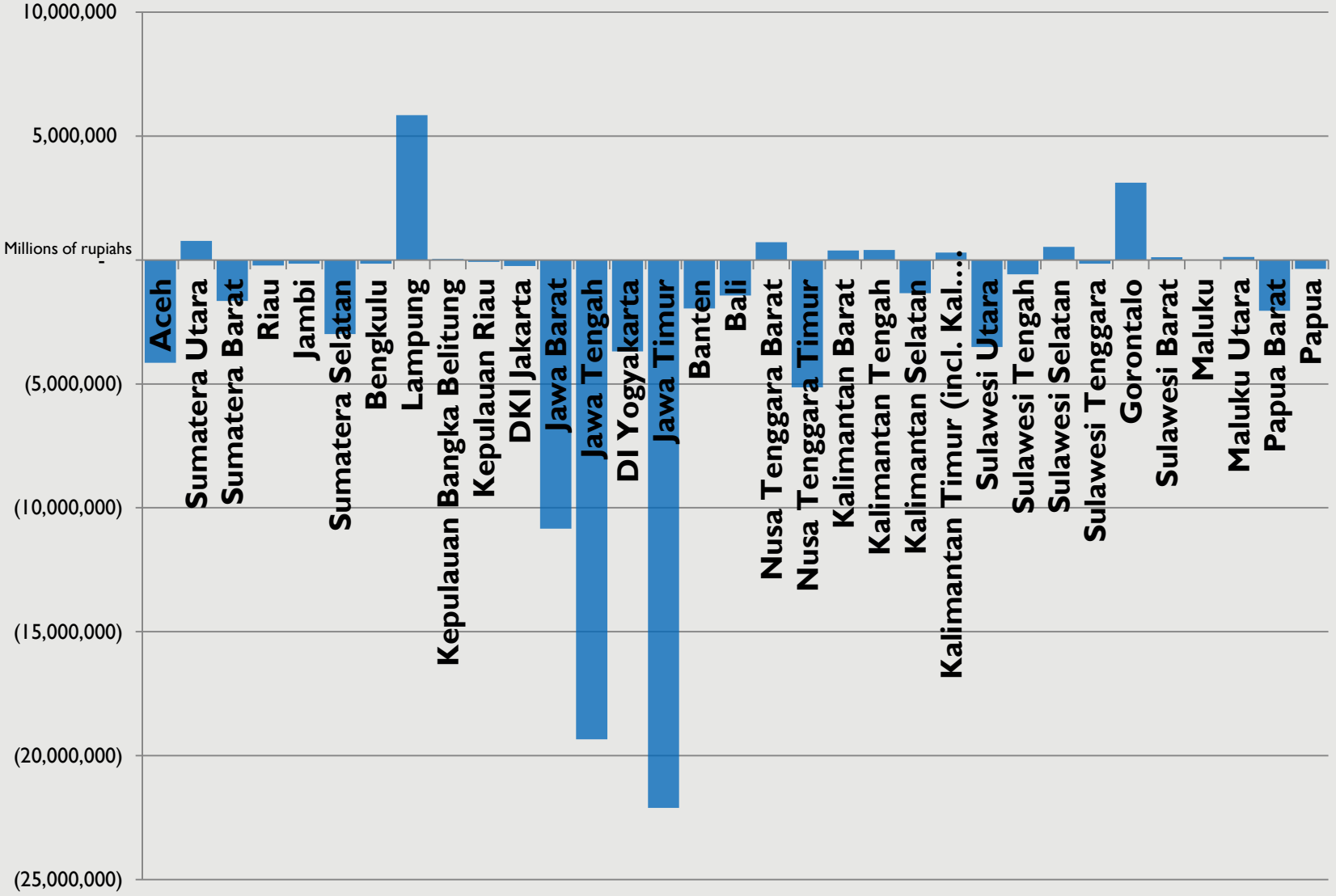
COSTS TO AGRICULTURE: DISCUSSION

- Overall impact on agriculture is negative, but where **changes in rainfall affect yield** – corn and rainfed rice – calculated impact is positive.
- Where **rainfall has no impact** – soybeans, sugarcane, and irrigated rice – value of output will drop due to increased temperature.
- Impacts **vary widely across provinces**, depending on where rainfall is projected to rise and on which crops dominate in each province.
- **Impact of greatly increased rainfall is not known**; we chose to place a ceiling on increase in yield, at 100%.
- Impact of **temperature and rainfall change accounts for 97%** of total agricultural loss; **SLR accounts for only 3%.**

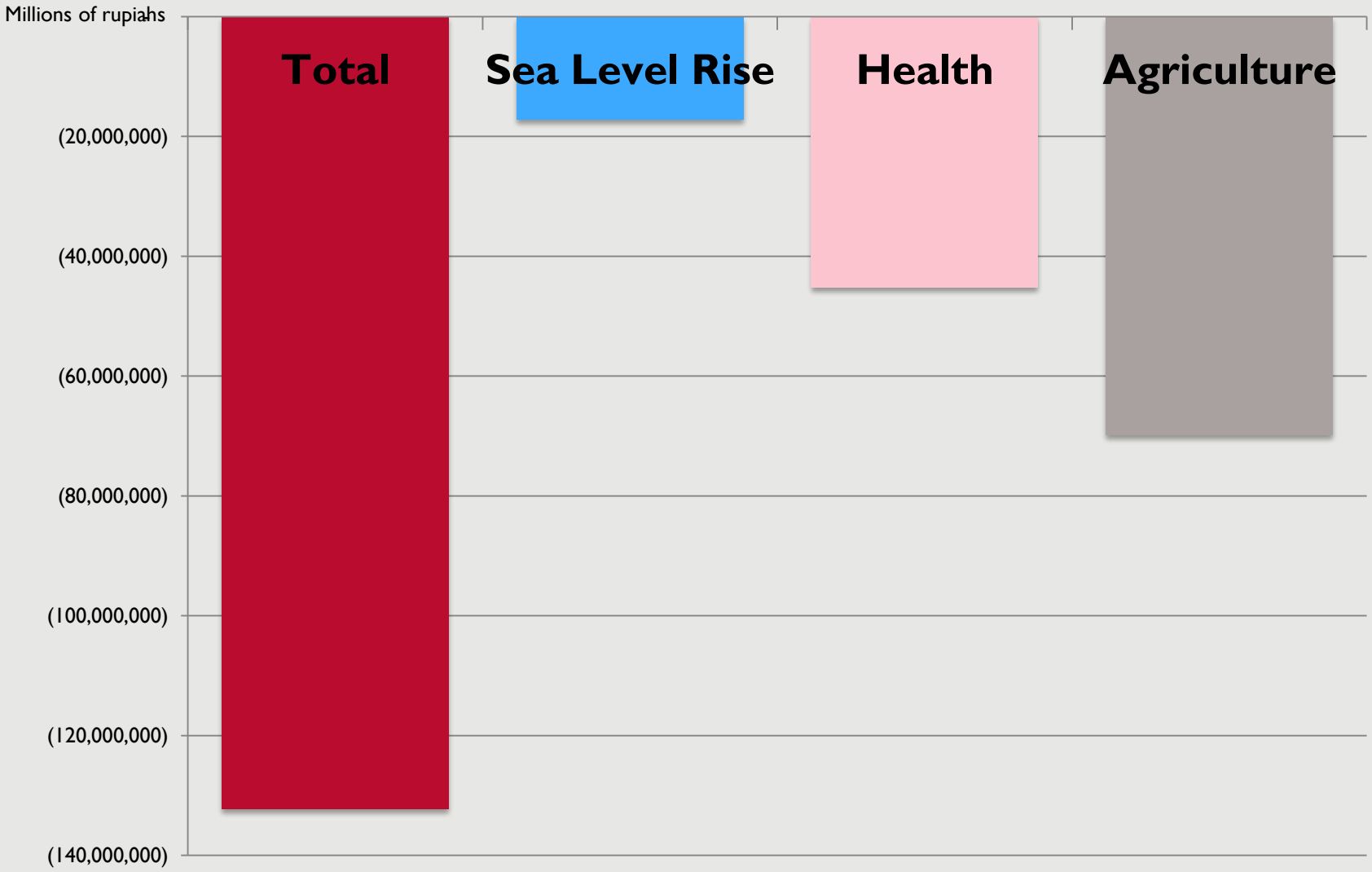
IMPACT OF CLIMATE CHANGE ON AGRICULTURE IN 2050



IMPACTS ON AGRICULTURE BY PROVINCE IN 2050

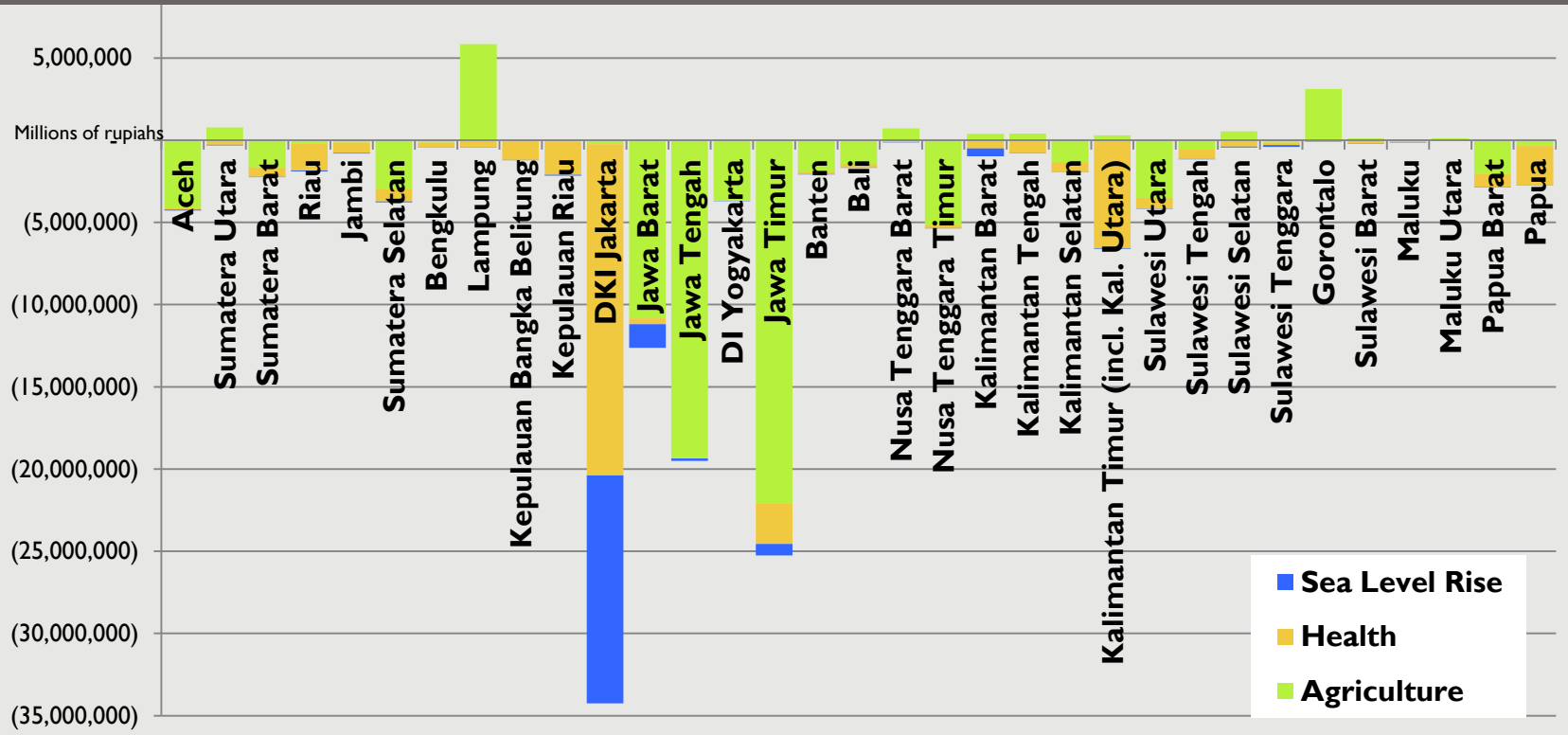


TOTAL IMPACT BY SECTOR IN 2050



TOTAL ECONOMIC IMPACT OF CLIMATE CHANGE BY PROVINCE IN 2050

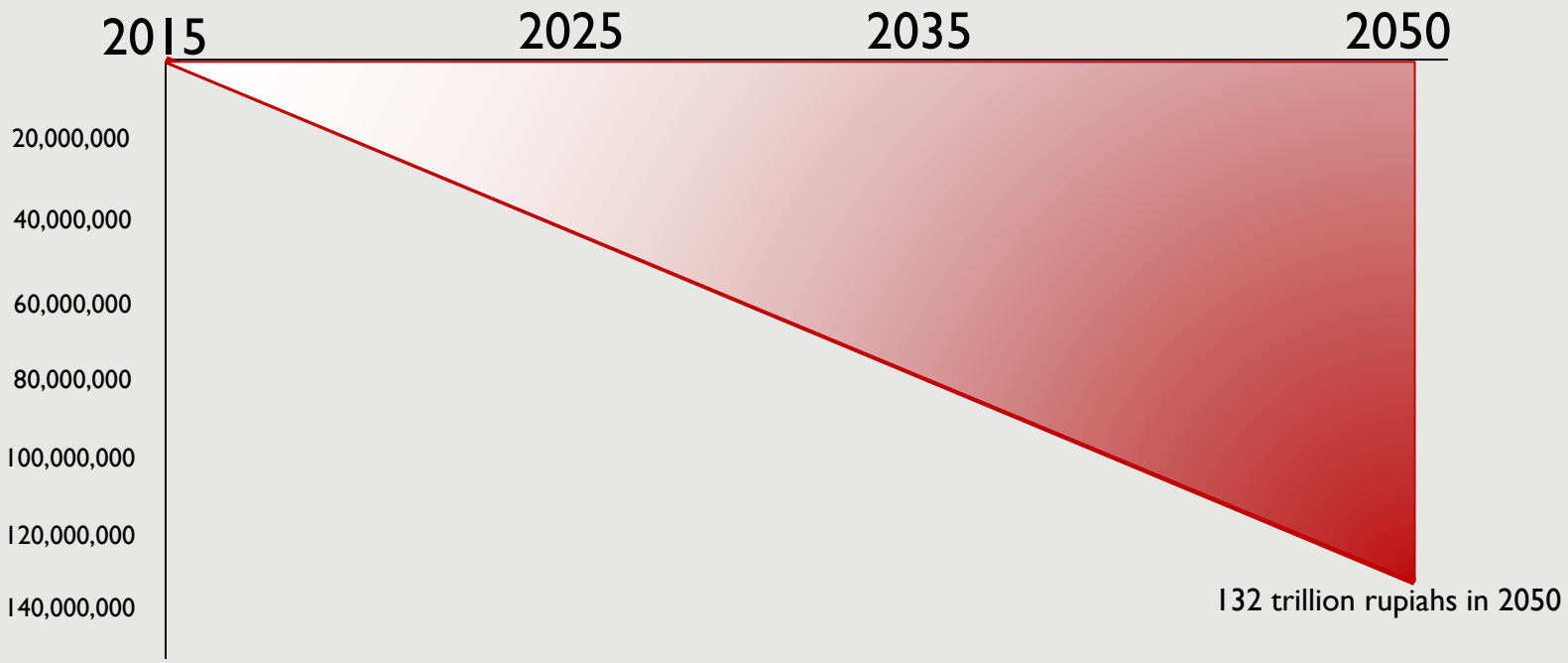
- Greatest impacts on Jakarta, followed by other provinces on the island of Java.
- Jakarta impacts are due to health and losses to SLR; other Java provinces affected through agriculture.
- Major (possible) beneficiaries are Lampung and Gorontalo, due to increased agricultural output.
- Impacts per capita are somewhat different from total impact, due to small population of some provinces (e.g. Gorontalo) and large population of others (e.g. Jakarta).



CONCLUSIONS AND RECOMMENDATIONS

- While this study is **neither comprehensive nor exact**, it covers major portions of the economy and offers useful insights. It is a good **point of departure for further** analysis by both Indonesia and interested international entities.
- Counter to most expectations, **not all impacts in all sectors in all places are negative**, thanks to some possible positive impacts on agriculture.
- It is **essential** to do **more research on impacts of climate change on agriculture,** especially on **specific crops**.
- Understanding the impacts of **extreme storms** is very important. This calls for more **research on the probability and severity of storms** in different parts of the country.
- Analysis of the **macroeconomic consequences** of extreme storms and other climate impacts on **infrastructure** and the **economic multiplier** is essential.

ONE MORE RECOMMENDATION



The most important recommendation:
As climate change is gradual, it may be assumed that Indonesia will increasingly and inexorably experience the costs each year. This means that policymakers should not wait until the future to implement changes.

CONCLUSIONS AND WRAP-UP
QUESTIONS, COMMENTS

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