



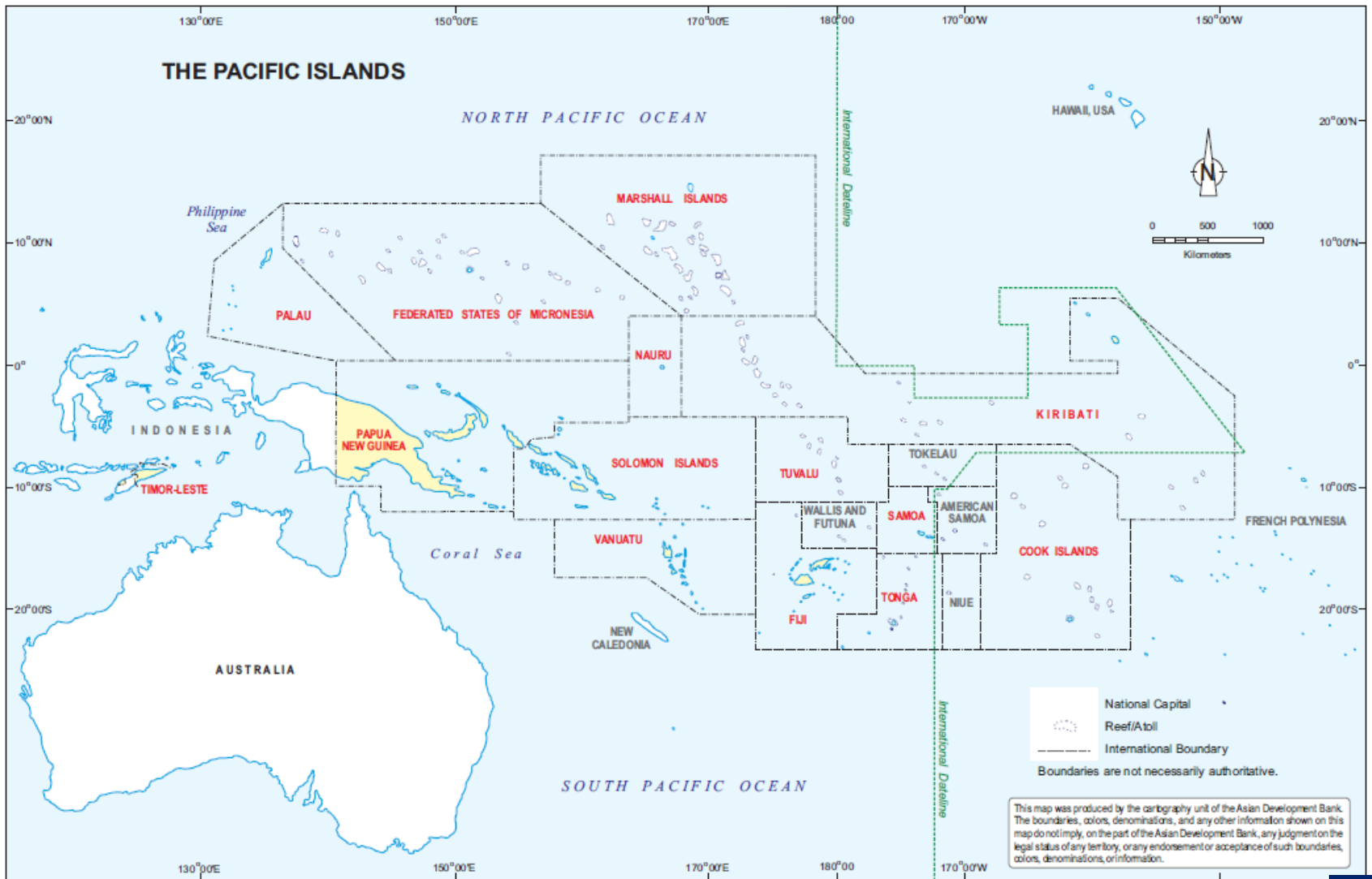
# The Economics of Climate Change in the Pacific

Asian Development Bank  
26 November 2013  
Sydney, Australia

# Key Questions

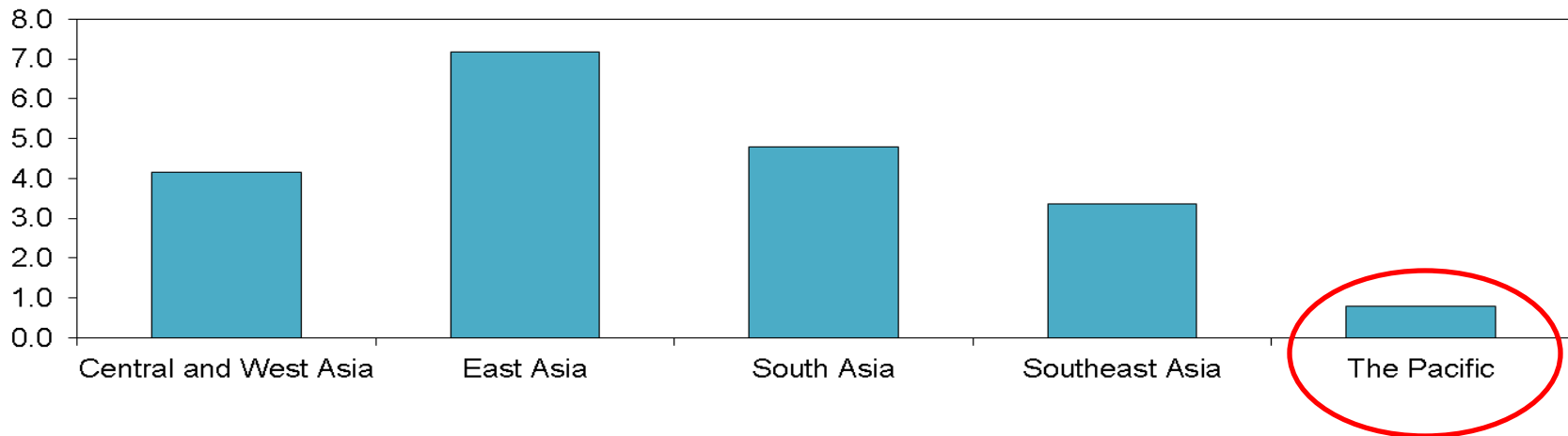
- How serious is the potential effect of climate change for the Pacific?
- What are the impacts of climate change on key economic sectors?
- How costly is climate change to the Pacific?
- How can countries adapt to a highly uncertain climate change?
- How much investment is needed for adaptation to climate change?

# Background on the Pacific - Geography



# Pacific Vulnerability

## Regional Growth in Real GDP Per Capita, 2000-2012



## Share of Pacific Economies Dependent on Natural Resources (GDP Share by Sector, %)

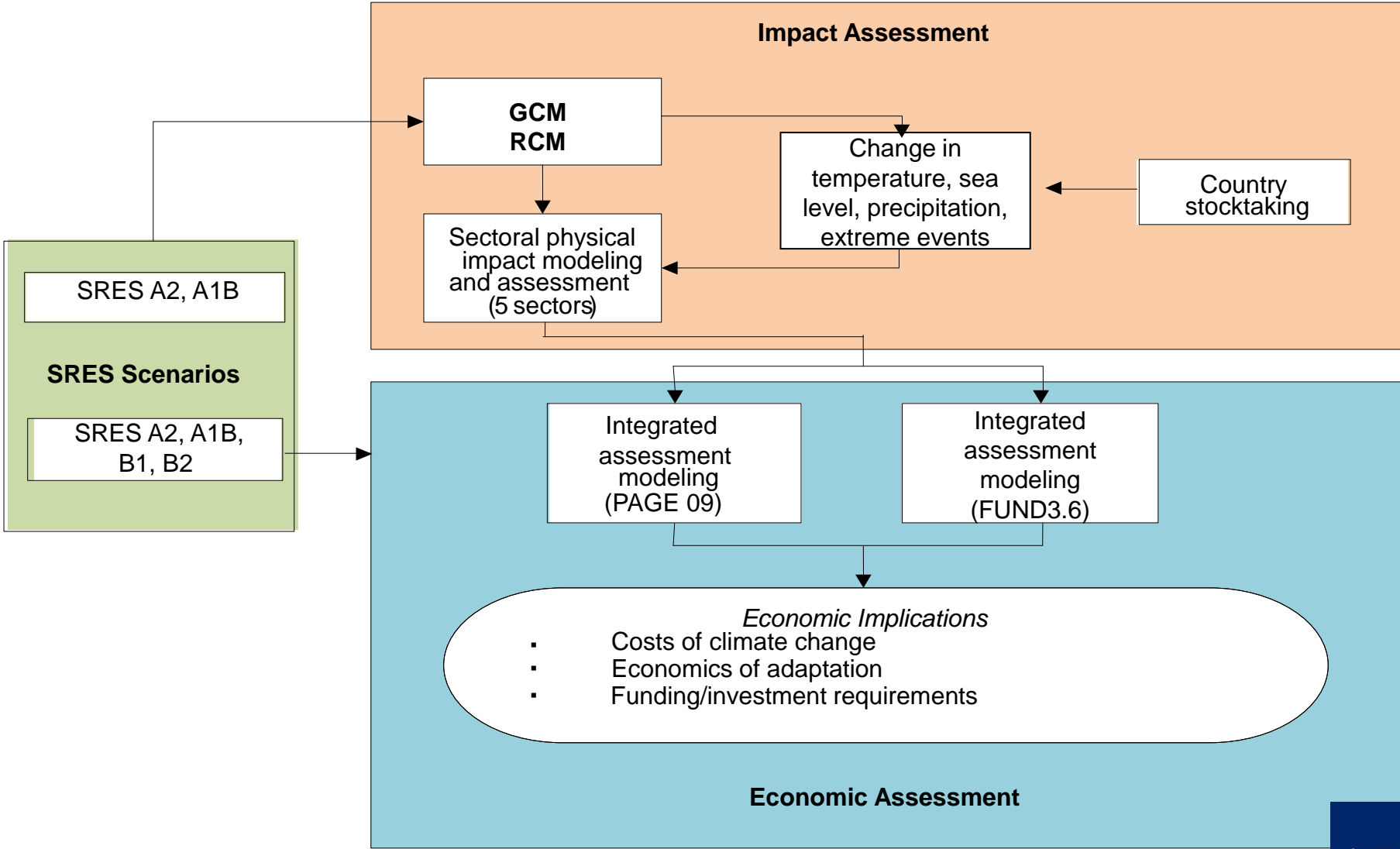
Economic Indicators	Cook Islands	Fiji	Kiribati	Marshall Islands	FSM	Palau	PNG	Samoa	Timor Leste	Tonga	Vanuatu
Agriculture	4.6	12.1	26.3	15.0	27.8	5.5	29.1	9.8	3.3	18.8	23.9
Industry	9.0	22.0	8.2	13.1	9.1	8.4	44.2	27.9	85.6	21.1	10.1
Services of which international tourism receipt	86.4	65.9	65.5	72.0	63.2	86.1	26.7	62.3	11.1	60.1	66.0
Tourism plus agriculture	44.4	23.4	2.9	2.0	8.4	56.0	0.03	20.2	2.6	5.8	34.1
Employment in agriculture	4.3	1.3	2.8	12.0	52.2	7.8	72.3	35.4	50.8	27.9	60.5

# Study Approach

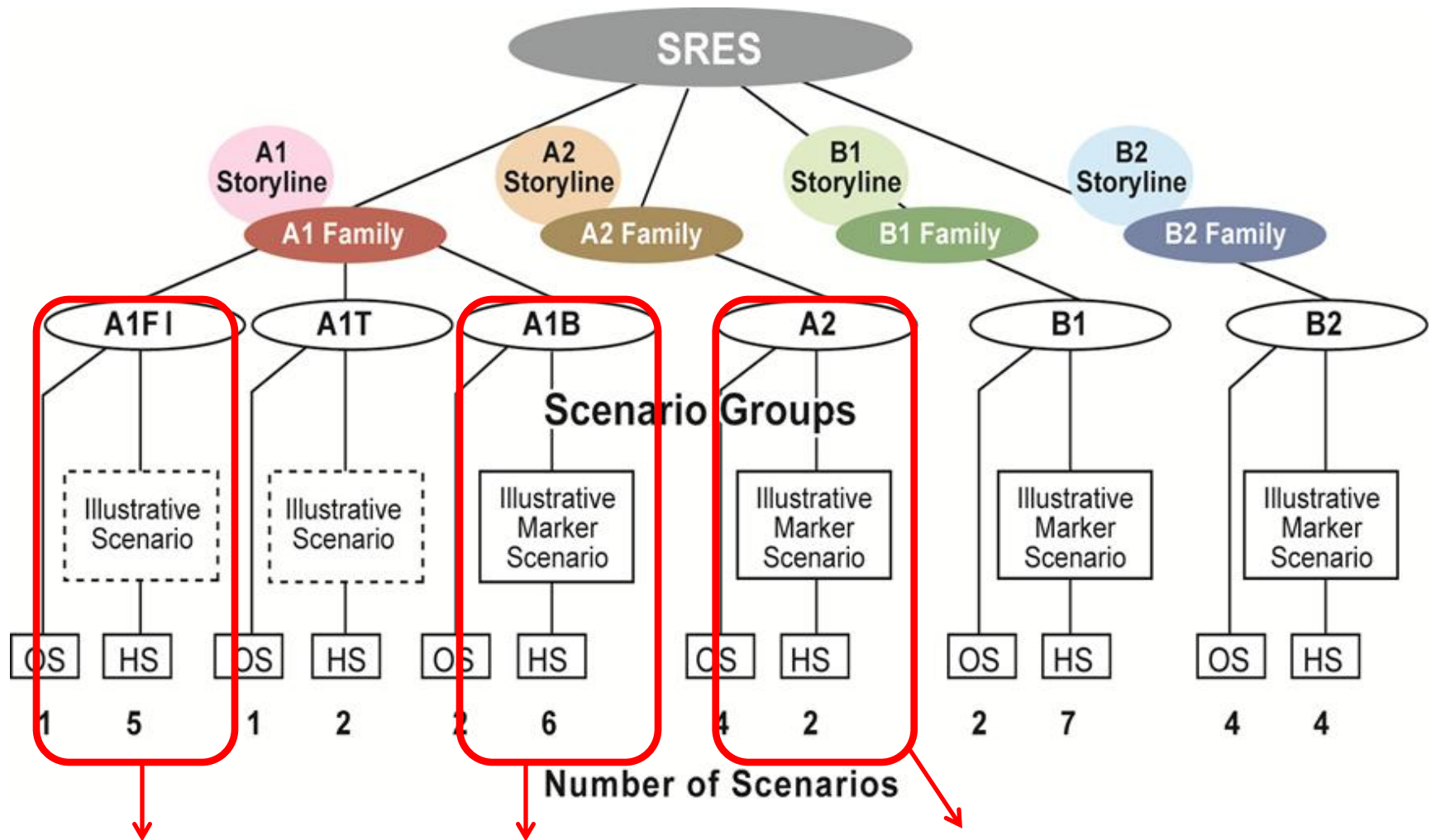
- Objective—to identify and indicatively quantify key potential impacts of climate change in the Pacific through 2100
- 3 components
  - Climate modeling
  - Sector impact assessment
    - Sea level rise, water availability and storm risk
    - Agriculture, marine/fisheries tourism and health
  - Integrated assessment modeling
    - FUND09
    - PAGE 3.6

# Methodology

## Modeling Framework



# Climate scenarios modeled

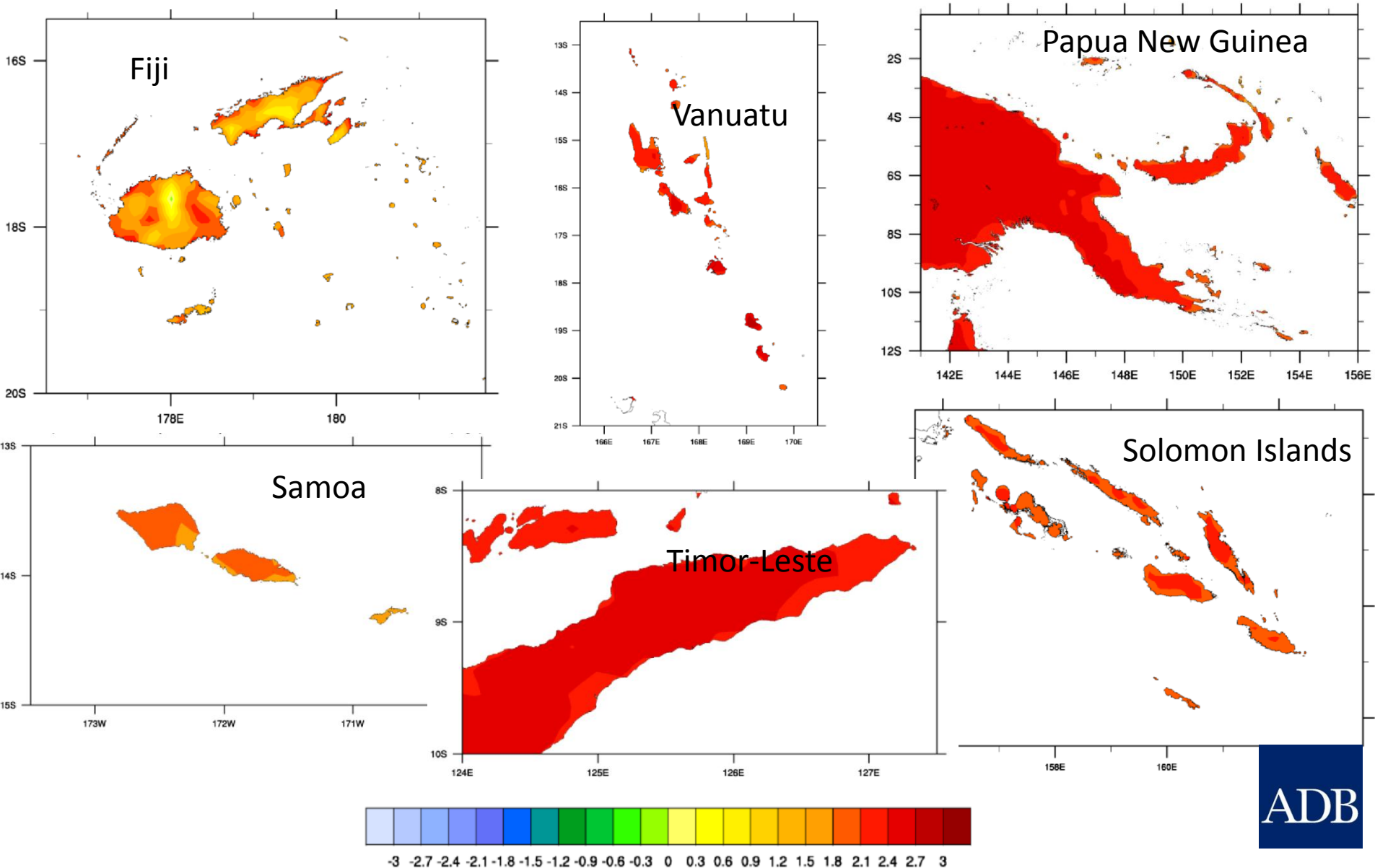


High emissions scenario  
(business as usual,  
fossil fuel-intensive growth)

Medium emissions scenario

High emissions scenario  
(resulting from slow economic  
growth and technological progress)

# Average temperature differences 2061-2080 vs 1980-1999 (mean of GCMs under A1B (Medium Emissions) Scenario)



# Rainfall – RegCM3 downscaling, mean of 16 GCMS, A1B (Medium Emissions) Scenario

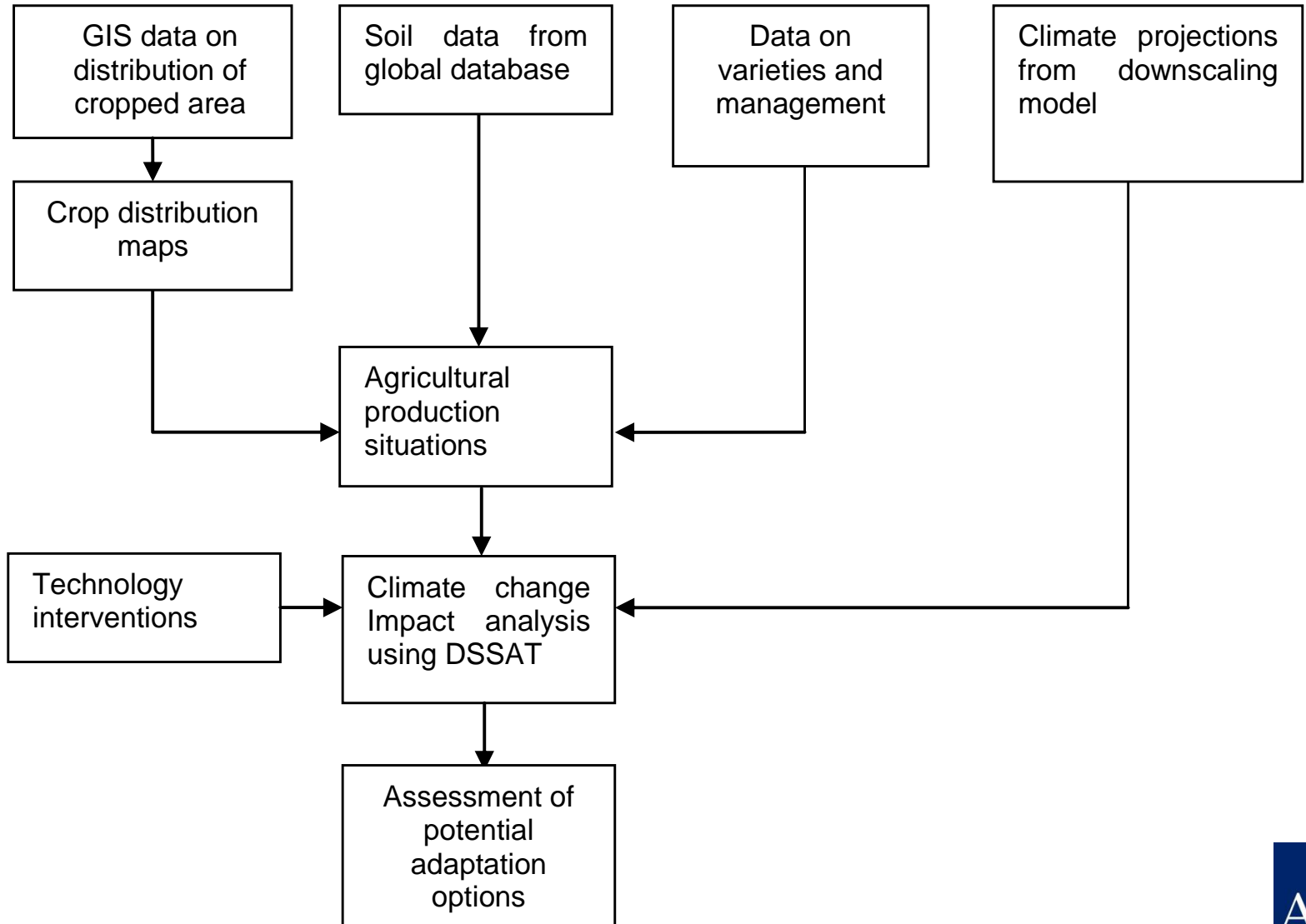
Country	Baseline Rainfall (mm)	Projected Change in 2050 (%)	Projected Change in 2070 (%)
<b>Papua New Guinea</b>			
Annual	3209	-7	-1
Peak Month (Dec)	313	-8	-13
Driest Month (Sep)	214	-10	-6
<b>Solomon Island</b>			
Annual	3028	-8	-13
Peak Month (Mar)	369	-3	-21
Driest Month (Jun)	172	-10	-17
<b>Vanuatu</b>			
Annual	2356	-6	-37
Peak Month (Mar)	364	-5	-34
Driest Month (Sep)	107	-8	-69
<b>Fiji</b>			
Annual	2720	22	21
Peak Month (Mar)	480	5	31
Driest Month	102	3	-5
<b>Samoa</b>			
Annual	2945	80	75
Peak Month (Jan)	437	29	14
Driest Month	113	123	149

# Projected sea level rise

## (A1B (Medium Emissions) Scenario, 7 GCMs)

	Sea level rise (m) relative to 2010						Area (km <sup>2</sup> )		% of land area	
	2050			2100			2050	2100	2050	2100
	Extrapolation of historical Aviso data	GCM Low	GCM High	Extrapolation of historical Aviso data	GCM Low	GCM High	Mean of GCMs			
Fiji Islands	0.283	0.328	0.628	0.628	0.738	1.413	0.3	1.4	0.002	0.008
Papua New Guinea	0.301	0.348	0.644	0.667	0.783	1.449	10.8	15930.3	0.002	3.426
Samoa	0.212	0.260	0.556	0.470	0.585	1.251	0.5	0.7	0.016	0.023
Solomon Islands	0.431	0.476	0.772	0.956	1.071	1.737	8.0	79.3	0.029	0.286
Timor-Leste	0.226	0.272	0.572	0.501	0.612	1.287	0.4	1.2	0.003	0.008
Vanuatu	0.257	0.304	0.604	0.571	0.684	1.359	1.0	1.8	0.008	0.014

# Crop growth modeling



# Agricultural modeling results commissioned for this study

(A1B (Medium Emissions) Scenario, ECHAM5 GCM, RegCM3  
downscaling, **no CO2 fertilization**)

Crop Type	Country	2050		2070	
		Worst case	Best case	Worst case	Best case
Sugarcane	Fiji	-9.05	-5.11	-20.55	-7.13
	Samoa	6.01	9.37	-2.30	5.69
Sweet potato	PNG	-59.16	-49.51	-59.14	-56.14
	Solomon	-14.97	-12.22	-31.02	-22.52
Maize	Timor Leste	-10.43	-6.07	-17.03	-13.51
	Vanuatu	-13.53	-8.03	n.d.	n.d.

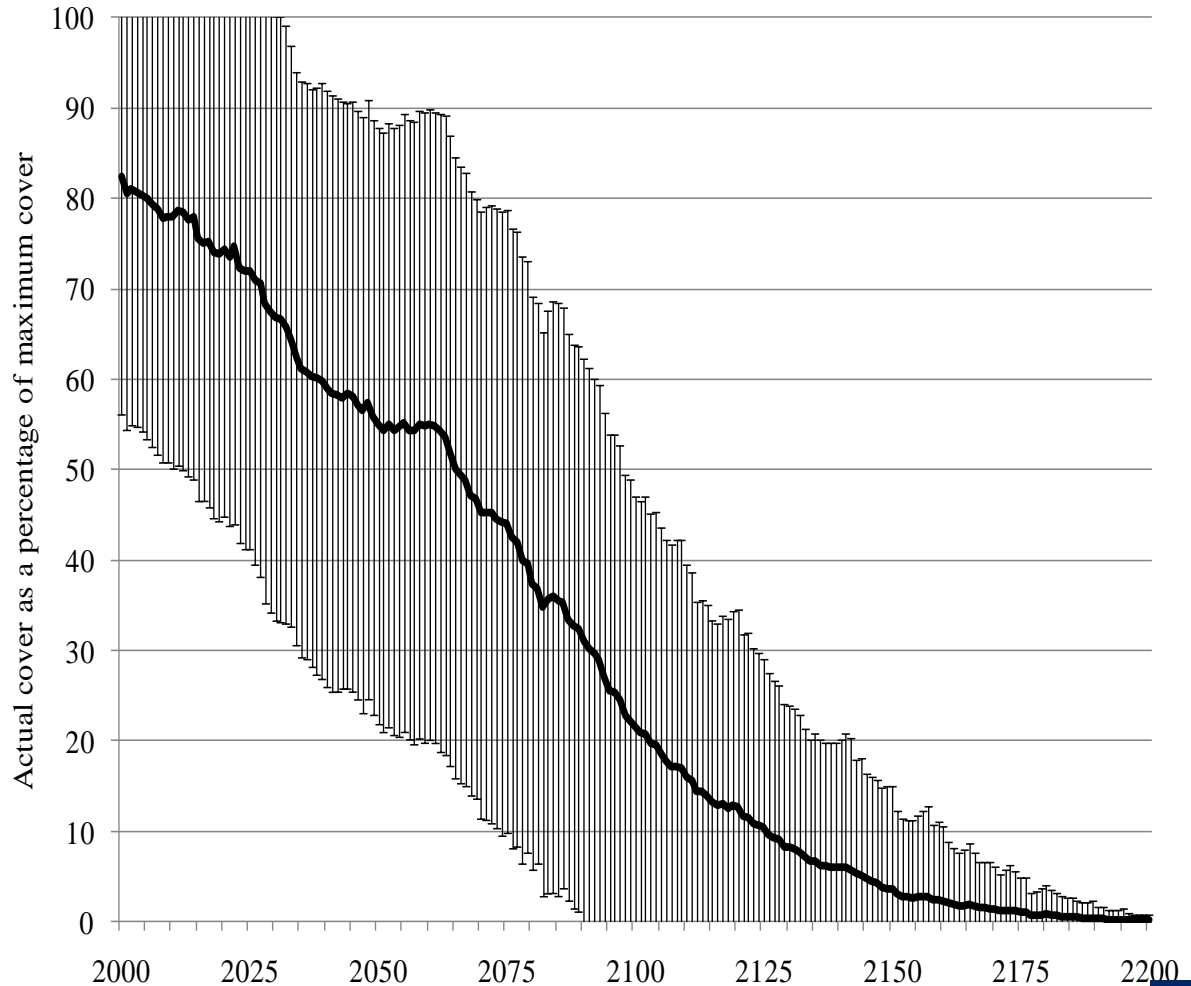
# Parallel agricultural modeling results by Rosegrant et al. (2013; A1B (Medium Emissions) Scenario, 5 GCMs, CO2 fertilization included)

	Yield effects from climate change 2050, compared with 2000 (%)					
	Papua New Guinea		Solomon Islands		Fiji	
Crop	Worst Case	Best Case	Worst Case	Best Case	Worst Case	Best Case
Cassava, rainfed	-30.8	-17.7	-27.8	-17.9	-36.5	-8.8
Maize, irrigated	-3.2	4.0	-9.6	0.7	-6.1	2.3
Maize, rainfed	-3.8	9.0	-16.5	-0.3	-7.0	1.0
Rice, irrigated	-8.3	12.4	-7.6	10.8	-7.1	11.7
Rice, rainfed	-7.5	11.7	-16.2	5.9	-11.0	3.5
Sugarcane, rainfed	-3.6	3.4	-12.9	0.9	-8.3	2.8
Sweet potatoes, rainfed	-10.9	-1.2	-15.0	1.5	-13.4	2.0
Taro, rainfed	-13.0	3.6	-18.6	-4.7	-17.5	1.1

# Marine/fisheries

- Thermal stress from increased ocean temperatures leads to coral bleaching
  - Estimated via FUND
- Ocean acidification as a result of increased CO2 absorption
- Distribution of open ocean fisheries catches moves eastwards

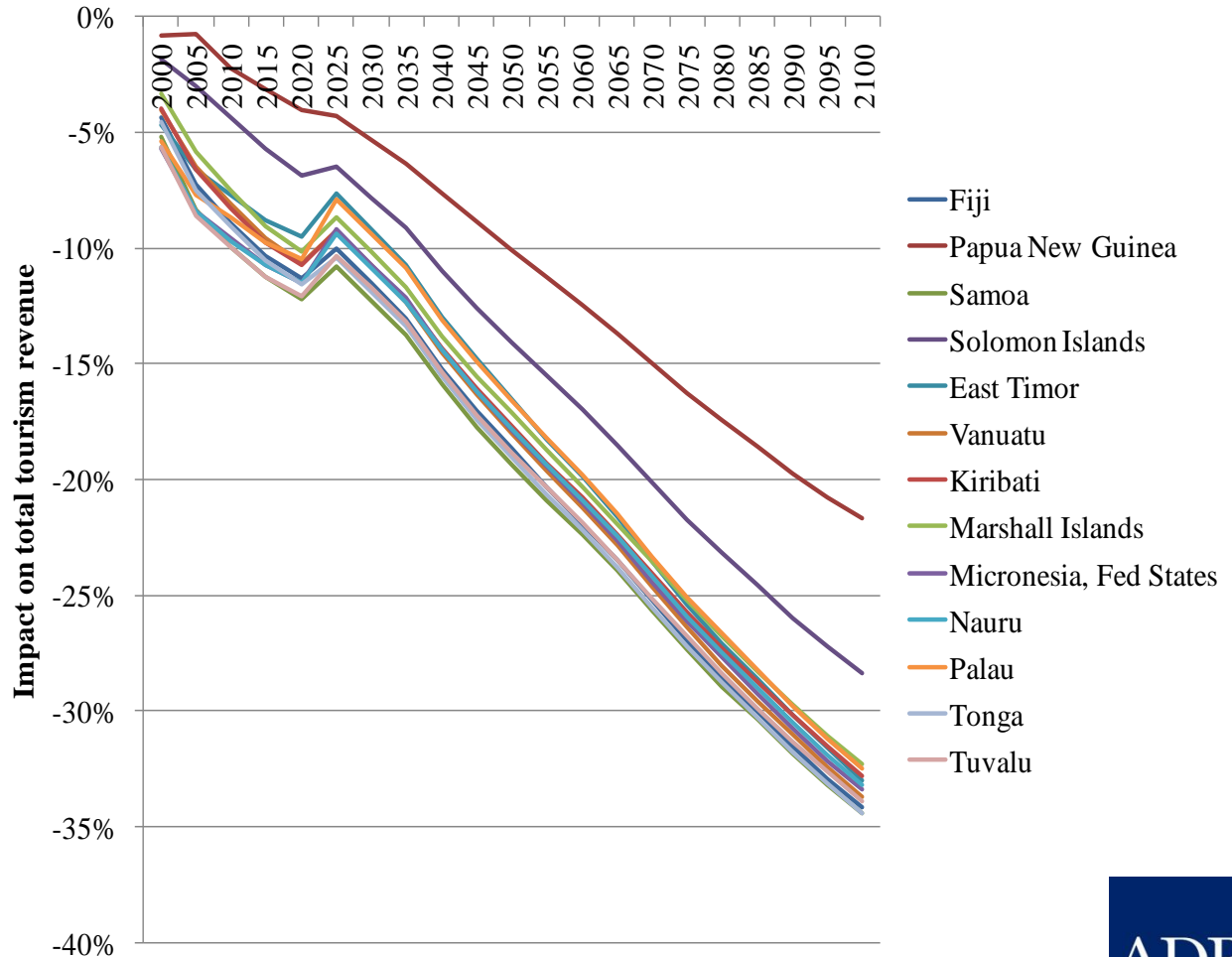
Projection of Coral Cover under Climate Change  
FUND A1B (Medium Emissions) Scenario



# Tourism

- Changes in tourism arrivals as a result of a less attractive climate
- Declines in all countries relative to baseline
- Will be exacerbated by coral bleaching

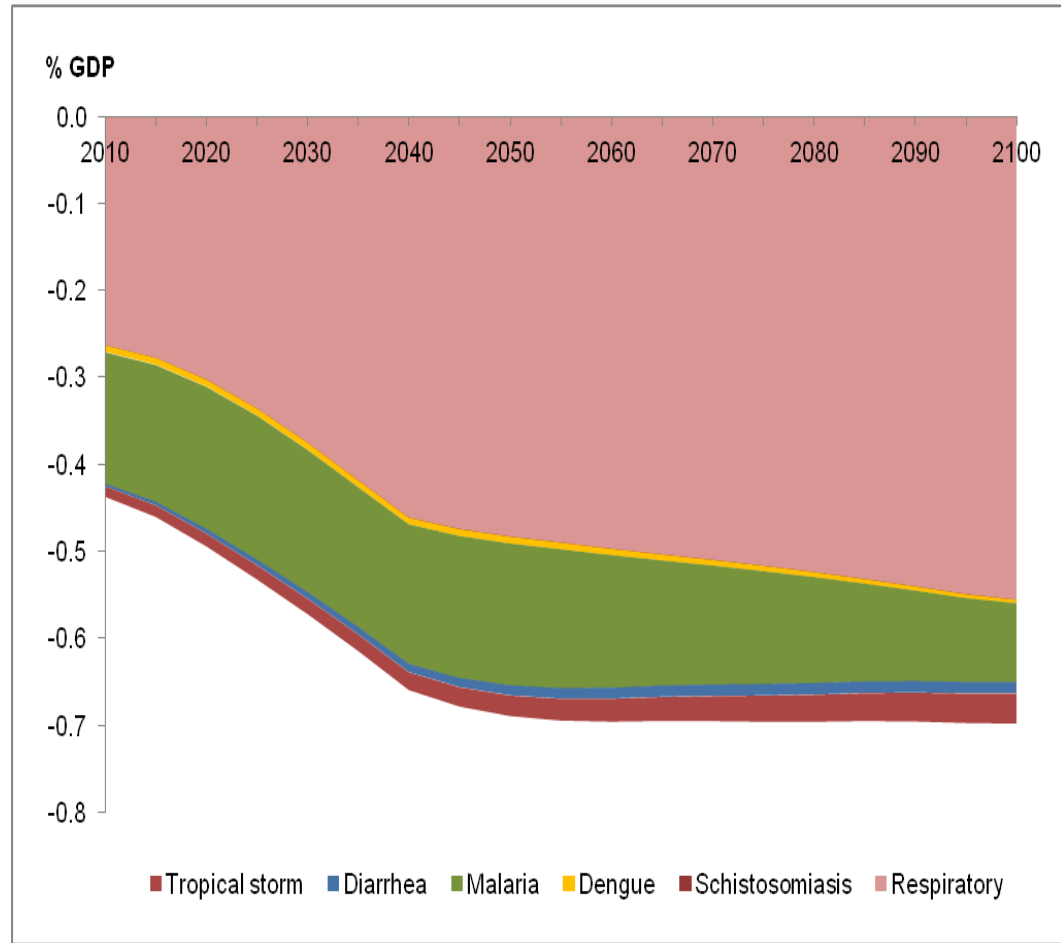
The impact of climate change on total tourism revenue in 13 Pacific island nations for the A1B (medium emissions) scenario



# Health

- Increased vector borne disease transmission
- Heat stress from increased heat and humidity, resulting in reparatory/ cardiovascular disease
- Increased food borne disease

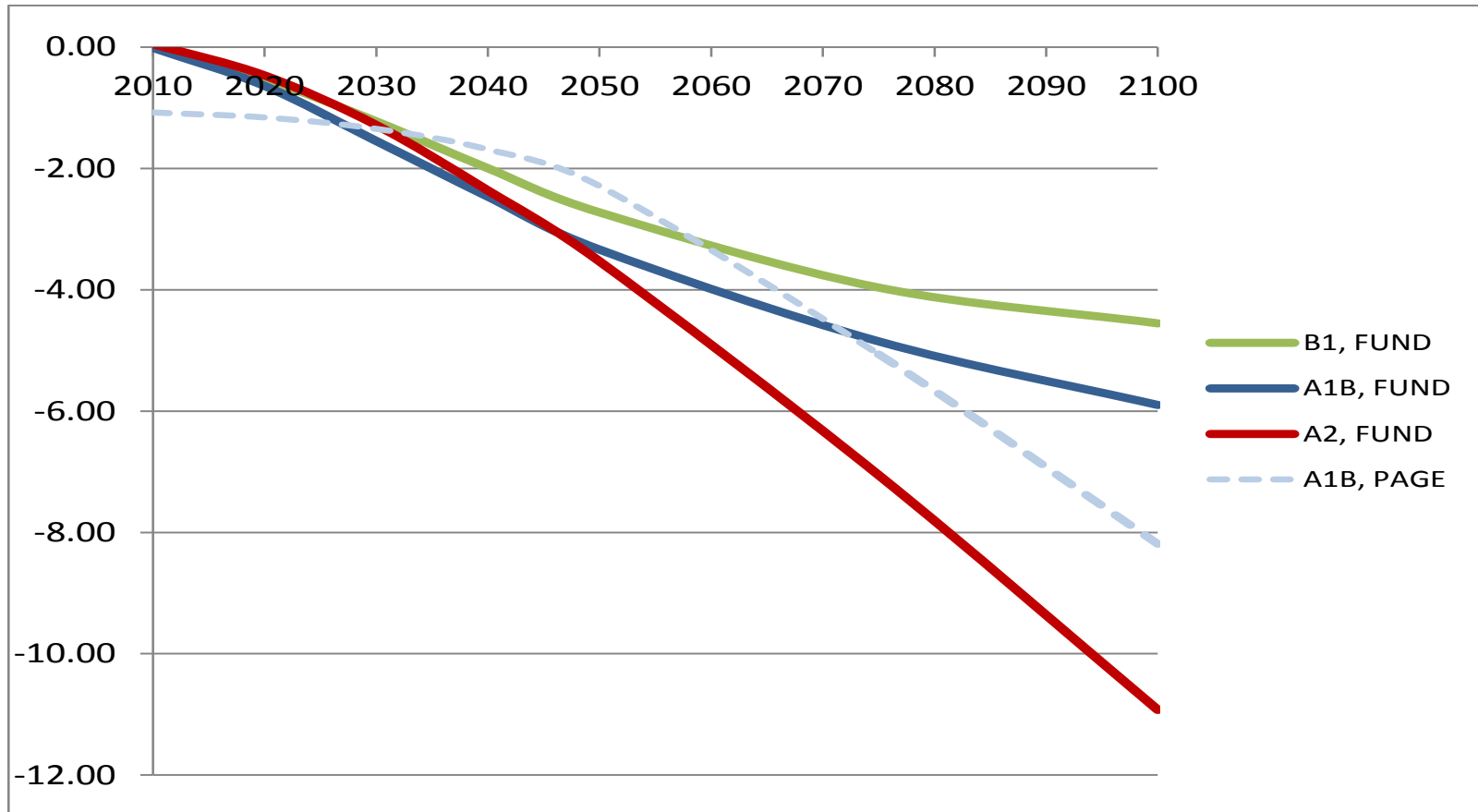
Health effects for 14 Pacific island nations under the A2 (high emissions) scenario, FUND 3.6



# Integrated assessment modeling

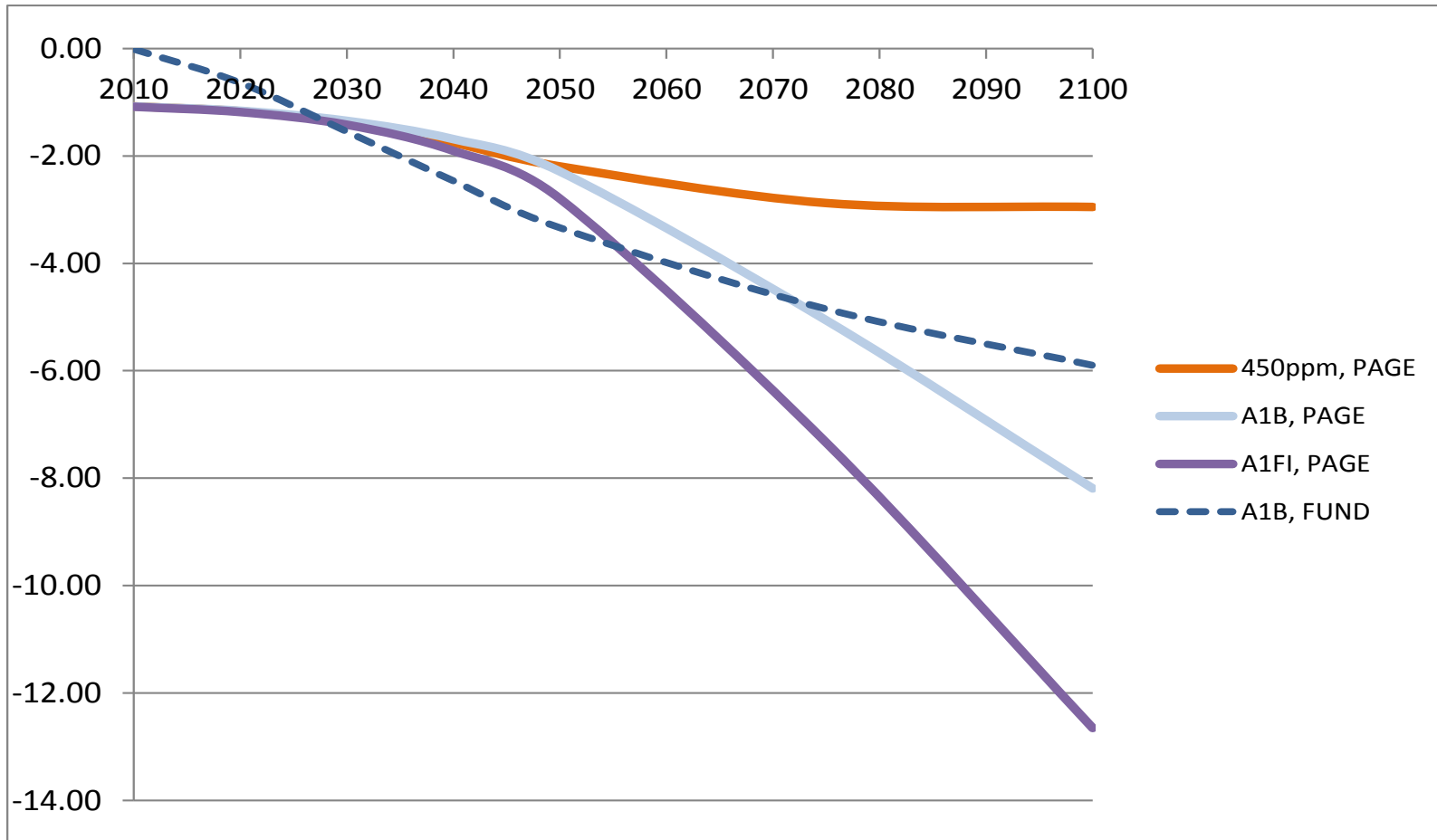
- Integrated climate-economic models
- FUND 3.6
  - Includes agriculture, forestry, sea-level rise, health, energy consumption, water resources, unmanaged ecosystems, and storms
  - Modeled as power functions or movement relative to optimum climatic conditions, in the context of exogenous changes affecting vulnerability
- PAGE09
  - Probabilistic model (Monte Carlo simulation)
  - 8 world regions and ten time periods to the year 2100
  - Four impact sectors (sea level, economic, non-economic, and discontinuities)

# Climate Change Cost in the Pacific by Scenario using FUND3.6



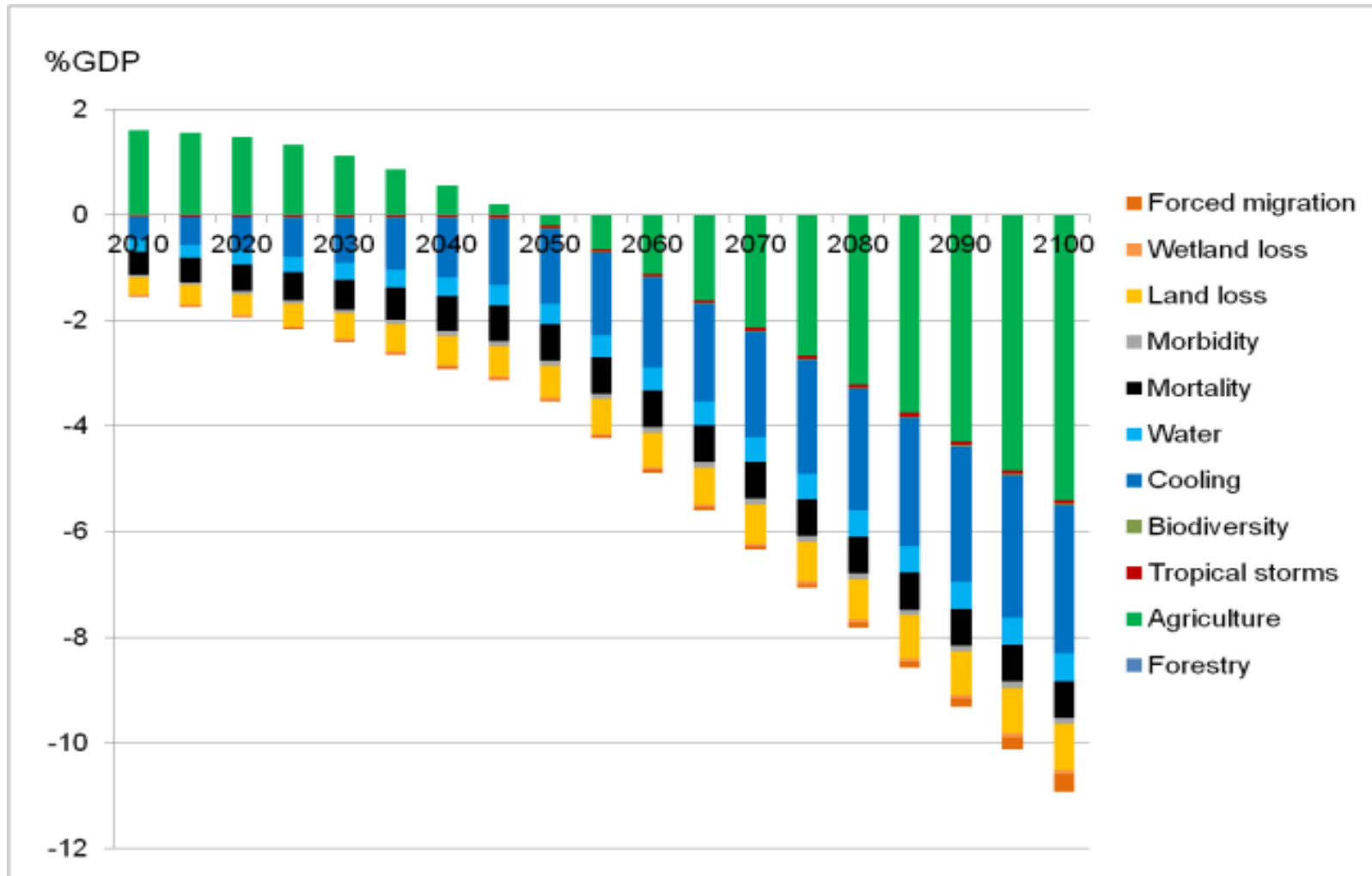
A1B = medium emissions scenario, A2 = high emissions scenario, B1 = low emissions scenario.

# Climate Change Cost in the Pacific by Scenario using PAGE09



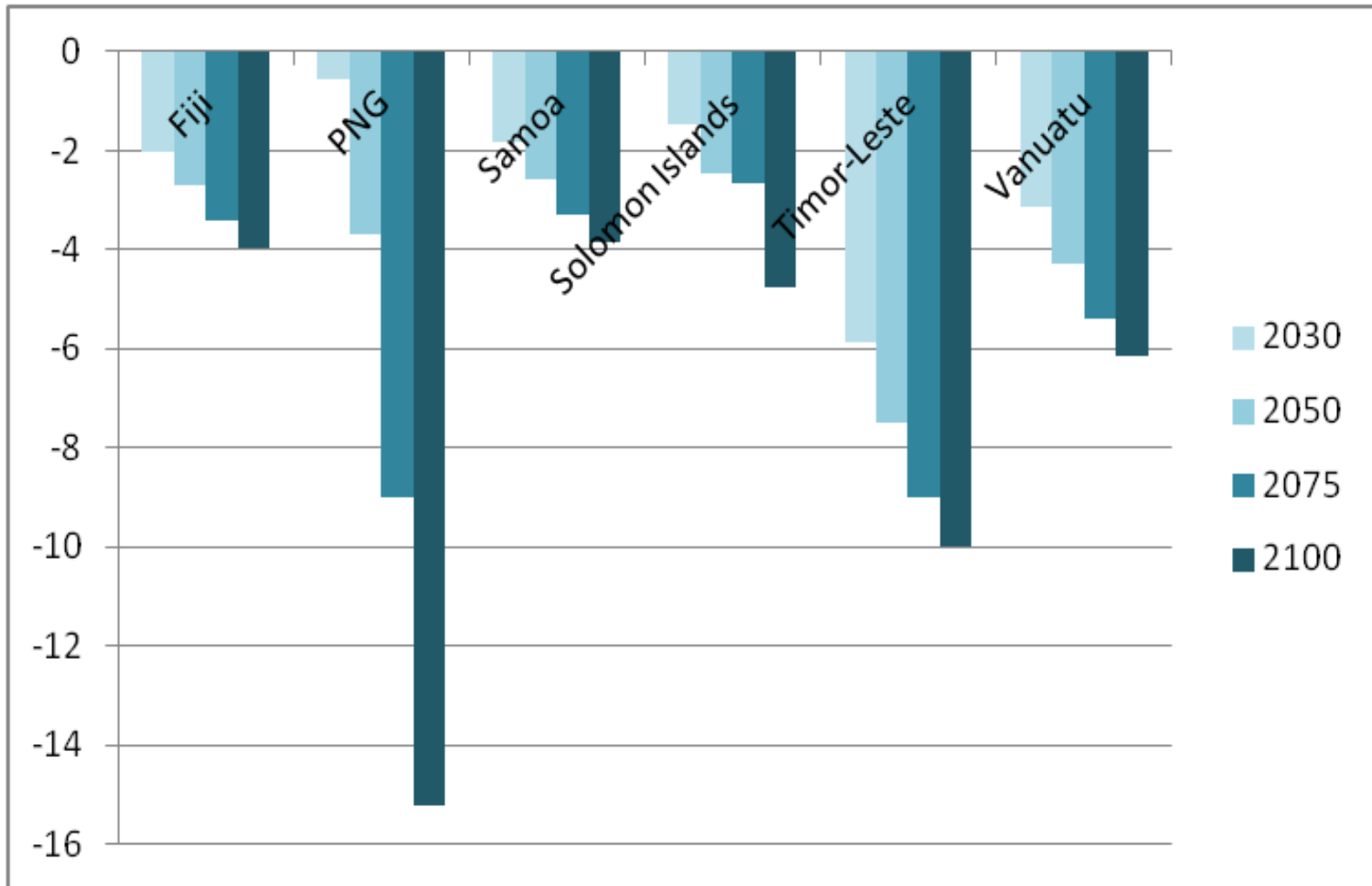
A1B = medium emissions scenario, A1FI = high emissions scenario.

# Overall economic effects by sector (FUND A2 (High Emissions) Scenario)



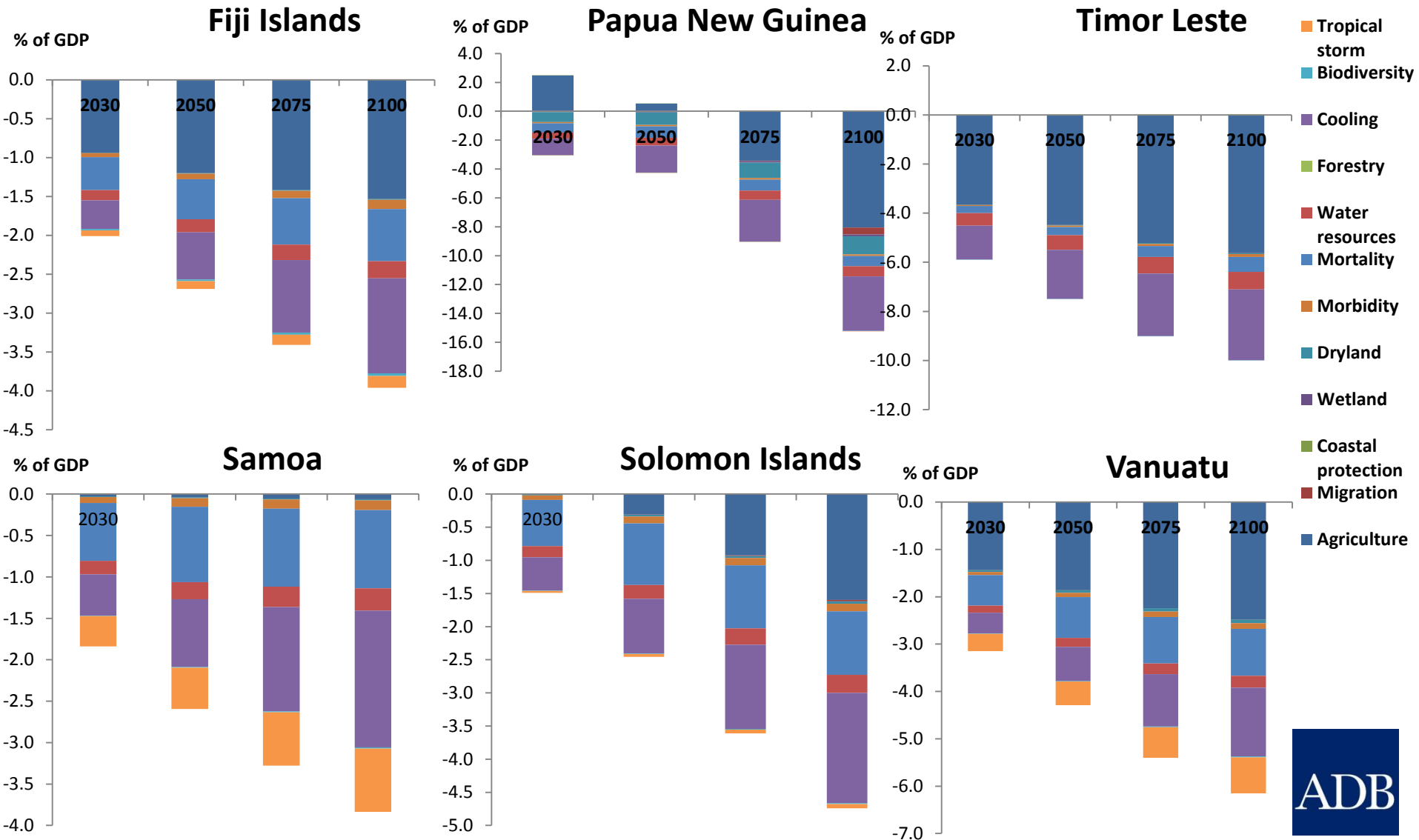
# Economic effects by country

(FUND A2 (High Emissions) Scenario, % GDP loss, annual)

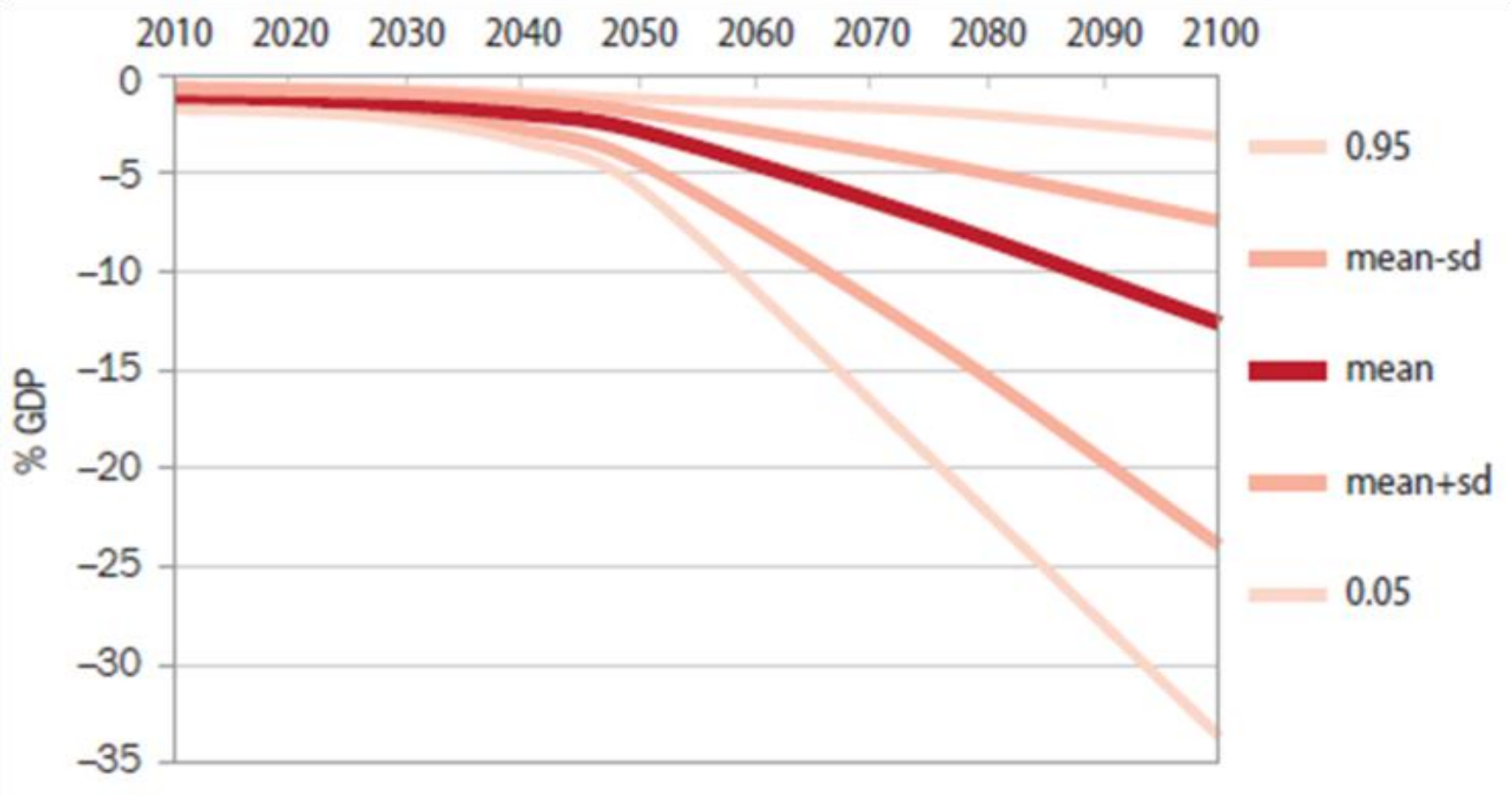


# Sectoral impacts by country

(FUND A2 (High Emissions) Scenario, % GDP, annual)



# Probabilistic Annual Cost of Climate Change in the Pacific (PAGE09, A1FI (high emissions) scenario)



# Annual average adaptation cost during 2010-2050 for Pacific, PAGE09

## a. Adaptation target aimed at the impact by 2100

Scenario	Adaptation target	Annual average cost	Range US\$ million	Annual average cost % GDP	Range % GDP
A1FI(a)	2100 worse case ( 95th percentile)*	446.7	214.6-775.4	1.52	0.78-2.54
A1FI(b)	2100 (4.5°C, 0.70 m SLR)	284.3	131.1-483.7	0.97	0.48-1.59
A1B	2100 (4.0°C, 0.65 m SLR)	253.1	118.9-438.4	0.86	0.44-1.43
450 ppm	2100 (2.5°C, 0.55 m SLR)	158.3	75.2-273.2	0.54	0.27-0.89

Note: The 95th percentile represents the critical point. Moving beyond, there is a low probability ( at 5% chance) that would lead to a catastrophic outcome

## b. Adaptation target aimed at the impact by 2050

Scenario	Adaptation target	Annual average cost	Range US\$ million	Annual average cost % GDP	Range % GDP
A1FI	2050 (2.5°C, 0.30 m SLR)	156.9	75.3-271.8	0.54	0.27-0.89
A1B	2050 (2.0°C, 0.30 m SLR)	126.5	59.7-222.8	0.43	0.22-0.71
450 ppm	2050 (1.9°C, 0.30 m SLR)	119.8	57.3-205.5	0.41	0.21-0.67

A1B = medium emissions scenario, A1FI = high emissions scenario.

# Key messages

- Average temperatures in the Pacific are expected to rise by 2.0-3.0°C above the 1990 level in 2060-2080
- Sea level rise poses a risk of inundation and freshwater salinization
- Effects of climate change on key economic sectors (agriculture, fisheries and tourism) are negative and potentially large
- Health effects will compound other sectoral impacts
- Climate change will cost the Pacific 2.2-3.5% of GDP annually by 2050; further losses are expected by 2100.
- Adaptation funding needs are substantial

# Policy implications

- Mainstreaming climate change actions in development planning is crucial to avoid large climate impacts
- “Low regret” adaptation measures are essential
  - E.g. Stress tolerant varieties, interventions to reduce disease transmission
- Risk-based approaches can help prioritize adaptation needs
- Climate proofing of infrastructure can help improve long-term sustainability
- Improved access to climate finance is needed to support adaptation
- Successful adaptation efforts require strong cooperation and coordination within and beyond the region

# Thank you.

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