Current challenges in the impacts and adaptation to climate change:

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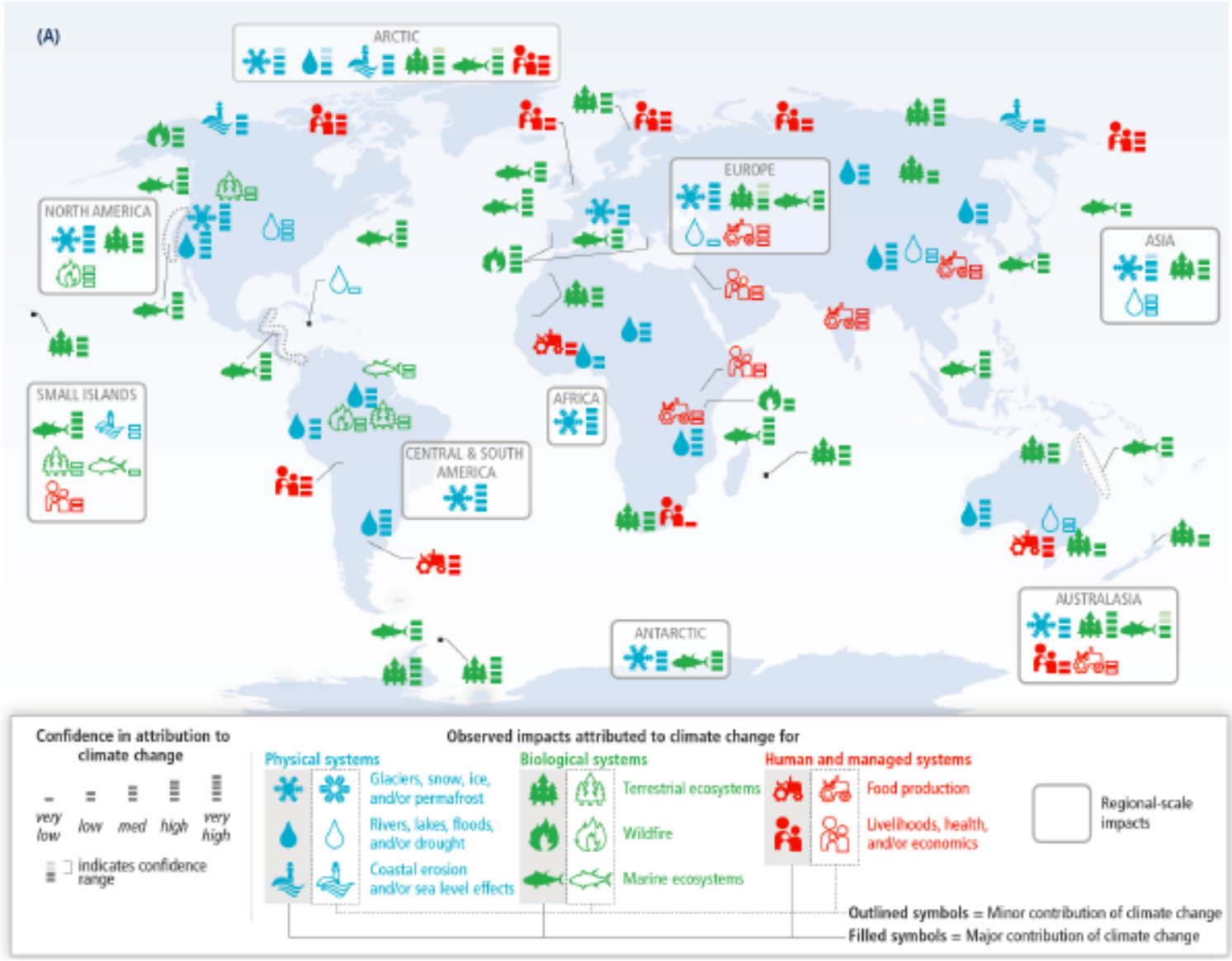
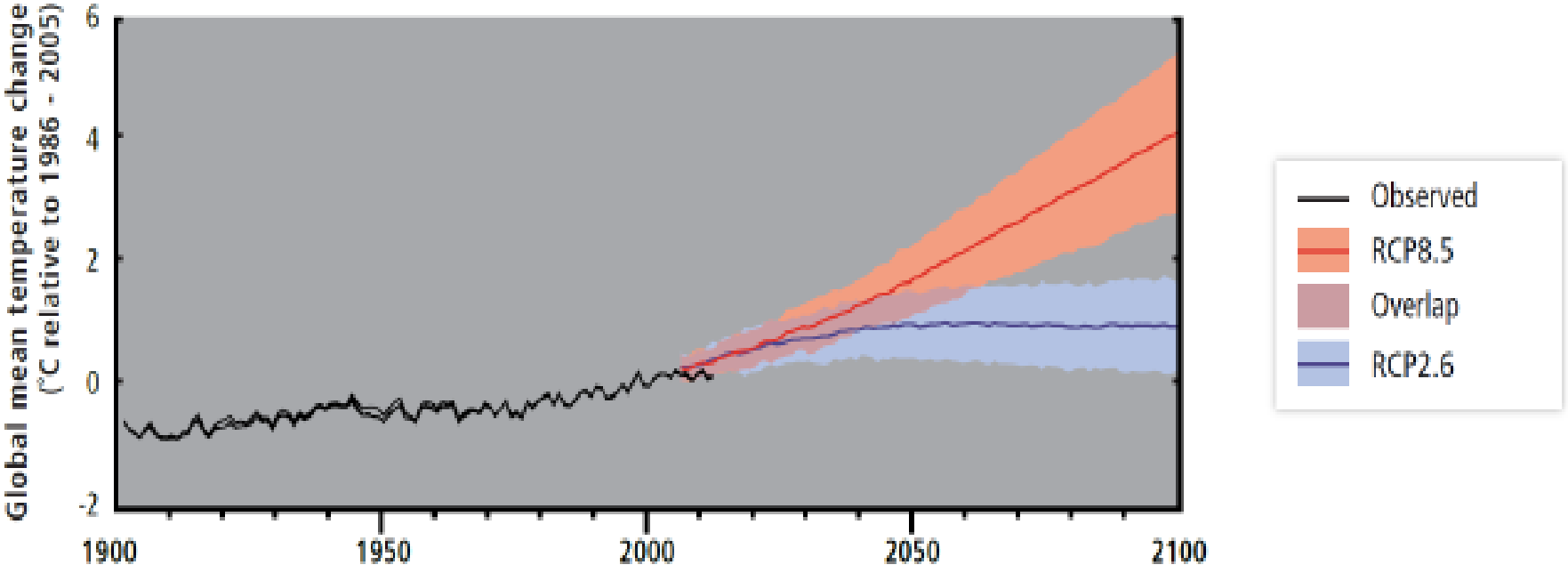
Observed Impacts of CC Vulnerability & Adaptation

- We are already seeing the effects of climate change and responses to it: changing precipitation affecting water resources, shifts in marine species, falls in crop yields and increases in climate related extremes.
- For countries at all levels of development the impacts are consistent with a significant lack of preparedness.

Observed Impacts of CC



Projected Climate Changes



- Observed increases from 1900 to 2005 are about 0.6ºC

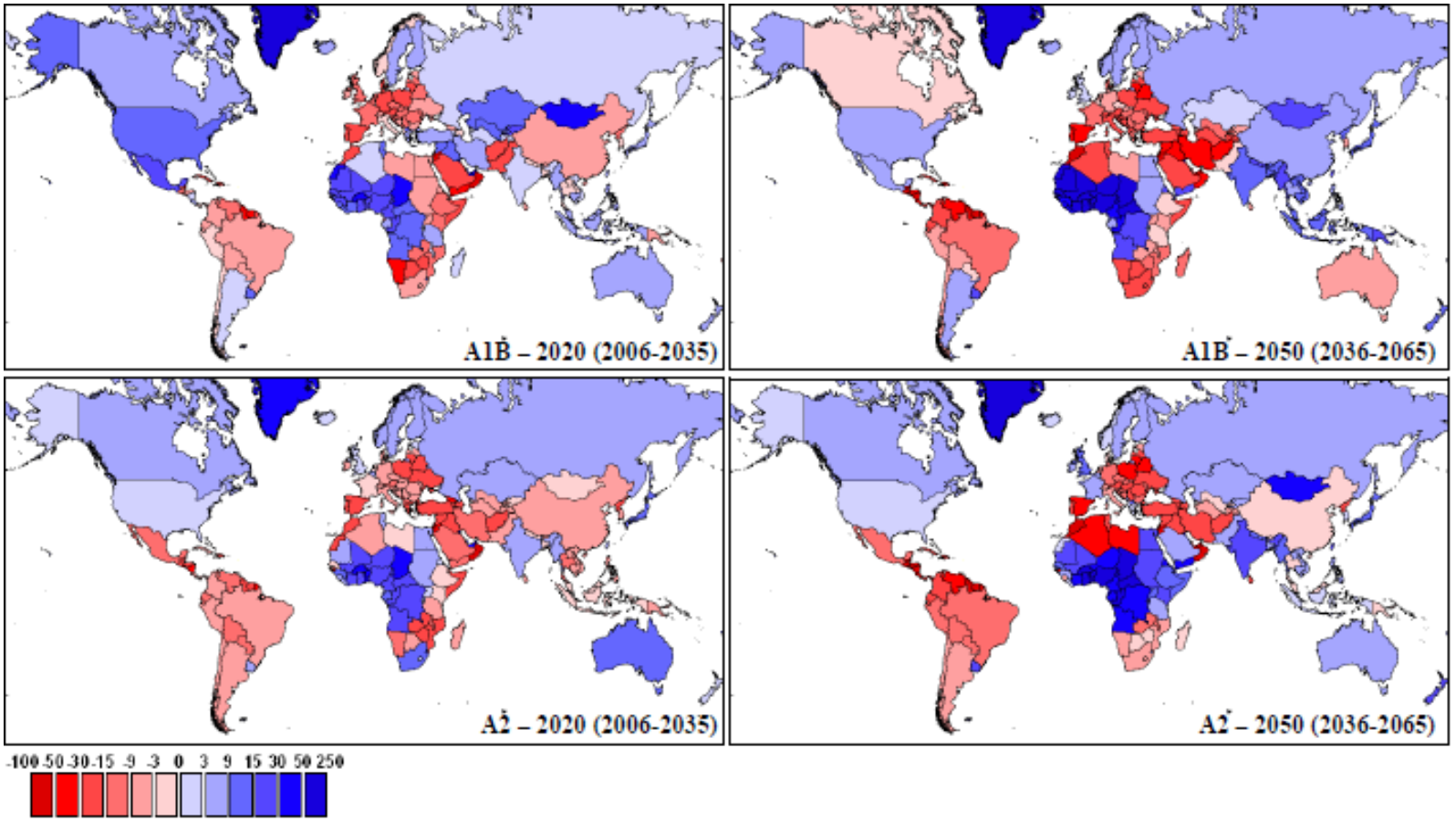
Future Risks

1. Risk of death, injury, ill-health and disrupted livelihoods in low-lying coastal areas and SIDS.
2. Risk of death, injury, ill-health and disrupted livelihoods for large urban populations due to inland flooding in some regions.
3. Systematic risks due to extreme weather events
4. Mortality and morbidity due to extreme heat
5. Food insecurity linked to warming, drought, floods, especially for poor populations.
6. Risks of loss of rural livelihoods due to lack of irrigation water and reduced agricultural productivity.
7. Loss of marine ecosystems, biodiversity and services they provide for coastal livelihoods.
8. Loss of terrestrial ecosystems and the services they provide for livelihoods.

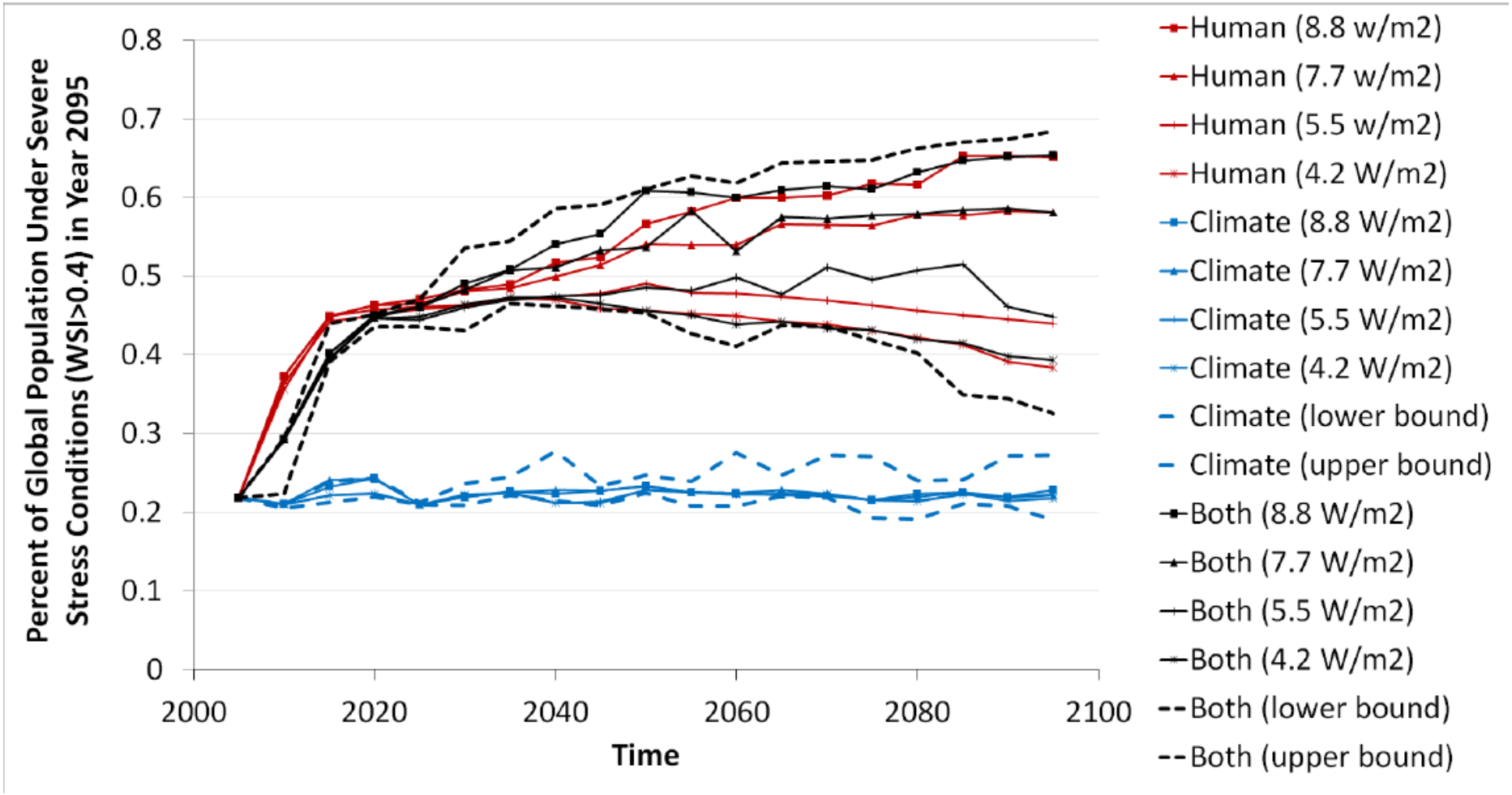
Sectoral Risks & Potential for Adaptation: Freshwater

- Projections are for a reduction in renewable surface and groundwater water in most sub-tropical regions.
- In contrast water resources are projected to increase in high latitudes.
- Quality of water likely to decline everywhere.
- Adaptation options: scenario planning, learning based approaches, flexible non-regret solutions can increase resilience to uncertain hydrological changes.

Percentage Change in Annual Average River Flow for 2020 and 2050 Under Two Emissions Scenarios Relative to the 1961-1990 Average



% of Population Facing Severe Water Stress: Human Dimension Dominates



Sectoral Risks & Potential for Adaptation: Terrestrial Ecosystems

- A large fraction of both terrestrial and freshwater species faces increased extinction risk under projected climate change during and beyond the 21st century, as climate change interacts with other stressors., such as habitat modification, over-exploitation, pollution, and invasive species.
- Valuation of these impacts in money terms is difficult and most studies do not attempt to do that.

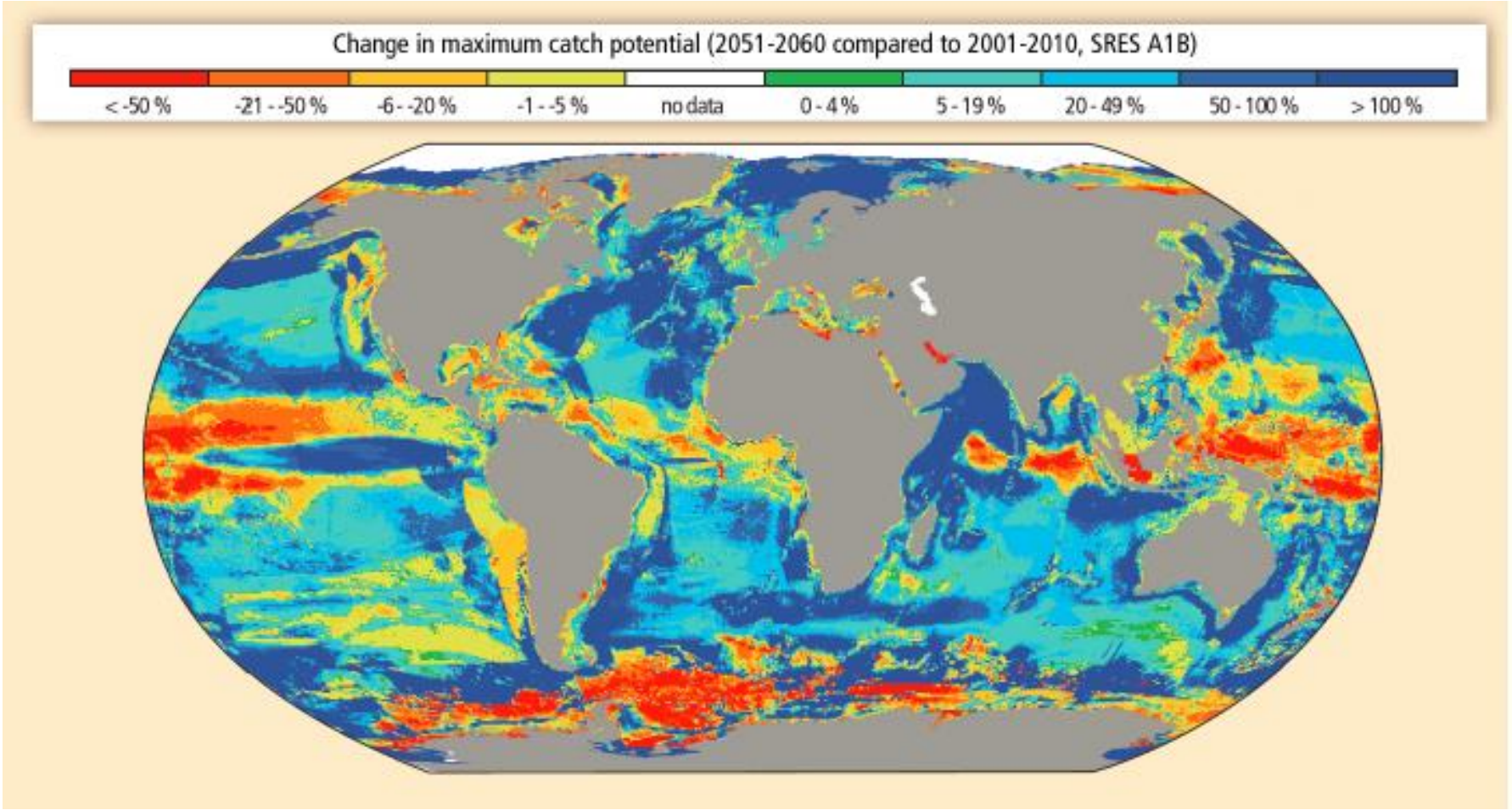
Sectoral Risks & Potential for Adaptation: Coastal & Low Lying Areas

- Sea-level rise projected throughout the 21st century and beyond, will increasingly cause adverse impacts such as submergence, coastal flooding, and coastal erosion.
- The population and assets exposed to coastal risks will increase significantly in the coming decades due to population growth, economic development, and urbanization.
- Adaptation options include protection measures as well as land use planning. Costs vary a lot by region and in some islands could be very high.

Sectoral Risks & Potential for Adaptation: Marine Ecosystems

- Spatial shifts of marine species due to projected warming will cause high-latitude invasions and high local-extinction rates in the tropics and semi-enclosed seas.
- Richness and fisheries catch potential are projected to increase, on average, at mid and high latitudes and decrease at tropical latitudes.
- For medium to high emissions scenarios ocean acidification poses substantial risks to marine ecosystems, especially polar ecosystems and coral reefs.
- Adaptation options discussed include large scale translocations of industrial fishing, flexible management, reductions of other stressors such as pollution, restoration of mangroves, coral reefs etc..

Changes in Catch Potential 2050+



Sectoral Risks & Potential for Adaptation: Food Security

- Projected changes in yields vary a lot by region and crop. Declines are larger in low latitudes and declines increase in all regions over time.
- Adaptation measures include development of more resilient varieties, shifts to crops that are less affected by climate change, changes in timing of crops and increased efficiency in the use of water.
- A part of this is autonomous but a part involves public decision-making.

Sectoral Risks & Potential for Adaptation: Urban Areas

- Heat stress, extreme precipitation, inland and coastal flooding, landslides, air pollution, drought, and water scarcity pose risks in urban areas.
- Risks are amplified for those lacking essential infrastructure and services or living in poor-quality housing and exposed areas.
- Reducing basic service deficits, improving housing, and building resilient infrastructure systems could significantly reduce vulnerability and exposure in urban areas.
- Urban adaptation benefits from effective multi-level urban risk governance, alignment of policies and incentives, strengthened local government and community adaptation capacity, synergies with the private sector, and appropriate financing and institutional development

Sectoral Risks & Potential for Adaptation: Human Health

- Until mid-century, projected climate change will impact human health mainly by exacerbating health problems that already exist . Throughout the 21st century, climate change is expected to lead to increases in ill-health in many regions and especially in developing countries with low income
- Examples include greater likelihood of injury, disease, and death due to more intense heat waves and fires; increased likelihood of under-nutrition resulting from diminished food production in poor regions; risks from lost work capacity and reduced labor productivity in vulnerable populations; and increased risks from food- and water-borne diseases and vector-borne diseases.

Estimated Deaths in 2030 Due to CC

Region	Under-Nutrition	Malaria	Dengue	Diarrhoea	Heat	Total
W. Europe	0	0	0	2	2,625	2,627
SS Africa	66,573	57,445	7	30,549	2,797	157,371
World	95,176 [-119,807 to 310,156]	60,091 [37,608 to 117,001]	258 [136 to 331]	48,114 [21,097 to 67,702]	37,588 [26,912 to 48,390]	241,227 [-34,054 to 543,580

Extreme events such as floods are not included. Over the last 30 years weather-related events have claimed average of 30,000 lives/year

Sectoral Risks & Potential for Adaptation: Human Security

- Climate change over the 21st century is projected to increase displacement of people.
- Displacement risk increases when populations that lack the resources for planned migration experience higher exposure to extreme weather events, particularly in developing countries with low income.
- Expanding opportunities for mobility can reduce vulnerability for such populations.
- Climate change can indirectly increase risks of violent conflicts in the form of civil war and inter-group violence by amplifying well-documented drivers of these conflicts such as poverty and economic shocks.

CC and Social Tension

- Each one standard-deviation increase in temperature and precipitation results in an increase of interpersonal violence by 4% and intergroup conflict by 14%. (Hsiang, 2013).
- The Internal Displacement Monitoring Centre (IDMC) 2016 *Global Report on Internal Displacement*, estimates that 19.2 million people have been displaced by natural disasters in 2015, with a note that these trends could be set to increase in the face of a changing climate.
- Migration is a coping mechanism that have benefits and costs but we must not forget that many people cannot migrate and are trapped.

Other Impacts on Economic Sectors

- In most sectors other factors such as change in population, age structure, technology, relative prices and governance have bigger impacts than climate change.
- CC is expected to change energy demand between heating and cooling, location choices, demand for water. For increases in temperature of around 2ºC losses are estimated between 0.2 and 2% of income. But there are large differences between countries and losses go up with temperature.

Estimates of Economic Costs: Paradox

- The economic costs of climate change to 2060 are small. Globally they amount to about 2% of GDP, although they vary quite a lot by region, with South Asia and SS Africa having the highest losses.
- In terms of GDP per capita, these figures are even smaller given the expected growth in national income to 2060.
- The following chart shows the losses by sector and region.

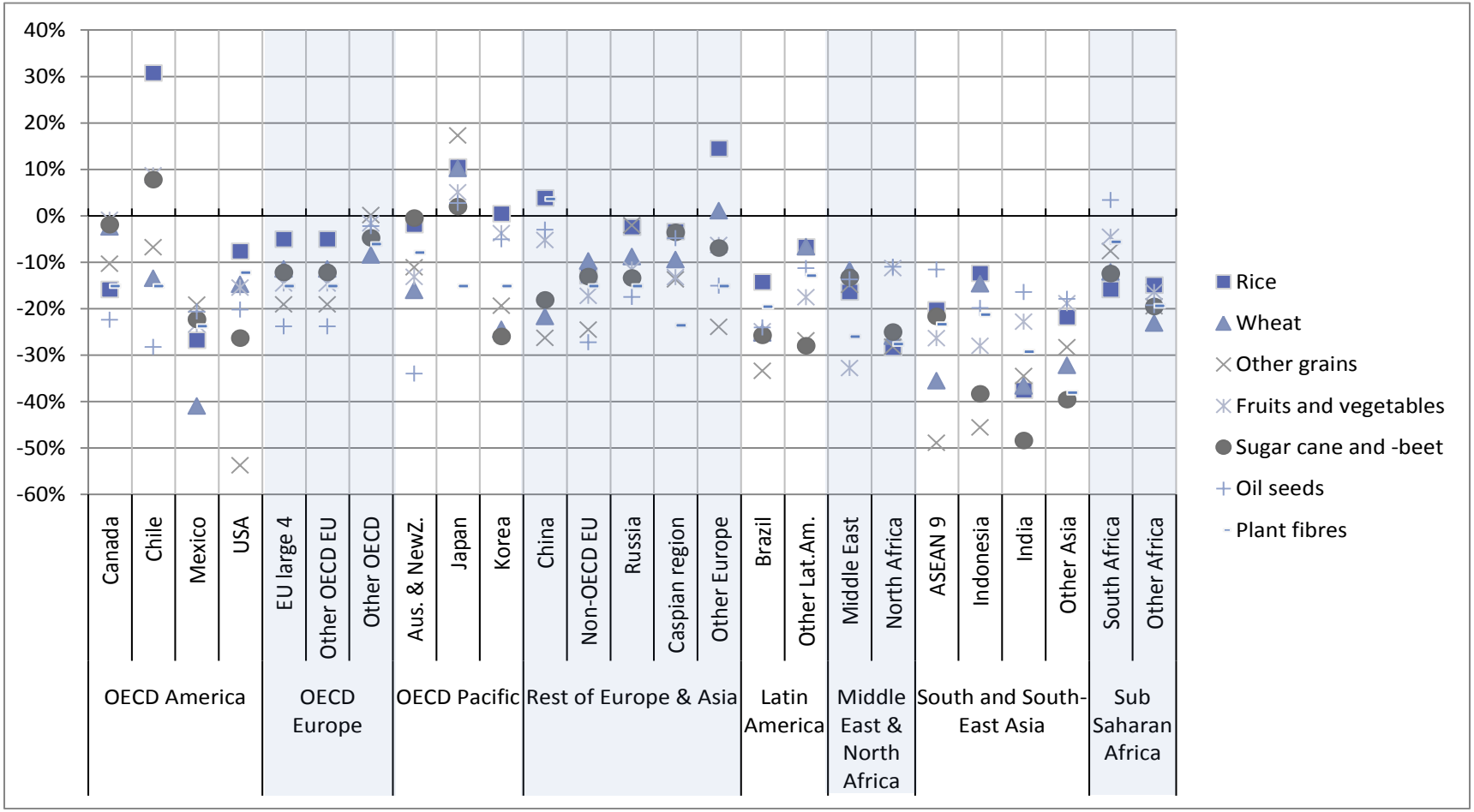
Valuation of Impacts in Money Terms

- Models divide impacts into those up to 2060 and those beyond 2060.
- Up to 2060 the modellers use CGE models, with exogenous growth paths that are affected by climate change.
- Beyond 2060 it is difficult to use such models as the structure of the economy is too uncertain. So IAM models are used at higher levels of aggregation.

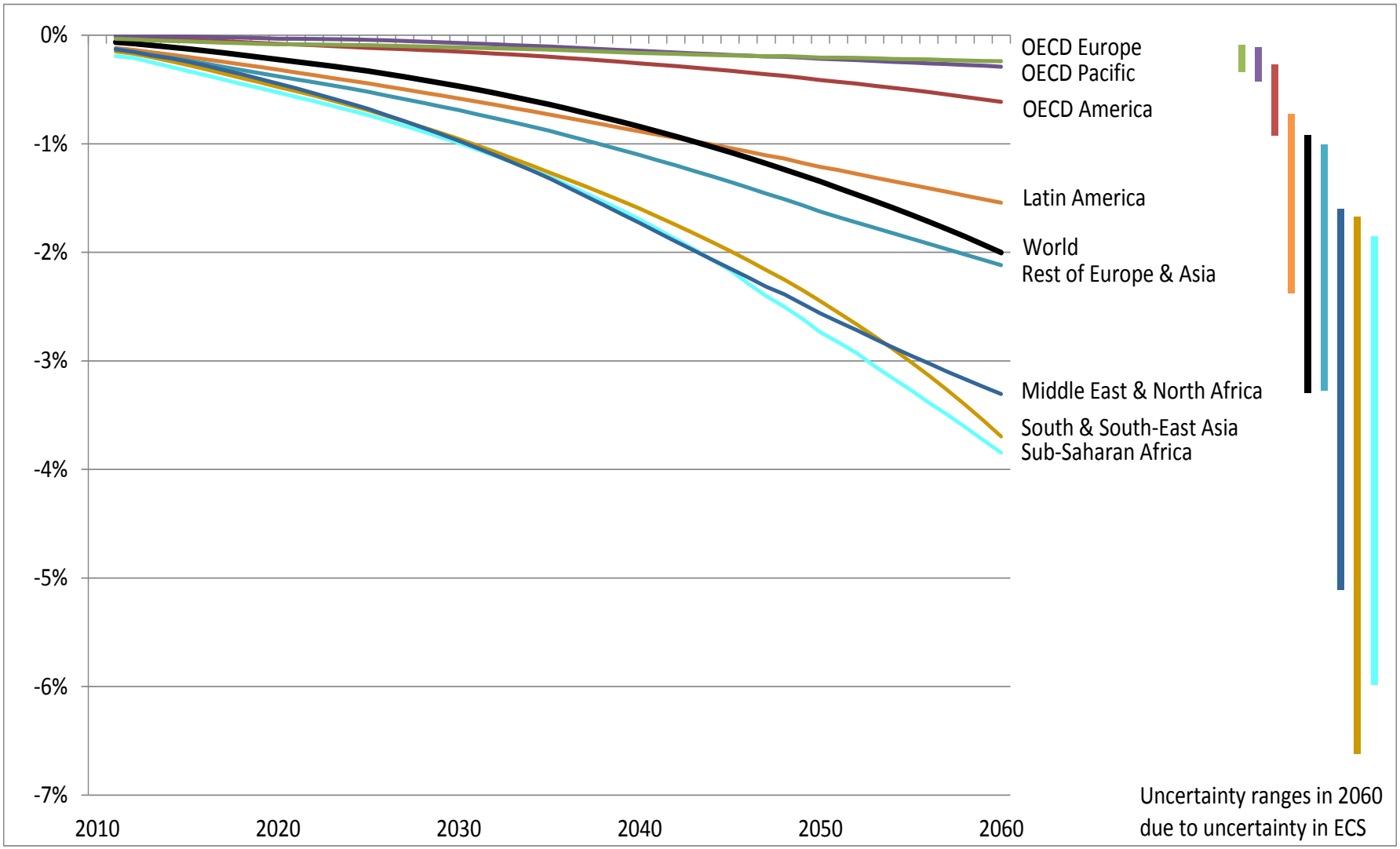
Impacts Valued and Not Valued

Climate Impacts	Impacts modelled	Source	Project	Time frame
Agriculture	Changes in crop yields	IMPACT model - Nelson et al. (2014)	Ag-MIP	2050
	Changes in fisheries catches	Cheung et. al (2010)	SESAME	2060
Coastal zones	Loss of land and capital from sea level rise	DIVA model - Vafeidis et al. (2008)	Climate Cost	2100
Extreme events	Capital damages from hurricanes	Mendelsohn et al. (2012)		2100
Health	Mortality and morbidity from infectious diseases, cardiovascular and respiratory diseases	Tol (2002)		2060
	Morbidity from heat and cold exposure	Roson and Van der Mensbrugghe (2012) and Ciscar et al. (2014) for Europe	World Bank ENVISAGE Peseta II (Europe)	2060
Energy demand	Changes in energy demand for cooling and heating	IEA (2013)	WEO	2050
Tourism demand	Changes in tourism flows and services	HTM - Bigano et. al (2007)	ClimateCost	2100
Ecosystems	No additional impacts covered in the modelling exercise			
Water stress	No additional impacts covered in the modelling exercise			
Tipping points	Not covered in the modelling exercise			

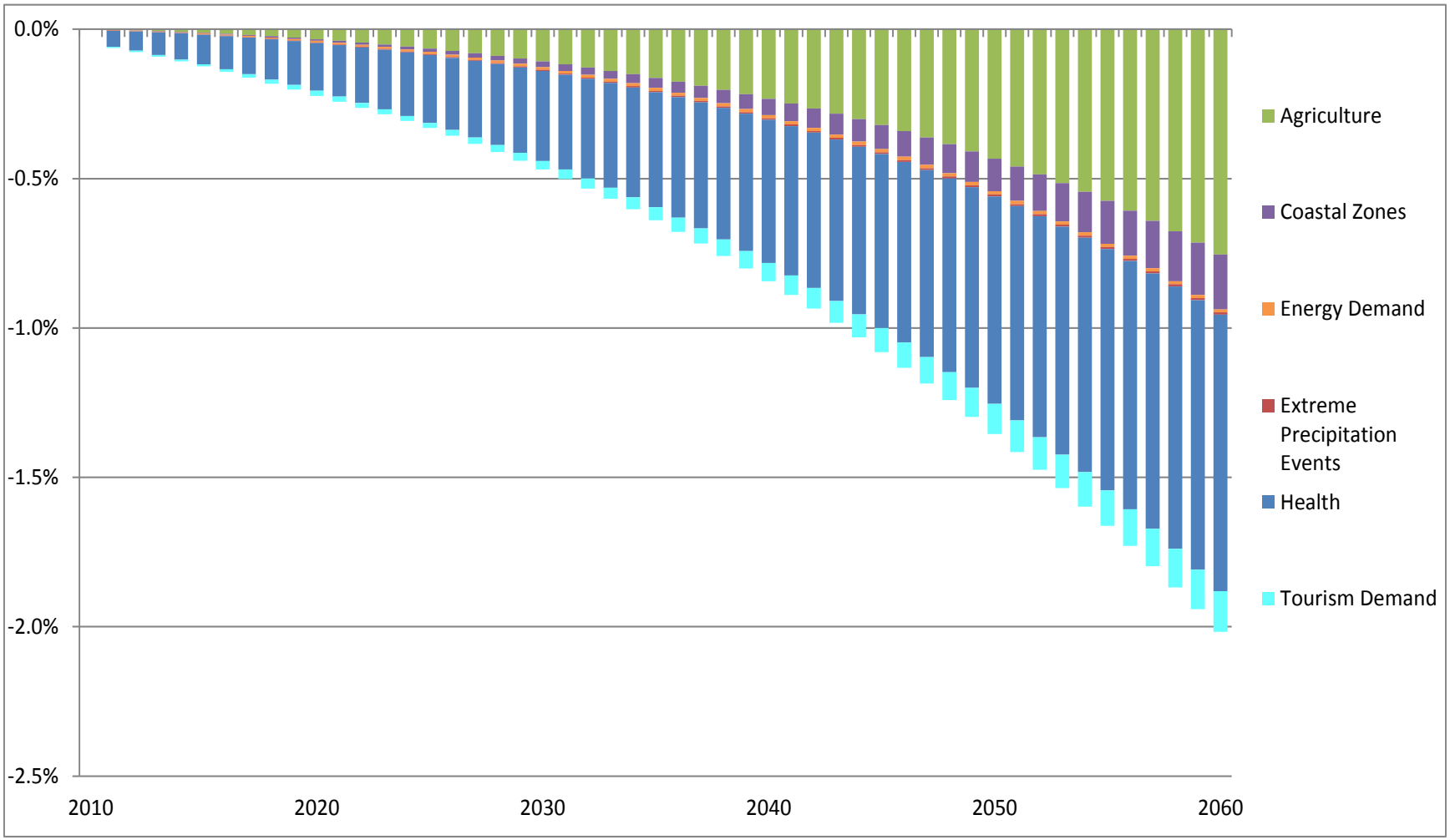
Impacts of CC on Crop Yields

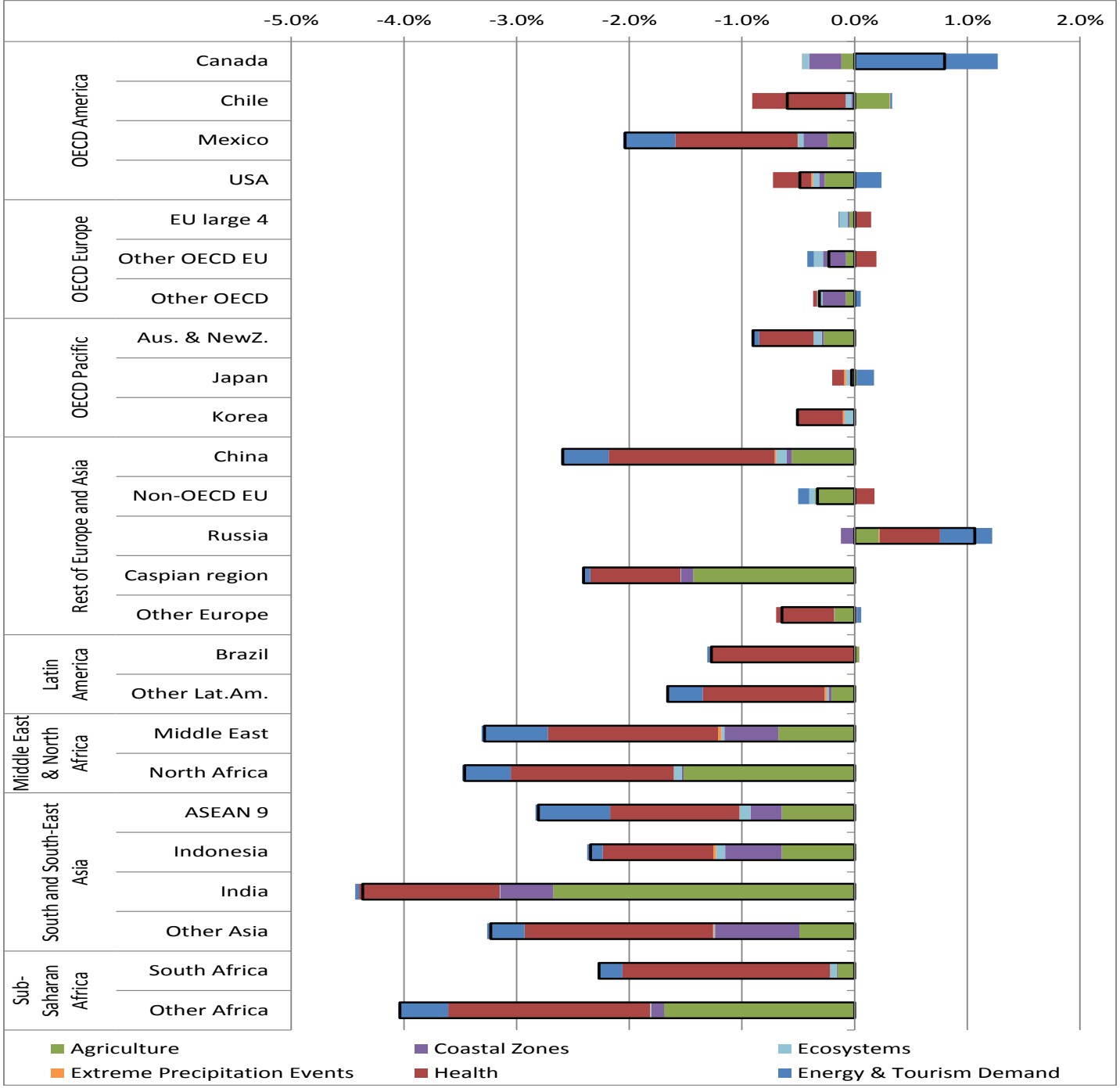


Regional Impacts of CC to 2060 (% of GDP)



Attribution of Damages By Sector




-5.0%
-4.0%
-3.0%
-2.0%
-1.0%
0.0%
1.0%
2.0%
OECD America
Canada
Chile
Mexico
USA
OECD Europe
EU large 4
Other OECD EU
Other OECD
OECD Pacific
Aus. & NewZ.
Japan
Korea
Rest of Europe and Asia
China
Non-OECD EU
Russia
Caspian region
Other Europe
Latin America
Brazil
Other Lat.Am.
Middle East & North Africa
Middle East
North Africa
South and South-East Asia
ASEAN 9
Indonesia
India
Other Asia
Sub-Saharan Africa
South Africa
Other Africa
Agriculture
Coastal Zones
Ecosystems
Extreme Precipitation Events
Health
Energy & Tourism Demand

A Sceptical View of CC

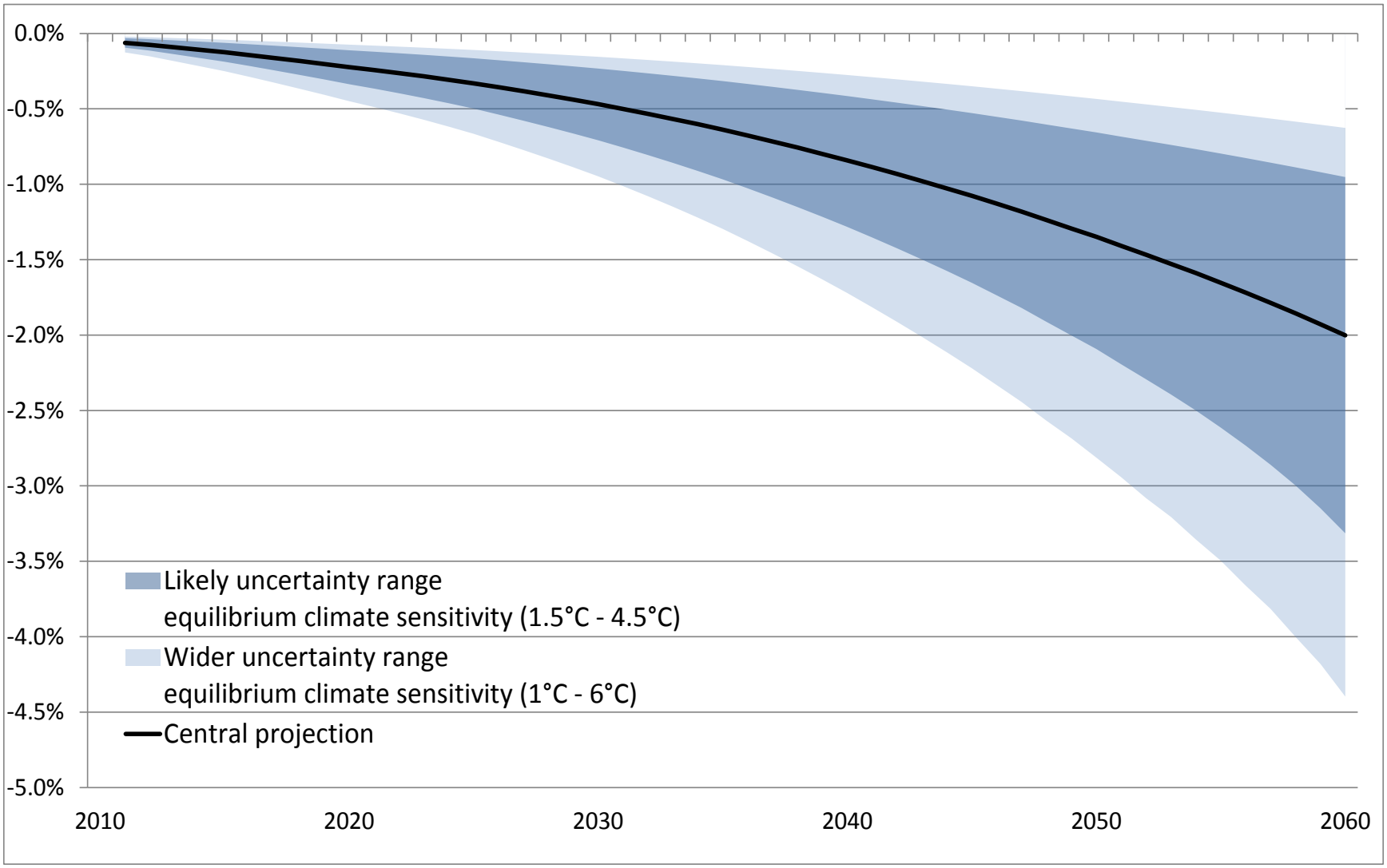
SSP1	GDP PC US$PPP		
	2010	2060	
		NO CC	CC
Germany	33,138	65,539	65,015
Spain	26,961	47,769	47,291
India	2,983	33,173	31,680
Kenya	1,481	17,450	16,752

Projections are from OECD SSP Scenario 1: Sustainable Growth
With projections like these climate change is "Much Ado About Nothing"!

What is Wrong with Economic Estimates of CC Damages to 2060?

- Not all impacts covered in economic assessment (livestock, possible loss of life)
- Considerable uncertainty in the estimates. If the upper bound turns out to be right the figures could be 2-3 times higher. Key source of uncertainty is Equilibrium Climate Sensitivity (ECS)
- The process for making the estimates is strongly driven by the underlying growth in the economy, which is assumed here to be around 2.8% per annum.
- The CGE model assumes relatively easy substitution between factors, so when there is a shock and an input such as land or water is reduced the model assumes the input can be replaced with other factors and any displaced labor can be absorbed by other sectors of the economy in a painless fashion.
- **But even including all these, we don't get huge average damage estimates to 2060!**

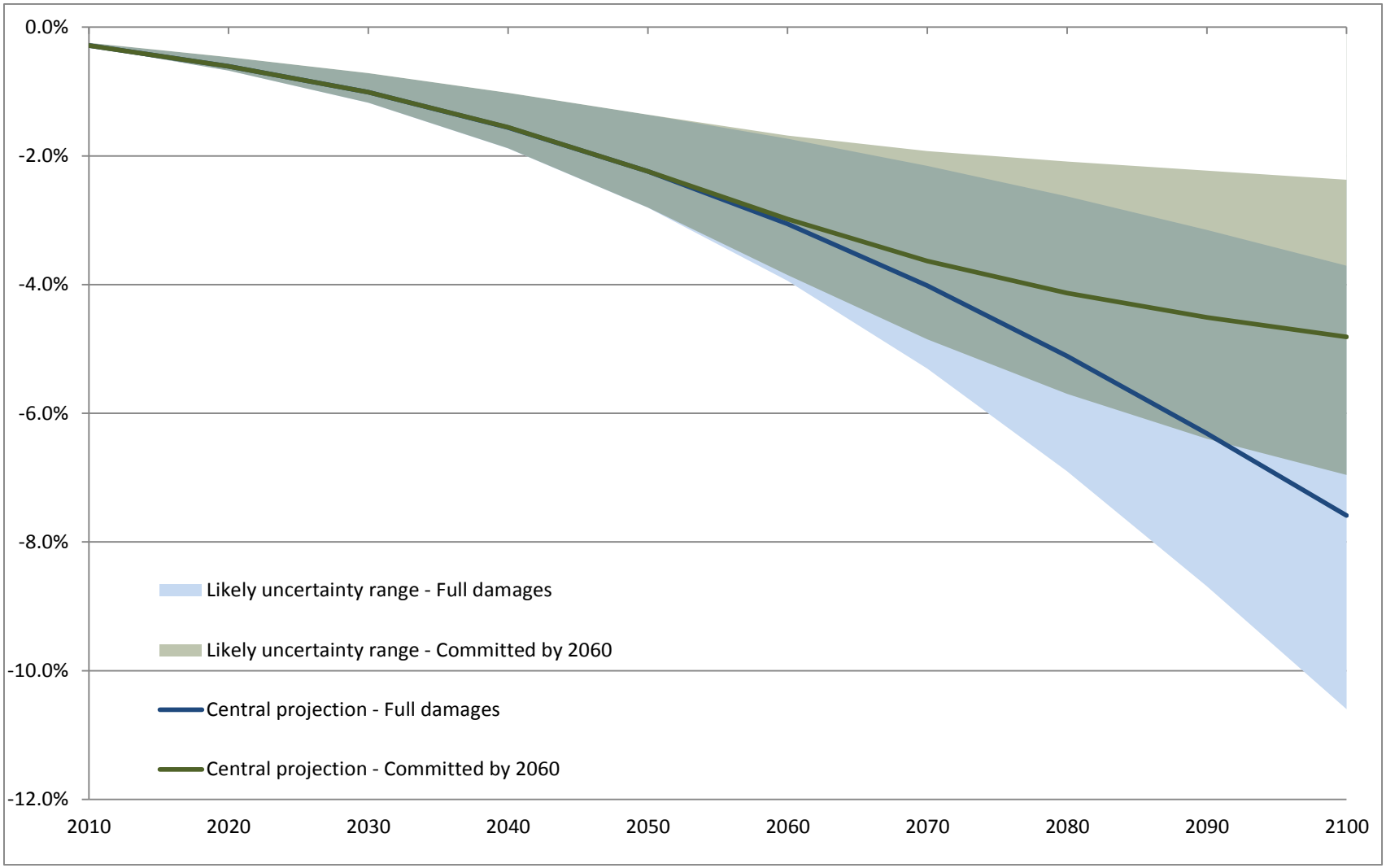
Uncertainty in Economic Cost Due to ECS



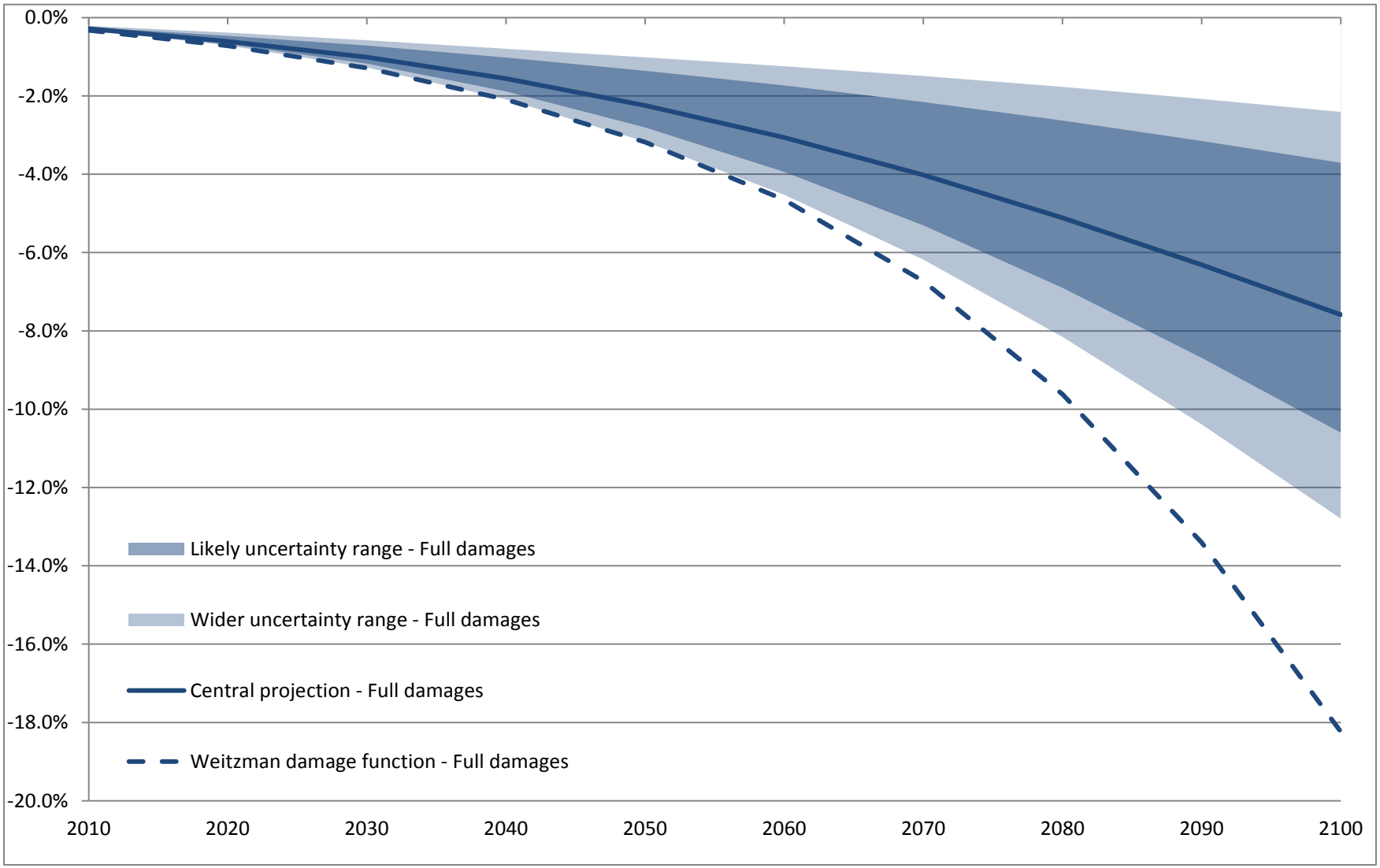
Estimates Beyond 2060

- Much more difficult to make – cannot use the detailed CGE models that link impacts of CC to individual sectors.
- Damage functions are very rough and uncertain, especially with temperature increase above $4^{o}C$.
- But even with all limitations, we can be sure damages are much bigger from 2060 onwards.
- And uncertainty is greater
- Moreover there is a lot of inertia built in from existing emissions.

Damages to 2100: “Normal Damage Function”



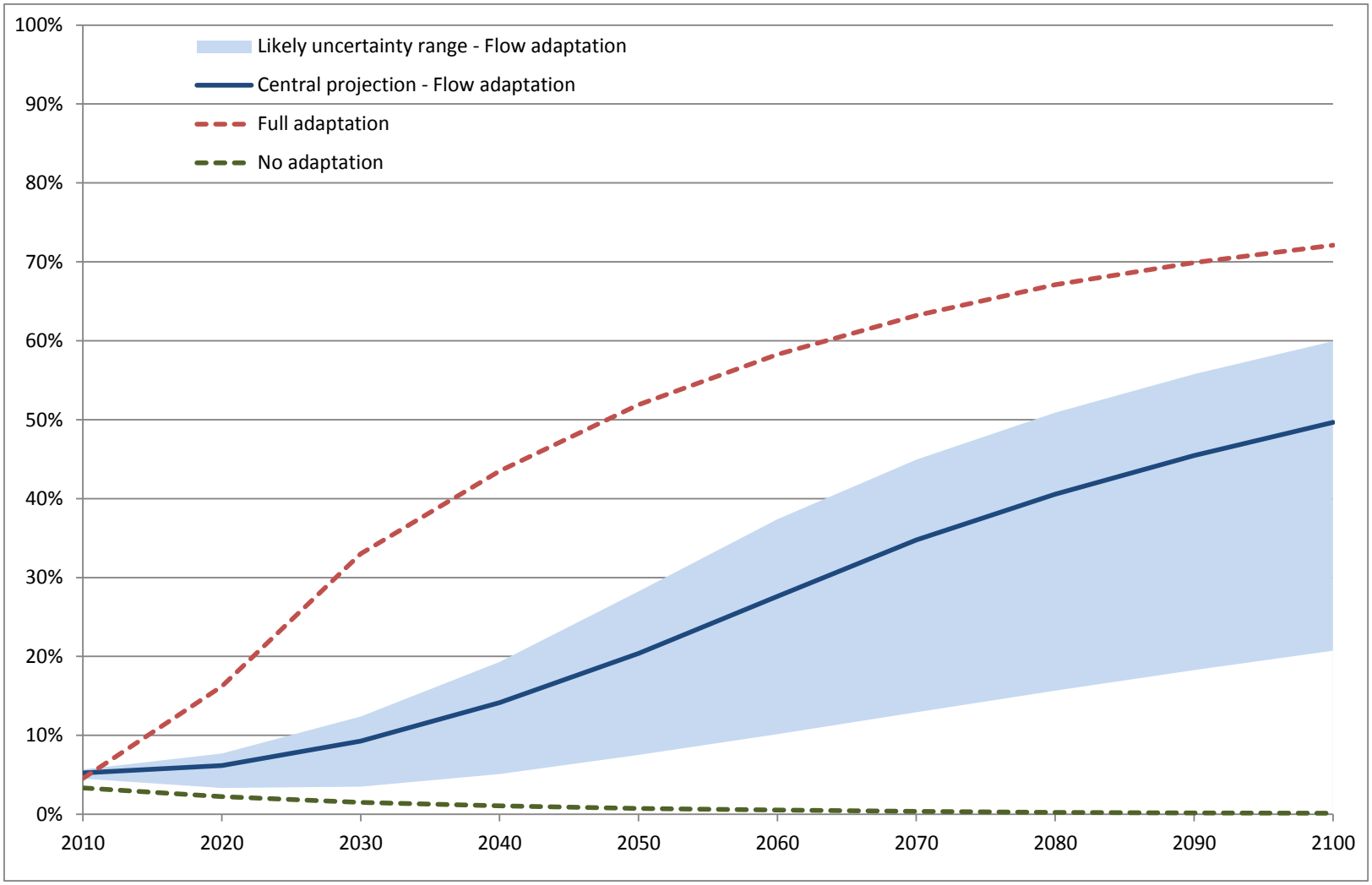
Damages to 2100: “Weitzman Damage Function”



Key Messages from the Impact Analysis

- Quantified damages to 2060 are modest if the growth story is true.
- But lack of action to mitigate emissions locks in further increases in temperature beyond 2060 that are not so modest.
- And they have a large uncertainty range. At the upper end of the potential increase modern economies may not function.
- And the changes are irreversible!

Percentage of Damages Addressed By Adaptation



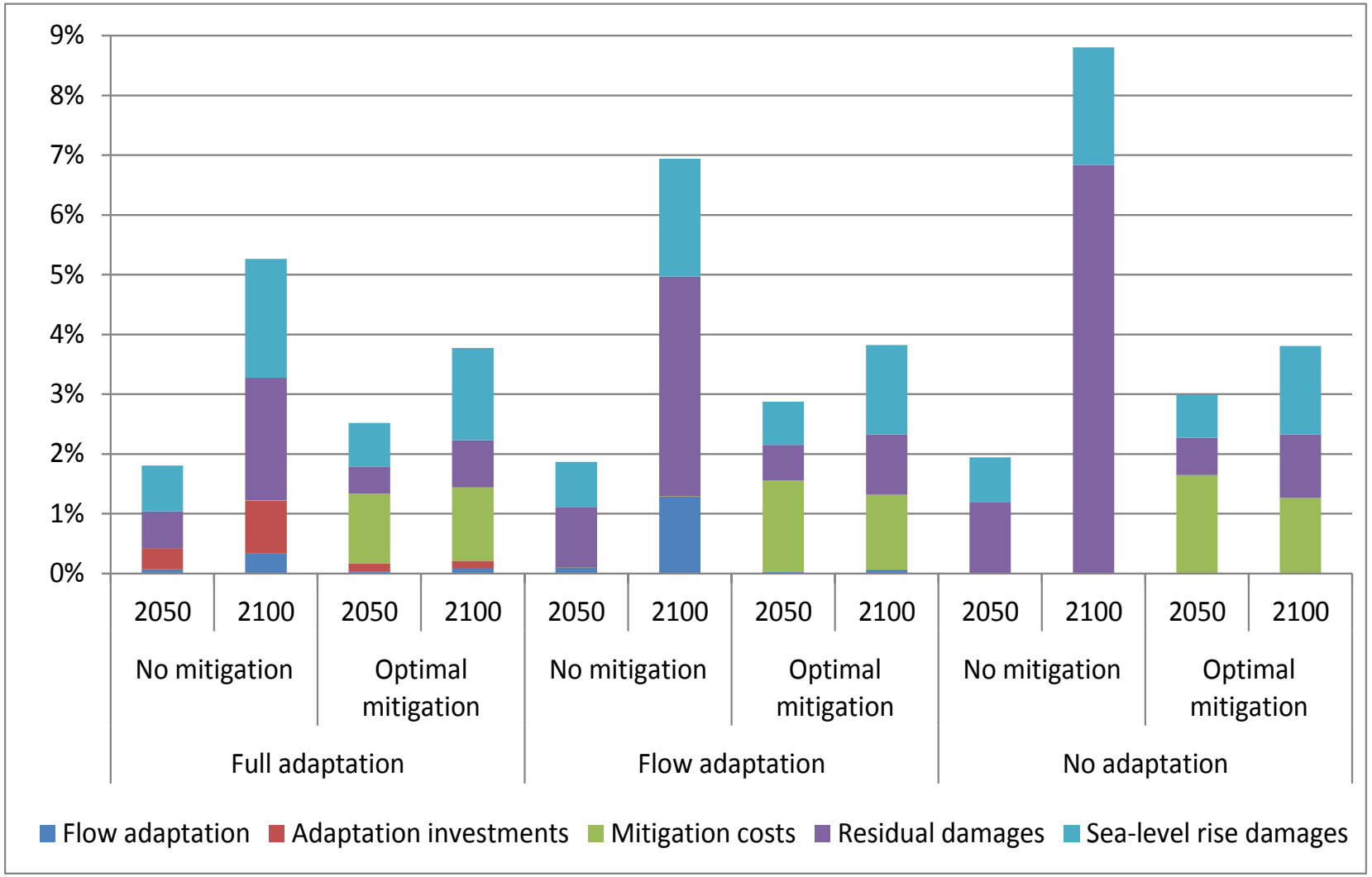
Mitigation and/or Adaptation

- The optimal level of emission reductions results from equating the marginal costs of one unit of additional emission reduction with the discounted stream of additional avoided damages.
- What discount rate do we take for this? Major debate in climate economics.
- The least-cost emission pathway implies a small reduction in the absolute level of emissions until 2030 and a more rapid reduction afterwards. The lower the equilibrium climate sensitivity, the lower the benefits from emission reduction are, and hence the larger the flexibility to adjust the timing of emission reductions in the least-cost emission pathway. With high ECS the reductions have to be much greater early on (e.g. Weitzman type function).

Interactions Between Mitigation and Adaptation

- The role of adaptation is much smaller when damages are limited by least-cost mitigation action.
- Adaptation and mitigation are both powerful instruments to limit climate damages.
- In terms of cost minimisation, both policies are needed.
- Next figure clearly shows that adaptation cannot be a perfect substitute for mitigation. If only adaptation policies are available damages are substantially larger than when only mitigation policies are available

Total Costs With Mitigation/ Adaptation Combinations



Adaptation Finance in Developing Countries

- Bottom-up estimates of the costs of adaptation range from USD 140-300 billion in 2030 and USD 280-500 billion in 2050.
- Top-down estimates of the costs of adaptation in 2050 range from USD 70-100 billion to as much as USD 940 billion
- Bilateral and multilateral adaptation finance flows have been increasing and totalled USD 25 million in 2014. Current commitments are for a fund of USD 100 billion.
- So there is a big gap to fill!

Principles for Effective Adaptation

1. Recognition of diverse interests, circumstances and contexts can benefit decision-making.
2. The decision support is most effective when it is sensitive to context and diversity of decision types, processes and constituencies.
3. Existing and emerging economic instruments can foster adaptation by providing incentives for anticipating and reducing impacts.

Principles for Effective Adaptation

4. Common constraints that impede adaptation include limited financial and human resources, limited integration of governance, uncertainties about projected impacts etc. Underestimating the complexity of adaptation as a social process can create unrealistic expectations of outcomes.
5. Poor planning, emphasizing short term outcomes or failing to anticipate consequences can result in maladaptation.

Principles for Effective Adaptation

6. Limited evidence indicates a gap between global adaptation needs and the funds available for adaptation.
7. Significant co-benefits, synergies, and tradeoffs exist between mitigation and adaptation and among different adaptation responses; interactions occur both within and across regions. Increasing efforts to mitigate and adapt to climate change imply an increasing complexity of interactions, particularly at the intersections among water, energy, land use, and biodiversity

Conclusions

- IPCC WGII has made a sober assessment of the impacts of climate change. They are significant, vary by region and country and pose important threats to our future.
- The report concludes that while impacts in the next 30 years or so are not dependent on mitigation, after that time they depend a lot on what emissions scenario we face. Adaptation options after 2050 are much more limited with high emissions

Conclusions

- On adaptation it is more optimistic for several areas. We can adapt to a significant extent if we take the right actions.
- The key is to focus on developing adaptation strategies that are inclusive, flexible, that look at the wider picture and that are based on a realistic estimate of the benefits.
- Not all regions and not all problems can be solved in this way but many can.
- For some problems we have a more difficult agenda but even for these there is some hope.

Typhoon Haiyan Philippines 2013

The most powerful tropical cyclone ever to strike land at 195 miles per hour.

ESKERRIK ASKO

THANK YOU