

Sea-level rise: assessing the benefits of future policy

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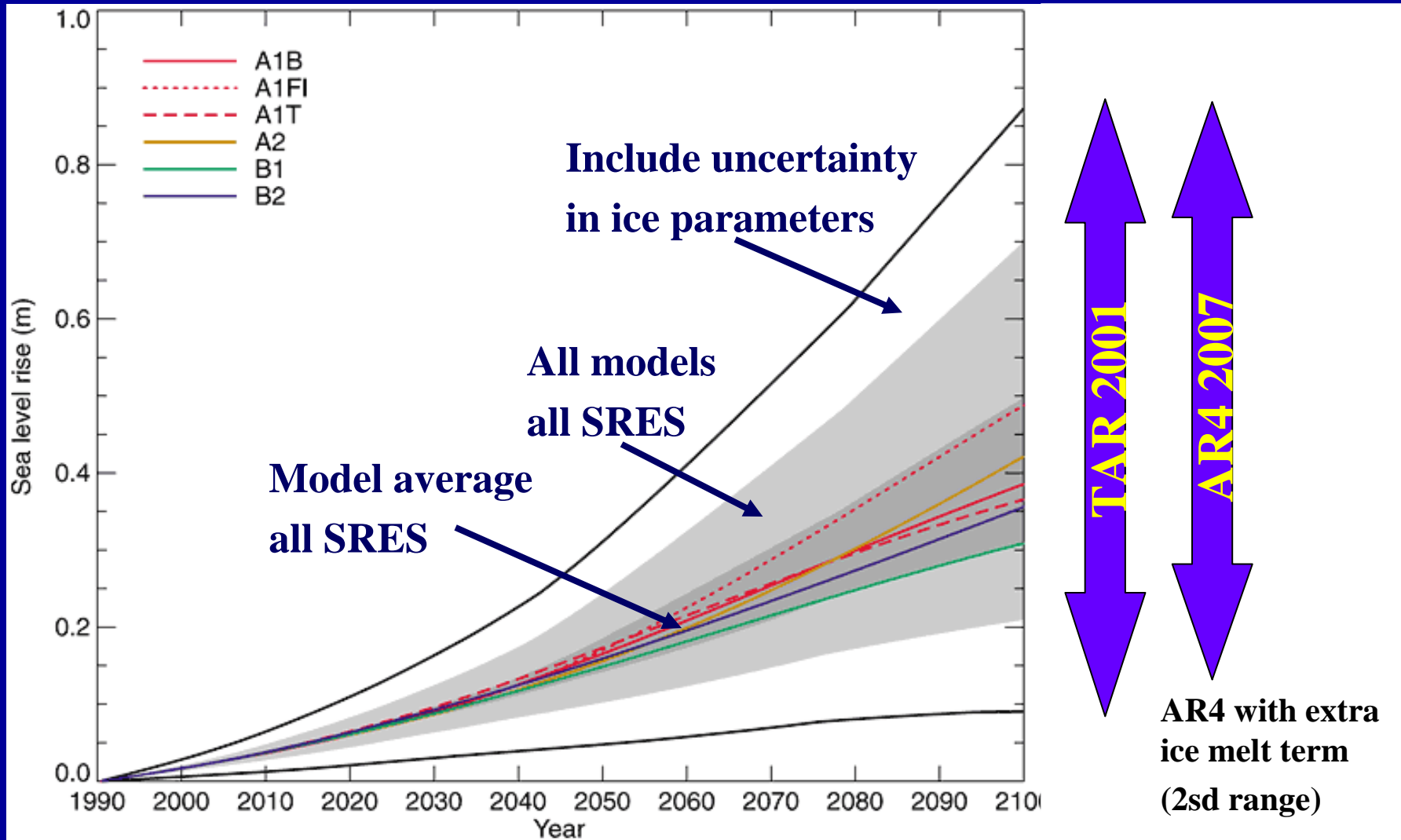
3. Economic and Social Research Institute, Ireland

Climate Change Impacts and Adaptation: Dangerous Rates of Change
University of Exeter
22 to 24 September 2008

PLAN

- Sea-level rise and mitigation
- Sea-level rise impacts and assessment
- Assessment methods
- Concluding Remarks

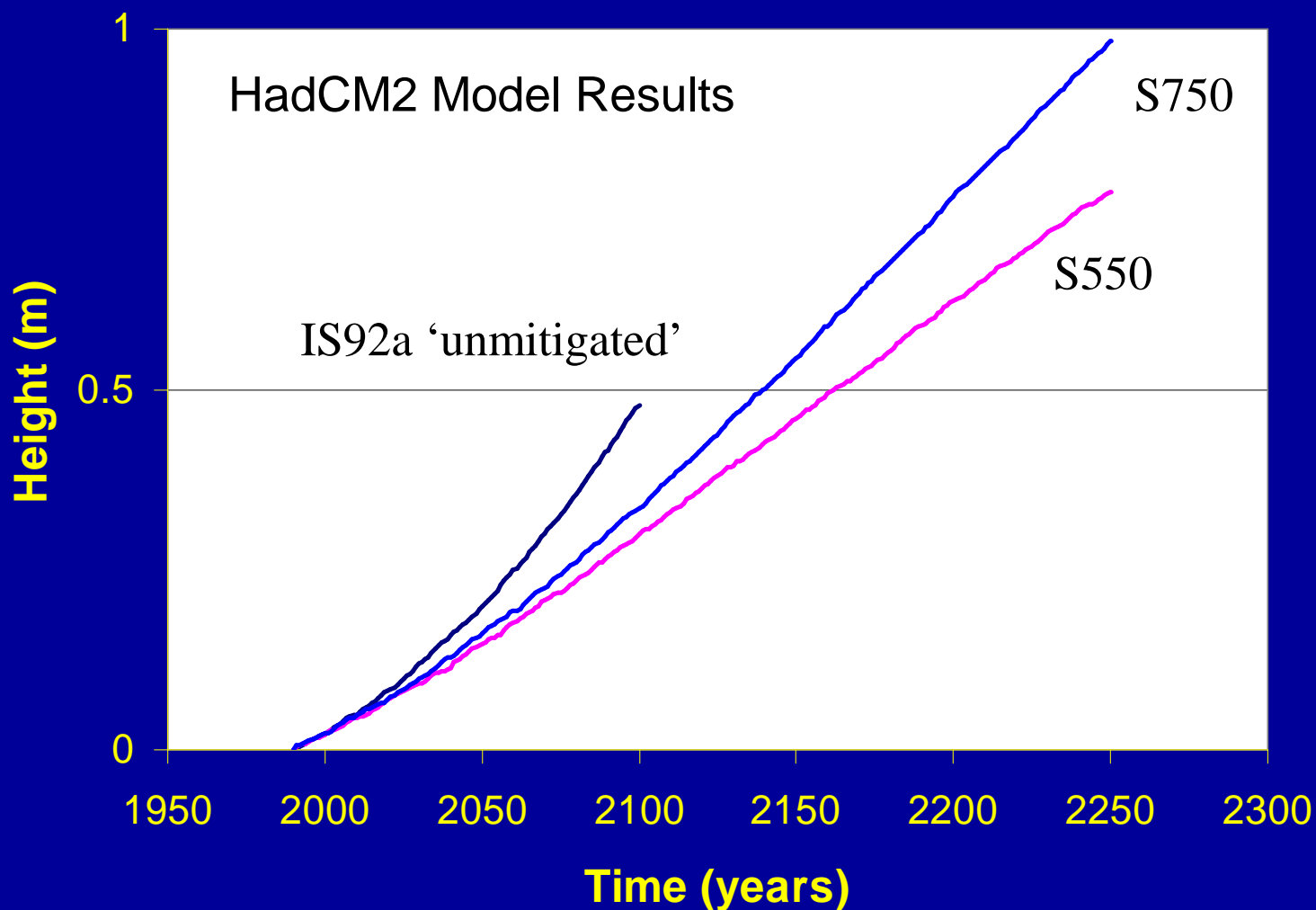
Sea level rise projections: TAR and AR4



Source: IPCC

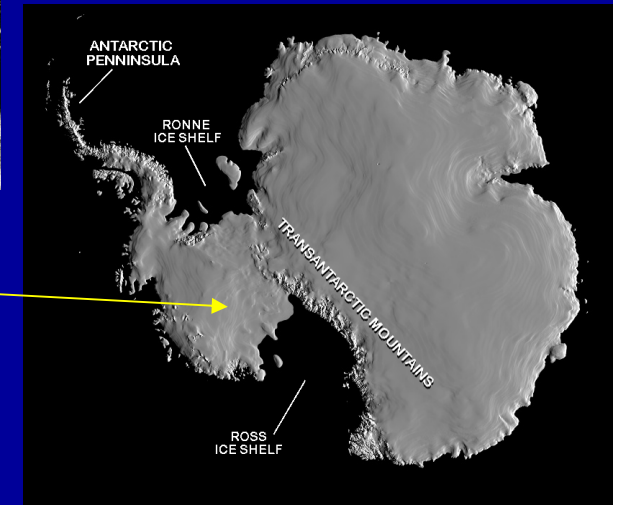
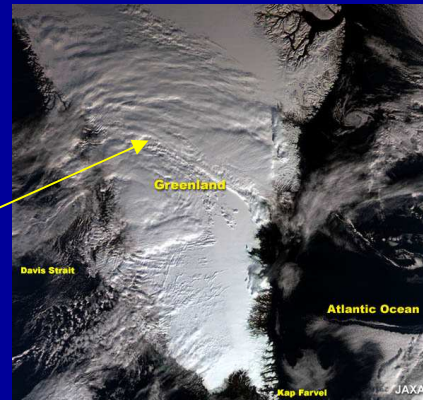
The 'Commitment to Sea-Level Rise'

Unmitigated and stabilised scenarios compared



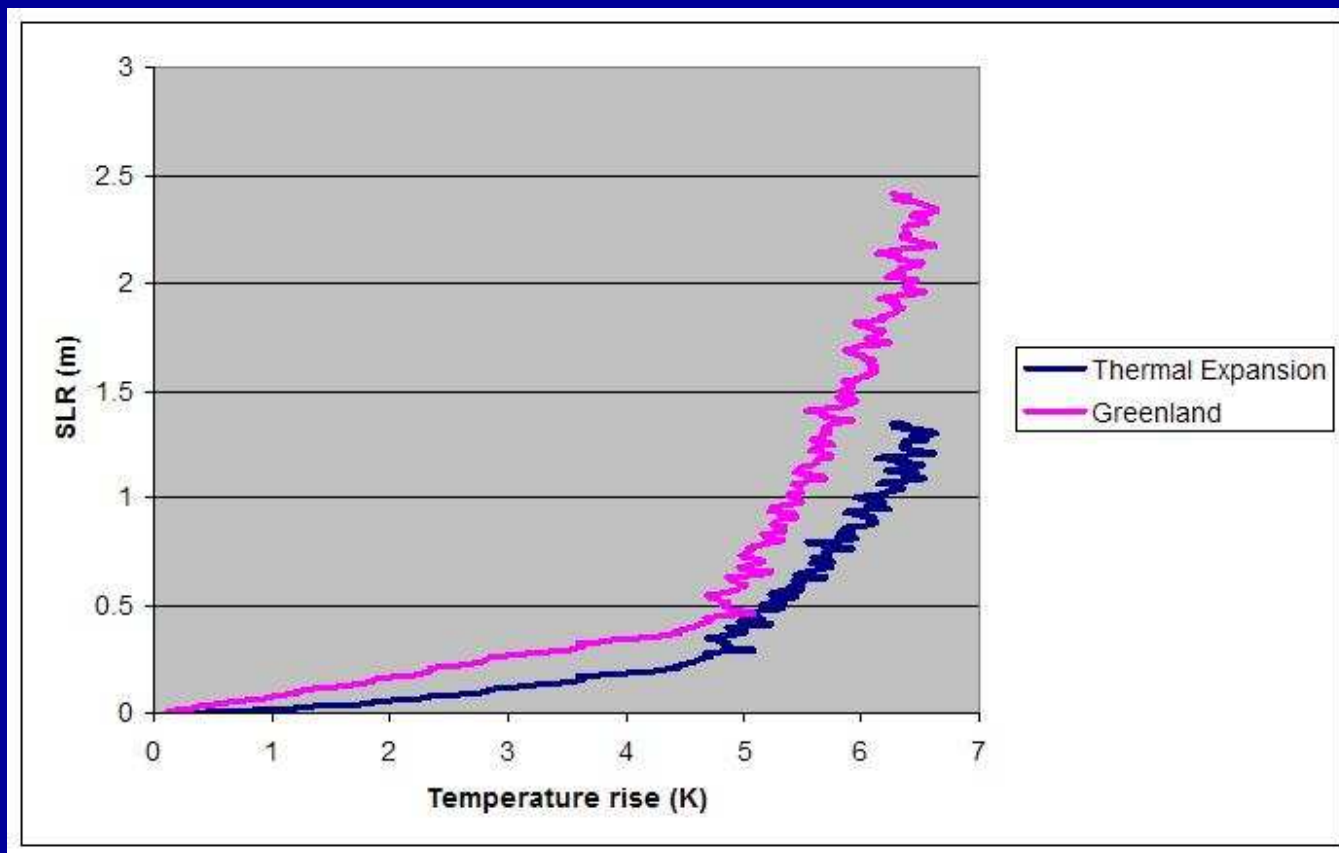
Sources of Global-Mean Sea-Level Rise

- Small Glaciers
- Thermal Expansion
- Greenland ice sheet
- Antarctic Ice Sheet
 - especially West Antarctic Ice Sheet
- Others e.g., changes to the hydrological cycle
- Potentially 15 m rise over millennia timescales

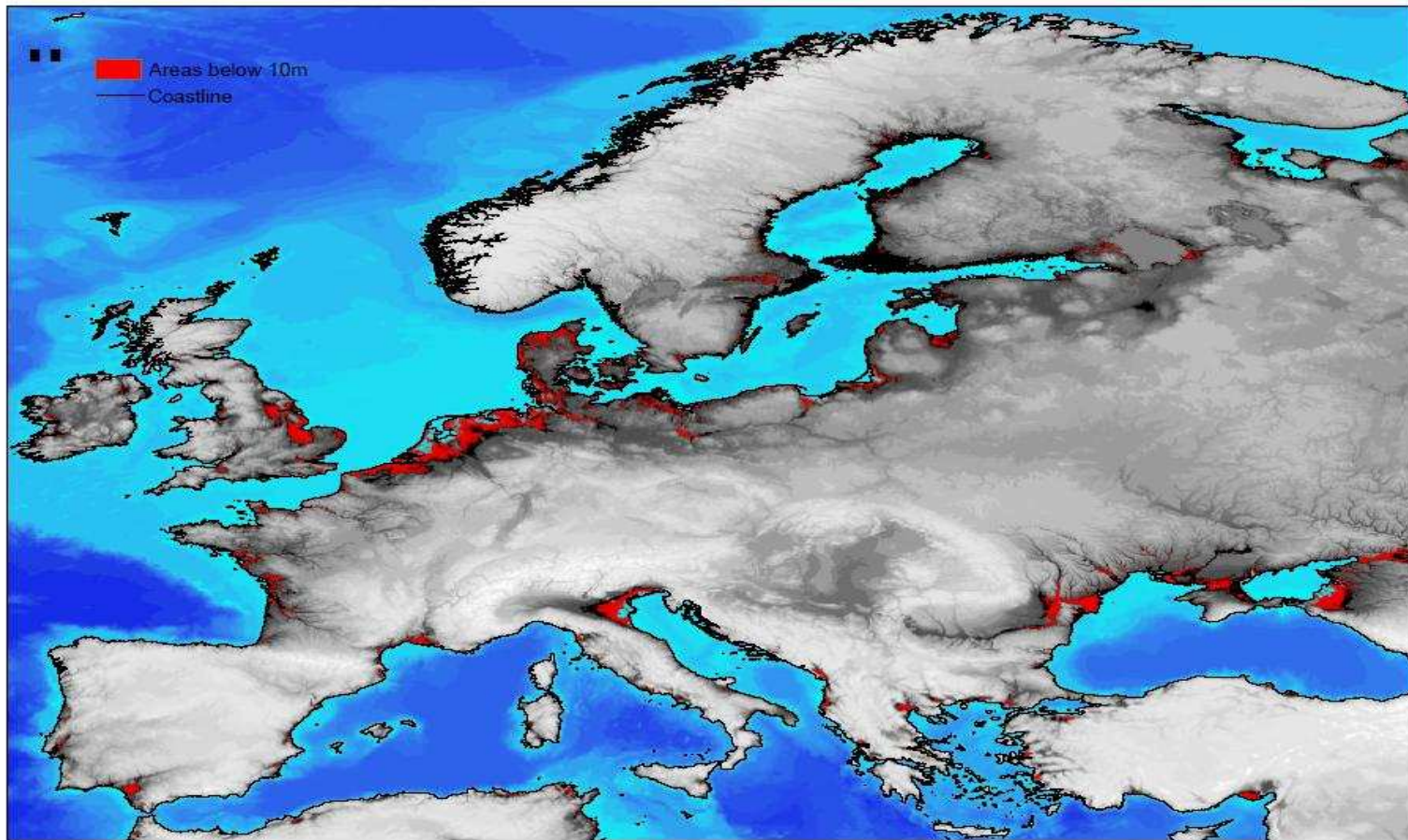


Thermal expansion and Greenland sea-level rise components against global mean temperature rise

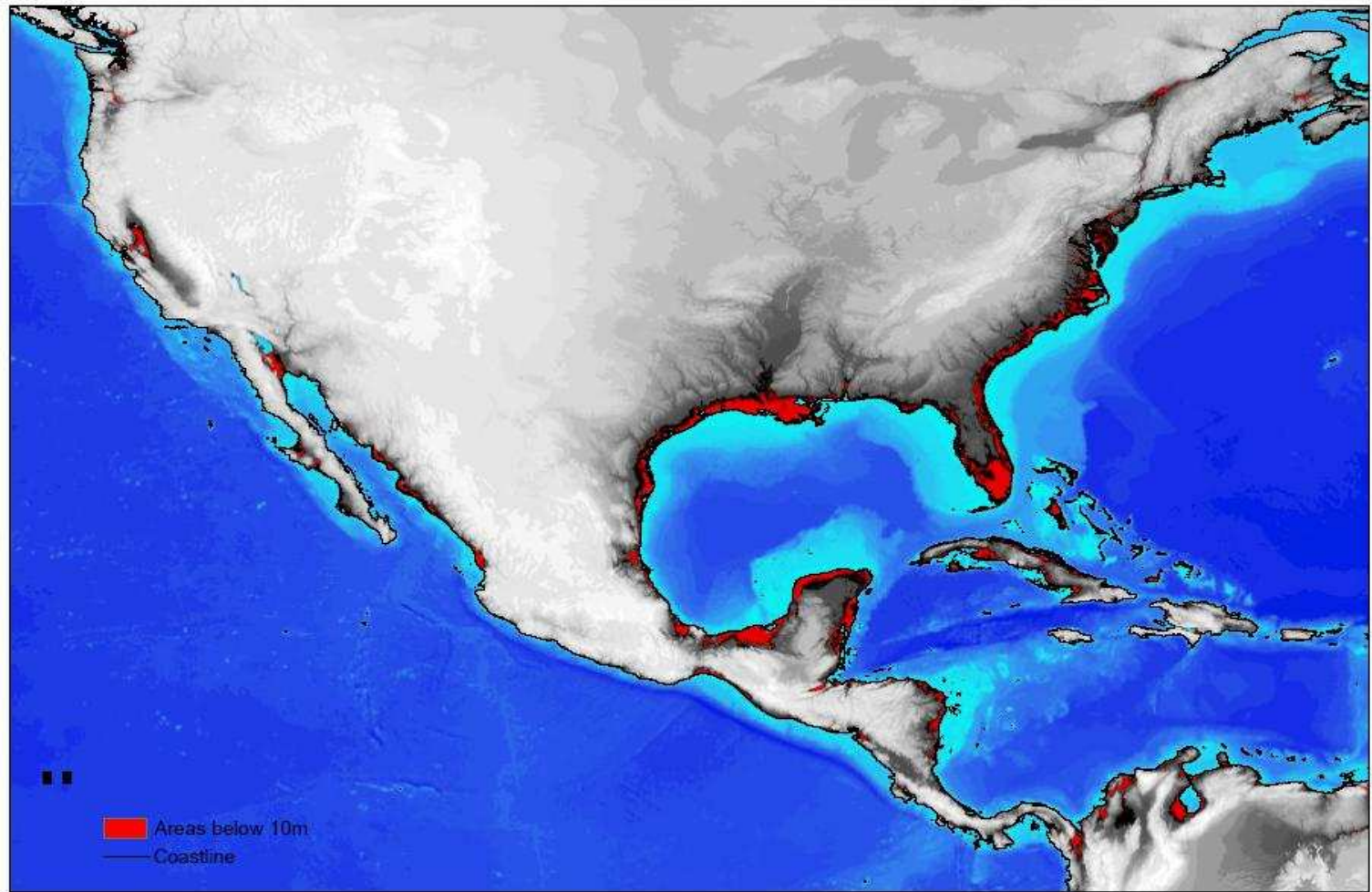
For a 4xCO₂ experiment with HadCM3 coupled to the GISM ice sheet model



Areas below 10-m elevation in Europe

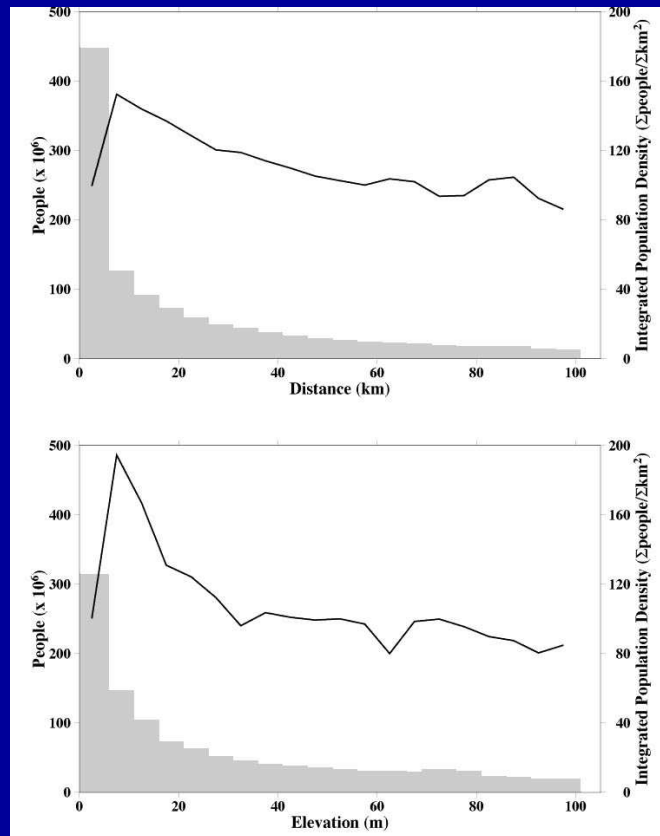


Areas below 10-m elevation in North America



Coasts and people

Population and economic density in the coastal zone is greater than other areas of the earth's surface.



Broad environmental and socio-economic trends for coastal areas

| <i>Environmental and Socio-economic Factors</i> | <i>Global non-climatic changes and trends (by SRES Future)</i> | | | |
|-----------------------------------------------------------------------------|----------------------------------------------------------------|-------------------|--------------------|-------------------|
| | <i>“A1 World”</i> | <i>“A2 World”</i> | <i>“B1 World”</i> | <i>“B2 World”</i> |
| <i>Population (2080s) (billions)¹</i> | 1.8 to 2.4 | 3.2 to 5.2 | 1.8 to 2.4 | 2.3 to 3.4 |
| <i>Coastward migration</i> | 1.8 to 2.4 | 3.2 to 5.2 | 1.8 to 2.4 | 2.3 to 3.4 |
| <i>Human-induced subsidence</i> | more likely | | less likely | |
| <i>Terrestrial freshwater/sediment supply (due to catchment management)</i> | Greatest reduction | Large reduction | Smallest reduction | Smaller reduction |
| <i>Aquaculture growth</i> | Large increase | | Smaller increase | |
| <i>Infrastructure growth</i> | Largest | Large | Smaller | Smallest |
| <i>Extractive industries</i> | Larger | | Smaller | |
| <i>Adaptation response</i> | More reactive | | More proactive | |
| <i>Hazard risk management</i> | Lower priority | | Higher priority | |
| <i>Habitat conservation</i> | Low priority | | High priority | |
| <i>Tourism growth</i> | Highest | High | High | Lowest |

¹ Population living both <100 m elevation above sea level and <100 km distance of the coast.

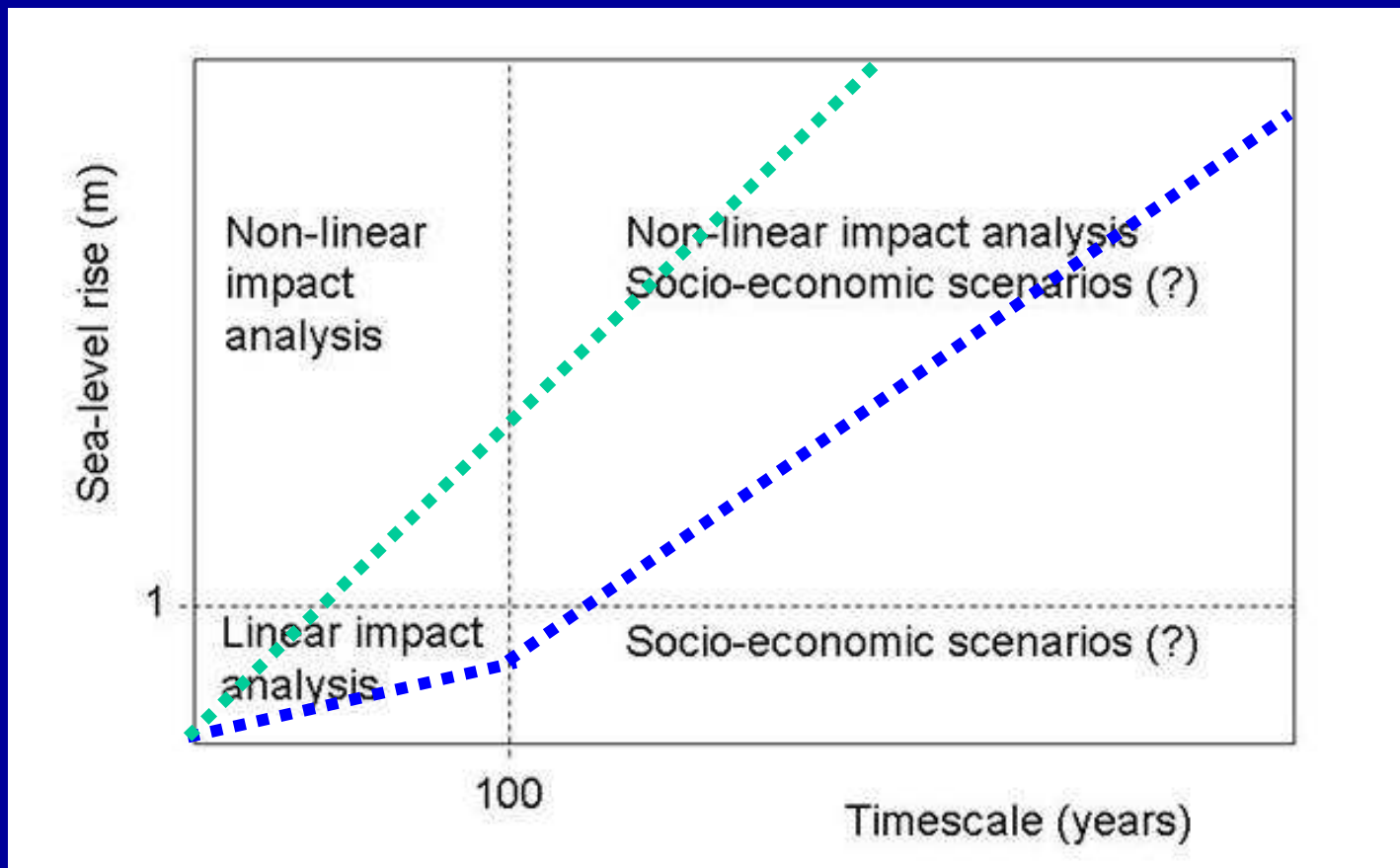
Source: IPCC (2007)

Impacts and Responses to Sea-level Rise

| NATURAL SYSTEM EFFECT | | POSSIBLE ADAPTATION RESPONSES |
|-----------------------------------------------------------|----------------|--------------------------------------------------------------------------------------------------------------|
| Inundation/Submergence | | Polders [P], Floodwise buildings [A], Land use planning/hazard delineation [A/R]. |
| damage | effect | Land use planning/hazard delineation [A/R]. |
| Wetland loss (and change) | | Land use planning [A/R], Managed retreat [A/R], Nourishment/sediment management [P]. |
| Erosion (direct and indirect morphological change) | | Coast defences [P], Nourishment [P], Building setbacks [R]. |
| Saltwater Intrusion | Surface Waters | Saltwater intrusion barriers [P], Change water abstraction [A/R]. |
| | Ground-water | Freshwater injection [P], Change water abstraction [A/R]. |
| Rising water tables/ impeded drainage | | Upgrade drainage systems/polders [P], Change land use [A], Land use planning/hazard delineation [A/R]. |

Assessing Sea-Level Rise Impacts

(with possible sea-level rise scenarios)



Assessment Methods

over the very long-term (≤ 500 years)

- **Exposure metrics** – threatened resources assuming no adaptation (i.e. potential or ‘worst-case’ impacts). GIS analysis with or without socio-economic scenarios.
- **Impact metrics** -- residual impacts after adaptation responses under relevant climate and socio-economic scenarios and appropriate decision-making approaches (e.g. benefit-cost).
- **Threshold metrics** -- (or a ‘scenario neutral’ analysis) identifying significant thresholds when impacts may occur – lends itself to well understood systems. (NOT DISCUSSED FURTHER – used in TE2100)

Exposure metrics

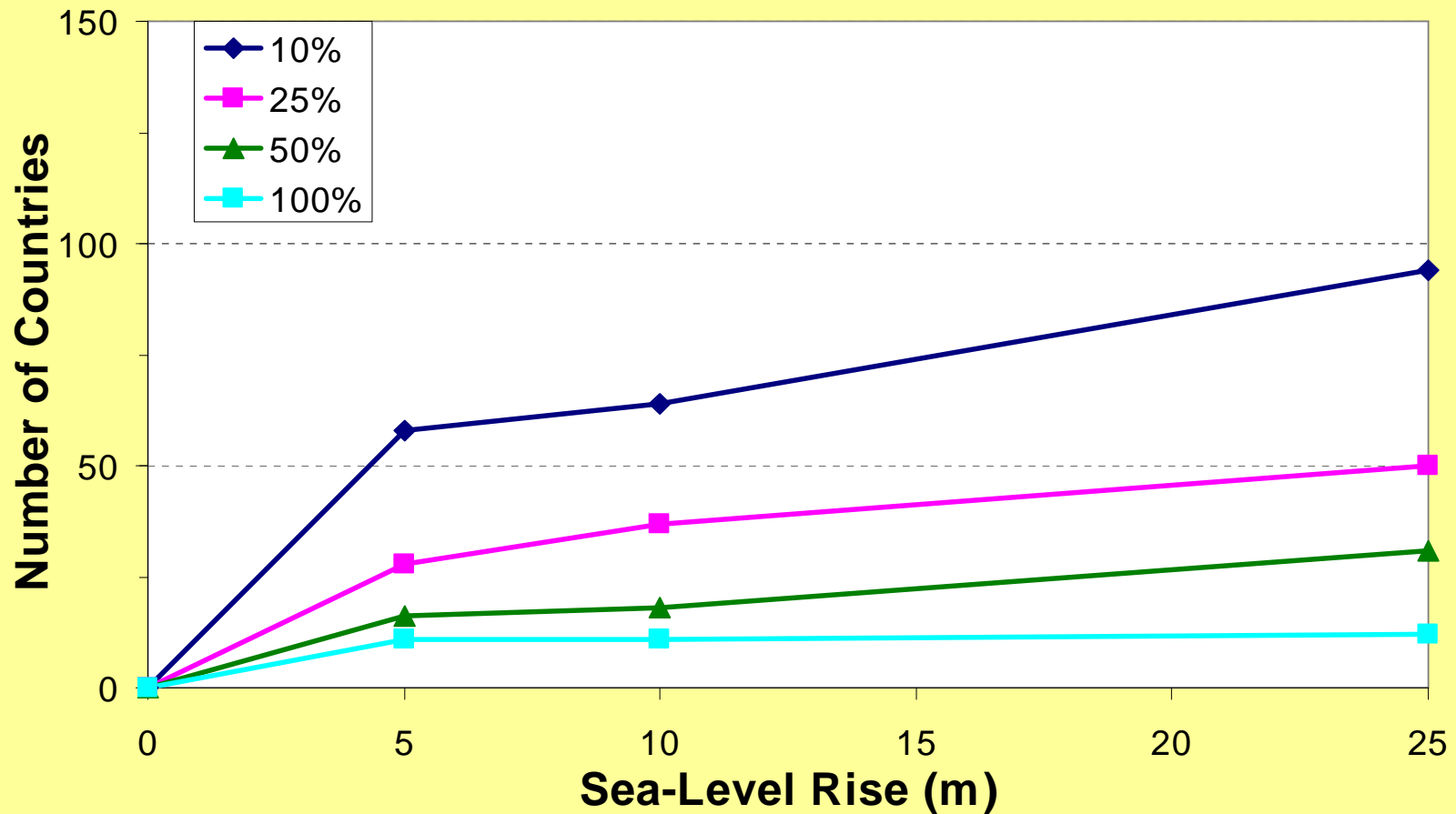
for assessing the potential impacts of long-term sea-level rise

Note that this list could be expanded

| METRIC | UNITS | COMMENTS |
|-----------------------------------------------|------------------------------------------------------------------------------------|-----------------------------------|
| Land area at risk | Threatened area (absolute: km ² , or relative impact: % available area) | Preferred metric in Questionnaire |
| People at risk | Number of people (absolute or relative impact: % population) | Scenario dependent |
| Ecosystems at risk | Threatened area of ecosystems (km ²) | Scenario dependent |
| Economic value at risk | Monetary value (absolute: monetary value or relative impact: % GDP) | Scenario dependent |
| Important human infrastructure at risk | Inventory approach (e.g., threatened transport corridors) | Scenario dependent |
| Cultural/heritage at risk | Inventory approach (e.g., threatened UNESCO World Heritage sites) | Based on existing distribution |

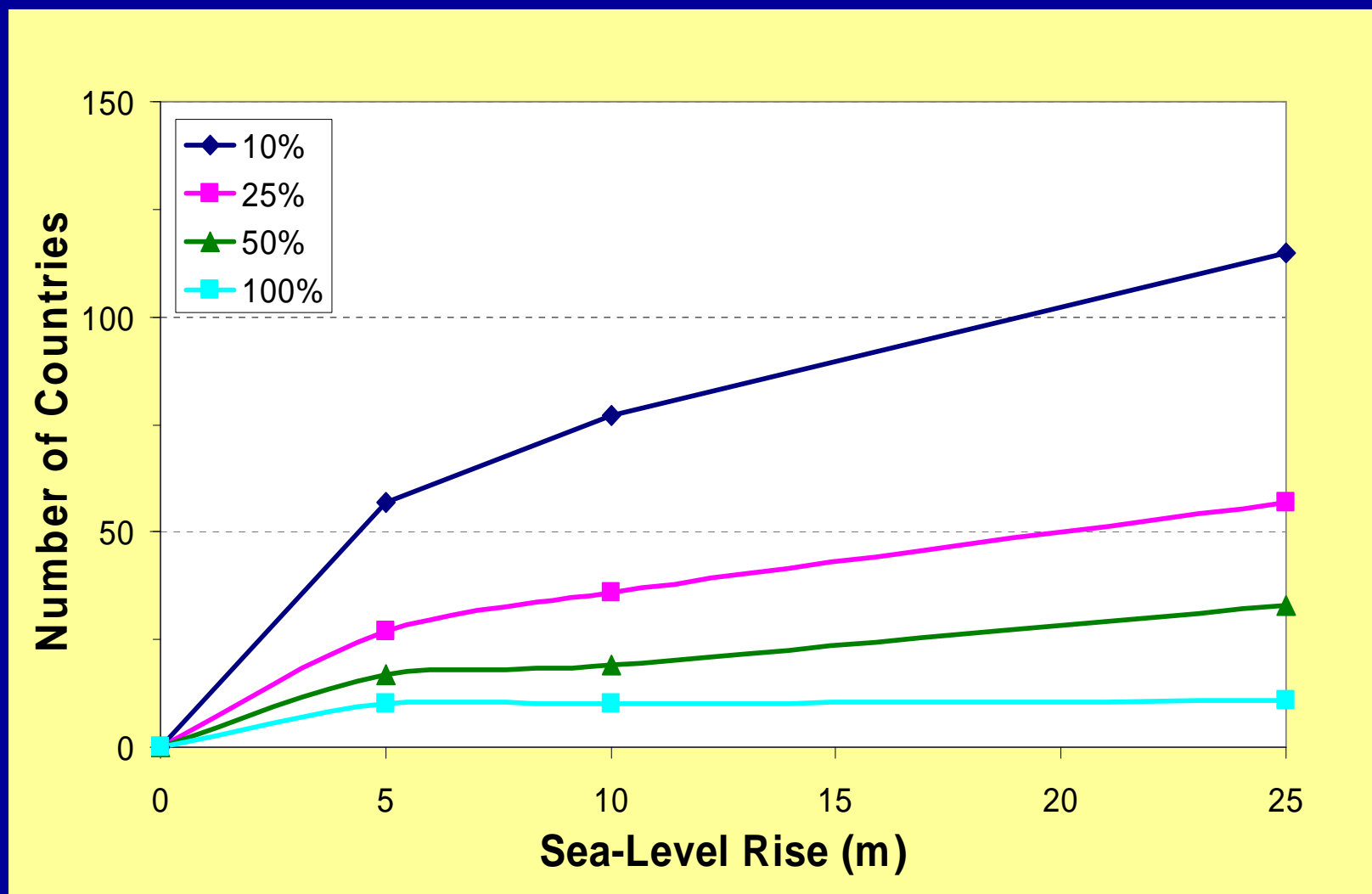
Land Exposed to Sea-Level Rise

using CEISIN's PLACE database



Population Exposed to Sea-Level Rise

(using present population in CIESIN's PLACE database)



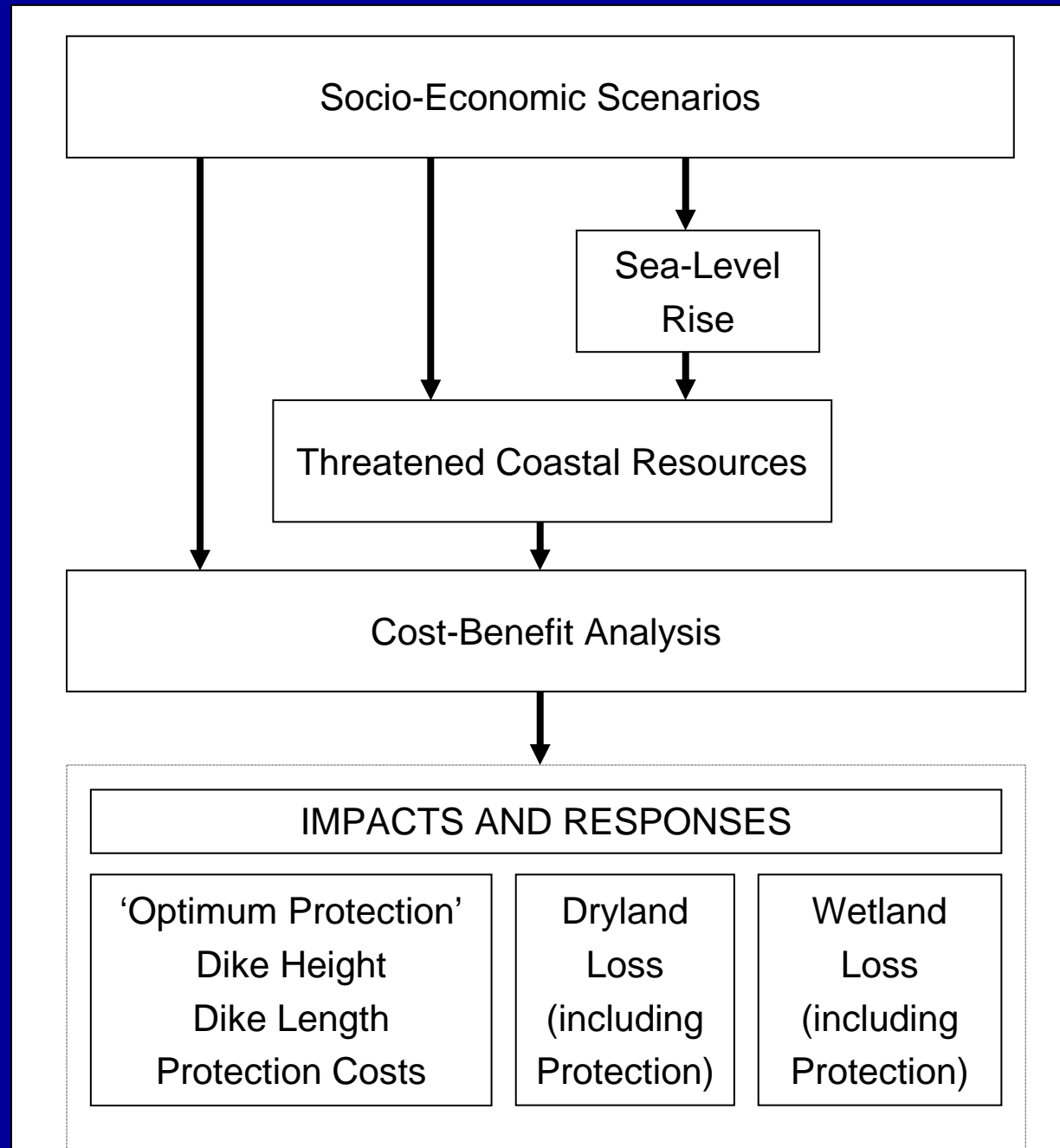
Impact metrics

for assessing the potential impacts of long-term sea-level rise

| METRIC | UNITS | COMMENTS |
|----------------------------------|------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------|
| Land area loss | Lost area (absolute: km ² , or relative impact: % available area) | Preferred metric in Questionnaire |
| People displacement | Number of people (absolute or relative impact: % population). Cost of displacement (absolute: monetary value or relative impacts: % GDP) | Scenario dependent |
| Ecosystems loss/change | Threatened area of ecosystems (km ²). Cost of losses/changes (absolute: monetary value or relative impacts: % GDP) | Scenario dependent |
| Economic value loss | Monetary loss (absolute costs in monetary terms or relative costs: % GDP) | Scenario dependent |
| Human infrastructure loss | Inventory of losses (e.g., list of disrupted transport corridors) | Scenario dependent |
| Cultural/heritage loss | Inventory of losses (e.g., list of lost UNESCO World Heritage sites) | Based on existing distribution |
| Adaptation costs | Monetary cost (absolute costs in monetary terms or relative costs: % GDP) | Usually assess protection |

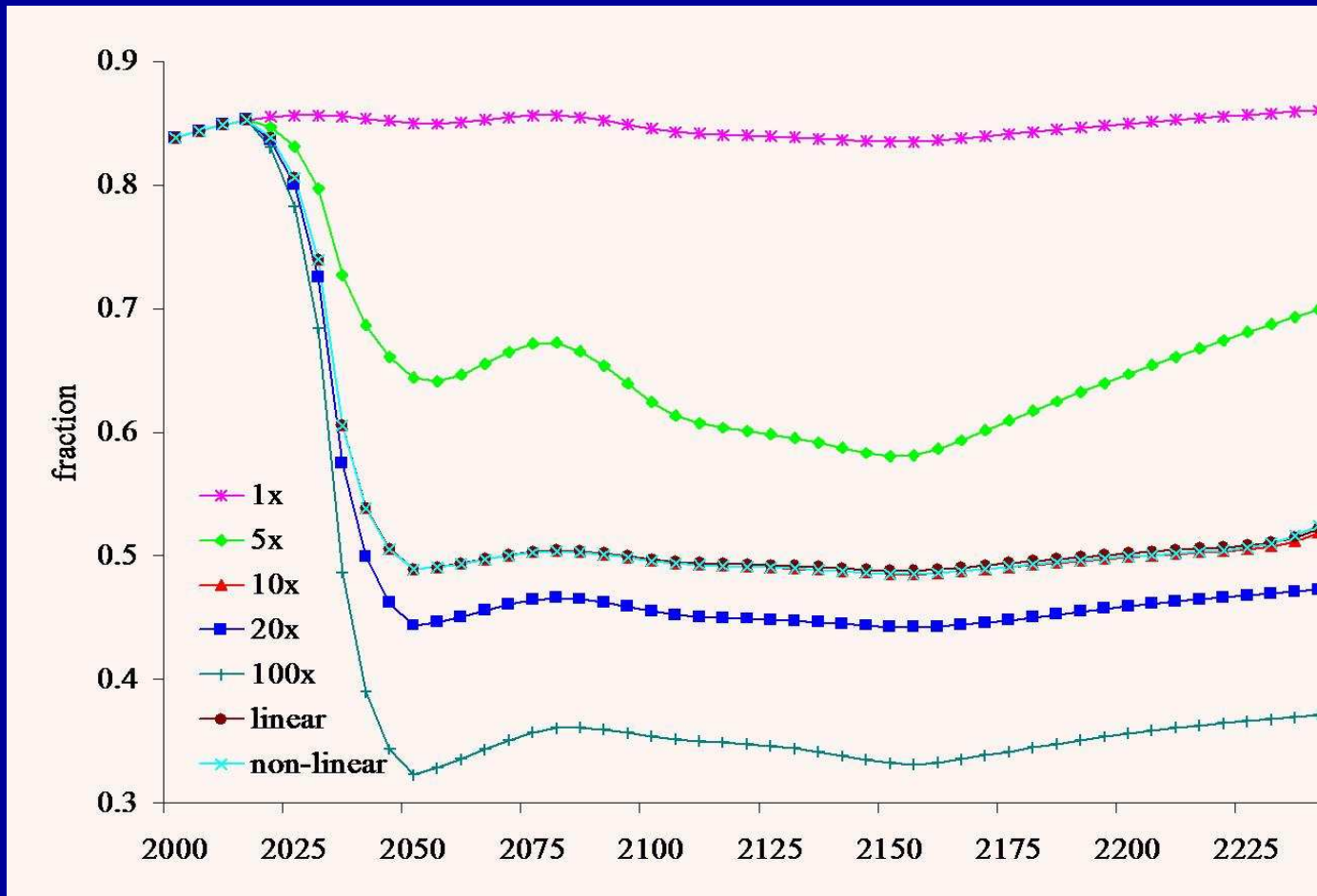
FUND

Analysis of extreme sea-level rise (≤ 5 m/century)



Protected Length

of developed coast by cost increase factor



Impact Assessment

Stresses that retreat from the shore due to sea-level rise is not inevitable – coastal societies have more choice than often assumed.

However, issues of concern include:

- Optimistic socio-economic scenarios – overemphasise our capability to adapt.
- Benefit-cost implies proactive protection – historical experience shows most protection is reactive.
- Will more frequent coastal disasters reduce assets at risk (coastal abandonment) – triggering a cycle of decline?
- This raises the possible role of thresholds in response to sea-level rise, but these issues are poorly understood.

IPCC AR4 Working Group II

- Rising sea levels raise a challenge for long-term coastal management – there is a ‘commitment to adaptation’.
- Stabilisation of climate could reduce the risks of ice sheet breakdown, and reduce but not stop sea-level rise due to thermal expansion.
- Hence, the most appropriate response to sea-level rise for coastal areas is a combination of *adaptation* to deal with the inevitable rise, and *mitigation* to limit the long-term rise to a manageable level.

Concluding Thoughts

- The long timescale of sea-level rise presents significant challenges.
- Assessments need to extend beyond 2100 to understand the full range of adaptation and mitigation choices.
- Long-term spatial planning offers a strategic response to the commitment to adaptation.
- But do we care? – there are widely divergent views on the importance/value of the very long-term change.

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