FONDAZIONE ENI ENRICO MATTEI

The Challenge of Climate Change to Policy: Adaptation, Mitigation and Innovation

Enrica DeCian

Fondazione Eni Enrico Mattei, Euro-Mediterranean Centre for Climate Change

Based on Joint work with F. Bosello and C. Carraro

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Outline

- Defining the climate change challenge
- Strategies to cope with the climate change
- Policy context to adaptation and mitigation

- Adaptation to climate change
  - Definition
  - Economic analysis joint with mitigation
- Agriculture: adaptation and the role of innovation

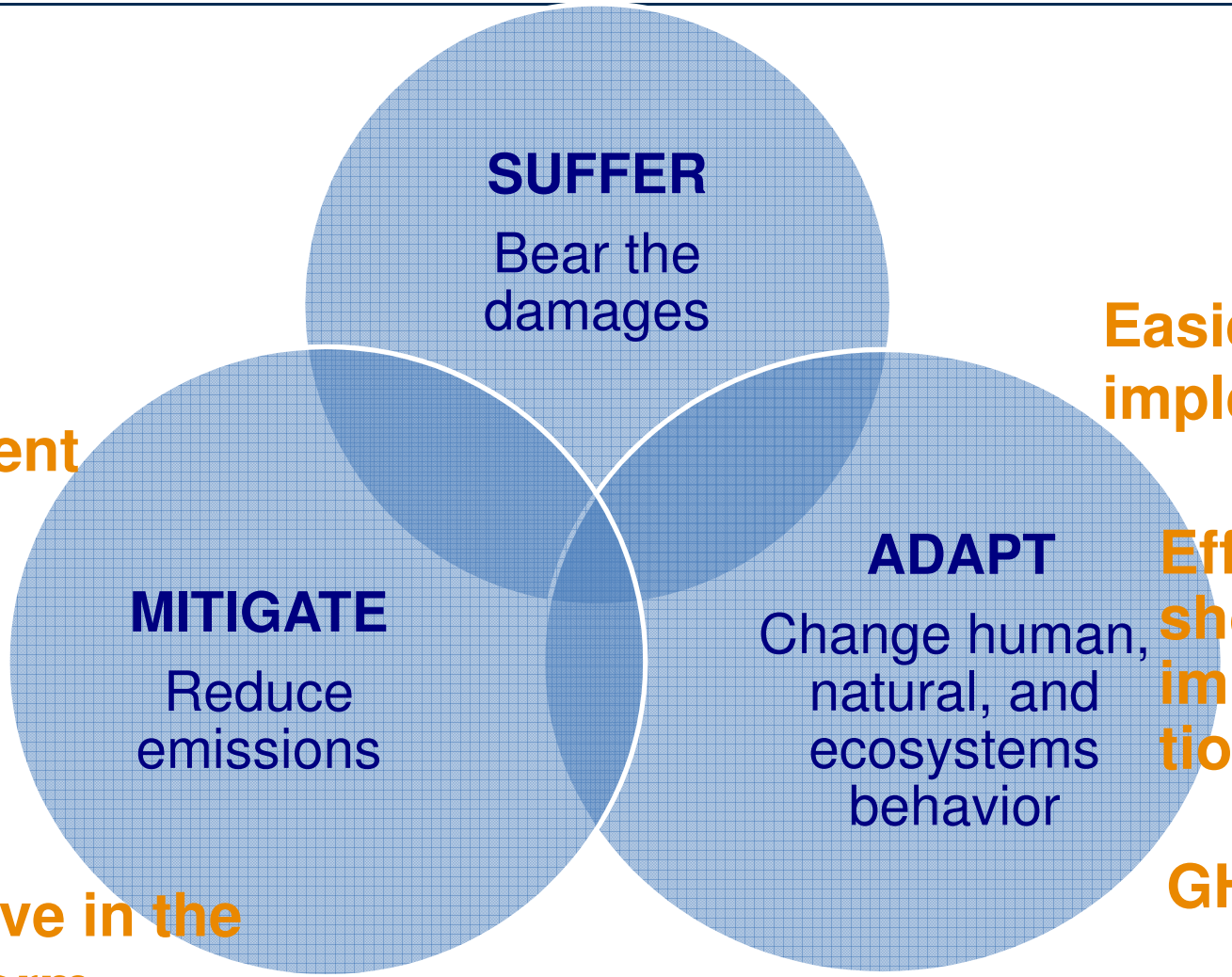
Defining the climate change challenge

GHG emissions, sea levels rise, and global temperature in line with the highest scenarios projected in AR4 (Post-4AR)

Changes in the extremes can cause more damage. With medium confidence drought, extreme sea levels, heavy precipitations will get worse, though with a lot of spatial variation (IPCC SREX 2012)

Socio-economic trends will exacerbate the climate change challenge: increasing pressure on natural resources for food, energy production, and dwelling (OECD 2012)

Strategies to cope with climate change damages



Hard to implement

Easier to implement

Effective short after implementation

GHG:+/-?

Effective in the long-term

The International negotiation framework

UNFCCC (Rio Earth Summit 1992)

Stabilize GHG concentrations in the atmosphere to prevent dangerous consequences for the human, social, and natural system (what has now become the 2DT)

Parties should “cooperate in preparing for adaptation to the impacts of climate change” and to “develop and elaborate appropriate and integrated plans for coastal zone management, water resources and agriculture, and for the protection and rehabilitation of areas, particularly in Africa, affected by drought and desertification, as well as floods”.

The International negotiation framework

Kyoto Protocol (1997)

Industrialized countries should reduce emissions by 5% compared to 1990 between 2008-2012

The COP […] shall ensure that a share of the proceeds from certified project activities is used to […] assist developing country Parties that are particularly vulnerable to the adverse effect of climate change to meet the cost of adaptation

Current policy context: from Copenhagen to Durban

Copenhagen COP 15 (2009)

- Long-run objective of the 2 ° C
- Copenhagen Pledges (COP15/16): unilateral commitments to emission reduction on a voluntary basis

Durban COP17 (2011)

- Second commitment period of the Kyoto Protocol will start in 2013 with voluntary unilateral participation
- A new agreement to be negotiated by 2015 and to be implemented by all Parties from 2020

Current policy context: future scenarios

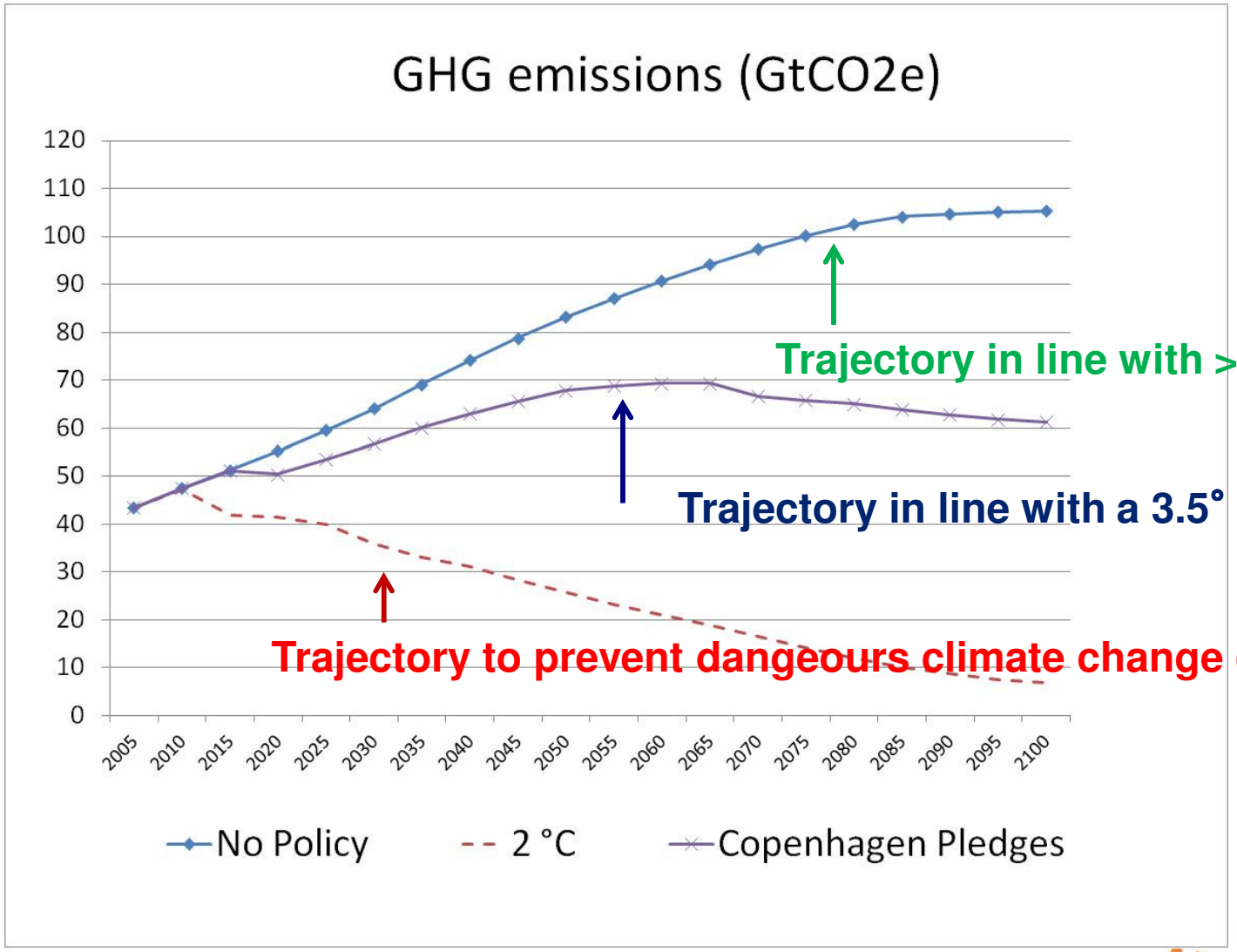
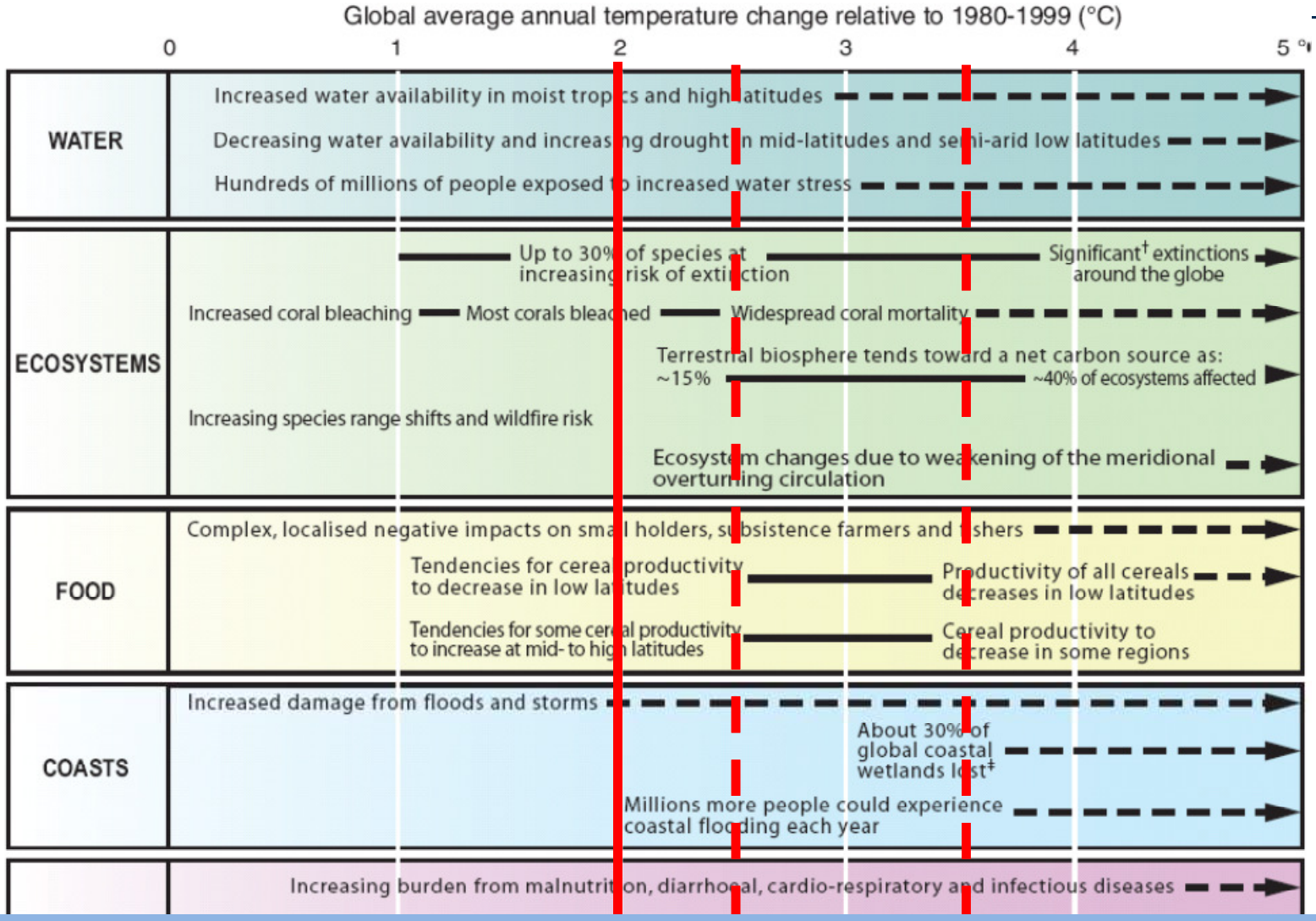


Figure Source: WITCH MODEL (FEEM)

Implications: climate change damages



Adaptation as the unspoken outcome of COP15-17 essential to fill the gap due to the weak mitigation action

Defining adaptation

Changes in processes, practices or structures to
- moderate or offset potential damages
- take advantages of opportunities associated with changes in climate

Adjustment in ecological, social, or economic systems to the actual or expected impacts of climate change

(IPCC TAR, 2001)

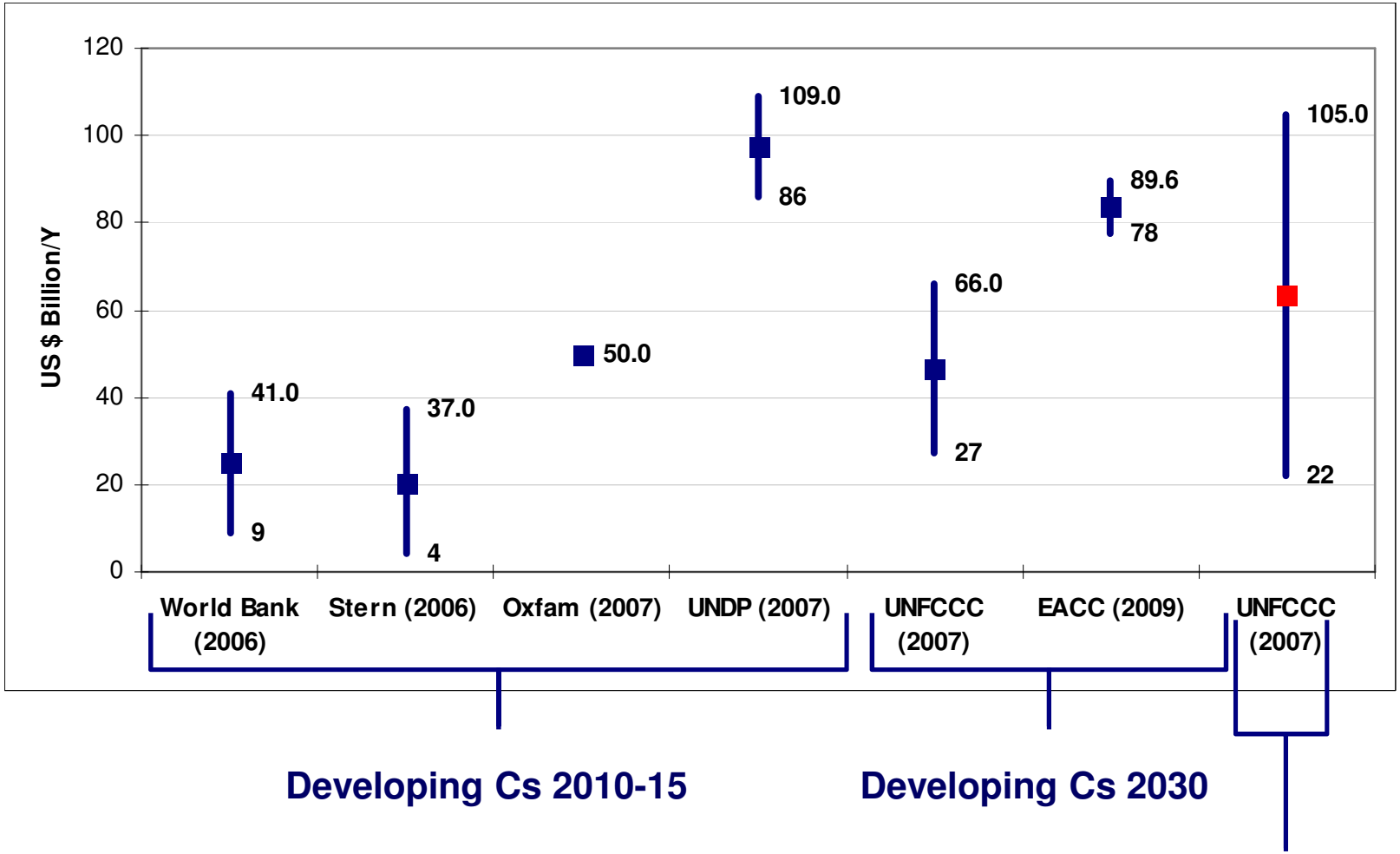
Defining adaptation

Autonomous/Market Adaptation: natural adjustment to a shock induced by changes in market forces (e.g. input substitution, changes in behaviours, changes in trade flows)

Planned/Policy Adaptation: strategies to alleviating damages related to government interventions, policies, or institutional reforms

- Markets adjust, but still room for policy
- Uncertainty in defining, measuring, and monitoring
- Often intertwined with other socio-economic changes

Estimating yearly adaptation costs and needs



They are relevant for both developing and developed countries

Policy questions

1. How does mitigation interact with adaptation?

2. How should resources be allocated between mitigation and adaptation and over time? *(Allocation of the Green Fund for adaptation and mitigation)*

3. What are the key priorities for adaptation, especially in developing countries?

A macro approach to adaptation: the AD-WITCH model

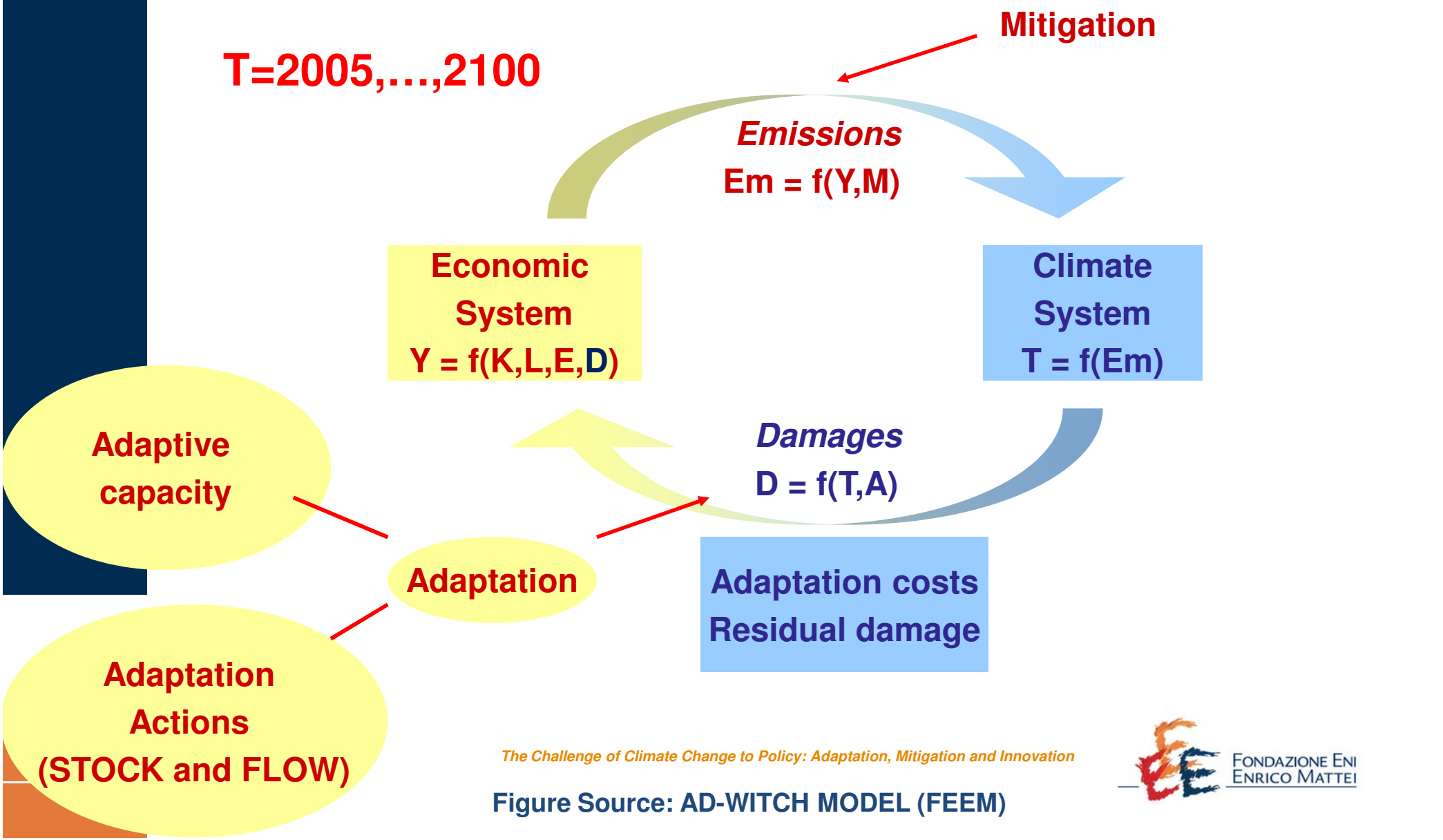


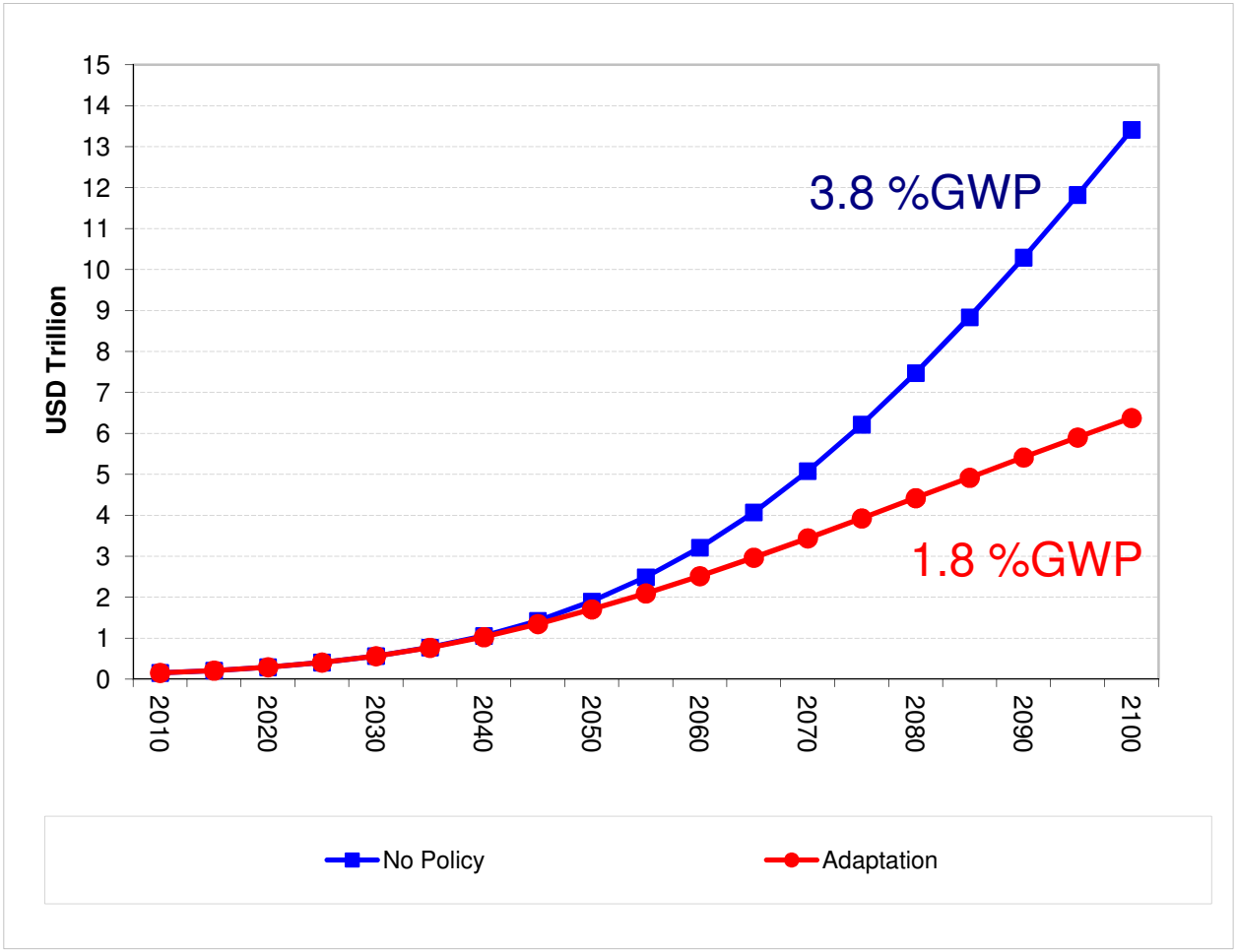
Figure Source: AD-WITCH MODEL (FEEM)

The exercise

Analyze the role of adaptation in the presence of a mitigation policy that keep temperature increase below 2.5° C

=> How to combine mitigation and adaptation

Strategic complementarity – Residual damage



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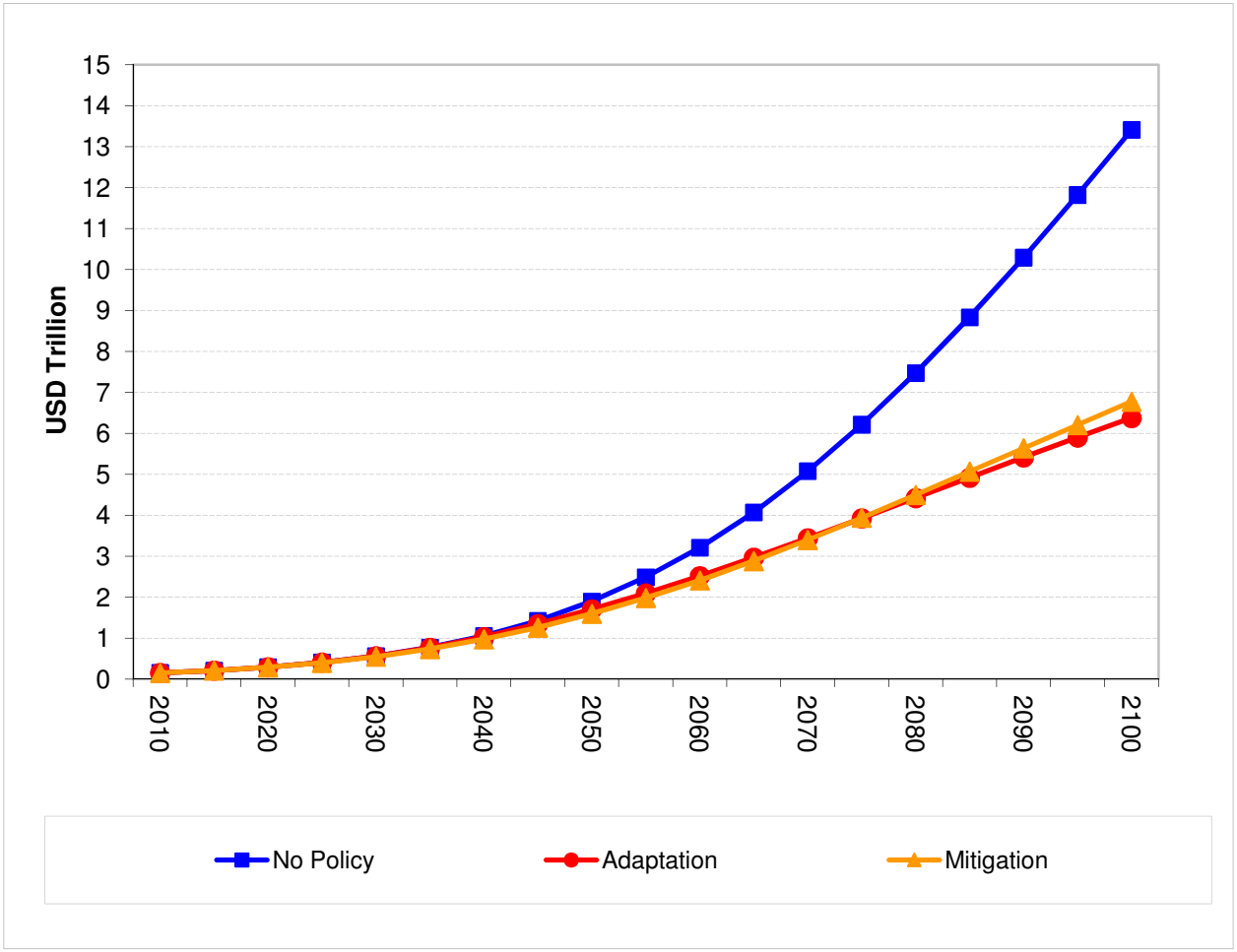
Strategic complementarity – Residual damage



3.5° C

2.5° C

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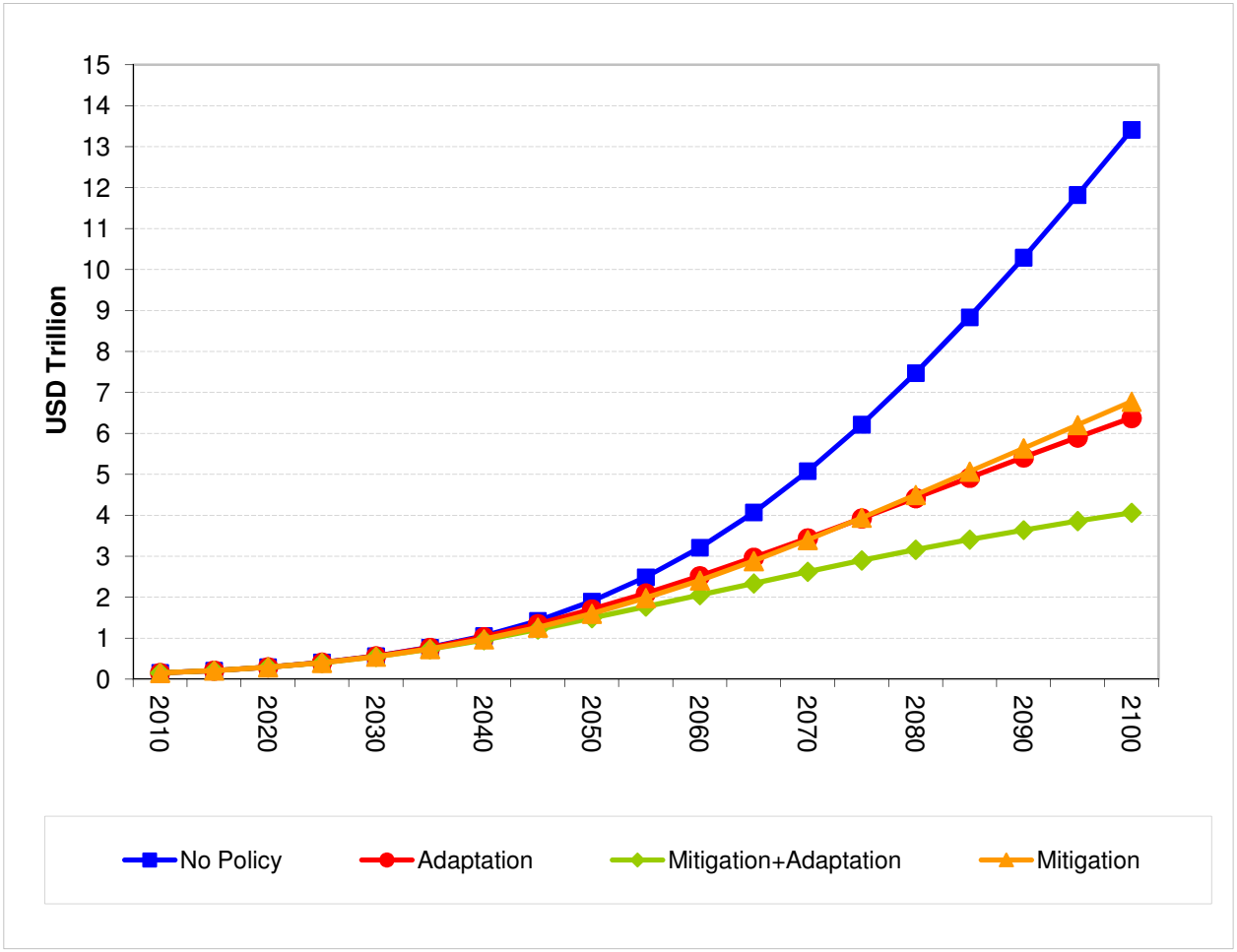
Strategic complementarity – Residual damage



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Strategic complementarity – efficiency gains

Two instruments are better than one

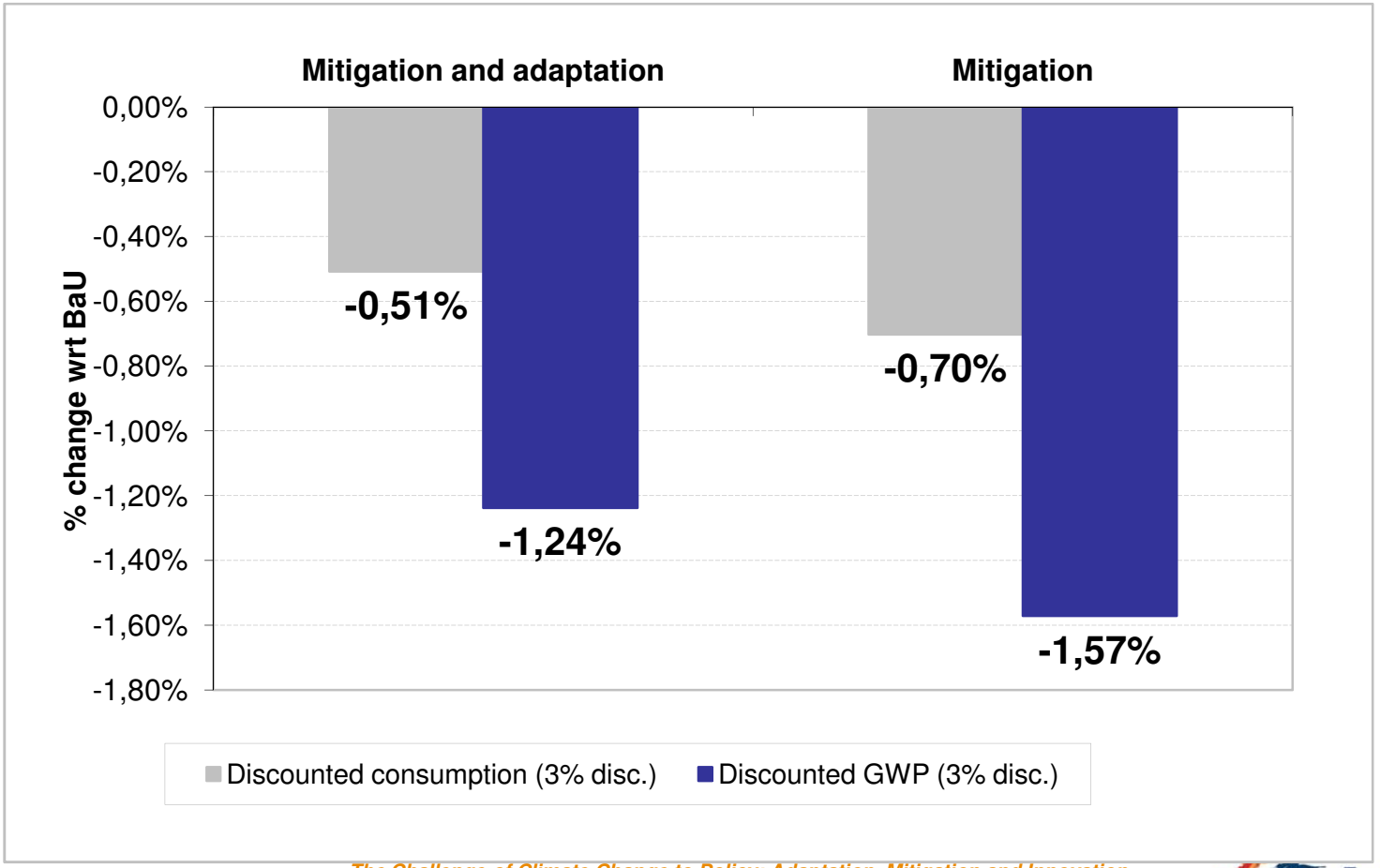
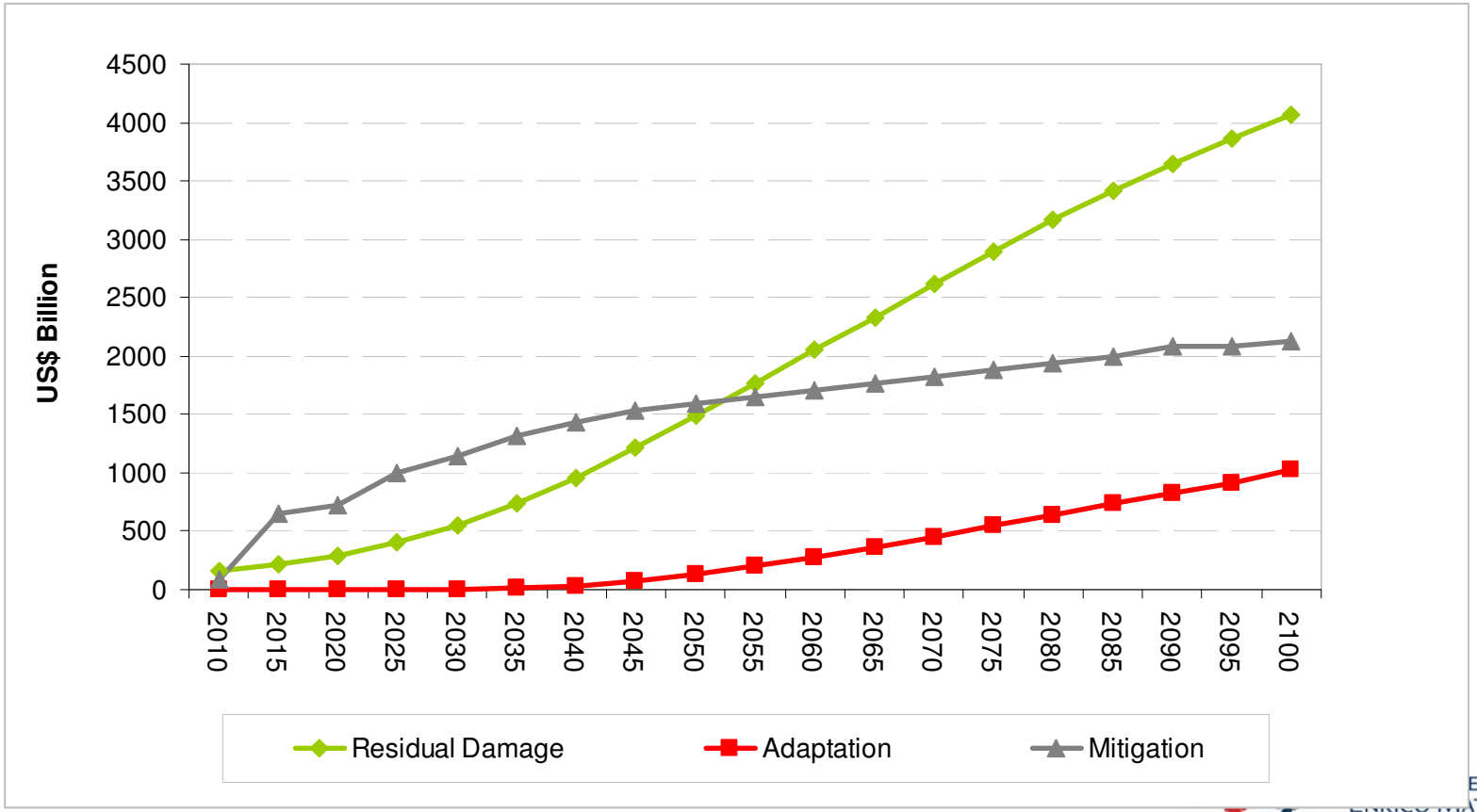


Figure Source: AD-WITCH MODEL (FEEM)

Timing of adaptation and mitigation

Mitigation must start immediately: delayed response in the energy and climate system

Adaptation expenditure increases with damage



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Equity-adverse impacts of climate change

Exposure: potential impacts are expected to be larger

Adaptation deficit: adaptive capacity (institutions, access to information, and education) is lower

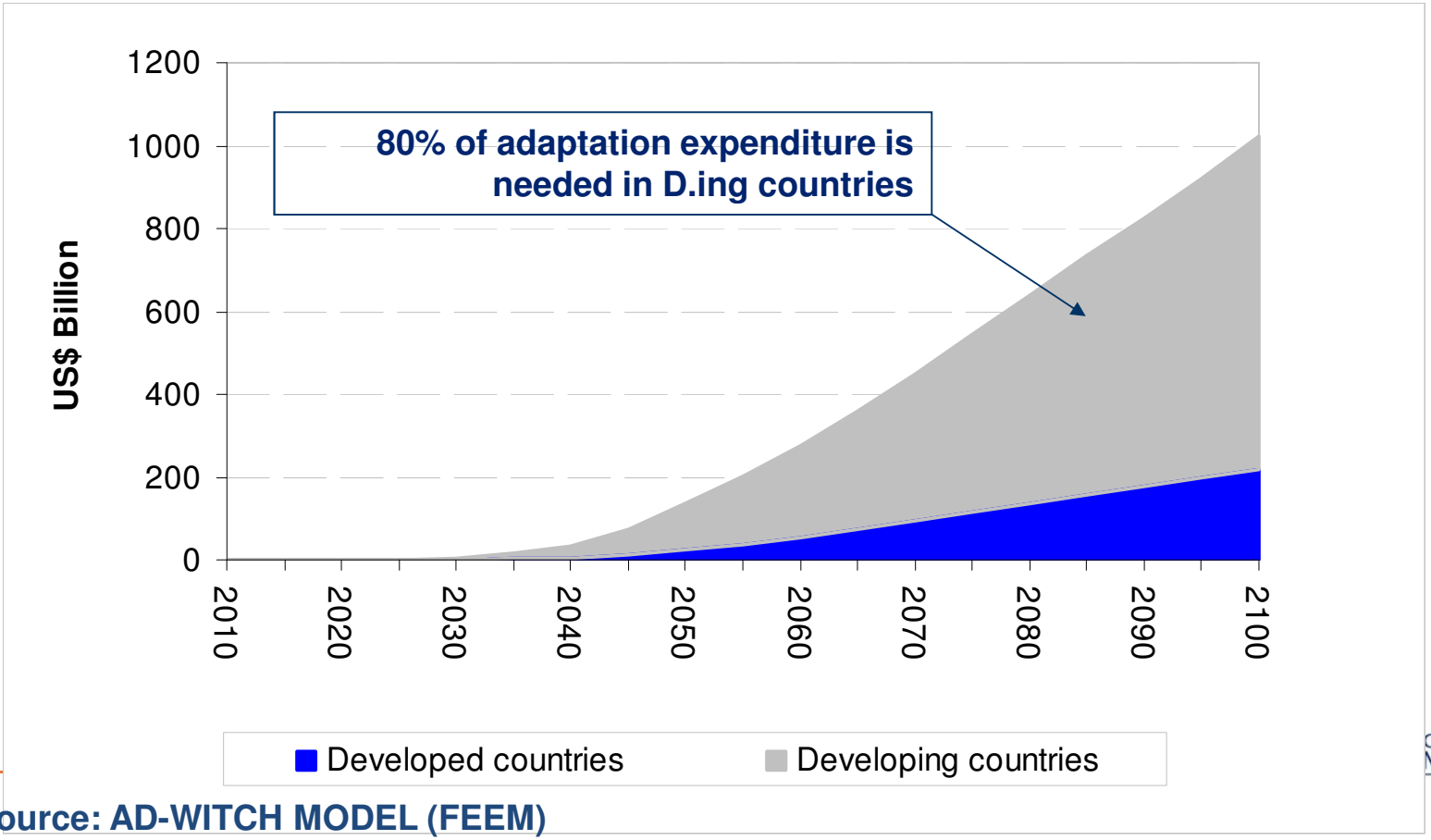


Figure Source: AD-WITCH MODEL (FEEM)

Key priorities for cooperation on adaptation

Short-term adaptation priority: soft adaptation measures and anticipatory measures to prevent damages

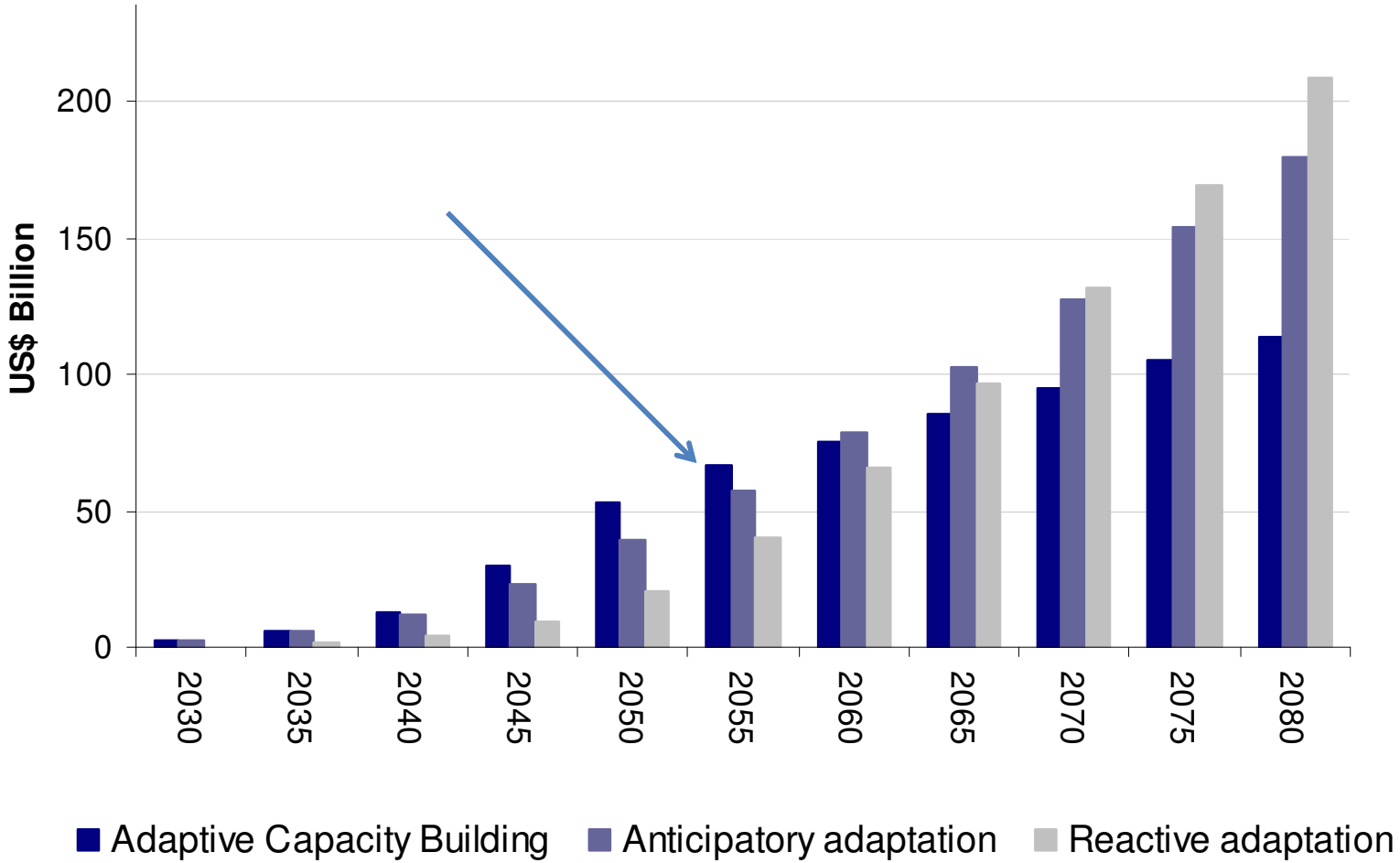


Figure Source: AD-WITCH MODEL (FEEM)

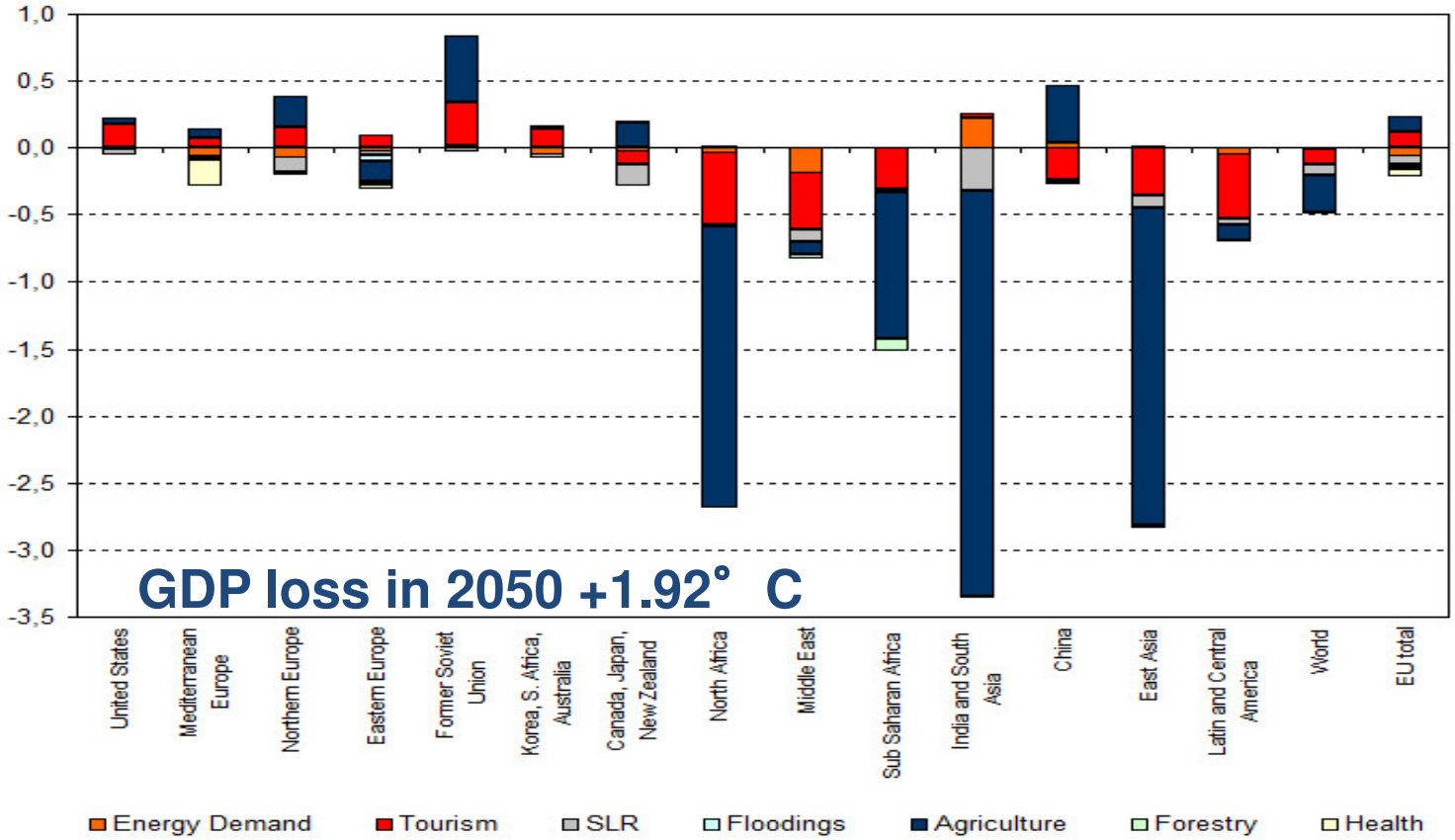
Policy Implications - 1

1. Combining mitigation and adaptation would be more effective to address the mitigation challenge, bringing efficiency gains
2. Stabilizing GHG concentrations at low levels requires first mitigation, then adaptation
3. Adaptation needed mostly in developing countries
4. Priority for adaptation funds in developing countries: capacity building, including innovation, especially in the short run

→ The case of agriculture

Impacts and adaptation in agriculture

Impacts on agriculture will be more severe in low-income, agriculture-dependent, tropical countries, with minimal adaptive capacity



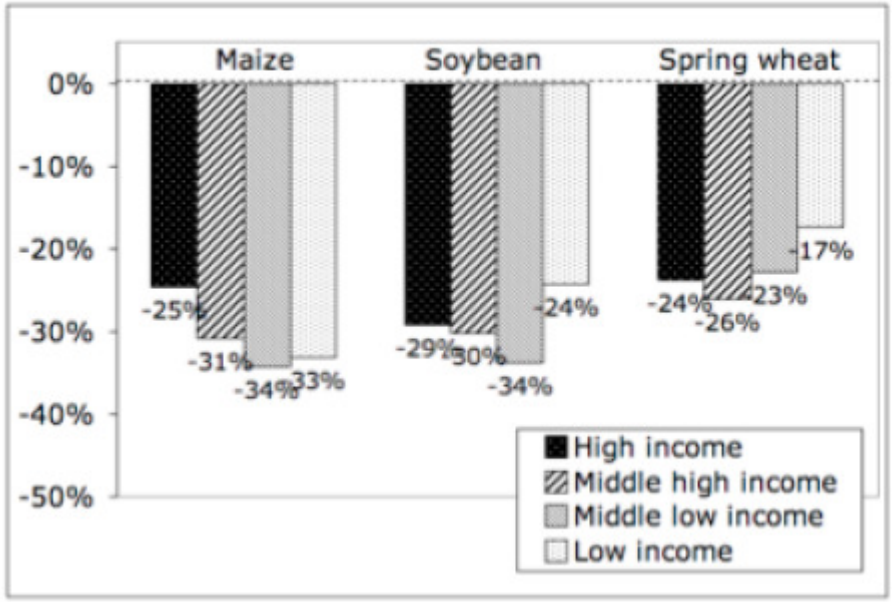
Source: the ICES model (Bosello et al. 2012)

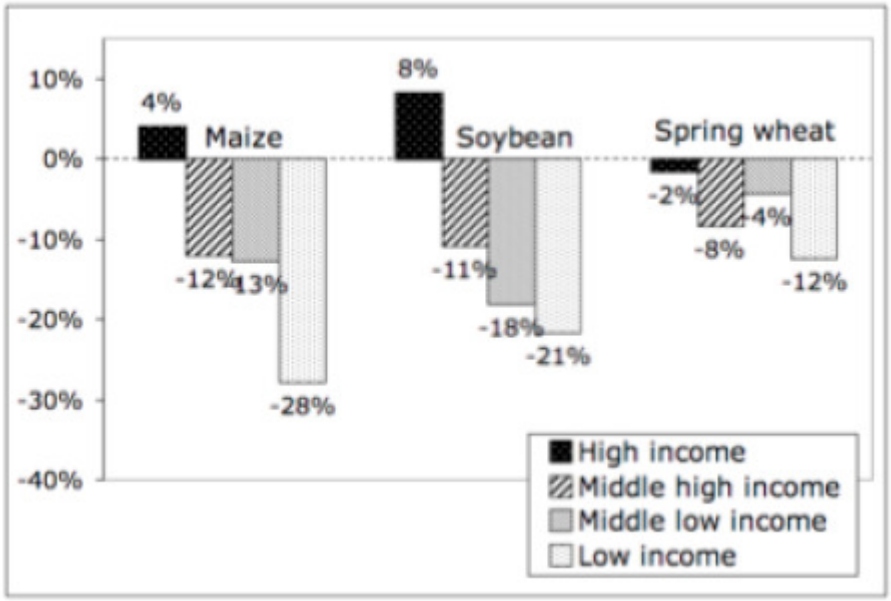
Impacts and adaptation in agriculture

Options for adaptation are fewer compared to temperate countries and thus adaptation is less effective

No adap

With adaptation (adjustments in planting and harvesting dates or varieties)





Yield changes in 2050 +2° C

Source: Deryng et al. (2011)

Adaptation options in agriculture

REACTIVE (with current technology)

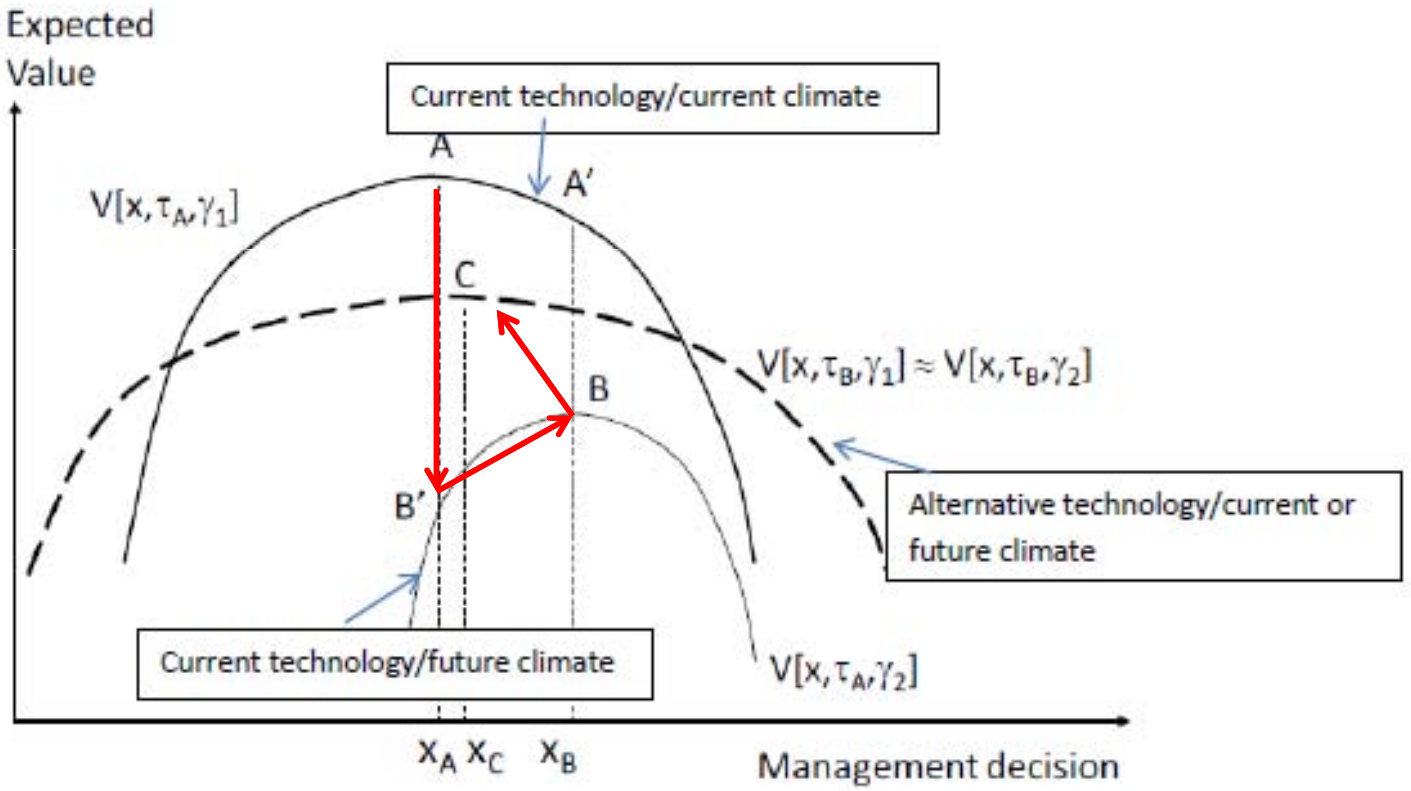
- Adjustments in planting and harvesting dates or varieties
- More intensive use of current inputs (nutrients, labor, irrigation)

PROACTIVE/PLANNED (with new technology)

- New crop seeds
- New methods of water harvesting
- Methods that improve production under extreme conditions
- Seasonal climate predictor
- Insurance, access to credit

Adaptation options in agriculture

Innovation has high potentials in enhancing adaptation options, especially in developing countries



Source: Antle and Capalbo (2010)

Policy Implications - 2

1. Mostly needed in developing countries, but R&D capacity is mostly in developed countries

2. China and Brazil started to show up in the R&D statistics, but the major threat is in Africa and South and East Asia where R&D capacity is extremely low

3. International cooperation to support adaptation-oriented R&D in developing countries

4. Innovation in agriculture will also be crucial to cope not just with damages, but also with increasing demand for food and energy crops

Primary energy mix in a 2D world

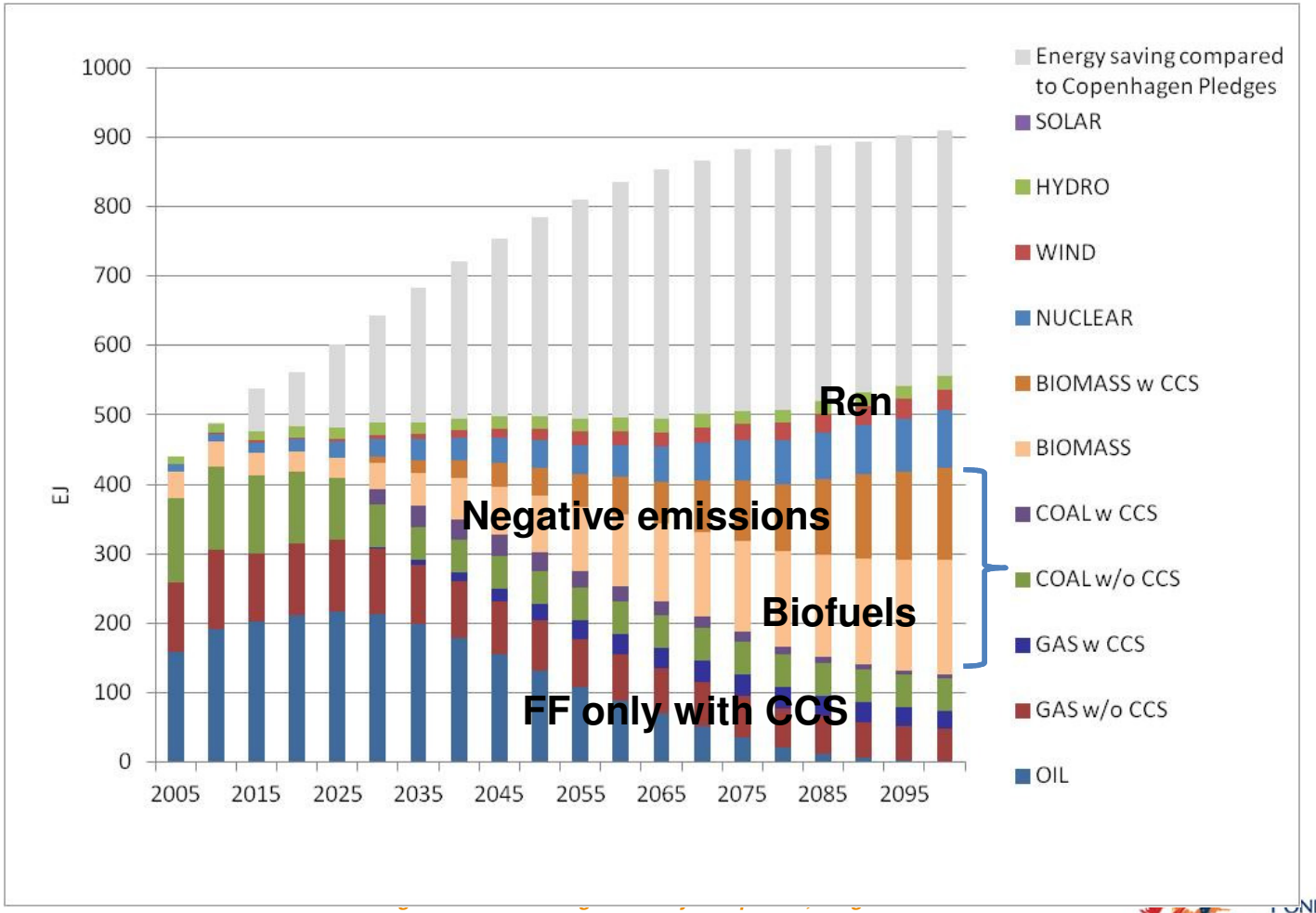


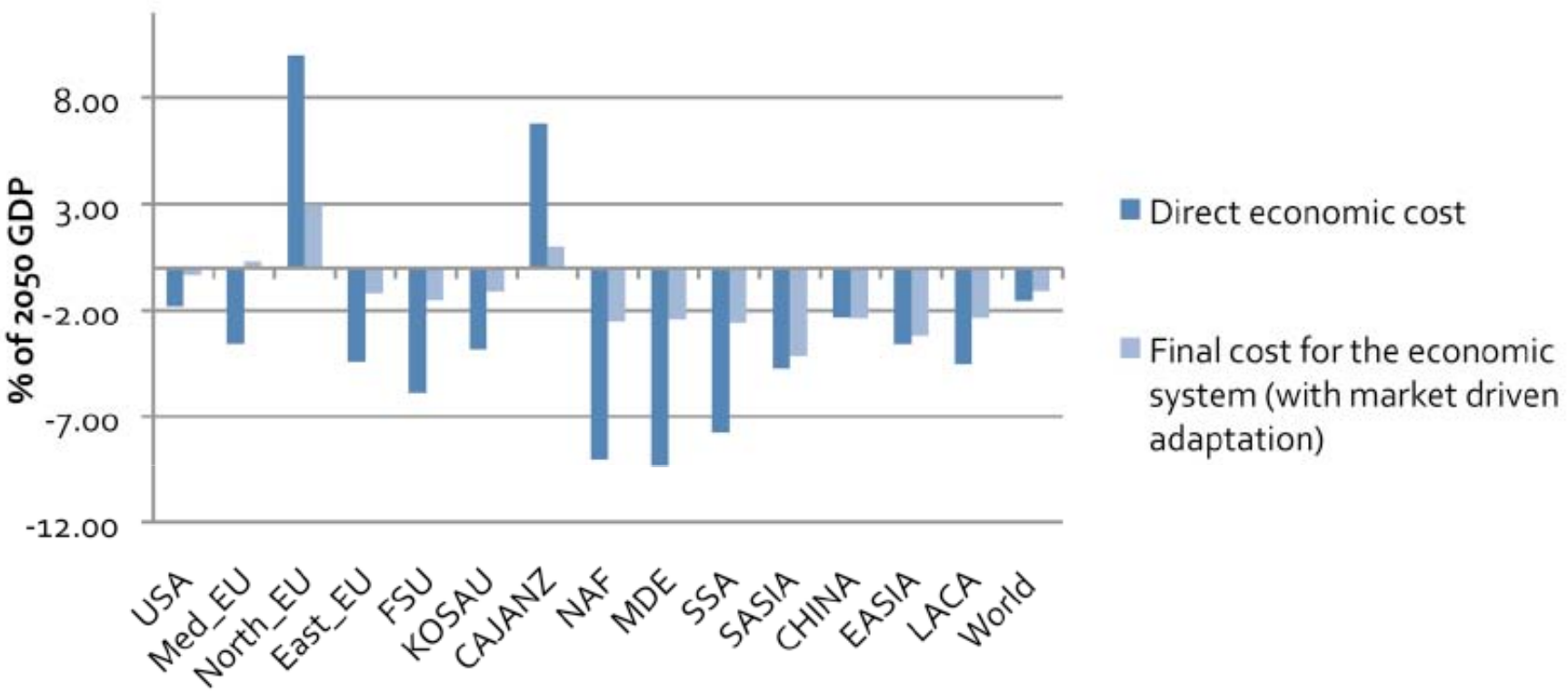
Figure Source: WITCH MODEL (FEEM)

Thank you!

Limitations of the top-down modeling approach

- The required aggregation used in top-down analyses does not provide indications on impacts/adaptation cost effectiveness at the sectoral level
- The spatial dimension, so important for adaptation, is missing
- Analyses of specific impacts and adaptation measures thus require a different investigation approach, typically "bottom-up" partial equilibrium models specified for the impact-sector-measure of interest

Autonomous adaptation for market impacts



Market-driven adaptation does not address the regional distribution of climate change impacts.

International trade can exacerbate initial impacts

Bottom line: Policy-driven adaptation should complement the effect of markets

Adaptation modeling: an economic approach

Adaptation investments are set on the basis of cost benefit considerations

Adaptation costs

the costs of protection measures

Adaptation benefits

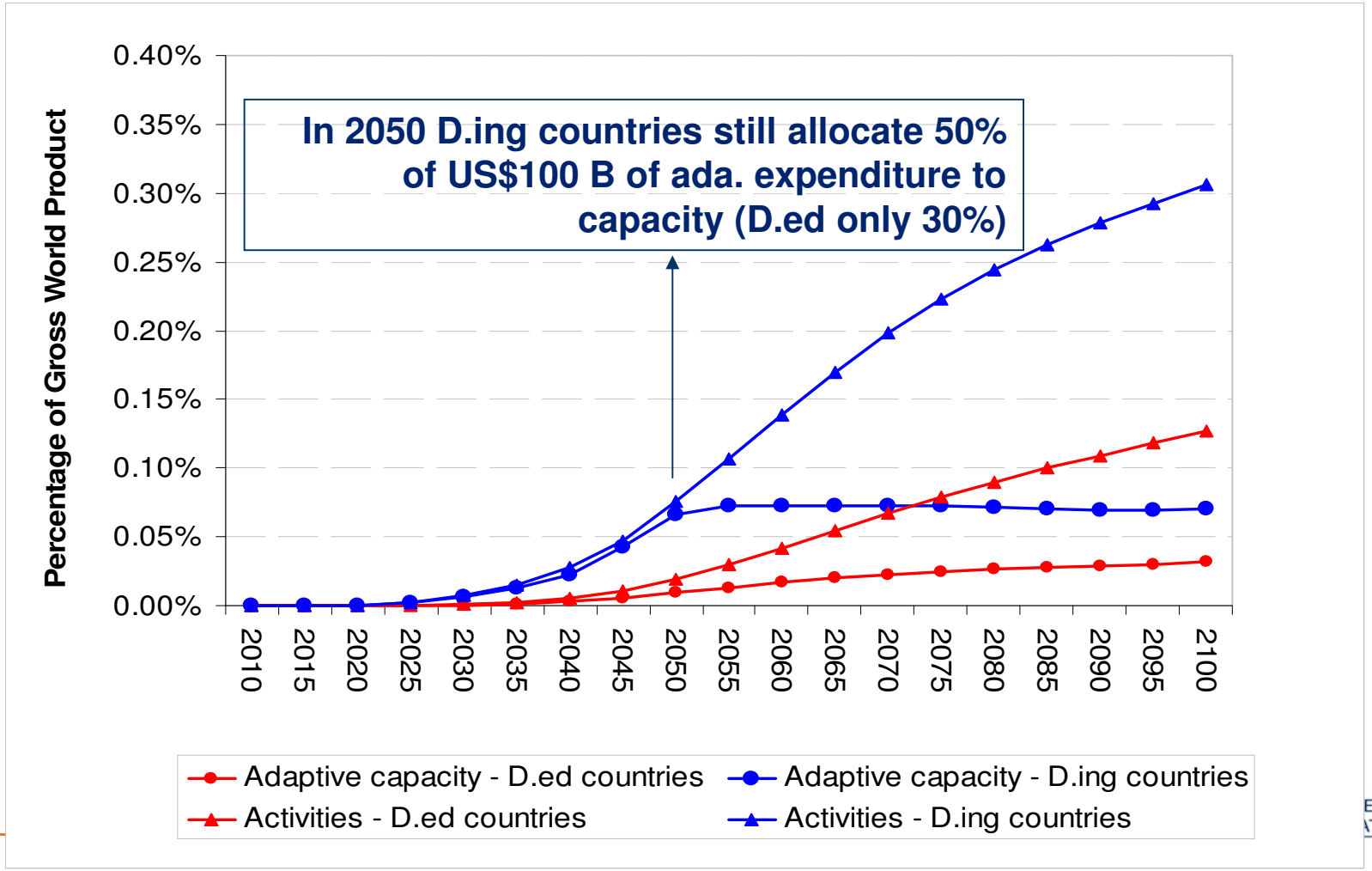
the reduced climate change damages

current mitigation investments

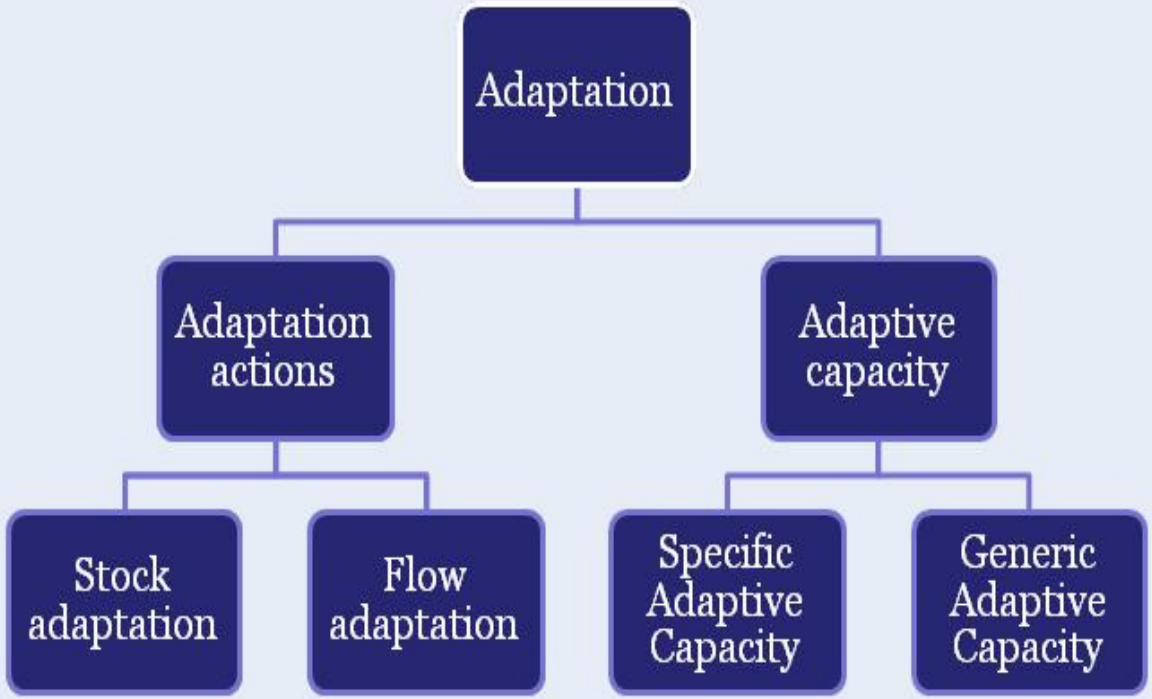
adaptation effectiveness (the potential of adaptation expenditure to reduce gross damages)

Regional adaptation: measures and capacity building

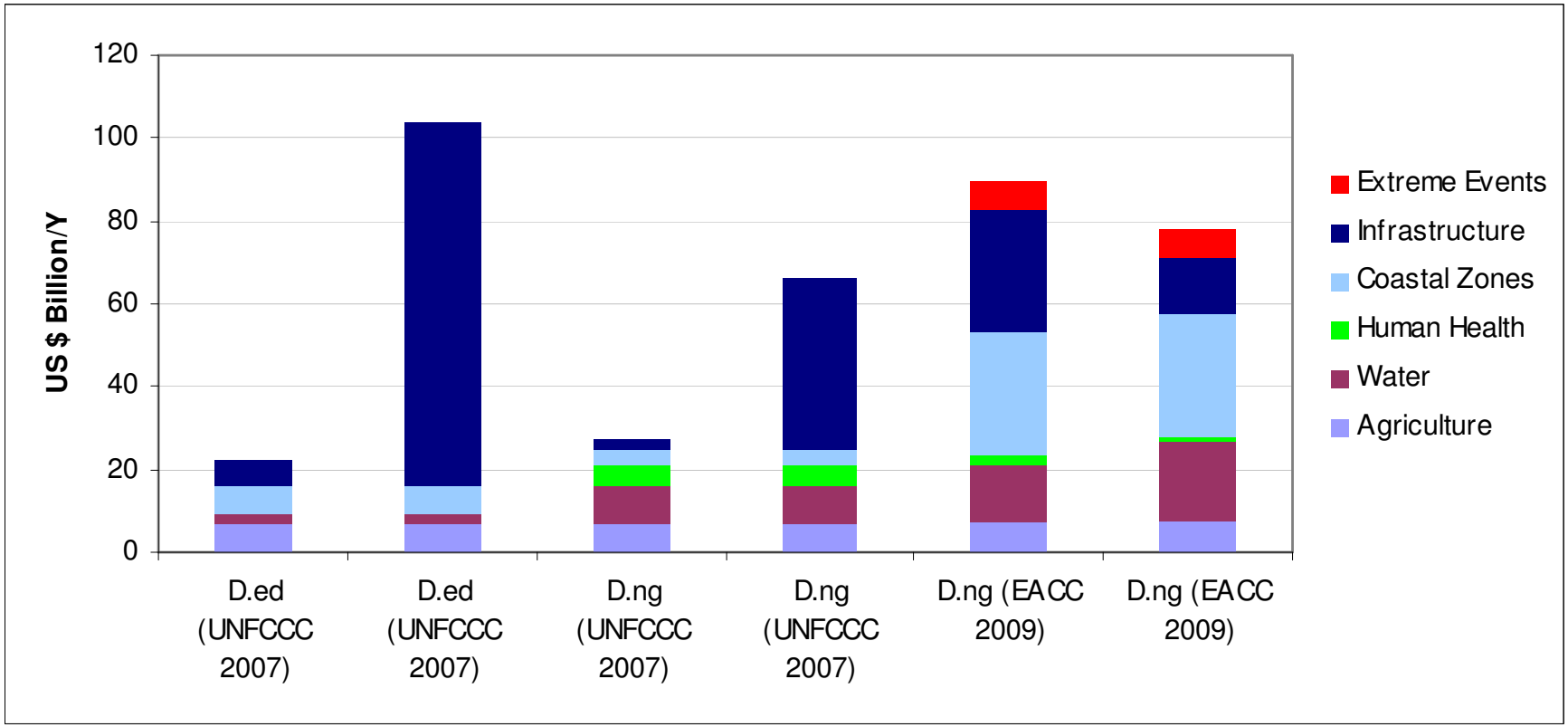
Developing countries would need more resources for adaptation measures and for building adaptive capacity



Adaptation modeling



Estimating yearly adaptation costs and needs (2030)



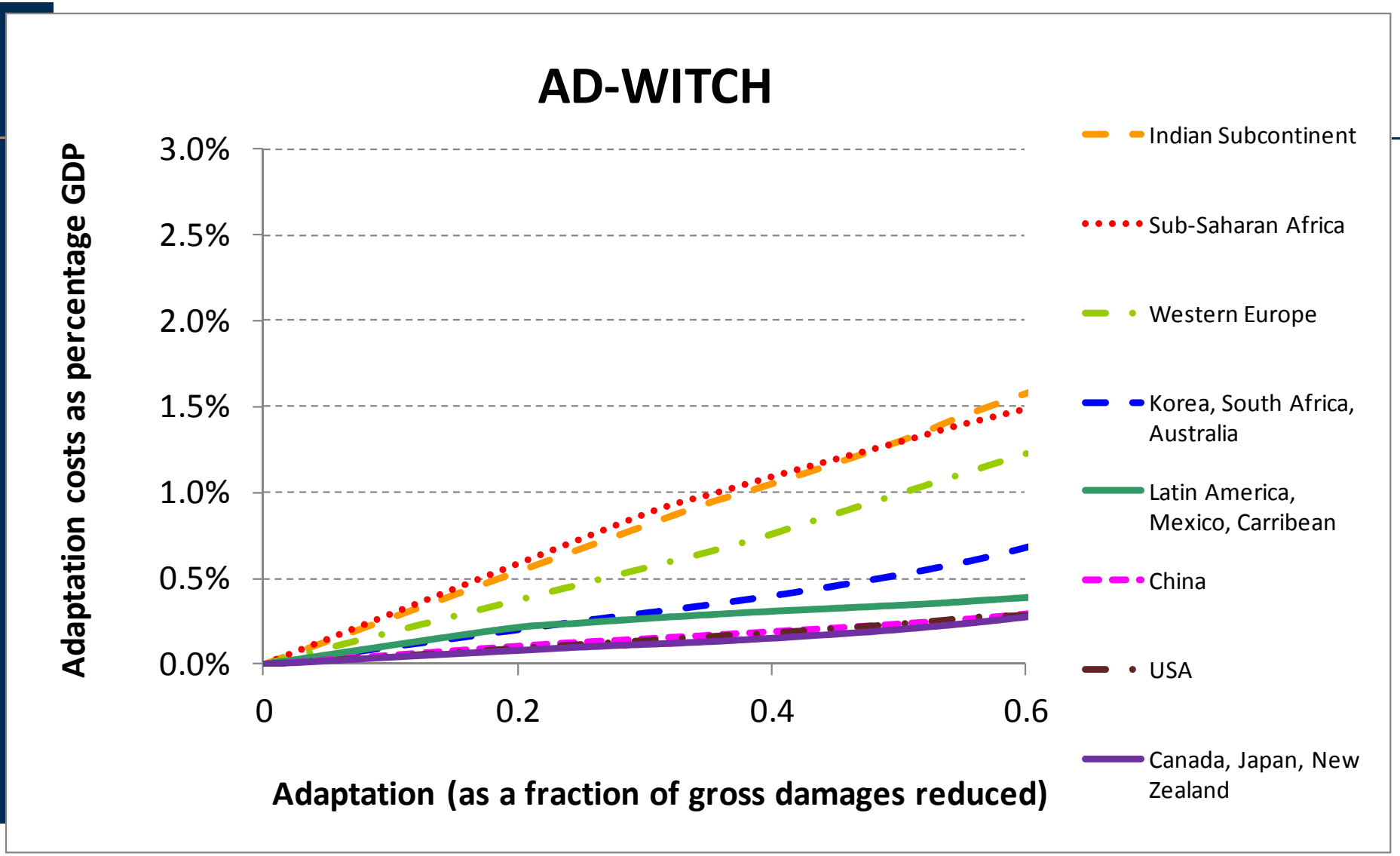
They are concentrated in some sectors, they are initially comparable in absolute magnitude across developing and developed countries.

Reactive and Proactive Adaptation

	AD-WITCH
AGRICULTURE	Stock
OTHER VULNERABLE MARKETS	Stock & Flow
CATASTROPHIC EVENTS	Adaptive Capacity
COASTAL SYSTEMS	Stock
SETTLEMENTS	Stock
NON-MARKET TIME USE	Flow
HEALTH	Flow

Damage categories considered are the same as in Nordhaus and Boyer (2000)

Calibration point: 2.5 degree temperature change (doubling of CO2 concentrations)


AD-WITCH
Adaptation costs as percentage GDP
3.0%
2.5%
2.0%
1.5%
1.0%
0.5%
0.0%
0
0.2
0.4
0.6
Adaptation (as a fraction of gross damages reduced)
Indian Subcontinent
Sub-Saharan Africa
Western Europe
Korea, South Africa, Australia
Latin America, Mexico, Carribean
China
USA
Canada, Japan, New Zealand

Trade-off

Mitigation halves adaptation

Still adaptation is needed, especially where residual damage remains high => developing countries