ECONADAPT WP8: Macro-economic assessment of planned adaptation

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Macroeconomic assessment of adaptation

- Adaptation mobilises financial resources for its implementation and triggers short and long-run economic effects.

- Planned adaptation measures are implemented locally but will induce additional indirect economy-wide effects through an increased demand for adaptation services and the reallocation of resources to produce them.

- Macroeconomic assessments provide insights on these second-order (indirect) effects by considering also the rest of the economy.

- In particular, general equilibrium analyses in which all sectors and regions are interconnected, allows capturing the propagation of indirect effects related to different climate change impacts and the corresponding adaptation measures.

The macroeconomic model: ICES

- Global recursive dynamic Computable General Equilibrium (CGE) model
- 22 sectors
- 22 countries/regions

Regional detail				
Europe	***Africa/Middle East***	***Americas***	***Asia***	***Oceania***
North Europe	North Africa	USA	Japan	Australia
North_EU15	Sub-Saharan Africa	Canada	South Korea	New Zealand
Med_EU15	South Africa	LACA	South Asia	
Med_EU12	Middle East		India	
East_EU12			China	
Rest of Europe			East Asia	
Rest of FSU				

- ***Baseline***: Shared Socio-Economic Pathways (O'Neill et al. 2012)
  - SSP2 ("middle of the road")
  - Projections for population and GDP growth trends (IIASA, OECD)
  - Simulation period: 2008-2050 (one-year time steps)

Modelling Adaptation in Agriculture

- Main focus: analysis of irrigation services in agriculture as a mean of adaptation → Climate change impacts on yields are contrasted with increases in irrigation demand/use

- Including irrigation in the ICES model as sector-specific investments/capital for irrigation
- Modifying accordingly the database, production function and cost structure of agricultural activities in the model

Data sources:

- **IFPRI** - International Food Policy Research Institute
- **AgMIP** - Global Gridded Crop Model Intercomparison Project
- **FAOSTAT** - Food and Agriculture Organization
- **GTAP** - Global Trade Analysis Project

D.8.2.2 ***"The implications of irrigation as a planned adaptation measure on an economy wide context"***

Adaptation in Agriculture: Simulation scenarios

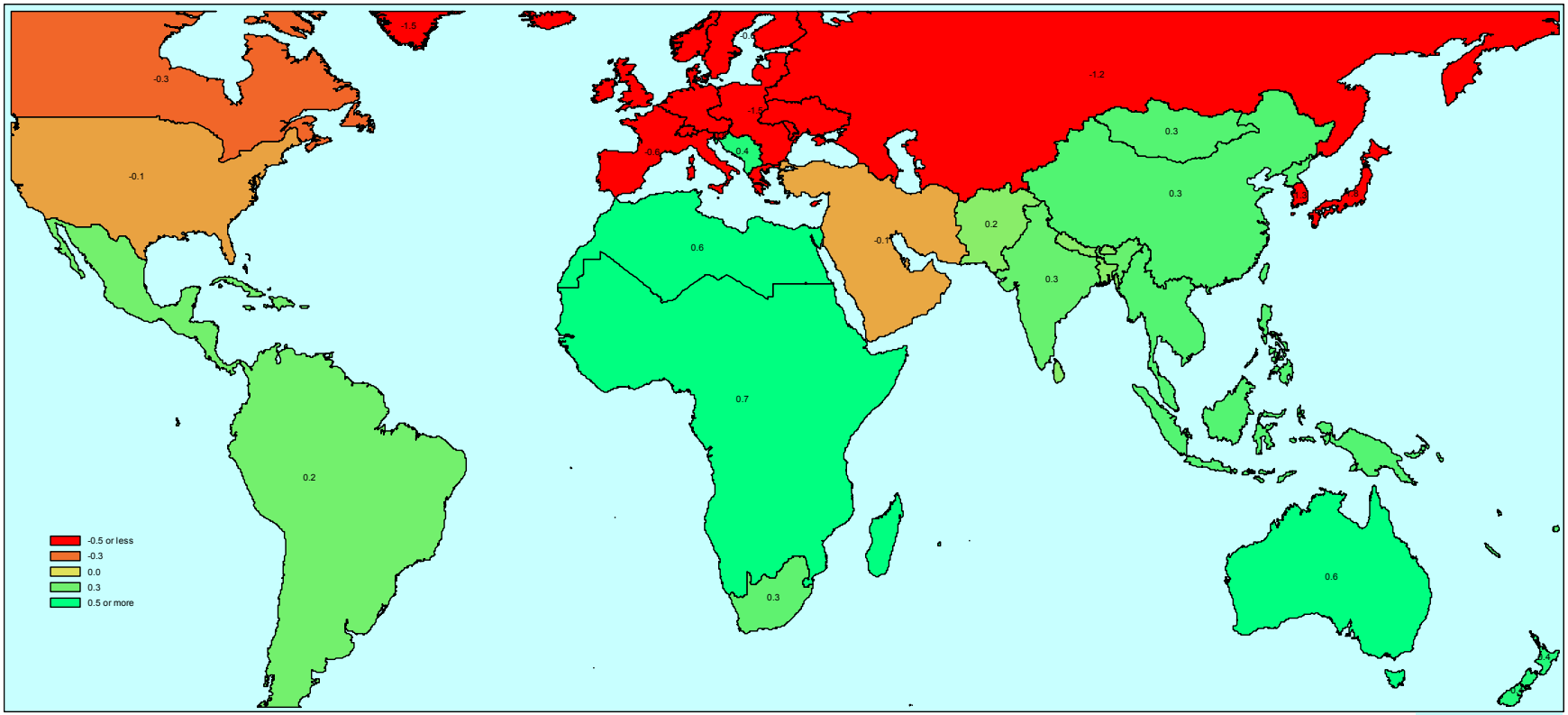
- ***No adaptation case:*** Fixed Irrigated land and rainfed land as in the baseline
- ***Adaptation case:*** Irrigable land and rainfed land adjust according to farmers demand.

Climate change scenarios

- RCPs: 2.6, 4.5, 6.0, and 8.5
- GCM: HadGEM2-ES
- Five crop Models from the Global Gridded Crop Model Intercomparison Project (AgMIP): ***EPIC, GEPIC, LPJmL, LPJ-GUESS, pDSSAT***

- Climate impact on yields
  - Differentiated by rainfed and irrigated land
  - No CO_2 fertilization effect

Changes in irrigated land by region in 2050 (RCP8.5)



Average of five crop models
Percentage change with respect to the No Adaptation scenario

-0.5 or less
-0.3
0.0
0.3
0.5 or more

Irrigation expansion can be an effective adaptation option for lower latitude countries enabling higher production and lower GDP losses.

Key messages for irrigation in agriculture

- The expansion of irrigated areas or higher irrigation efficiency could play a key role in climate change adaptation in agriculture.
- However irrigation is costly. Its widespread use could trigger indirect effects due to higher production costs. An increased demand for irrigation services can eventually increase the price of agricultural commodities notwithstanding the positive effect on yields.
- Even though irrigation reduces the adverse climate change effects on yields its final economic higher order effect is not necessarily positive for all.
- The adaptation scenario features a reallocation of crop production from developed to developing countries which are advantaged in relative terms by a combination of lower irrigation costs with the initial climatic impacts.

Modelling Planned Adaptation for Coastal Zone Protection

- Main focus: assess the effect of planned adaptation expenditures for coastal protection considering climate change damage reduction and effect on public budgets

- Enhancing the representation of the public sector in ICES
- Focus on government expenditures/investments on infrastructure
- Developing an adaptation module in ICES: Adaptation costs are borne by the government increasing:
  - Investments for dike construction
  - Recurrent expenditures for dike maintenance
  - Public adaptation is funded by issuing public debt
- Coordination with the DIVA modelling team
  - S. Brown (University of Southampton)
  - J. Hinkel (GCF – Global Climate Forum)

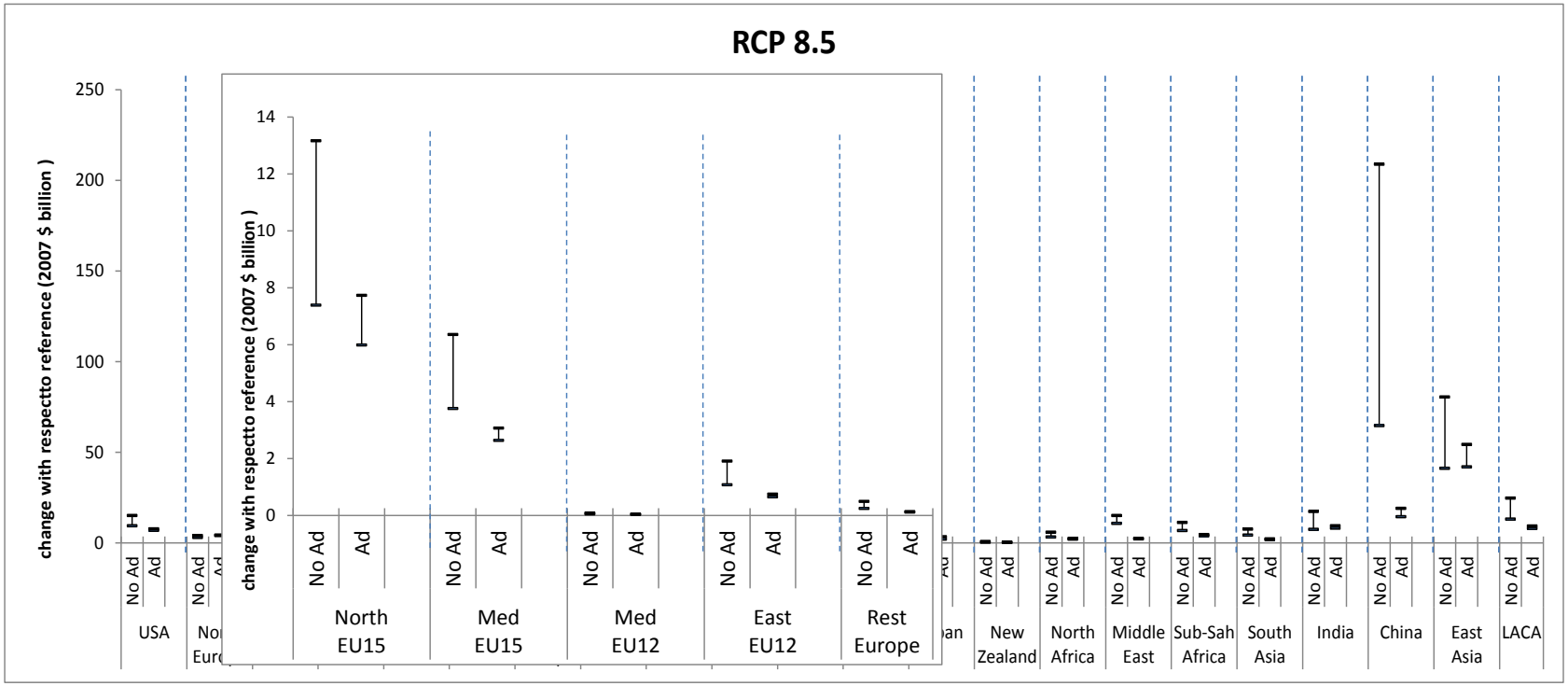
D8.2.3: "***Modelling Planned Adaptation for Coastal Zone Protection in a General Equilibrium Framework***"

Adaptation to Sea level rise: Simulation scenarios

- **No additional adaptation** (Inaction): Only SLR impacts
- **Adaptation**: Adaptation investments and residual damages following DIVA projections.

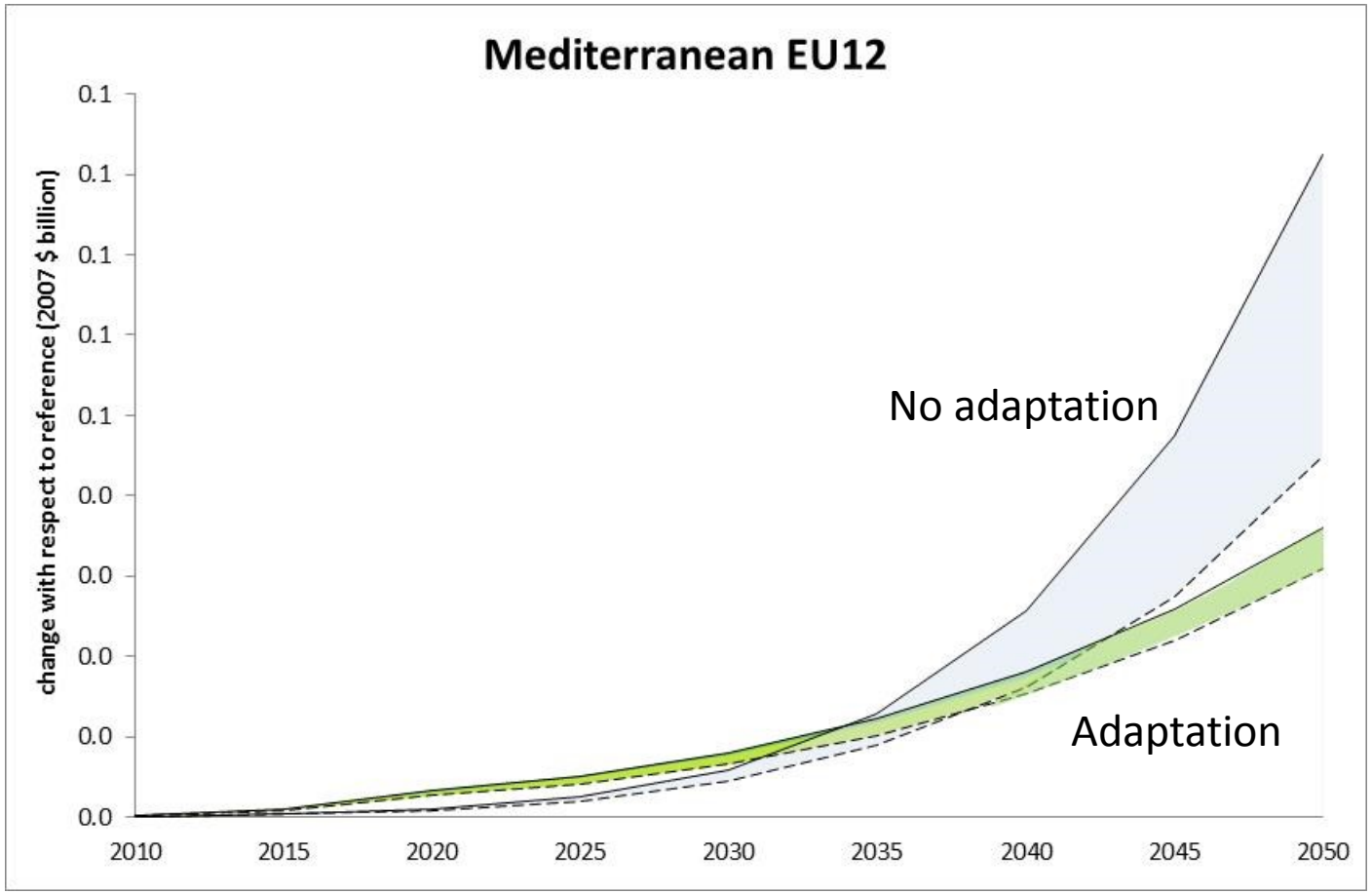
- Climate change Impacts and adaptation data from DIVA model runs (RCPs: 2.6 and 8.5 and SSP2)
  - Expected damage to assets implemented as capital and land stock losses
  - Expected annual number of people flooded implemented as decreased labour productivity
  - Annual cost of dike construction and updates
  - Annual cost of dike maintenance

Effects of public SLR adaptation on public deficit by region in 2050



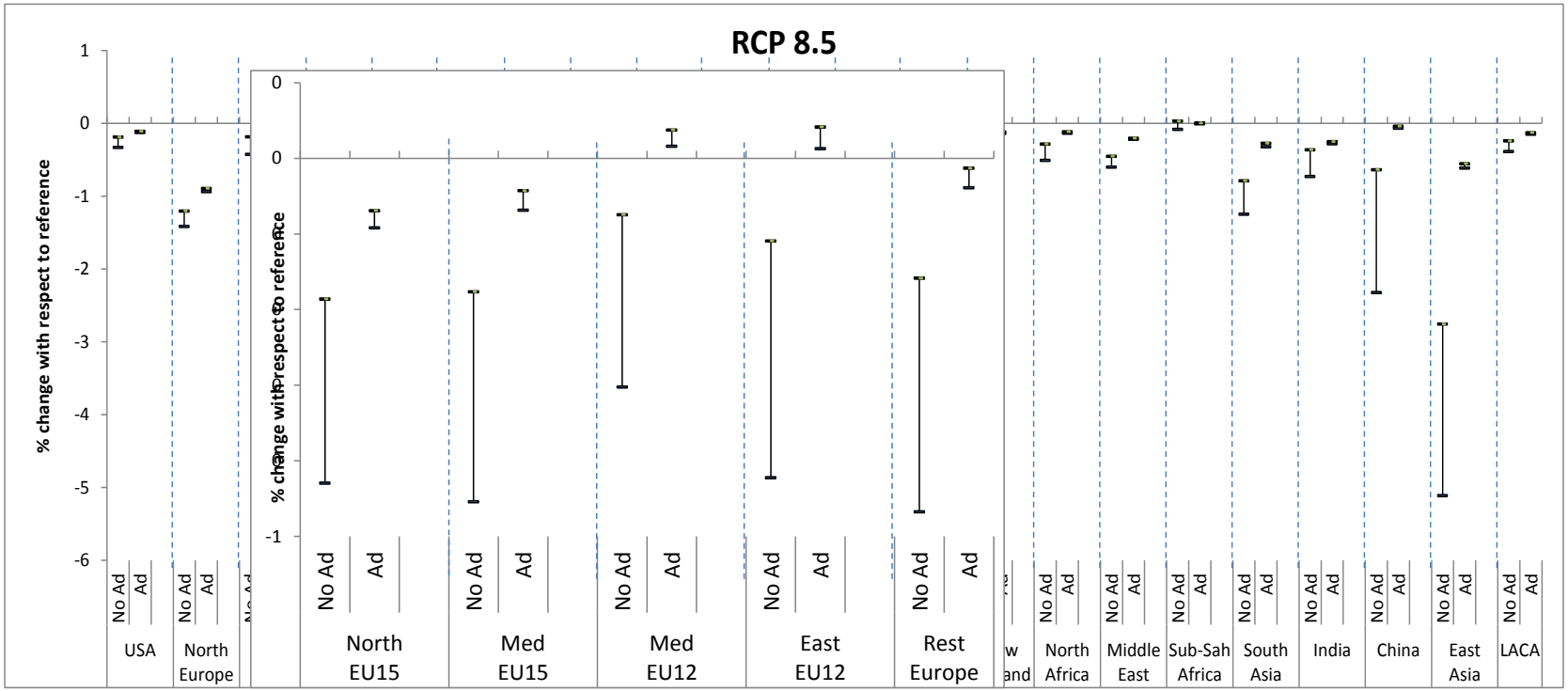
- Without additional adaptation all regions increase their public deficits mainly driven by reductions in tax revenues,
- A higher deficit deteriorates public finance therefore the government borrows from household savings, which eventually reduces also the available resources for private investments.
- With adaptation, lower impacts of SLR translate in lower deficits. The government borrows less from households => increased capital accumulation in the long-run.

Effects of public SLR adaptation on public deficit



- Implementing adaptation measures for coastal zone protection may imply higher deficits in the short-run but with much lower levels in the long-run.

Effects of public SLR adaptation on GDP by region in 2050



- Adaptation reduces GDP losses from sea-level rise, which is more pronounced in regions where sea-level rise has more pronounced impacts (Asian, Sub Saharan, Middle East and North Africa countries).
- This positive result of adaptation is the compounded effect of two mechanisms directly and indirectly related with the impacts of SLR.
    1. Avoided direct impacts (loss of labour productivity, land and capital).
    2. The reduction of the public deficit effect

Key messages for coastal zone protection to SLR

- Expenditure on adaptation is not only able to reduce adverse consequences of climate change, but could also reduce public deficits. The higher GDP and the lower future remediation expenditure overcompensate the initial public expenditure.

- A key message is related to the way adaptation is financed. Combining adaptation with mitigation efforts based on a carbon tax can trigger positive synergies between policies.

    - ***Mitigation policy:*** pledges submitted to the UNFCCC as Intended Nationally Determined Contributions (INDCs) during the last COP 21 in Paris, implemented in 2030.

    - ***Adaptation policy:*** protection against sea-level rise in 2030 for RCP8.5 as a climate change scenario coupled with high sea-level rise estimates based on projections from the MIROC-ESM climate model.

- Revenues from mitigation actions accrue to the public budget; decrease the need by the public sector to borrow money from the private sector. This reduces the crowding out of public current expenditure on private investment, and, eventually, decrease the penalization on the capital accumulation process.

Final Remarks on modelling adaptation

1. The main limitation for macroeconomic assessments is data availability for adaptation measures.
2. It is difficult to generalise costs from specific/local studies to the rest of the country or to a region.
3. There is ample potential to collaborate with bottom-up modelling groups to include adaptation in those models and then establish links with macroeconomic (e.g CGE) models.
4. How to improve and extend the methodology to other sectors?
    - Improve the availability /generation of data for adaptation assessment
    - Extend data produced by bottom-up models for other impacts (Health, energy demand/supply, riverine floods, etc.)
    - Extend the macroeconomic model to include those data following the suggested structure of the bottom-up data.

Thank you

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