Spatially explicit assessment of coastal vulnerability – The DIVA-Med tool

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Plan

- Background of the DIVA modelling tool
- Coastal databases and representation of coastal space
- Application and further development of DIVA within the CIRCE project
- Metrics
- Future research needs

Dynamic and Interactive Assessment of National, Regional and Global Vulnerability of Coastal Zones to Climate Change and Sea-Level Rise
The DINAS-COAST project (EU / IGBP-LOICZ)



The Consortium

Potsdam Institute for Climate Impact Research, Germany (Co-ordinator)

Flood Hazard Research Centre, Middlesex University, UK

WL|Delft Hydraulics, The Netherlands

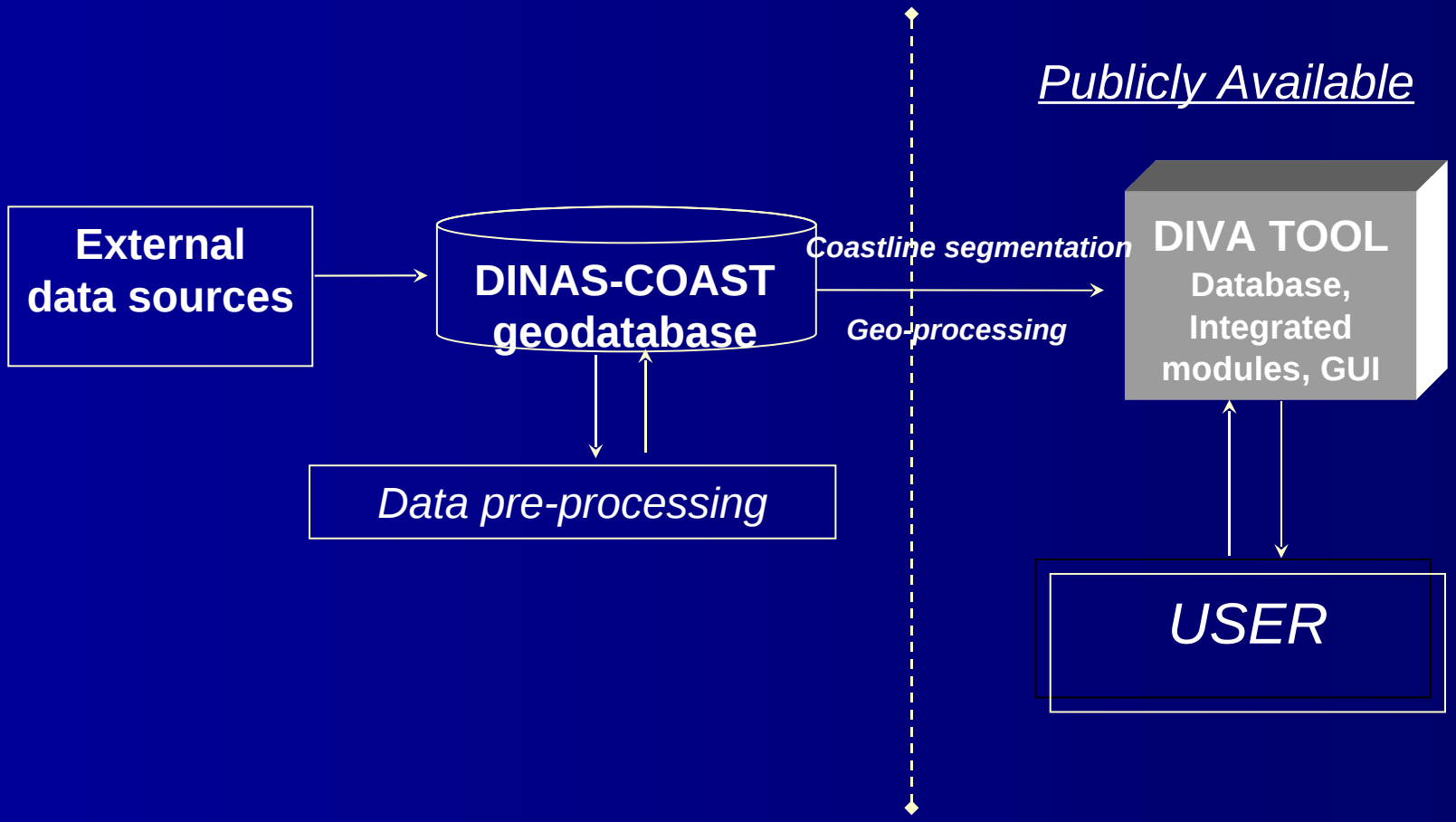
The Centre for Marine and Climate Research, Hamburg University, Germany

The Free University of Amsterdam, The Netherlands

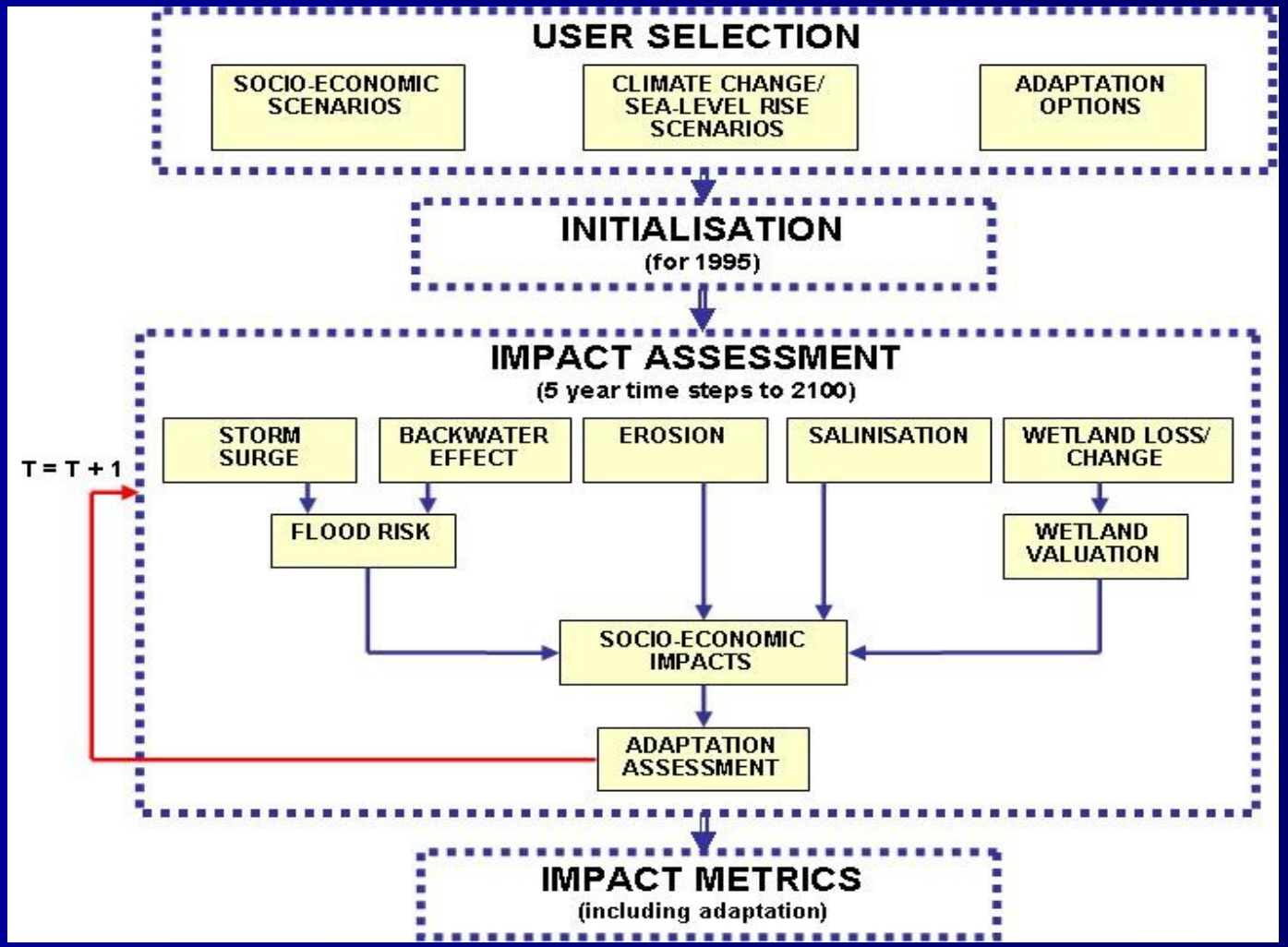
The Dynamic and Interactive Vulnerability Assessment (DIVA) Tool

- Main product/deliverable of DINAS-COAST
- A dynamic, interactive and flexible assessment tool
- A CD-ROM that includes: Models, GUI and database
- It enables consistent and comparative analyses of mitigation and adaptation policies for a range of emission, s-e and other scenarios
- User friendly, low requirements so that it can be used by policy makers everywhere in the world

The DIVA Tool



Schematic view of the operation of the DIVA tool



Limitations for global-scale vulnerability analysis

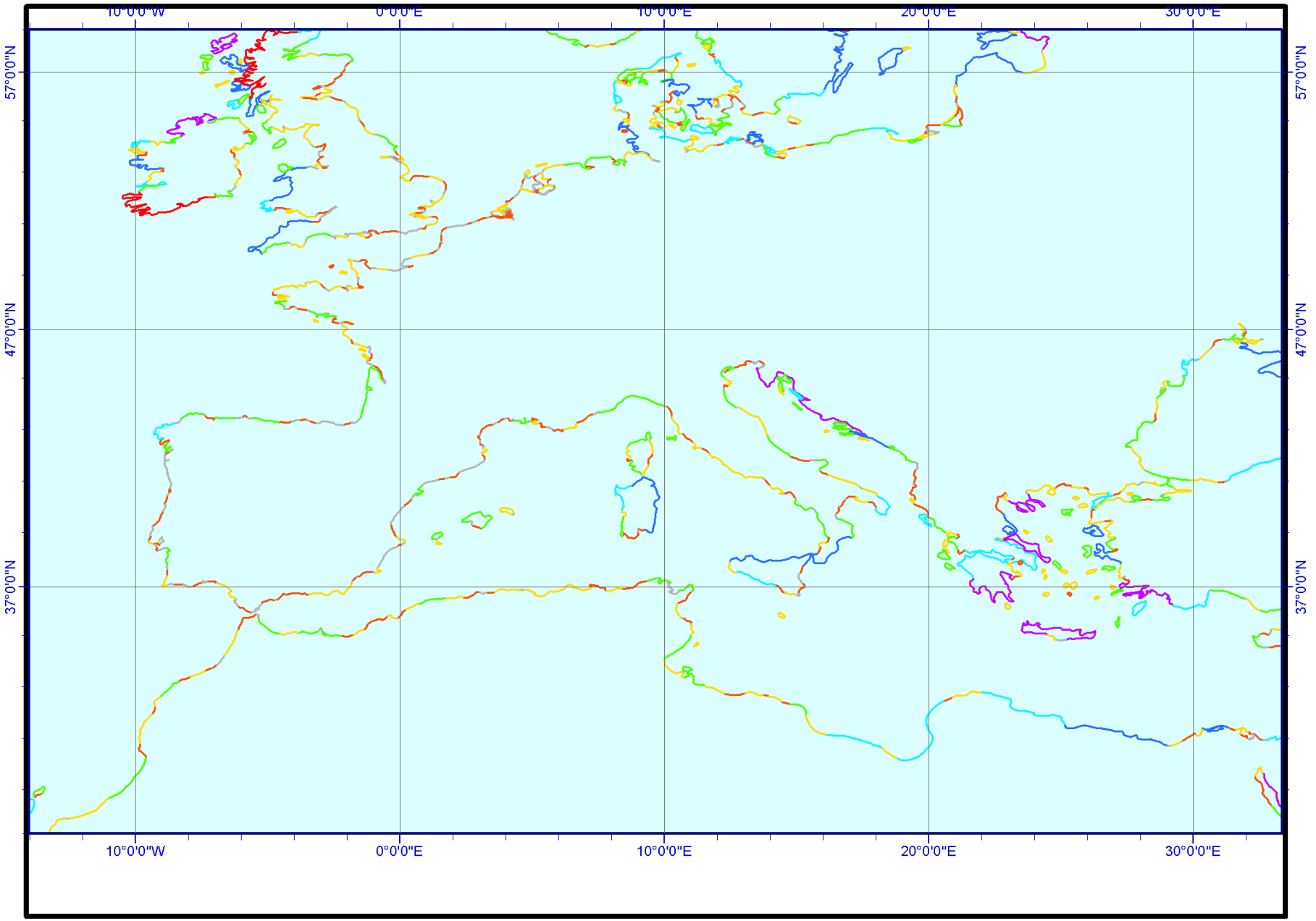
- Lack of consistent evaluations of coastal vulnerability at global scale
- Lack of tools and data that address the information needs for international climate policy
- Existing data are not directly accessible by researchers and policy makers
- Lack of a coherent and non-fragmented source of data input at a global scale

Considerations

- Representation of coastal space - data model
- Particularities of coastal Geographic Information Systems
- Physical & socio-economic data
- Dynamic nature of the coast – database updating and upgrading

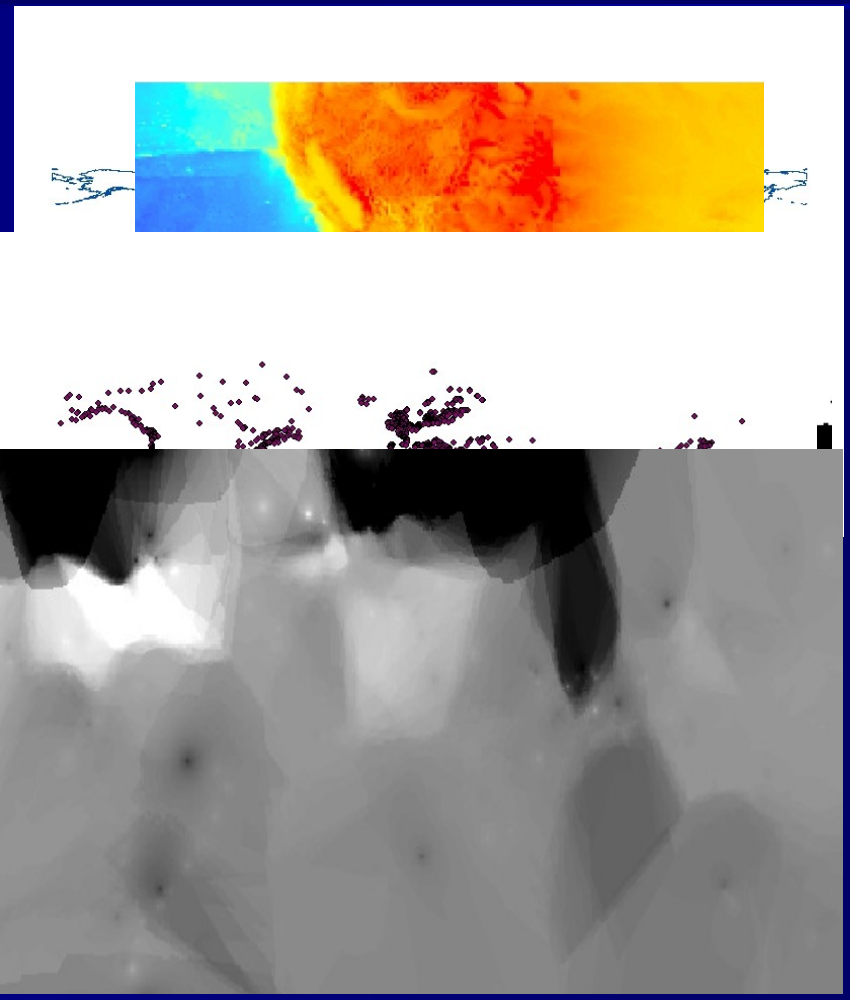
DIVA database for impact and vulnerability analysis to SLR

- Global database of physical and socio-economic parameters of the coast
- Available at http://www.civil.soton.ac.uk/DIVA
- Fundamentally different structure from other global databases
- Make data available to users with low-specification hardware
- Make data available to users with non-specialised software


10°0'0"W
0°0'0"E
10°0'0"E
20°0'0"E
30°0'0"E
57°0'0"N
47°0'0"N
37°0'0"N

Examples of datasets

- Coastline vector
- Elevation, Bathymetry
- Population
- Wetland characteristics
- Subsidence/uplift
- Tidal range
- World Rivers



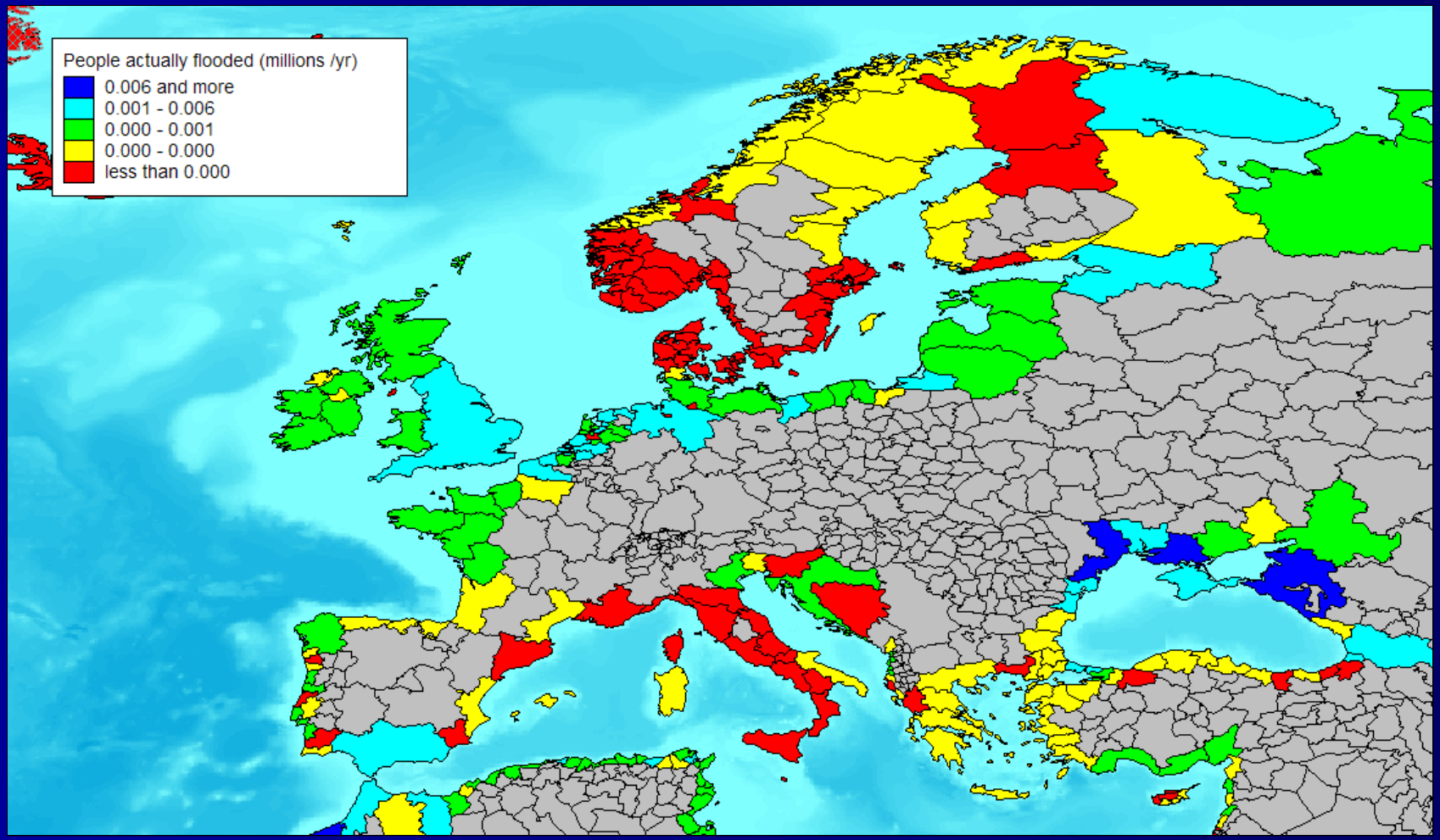


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LATI	38.338
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SLTRWGT	0.3
WAVECLIM	2
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AREA2	4
AREA3	6
AREA4	3
AREA5	6
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LENGTHY	317.041
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5175	5	0		1.224	1.388	1.563	1.745	1.000
5177	5	0		1.165	1.306	1.454	1.606	1.000
5178	5	0		0.967	1.130	1.303	1.483	1.000
5179	5	0		1.020	1.192	1.375	1.567	1.000
5180	5	0		1.151	1.316	1.490	1.672	1.000
5181	5	0		1.158	1.299	1.445	1.597	1.000
5203	0	0		1.478	1.578	1.678	1.778	1.000
5204	0	0		0.354	0.454	0.554	0.654	1.000
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5267	4	0		0.400	0.500	0.600	0.700	1.000

Estimated People Flooded (per year) by surges in 2000



Diva 2.0

p

ut analysis

- Input parameters
  - Global data
  - Country data
  - Administrative unit data
  - Tidal basin data
  - River data
  - World Heritage Site data
  - Coastline segment data
- Initial values
  - Country data
  - Coastline segment data
- Results
  - Country data
  - Administrative unit data
  - Tidal basin data
  - River data
  - Theatened world heritage
  - Coastline segment

Results

Coastline segment

Locations	Parameters								
	Protection cost	Beach nourishment	Beach Nourishment Costs	Costs of land loss	Costs of salinity intrusion	Land loss total	Migration	Migration costs	Protection Level
	$	m^3/yr	$/yr	$/yr	$/yr	m^2	#/yr	$/yr	year
1286 South Africa	0	0	0	0	0	0.00E+00	0	0	217
1287 South Africa	25	3015473	18092840	27805	0	2.23E+05	14	147819	149

Columns: Rows:



Parameters:	Costs of land loss	Select subset		axis position:	X (Horizontal)
Locations:	1251 South Africa	Select subset		axis position:	Y (Vertical)
Timesteps:	2000	Select subset		axis position:	Z1 (Depth)
Cases:	Case SRES A1B / SLR LR	Select subset		axis position:	Z2 (Depth)

Template: default

DIVA 1.0

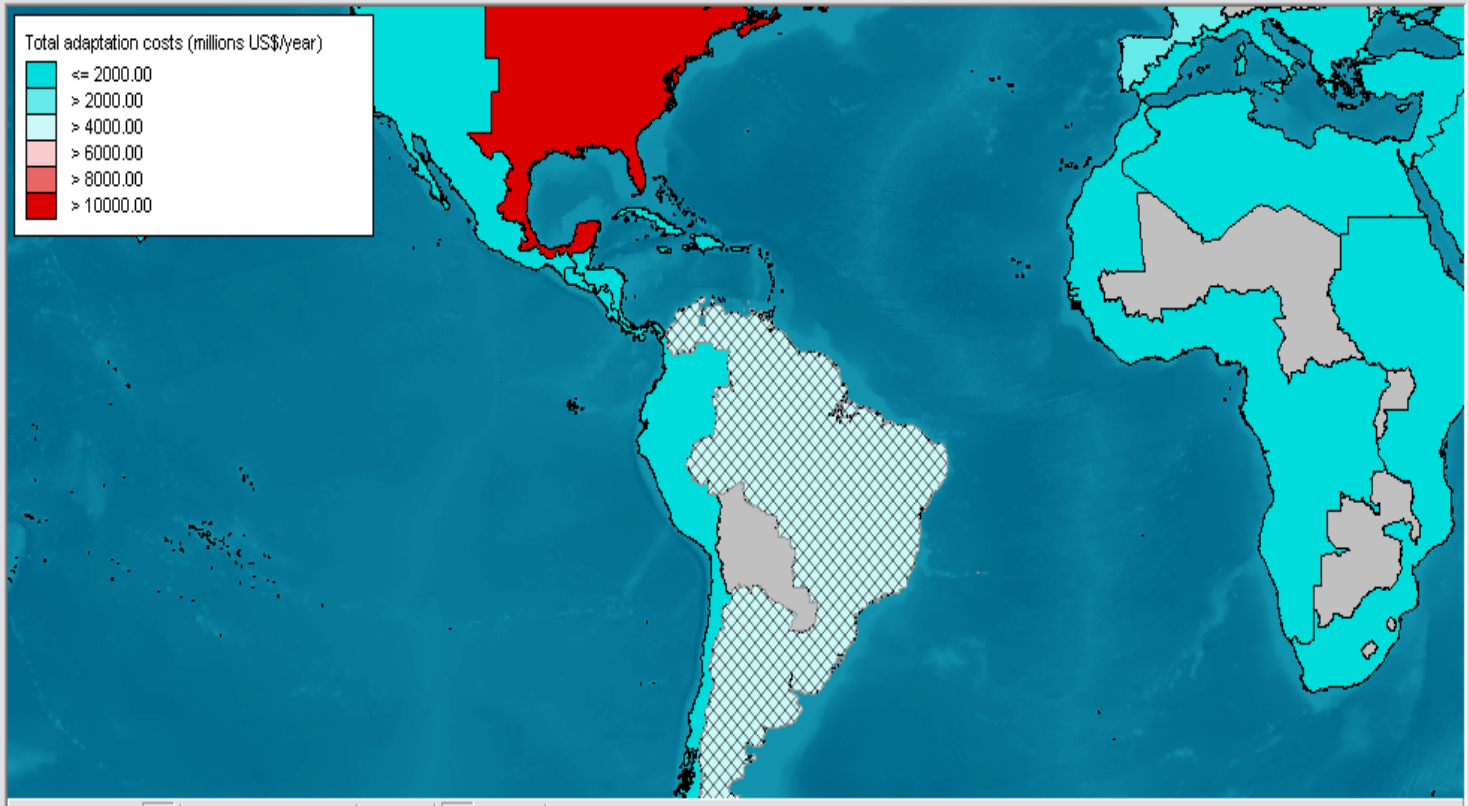
Case Help

input analysis

- Input parameters
- Initial values
- Results
  - Global
  - GVA region data
  - SRES region data
  - Country data
  - Administrative unit data
  - Tidal basin data
  - River data

Results

GVA region data

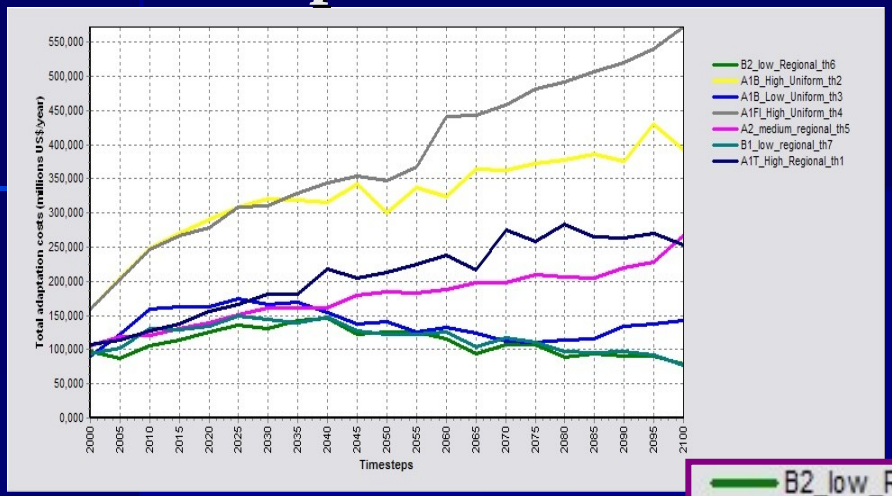


Locations:	South America Atlantic Ocean	Select subset	Select all	axis position:	X (Horizontal)
Parameters:	Total adaptation costs	Select subset	Select all	axis position:	Y (Vertical)
Timesteps:	2000	Select subset	Select all	axis position:	Z1 (Depth)
Cases:	Quick Tour1	Select subset	Select all	axis position:	Z2 (Depth)

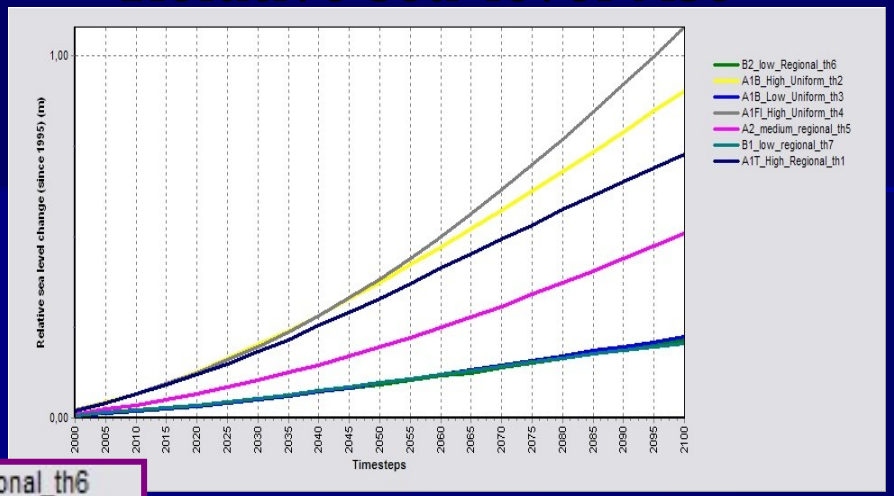
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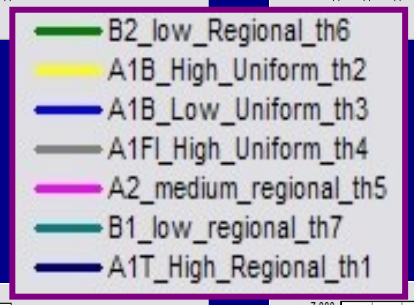
Eastern Europe

Total adaptation cost

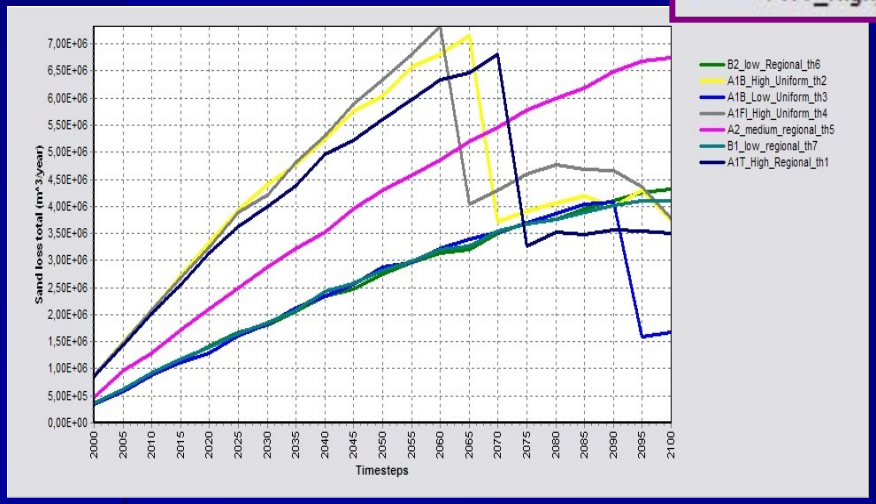


Relative sea-level rise

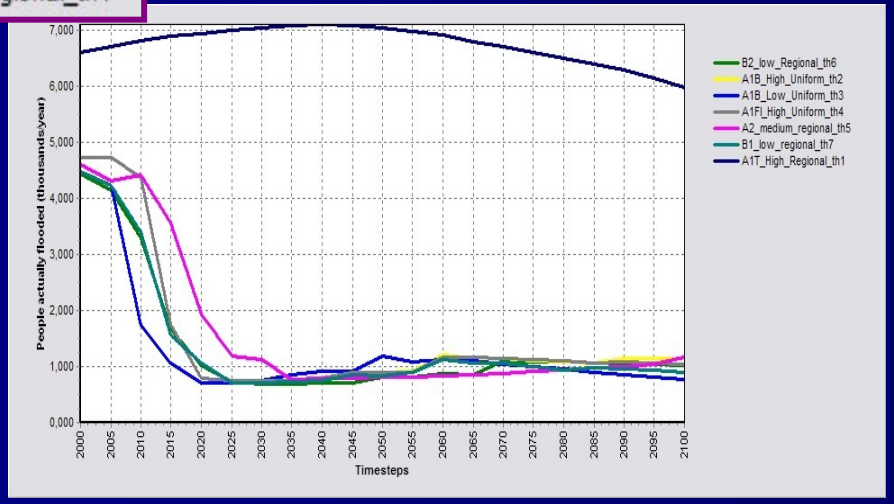




Sand loss total



People actually flooded



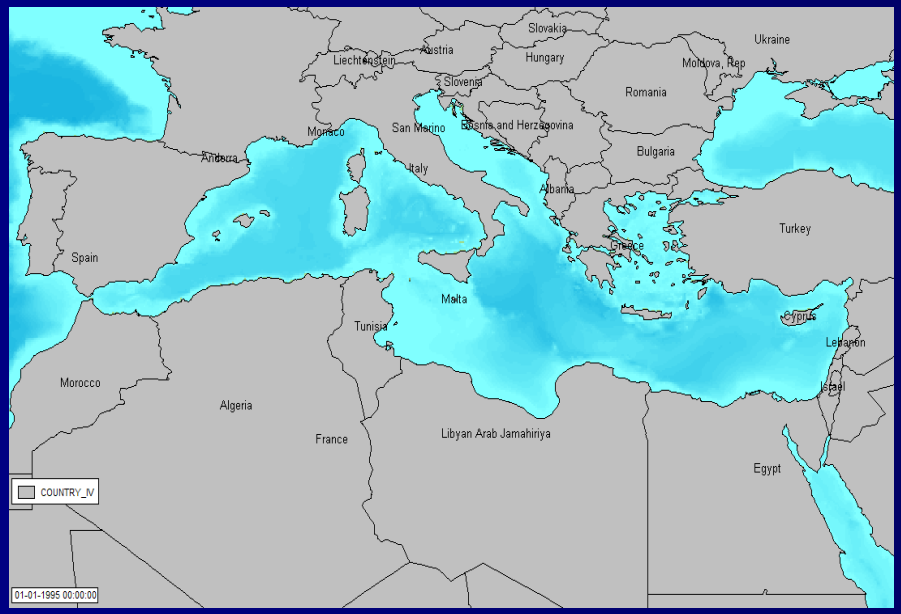
CIRCE – Climate Change and Impact Research: The Mediterranean Environment

- Integrated Project – EU FP6
- 59 Participants
- Economic Impacts – WP10.6, Sea-Level Rise
- Develop DIVA-Med
  - Updated database
  - Improved algorithms
- Provide an assessment of SLR impacts in the Med & input for CGE model

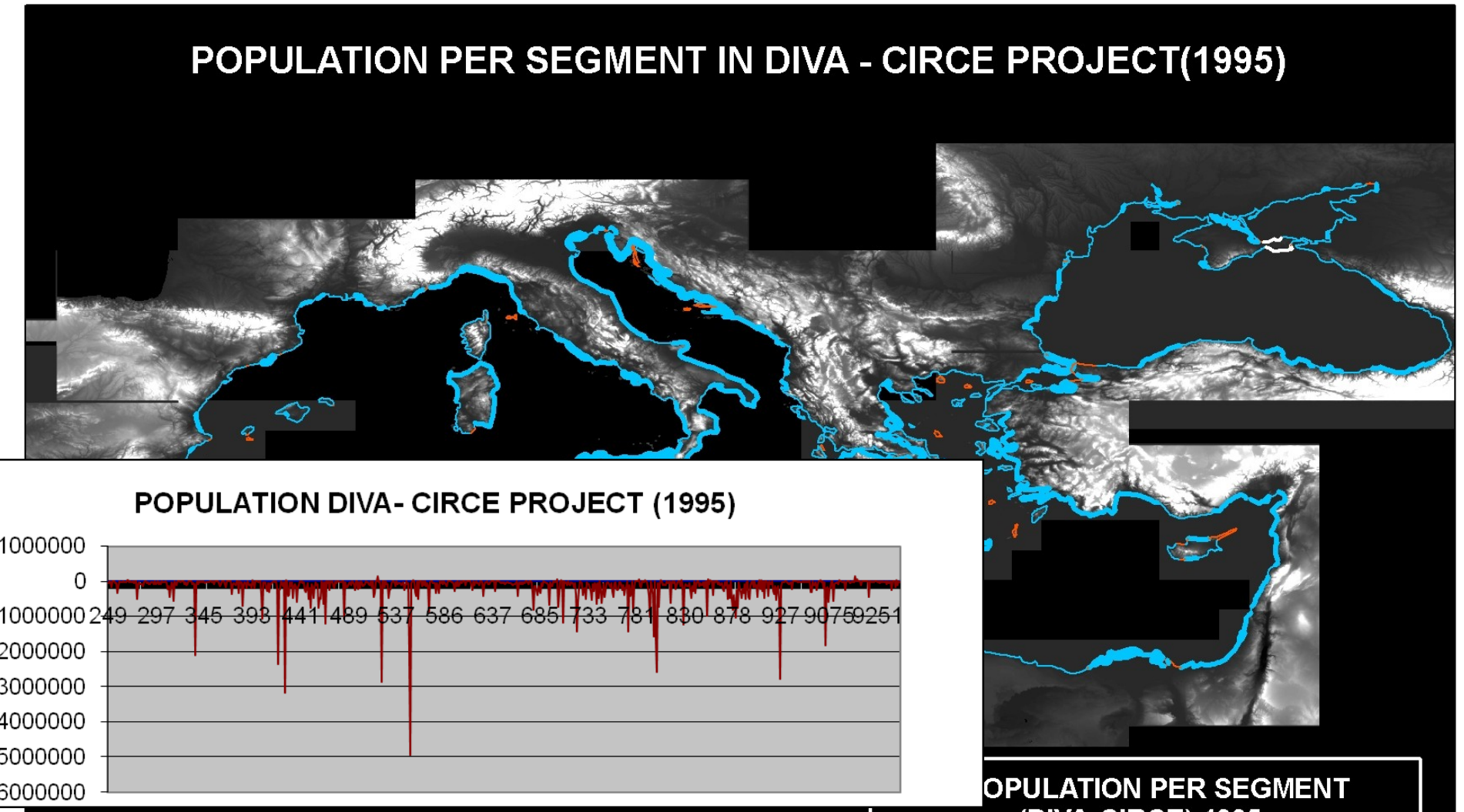
Mediterranean Basin

Countries

- Albania
- Algeria
- Cyprus
- Egypt
- France
- Greece
- Italy
- Israel
- Lebanon
- Malta
- Spain
- Syrian And Arab Rep
- Tunisia
- Turkey
- Morocco
- Libyan Arab Jamahiriya
- Yugoslavia
- Bosnia and Herzegovina
- Croatia
- Slovenia
- Monaco

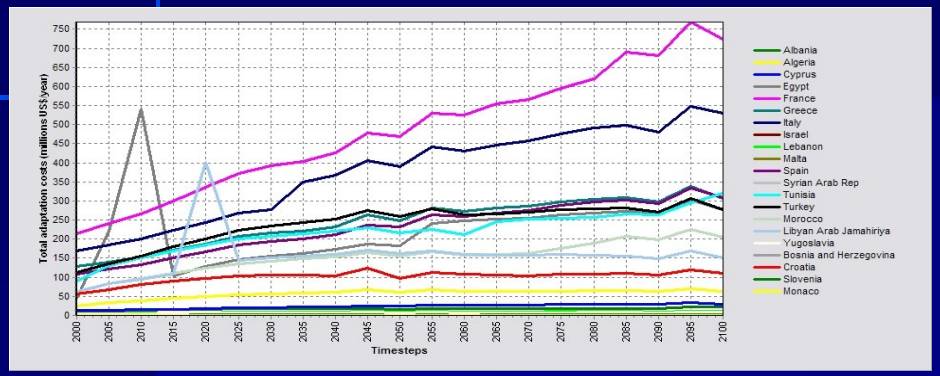


POPULATION PER SEGMENT IN DIVA - CIRCE PROJECT(1995)

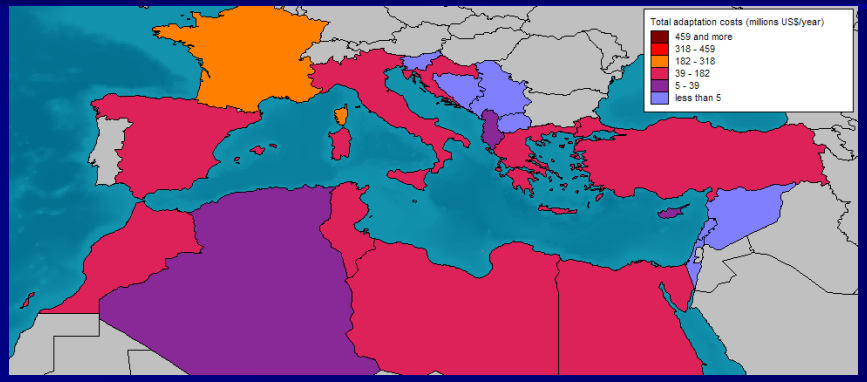


Total Adaptation Costs
(millions US$/year)

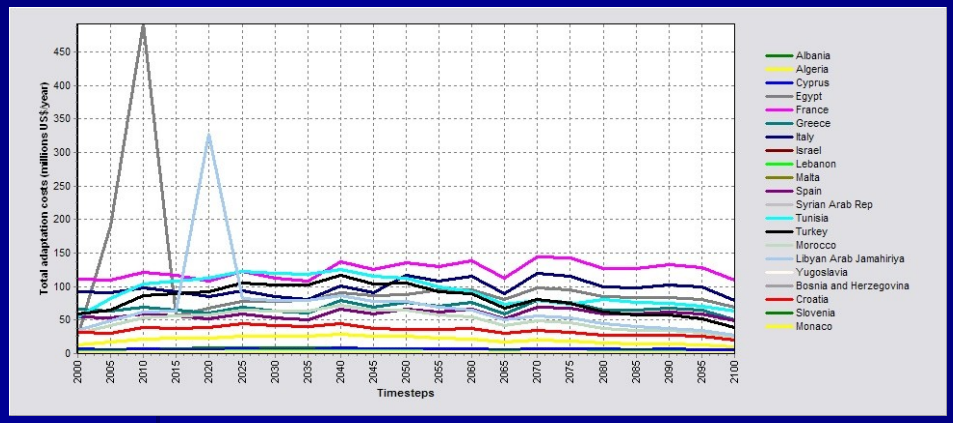
A1B_High_Uniform

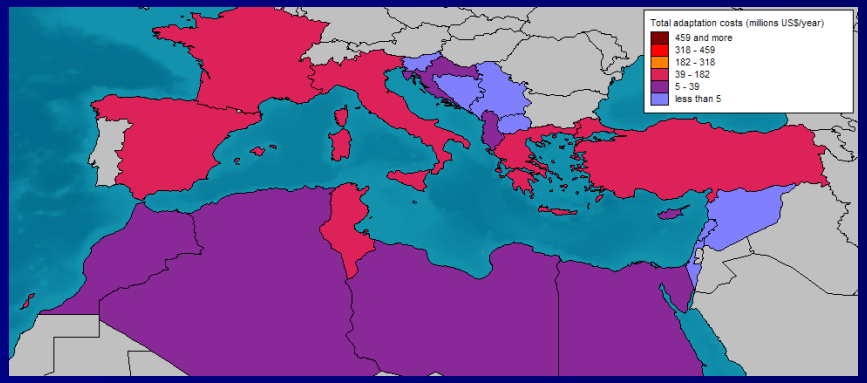


2000



B1_Low_Regional





Metrics for exposure analyses and impact assessment

- Exposure assessment
- Impact assessment
- Applications
- Issues of concern

Nicholls et al., 2006, OECD report

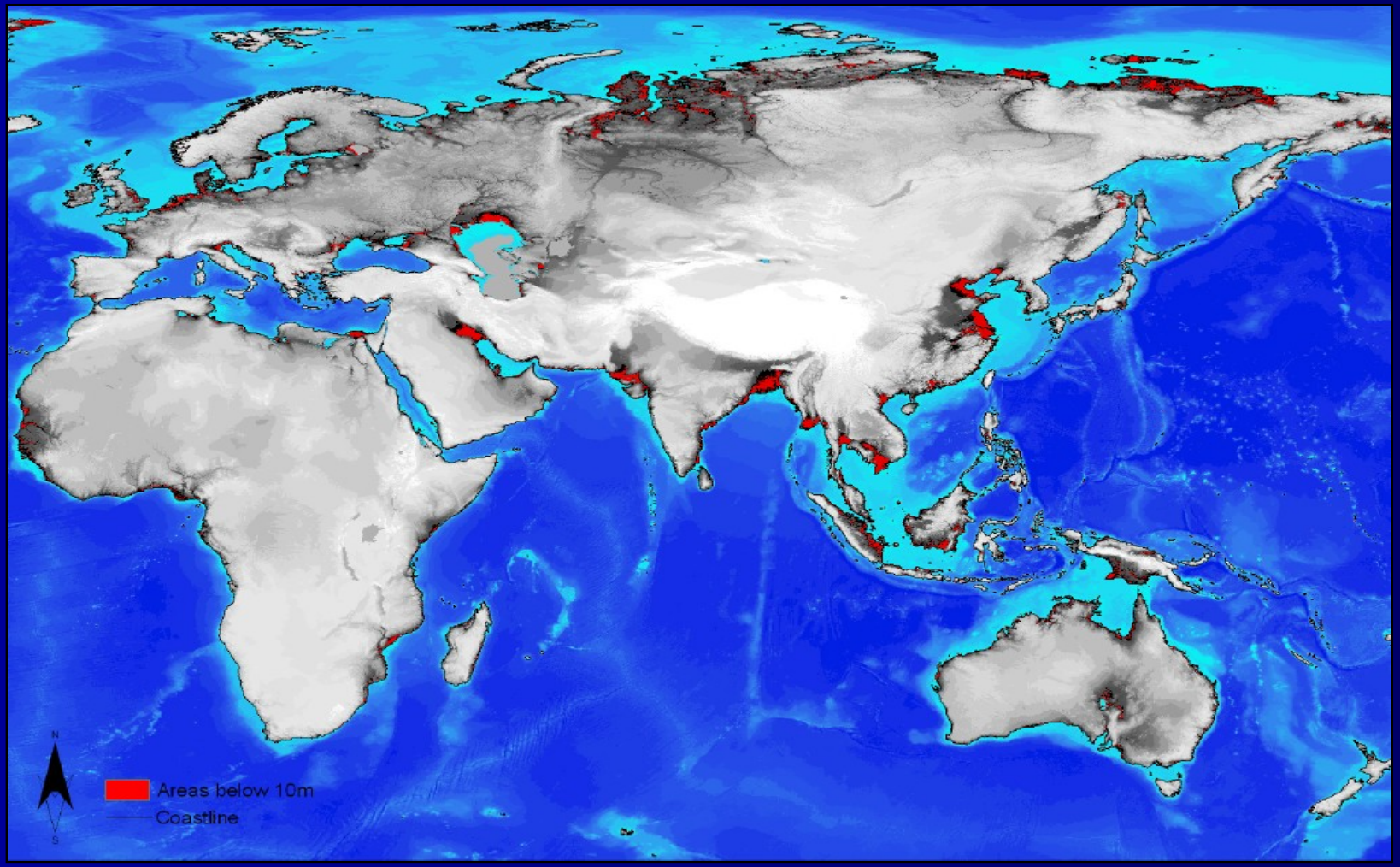
Assessment methods

- Exposure metrics – threatened resources assuming no adaptation, GIS analysis (with or without scenarios)
- Impact metrics – residual impacts after adaptation responses under relevant climatic and socio-economic scenarios and appropriate decision-making approaches (e.g. cost-benefit)
- Threshold metrics – (or tipping-point analysis)

Exposure metrics (for long-term sea-level rise)

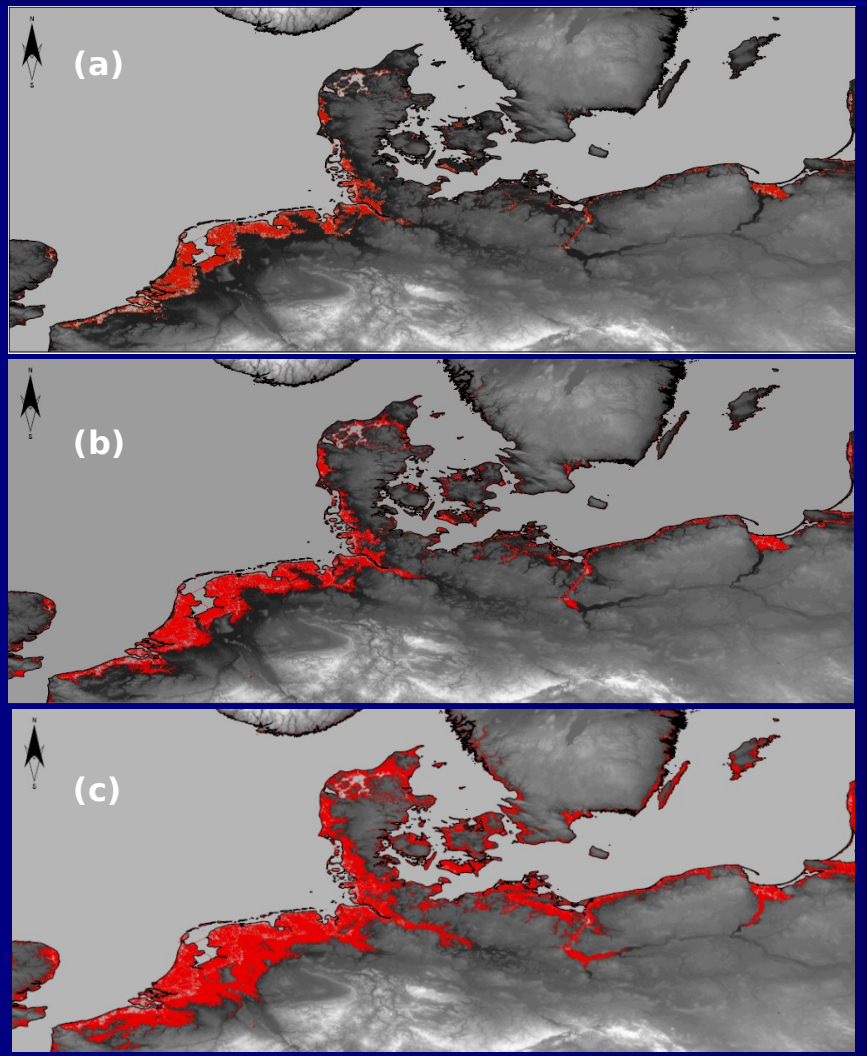
Metric	Units
Land area at risk	Threatened area (absolute: km2, or relative impact: % available area)
People at risk	Number of people (absolute or relative impact: % population)
Ecosystems at risk	Threatened area of ecosystems (km2)
Economic value at risk	Monetary value (absolute: monetary value or relative impact: % GDP)
Infrastructure at risk	Inventory approach (e.g., threatened transport corridors)
Cultural / Heritage at risk	Inventory approach (e.g., threatened UNESCO World Heritage sites)

Areas below 10-m elevation

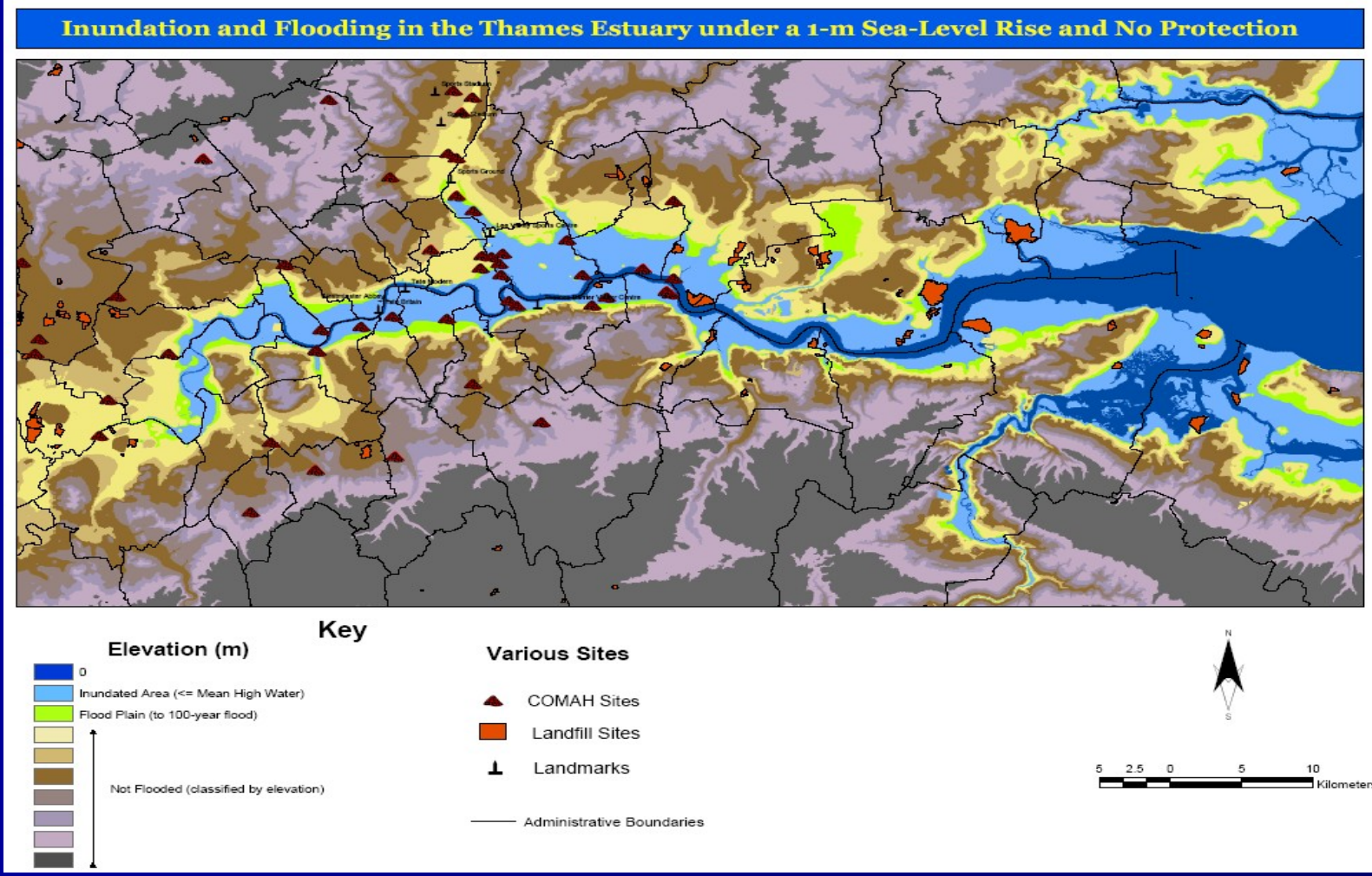


Land area below various contours

COUNTRY	NATIONAL LAND AREA BELOW (KM2)		
	1-m	5-m	10-m
Denmark	3177	8437	14707
Germany	13910	22211	31873
Netherlands	20277	26611	32889
Poland	3781	5410	7360
Belgium	1148	3209	5680

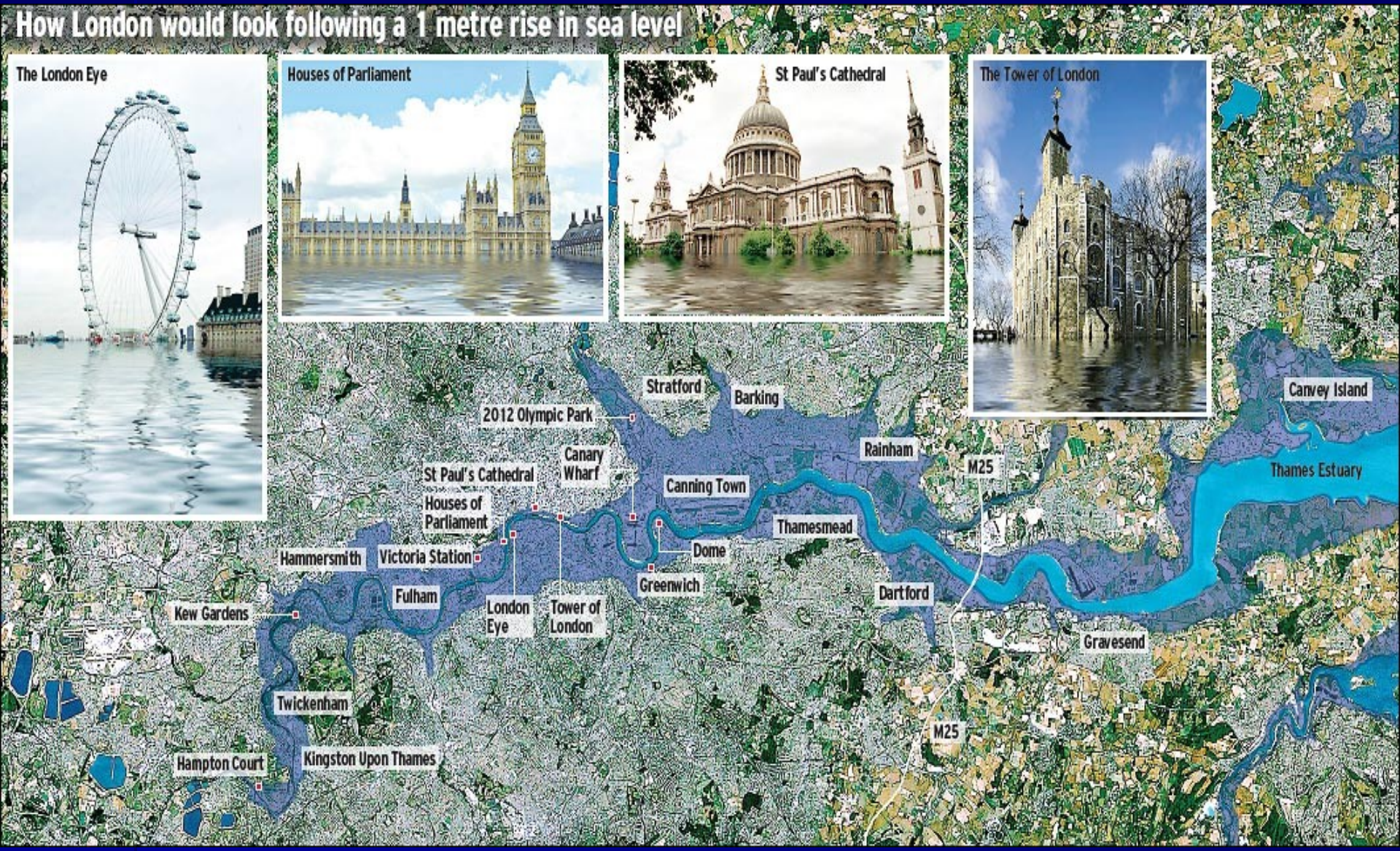


The Thames Estuary

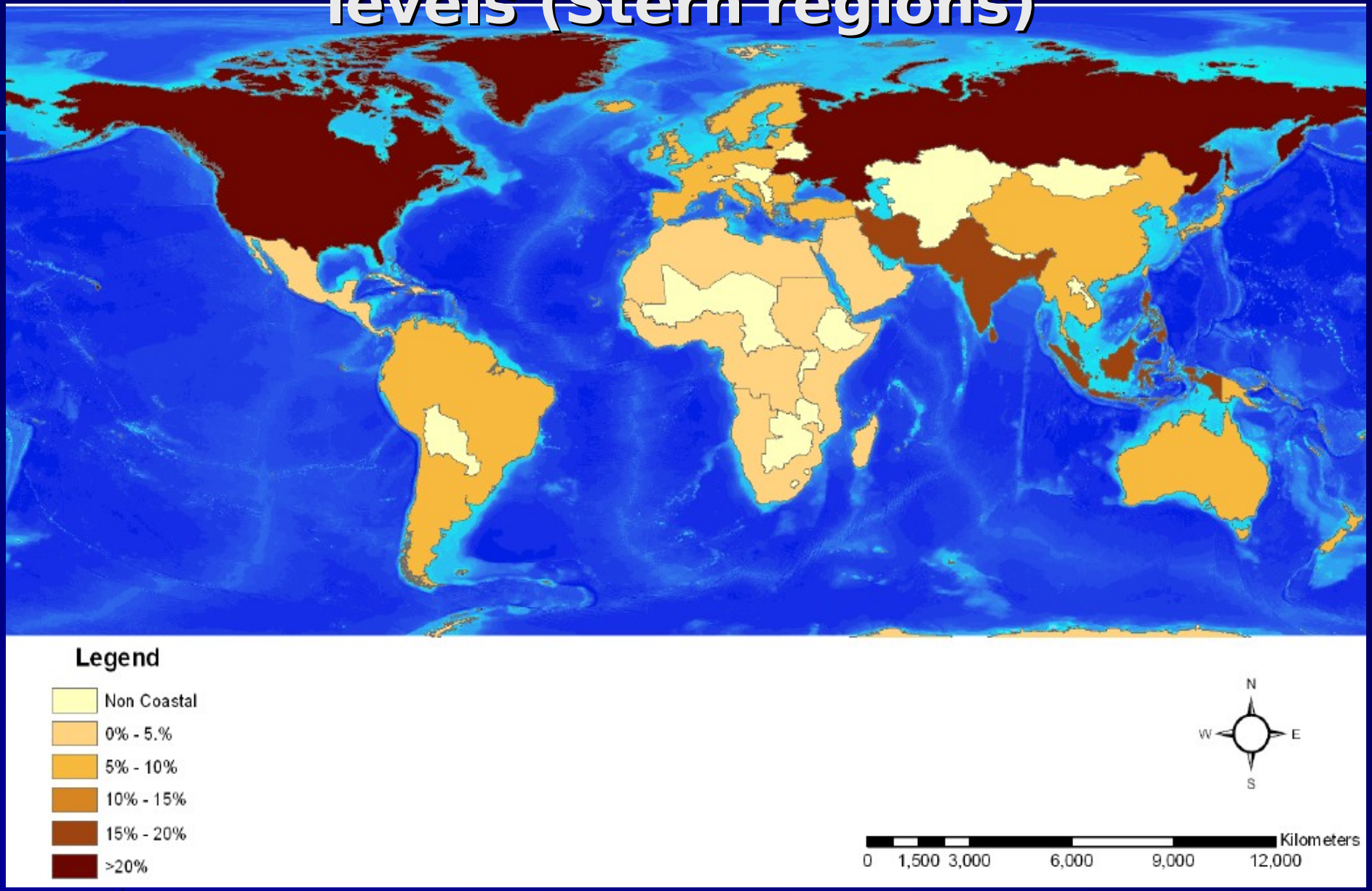


Flooding in the Thames Estuary

- Land: 257,077 hectares
- Population: 2,250,000 people
- Household places: 1,008,000
- Property losses (2001 prices), Mean house-price in the affected areas: £183,504
- Triggered further analysis (Dawson et al., 2005) and discussions regarding the planning and design of the upgrades for the Thames Barrier


How London would look following a 1 metre rise in sea level
The London Eye
Houses of Parliament
St Paul's Cathedral
The Tower of London
Stratford
Barking
2012 Olympic Park
Canvey Island
Rainham
M25
Canary Wharf
St Paul's Cathedral
Canning Town
Thames Estuary
Houses of Parliament
Thamesmead
Hammersmith
Victoria Station
Dome
Greenwich
Fulham
Dartford
Kew Gardens
London Eye
Tower of London
Gravesend
Twickenham
M25
Hampton Court
Kingston Upon Thames

Relative distribution of exposed land within 10-m of present sea-levels (Stern regions)

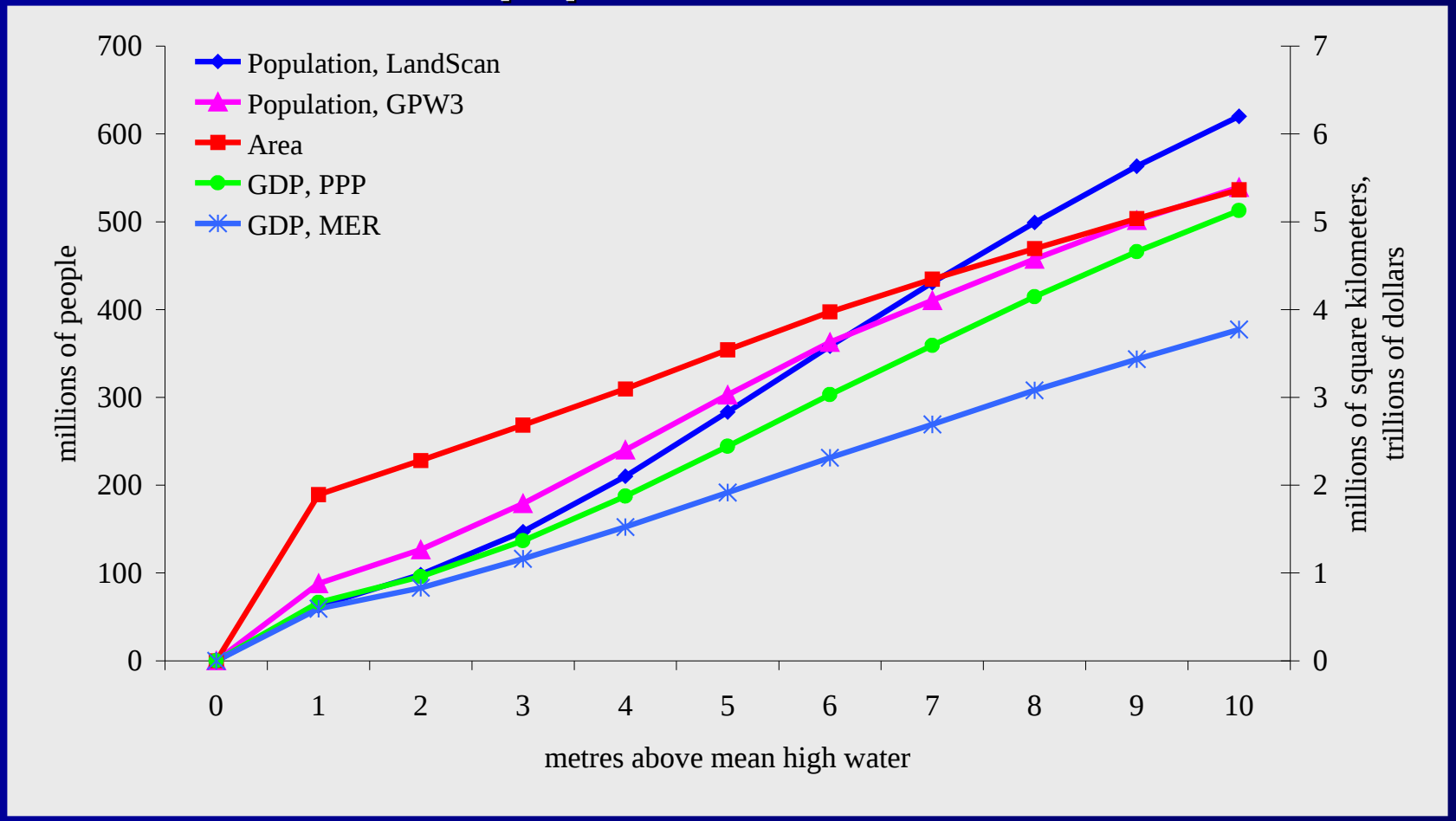


Relative Distribution of Exposed Population Within 10-m of Present Sea Levels, by Stern Region



Observed coastal distributions

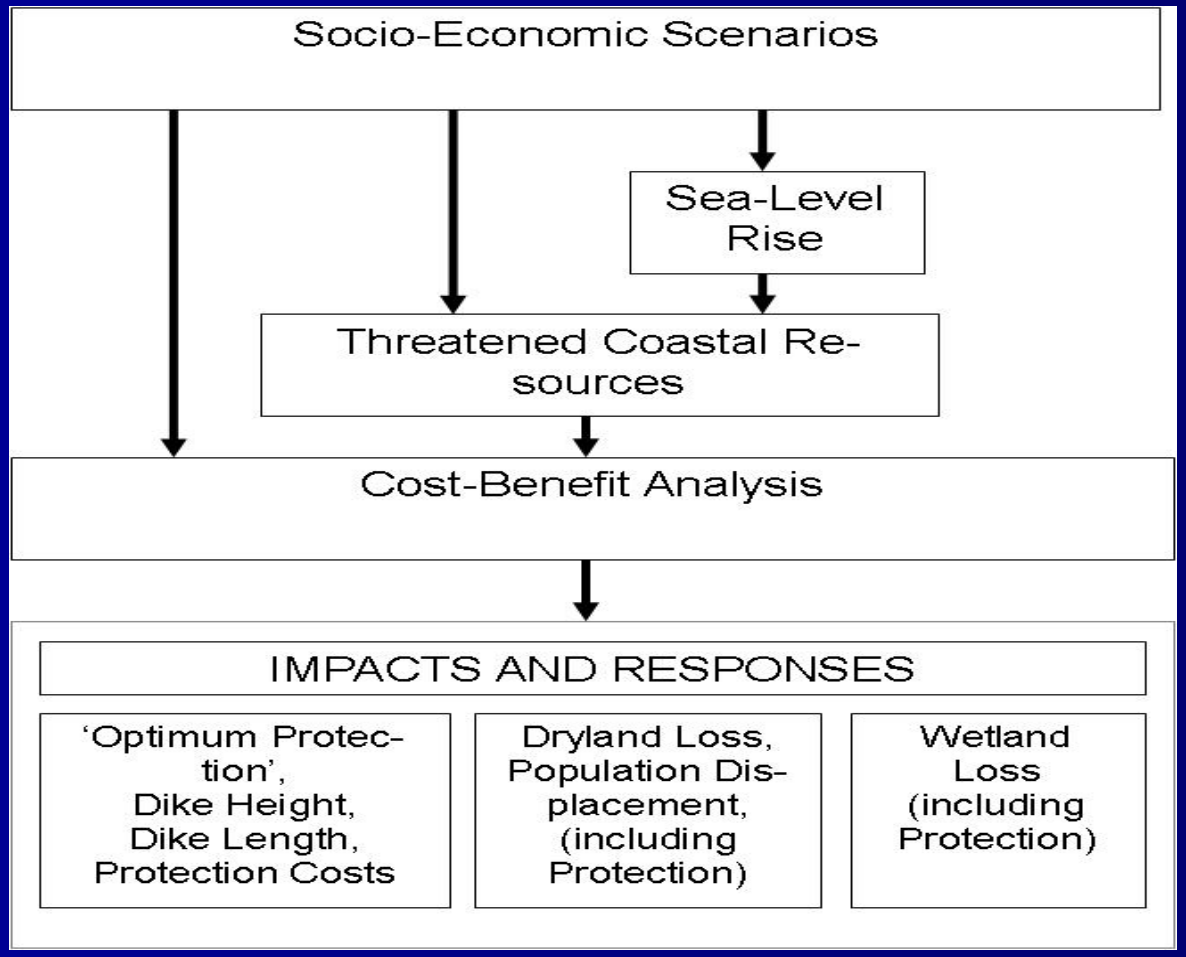
area, population and GDP



Impact metrics

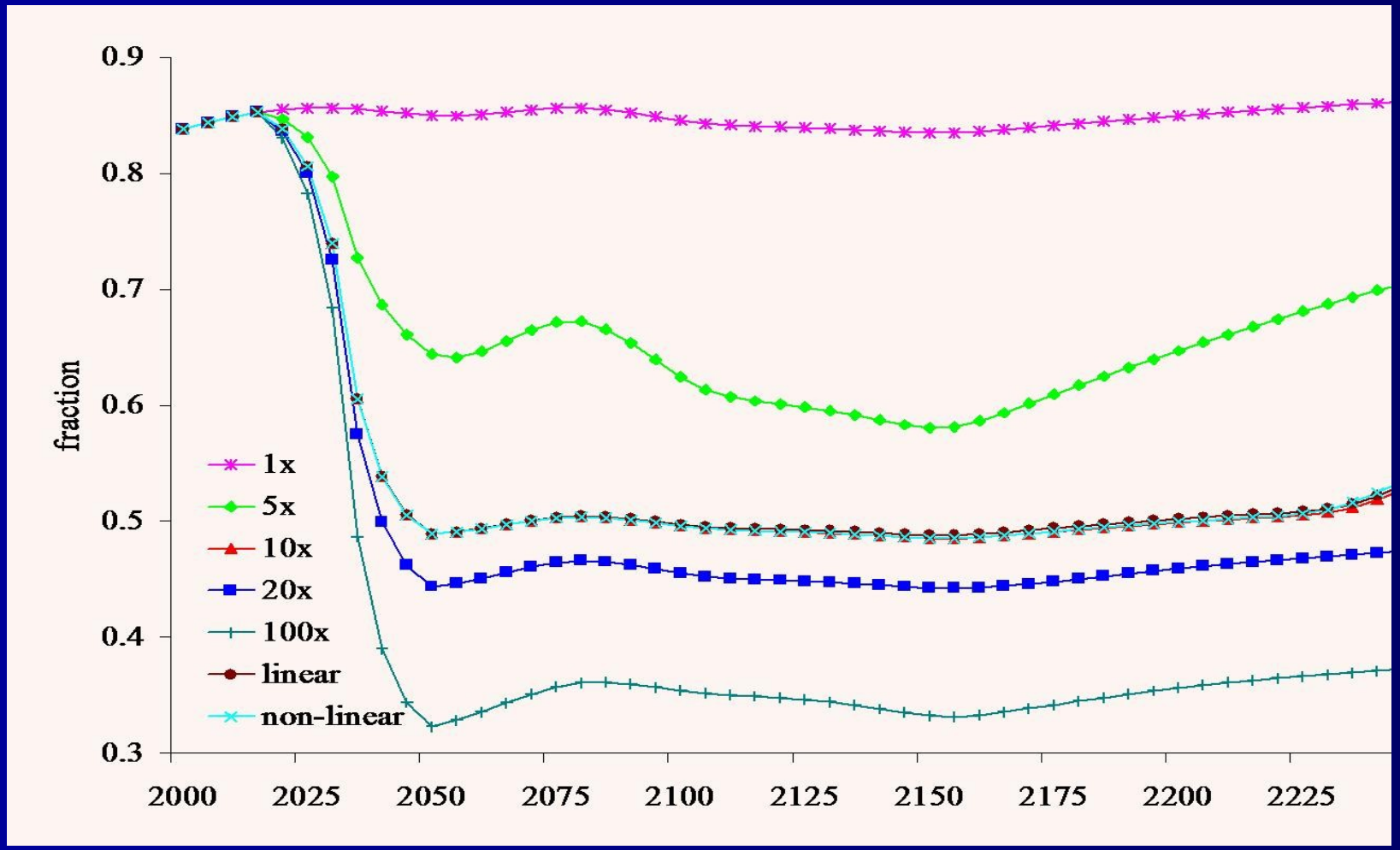
Metric	Units
Land area loss	Lost area (absolute: km2, or relative impact: % available area)
People displacement	Number of people (absolute or relative impact: % population). Cost of displacement (absolute: monetary value or relative impacts: % GDP)
Ecosystems loss/change	Threatened area of ecosystems (km2). Cost of losses/changes (absolute: monetary value or relative impacts: % GDP)
Economic value loss	Monetary loss (absolute costs in monetary terms or relative costs: % GDP)
Human infrastructure loss	Inventory of losses (e.g., list of disrupted transport corridors)
Cultural/Heritage loss	Inventory of losses (e.g., list of lost UNESCO World Heritage sites)
Adaptation Costs	Monetary cost (absolute costs in monetary terms or relative costs: % GDP)

FUND (coastal module) - Analysis of extreme sea-level rise



Tol, 2002; Anthoff et al., 2006

Protected coast under different cost factors



Issues of concern

- 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.

Future research

- Coastal Databases
  - Work at larger cartographic scales, nested databases? Deltas, hotspots (nested elements)
  - Explore links between scales, identify the processes that dominate at different scales
- Develop novel tools for risk and vulnerability assessment operating at various scales
- Identify data and information requirements – redefine the role of EO for coastal research at all scales

Thank you!

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