BASE BOTTOM-UP CLIMATE ADAPTATION STRATEGIES TOWARDS A SUSTAINABLE EUROPE

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Economic evaluation of climate change adaptation measures

Results and lessons learnt from 27 European case studies

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Outline

1. Introduction
2. Assessments of climate change adaptation measures in BASE
   - Step 1 - Risks
   - Step 2 - Measures
   - Step 3 - Methods
   - Step 4 - Data
   - Step 5 - Evaluation
3. Conclusions

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Introduction

- Climate change adaptation not only discussed on strategic level but increasingly **adaptation projects on all levels implemented**
- Often focus on existing climate-related risks
- Decision makers have to **choose between alternative adaptation measures** to limit adverse effects or take advantage of changing climate conditions
- Consideration of **manifold criteria**, **uncertain data** (changes of climate parameters, impacts, effects of adaptation measures), diverging **stakeholder interests** etc.
- Multitude of **handbooks, tools, guidelines available** to support identification of most suitable adaptation option(s) for various decision making contexts

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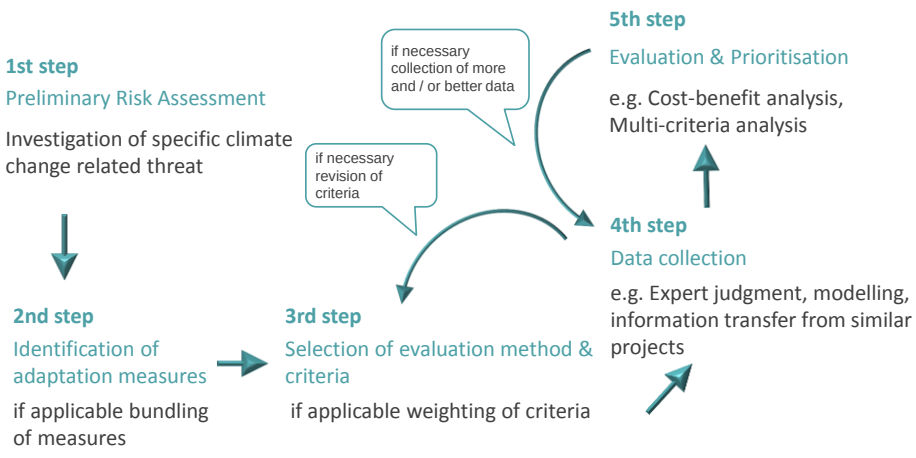

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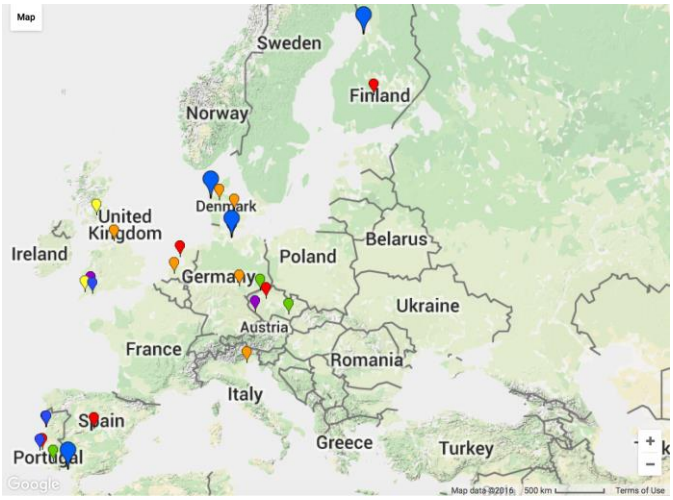
- Coastal zones
- Agriculture & forestry
- Water resources
- Human settlements & infrastructure
- Biodiversity & ecosystems
- Health



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Primary risks	Case studies
Floods	*Coastal*: Timmendorfer Strand (GE), Venice (IT), Kalundborg (DK), Aveiro Coast (PT), Copenhagen (DK), South Devon Coast (UK), Rotterdam (NL) *Fluvial*: Copenhagen (DK), Cascais (PT), South Devon Coast (UK), Rotterdam (NL), Prague (CZ), Holstebro (DK), Kalajoki (FI), Leeds (UK)
Heat stress / Health	Jena (GE), Madrid (ES), Prague (CZ), UK Health (UK), Cornwall (UK)
Ecosystem degradation	Green roof (CZ)
Water quality	Kalajoki (FI)
Water scarcity	Alentejo (PT), Doñana (ES)

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Primary risks	Type of measure	Examples
Floods	Structural protection (public)	Dike, sluice, seawall
	Structural protection (private)	Domestic flood gates, pumps, house flood proofing
	Retention measures	Room for the River, Sustainable urban drainage
	Exposure / vulnerability reduction	Re-routing railway line
Heat stress, health	Structural	Roof greening, use of highly reflective materials
	Exposure / vulnerability reduction	Heat health watch warning system, health campaign
	Nature-based	Trees, Façade greening
Ecosystem degradation	Non-structural	Sustainable forest management, Peat land and water course restoration, enlargement protection zones
Water quality	Nature-based	Buffer zones, constructed wetlands, winter time vegetation cover, perennial grass cover, controlled drainage, optimal fertilization
Water scarcity	Technological	Water recirculation
	Organizational	Reduction of cultivated surface
	Governance	Increase coordination between institutions

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	CBA	CEA	MCA	PCBA
Floods	Kalajoki Copenhagen Rotterdam Aveiro Coast South Devon Coast Leeds Timmendorfer Strand Prague	Cascais Holstebro	Kalajoki Copenhagen Rotterdam Aveiro Coast	Cascais
Heat stress, Health	Jena Madrid Cornwall UK Health		Jena	
Ecosystem degradation	Green roof			
Water scarcity	Alentejo Doñana		Doñana	Alentejo
Water quality		Kalajoki		

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Climate data

- CORDEX simulations with GCM CNRM-CM5, SMHI regional model RCA4-v1
- CMIP5 data of 37 GCMs: Jena, Prague
- National data: Rotterdam, UK cases, Timmendorfer Strand, Kalajoki, Venice, Copenhagen, Holstebro, Kalundborg

Cost data

- Official planning documents, literature, modelling
- Experts: scientists, plan./engin. consultancies, service/construction companies

Benefit data

- Official planning documents, literature, modelling
- Experts: stakeholder, private households, consultancies, insurance companies

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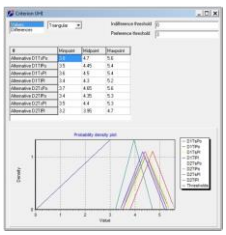
Models and tools used…

- **Planning Kit DPRD:** Investment costs and expected flood damage costs
- **KUTOVA:** Cost-effectiveness of agro-environmental measures
- **WAAPA:** Water Availability and Adaptation Policy Assessment
- **URBAHT:** Urban heat stress model
- **InVEST:** Ecosystem service valuation
- **VEMALA:** Nutrient loading model
- **DREMFIA:** Economic agricultural sector model
- **PRIMATE:** Decision support tool for CBA and MCA under uncertainty



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Floods

- In some **big cities large structural flood risk management measures** and/or **coastal protection system** proved to be highly **efficient** (Prague, Leeds, Copenhagen)
- Similarly structural measures **also efficient in rural and/or coastal areas** (South Devon, Kalajoki, Kalundborg, Aveiro Coast)
- Also **non-structural measures** - although often **in combination with structural measures** - can be **efficient** or **cost-effective** in urban contexts

➢ e.g. Rotterdam: Small room-for-the-river option + dike reinforcement most cost-effective pathway in the medium-term

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Floods

- Sometimes **business-as-usual strategies complemented with compensation of expected damages** more efficient than alternative adaptation strategies (South Devon railway)
- In some cases **supplementing existing infrastructure systems with specific adaptation measures** most efficient (Copenhagen)
- **Private** flood protection **measures** can be **efficient**, but question of cost bearing highly relevant for implementation (South Devon, Venice)

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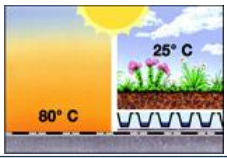
Heat stress & Health

- Green and blue **land use-related measures can limit urban heat stress levels** to certain thresholds at least in the short- to medium-term perspective (Prague)
- **Large-crowned trees** and **highly reflective materials** very **suitable** for mitigating reinforcing urban heat island effects (Jena)
- **Conflicting results** obtained for adaptation measure **roof greening** – efficient in region with well-established producers and favourable framework conditions (Jena) and not efficient where costs are substantially higher and incentives missing (Madrid)



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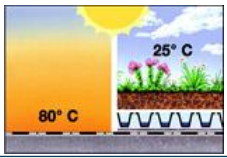
Heat stress & Health

- **Heat & health warning system** very **efficient,** low regret measure (Madrid)
- **Public health campaign** regarding UV exposure and related skin cancer risk **highly efficient**, no-regret measure (Cornwall)
- Prescription demand and **mental health problem prescription costs will decrease** under climate change (UK Mental Health)



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Ecosystem Services

- Czech Green roof case study: "**Green adaptation strategy**", prioritising nature conservation turns out to be **most efficient**, the "**Shared-vision adaptation strategy**" **efficient** whereas the "**Red adaptation strategy**" focussing on economic development is **inefficient**

Water Scarcity

- Alentejo: **Water retention landscape lakes** of Tamera **no efficient** adaptation measure

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Water quality

- Kalajoki case study: All **agro-environmental measures** to reduce phosphorus input loads will become **more cost-effective** under future climate conditions
- **Little / Moderate adaptation scenarios: Mixed results** - Cost-effectiveness of field measures, e.g. buffer zones, winter time vegetation, decreases and of measures such as wetlands, controlled drainage, optimal fertilization increases
- **Successful adaptation scenario: All measures more cost-effective than** under current conditions
- Even most cost-effective combination of measures can hardly achieve **the target level of good ecological status in the future**

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Cost-benefit analysis

- **Applicability** depends largely on the **availability of models** and **expertise** to produce necessary monetary input data
- Frequently applied for coastal, fluvial and pluvial flood management assessments (also in BASE)
- Monetary damage estimation is **often limited to tangible damages** as monetisation of intangible effects requires substantial effort and/or is not compulsory

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Multi-criteria analysis

- **CBA and MCA can complement each other in an iterative way**
- Copenhagen (Coastal flooding): CBA to analyse efficiency of potential coastal protection solutions; MCA used to **determine specific design of most efficient solution** in a participatory process involving relevant stakeholder groups
- Kalajoki (Fluvial flooding): MCA conducted for **pre-selecting measures** to be considered for the flood risk management plan taking into account political, social and environmental aspects

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Participatory cost-benefit analysis

- Strong methodological links to MCA
- **Comprehensible, inexpensive process-oriented** method
- **Facilitation / focalization** of the debate of pivotal importance
- **Consideration of temporal aspects** through use of discount rates possible

➢ For several measures, i.e. Reforestation, Green Corridors, Re-naturing of Cascais water streams, negative time-preferences (=negative discount rates) revealed (Cascais)

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Dealing with uncertainties by use of …

- **Climate change scenarios**
- **Socio-economic change scenarios** (e.g. Rotterdam, Green roof, Madrid)
- **Sensitivity analysis**: Variation of input data, use of different discount rates (most case studies)
- **Monte Carlo analysis**: Random sampling of input data from a given score range (Jena)
- **Weighting (MCA)**: Varying preferences of different decision-makers and/or stakeholders considered in MCA through weighting sets (e.g. Jena)

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Transferability of results

- Although the process of economic evaluation in all case studies followed the **same protocol** …
- … the different site-specific context conditions (e.g. baselines, timeframes) and data restrictions (e.g. due to decision maker demands or availability) made **case study results hardly comparable**

➢ **Transfer** of assessment results requires vigorous reflection on the case-specific framework conditions

➢ BASE assessment report D5.2 provides overview of **adaptation measures** assessed in the various case studies including information on primary **risks** addressed, assessment **criteria** used, (discounted) **costs** and **benefits**, **net present values**, **benefit-cost ratios**, **baseline options** etc.

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Recommendations

- Use of one of the various **guidelines for climate adaptation-related evaluations** recommended to inform assessment process, selection of potential adaptation measures, suitable method(s) and possible data sources

➢ e.g. PROVIA 2013 “Guidance on Assessing Vulnerability, Impacts and Adaptation to Climate Change”, BASE D5.2 Annex 1: Guidance for economic evaluation of adaptation options http://base-adaptation.eu/publications

- For method(s) selection existing formal and informal decision making frameworks should be taken into consideration
- Different **assessment approaches** can be used in a **complementary** manner
- **Use of existing impact assessment tools** preferable, especially for flood risk assessments, but also for heat stress levels, water availability / quality, provision of ecosystem services

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Thank you!

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Conclusions: Evaluation process & Applicability of methods

Factors		
Objective	**Pre-feasibility study**	**Investment decision**
	Simple CEA, CBA or MCA	Comprehensive CBA, participatory MCA, RDM
Investment costs	**Low**	**High**
	Simple CEA, CBA or MCA	Comprehensive CBA, participatory MCA, RDM
Uncertainties	**Low**	**High**
	Simple CEA, CBA or MCA	CBA or MCA with Monte-Carlo simulation, RDM, ROA, DAP
No of evaluation criteria	**Low**	**High**
	CEA, partial CBA	Comprehensive CBA, MCA
Data availability	**Low**	**High**
	MCA	CBA, RDM