Cost-benefit analysis of adaptation measures in Germany

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Introduction to Ecologic Institute

Ecologic Institute

- **Founded in:** 1995
- **Type of institute:** independent, not-for-profit think tank for applied environmental research, policy analysis and consultancy, science-policy interface
- **Locations:** Headquarters Berlin, offices in San Mateo CA, Washington DC & Brussels
- **Team:** about 140 staff members, interdisciplinary, wide range of issues focussing on environmental and sustainability policy

Fields of work

- Different teams:
  - Agriculture and Bioenergy
  - Biodiversity and Forest
  - Economics
  - Climate and Energy
  - Water
  - Marine Policy
  - Ecologic Legal
  - Transatlantic
  - Conference Team

Further and related isues:

- Climate change mitigation & adapation
- Soil protection and Land use
- Rural development
- Nature protection, Ecosystem services
- Consumer Policy
- Waste
- Transport

Adaptation related projects of Ecologic Institute

Project overview: „Costs and benefits of adaptation to climate change“

- Research project for German Federal Environmental Agency (UBA)
- Duration: 28 months (Nov. 2009 – Febr. 2012)
- Lead: Ecologic Institute (Berlin), Partners: INFRAS (Zuerich), Fraunhofer ISI (Karlsruhe)
- Research Questions:
  - How can cost-benefit analysis support the prioritisation and selection of adaptation measures?
  - How is the database in Germany and which recommendations can be formulated based on the existing data?

Structure of project

- Literature analysis on state of the art: main climate risks, sectoral damages and adaptation costs
- Development of criteria set for comparison and evaluation of different adaptation measures
- Assessment of 25 selected adaptation measures in different sectors based on the criteria set (mainly based on literature and small number of expert interviews)
- Detailled analysis of three case studies (measures) in sectors: urban/regional planning, biodiversity, water

Project overview: „Climate Proofing of Cohesion Policy and Common agricultural policy (CAP)“

- for European Commission, DG Climate
- Duration: 11 months (Oct. 2011 – July 2012)
- Lead: IEEP (London) Partners: Ecologic Institute (Berlin), milieu (Brussels), EAA (Vienna), GHK (London)
- Project objectives:
  - Identification of vulnerabilities for relevant sectors (especially damage costs)
  - Identification and evaluation of adaptation options on EU level

Project overview: „Climate Proofing of Cohesion Policy and Common agricultural policy (CAP)“

- Recommendations for better implementing approaches to climate-proofing investments and measures and mainstreaming climate change concerns into the spending practice of the CAP and the Cohesion Policy
- Revise technical guidance documents and provide a platform for strengthening stakeholder interaction

Workflow for cost-benefit analysis

1. Identification of possible adaptation measures

2. Screening of relevant measures for EU Cohesion Policy and CAP -> result: list of 75 adaptation measures

3. Along different evaluation criteria : narrowed down to 14 options

4. Cost-benefit analysis for 14 options

Project overview: „ Economic Impacts of Climate Change and Costs of Adaptation for the City of Hamburg“

- for Free and Hanseatic City of Hamburg
- Duration: 7 months (Jan. 2012 – July 2012)
- Lead: Hamburgisches WeltWirtschaftsInstitut gemeinnützige GmbH (HWWI) (Hamburg), Partner: Ecologic Institute (Berlin)
- Project objectives:
  - Support the development of the Adaptation Strategy of Hamburg
  - Input on the evaluation of adaptation measures in Hamburg

Project structure

- An overview of the current knowledge of the economic adaptation research
- Cost-benefit analysis of adaptation measures in Hamburg:
    1. Water Management Sector: Rising groundwater levels
    2. Buildings Sector: Green Roofs for Hamburg
    3. Agriculture Sector: Adapted plant species
    4. Civil Protection Sector: The extreme rain in June 2011 (only damage costs)
- Recommendations on necessary measures to be implemented in the adaptation strategy of the City of Hamburg

Further related Ecologic projects

- Bottom-Up Climate Adaptation Strategies for a Sustainable Europe (BASE) (FP7 project, EU Commission, DG Research, 2012-2016, http://base-adaptation.eu/)
- Regional Adaptation Strategies for the German Baltic Sea Coast (RADOST) (German Federal Research Ministry (BMBF), 2009-2014, http://klimzug-radost.de/en)
- Ecosystem-based approaches for climate change adaptation and mitigation (EU Commission, DG Climate; 2010/2011)

General information on cost and benefits of climate adaptation

Why is it necessary to evaluate cost and benefits of adaptation measures?

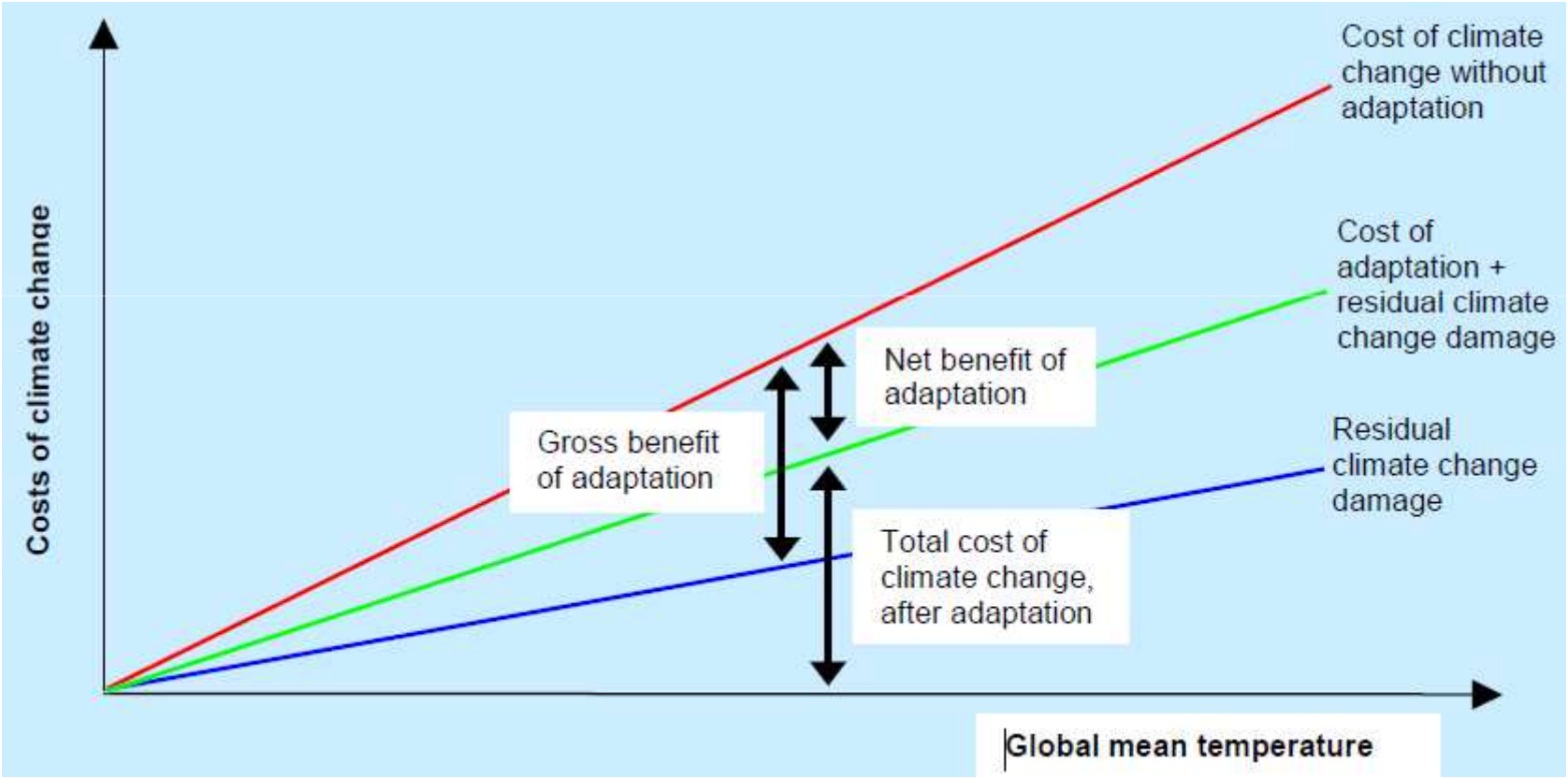
- Development and implementing of adaptation measures needs a further decision between:
  - Different relevant sectors
  - Different protected environmental space and humanities (e.g. health, investments goods, buildings, infrastructure, ecosystems)
  - Very different timeframes of measures
- Need for identification of priority sectors and measures (or set of measures)
- As justification for adaptation strategies
- Well-established instruments for analysing and supporting decision processes

Cost and benefit components

Cost components	Benefit components
Direct costs, e.g.: • Investment costs • Current (technical) costs • Administrative costs **Indirect costs**, e.g..: • Opportunity costs • Transaction costs	**Direct benefits**, e.g..: • Avoided damages (at buildings, yields, insured persons, environment) • Avoided loss of value **Indirect benefits**, e.g..: • Change of recreational function, tourism • Change of potential for developing • Change of biodiversity and ecosystem services • Change of values of goods or land • Dynamic economic incentive

Source: Grünig, M.; Kowalewski, J.; Schulze; S.; Tröltzsch, J. (2013): Gutachten zu den ökonomischen Folgen des Klimawandels und Kosten der Anpassung für Hamburg, Hamburg. http://www.hamburg.de/contentblob/3815154/data/gutachten-oekonomischen-folgen-des-klimawandels.pdf

Cost and benefit of adaptation



Source: Stern Review (2006)

Coverage of adaptation studies in Europe

Sector	Coverage	Cost estimates	Benefit estimates
Coastal zones	Very high coverage (infrastructure/erosion) for Europe, regions, several Member States as cities/local examples	+++	+++
Agriculture	High coverage of farm level adaptation benefits, as well as on costs of climate change, but less on adaptation	++	++
Health	Low – medium. Adaptation costs for heat alert and food-borne disease, but less coverage of other health risks	+	
Water	Low-medium. Limited number of national, river basin, or subnational studies on water supply	+	
Tourism	Low-medium. Studies on winter tourism (Alps) and some studies of autonomous adaptation from changing summer tourism flows.	++	+
Biodiversity / eco-system services	Low- limited number of quantitative studies	+	
Business and industry	Very low – no quantitative studies found		

- Source: Climate Cost Project.

Criteria set for evaluation of adaptation measures

- Three categories of criteria (further splitted in 14 individual criteria)
  - **Basic information** – to describe a measure
  - Information on **costs** and **benefits** of measures
  - Criteria for **evaluation** of measures

Criteria set II

Basic information	Cost/benefit	Evaluation
- Sector - Type of measure - Relevance for public sector - Urgency, Time-lag between implementation and effect, life-time	- costs: direct costs, further economic costs, external costs - Benefits: economic, environmental, socio-economic benefits - Uncertainty of evaluated costs and benefits	- Relevance - Effectivity - Windfall profits - Dynamic incentives - Acceptance - Interactions with other adaptation measures - Flexibility (no-regret, scenario-variability)

Case Studies

Case study: Heat warning system

- Climate impacts:
  - Climate projections for Germany: increase of heat events until 2100 between 1 and 25 days per year (based on 1961-1990)
  - Regional differences between Northern and Southern part of Germany:

	Scenario B1 (Increase of heat days per year)	Scenario A1B+B2 (Increase of heat days per year)
Northern part of Germany	+1	+1
Southern part of Germany	+18	+25

Case study: Heat warning system

- Basic information:
  - Health-related measure, which consists of warning systems and additional activitities in case of warning: additional support for especially vulnerable people (e.g. in nursing homes), opening of cooling rooms, etc.
- Costs/benefits:
  - Included costs:
    - Costs for establishing warning system, information delivery to public, support at heat day: hotline, additional nursing staff

Case study: Heat warning system

- Costs based on data from the Philadelphia Heat Warning System
- Costs for delivery of heat warning to nursing homes, schools, information of public, installation of telephone service at heat day -> 2,000 €/day
- Costs for additional personal at hospitals and nursing homes and services at heat days -> 3,000 €/day
- Data was transfered to number of inhabitants of Germany
- For an average of heat days in 2100 -> **5,0 mio. €/year**

Case study: Heat warning system

- Included benefits:
  - **Avoided heat deaths:** based on mortality rates from historical event (heatwave in summer 2003), including demographic changes
  - Assumption: 30% of damages can be avoided by these measure
  - Monetarization via: value of life year-concept (Willingness to pay)
  - **2,36 bn. €/a in 2071-2100**
  - **Avoided heat-related costs in hospitals:** based on additional number of persons with heat-related illnesses during heatwave 2003
  - Monetarization: Average of hospital costs – 30% could be avoided
  - **2,51 bn. €/a in 2071-2100**

Case study: Heat warning system

- Cost-benefit ratio: costs (5 mio. € per year, 2100) lower than benefits (up to 2,5 bn. € per year)

- Evaluation:
  - Relevance: high – Health of population
  - Effectiveness: medium – only part of damages on heat days avoidable
  - Acceptance: high, but nursing home, etc faced by additional costs

Case Study: Green roofs

Copyright: pnwra

- Developed for the City of Hamburg
- Basic information:
  - In large cities – increased heat island effect

caused by sealed surfaces

  - Green roofs can decrease heat island effect by absorption sun energy, reduce impact of extreme rain events
  - Roofs up to a roof angle of 35 degree are suitable for green roofs.

Case Study: Green roofs

- Costs:
  - Estimation based on the evaluation of theoretical potential for green roofs in Hamburg (no evaluation is existing at the moment: assumptions based on estimations for other countries (Berlin) and from a study which focus on potential roof space for photovaltaic systems)
  - Monetisation via subsidies for installation of green roofs
  - From literature: subsidies between 5 and 15 €/m^2 are found, 50% of the potentiell roof area should be financially promoted

Case Study: Green roofs

- Benefits:
  1. Effect of green roofs for the city‘s climate and consequences for the health of inhabitants (avoided heat related mortality and avoided hospital costs)
  2. Positive impacts on solar energy production of roofs with photovoltaic system
     - If temperatures are higher then 25 degrees the energy production of photovoltaic systems are decreasing – per 1% by 1 degree of temperature
     - Green roofs can cool down photovoltaic systems and can increase energy production by renewable energies, decrease CO_2-emissions
     - Monetization via prices for CO_2-emissions certificates

Case Study: Green roofs

- Overview:

Different components	in mio. Euro (discounted by 2100)
Costs:	
Subsidies	268 bis 805
Benefits:	
Avoided deaths	174 bis 1.044
Avoided hospital costs	7,9 bis 15,8
Not used emission certificates	0,54 - 2,71

- For the most scenarios benefits are higher then costs are at least balanced

Source: Grünig, M.; Kowalewski, J.; Schulze; S.; Tröltzsch, J. (2013): Gutachten zu den ökonomischen Folgen des Klimawandels und Kosten der Anpassung für Hamburg, Hamburg. http://www.hamburg.de/contentblob/3815154/data/gutachten-oekonomischen-folgen-des-klimawandels.pdf

Case Study: Green roofs

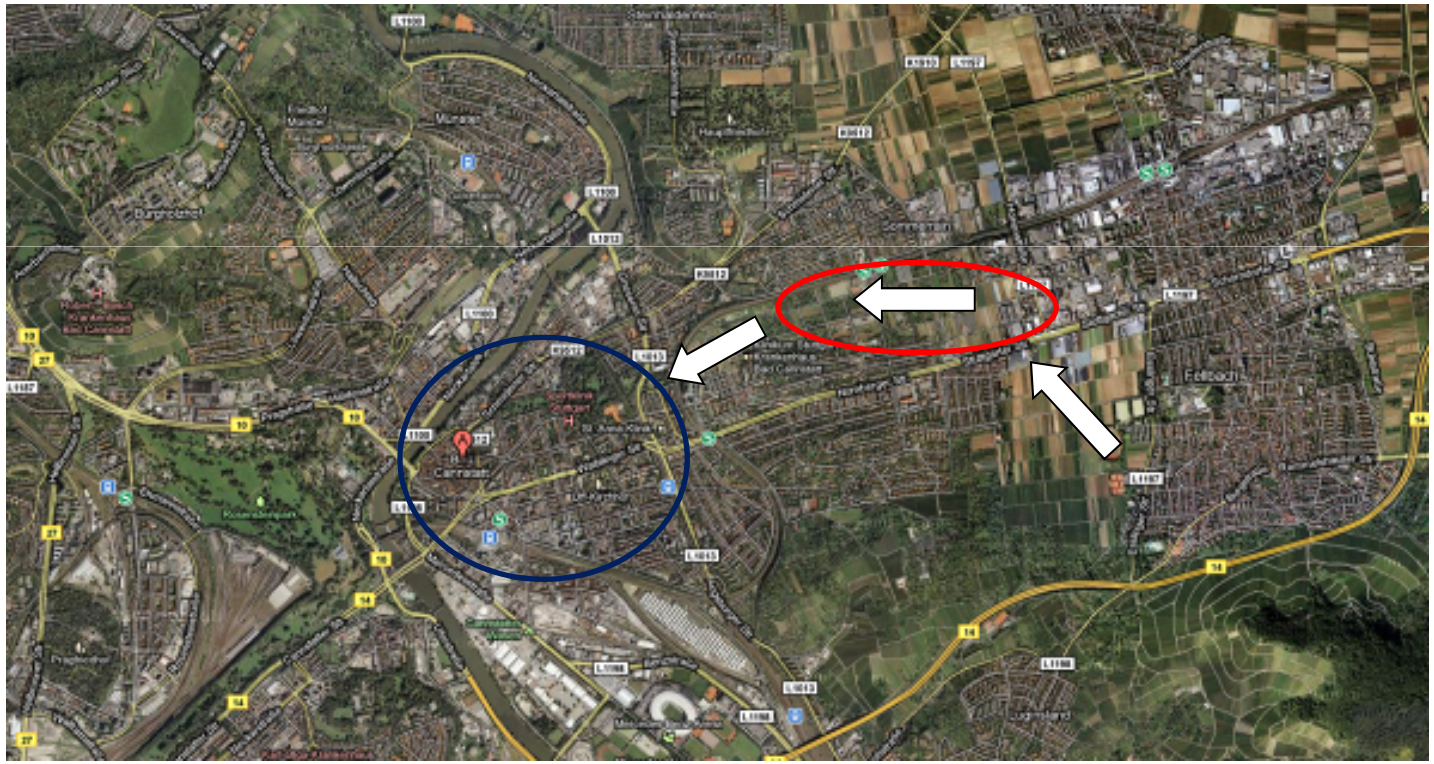
- Evaluation:
  - Relevance: Protection of public health, but other alternatives are available.
  - Effectivity: Medium: not all damages can be avoided. Roofs decrease there effect during long drought periods
  - Windfall profits: Medium: private actors could finance measure at least partially on their own budget.
  - Side-effects: Green roofs have a longer lifetime compared to „traditional“ roofs.
  - Acceptance: because of aesthetical reasons acceptance problems possible

Case Study: Green areas (fresh air corridor)

- Basic information:
  - Preventive urban planning to avoid heat island effect with the objective to reduce health risks for inhabitants
  - Case Study in Stuttgart – Area „Espan“
  - Urgency high due to long time horizones for decisions in urban planning, decision very difficult to reverse

Copyright:Nigel Chadwick

Case Study: Green area



Source: Tröltzsch, J., Görlach, B., Lückge, H., Peter, M., Sartorius, C. (2012): Kosten und Nutzen von Anpassungsmaßnahmen an den Klimawandel. Analyse von 28 Anpassungsmaßnahmen in Deutschland. Umweltbundesamt, Dessau Online verfügbar unter: http://www.umweltbundesamt.de/uba-info-medien/4298.html.

Case Study: Green area

- Costs:
  - Costs are loss of revenues for alternative uses of land
  - Analysis of alternatives – are residential building or companies interested/possible for area? - in 1990s a hospital was planned, which will be built in another part of Stuttgart, where use for industry and services is not possible now.
  - Monetarization via loss of tax income for city (trade income tax revenues)
- Benefits:
  - Air corridors have an effect on reduction of wind chill temperature, but air exchange procsses have very often a very local effect, only relevant for a limited areas

Case Study: Green area

- City climate analysis – help to define area which can benefit from air exchange via green areas
- In our case no modelling was availble – Assumption for area with benefits based on expert from city of Stuttgart
- Montarization: rough estimation of reduced heat island effect via avoided mortality and avoided hospital costs

Case Study: Green area

- Overview:

Compenents	in mio. Euro
Costs:	
Loss of trade income tax revenues	0,9
Benefits:	
Avoided deaths	0,5 bis 1,01
Avoided hospital costs	0,06

- Costs are higher than benefits, in best case balanced benefit-cost ratio

Case Study: Green area

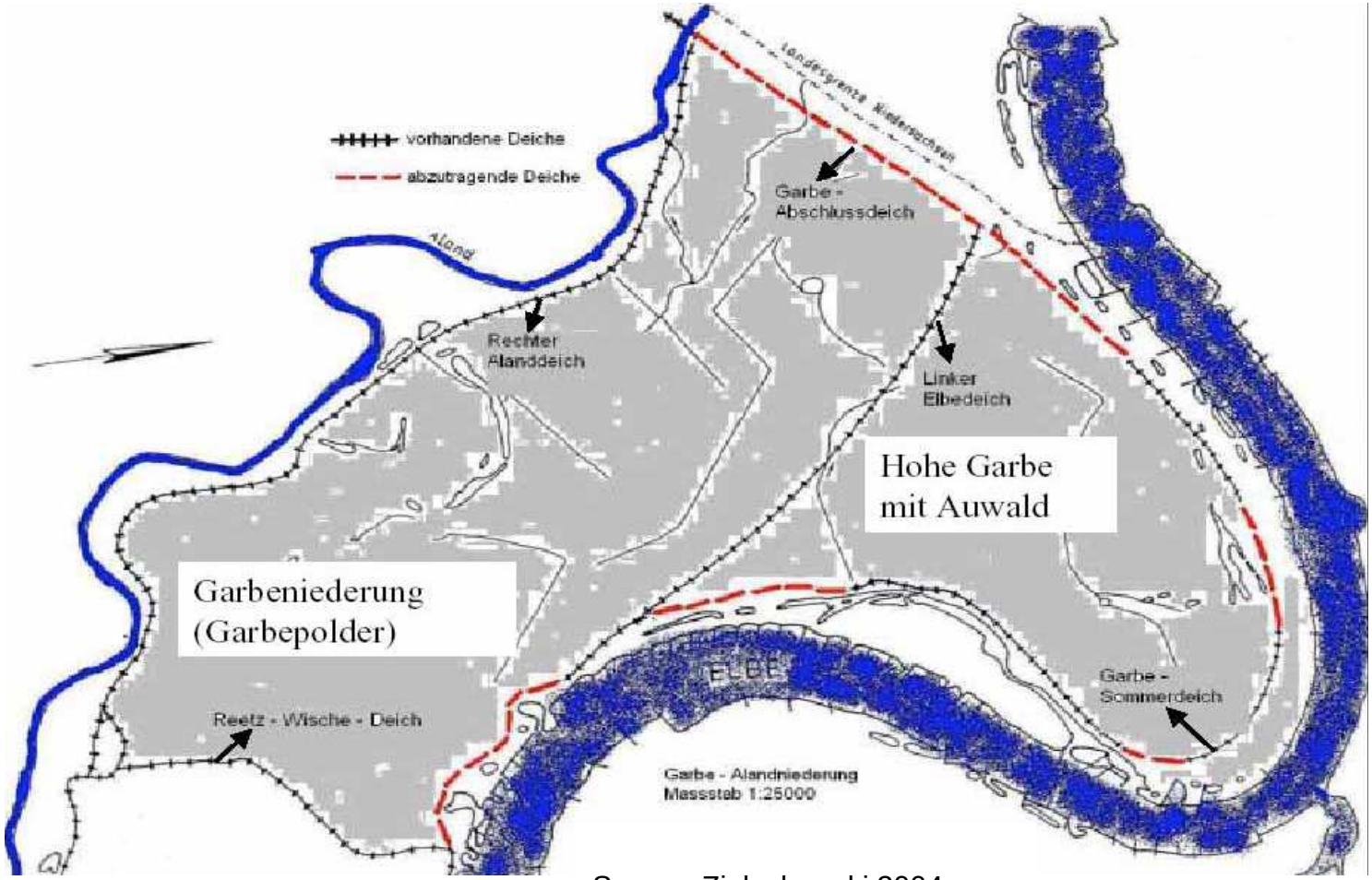
- Evaluation:
  - Relevance: Protection of public health, but alternatives available
  - Effectivity: Medium: Not all damages at heat days can be avoided
  - Windfall profits: low, because measure have to be implemented by public institutions
  - Acceptance: Winner: inhabitants nearby green areas, Looser: local investors or industrial companies
  - Further side effects: Increase of living and life quality in the district

Case study: restoration of pastureland

Copyright:Potupin

- Basic information:
  - Analysed a concrete example at the river Elbe in the north of Germany (size of restoration area: 611 ha, potential 13 mio. m^2 water retention)
  - sector: biodiversity, water (flood protection)
  - urgency: high, because long implementation time and time-lag between implementation and effect

Case Study: restoration of pastureland



Source: Zielaskowski 2004

Case study: restoration of pastureland

- Cost/benefit analysis:
  - Included costs:
    - costs to rebuilt dikes and built new dikes
    - Costs to buy land from farmers
    - Lossed income for farmers
    - Planting costs for pasture forest

Case study: restoration of pastureland

- Included benefits:
  - Lower maintenance costs for dikes, due to shorter length
  - Avoided damage costs in case of flooding
  - Nutrition retention
  - Evaluation of biodiversity
- Benefit-cost-ratio: costs (14-18 mio. €) lower than benefits (30-45 mio.)

(Discounted costs and benefits until 2100)

Case study: restoration of pastureland

- Calculated two scenarios:
  - first – business as usual (without climate change)
  - Second – with climate change
- Benefit-cost-ratio:

	Business as usual	With climate change	Main factors
Costs	10 mio. €	10 mio. €	Dike re/building, income losses
Benefits	20-35 mio. €	+ 10 mio. € (total: 30-45 mio. €)	Value for biodiversity conservation
Discounted costs and benefits until 2100.			

Case study: restoration of pastureland

- Evaluation:
  - Relevance: High, because biodiversity conservation is basis for human livelihood
  - Effectivity: High, restoration would increase adaptive capacity of eco-systems, effect is proofed
  - Windfall profits: low, because nature conservation mainly task of public institutions

Summary of main results

Results: Cost-benefit ratio of different measures

Benefits higher than costs	Balanced costs and benefits	Costs higher than benefits
- Information compaigns for companies - Heat warning systems - Regional/urban planning - Road/rail infrastructure - Restoration pastureland - Adapted crops	- Green roofs, efficient cooling of offices or hospitals - Cooling of thermal power stations - Diversified tourism offers - Improved disaster management	- Irrigation in agriculture - Adaptation of electricity grid - Cooling of homes

Results/Summary

- Cost-benefit-ratio should be accompanied by further criteria: relevance, no-regret/regret, urgency, etc.
- Main problem: estimation of effect of measures -> which part of climate impact (and costs) can be avoided by the measure?
- Monetisation of benefits –> vary over different sectors (better for sectors, where market price is availabe, e.g energy, agriculture, worse for biodiversity)
- Monetisation of health impacts – in principle possible, strong influence on the results of benefit assessment
- Monetisation of decrease of productivity (e.g. transport, energy, cooling of offices) – quite unproblematic

Results/Summary II

- Local effects of climate change and implementation of measures – problematic for national evaluations (e.g. regional planning)
- Urgency varies over different measures – important for priorisation and selection
- Not only costs and benefit estimates are relevant, also distribution of costs/benefits over different stakeholder groups, risk of windfall profits, separation of autonomous adaptation
- Effects allways assessed against business-as-usual scenario:
  - Difficulties: Integration of other developments, like demographic change
  - A lot of trends can only be assessed very rough – e.g. technological development, change of consumer behaviour

Many thanks for your attention!

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