

BMBF-Research Project

Change and Management of Risks due to extreme flood events in large river basins – the example of the Elbe River (VERIS-Elbe)

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17. Meeting IKSE WG „Flood protection“, 28th November 2008, Dresden

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1. Introduction
2. Modelling the flood risk system of the Elbe River
3. Conceptualisation of futures
4. Risk analysis ex ante
5. Conclusions and outlook



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Consortium

Project partners

- Leibniz Institute of Ecological and Regional Development (IOER)
- Technische Universität Dresden (TUD)
 - Institut für Hydrologie und Meteorologie (IHM)
 - Institut für Wasserbau und technische Hydromechanik (IWD)
- Bundesanstalt für Gewässerkunde (BfG)

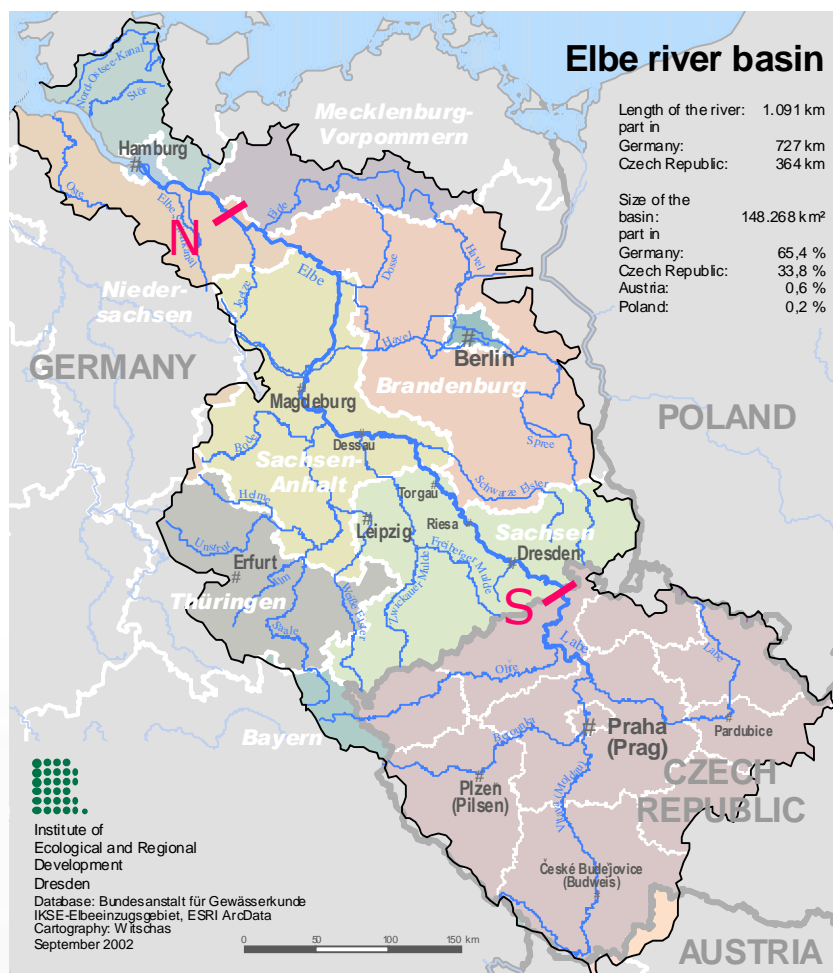
in collaboration with

- European Commission, DG Joint Research Center (JRC)
- PlanEVAL
- Plan + Risk Consult

Co-operation partners

- Dresden Flood Research Center (D-FRC)
- Potsdam-Institut für Klimafolgenforschung (PIK)
- Max-Planck-Institut für Meteorologie (MPI)

Research area



Elbe River basin

- ▶ 148.268 km²
 (65,4% D, 33,8% CZ,
 0,6% A, 0,2% PL)

VERIS-Elbe

Entire basin

- ▶ LISFLOOD (VERIS-Elbe)
- ▶ Projection climate change STAR
- ▶ Projection climate change REMO

German flood plain of the Elbe River

- ▶ Coupled models for risk analysis

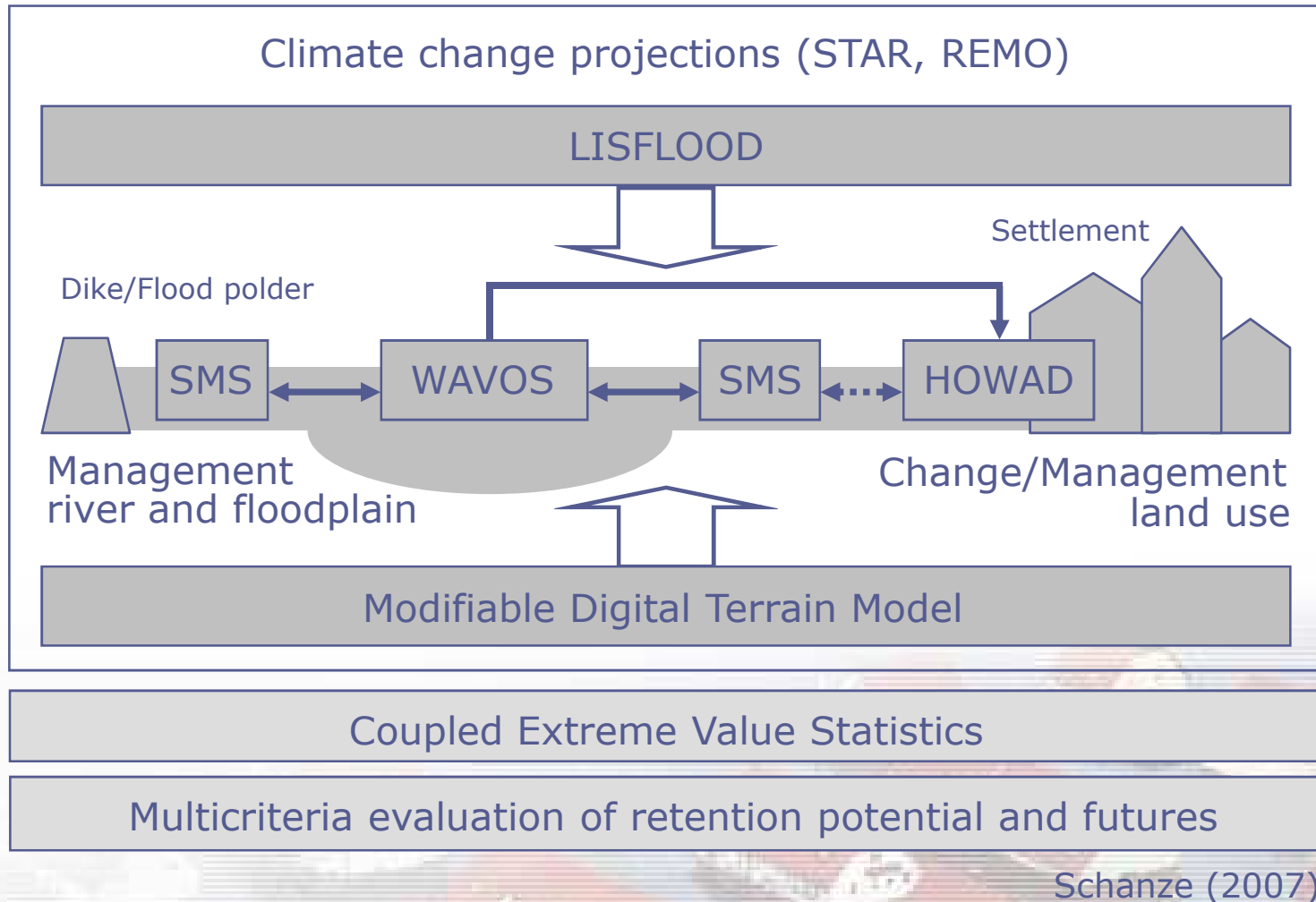
- Gauge Schöna
- Gauge Neu Darchau

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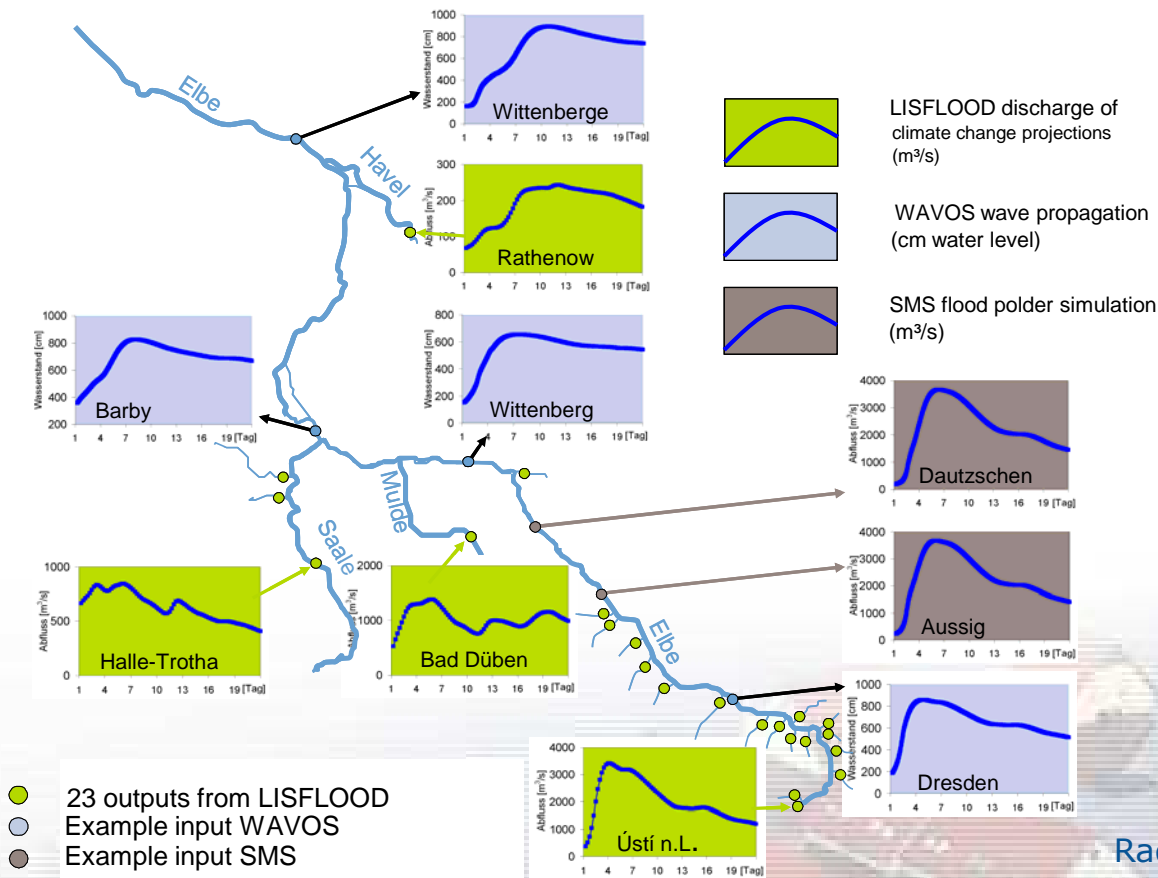


Coupled models for risk analysis



Schanze (2007)

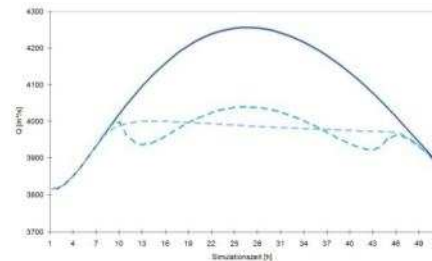
RR modelling and wave propagation (LISFLOOD-WAVOS-SMS)



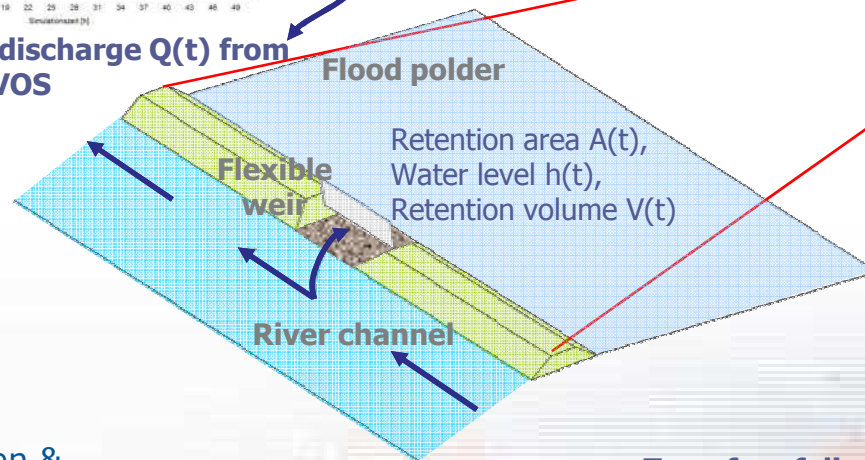
Burek &
Rademacher (2007)

Coupling WAVOS - SMS

- Coupling of WAVOS and SMS using the discharge $Q(t)$ as parameter

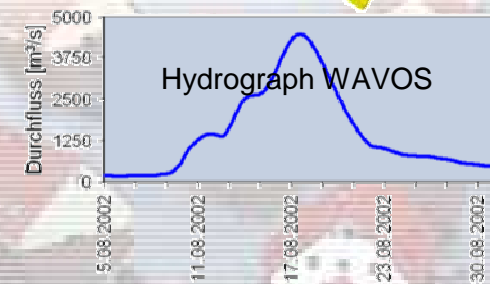


Transfer of discharge $Q(t)$ from
SMS to WAVOS



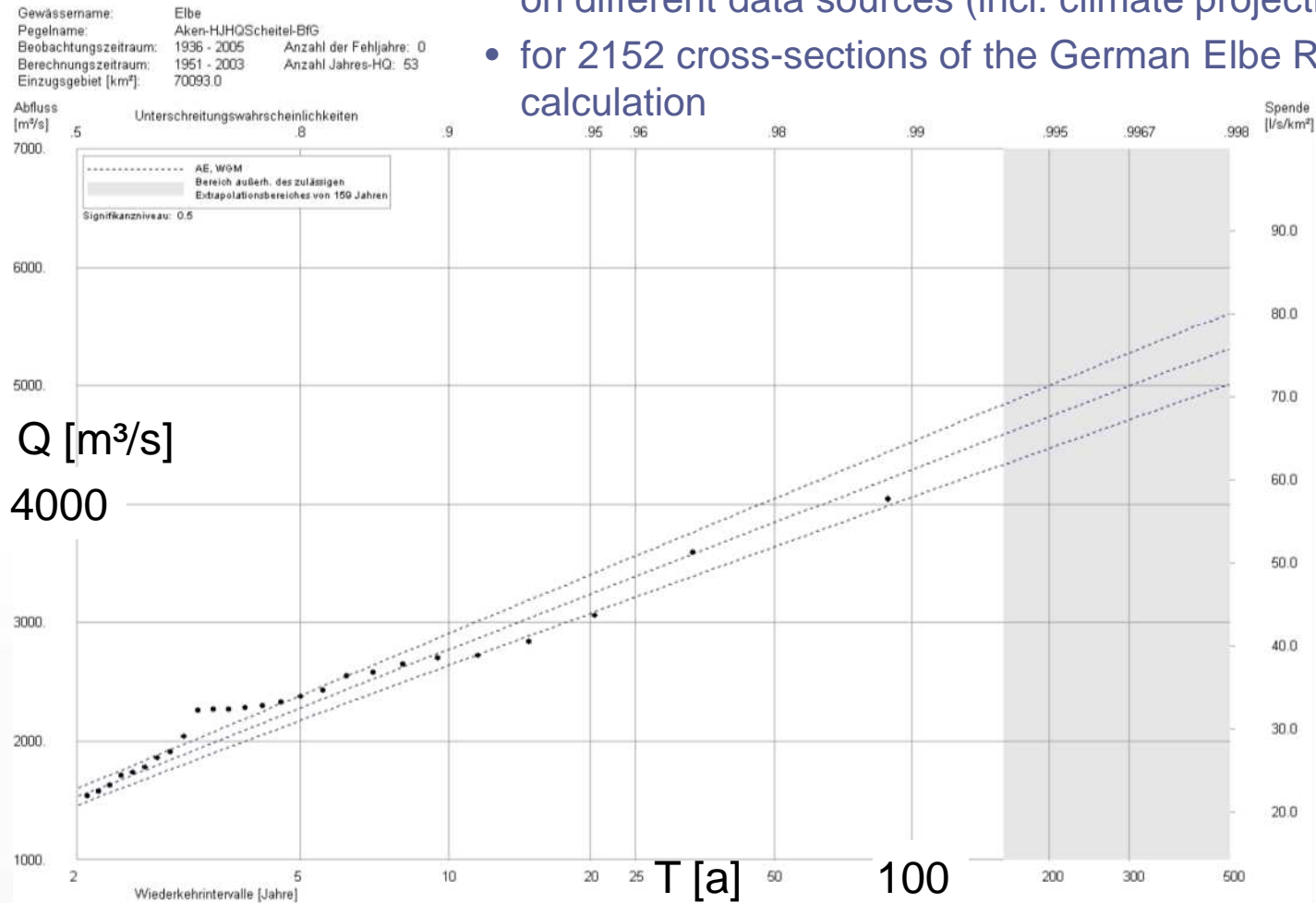
Carstensen &
Kopp (2007)

Transfer of discharge $Q(t)$
from WAVOS to SMS



Extreme value statistics

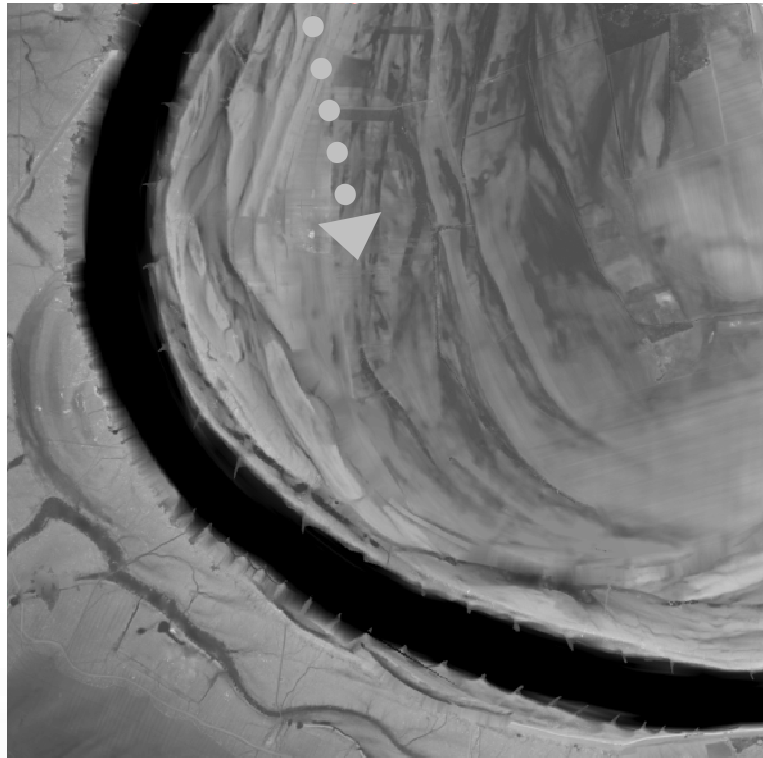
- Statistical analysis (annuality T) of all maximum events based on different data sources (incl. climate projections)
- for 2152 cross-sections of the German Elbe River – automatic calculation



e.g. Gauge Aken/Elbe,
 Measurements
 1951–2003, AE-WGM

Schmidt et al. (2007)

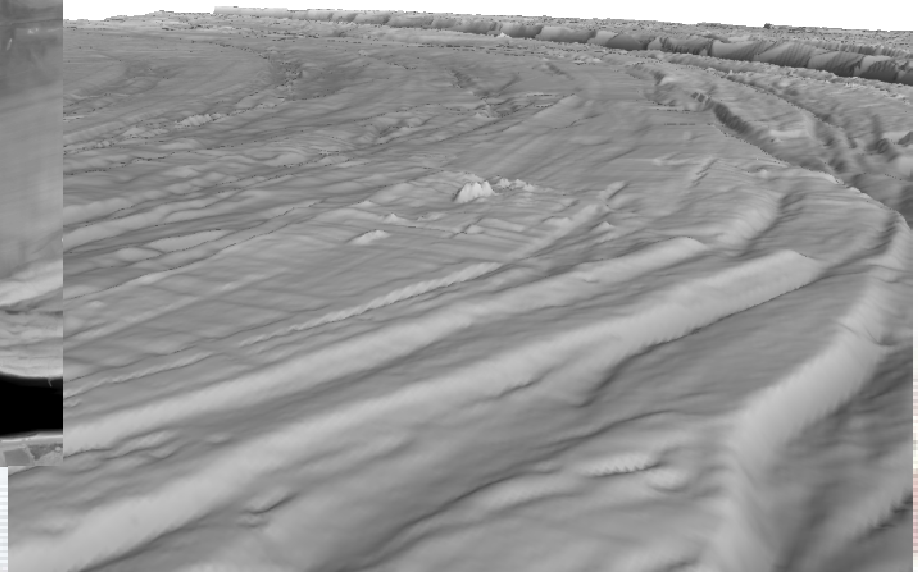
Modifiable Digital Terrain Model



DTM cutout

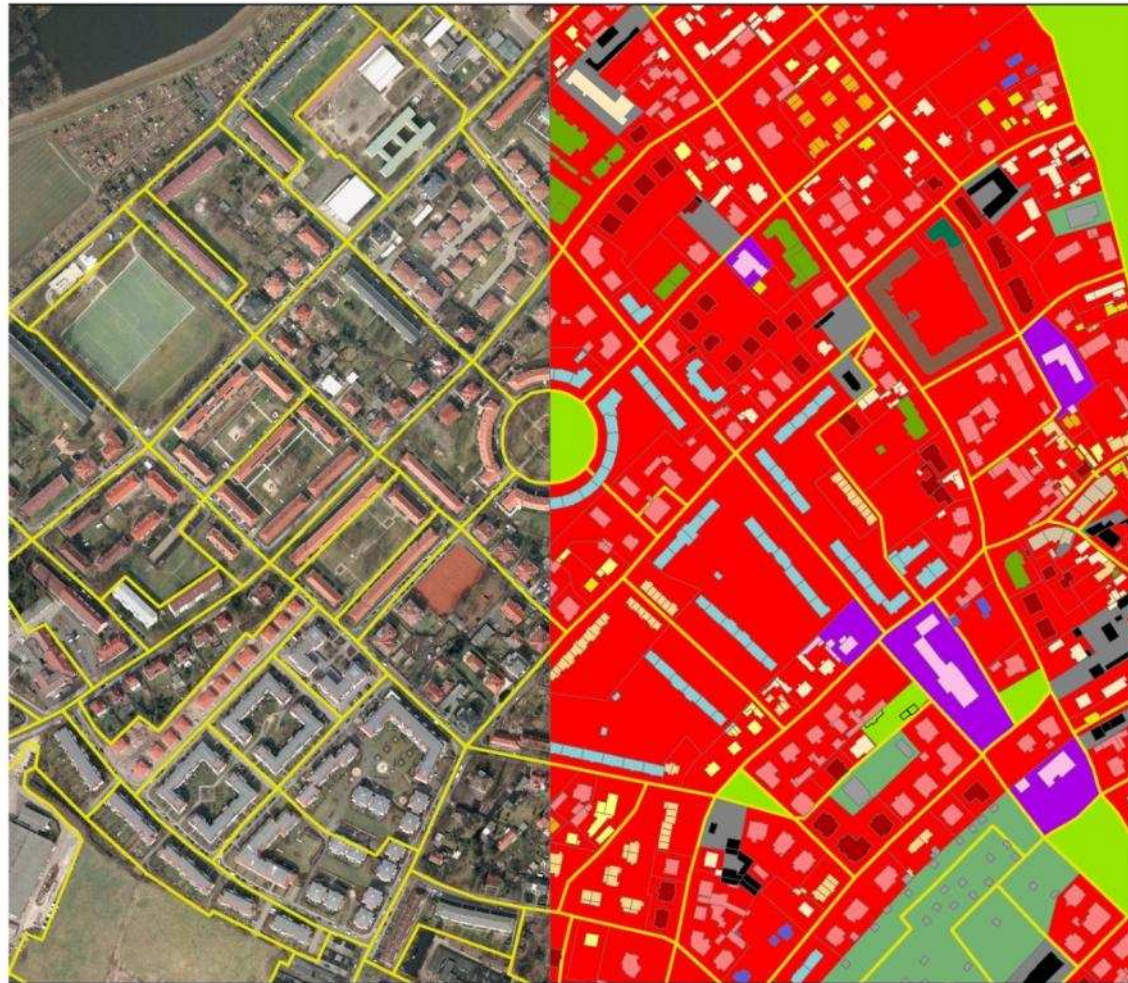
Krüger (2008)

Example dike extraction



Perspective view (heights by factor 10)

Land use and building structure types



Naumann et al. (2008)

Damage analysis for representatives of building types



Der Repräsentant kennzeichnet einen für die Frühindustrialisierung charakteristischen Gebäudetypus. Derartige Gebäude errichtete man in großer Anzahl vorwiegend um die Mitte des 19. Jahrhunderts. Sie sind unter anderem im Elbtal und dessen Nebentälern verbreitet. In ihrer ursprünglichen Raumstruktur dienten sie als Wohngebäude für Arbeiter und Handwerker. Das baukonstruktive Gefüge ist durch variierende massive Wandbauweisen, gewölbte Kellerdecken und Holzbalkendecken über den Wohngeschossen geprägt.

Merkmale im Überflutungsfall

- Einlaufschwelle
- Gründung
- Außenwände im Keller- und Erdgeschoss
- Außenwände im Obergeschoss, Innenwände in Erd- und Obergeschoss



Hohlmauerwerk der Außenwände im Obergeschoss

- Kellerdecke als gewölbte Massivdecke
- Geschossdecken als Holzbalkendecken



Holzbalkendecke als Einschubdecke, Lehmenschlag als Auffüllung

- Betrachtungsgrenze für Überflutungshöhen

GEBAUDESTRUKTUR

Signatur VERIS-Elbe
 Baujahr
 Bebauung
 Geschosse
 Unterkellerung
 Dachform
 Lage Treppenhaus
 Treppenlauf

Geometrie
 Grundfläche Gebäude
 Länge, Breite
 Sockelhöhe
 Traufhöhe, Firsthöhe
 Raumhöhen i. L.

Höhenkoten
 OK Gelände
 OK FF KG/EG/OG
 Einlaufschwelle

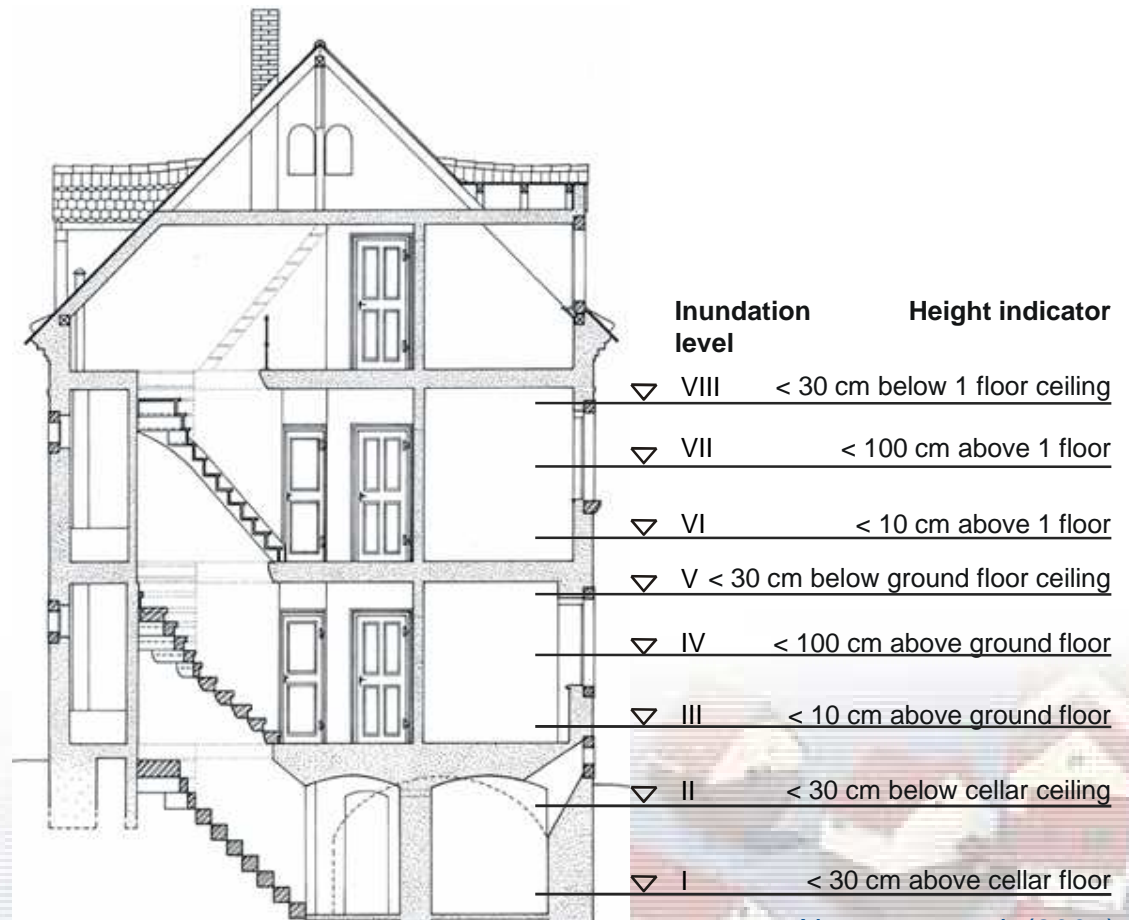
Nutzungen
 Kellergeschoss, EG, OG, DG

Baukonstruktion I
 Gründung
 Außenwände KG
 Innenwände KG
 Kellerdecke
 Kellertreppe
 Fußboden KG

Baukonstruktion II
 Außenwände EG
 Innenwände EG
 Geschossdecke über EG
 Geschosstreppe im EG
 Fußboden EG

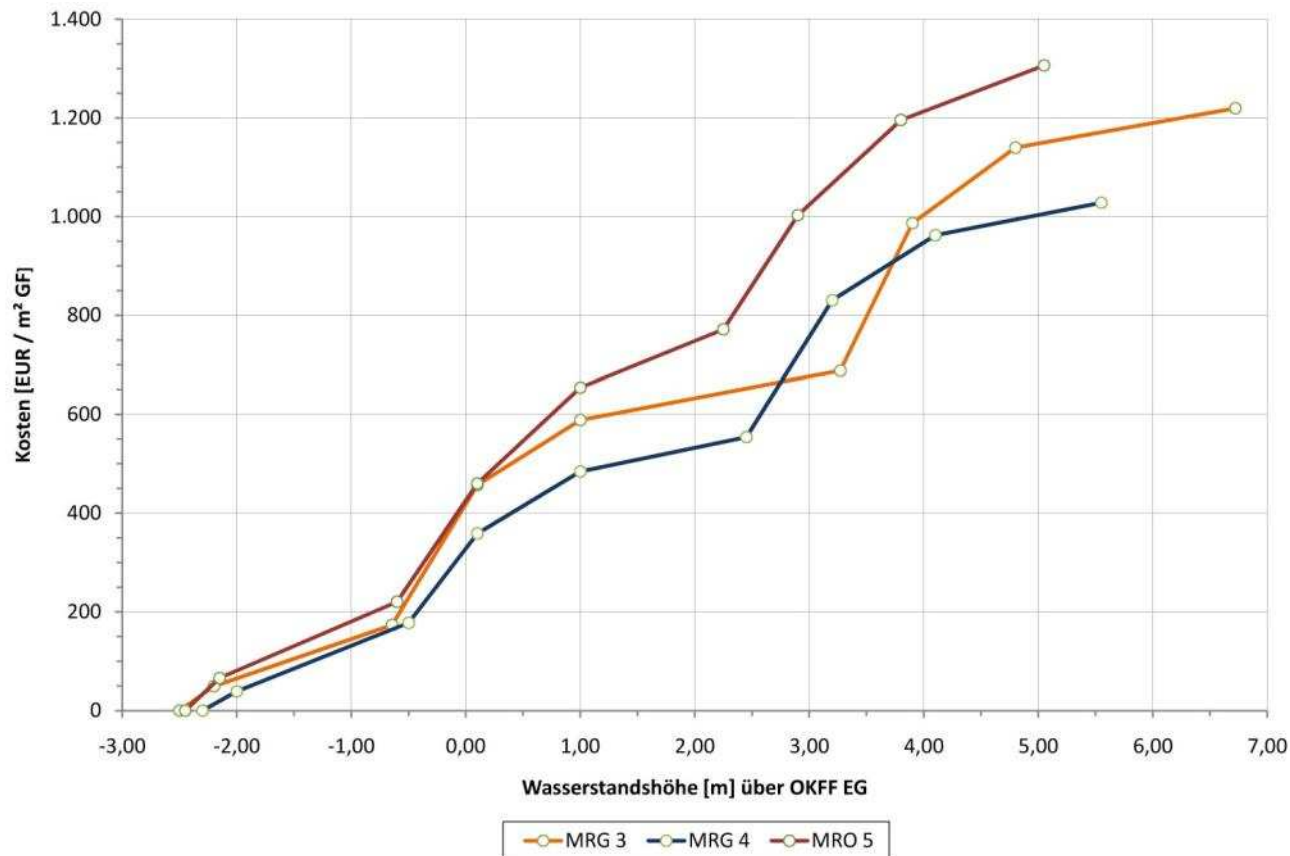
Baukonstruktion III

Baukonstruktion IV
 Dachtragwerk
 Dachdeckung
 Fassade
 Zierelemente
 Fenster



Naumann et al. (2007)

Building-type specific depth-damage functions (examples)



MRG 3 (1903)



MRG 4 (1924)



MRO 5 (1985)

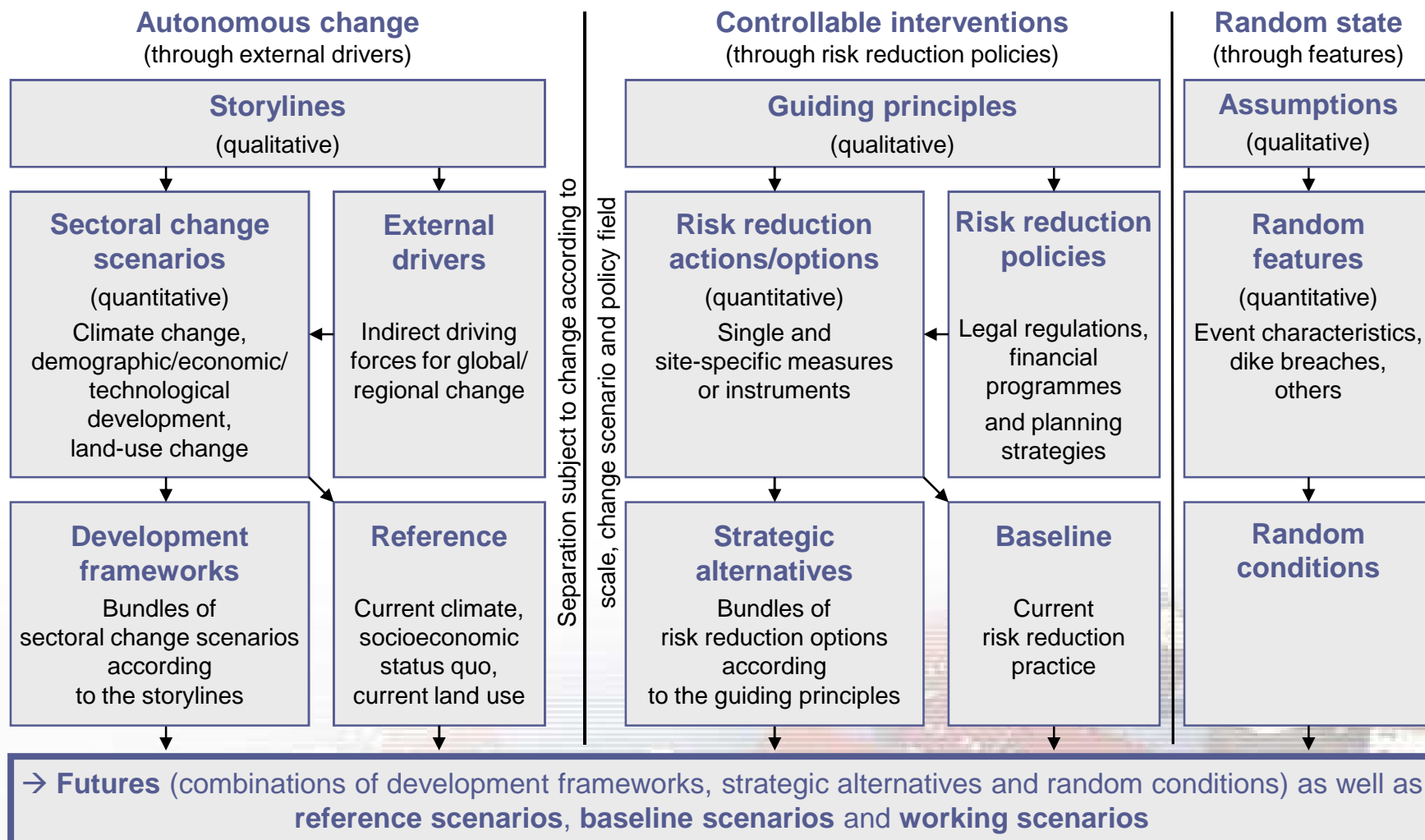
Naumann et al. (2007)

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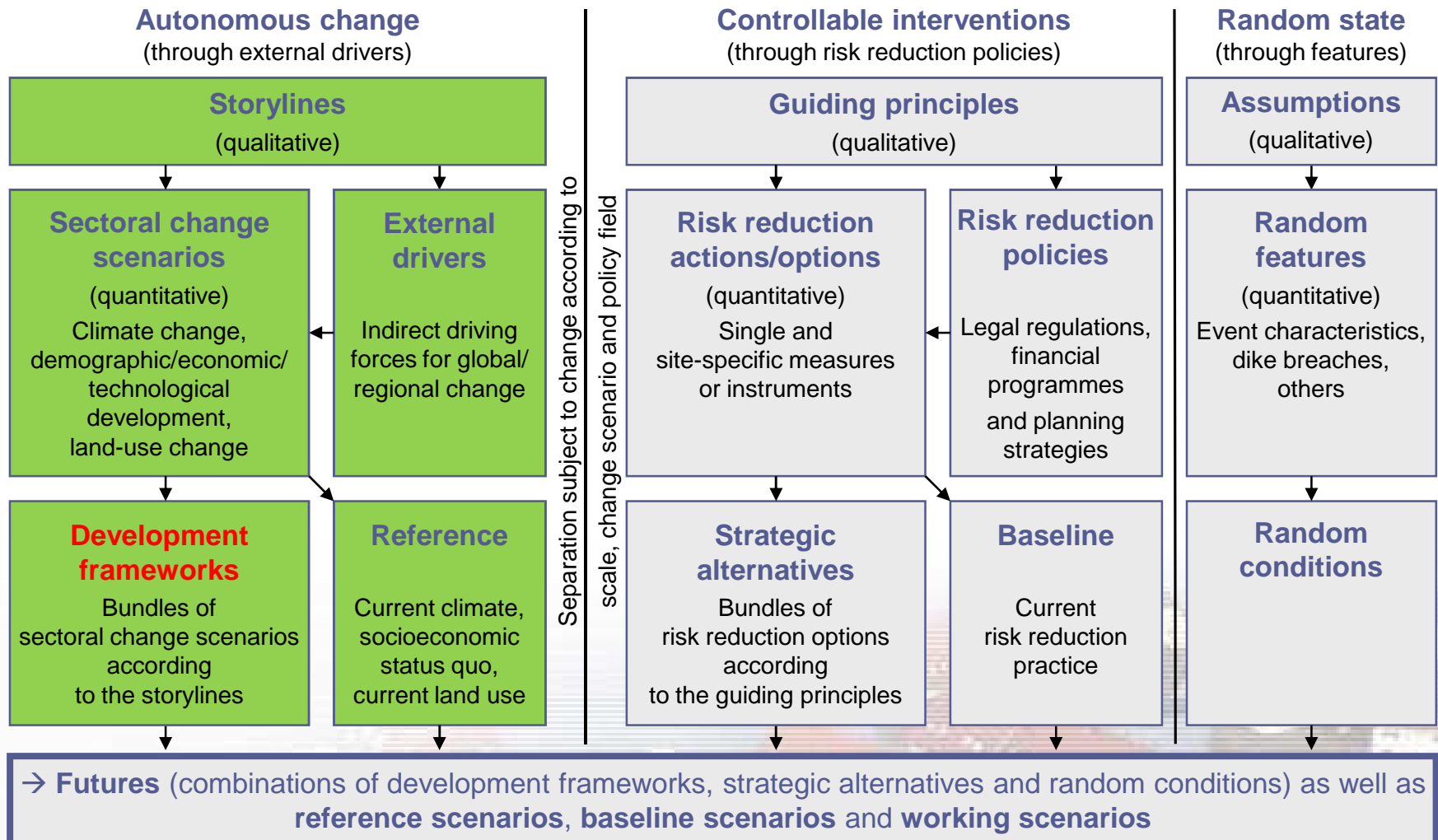
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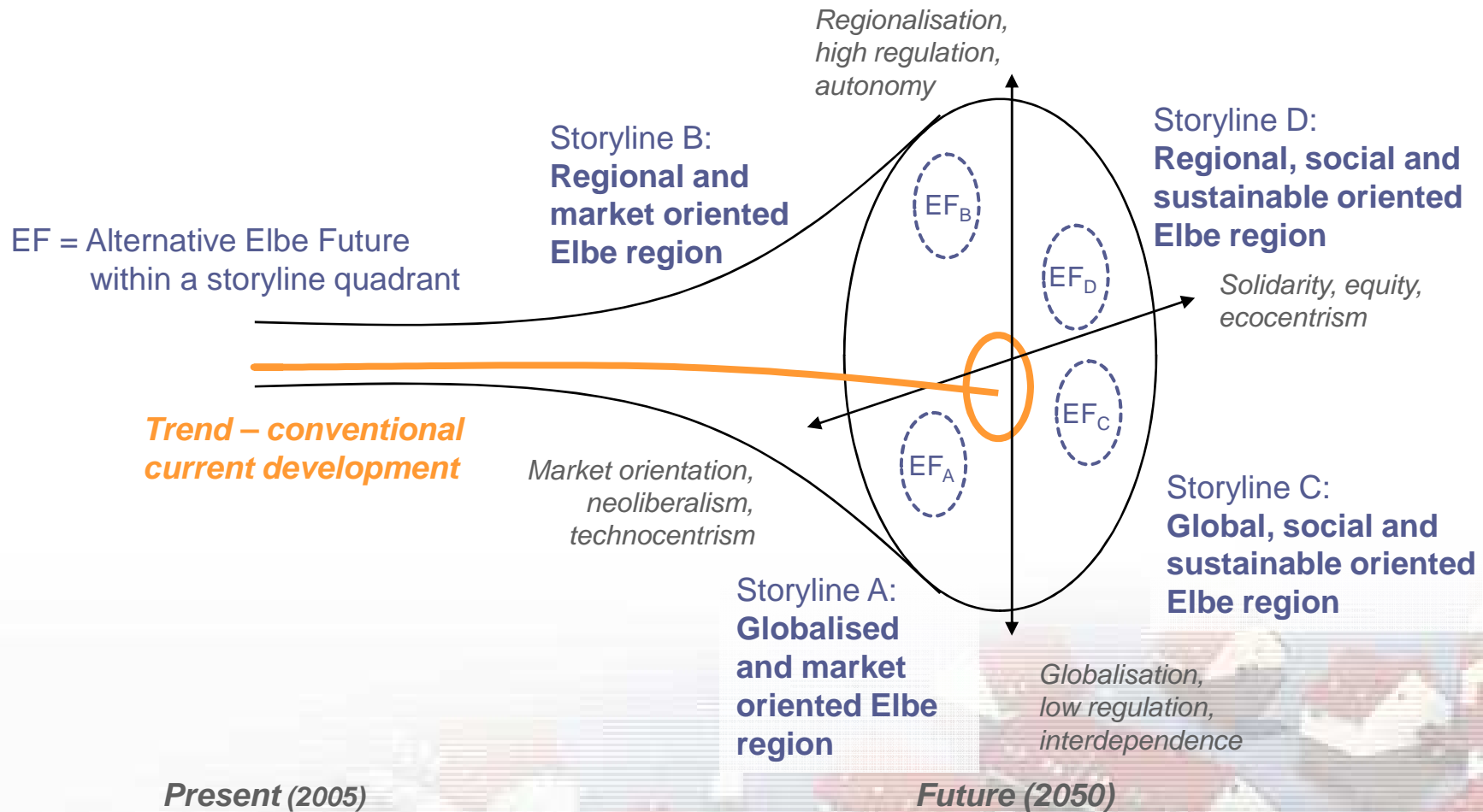
Composition of alternative futures



Composition of alternative futures



Storylines for deriving development frameworks

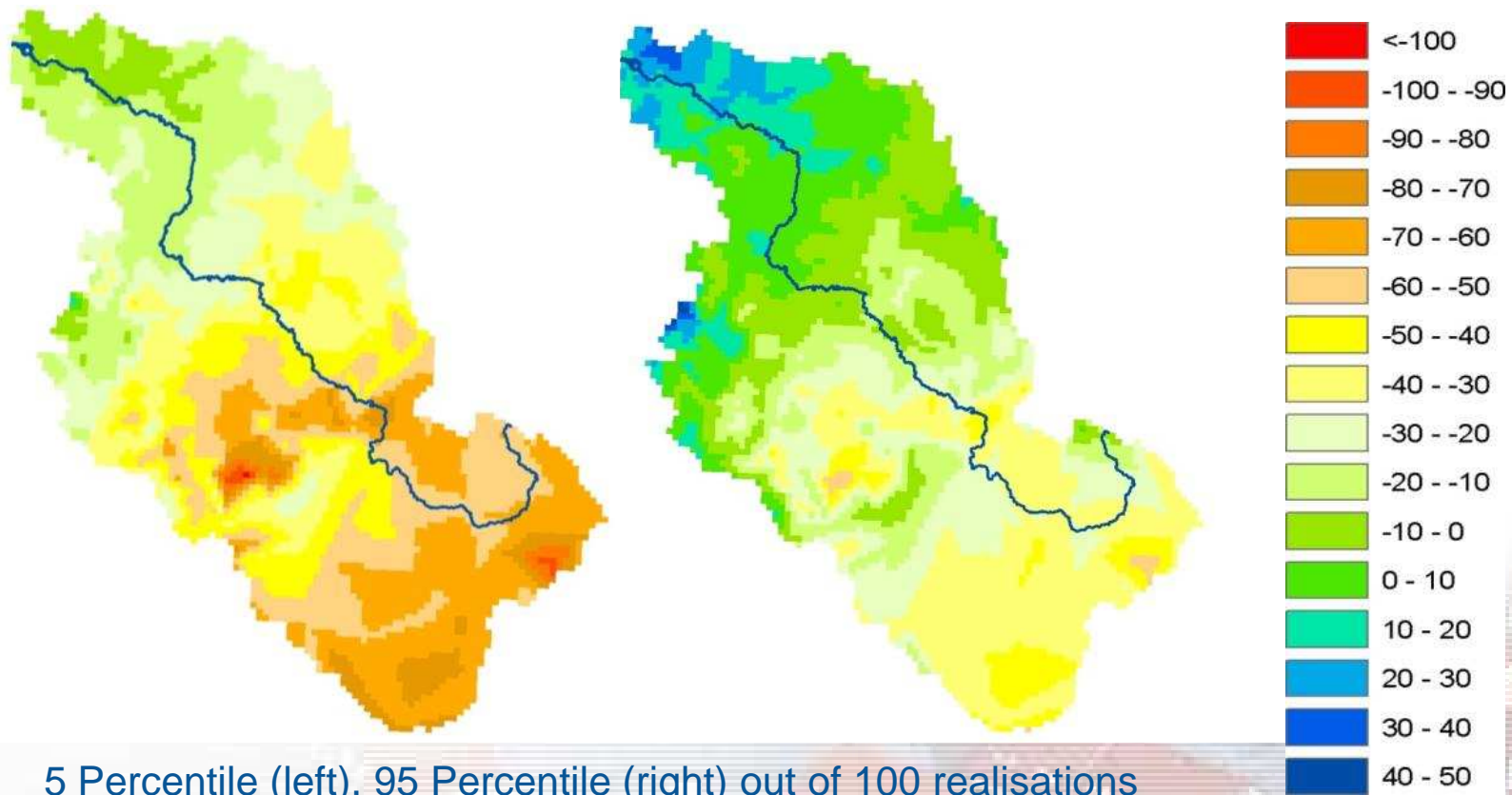


Assignment of change scenarios to development frameworks

Storylines Change scenarios (2050)	"A globalised and market-oriented Elbe region" Development framework A	"A market-oriented Elbe region with a regional focus" Development framework B	"A globalised Elbe region with a focus on social equity and sustainability" Development framework C	"An Elbe region with a regional focus on social equity and sustainability" Development framework D
Climate change	High (IPCC A2, 95 percentile)	Median (IPCC A2, 50 percentile)	Medium-low (IPCC A2, 25 percentile)	Medium-low (IPCC A2, 5 percentile)
Population development (absolute)	Slower decrease, local increase (3rd , SBA 2007 "6-W2")	Strong decrease (4th , "6-W1")	Slower decrease, local increase (1st , "3-W2")	Strong decrease (2nd , "3-W1")
Economy (GDP)	2% annual growth in Germany	1,75% annual growth in Germany	1,5% annual growth in Germany	1,25% annual growth in Germany
Land use change	High sub-urbanisation, agricultural extensification	Moderate sub-urbanisation, agricultural intensification	Focus on dense urban structures, few changes in agriculture	Focus on dense urban structures, agricultural intensification
<i>Corresponding roughly to IPCC SRES emission scenario storylines:</i>				
	A1B	A2	B1	B2

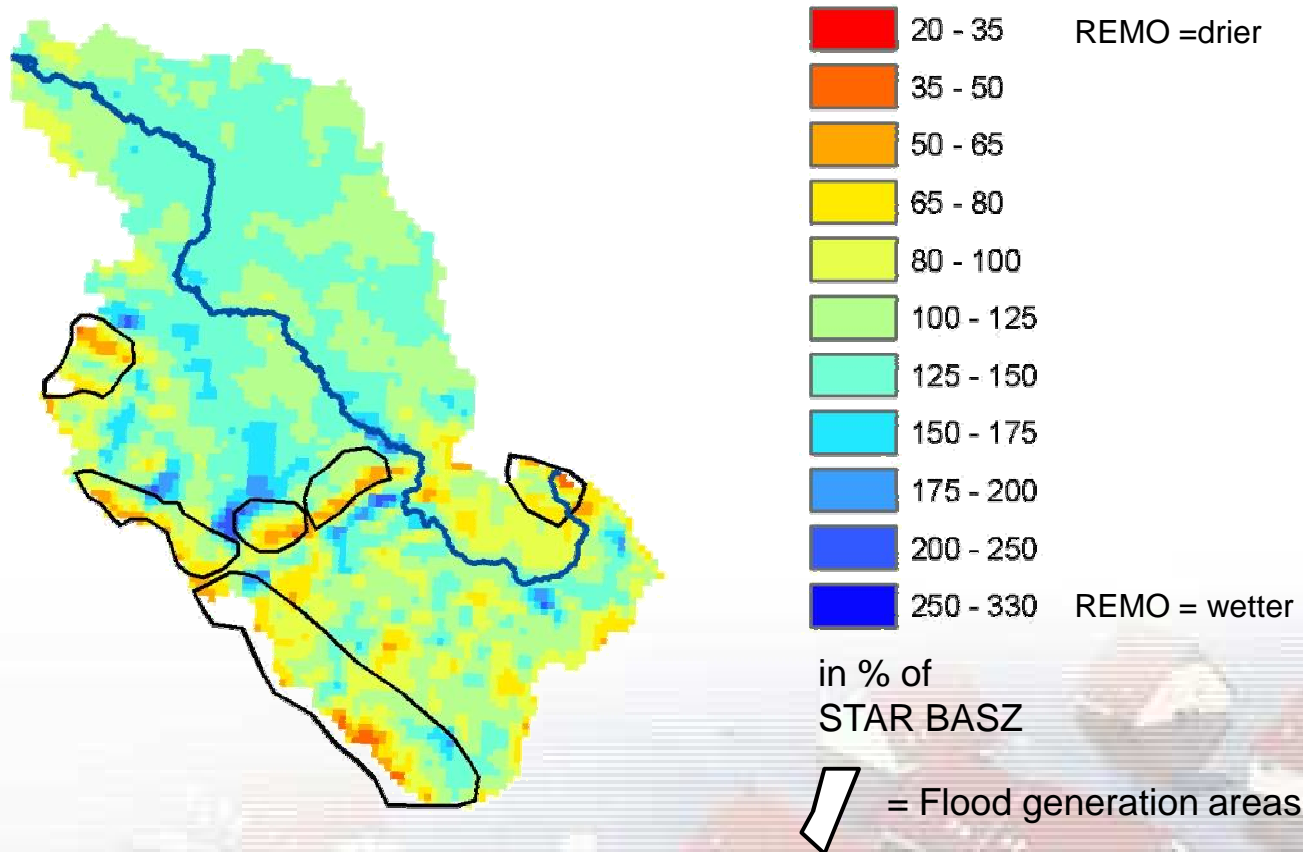
Comparison of baseline and projected average annual precipitation

Baseline scenario (1950-2000) and STAR A2 (2000-2050)



Wagner (2008)

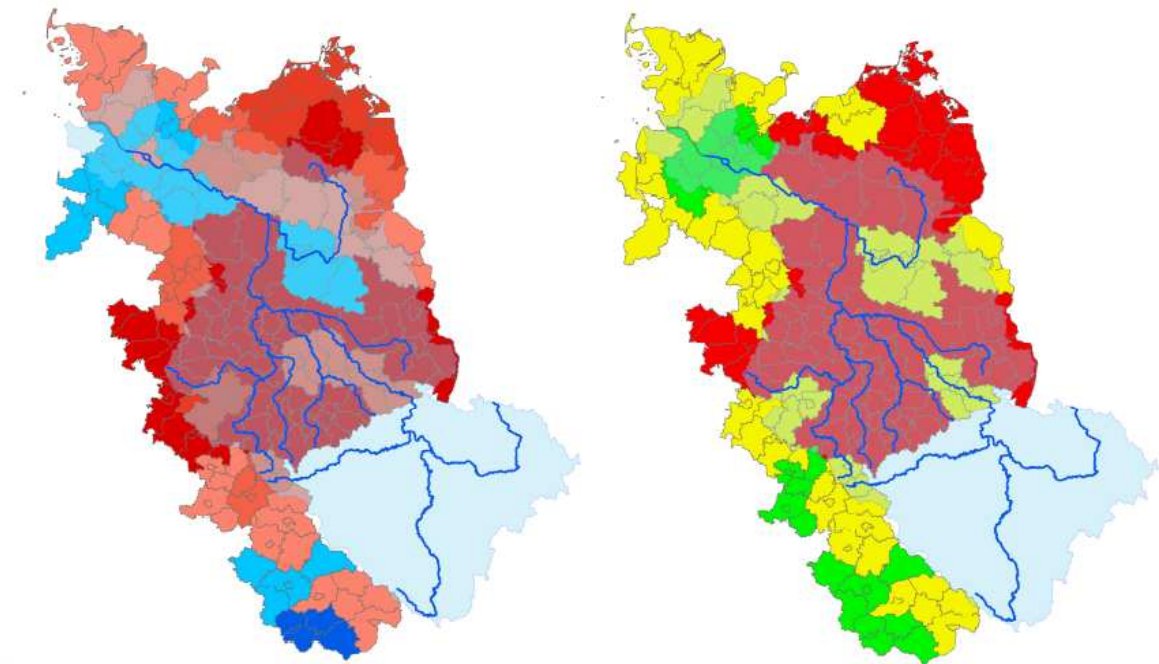
Comparison of re-analysing the average annual precipitation STAR und REMO (1951-2000)



Wagner (2008)

Projection of demographic and economic change

Change in population
(2002-2050, left) and
annual GDP growth
(2003-2050, right) for
development framework
„C“



Legende

Elbeinzugsgebiet

Veränderung der Bevölkerung in % (2002 zu 2050)

- 30 bis -45%
- 20 bis unter -30%
- 10 bis unter -20%
- 0% bis unter -10%
- 0% bis unter +10%
- +10% bis +20%

Legende

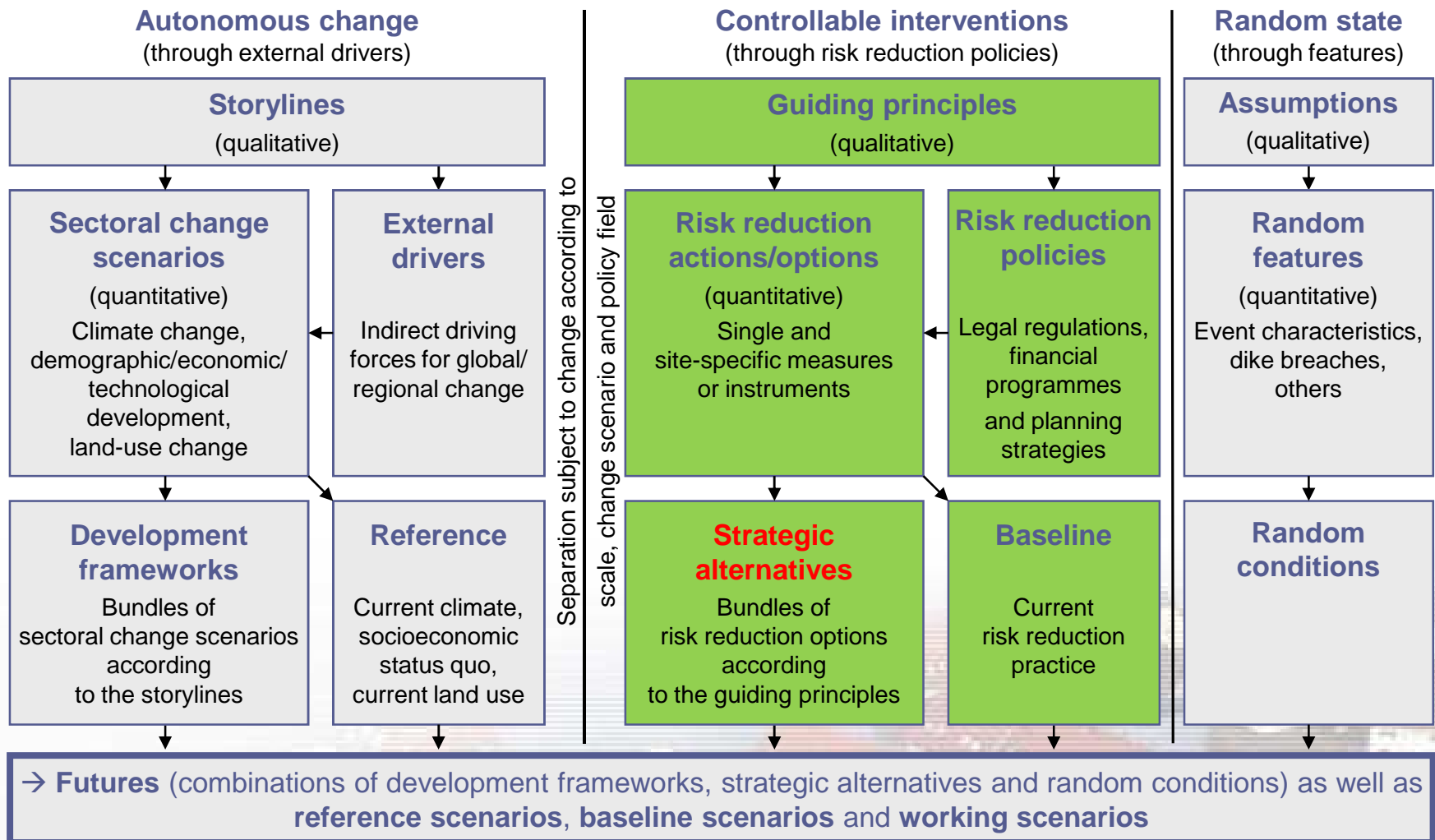
Elbeinzugsgebiet

jährliches BIP-Wachstum nach ROR (2003-2050)

- 0,74%
- 1,37%
- 1,64%

Luther (2008)
based on BBR
(2006, SBA (2007)
und Oeltze et al.
(2007)

Composition of alternative futures



Guiding principles for deriving strategic alternatives

Guiding principles	Prevention of the flood hazard					Mitigation of flood vulnerability			
	Flood polder	By-pass channel	Dikes			Building ban	Flood proofing	Evacuation	
			new	Heightening	Relocation			Persons	Inventory
„Resistance“	x			x	x				
„Resilience“						x	x	x	x
„Combination“	(x)		(x)?	(x)		x	(x)	x	
„All measures“	x	x	x	x	x	x	x	x	x
Reference	(x)	x		(x)	(x)	(x)	(x)	x	(x)

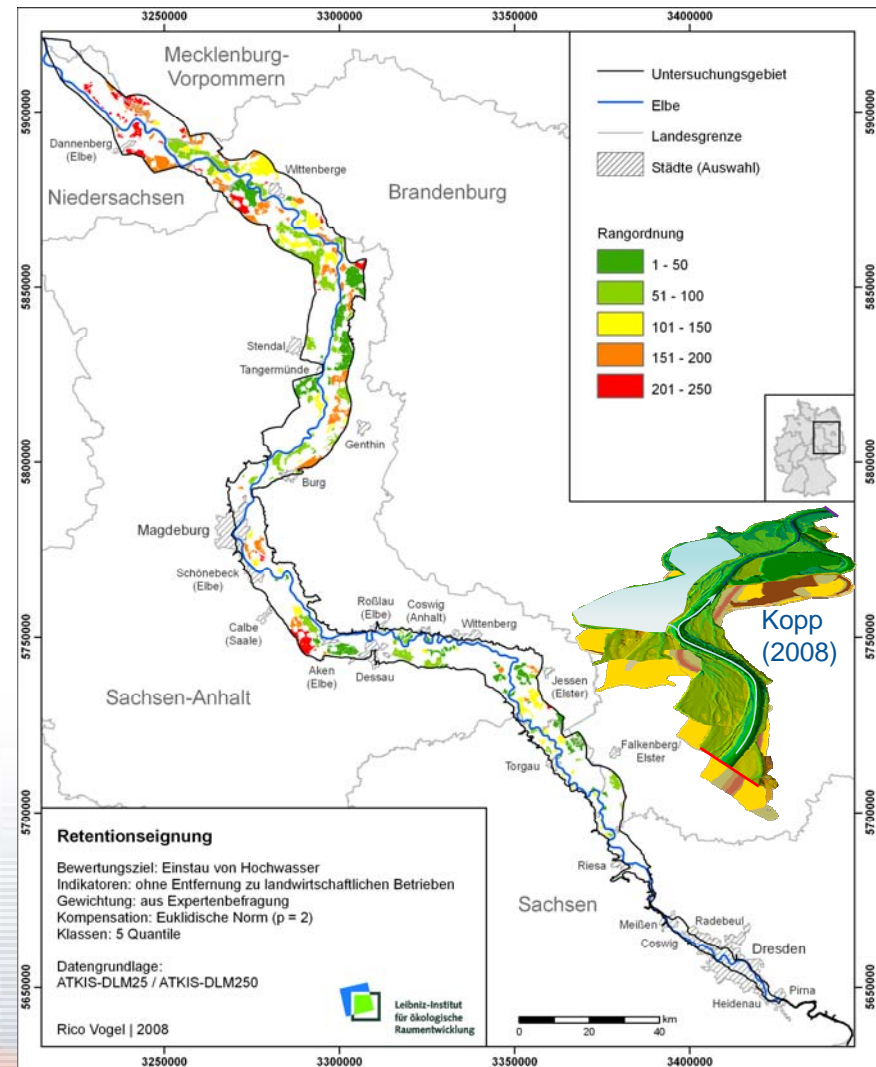
Luther (2008)



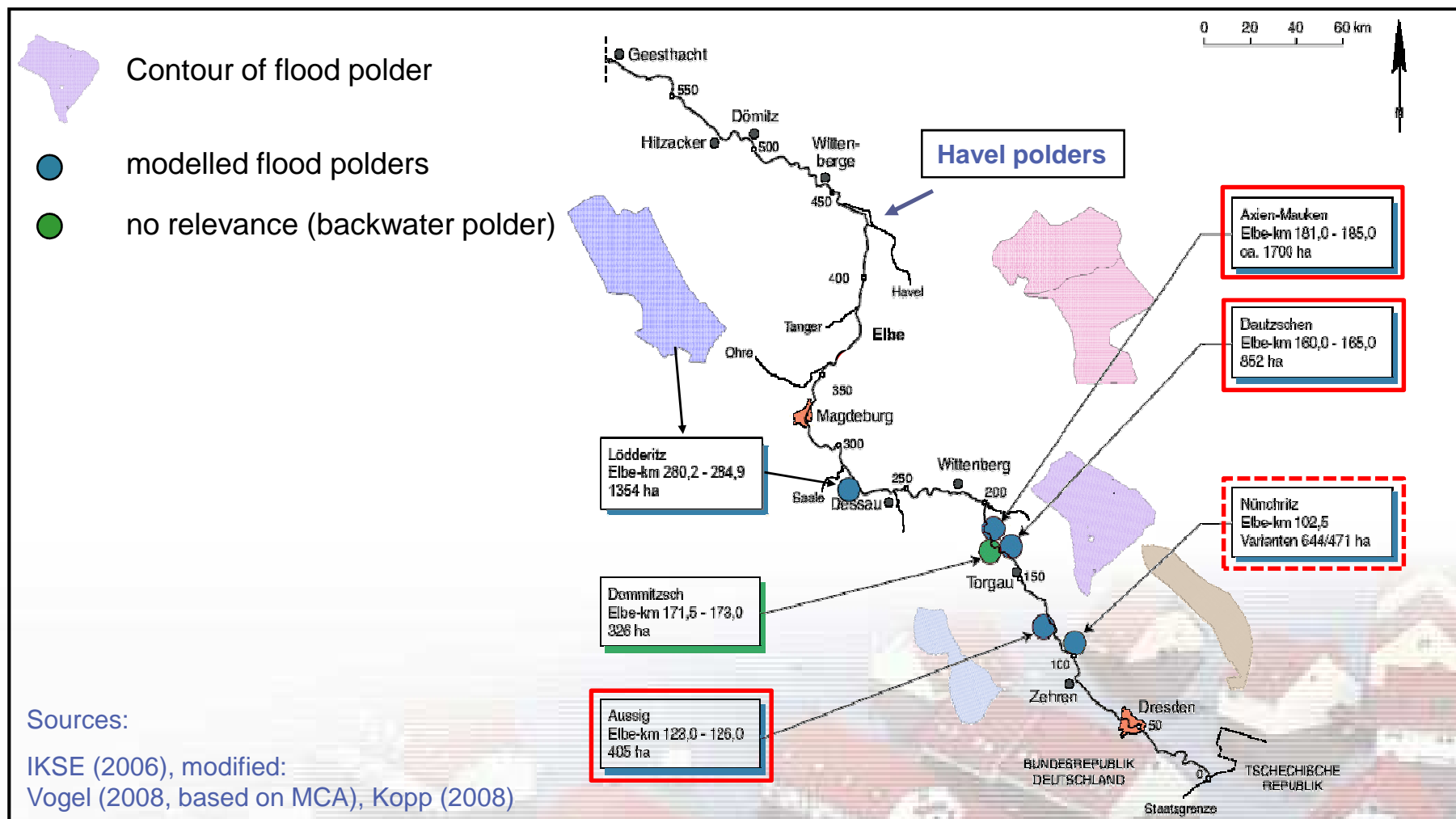
Multi-criteria evaluation of retention potential for flood polders

- Multicriteria evaluation of the area resistance (11 indicators)
- Weighing (expert interviews)
- Exclusion:
 - Active flood plain (1:100 yrs)
 - Water level 1:100 yrs < 1 m
- Ranking according to:
 - Areas resistance
 - Distance to the river bed
 - Stationing
 - Volume (HQ₁₀₀)
 - Protection status

Vogel (2008)



Considered flood polders



Investigated groups of flood polders

„Resistance“: **(all flood polder)** Nünchritz, Aussig, Dautzschen, Axien,
Lödderitz, Burg (potential polders with priority)

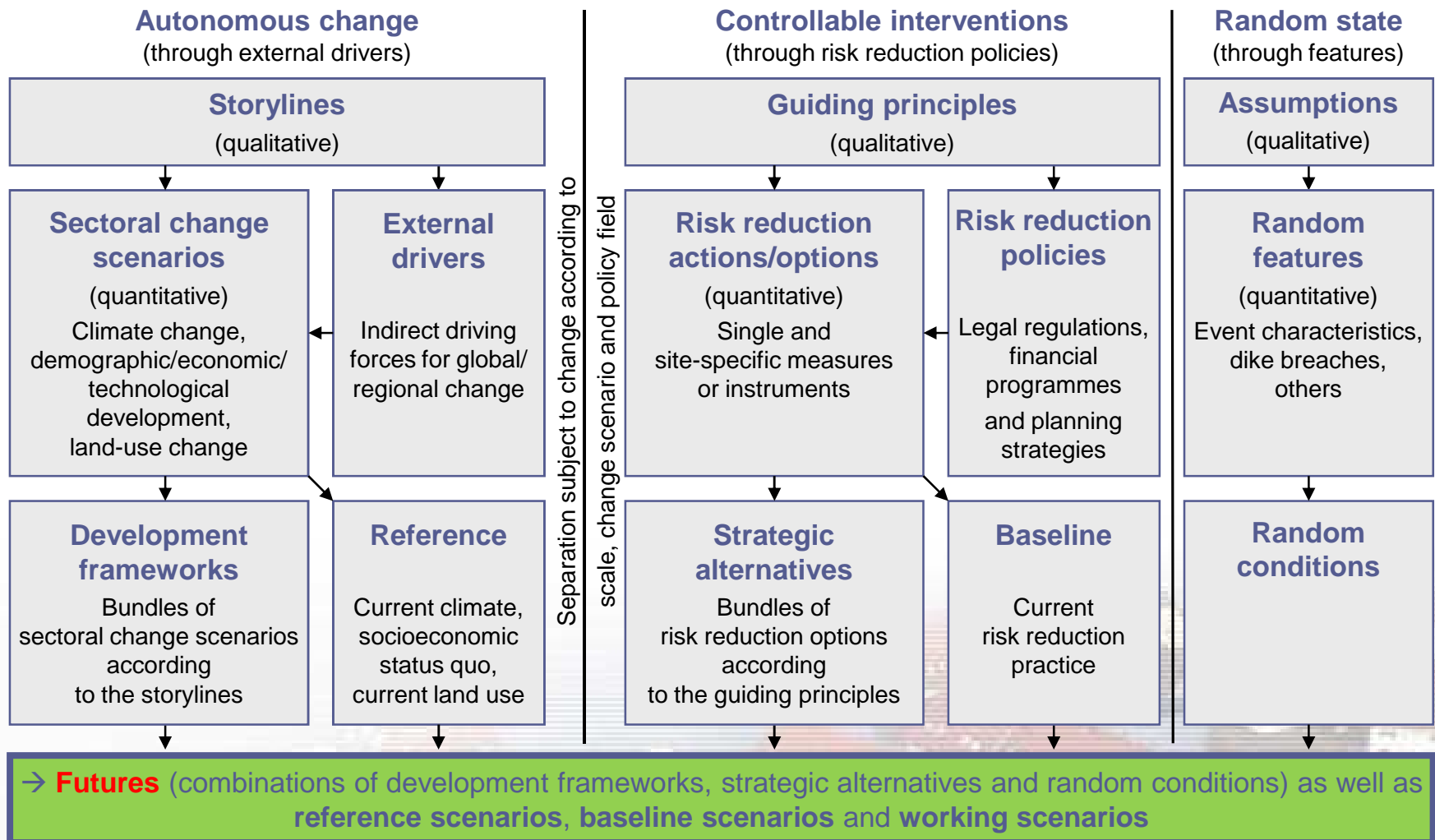
Total retention area: 5786 ha

„Combination“: **(Selection)** Aussig, Dautzschen, Axien (polders with priority)

Total retention area: 2957 ha



Composition of alternative futures



Combination of development frameworks and strategic alternatives

Strategic alternatives	Development framework				Presence	
	A	B	C	D	Re-analysis	Measure-ment
I						
II	Robustness of a strategic alternative				Reference-scenario	
III						
IV						
0 (Referenzce)	Impact of development frameworks					
	Baseline scenario					
X	Working szenarios					

Luther & Schanze (2008)

Combination of development frameworks and strategic alternatives

Handlungs- alternativen	Entwicklungsrahmen Globaler Wandel				Gegenwart	
	A	B	C	D	Reanalyse	Messwerte
I		EF-B(S, GL100)-I EF-B(S, GL300)-I				
II		ES_B(S, LS100)_II ES_B(S, LS300)_II				
III	ES_A(S, LS100)_III ES_A(S, LS300)_III	ES_B(S, LS100)_III ES_B(S, LS300)_III	ES_C(S, LS100)_III ES_C(S, LS300)_III	ES_D(S, LS100)_III ES_D(S, LS300)_III		
IV		ES_B(S, LS100)_IV ES_B(S, LS300)_IV				
0 (Referenz)	BL_A(S, LS100)_0 BL_A(S, LS300)_0	BL_B(S, LS100)_0 BL_B(S, LS300)_0	BL_C(S, LS100)_0 BL_C(S, LS300)_0	BL_D(S, LS100)_0 BL_D(S, LS300)_0	BL_G(S, LS100)_0 BL_G(S, LS200)_0 BL_G(S, LS300)_0	BL_G(M, LS50)_0 BL_G(M, LS100)_0 BL_G(M, LS200)_0 BL_G(M, LS300)_0
		BL_A(R, LS100)_0			BL_G(R, LS100)_0 BL_G(R, LS200)_0 BL_G(R, LS300)_0	
X		AS_B(S, LS300)_X AS_B(S, LS200OL/UL))_0				

Luther & Schanze (2008)

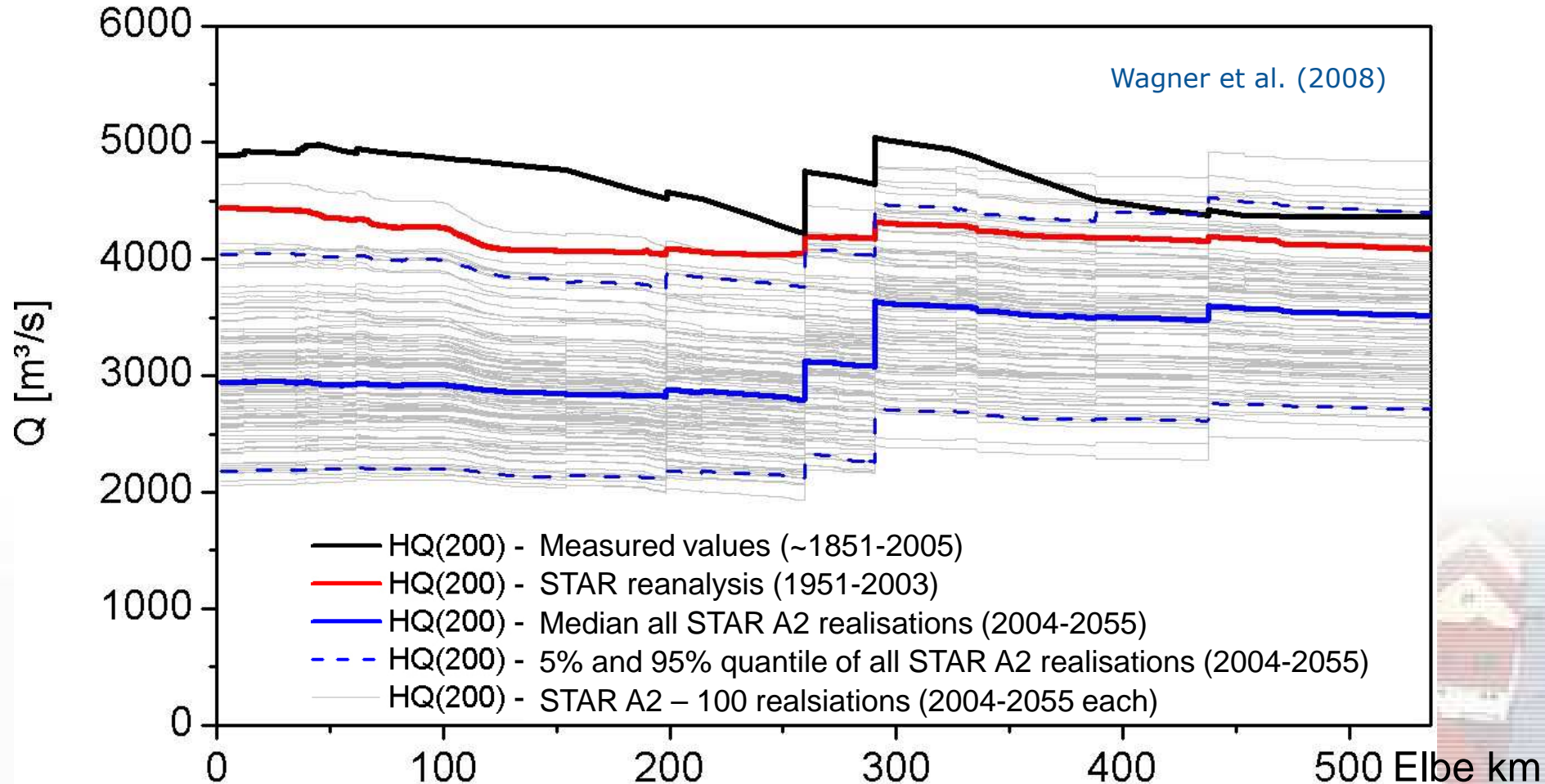
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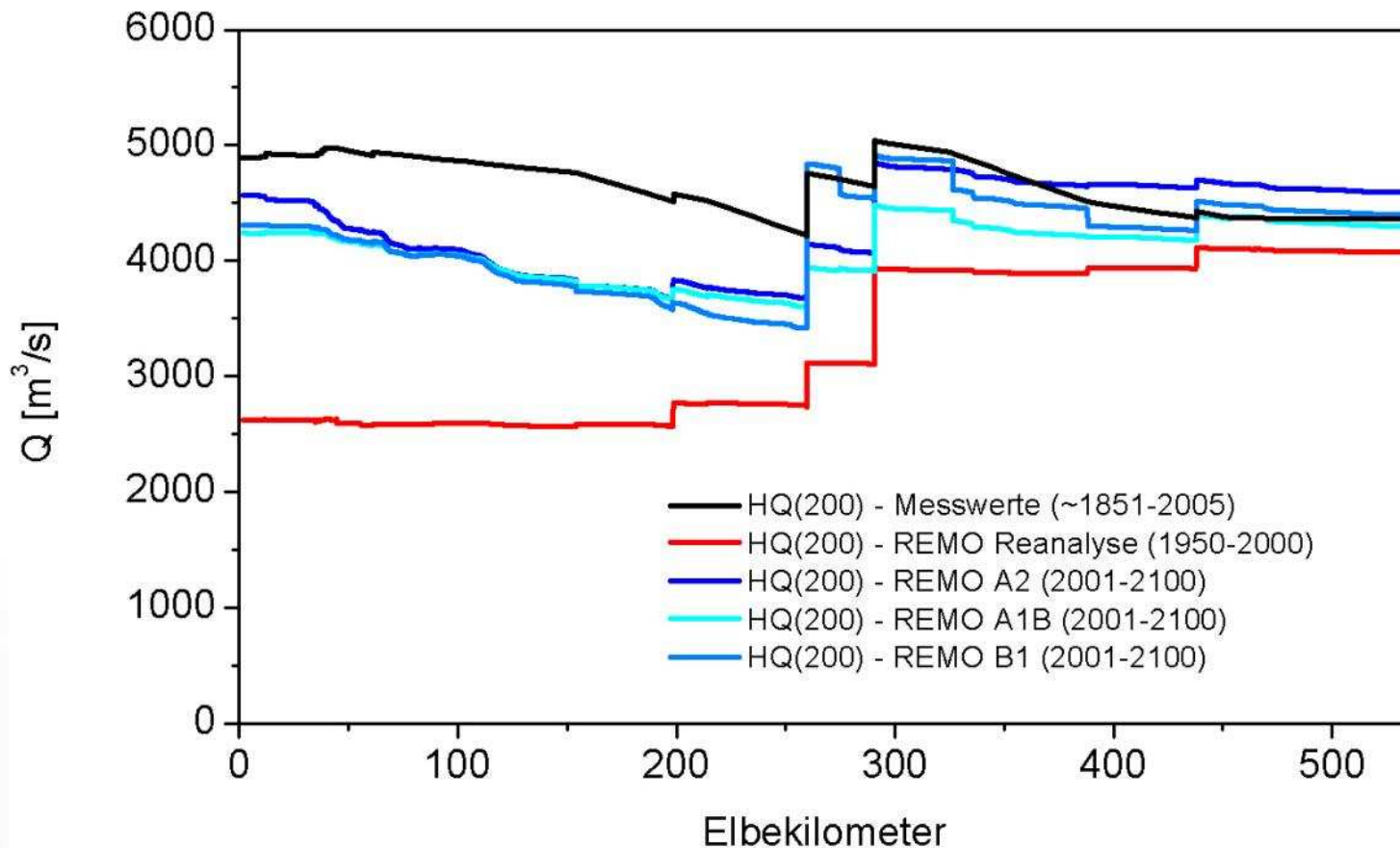
Simulated discharge of the Elbe River

Measurements, Baseline scenario, STAR A2



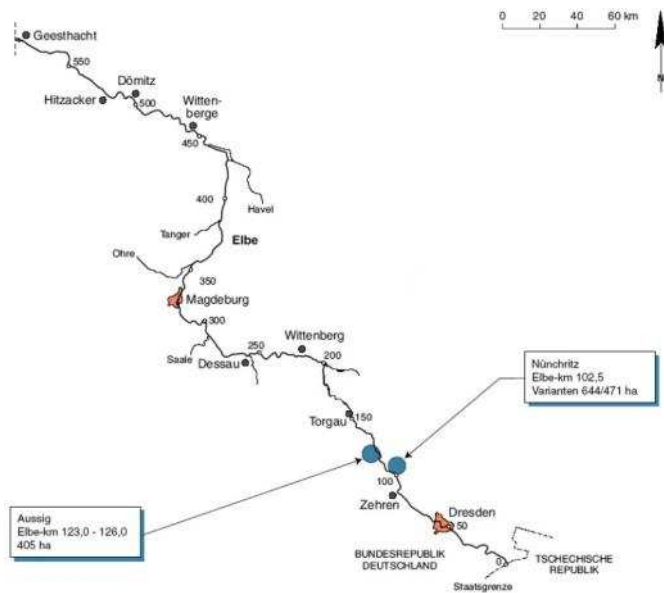
Simulated discharge of the Elbe River

Measurements, Baseline scenario, REMO A1B, A2, B1

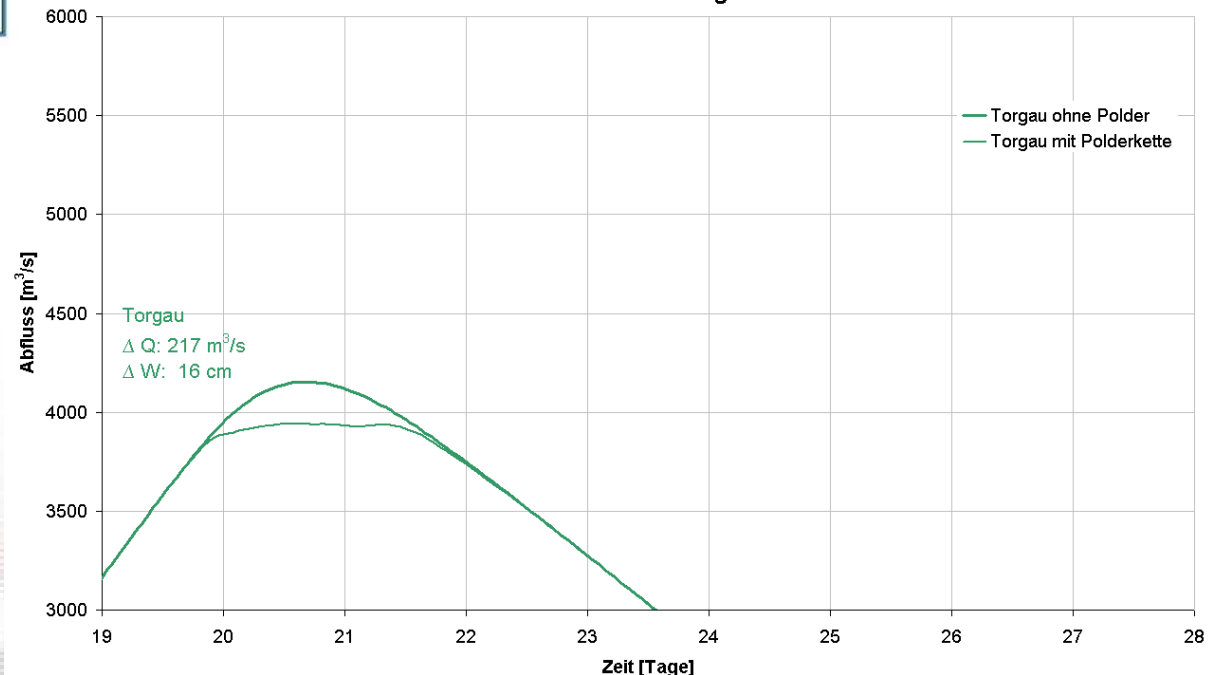


Wagner et al. (2008)

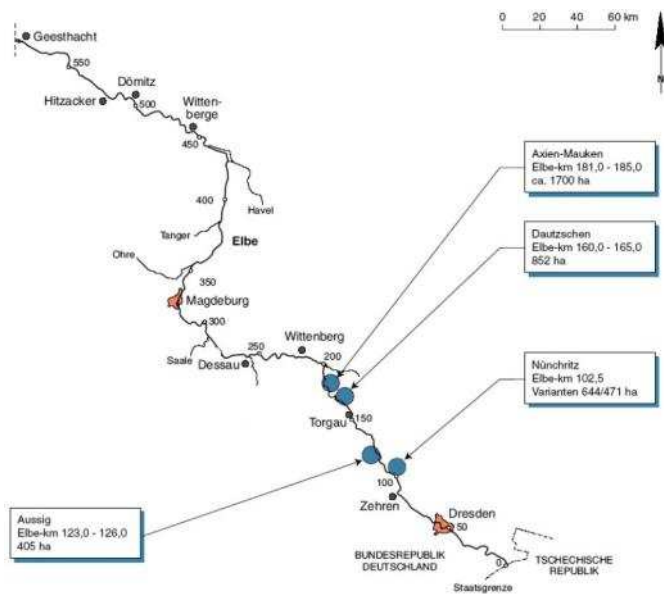
Effects of flood polders



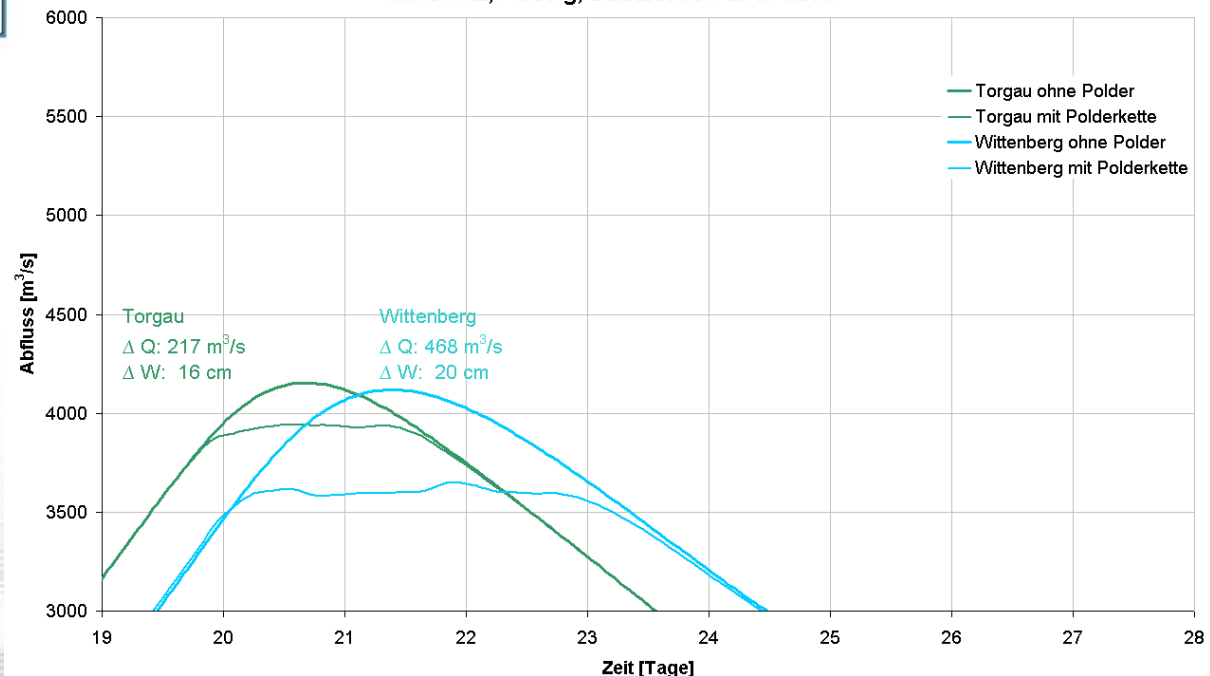
Vergleich Wellenablauf HQ100 unter Berücksichtigung der potenziellen Flutpolder
Nünchritz und Aussig



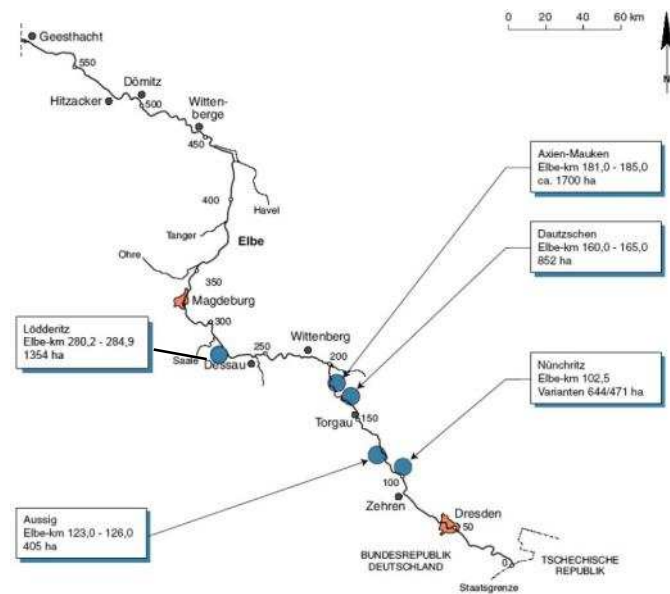
Effects of flood polders



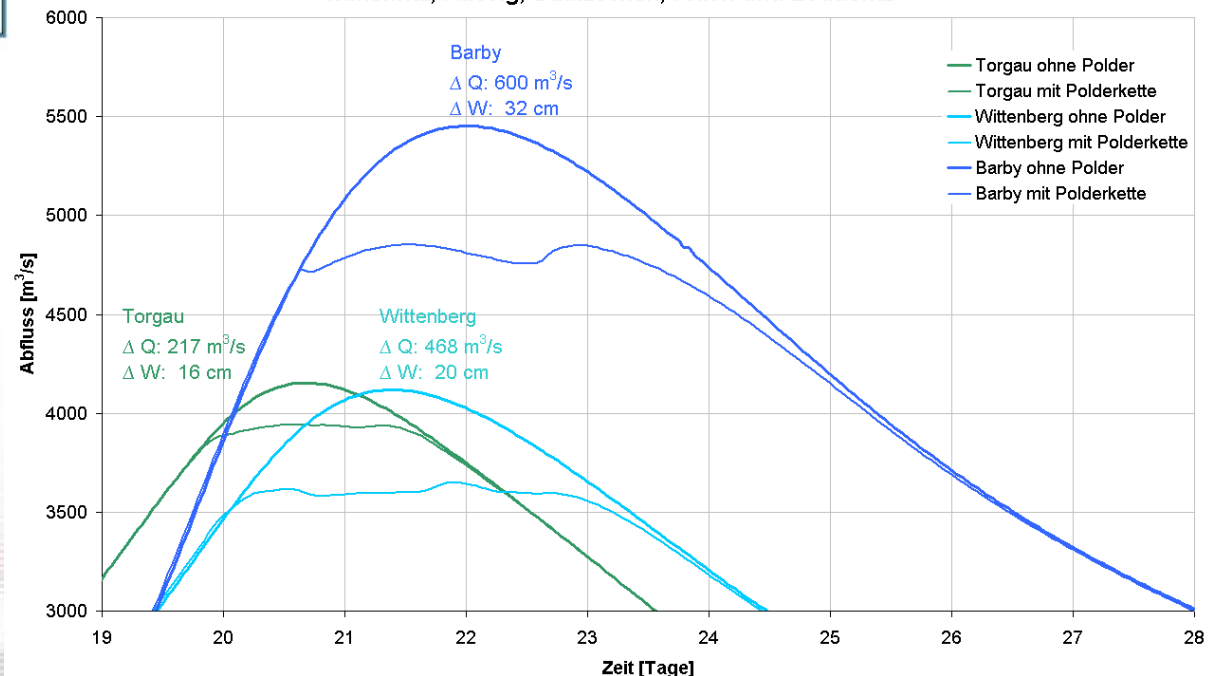
Vergleich Wellenablauf HQ100 unter Berücksichtigung der potenziellen Flutpolder
 Nünchritz, Aussig, Dautzschen und Axien



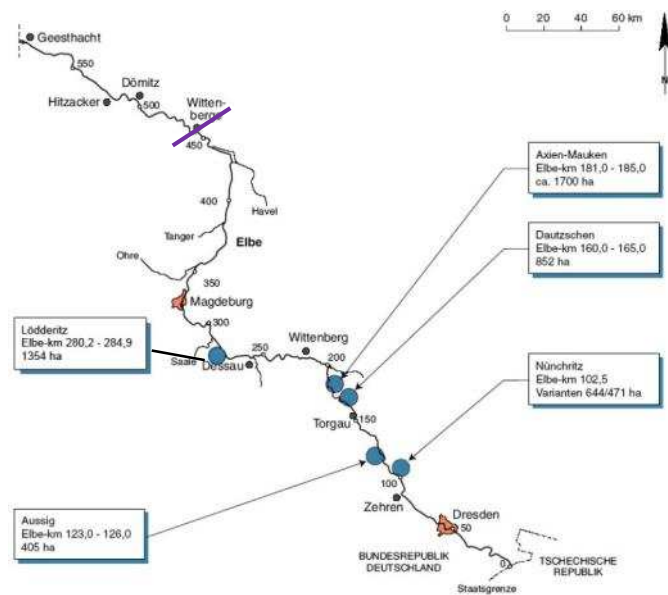
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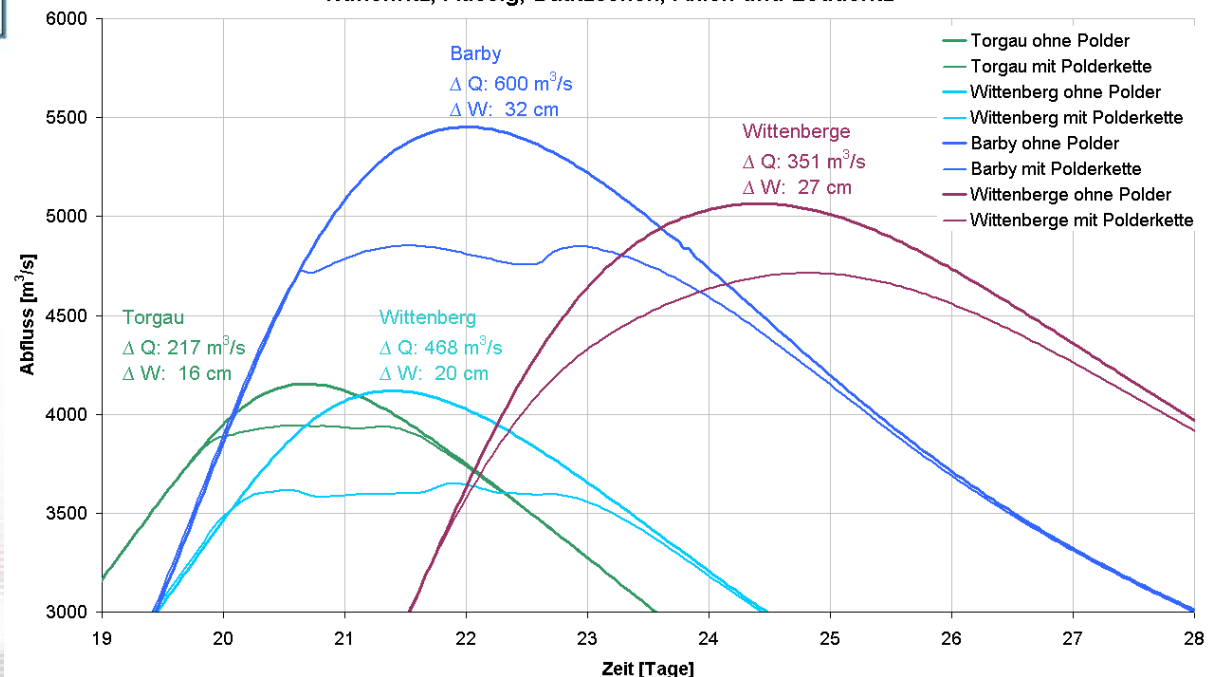
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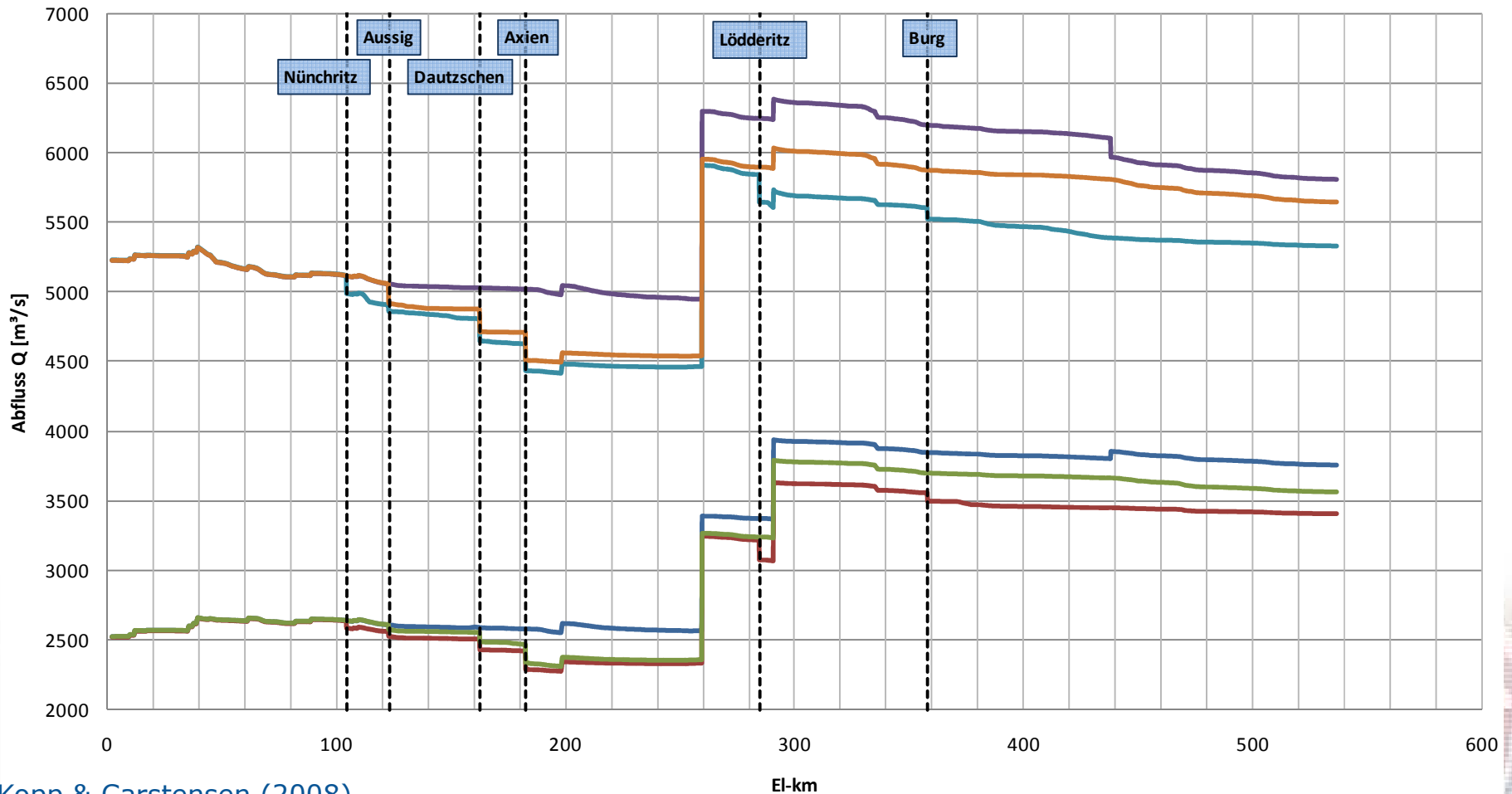
Effects of flood polders



Vergleich Wellenablauf HQ100 unter Berücksichtigung der potenziellen Flutpolder
Nünchritz, Aussig, Dautzschen, Axien und Lödderitz



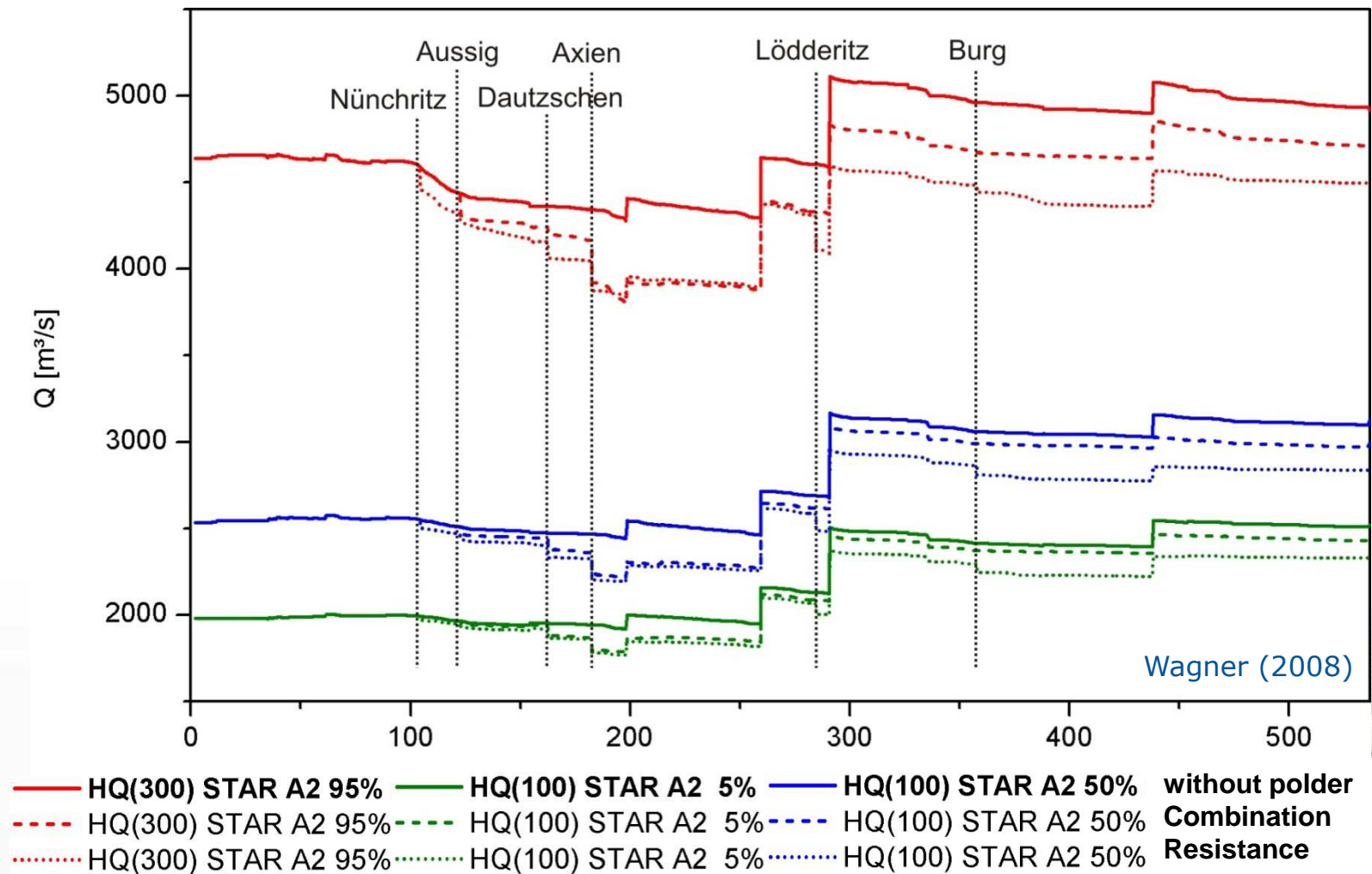
Effects of flood polders



Kopp & Carstensen (2008)

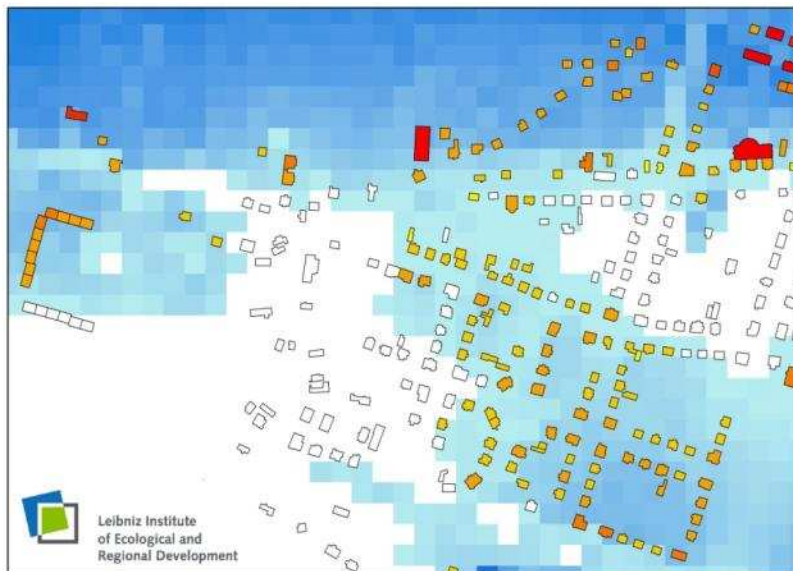
R03_LS_HQ100_stara2_50_Q R03_LS_HQ100_stara2_50_Resi_Q R03_LS_HQ100_stara2_50_Kombi_Q
 R08_LS_HQ300_mess_Q R08_LS_HQ300_mess_Resi_Q R08_LS_HQ300_mess_Kombi_Q

Effects of flood polders



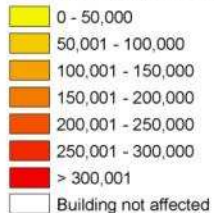
Simulation of flood risks (selection)

Baseline scenarios and scenario B (STAR A2, 2050, 1:200)

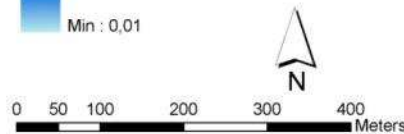


Legend

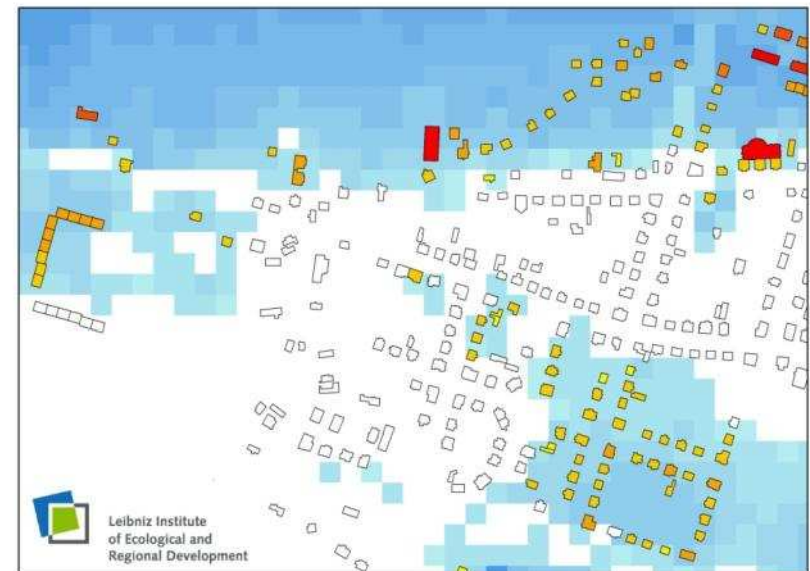
Building damage costs [€]



Waterlevel above ground [m]

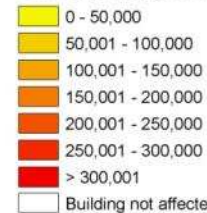


Processing/Map: Dr. Marco Neubert, IOER, 2008

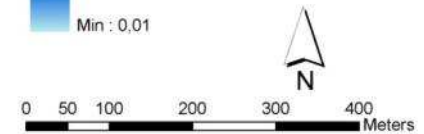


Legend

Building damage costs [€]



Waterlevel above ground [m]



Processing/Map: Dr. Marco Neubert, IOER, 2008

Neubert, Naumann & Deilmann (2008)

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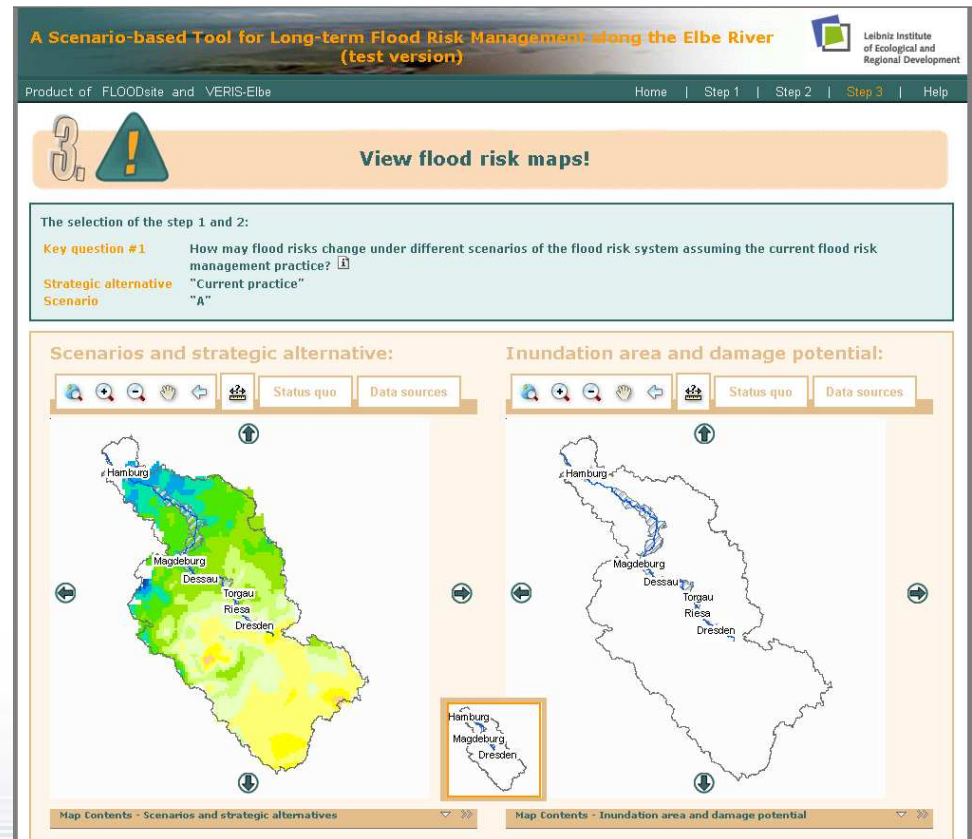
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Conclusions

- Statements on the change of the flood regime based on current climate change projections involve **considerable uncertainty** (need for follow up)
- Calculations with STAR indicate a **slight decrease of the flood hazard**; but: a few runs and particularly results with REMO show also an increase
- **Flood risks** however **could still increase** in both cases due to land-use change (running analyses)
- **Requests for enhanced flood protection measures** at the German Elbe River **cannot be reasoned** by the results of this study; instead current concepts should be followed as far as no other outcomes are available
- Proposal: Design levels based on return periods should be amended or substituted by **socially accepted design discharges**
- Measures for **mitigating the flood vulnerability** should be **enhanced**
- The study provides consistent outcomes **across all borders of the German federal states**; a **relation to work carried out in the Czech Republic** would be **valuable**.

Outlook: Scenario and webbased decision support tool



Petroschka, Schanze, Luther, Walz (2008)

Thank you for your attention.



Discussion with

Mr. Michael Wagner, Institute for Hydrology and Meteorology (IHM),
Technische Universität Dresden (TUD)

Dr. Dirk Carstensen, Institute for Hydraulic Engineering and Technical
Hydromechanics (IWD), Technische Universität Dresden (TUD)