Workshop: Decision making in disaster risk reduction across different levels
Bonn, 10 – 11 December 2014

Flood Risk Management Strategies

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Strengthening and Redesigning European Flood Risk Practices Towards Appropriate and Resilient Flood Risk Governance Arrangements

Anatomy of flood risk

Floods on the rise

Flood risk management and EU Floods Directive implementation

Flood risk management strategies

Flood risk governance arrangements

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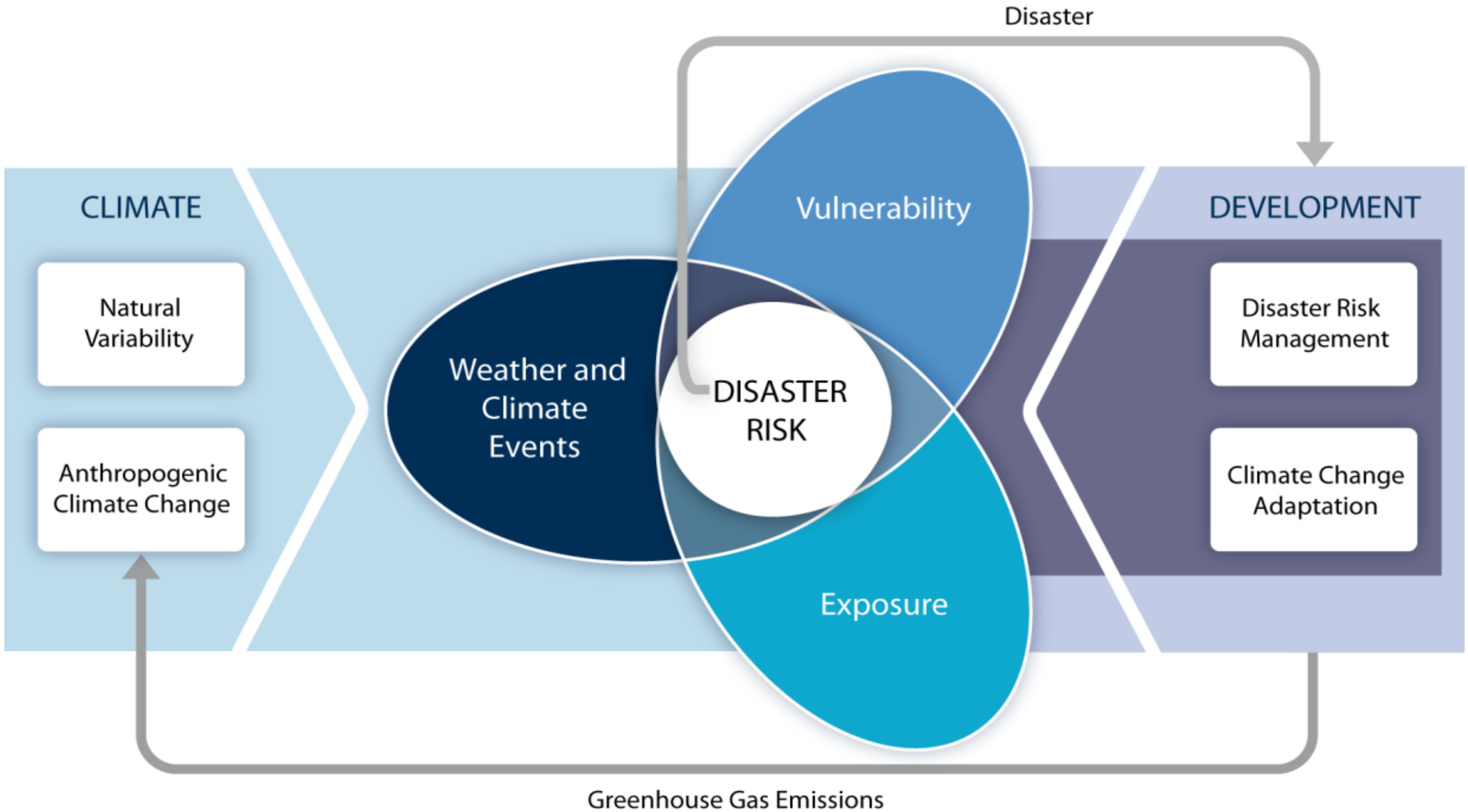
Abundance of water

Blessing		Curse

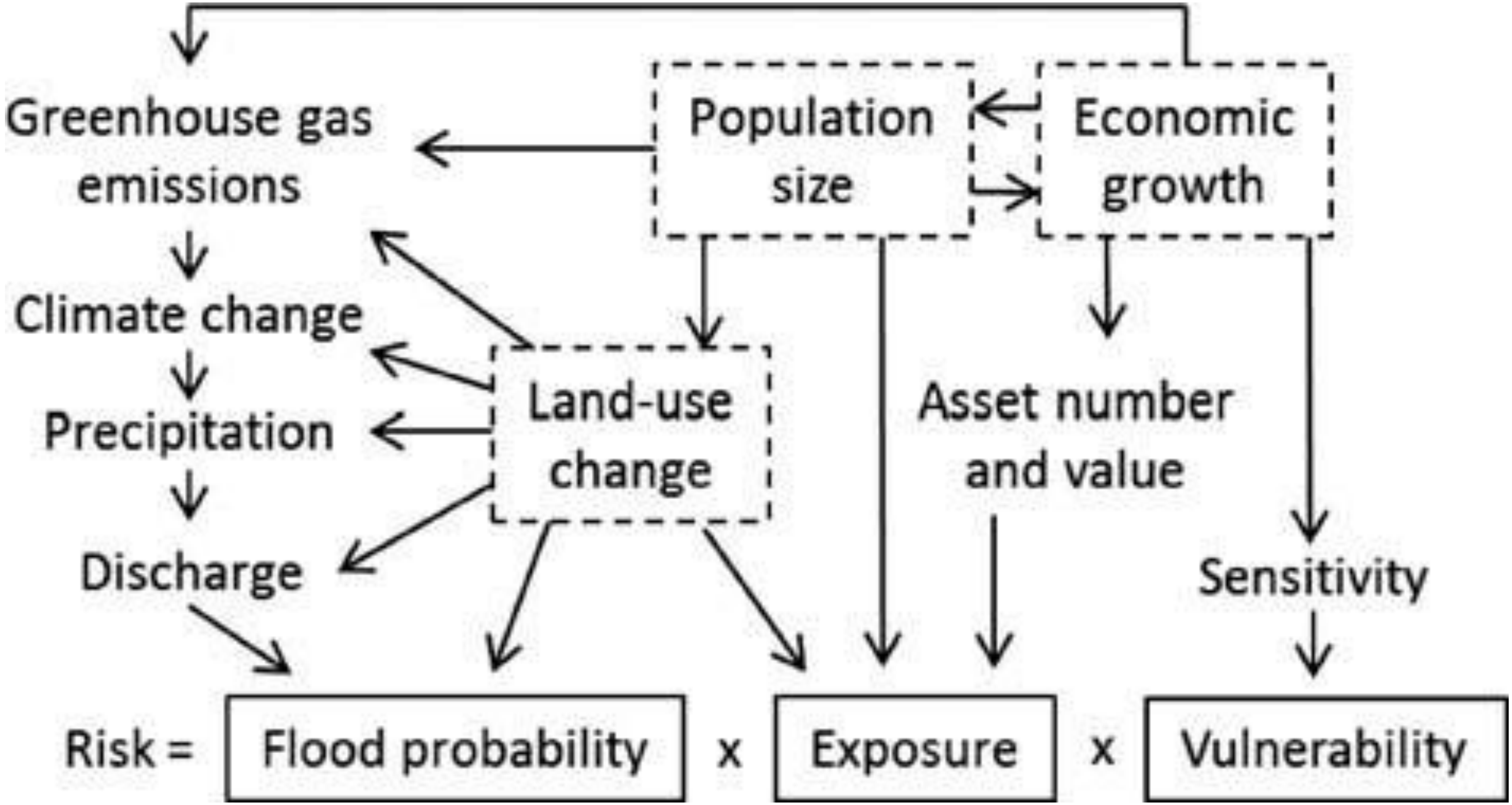
Increasing vulnerability, exposure, or severity and frequency of climate events increases disaster risk



*Disaster risk management and climate change adaptation can influence the degree to which **extreme events translate into impacts** and **disasters***

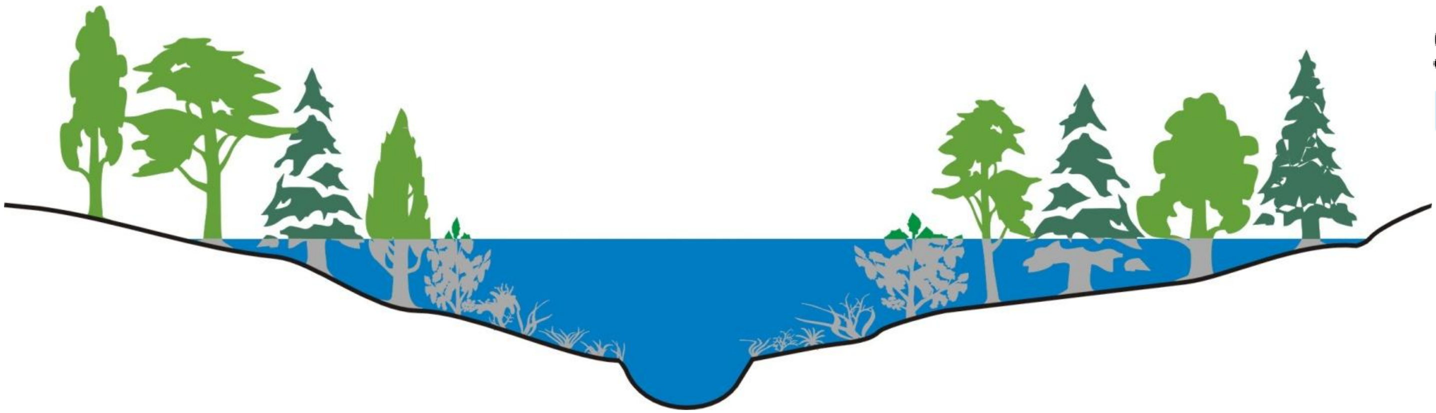
(IPCC SREX, 2012 www.ipcc.ch)

Source: Kundzewicz, Z. W.; Kanae, S.; Seneviratne, S. I.; et al., (2014) Flood risk and climate change: global and regional perspectives. Hydrol. Sci. J. 59(1), 1-28.

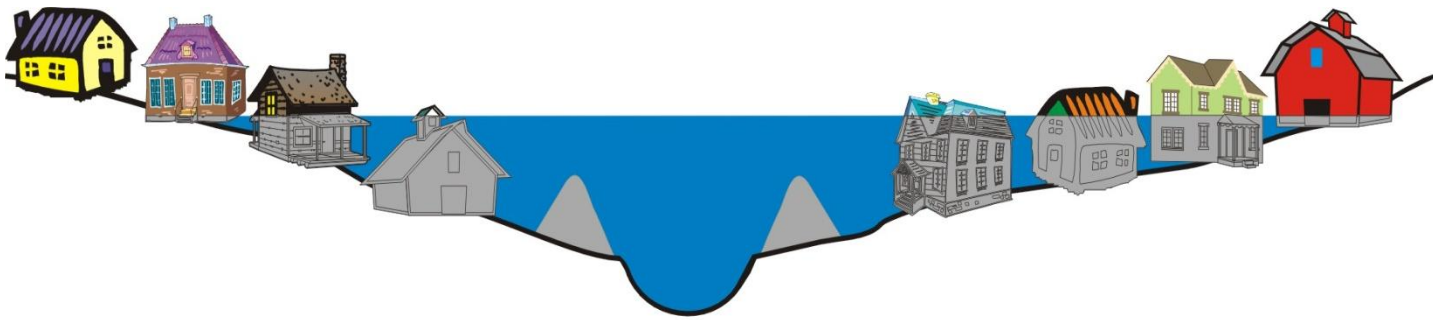


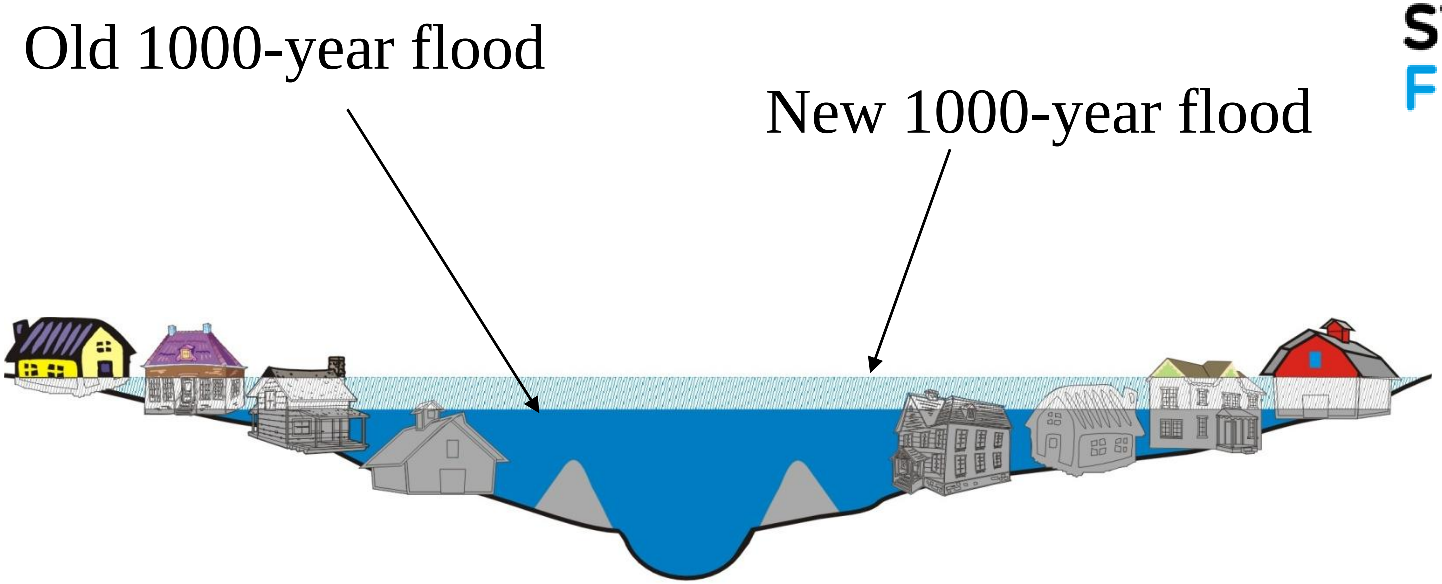
Changes in flood risk

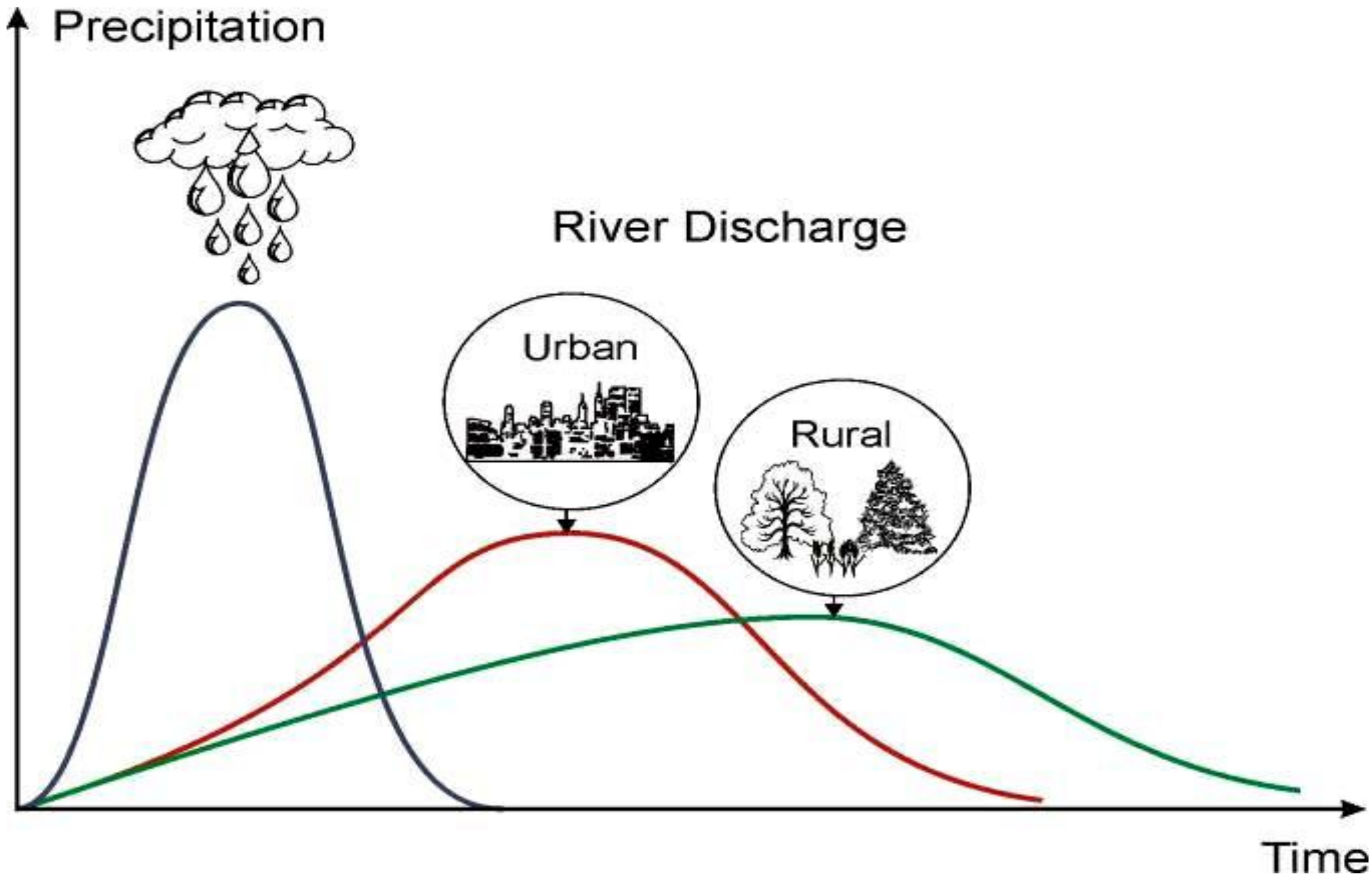
- Changes in **climate and hydrological systems** (heavy precipitation, land-use change, urbanization, deforestation, river regulation – channel straightening, embankments)
- Changes in **socio-economic** systems: (increasing exposure – flood plain development, growing wealth in flood-prone areas)



1000-year flood




Old 1000-year flood
New 1000-year flood



In comparison to rural areas, the peak flow corresponding to a given precipitation is higher and faster in urban areas.

Water holding capacity of the atmosphere

Clausius-Clapeyron equation

$$de_s(T) / e_s(T) = L\, dT / R\, T^2$$

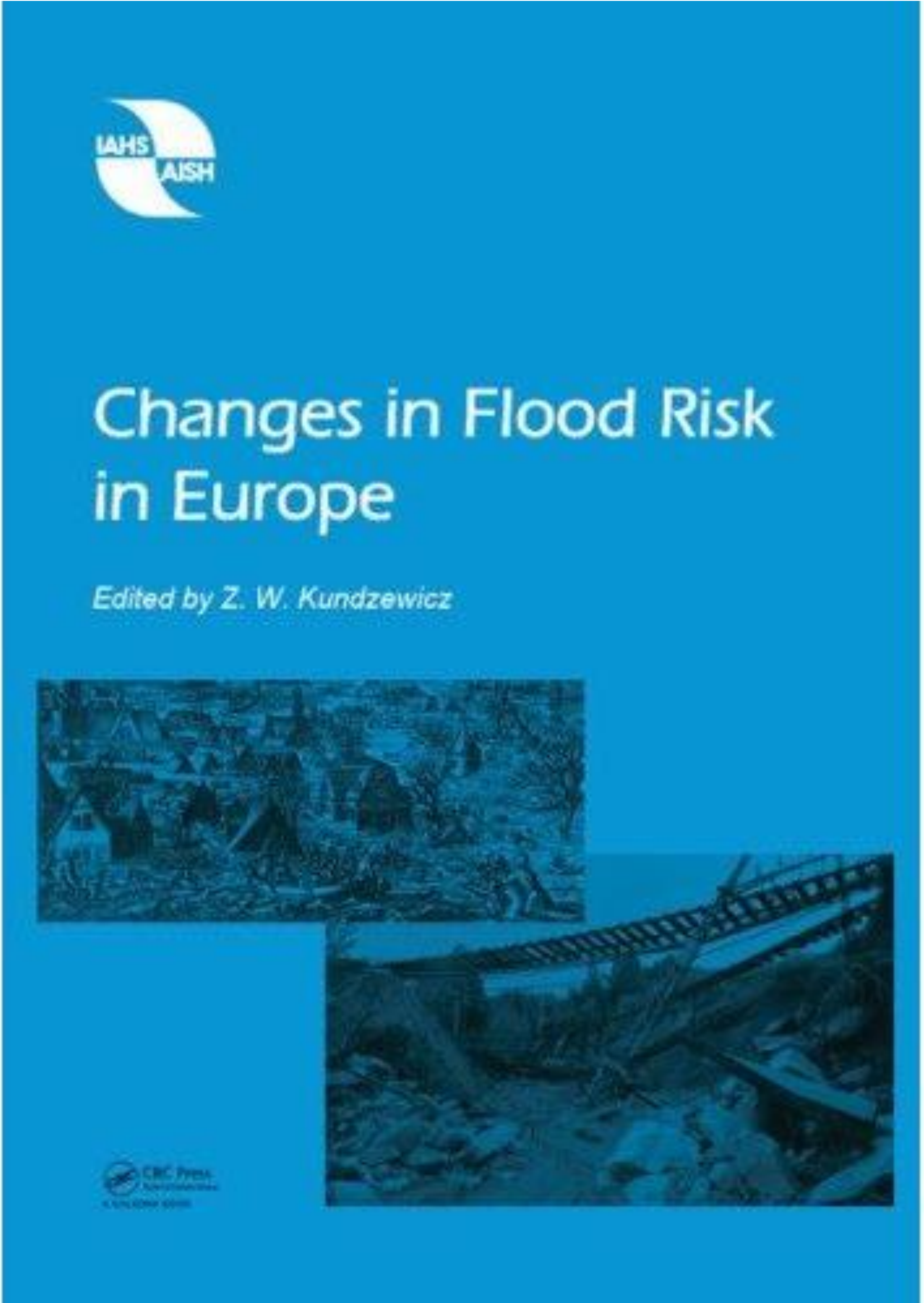
where $e_s(T)$ is the saturation vapor pressure at temperature T,

L is the latent heat of vaporization,

and R is the gas constant.

T grows $e_s(T)$ grows

1°C 6-7%



STAR FLOOD

IAHS Press / CRC Press (Taylor & Francis)

IAHS Special Publication 10

(*April 2012*)

516 + xvi pages

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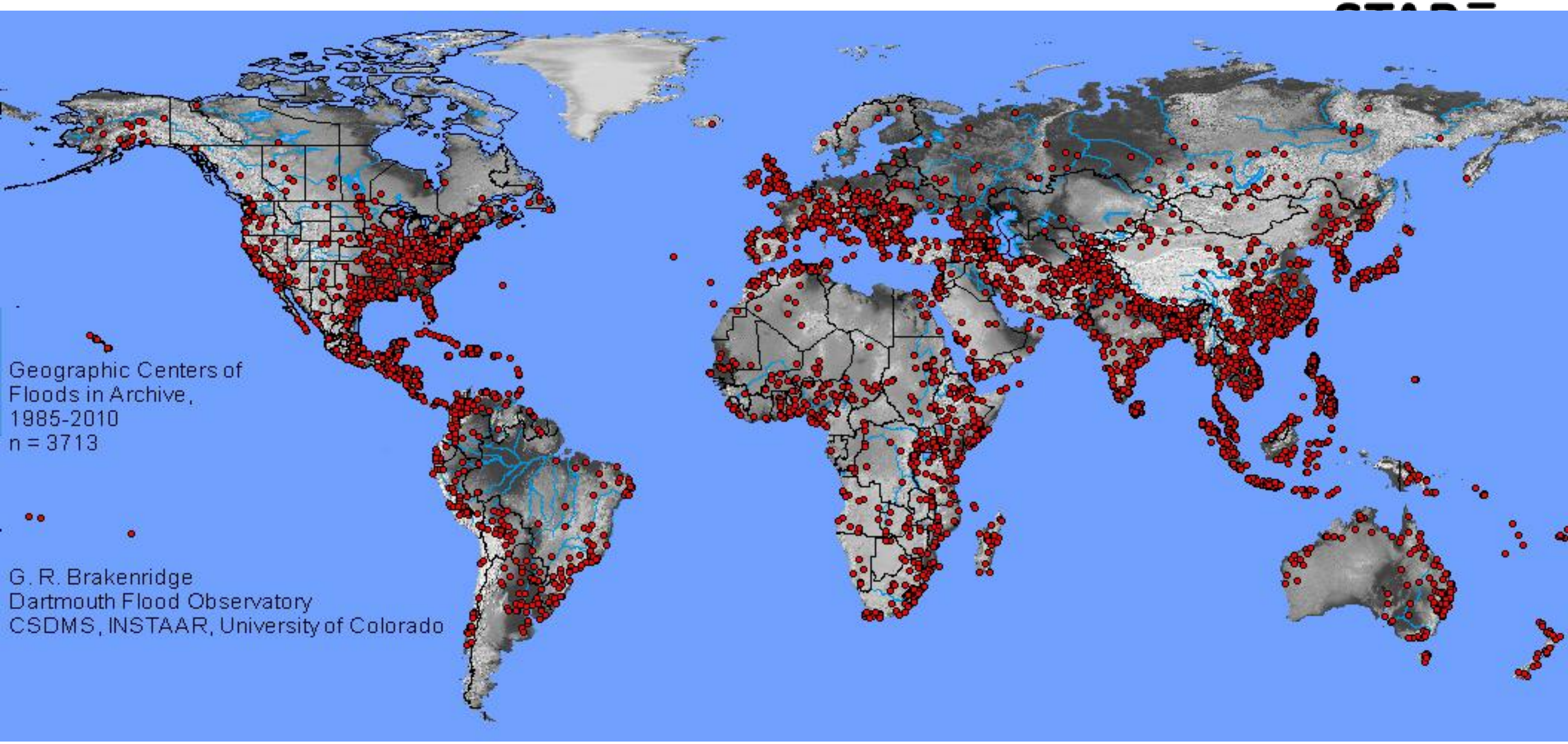
Geographic Centers of
Floods in Archive,
1985-2010
n = 3713
G. R. Brakenridge
Dartmouth Flood Observatory
CSDMS, INSTAAR, University of Colorado

Exposure to floods Source: Kundzewicz, Z. W.; Kanae, S.; Seneviratne, S. I.; et al., (2014) Flood risk and climate change: global and regional perspectives. Hydrol. Sci. J. 59(1), 1-28.

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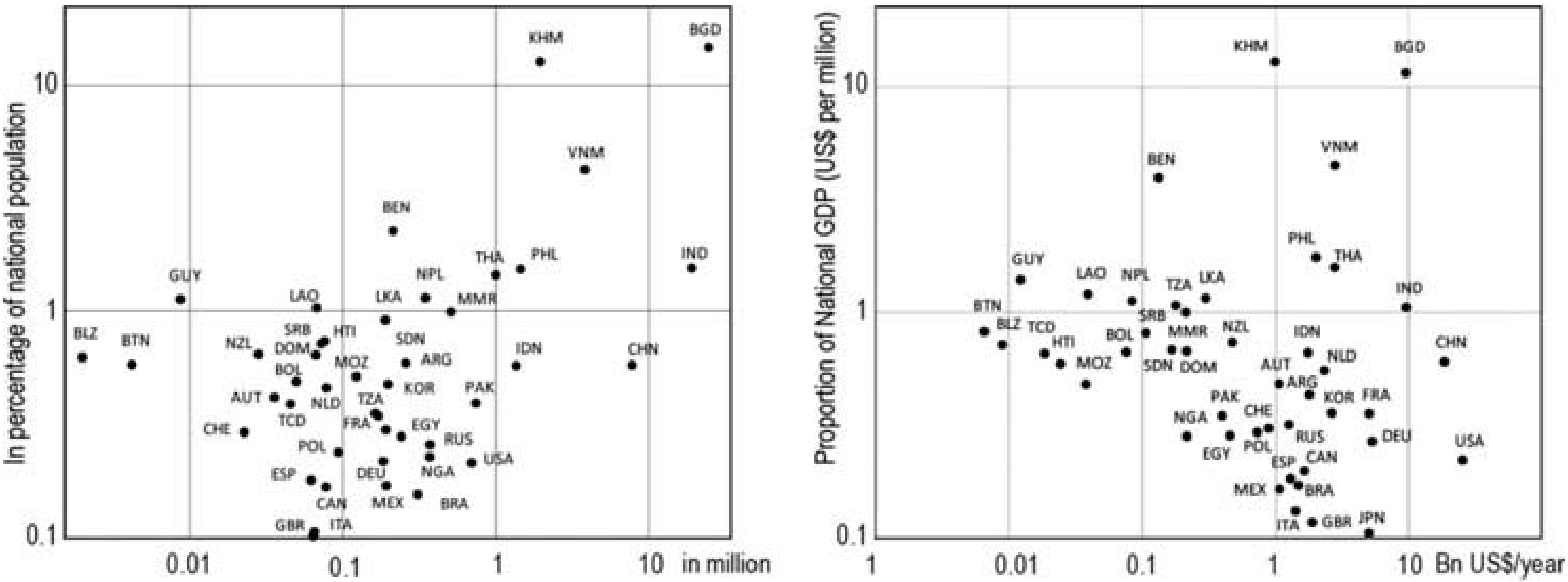
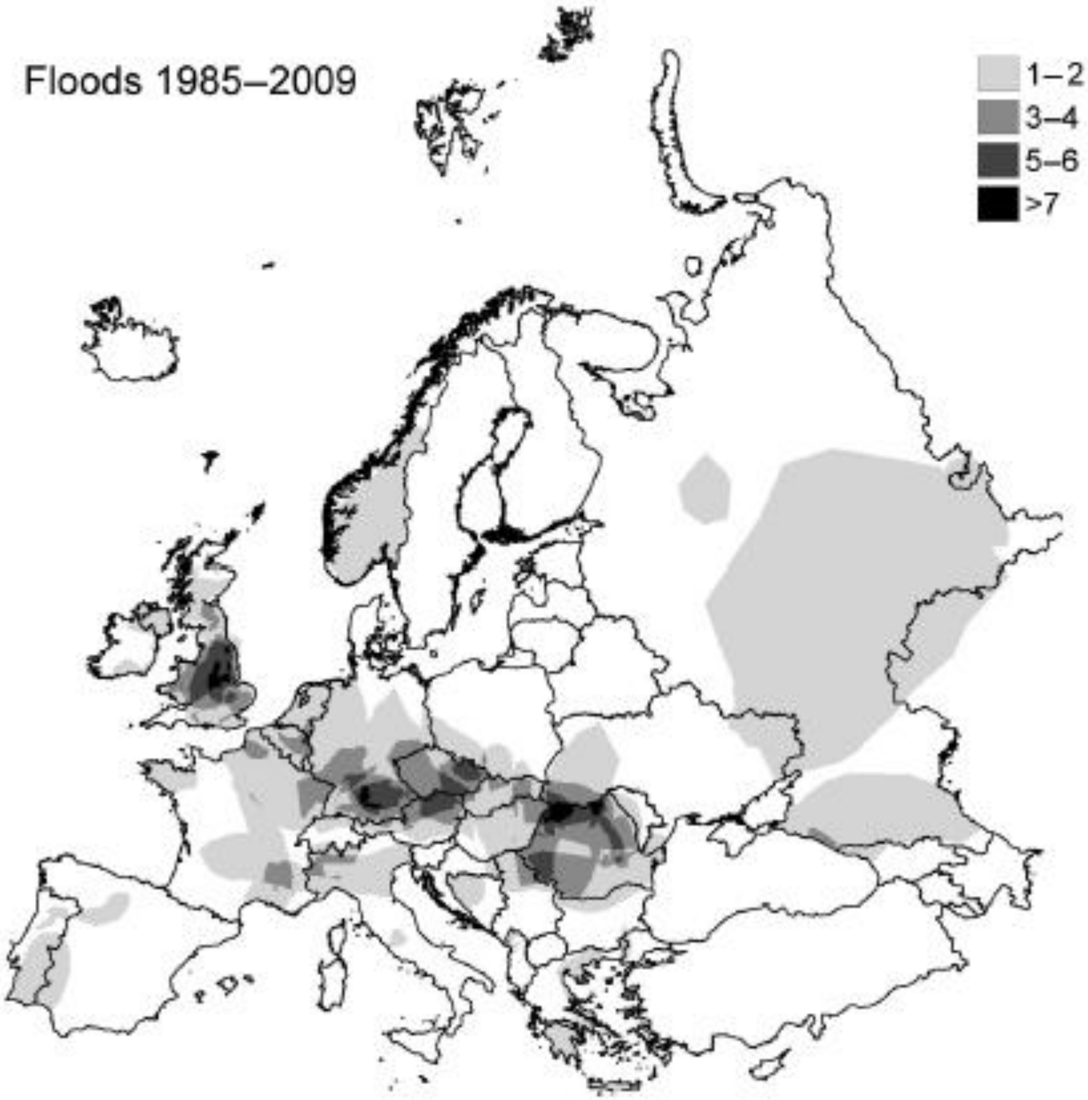


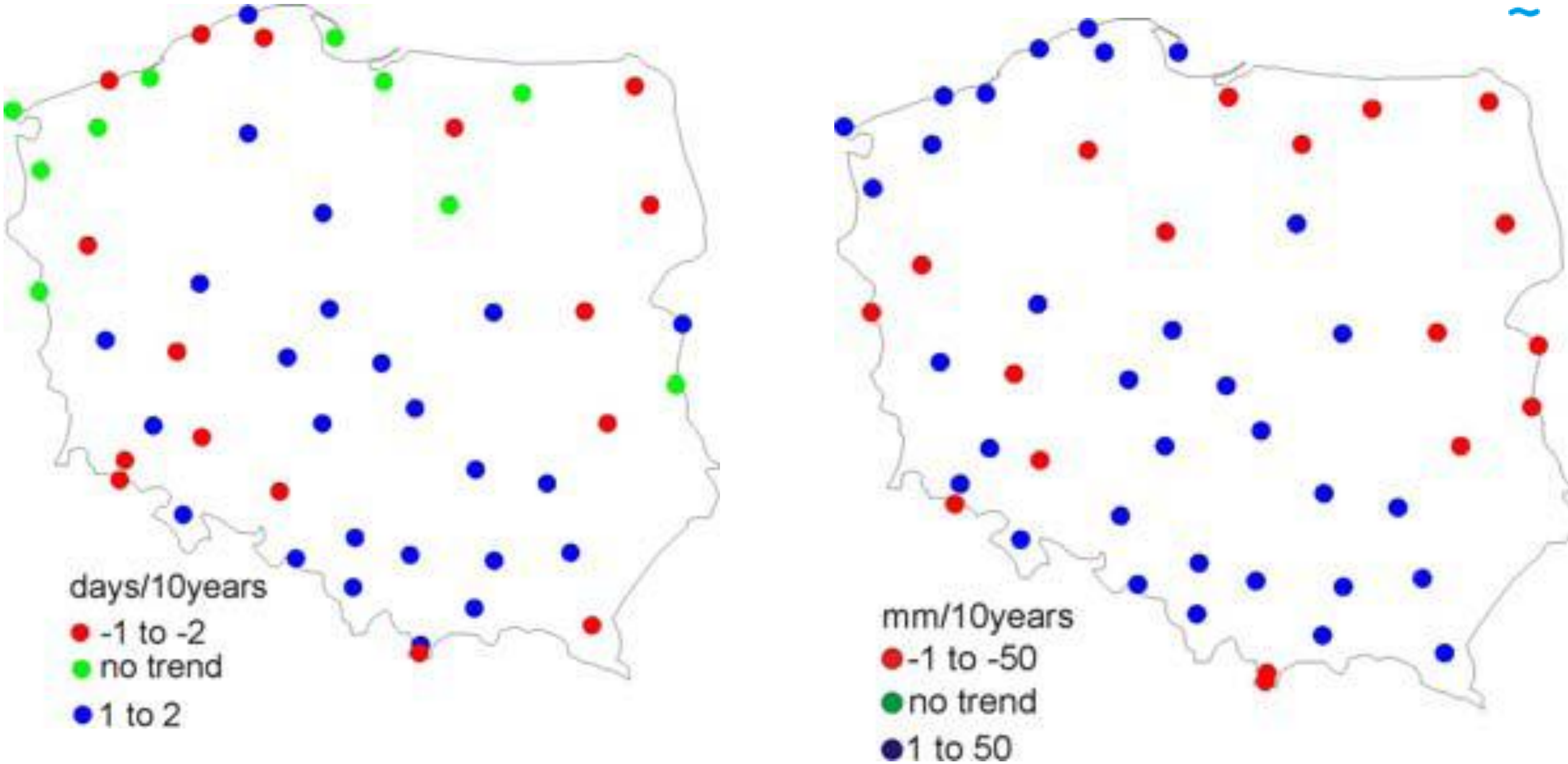
ISO3	Country
ARG	Argentina
AUT	Austria
BGD	Bangladesh
BLZ	Belize
BEN	Benin
BTN	Bhutan
BOL	Bolivia
BRA	Brazil
KHM	Cambodia
DOM	Dominican Republic
EGY	Egypt
FRA	France
DEU	Germany
GUY	Guyana
HTI	Haiti
IND	India
IDN	Indonesia
ITA	Italy
MEX	Mexico
MOZ	Mozambique
MMR	Myanmar
NPL	Nepal
NLD	Netherlands
NZL	New Zealand
NGA	Nigeria
PAK	Pakistan
PHL	Philippines
POL	Poland
KOR	Republic of Korea
RUS	Russian Federation
SRB	Serbia
ESP	Spain
LKA	Sri Lanka
SDN	Sudan
CHE	Switzerland
THA	Thailand
GBR	U.K.
TZA	United Rep. of Tanzania
USA	United States of America
VNM	Viet Nam

Source: Kundzewicz, Z.; Pińskwar, I; Brakenridge, R. (2013) Large floods in Europe, 1985-2009. HYDROL. SCI. J. 58(3), 736-736.

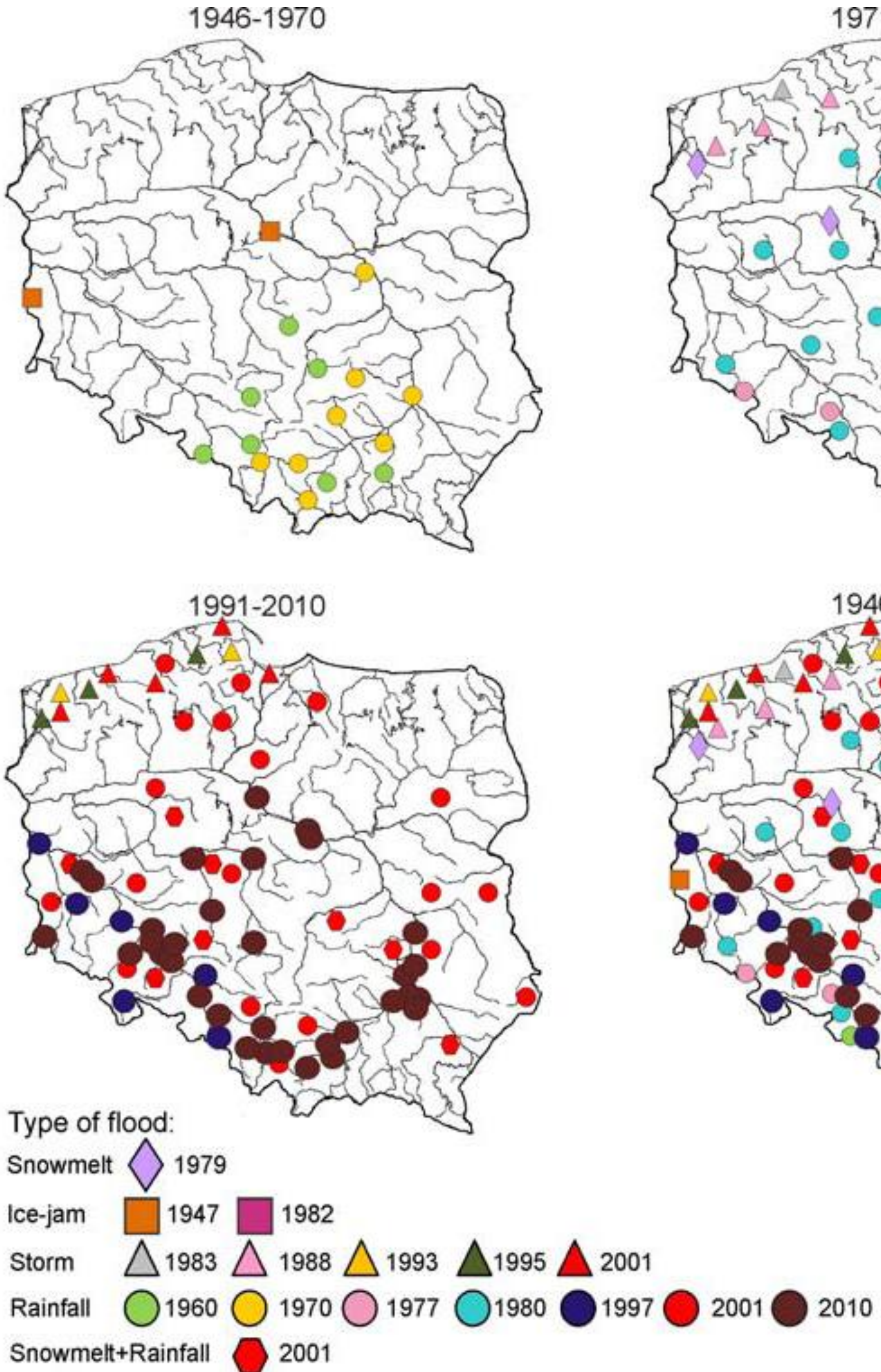


17 Floods in Poland

ZBIGNIEW W. KUNDZEWICZ[1,2], ANDRZEJ DOBROWOLSKI[3],
HALINA LORENC[4], TADEUSZ NIEDŹWIEDŹ[5], IWONA PIŃSKWAR[1] &
PIOTR KOWALCZAK[1]



Trend in number of days with precipitation in excess of 30 mm, and (b) trend in maximum 5-day precipitation, 1971–2002 (after Lorenc & Olecka, 2006).



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Catastrophic floods of regional extent in Poland:

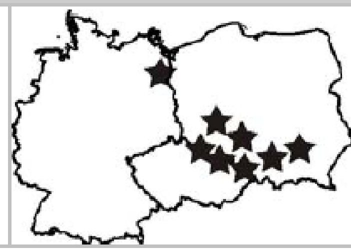
from 1946 to 1970; from 1971 to 1990; from 1991 to 2010;

from 1946 to 2010.

Source:

Kundzewicz et al. (2012)

Central Europe (July 1997)

Czech Republic, Poland, Germany	Regions: Hradec Králové, Moravian-Silesian (Cze), Malopolska, Silesia, Opole, Lower Silesia, Lubuskie (Pol), West Pomerania, Brandenburg (Ger). Rivers: Odra/Oder and its tributaries, Vistula and its tributaries	
Mechanism	Heavy rain	
Material damage	5.9 B US$ (MR) 5.597 B US$ (EM-DAT)	
Infl. adj. damage	2.758 – 8.340 B US$	
Fatalities	118 (MR) 113 (EM-DAT) 100 (NOAA/NCDC)	

The heavy and long-lasting rain in the period 4–10 July caused destructive flooding. precipitation between 5 and 9 July was recorded in Lysa Hora, Czech Republic (585 Polish drainage basin of the Odra, the highest precipitation amounts were recorded i and Międzygórze (455 mm). Then, a few days later, from 15 to 23 July, another serie occurred. The highest precipitation from 17 to 22 July was recorded in the drainage b Bystrzyca and Kaczawa (tributaries to the Odra; up to 120–300 mm) and of the river to 150–200 mm), while in the Klodzko valley the precipitation totals reached 100–2(spell in July 1997 took place basically in the drainage basin of the River Vistula (Ku

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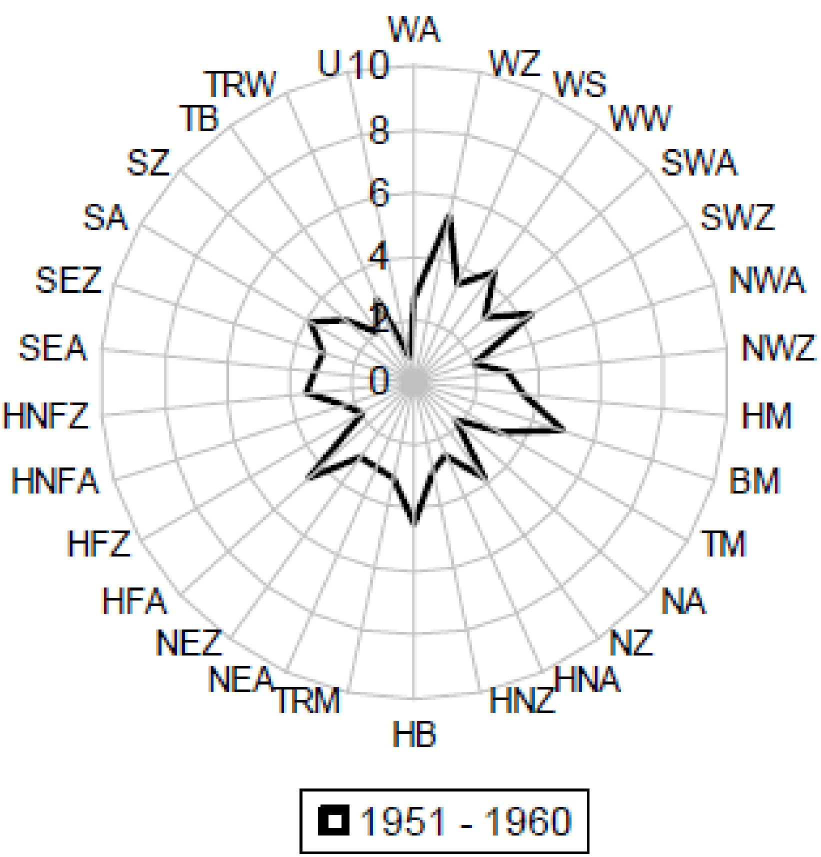
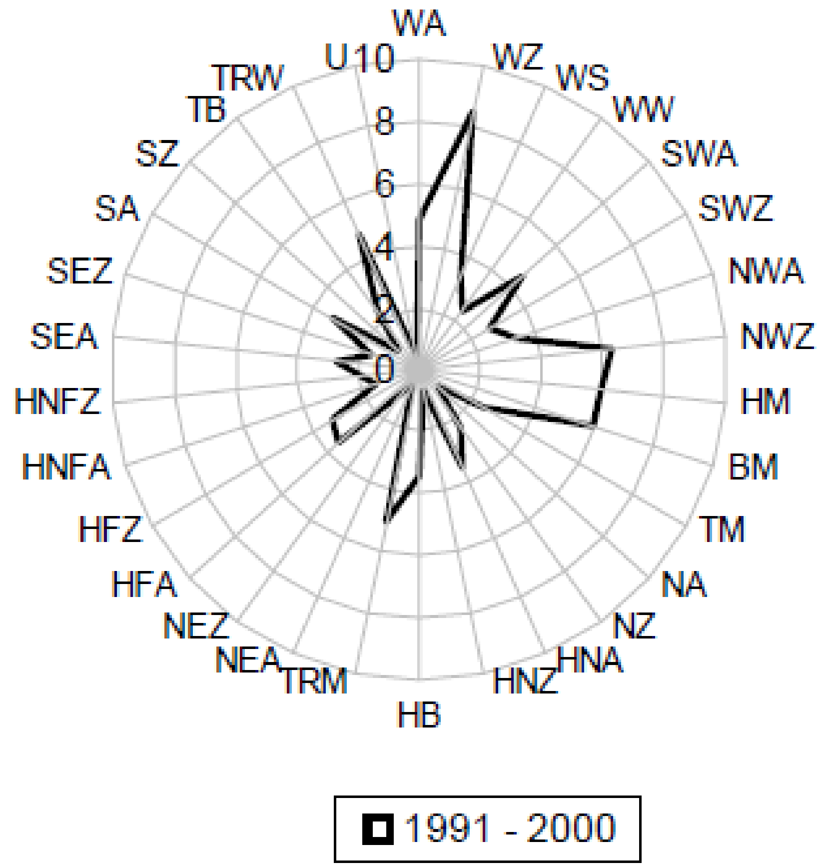
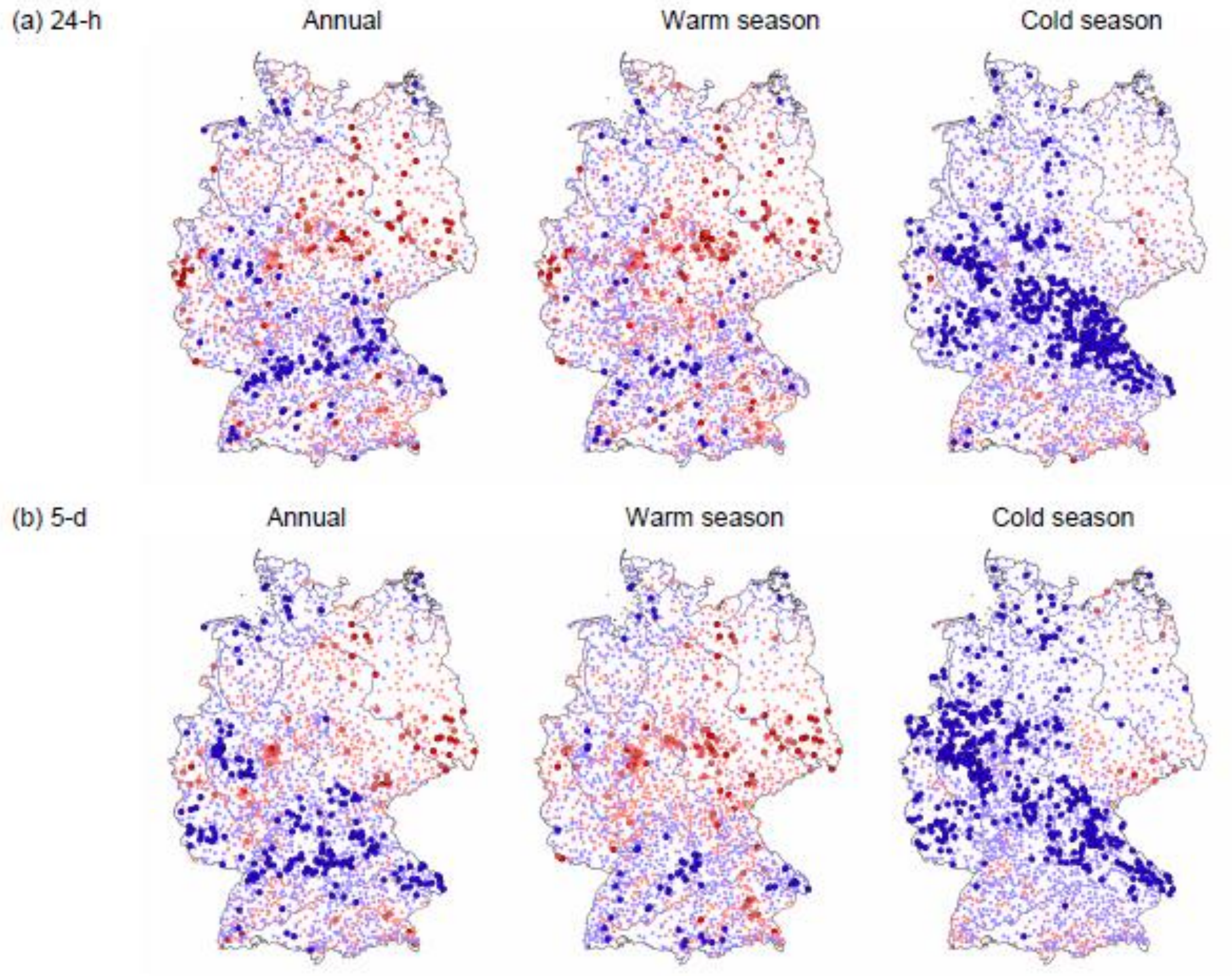
Source	Country	River	Station	Date	Max. disch. ($m^3 s^{-1}$)
IAHS	Poland	Skawa	Wadowice	08.07.1997	725
		Nysa Klodzka	Skorogoszcz	10.07.1997	1200
		Odra	Gozdowice	31.07.1997	3180
	Germany	Odra	Hohensaaten Finow	31.07.1997	3000

In summer 1997, the flood was the theme of cover stories of many issues of weekly magazines in Poland.

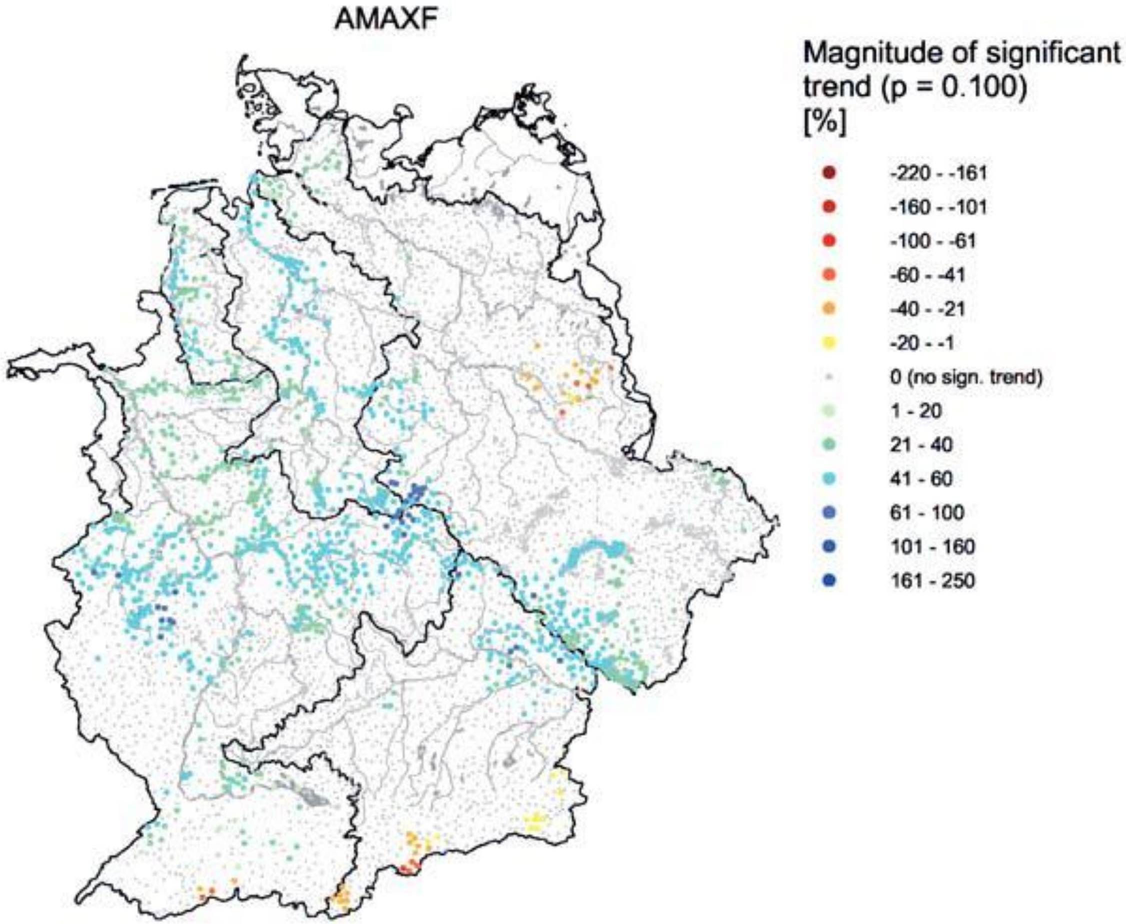
Mean duration (in days) of circulation patterns for the winter season of the decades 1951–1960 (left) and 1991–2000 (right). (Hattermann et al., 2012; based on Merz)







Trends in (a) 24-hour maximum and (b) 5-day maximum precipitation.
(Hattermann et al., 2012)



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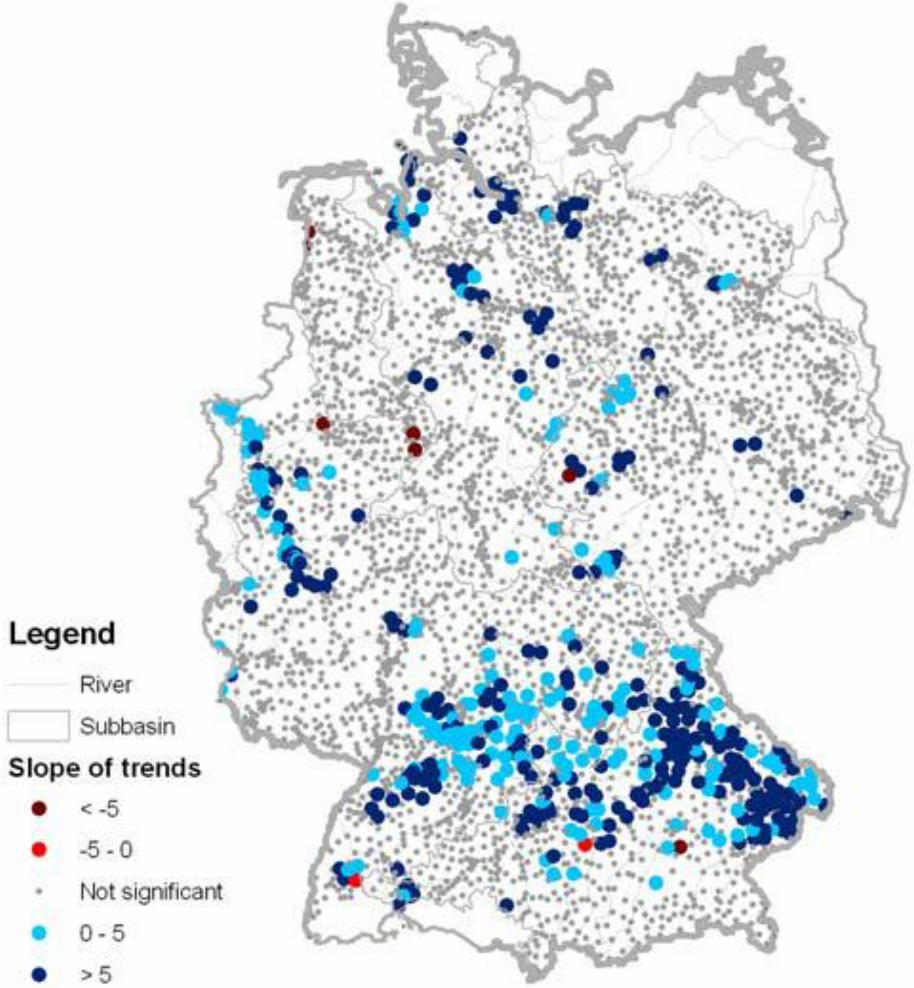
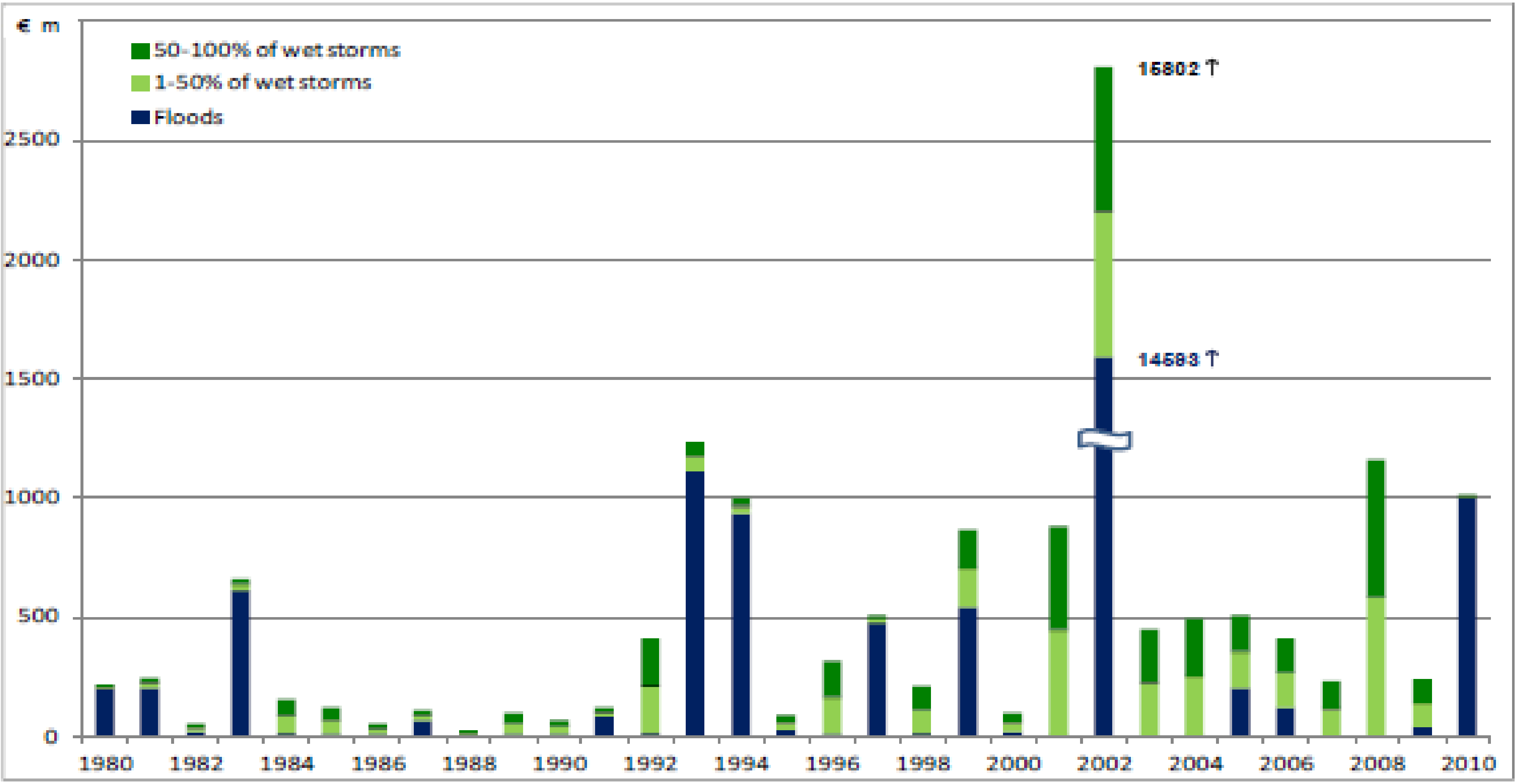
Trends in annual maxima of river discharges in the five big German river basins, including their upstream parts in neighbouring countries in the period 1951–2003, estimated with the help of the SWIM model (based on Huang et al., 2010).



Trend slope of the material damages over Germany, adjusted for inflation, in the period 1951–2003 (Hattermann et al., 2012).



Losses from floods and wet storms for 1980–2010 in Germany (in 2010 values). It is assumed, for simplicity, that water component is responsible for half of in damage caused by wet storms (the other half being wind, hail, etc.) – Note: the height of the bar for 2002 is not consistent with the axis (Source: Kron et al., 2012).

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Kundzewicz, Z. W. (2013) Floods: lessons about early warning systems. In: European Environment Agency (EEA) Late lessons from early warnings: science, precaution, innovation. Vol. II. Part B Emerging lessons from ecosystems. Ch. 15, 347-368, EEA Report, Copenhagen, No. 1/2013.

Two interpretations of the notion of early warning:

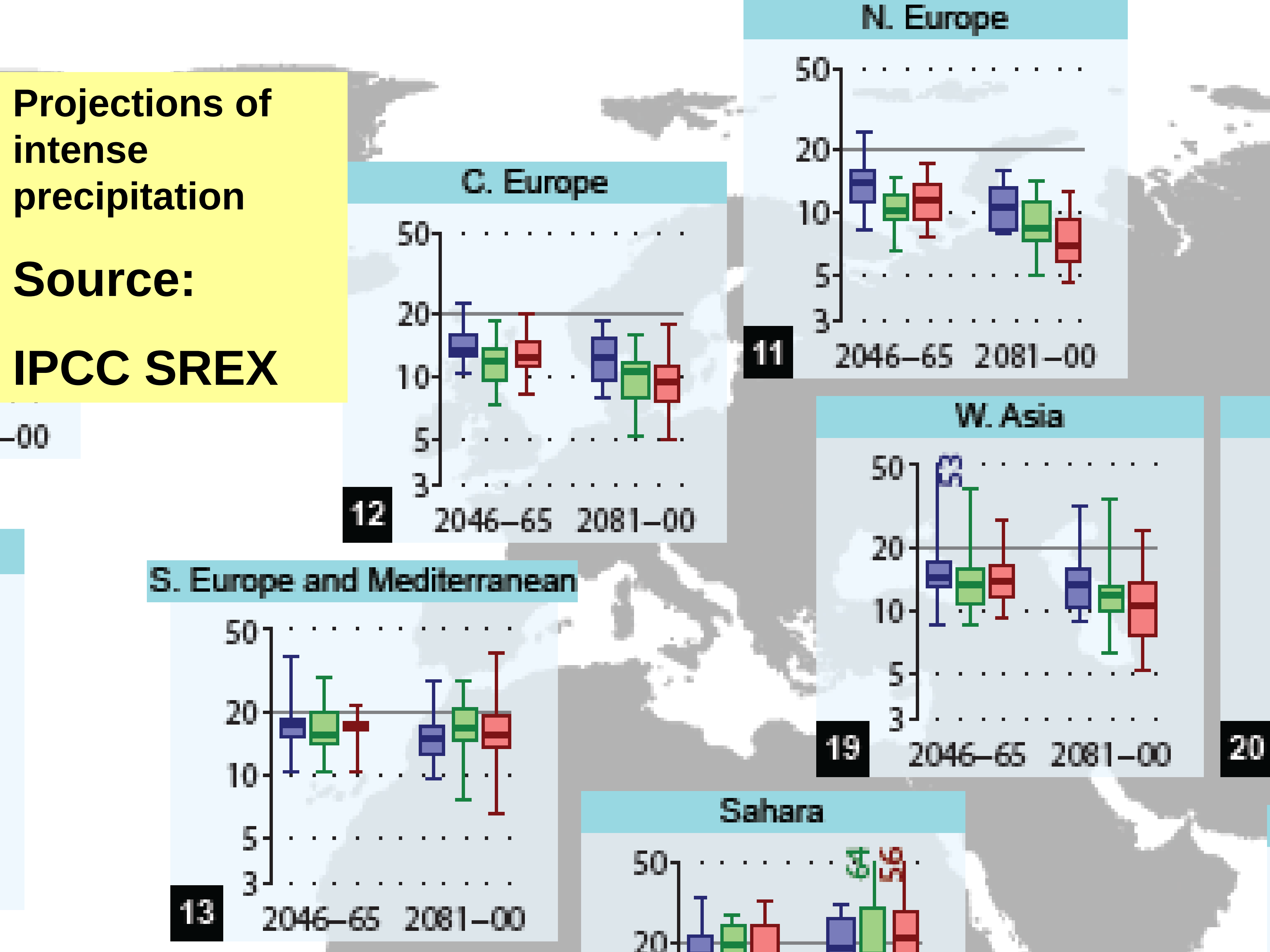
1) Notion referring to a **short-term** flood preparedness system - ‘flood warning’ is specific timely information, based on a reliable forecast, that a **high water level is expected to occur at a particular location at a particular time**.

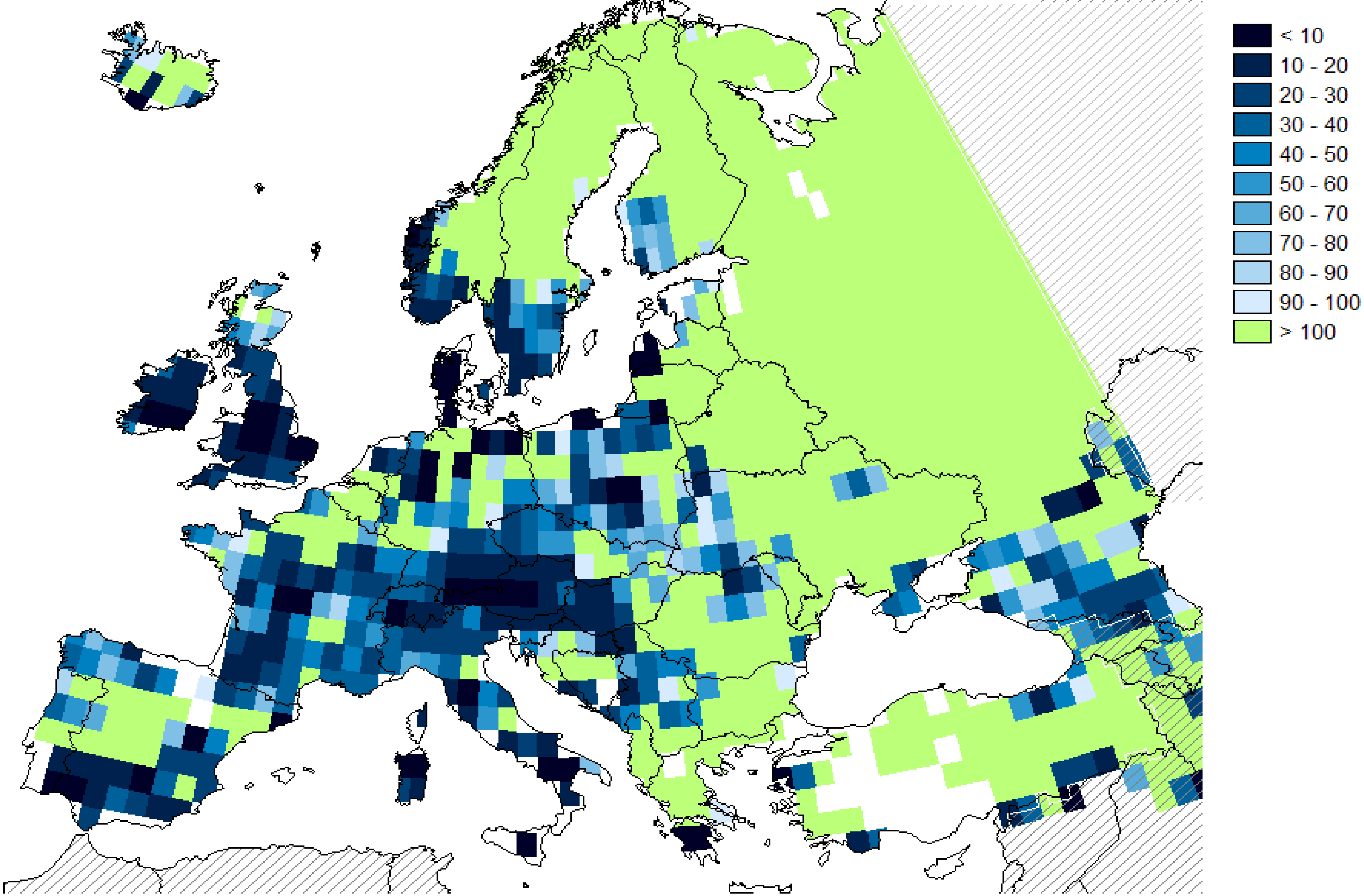
2) Notion referring to a **long-term** flood preparedness system - ‘early warning’ is a **‘prediction’ of change in flood frequency**, e.g. statement that the present (i.e. corresponding to some reference period, such as the climate standard normal, 1961-1990) 100-year flood (river flow exceeded once in 100 years; on average) may occur more frequently, e.g. becoming a 50-year flood in some defined future time horizon.

Projections of intense precipitation

Source:

IPCC SREX





Projections of changes in 100-year flood. Kundzewicz, Z. W., Lugeri, N., Dankers, R., Hirabayashi, Y., Döll, P., Pińskwar, I., Dysarz, T., Hochrainer, S., Matczak, P. (2010) Assessing river flood risk and adaptation in Europe—review of projections for the future. *Mitig. Adapt. Strategies for Global Change* 15(7), 641 – 656.

Feyen et al. (2009)

Assumption: Future flood protection level depends on the country's GDP (protection up to 100-year, 75-year, and 50-year flood for countries with GDP above 110%; in the range from 55% to 110%; and below 55% of the average EU 27 GDP level, respectively).

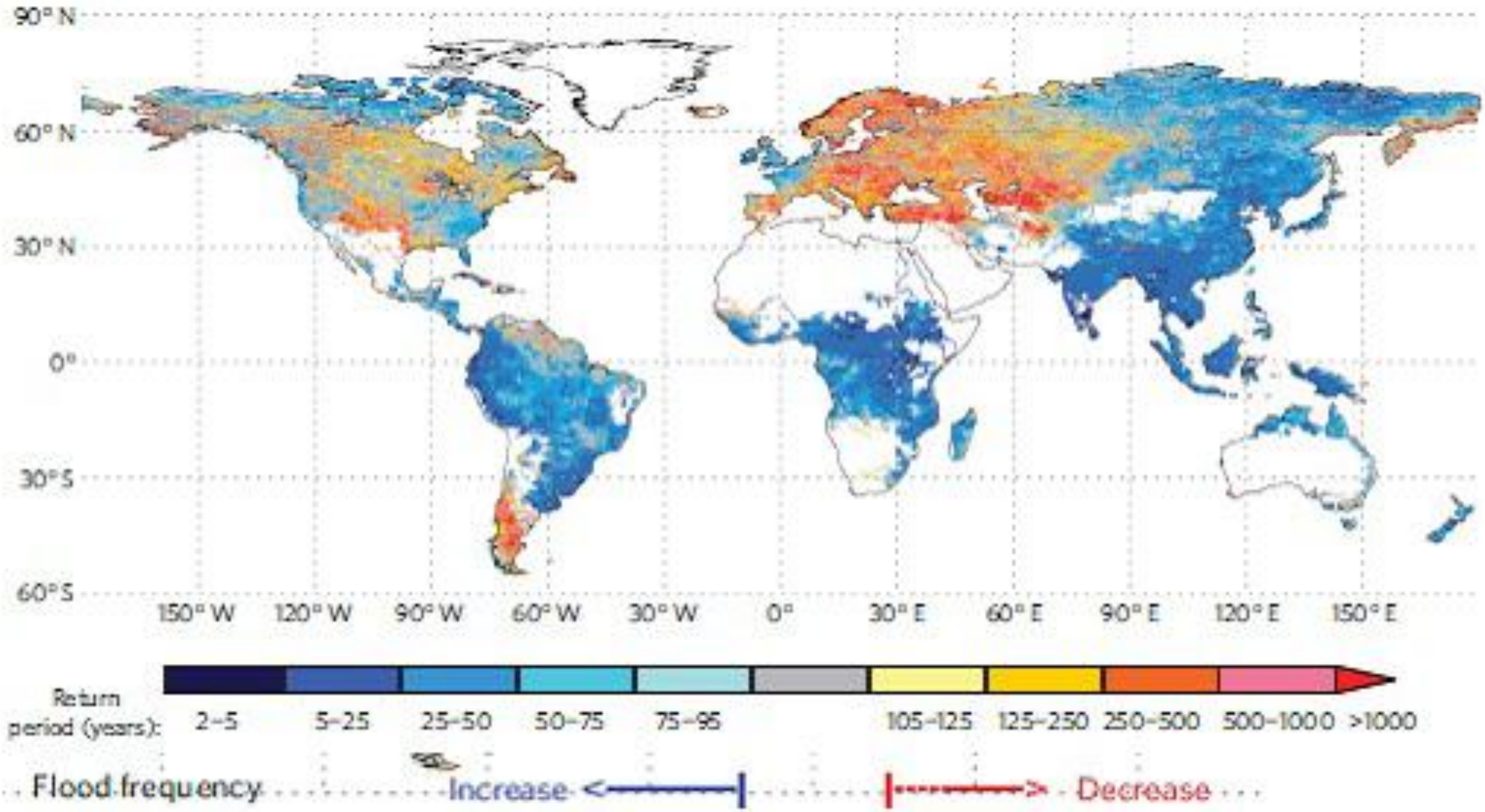
Present expected annual damage of 6.5 billion Euro may rise to 18 billion Euro in 2071–2100 under SRES A2 scenario

In five countries the expected annual damage in the future horizon was projected to exceed **1** billion Euro, with highest value being **4** billion Euro. Among 27 countries of the EU in 25 there were non-zero flood damages in the control period. Out of these 25 countries, **increase (up to 80%) is projected in 20** and **decrease (even by 85%) is projected in five countries**.

European Union Floods Directive

„Firstly, the **scale and frequency of floods** are **likely to increase in the future** as a result of **climate change**, **inappropriate river management** and **construction in flood risk areas**.

Second, there has been a marked **increase in vulnerability** due to the **number of people and economic assets located in flood risk zones**."



Changes in frequency of 100-year river discharge
(Hirabayashi et al., 2013)

Better accommodation of extremes of present climate variability augurs better for the future climate, subject to change.

Since uncertainty in projections for the future is large, precautionary attitude should be taken when planning adaptation.

Despite the uncertainty, water managers in a few countries have begun to consider the implications of climate change explicitly in flood management.

In the **UK** and in some German federal states (e.g. **Bavaria)** design flood magnitudes have been increased by **20%** and **15%**, respectively, to reflect the possible effects of climate change.

Measures to cope with the increase of the design discharge for the Rhine in the Netherlands from **15 000 to 16 000 m^3/s** must be implemented by **2015** and it is planned to increase the design discharge to **18 000 m^3/s** in the longer term due to climate change.

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Flood protection and management strategies modify either <u>**flood waters**</u>, or <u>**susceptibility** to flood damage</u> and <u>**impact** of flooding</u>.

Protect

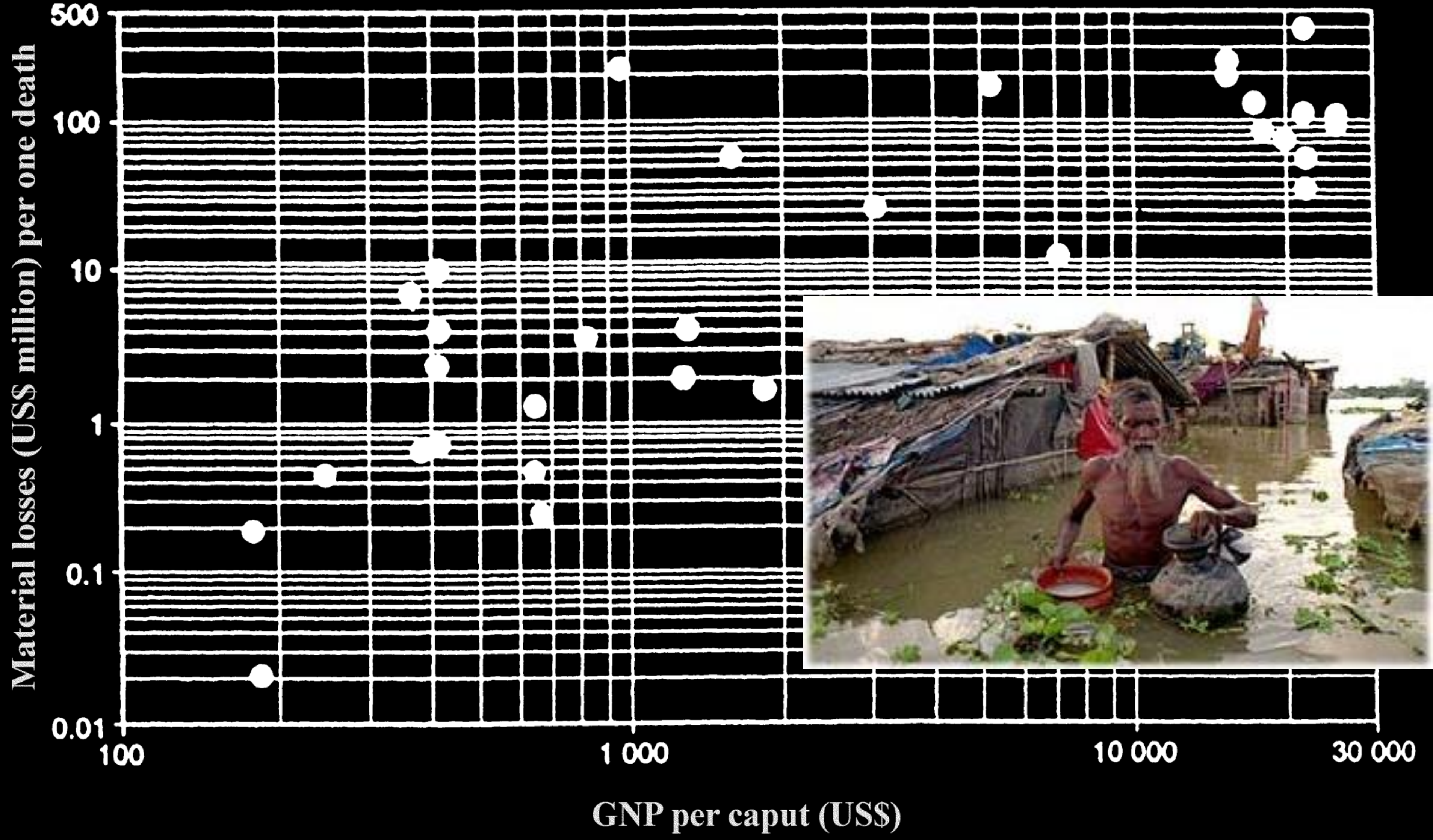
[Absolute protection does not exist]

Accommodate

[Living with floods, learning from them]

Retreat

[The state/province purchases land and property in flood-prone areas]



Flood protection depends depends on wealth *Kundzewicz, Z. W. & Takeuchi, K. (1999) Flood protection and management: quo vadimus? Hydrol. Sci. J.* ***44****(3) 417-432.*

I. Keeping water away from people

- Flood defence
- Flood flow improvement and retention

II. Keeping people and wealth away from water

- Flood risk prevention

III. Being prepared to a flood occurrence

- Flood risk mitigation
- Flood preparation
- Flood recovery

Strategies do not have to be inclusive. Usually they come together: If DEFENCE is a sole strategy, this means ignorance of the residual risk. Diversification of Flood Risk Management Strategies: multiple strategies are applied simultaneously and linked together. **Multi-layer strategy.**

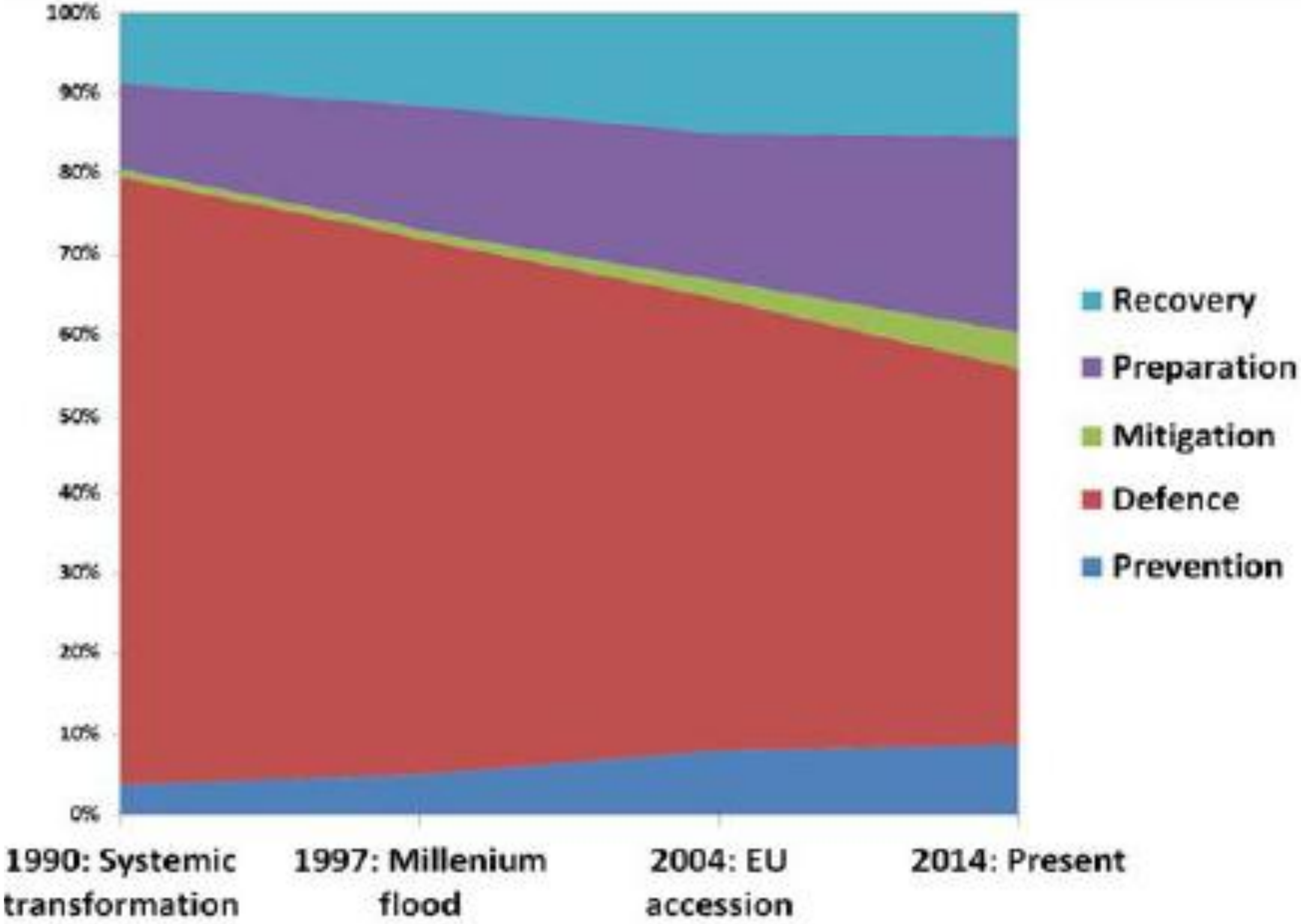
Be prepared for coincidence of abundant water and damage potential in the same place and time.

Instead of limiting consideration to a **fail-safe** system that never fails, we should strive to build a **safe-fail** system that fails in a safe way and recovers after failure.

This is the essence of the notion of resilience.

Flood risk management strategies in Poland – experts´ assessment

Source: Polish report for STAR-FLOOD



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Source: STAR-FLOOD DoW

Table 2 Operationalization of the Flood Risks Governance Arrangements concept (based a.o upon Wiering and Arts 2006). The italic sub-dimensions have been added to the original framework

Actors	Discourses	Rules	Power & Resources
Public actors	Relevant scientific paradigms and uncertainties	Legislation (including jurisprudence/case law)	Legal authority, including the right to regulate property (regulation, compensation and expropriation)
Private actors	Policy programmes, policy objectives and policy concepts	Constitutional, procedural and substantive norms	Financial power
Coalitions and oppositions	Historical metaphors/ narratives	Legal instruments	Knowledge
	Policy and legal values and principles	Legal traditions	Interaction skills
		Informal rules	

Resilience and appropriateness

(legitimacy, effectiveness, efficiency)

Marleen Van Rijswick:

The governance arrangements differ in:

- the division of responsibilities among the actors involved (collective/public vs individual/private),
- how priorities are set,
- how Flood Risk Management Strategies are integrated with other societal ambitions,
- the standards of protection that are in place,
- financing structures,
- the distribution of costs and benefits,
- how risks are communicated.

Actors in Poland

Source: Polish report for STAR-FLOOD WP3

Risk Prevention	Flood Defence	Flood Mitigation	Flood Preparation	Flood Recovery
National Water Management Board (KZGW)	Provincial Authorities of Drainage, Irrigation and Infrastructure (WZMiUWs)	State Forest Holding (PGLP)	Fire brigades (KG PSP)	
Institute of Meteorology and Water Management (IMGW)				
Regional Water Management Boards (RZGWs)				
	Water companies			
NGO's within river basins				
Consultative and scientific bodies				
			Government Centre for Security	
			Crisis management departments	
	National Environmental Protection and Water Management Fund			
Insurance companies				
Municipalities				
	Office of Inland Waterways			

Source: STAR-FLOOD DoW

Table 4: Expected link between Flood Risk Strategies (FRSs) and Flood Risk Governance Arrangements

Basic direction	Prevention		Response		
FRSs	1.Risk Prevention	2.Flood defence	3.Flood mitigation	4.Flood preparation	5.Flood recovery
Typical measures	Proactive spatial planning /allocation politics/ location of building areas	Dikes, dams, embankment, sand banks	Urban green infrastructure, flood retention, urban design taking into account flood risks	Warning systems, plans for disaster management/ evacuation	Rebuilding areas, insurance systems
Flood Risk Governance Arrangements (FRGAs)					
Dominant actors and coalitions	Spatial planning authorities	Public authorities, water managers	Authorities, private parties, NGOs, citizens	Public authorities and citizens	Citizens, NGOs, public authorities or private (insurance) companies
Dominant Discourses	"Precautionary principle"	"Technology may protect you"	"Risk Integration (culture of risk) will minimize flood impacts"	"Early warning will prevent calamities and loss of life"	"Public or private solidarity will ease the burden"
Rules of the game	Public hierarchical steering	Public hierarchical steering	Public and private forms of governance are possible	Public and private forms of governance are possible	Public and private forms of governance are possible
Division of resources	Legal power of public authorities	Legal, cognitive and financial resources of public authorities	Legal, cognitive and financial resources can be concentrated or diffuse	Centralization of control and resources	Legal, cognitive and financial resources can be concentrated or diffuse

4 czerwca 2010 r., Świniary. Żołnierze i strażacy budują tzw. opaskę w miejscu, gdzie Wisła przerwała wał. Opaska ma pomóc w zasypaniu wyrwy w wale oraz chronić pobliskie miejscowości przed ponownym zalaniem

Wzmocnić zabezpieczenia, dostosować się do „życia z powodzią" lub na trwałe opuścić tereny zagrożone – oto sposoby na nękające nas powodzie

Po powodzi, przed powodzią

PROF. ZBIGNIEW W. KUNDZEWICZ*

Dawno opadły wielkie wody polskich rzek. Temat prze-

klimacie. Wprawdzie ryzyko powodzi roztopowych zmniejsza się wraz ze spadkiem grubości pokrywy śnieżnej, jednak rośnie zagrożenie spowodowane desz-

towne wezbrania w górach spowodowane ulewą, bo strumień wzbiera bardzo szybko. Zupełnie inna jest skala czasowa ruchu wielkich mas wodnych

trema procesów losowych mogą wystąpić częściej lub rzadziej, a jeśli już zdarzy się powódź, prawdopodobieństwo szybkiego nawrotu znacznie ro-

rzeczne odpowiadające określonemu opadowi. Wraz z ociepleniem intensywne opady stają się częstsze i silniejsze, więc wysokie stany rzek powsze-

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Thank you