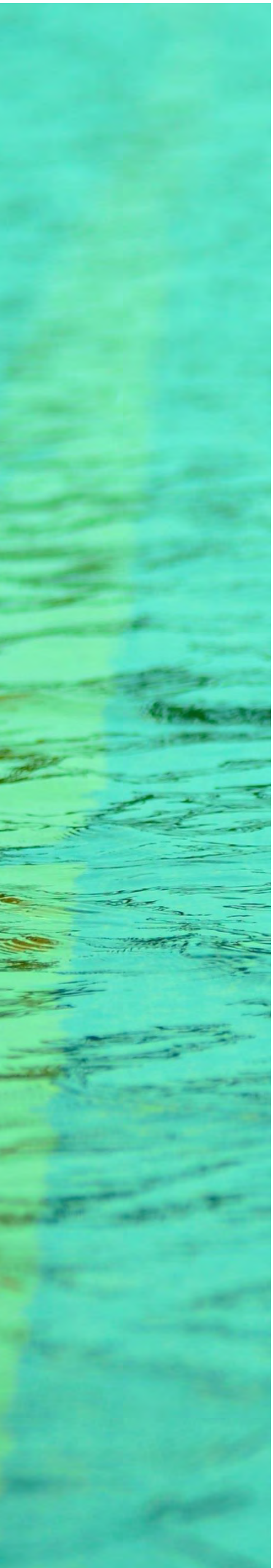


OECD Conference on the Financial Management of Flood Risk

Building financial resilience in a changing climate

PRESENTATIONS – SESSION 1

12-13 May 2016
Paris, France

OECD

OECD CONFERENCE ON THE FINANCIAL MANAGEMENT OF FLOOD RISK: PARIS, MAY 12-13TH 2016

THE EVOLVING NATURE OF FLOOD RISK (INTRODUCTION)

Robert Muir-Wood

RMS Chief Research Officer

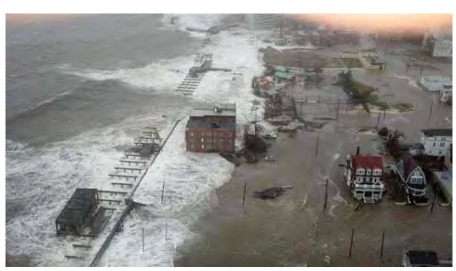
DIFFERENT CLASSES OF FLOODS

Pluvial

Fluvial

Ice Dam

Groundwater



Storm Surge

Damburst

FLOODS ARE NATURAL…

BUT FLOOD RISK IS PREDOMINATELY MAN MADE

Thailand: 1990-2010 Industry Cluster Development Policy & 2011 Rainfall

RMS

Wanted

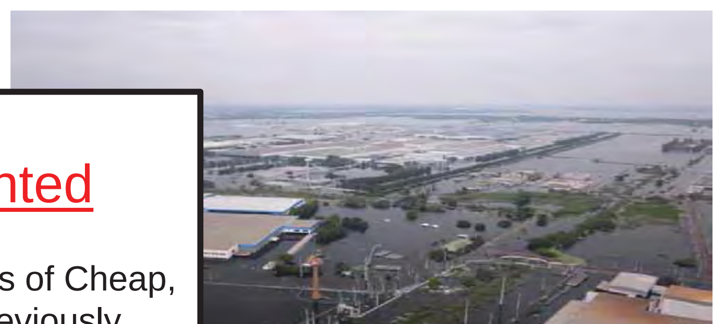
Large Areas of Cheap, Flat, Previously Undeveloped, Land.

Close to Bangkok

Thailand: 1990-2010 Industry Cluster Development Policy & 2011 Rainfall

RMS


Navanakorn Industrial Estate

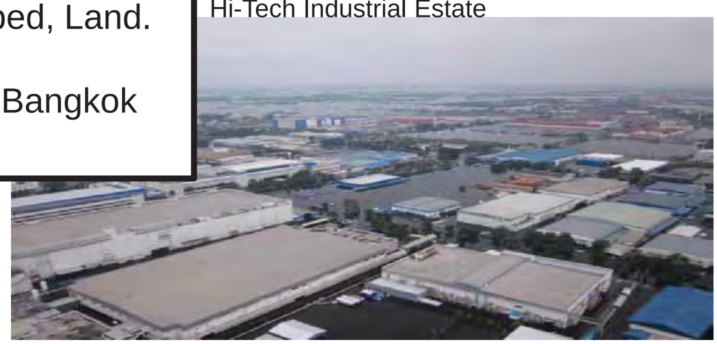

Hi-Tech Industrial Estate

Wanted

Large Areas of Cheap, Flat, Previously Undeveloped, Land.

Close to Bangkok


Rojana Industrial Estate


Bang Pa-in Industrial Estate

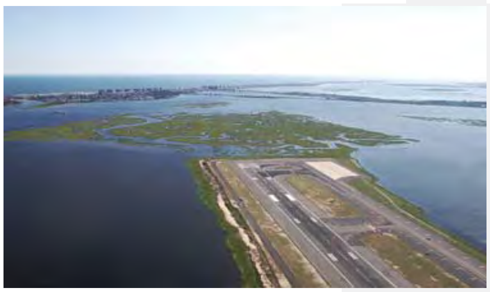
COAST SPECIFIC EXPOSURE CATEGORIES

PORTS

HOTELS & CONDOS

POWER PLANTS

AIRPORTS

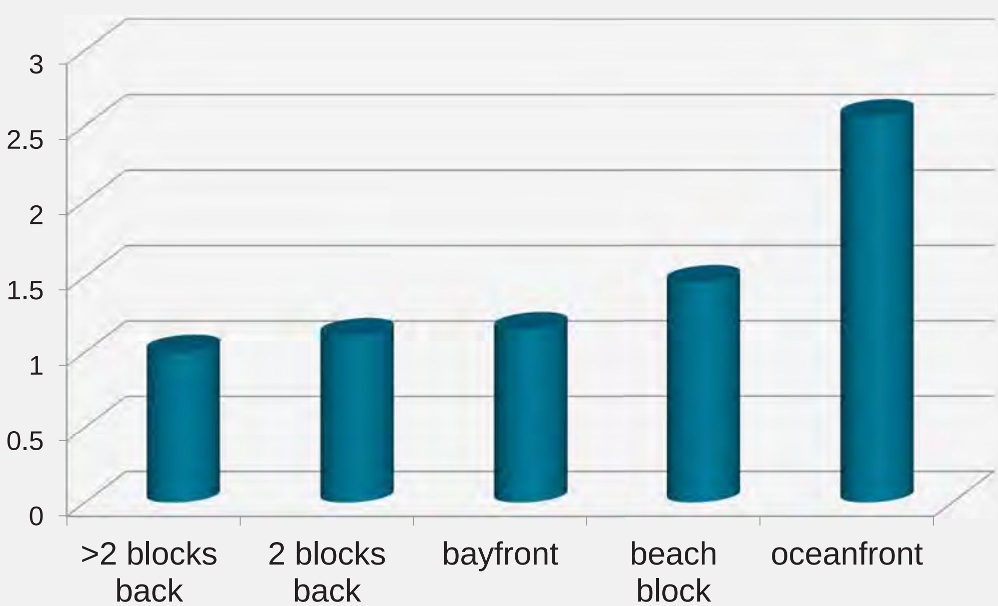


REFINERIES

MARINAS

HOW PRICES FOR IDENTICAL HOUSES INCREASE AT THE COAST

Data from Stone Harbor and Avalon, New Jersey 2002/2003

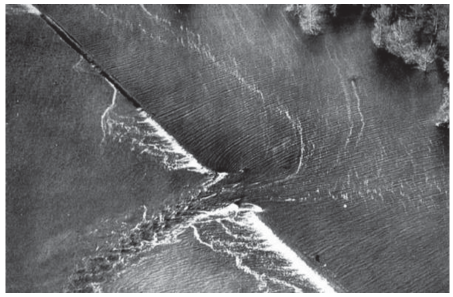


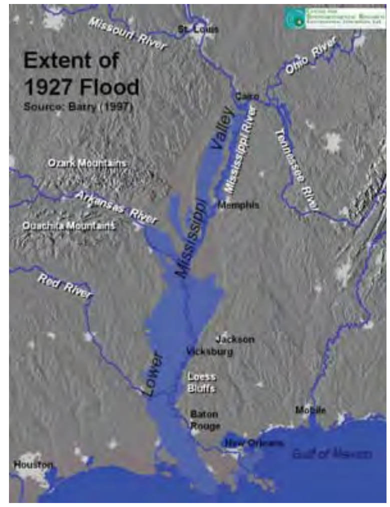
http://www.gradschool.psu.edu/diversity/mcnair/papers2003/majorpdf/

THE MASS PRODUCTION OF COAST

WHAT DETERMINES FLOOD INSURANCE?

HOW THE 1927 MISSISSIPI FLOODS ENDED U.S. PRIVATE FLOOD INSURANCE

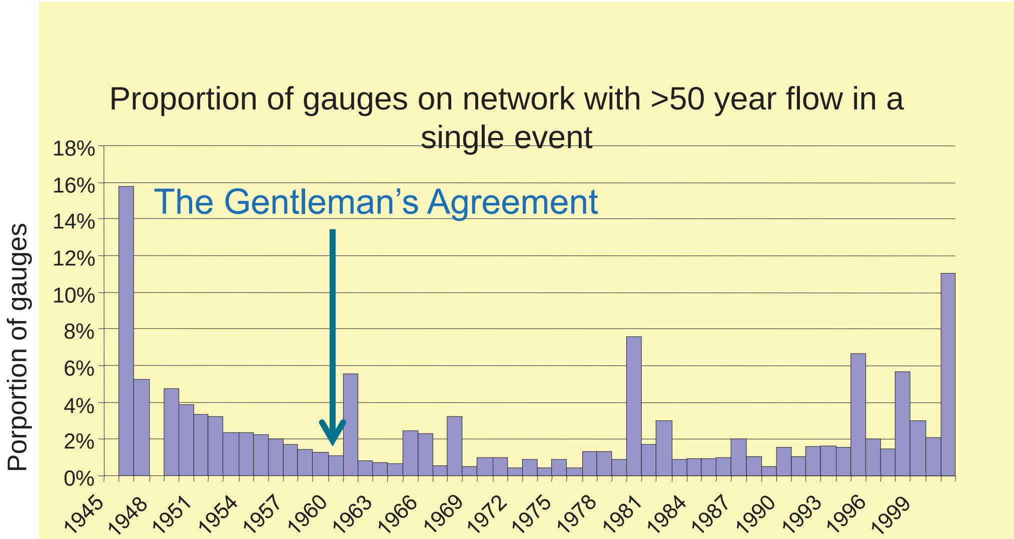




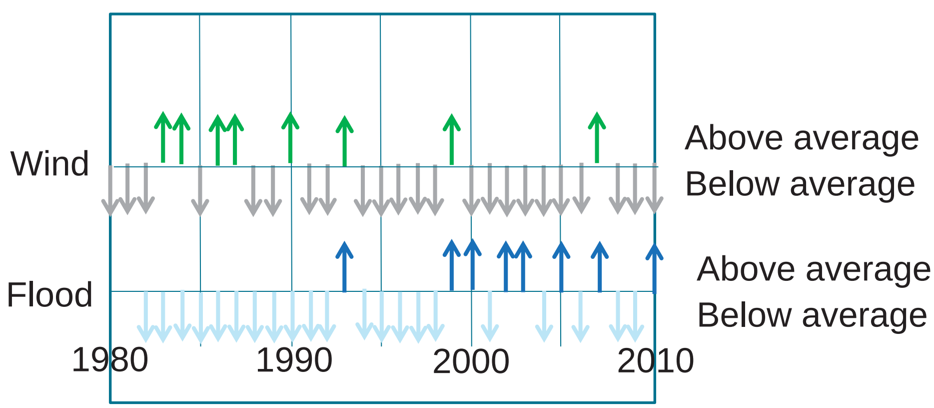
REACTIVE RISK MANAGEMENT: RAISED FLOOD DEFENCES AT THE 7 FLOODED THAI INDUSTRIAL PARKS IN 2012

- Reinforced defences raised 1.5-2.0m
- Demanded by lead Japanese Industries
- Funded by $200m in soft loans from the Government
- Single site flood risk is now beyond 500 year RP
- No protection for the labour-force or supply lines

FLOOD INSURANCE AND CORRELATED RIVER FLOODING IN THE UK



ANNUAL EUROPEAN WIND & FLOOD INSURANCE LOSSES



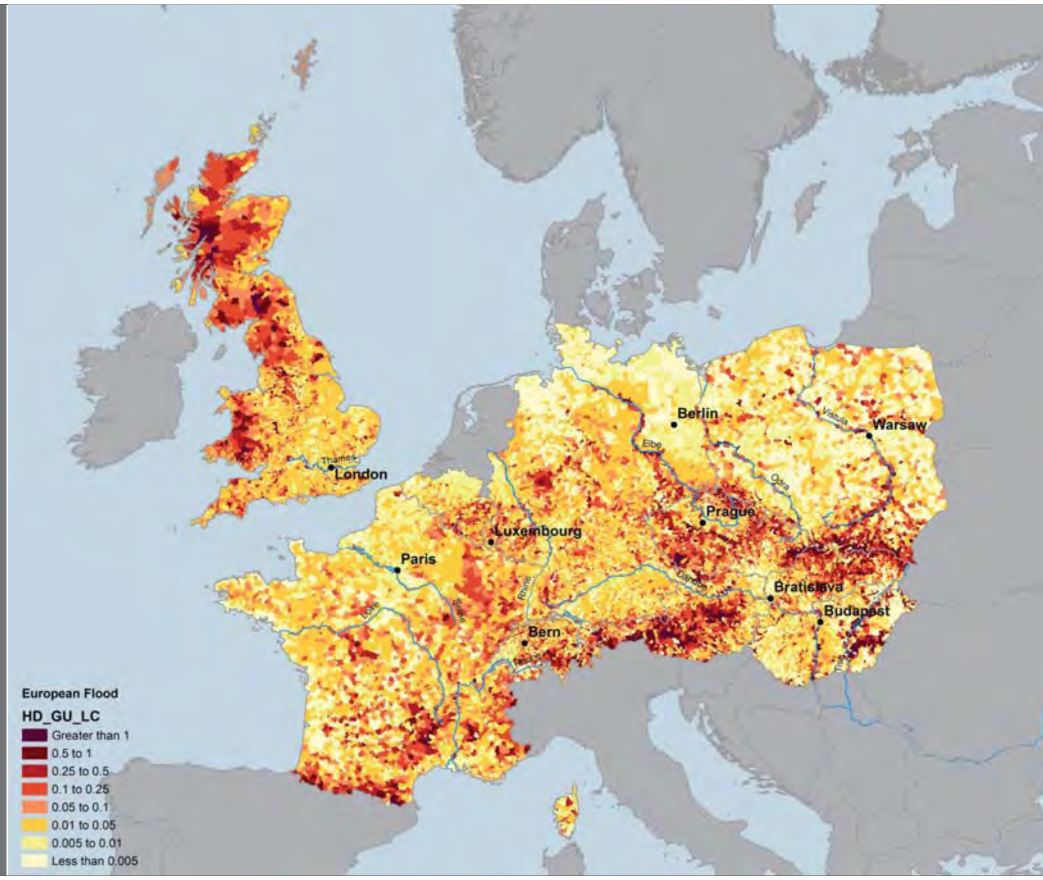
Europe

IED All Lines

Ground Up

‰ Loss Cost

Generally higher LCs in mountainous or hilly terrain



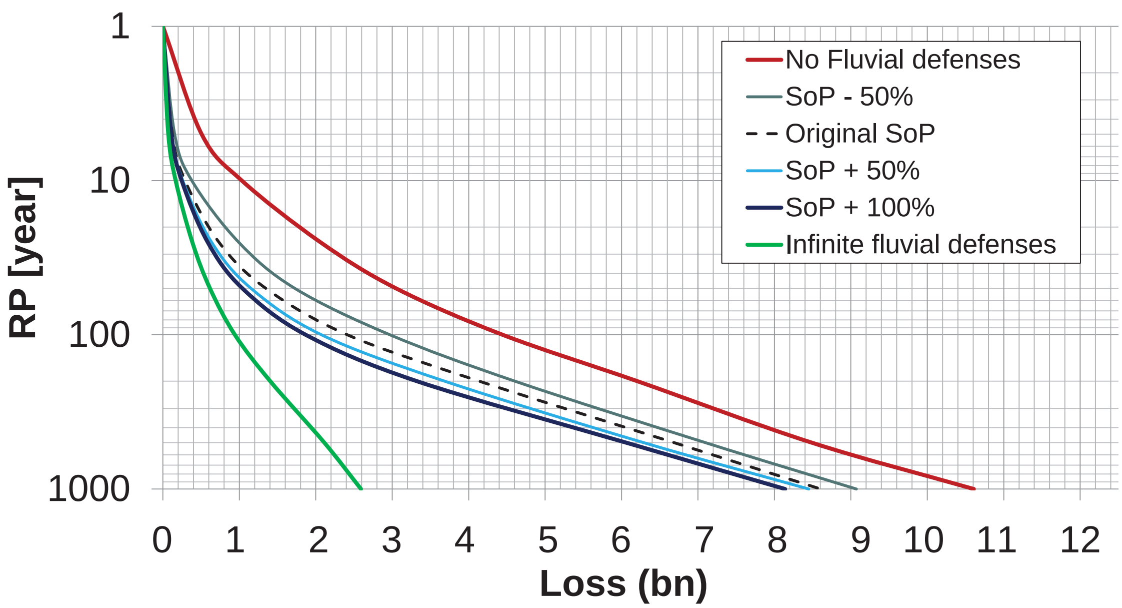
High resolution hazard maps to support technical flood underwriting

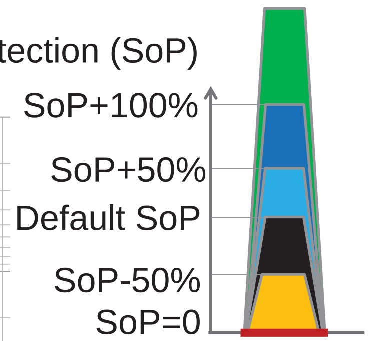
- Flood hazard high-resolution maps:
  - UK 2m
  - Continental Europe 5m
- 7 return periods, 13 flood depth bands
- Provide **Extent** and **Depth** of flooding
- **Undefended** and **defended**

Flood risk cost can vary by 100+% for adjacent buildings

2m RMS RP FL map of London

DYNAMICALLY MODELLED EFFECT OF DEFENCES
MULTI-COUNTRY PORTFOLIO

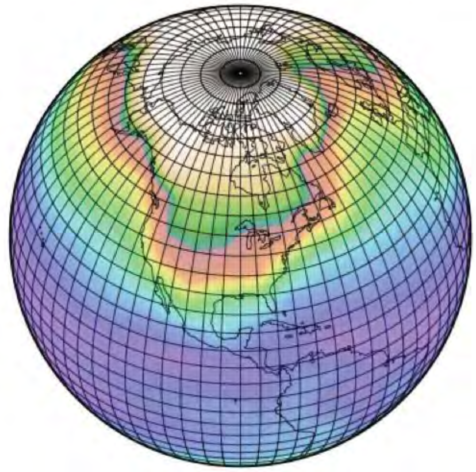




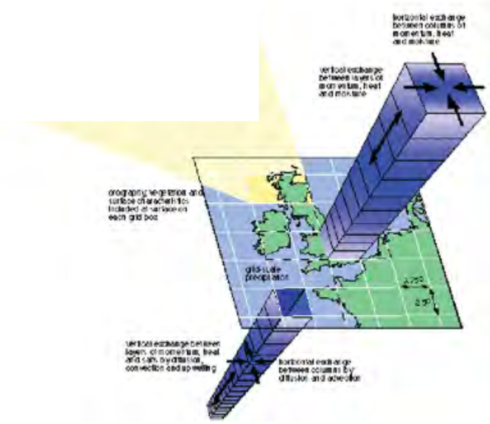
IS CLIMATE CHANGE ALTERING THE OCCURRENCE OF EXTREMES?

20,000 years of climate simulation

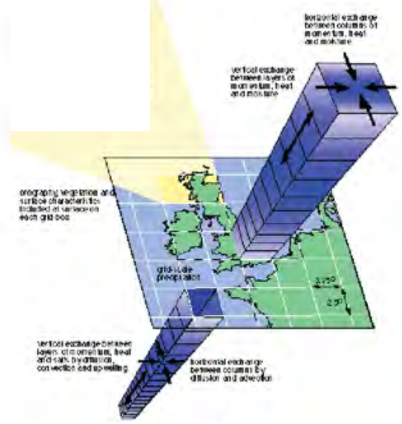
ATTRIBUTION STUDIES



Without post 1950 increase in GHGs



With post-1950 increase in GHGs



LETTER

doi:10.1038/nature09762

Anthropogenic greenhouse gas contribution to flood risk in England and Wales in autumn 2000

Pardeep Pall[1,2]†, Tolu Aina[3], Dáithí A. Stone[1,4], Peter A. Stott[5], Toru Nozawa[6], Arno G. J. Hilberts[7], Dag Lohmann[7] & Myles R. Allen[1,4]

382 | NATURE | VOL 470 | 17 FEBRUARY 2011

England and Wales (proxy indicators of flood events). The precise magnitude of the anthropogenic contribution remains uncertain, but in nine out of ten cases our model results indicate that twentieth-century anthropogenic greenhouse gas emissions increased the risk of floods occurring in England and Wales in autumn 2000 by more than 20%, and in two out of three cases by more than 90%.

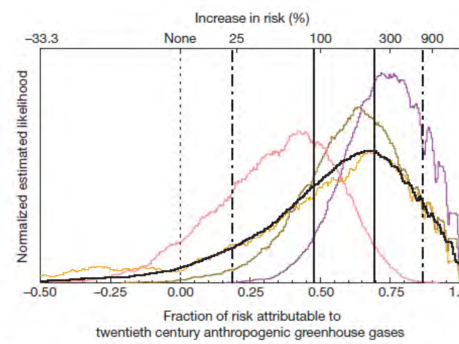


Figure 4 | Attributable risk of severe daily river runoff for England and Wales autumn 2000. Histograms (smoothed) of the fraction of risk of severe synthetic runoff in the A2000 climate that is attributable to twentieth-century anthropogenic greenhouse gas emissions. Each coloured histogram shows this fraction of attributable risk (FAR) with respect to one of four A2000N climate estimates in Fig. 3 (with corresponding colours). The aggregate histogram (black) represents the FAR relative to the full A2000N climate, with the dot-dashed (solid) pair of vertical lines marking 10th and 90th (33rd and 66th) percentiles. Top axis is equivalent increase in risk.

ATTRIBUTION STUDIES VS CHANGES IN OVERALL RISK (UK FLOOD)

Increased risk

Storm Desmond 2015 record warm December

Decreased risk

Snow-thaw floods March 1947 at the end of record cold winter

EVOLUTION OF DIFFERENT CLASSES OF FLOODS

Pluvial

Fluvial

Ice Dam

Groundwater

Storm Surge

Damburst

Aspects of flood risk

Wolfgang Kron
Geo Risks Research/Corporate Climate Centre

OECD Conference on the Financial Management of Flood Risk – Paris 12 May 2016

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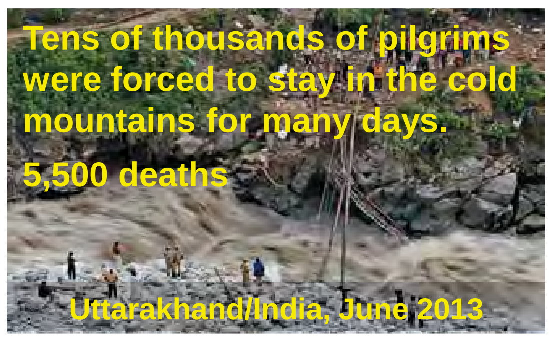
Recent large flood disasters



Flood disasters
Increase in number of events

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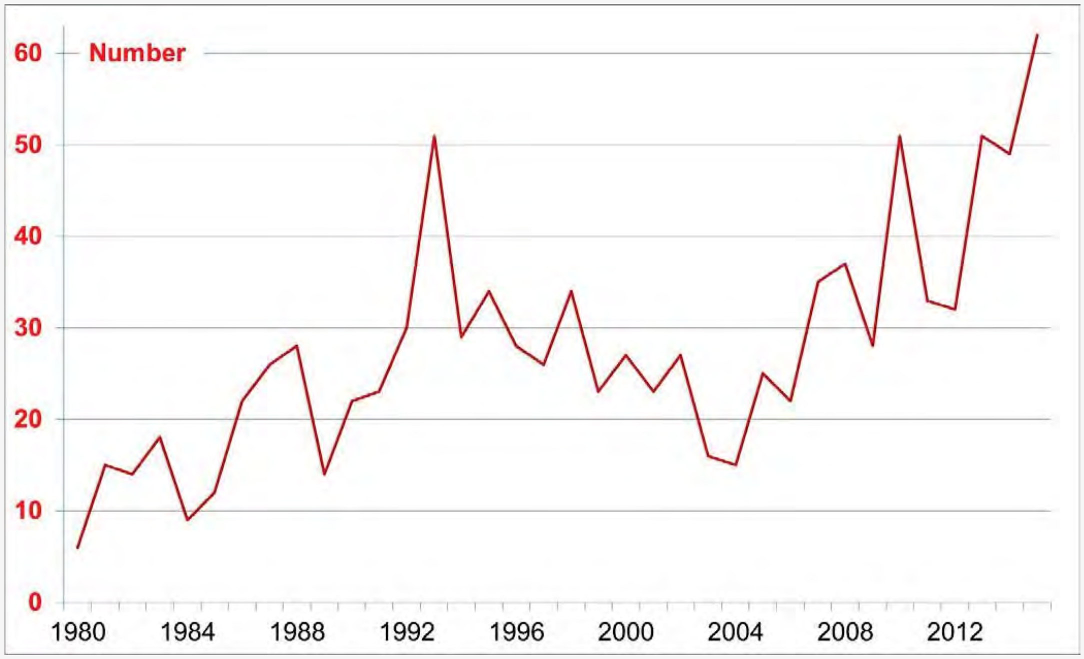
Inland flood losses 1980 – 2015

(only events with inflation-adjusted loss **>US$** 50m are shown)



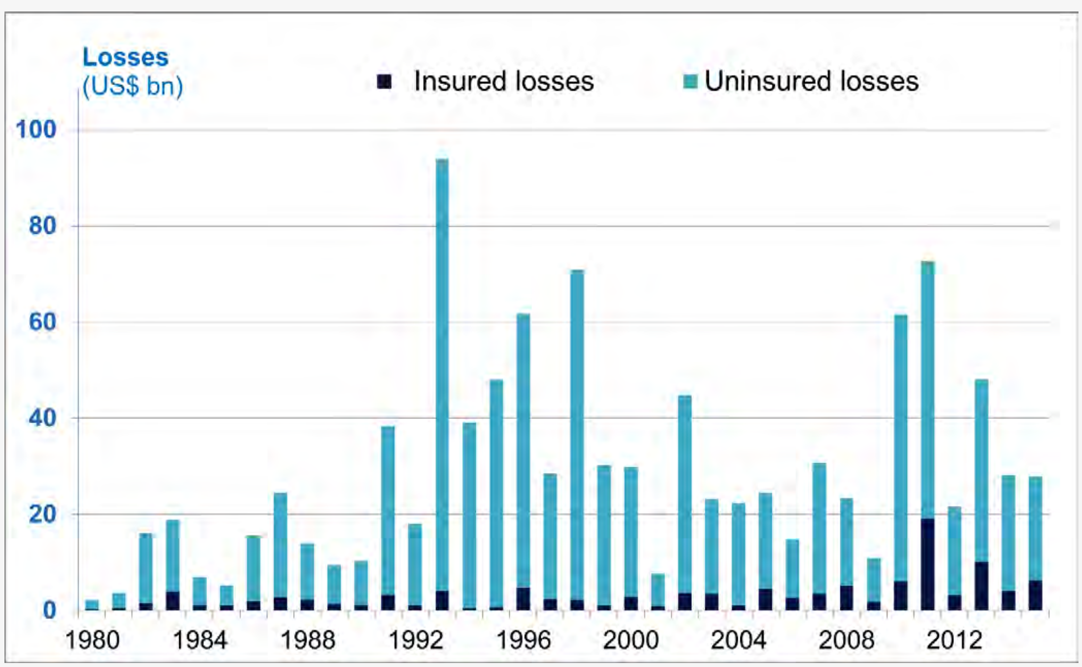
Munich Re NatCatSERVICE, 2016

Flood disasters
Increase in losses

Munich RE

Inland flood losses 1980 – 2015

(only events with inflation-adjusted loss **>US$** 50m are shown)



Munich Re NatCatSERVICE, 2016

Flood disasters
Increase in insured losses

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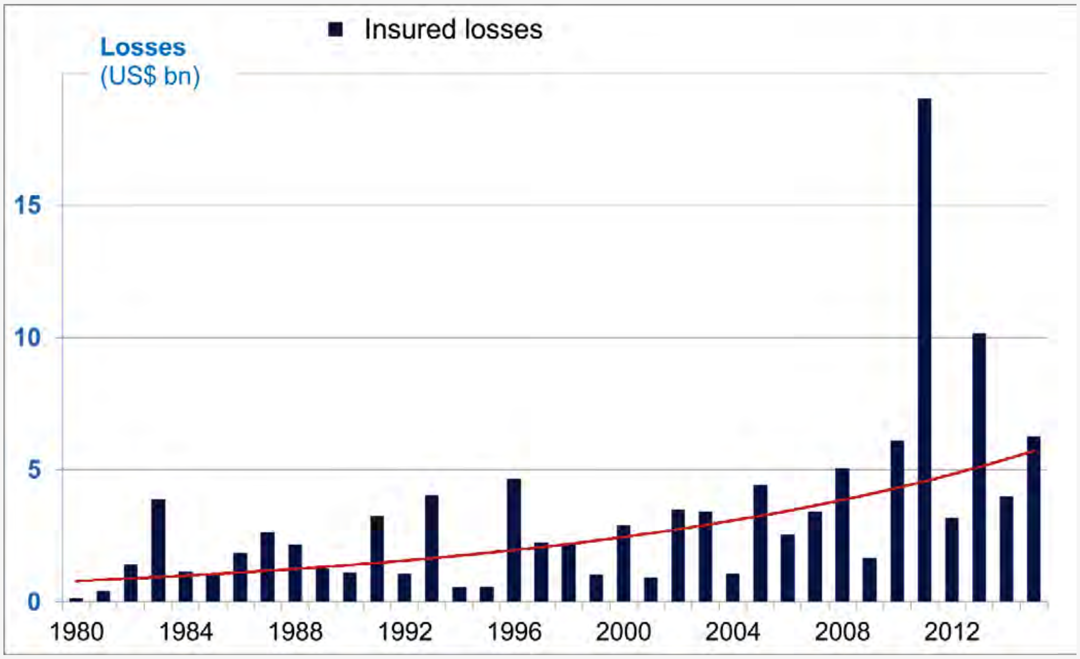
Inland flood losses
1980 – 2015



(only events with inflation-adjusted loss **>US$** 50m are shown)

Munich Re NatCatSERVICE, 2016

Flood disasters
Trends in

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What is Risk?

Definition

Risk = f [Hazard H, Exposure E, Vulnerability V]

R = H x E x V

Upper Rhine Valley prior to 1800

Upper Rhine Valley today

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Changes in environmental conditions

→ Influences on flood peak and wave propagation

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Changes in landuse

→ Creation of loss potential

Population development
(Example Florida)

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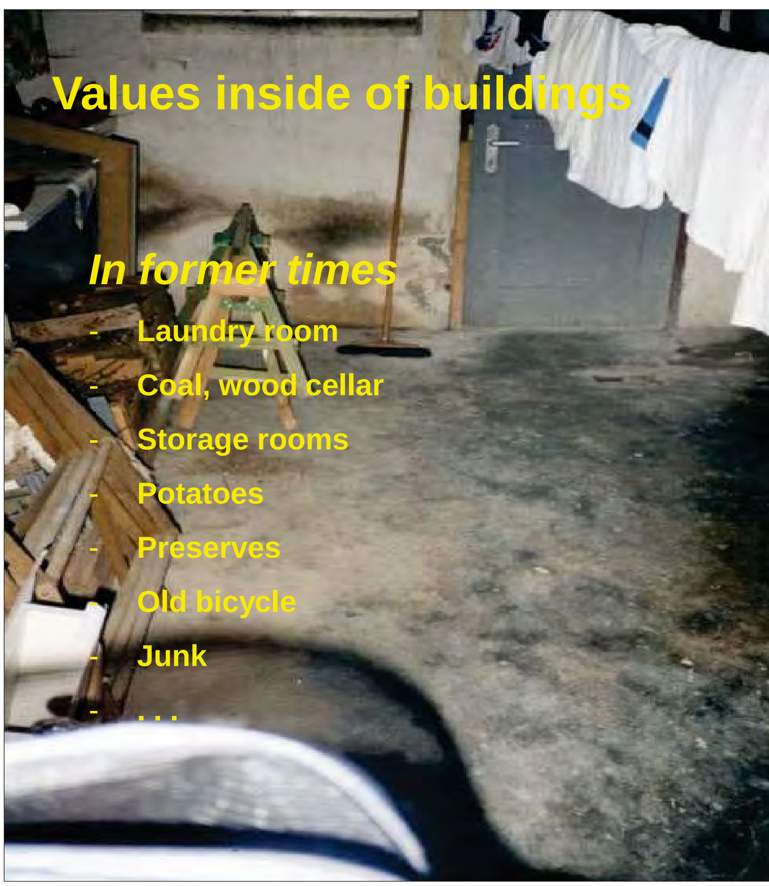
	1920	2000	2020
Inhabitants	100 000	15 000 000	25 000 000
Tourists	0	45 000 000	85 000 000



Values inside of buildings

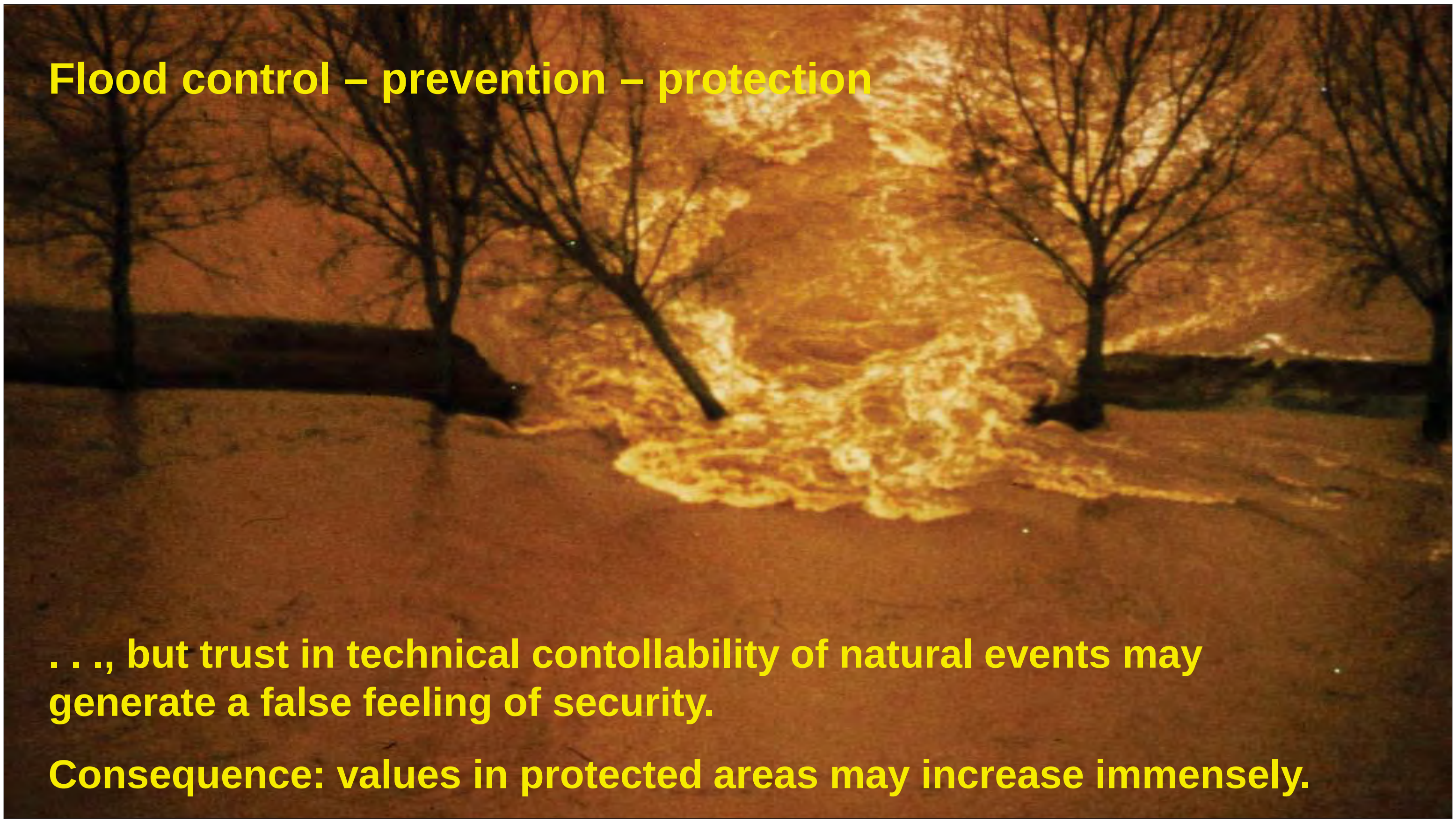
(Example: basement)

In former times
- Laundry room
- Coal, wood cellar
- Storage rooms
- Potatoes
- Preserves
- Old bicycle
- Junk
- . . .

Today
- Electrical washing machines
- Hobby rooms
- Party cellars
- Wall-to-wall carpets
- Computers, TV sets, stereos
- Electrical distribution boxes
- Control devices for air condition/elevators
- Computer centers
- Storages
- . . .


High vulnerability


Flood control – prevention – protection
Reduce the risk


Flood control – prevention – protection
. . ., but trust in technical contollability of natural events may generate a false feeling of security.
Consequence: values in protected areas may increase immensely.


Climate change
Climate change is mainly manifested in WATER-related effects:
Droughts – Torrential rain – Floods – Sea level rise – Storm surges

Types, causes and impacts of floods

Un-official classification, not comprehensive

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1 **Coastal floods (sea-borne)**
2 **Lake floods**
3 **River floods (fluvial floods)**
4 **Flash floods (pluvial, off-plain)**
5 **Mountain floods**
6 **Groundwater/waterlogging floods**
7 **Backup floods**
8 **„Break“ floods**
9 **Subsidence-caused floods**

Types, causes and impacts of floods

1 Coastal floods

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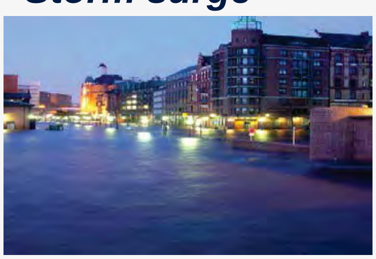
Storm surge

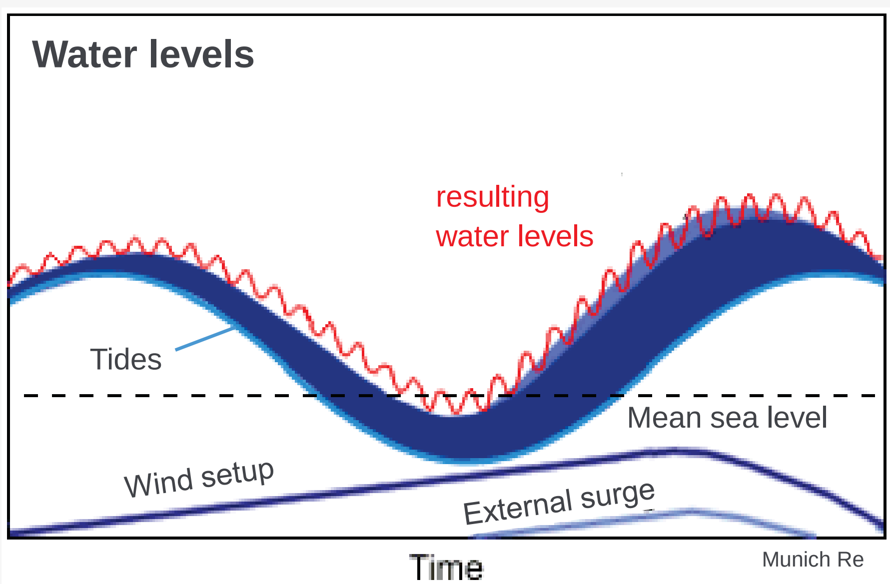


Main cause: wind

High water levels are generated by a superposition of:

- Astronomical tides
- Wind setup
- External surge
- Surface waves

Rain is not a factor!



Types, causes and impacts of floods
1 Coastal floods

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Storm surge

Cause:	high water level due to superposition of high tide, wind setup, external surge
Conditions:	strong wind towards the coast for many hours
Exposed areas:	coastal plains
Forecast:	good (several hours up to one day)
Duration:	usually < 1 day
Damage factors:	salt water (corrosive), wave forces
Losses:	• very low frequency (high standard of coastal protection) • extremely high loss potential

Types, causes and impacts of floods
1 Coastal floods

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Swell/meteo-tsunami

- Induced by air pressure effects
- Can cause damage

High waves

- Extremely powerful
- Can destroy rein-forced concrete structures in a short time
- Coastal erosion

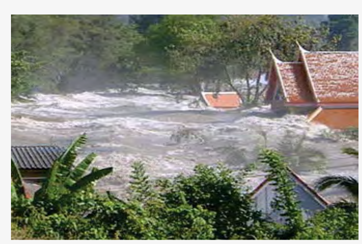
Sea level rise

- Climate change-related
- Other effects play a role (see 9 Subsidence)

Tsunami

Generated by:
- Earthquake
- Volcanic eruption
- Landslide (into the water, under water)
- Extraterrestrial impact

Extremely destructive



Types, causes and impacts of floods

2 Lake flooding

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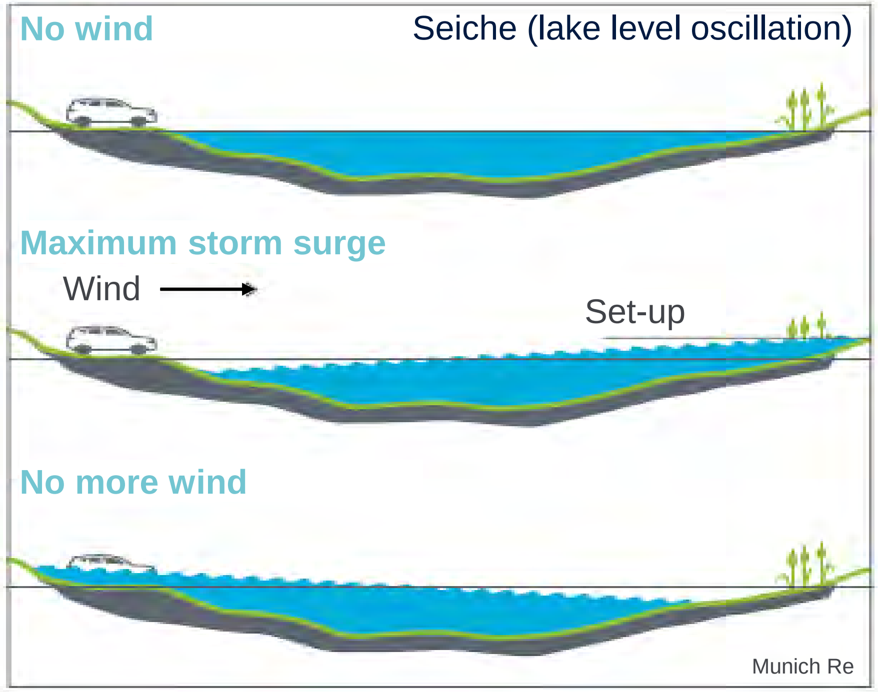
- Overflowing due to high inflows
- Storm surge
- Seiches
- Swell/meteo-tsunamis
- High waves
- Tsunami



Types, causes and impacts of floods

3 River floods (fluvial floods)

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Generated by:

- (Long-lasting) Rainfall with high depth over a large area, or snowmelt (→ thaw floods)
- Infiltration capacity of the soil is exceeded.
- Water converges in the drainage system.
- Flood wave builds up in the entire system or in principal stream(s).

Flooding process:

- Areas adjacent to the river are affected first.
- Flooding originates from the river channel.

Impact:

- Flood plains are usually high-value areas

  → huge loss potential

Good news:

- Flood control/protection/ prevention is possible (e.g. dikes, reservoirs).
- **These measures always pay off in the long run!**

Types, causes and impacts of floods
3 River floods (fluvial floods)

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River flood

Cause:	long-duration rainfall with high depth over a large area (sometimes snowmelt)
Conditions:	soil naturally sealed by previous rainfall
Exposed areas:	floodplains and valleys
Forecast:	depending on the characteristics of the catchment area (several hours to days)
Duration:	days to weeks
Damage factors:	• long-lasting impact of water; • contamination of the water (e.g.oil)
Losses:	• low frequency • high loss potential

Types, causes and impacts of floods
4 Flash floods (pluvial floods, offplain floods)

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Flash flood

- Fast
- Furious
- Dangerous
- Deadly
- Destructive

Types, causes and impacts of floods
4 Flash floods (pluvial floods, offplain floods)

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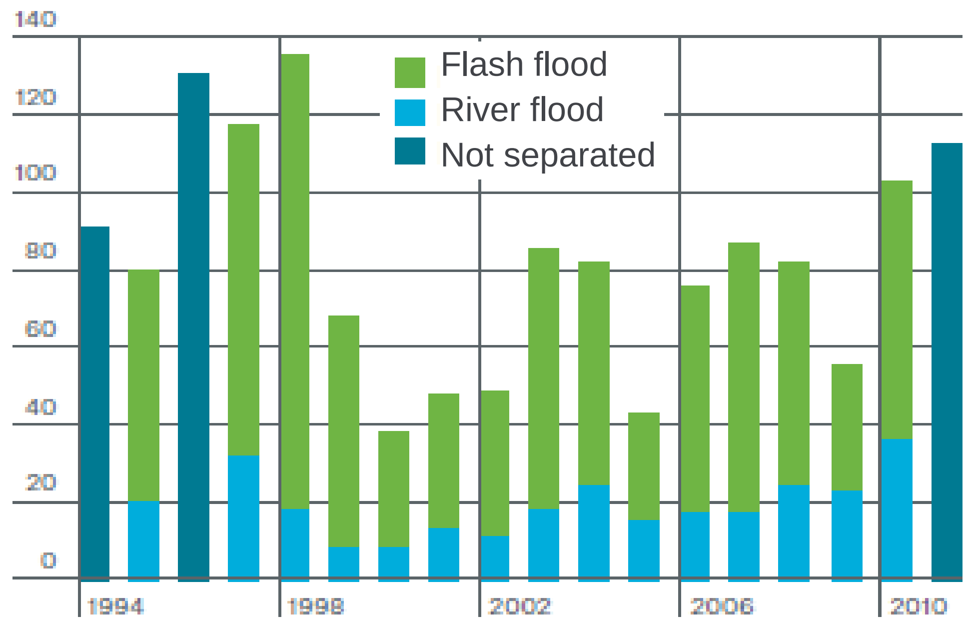
Flood-related deaths in the United States

Flash flood is one of the most frequent causes of death from natural hazards in the US (on average >50 per year).



Munich Re, based on NOAA-NWS

Types, causes and impacts of floods
4 Flash floods (pluvial floods, offplain floods)

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Urban flooding

- High percentage of impermeable surfaces
- No space for orderly runoff during intense rainfall
- High loss potential

Surface flooding

- Resulting from insufficient capacity of or overwhelmed urban drainage systems

Surface runoff („wild water“)

- Especially on slopes
- May happen where not at all expected

Types, causes and impacts of floods
4 Flash floods (pluvial floods, offplain floods)

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Flash flood

Cause:	intense precipitation (thunderstorm, tropical cyclone, orographic amplifying, etc.)
Conditions:	none
Exposed areas:	practically everywhere
Forecast:	only via rainfall forecast (uncertain to hardly feasible)
Duration:	minutes to hours
Damage factors:	• mechanical effects of fast flowing water • sometimes much sediment
Losses:	• high frequency (not at the same location) • relatively small losses from single events • damage by erosion

Types, causes and impacts of floods
5 Mountain floods

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Torrent

- Special type of flash flood with high sediment transport rates

Debris flow

- Mixture of sediment and water (30-70% of solids)
- High velocity
- Sediment deposits
- Extremely destructive

Lahar

- Washing off of volcanic ash by intense rain
- Melting of snow/ice cover during a volcanic eruption
- High-viscosity flow → fast
- Extremely destructive
- Sometimes hot

Types, causes and impacts of floods
6 Groundwater/waterlogging floods

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Rising groundwater table

- Local or widespread high rainfall in flat areas
- Relatively slow onset
- Long lasting
- Interruption of GW flow

Seepage underneath a dike

- If coarse valley sediments are present, groundwater may rise quickly during a high flood stage in the river

„Plum rain“ („Meiyu“)

- Very long lasting drizzle-type rain soaks the ground from the surface and thereby seals it.
- In little or moderately permeable underground situations.
- Highly damaging to crops

Types, causes and impacts of floods
7 Backup floods

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Landslide/ glacier blocking

- Landslide or glacier backs up a river
- Sudden break-through when natural dam is overtopped

Log jam

- Floating debris clogs river narrows (e.g. a bridge passage) or a river bend

Ice jam

- Less frequent than in the past due intensive use of rivers (e.g. cooling water)
- Regularly a problem in northward flowing rivers in USA, Canada, Russia

Types, causes and impacts of floods
8 „Break“ floods

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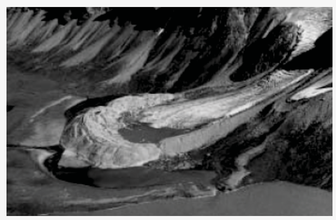
Dambreak flood

- Similar to flash floods/debris flows
- Extreme depths possible
- Very few large dams have failed in history.
- Hundreds of small dams fail every year.

GLOF (Glacial Lake Outburst Flood)

- Moraine dam formed by a retreating glacier breaks
- Sudden release of large masses of water



Jökulhlaup

- Melting of a glacial icecap during a volcanic eruption
- Sudden escaping of water from a subglacial lake
- Jökulhlaups have produ-ced the largest known discharges on earth.

Types, causes and impacts of floods
9 Subsidence-caused floods

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Man-made causes:

Groundwater Pumping + Load from buildings

- Settlement of ground up to several meters
- Many coastal cities affected
- Effect is like sea level rise

Reduced sediment input

- Sediment is trapped in reservoirs
- River training prevents flooding and sediment input on flood plains and deltas
- Sediment is con-veyed to and depo-sited in the sea.

Natural causes:

Earthquake

- Vertical displacement of crustal plates

Isostatic sinking

- Late effect of past ice age: land movement due to changed ice load

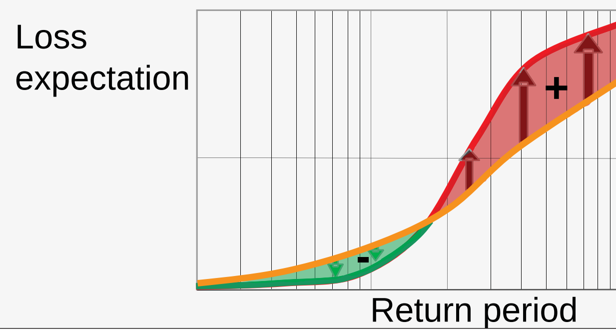
Does the flood risk increase?
River floods

Flood control measures can be concentrated along rivers;
early warning is often possible.

The risk up to medium exceedance probabilities (in the order of 1%) will decrease despite increasing values and climate change.

The risk from extreme events will increase, because values increase and flood control has only a limited effect.

A generally valid statement with regard to the total risk is not possible.



Does the flood risk increase?
Flash floods

General protection against floods following intense local precipitation is not feasible.

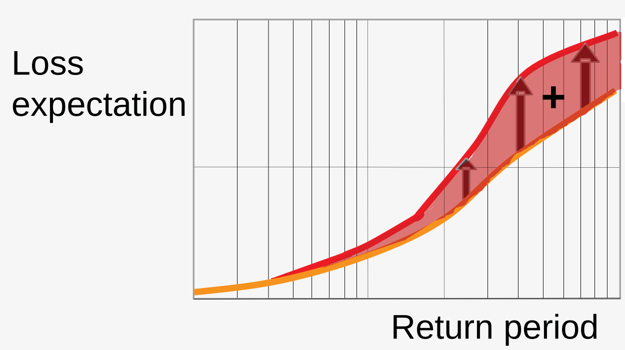
Instead of quantitative forecasts only qualitative warnings are possible.

Structural precaution is easily possible for newly constructed buildings, but hardly feasible (and expensive)
for existing buildings.

Values do increase.

Climate change is happening.

The risk from flash floods will increase.



Conclusion

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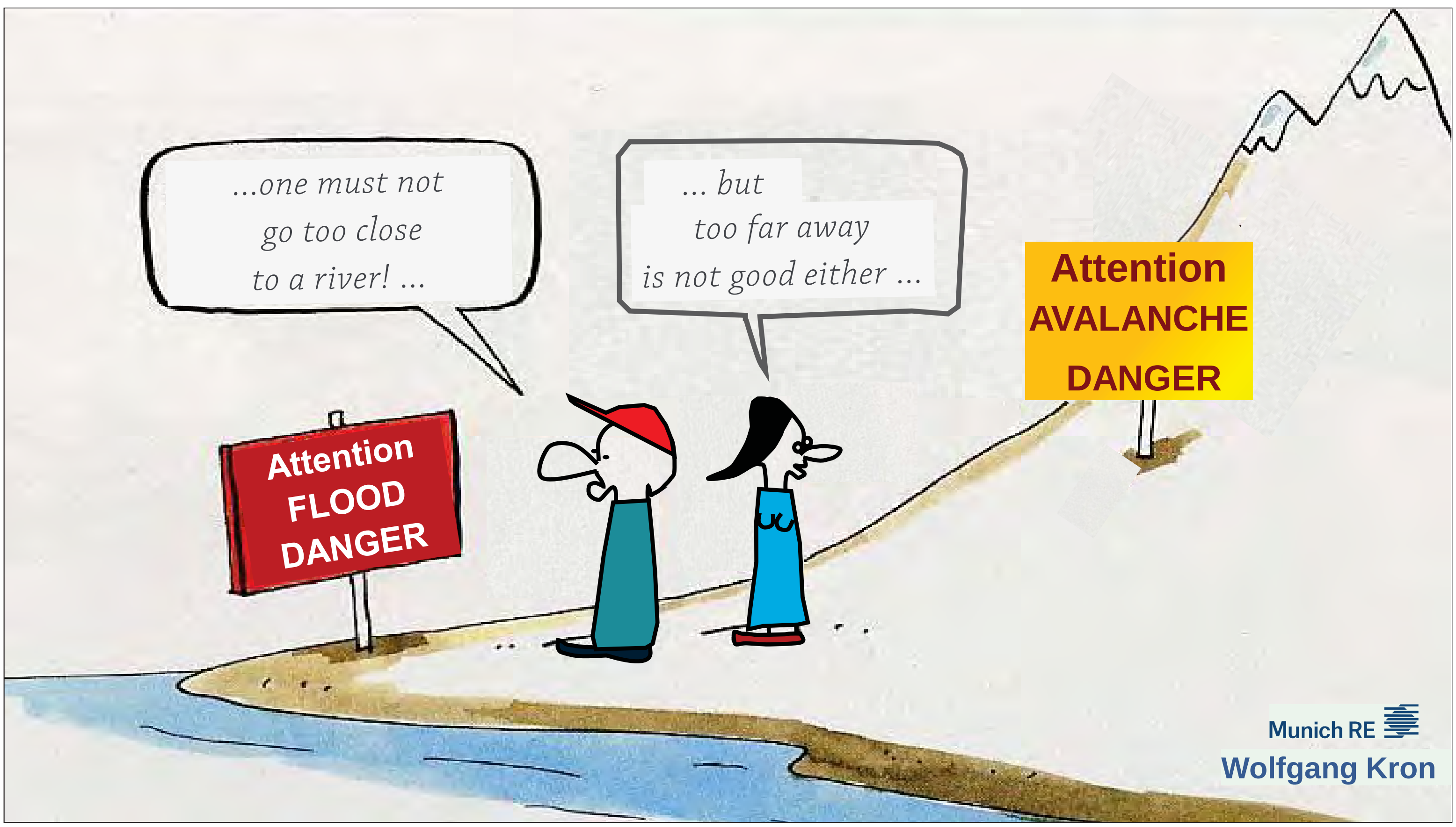
We must learn to live with the flood hazard, but, at the same time, develop a culture of coping with the resulting risk.



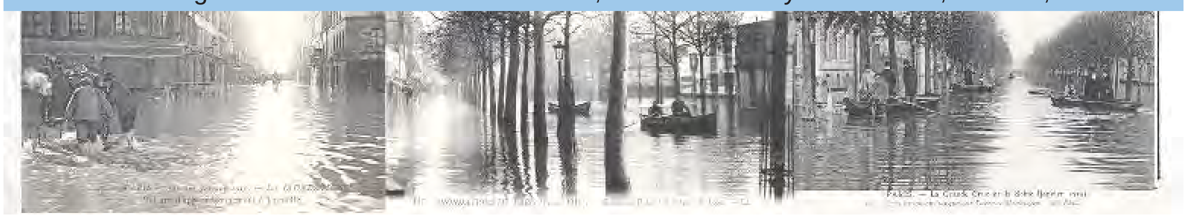
OECD Conference on the Financial Management of Flood Risk:
Building financial resilience in a changing climate

Paris, 12-13 May 2016

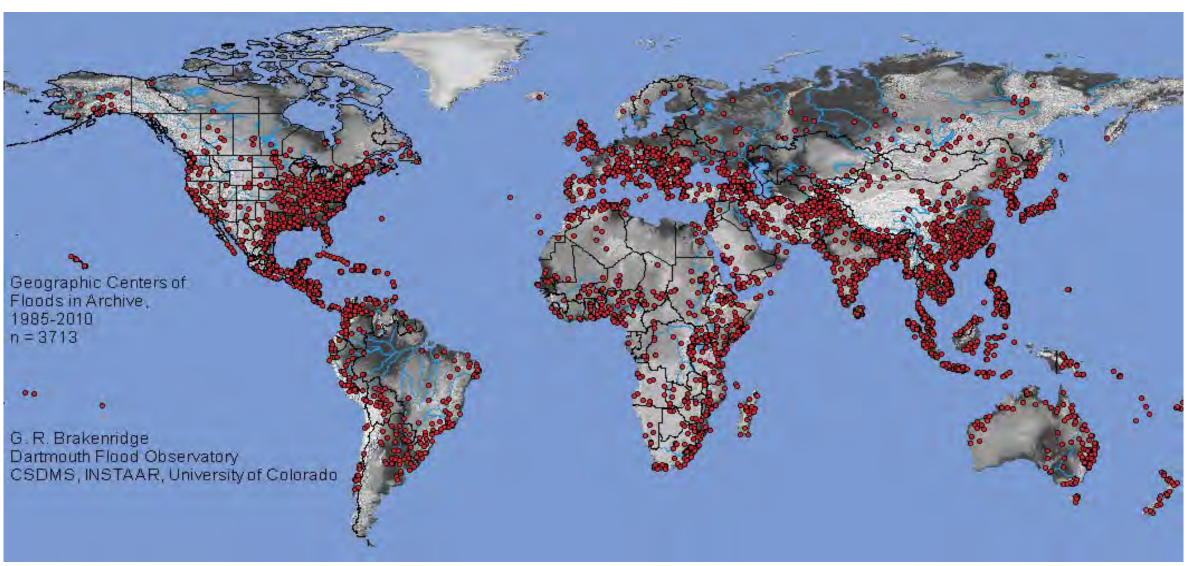
Climate Change and Flood Risk

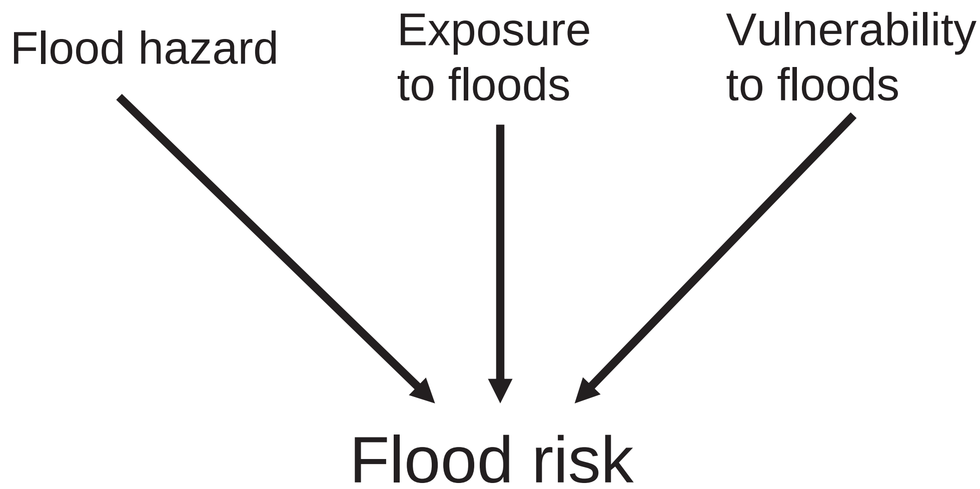
ZBIGNIEW W. KUNDZEWICZ

Institute of Agricultural and Forest Environment, Polish Academy of Sciences, Poznan, Poland

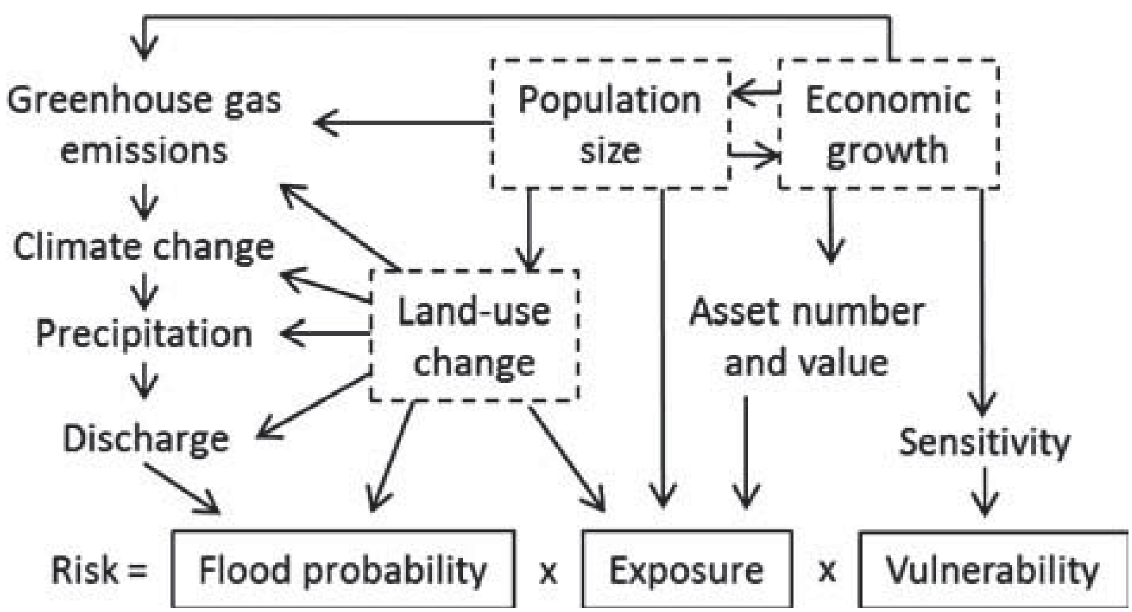


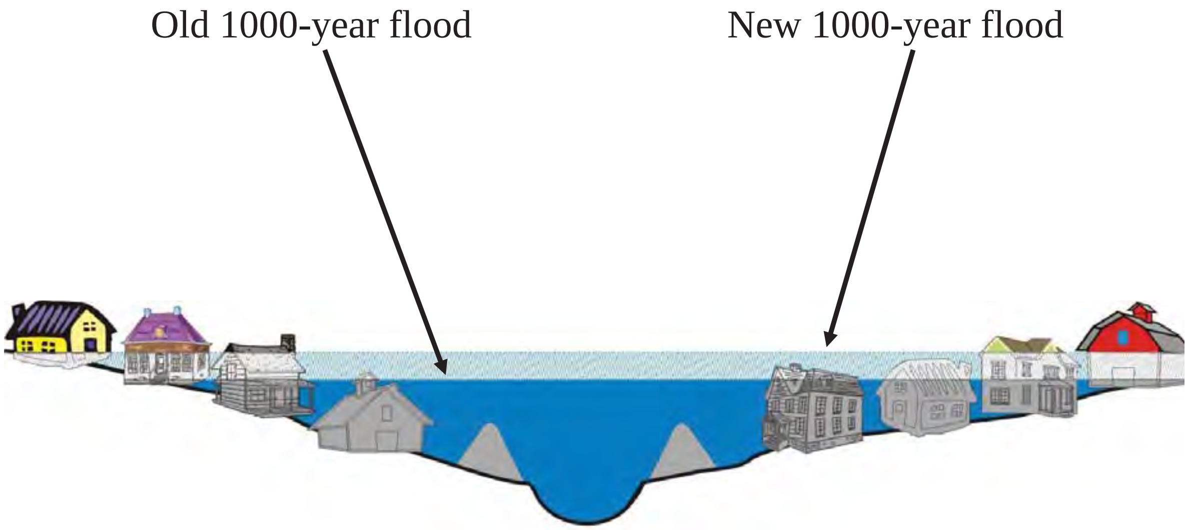
Many floods with high material damage and fatalities have been recorded worldwide. Source: G. R. Brakenridge.

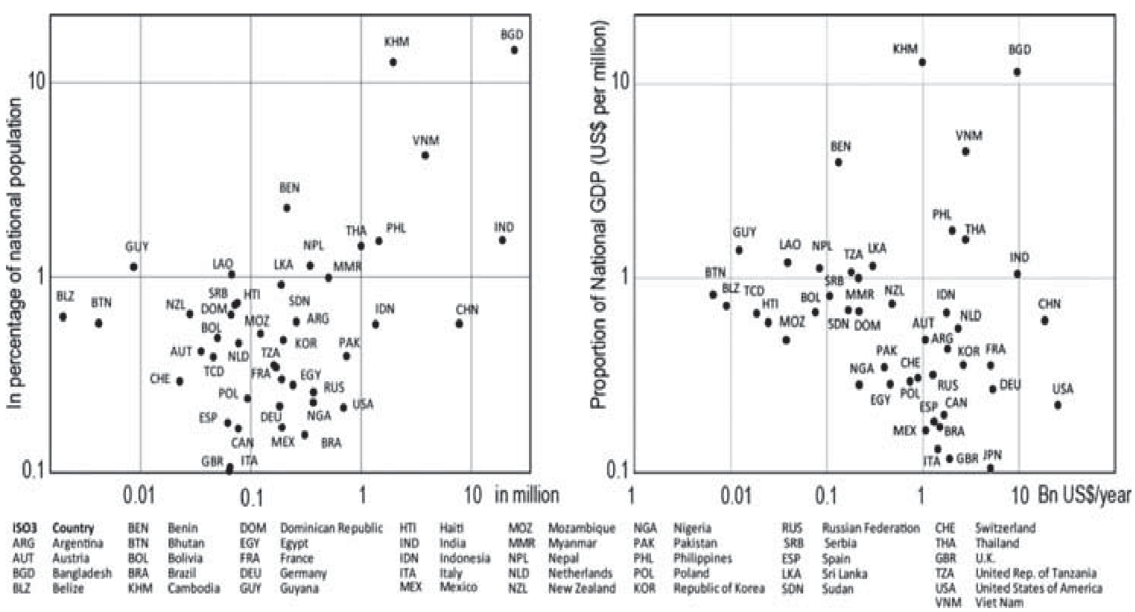




Source: Kundzewicz, Z. W.; Kanae, S.; Seneviratne, S. I.; et al., (2014) Flood risk and climate change: global and regional perspectives. Hydrol. Sci. J. 59(1), 1-28.

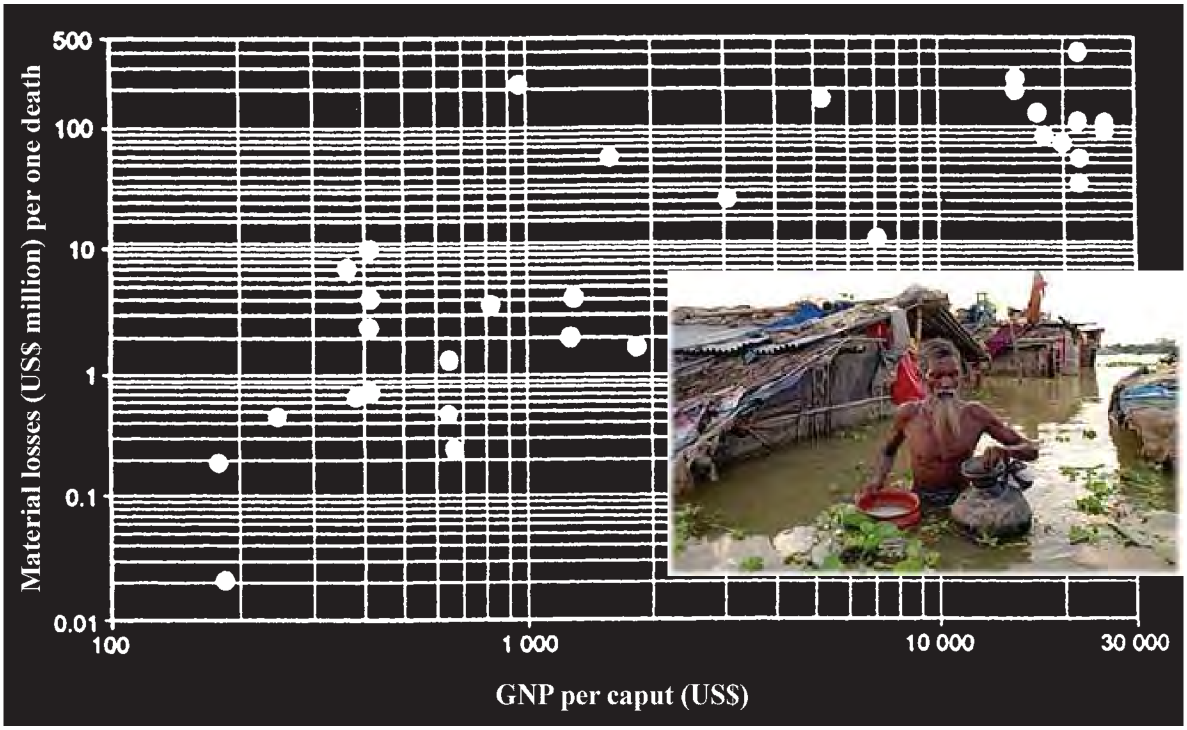






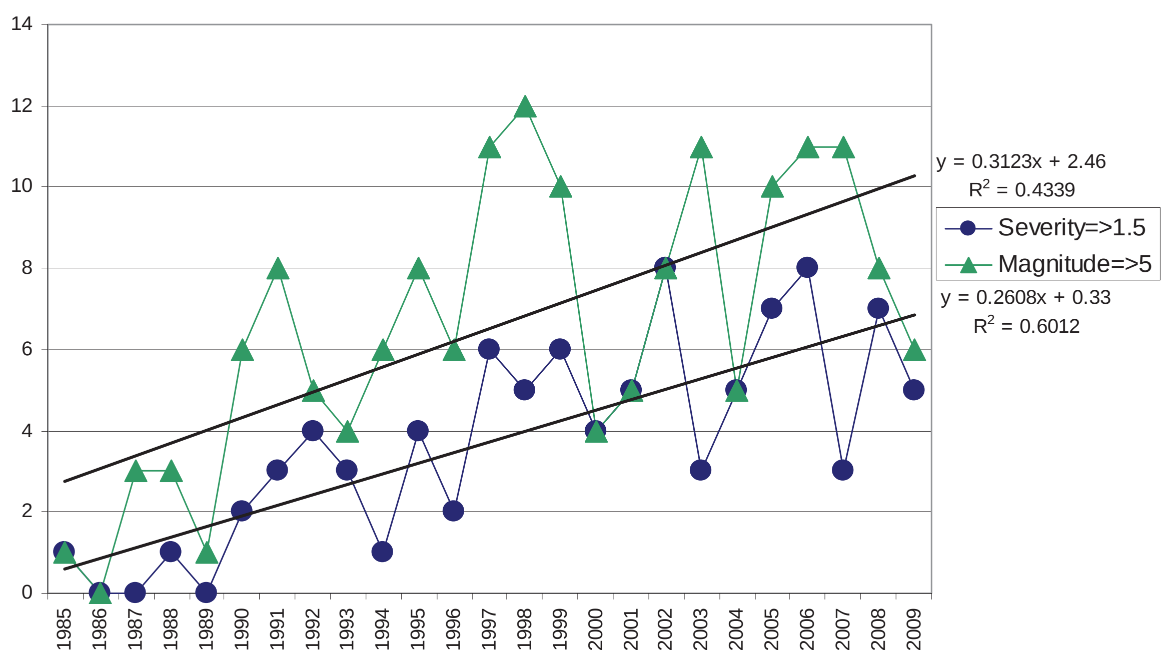
Exposure to floods: (left) number of people exposed to floods (per year) in terms of absolute numbers and relative proportions; (right) total assets and GDP exposed to floods (per year), absolute and relative.

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. Based on work by **Peduzzi.**



Flood preparedness depends on wealth

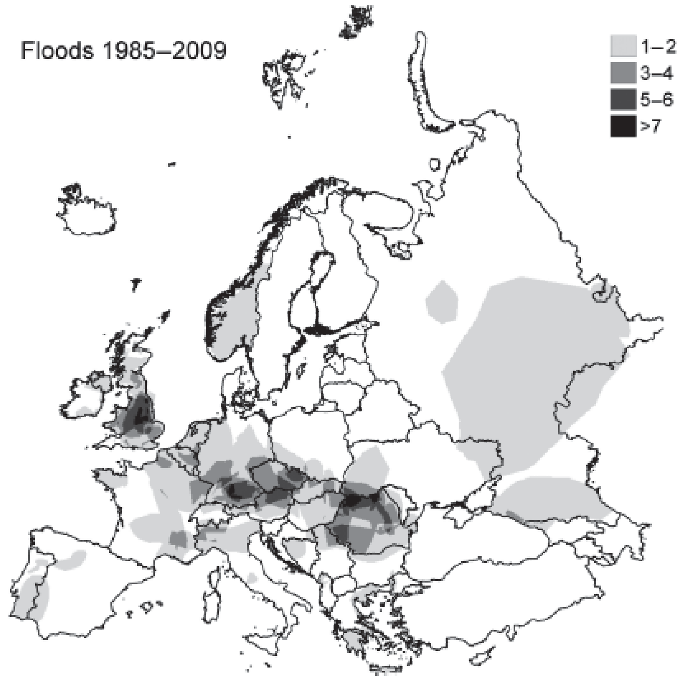
[Kundzewicz & Takeuchi, 1999]



Increasing number of large floods in Europe, according to the data in Dartmouth Flood Observatory. Source: Kundzewicz, Z.; Pińskwar, I.; Brakenridge, R. (2013) Large floods in Europe, 1985-2009. HYDROL. SCI. J. 58(3), 736-736.

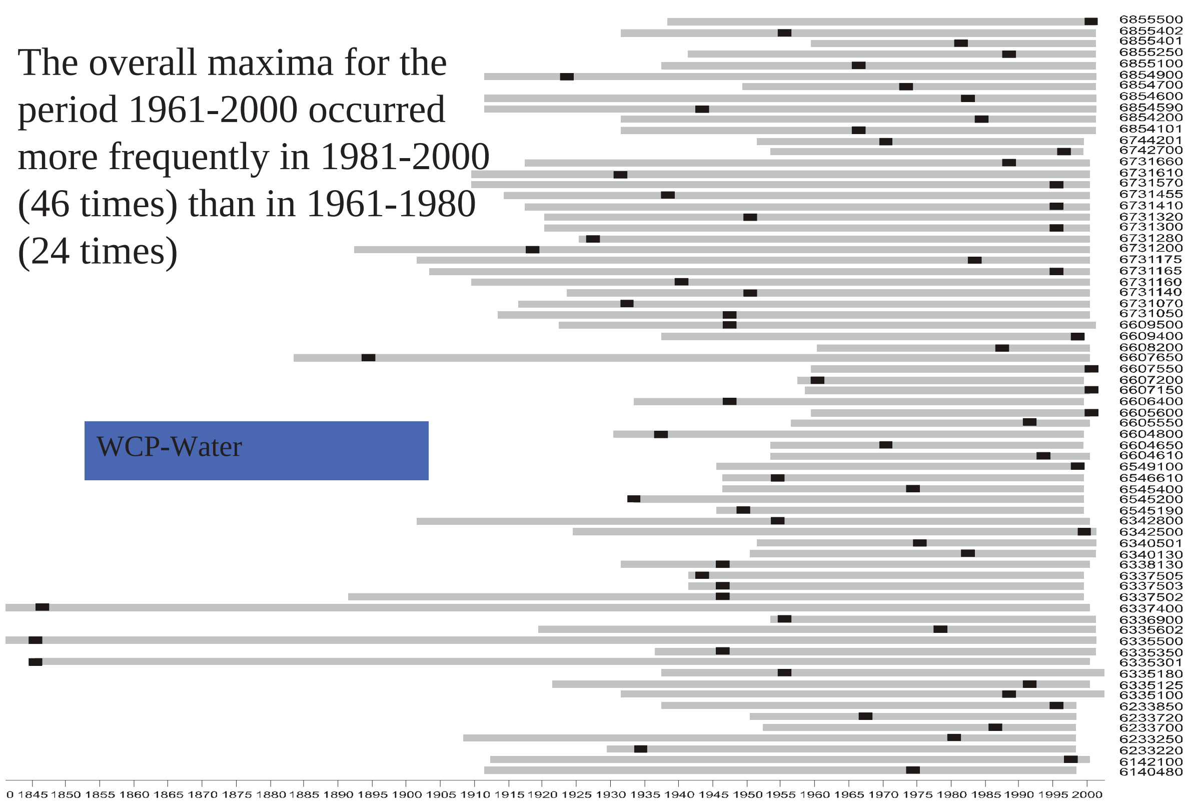
Spatial distribution of number of large floods in Europe, 1985-2009

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



Year of occurrence of maximum flow in Europe (Source: Kundzewicz et al., *Hydrol. Sci. J.*, 2005)

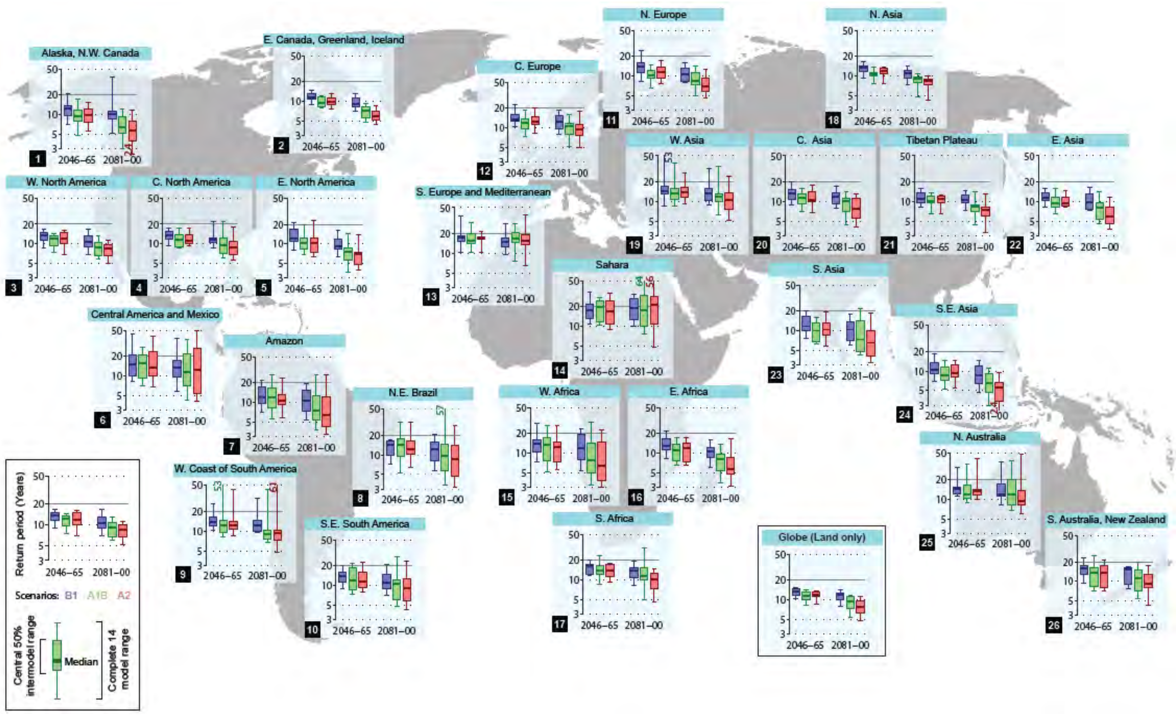
The overall maxima for the period 1961-2000 occurred more frequently in 1981-2000 (46 times) than in 1961-1980 (24 times)

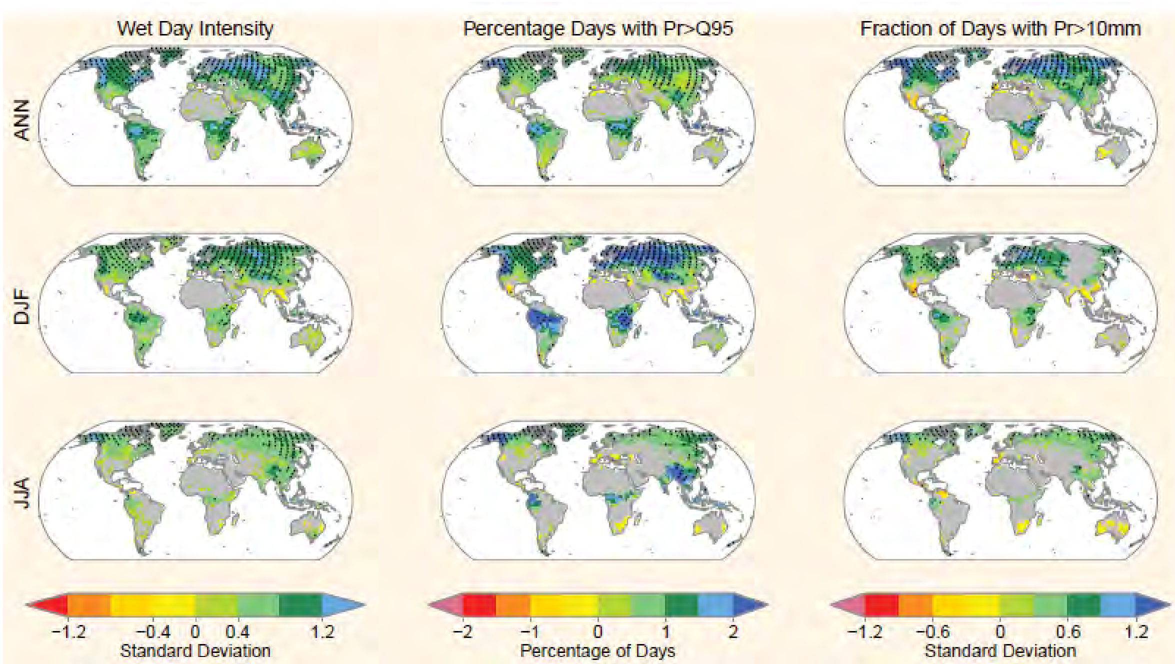


WCP-Water

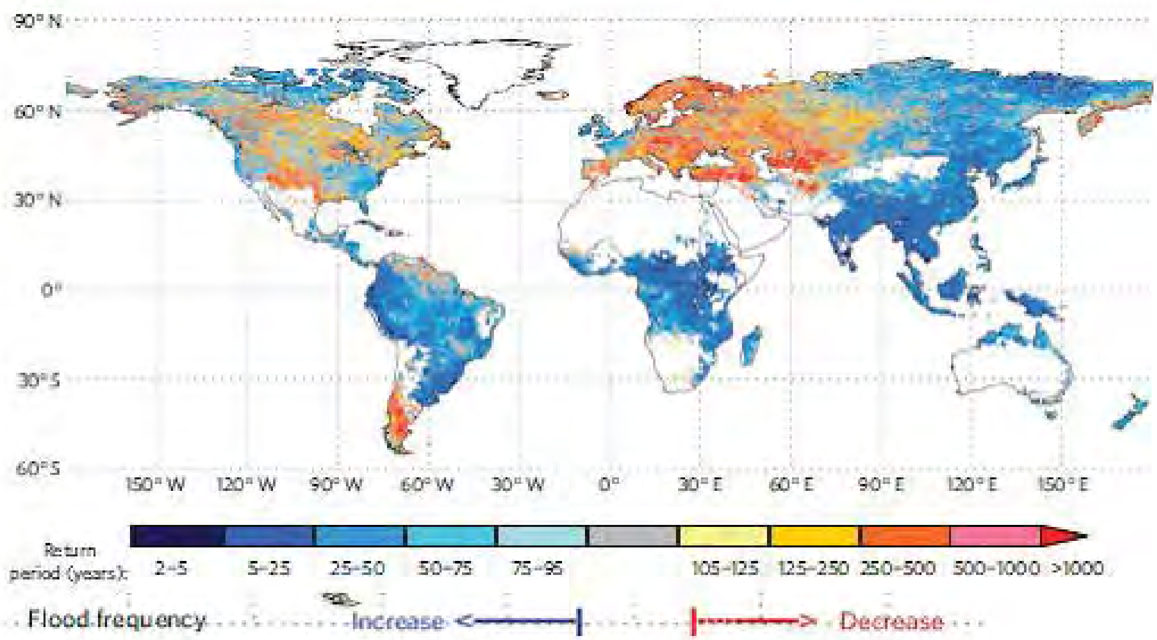
Projections show increase of intense precipitation

Source: IPCC SREX

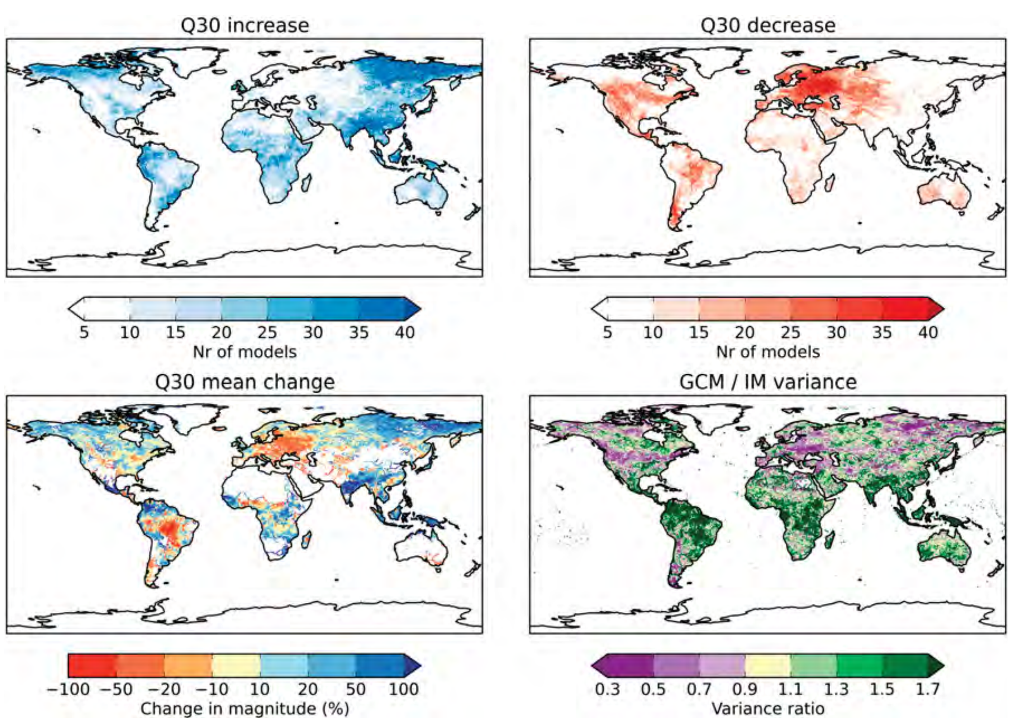




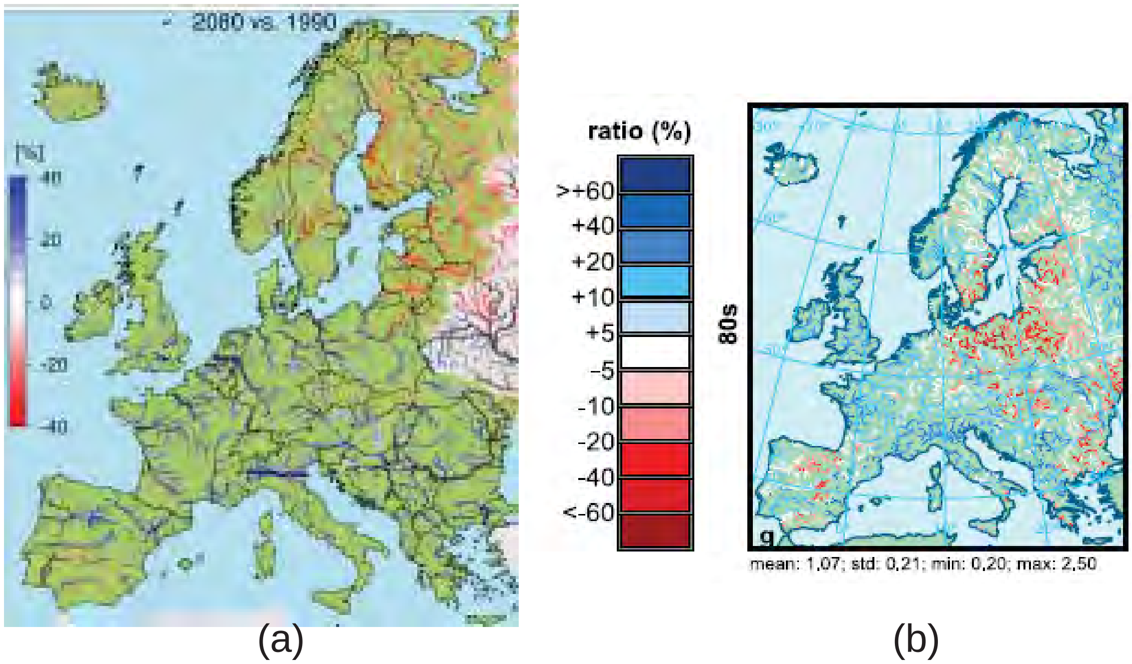
Projected annual and seasonal changes in three indices for daily precipitation (Pr) for 2081-2100 with respect to 1980-1999, based on 17 GCMs contributing to the CMIP3. Source: Seneviratne et al., SREX, 2012.



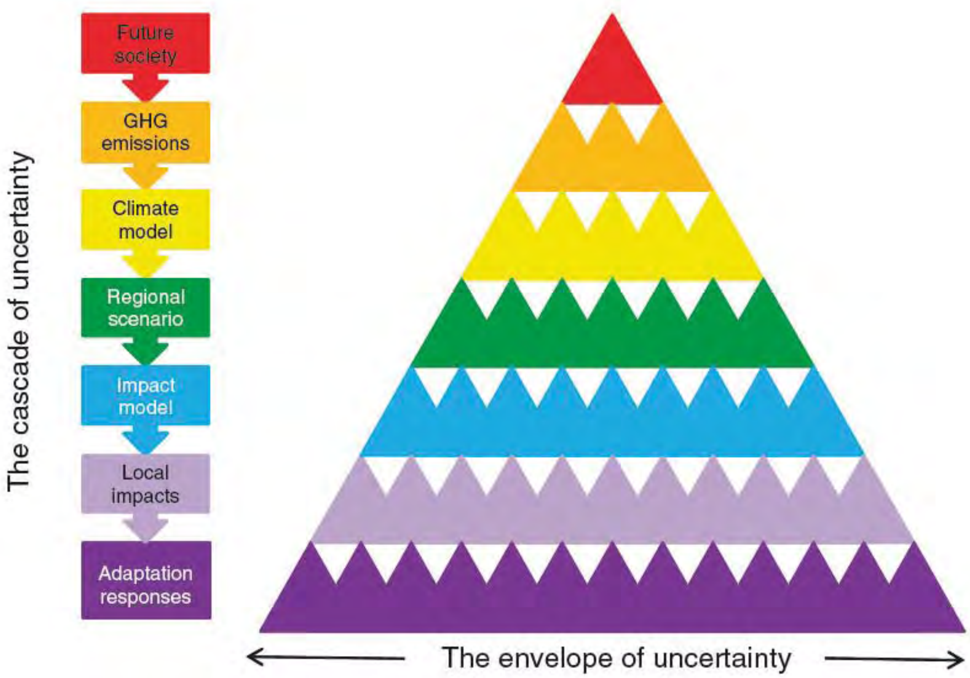
Changes in frequency of 100-year river discharge (Hirabayashi et al., 2013)



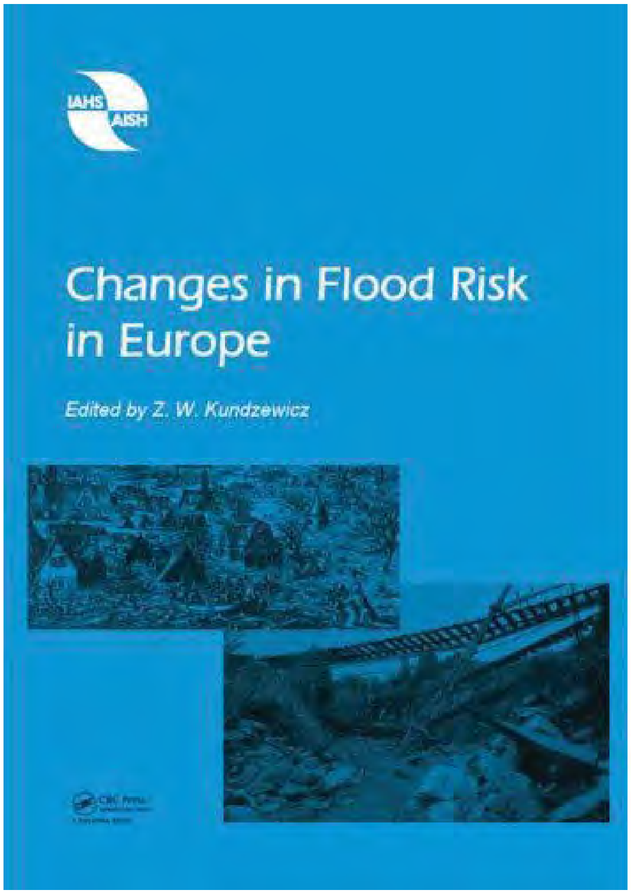
(Upper) Number of experiments (out of 45 in total) showing an increase (Left) or decrease (Right) in the magnitude of Q30 of more than 10% in 2070–2099 under RCP8.5, compared with 1971–2000. (Lower Left) Average change in the magnitude of Q30 across all experiments. (Lower Right) Ratio of GCM variance to IM variance. Source: **Dankers et al., PNAS, 2014**



Comparison of flood hazard projections reported in (a) Alfieri *et al.* (2015) and (b) Rojas *et al.* (2012). Maps show changes in Q100 between the time horizon 2080s and the control period (a) 1976-2005 and (b) 1961–1990. Source: Kundzewicz, Z. W., Krysanova, V., Dankers, R., Hirabayashi, Y., Kanae, S., Hattermann, F. F., Huang, S., Milly, P. C. D., Stoffel, M., Driessen, P.P.J., Matczak, P., Quevauviller, P., Schellnhuber, H.-J. (2016) Differences in projections of changes in flood hazard in Europe – their causes and consequences for decision making – submitted to *Climatic Change*.



Source: Wilby & Dessai, 2010



IAHS Press / CRC Press
(Taylor & Francis)

IAHS Special Publication 10

(*April 2012*)

516 + xvi pages

(**WATCH, FLORIST** projects)

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OECD Conference on the Financial Management of Flood Risk, Building financial resilience in a changing climate

Understanding floods: technical Improvements, Improvement Technique

12-13 May 2016
OECD Paris

Dominique Berod
GEO secretariat

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Swiss Alps, 13-15 October 2000

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Messages

1. Floods are complex processes. They occurred, and will occur, anywhere and anytime.
2. Prevention is the best solution
3. Survey is the key
4. Cooperation is crucial

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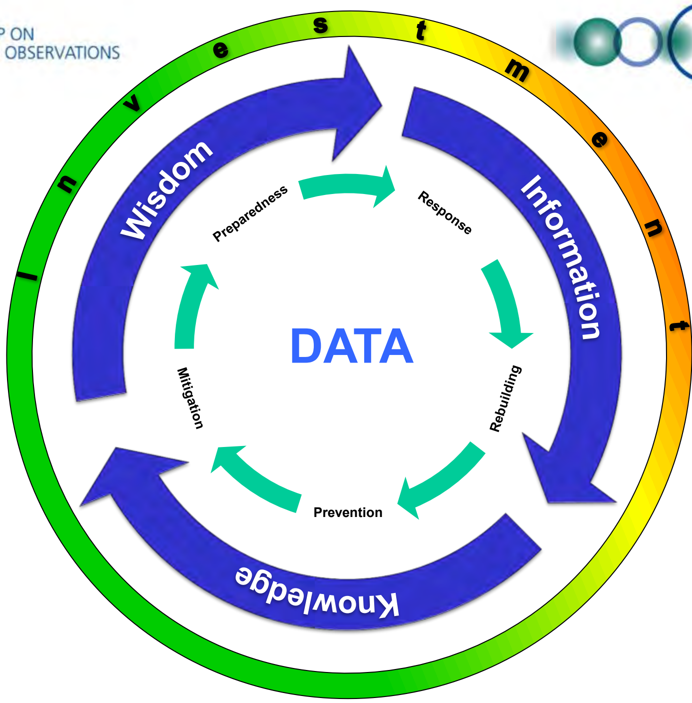
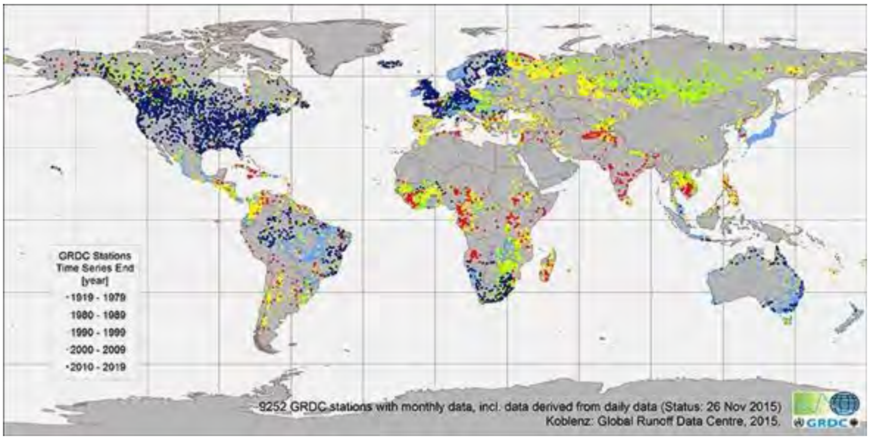


National hydrometry networks



Hydrometry networks are: 1. Essential and 2. Insufficient

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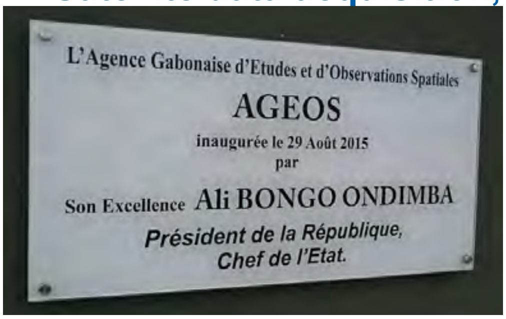
Satellite data acquisition, example of Gabon



COPERNICUS: 1250 DVD per day:
impossible to analyse all acquired data!

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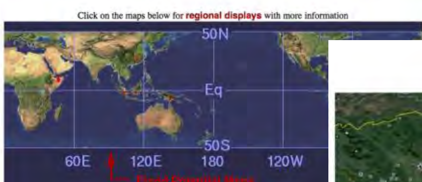
Example of satellite product



HV-polarized ALOS-2 Charter image from Vietnam flooding, 0445 UTC 31 July 2015

JAXA, Courtesy Bob Kuligowski - NOAA Federal

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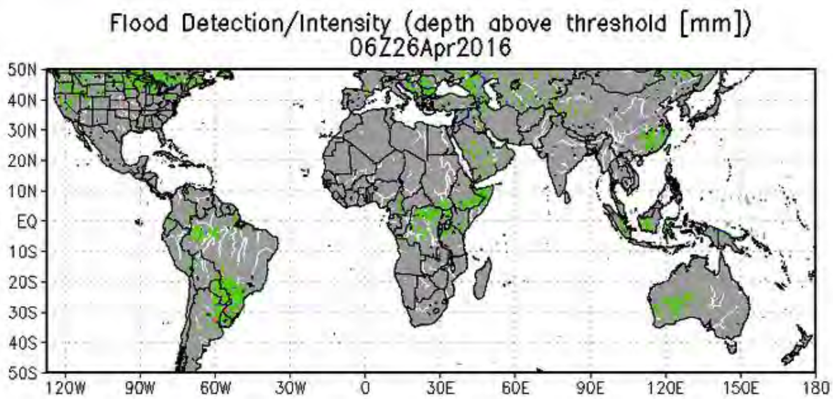
The Global flood monitoring System (GFMS), University of Maryland

Real-time quasi-global hydrological calculations at 1/8th degree and 1 km resolution (source: flood.umd.edu)



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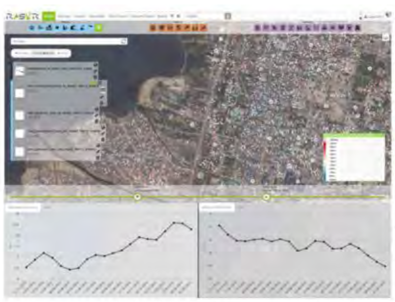
Prototype of Flash Flood dashboard for Caribbean/Central America

http://matsu-flashflood.opensciencedatacloud.org/

Courtesy Stu Frye, NASA



Map of Port-au-Prince with elevation changes determined by RASOR team (red=decrease; blue=increase) based on ~1 year of RADARSAT-2 images. This can in turn be related to changes in flood risk. (Credit: F. Kuodogbo, Altamira)

Courtesy Bob Kuligowski, NOAA Federal

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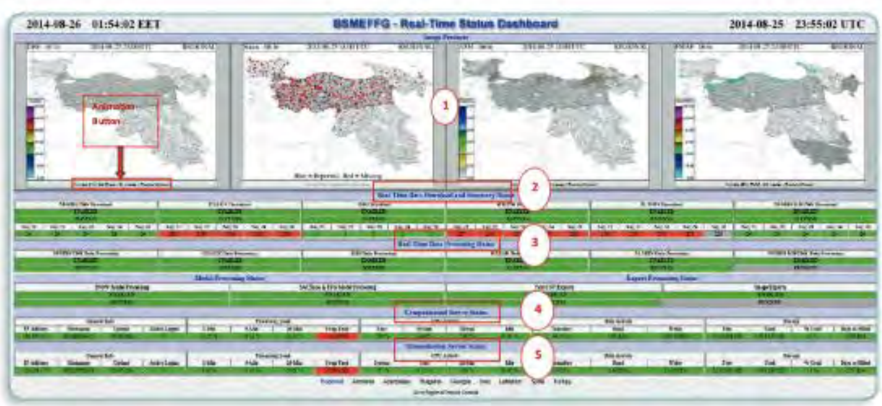
Example of real time data integration: Black Sea flash floods system



From: From: Black Sea And Middle East Flash Flood Guidance System User Guide, Turkish Meteorological Service, 2015

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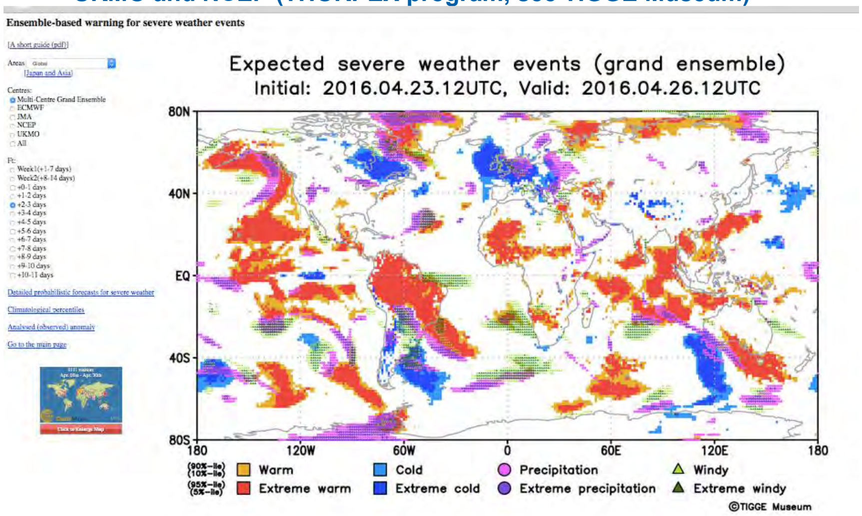
Example of ensemble-based early warnings products for extreme weather events: TIGGE

Operational ensemble forecasts from global centres: ECMWF, JMA, UKMO and NCEP (THORPEX program, see TIGGE Museum)



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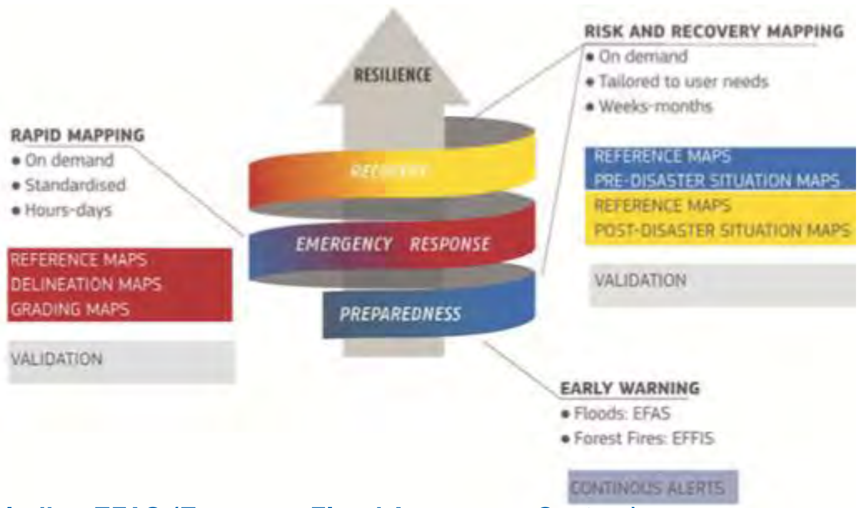
COPERNICUS Emergency service



Including EFAS (European Flood Awareness System)

Courtesy Françoise Villette, EC-COPERNICUS

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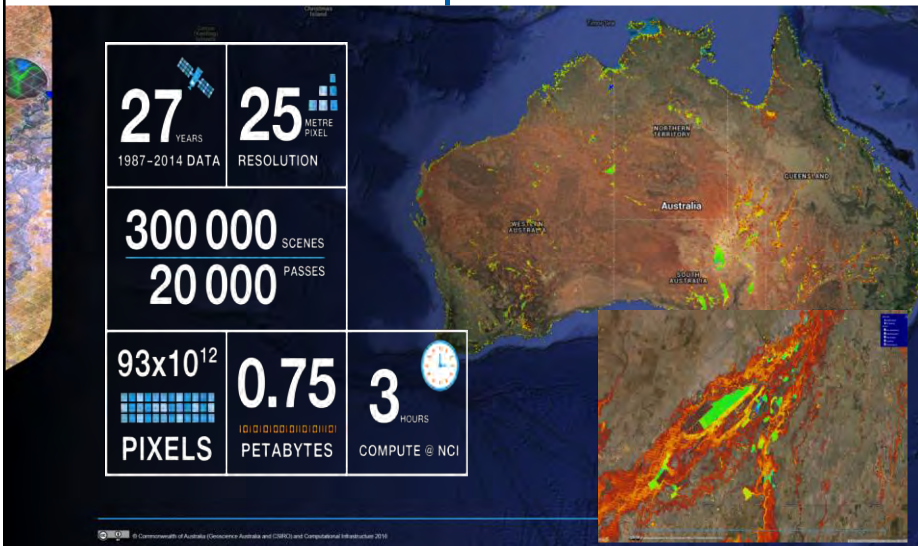
Multiple algorithms: the Australian Data Cube

Courtesy Stuart Minchin, Geoscience Australia

Data Cube example: combination of water observations from space



Courtesy Stuart Minchin, Geoscience Australia

Many actors involved in disaster risk reduction

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The intergovernmental Group on Earth Observations (GEO)

- Voluntary partnership between governments and organizations
- **Coordinated, comprehensive and sustained Earth observations and information informing decisions and actions, for the benefit of humankind**
- **Open data policy**
- **GEOSS: A Global, Coordinated, Comprehensive and Sustained System of Observing Systems**

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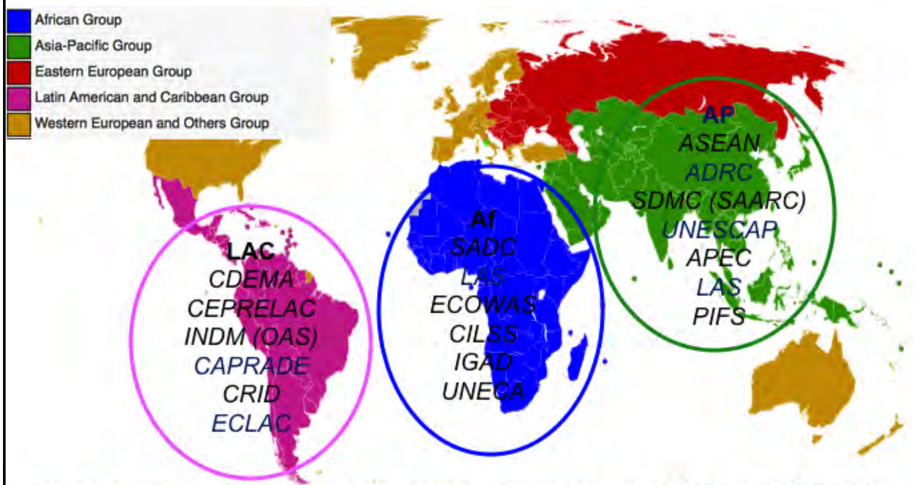
Cooperation exemple: GEO – DARMA starting in 2016

Establish an inclusive, comprehensive process to address local DRR requirements by using EO technologies efficiently.

GEO-DARMA Partnership Approach



Courtesy Ivan Petiteville, ESA

International: consider regional processes and programmes of GFDRR, UNDP, UNEP, UNESCO, across regions and in areas where there is no regional organisation (e.g. Central Asia

Summary

$$\frac{\partial \rho}{\partial t} + \nabla\cdot(\rho \mathbf{u}) = 0 \qquad \rho\left(\frac{\partial \varepsilon}{\partial t} + \mathbf{u}\cdot\nabla\varepsilon\right) - \nabla\cdot(K_H \nabla T) + p\nabla\cdot\mathbf{u} = 0 \qquad \frac{\partial \mathbf{u}}{\partial t} + (\mathbf{u}\cdot\nabla)\mathbf{u} = -\frac{1}{\rho}\nabla p + \mathbf{F} + \frac{\mu}{\rho}\nabla^2\mathbf{u}$$

From Data to Decision: a multidisciplinary value chain

Many new developments, many remaining challenges: IMPACT!

Partnerships & coordination mechanisms for data collection AND interpretation

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Thank you!

earthobservations.org

dberod@geosec.org

(as of June 1, 2016: dberod@wmo.int)

The Evolving Nature of Flood Risk – Understanding Flood Drivers and Impacts

Milan Simic, PhD

AIR WORLDWIDE

Main Innovations in Modelling Flood Risk

AIR

Many Organisations are Contributing to the Global Understanding of Flood Risk

KatRisk

RMS

JBA risk management

CoreLogic

ambiental predicting · preventing · protecting

RISK FRONTIERS

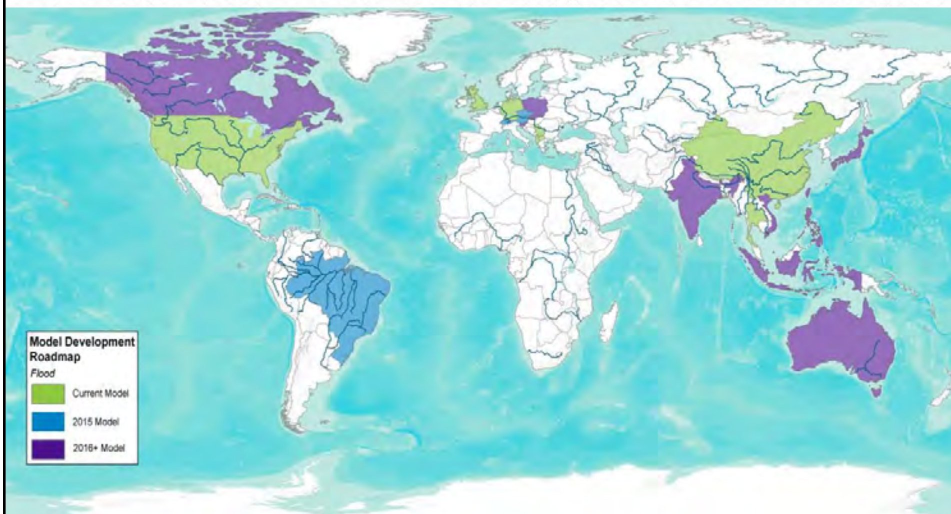
Met Office

SSBN FLOOD RISK SOLUTIONS

Flood Hazard Maps have Become Well-Established

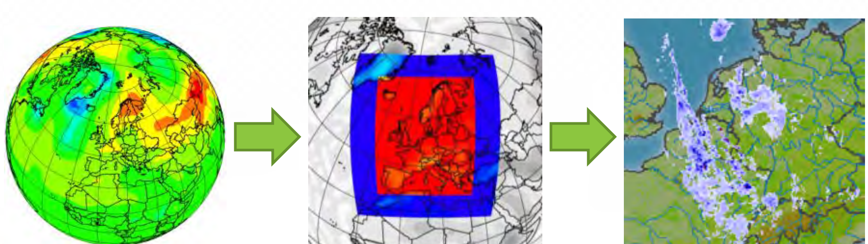
- Hazard maps are
  - Areas of uniform hazard
    - 100 year, 250 year, and 500 year
  - Defined by the probability of hazard
  - Can use physical processes and/or statistical regression
- Hazard maps are NOT
  - Footprints of individual events or potential events
  - Based on loss information

Flood Hazard Map Coverage and Quality Increases All the Time … but They Have Known Limitations

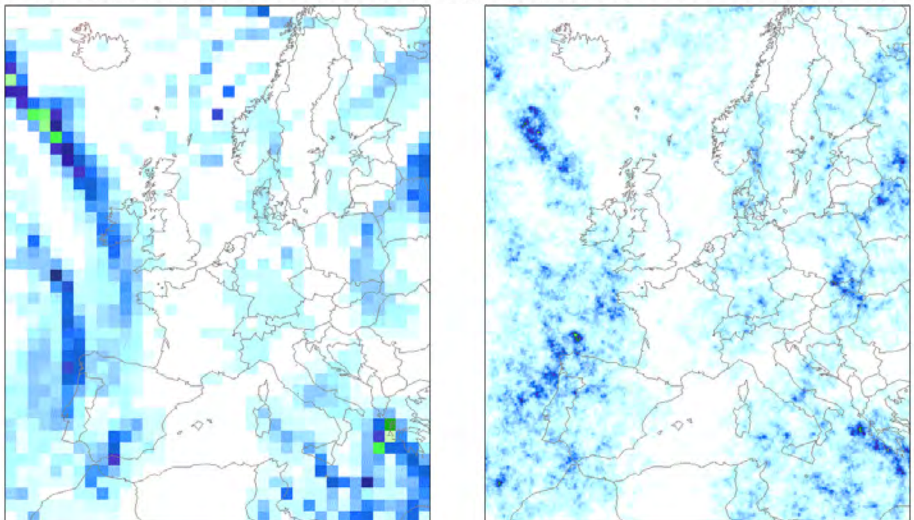


How to Model Local Realisation of a Global Phenomenon?

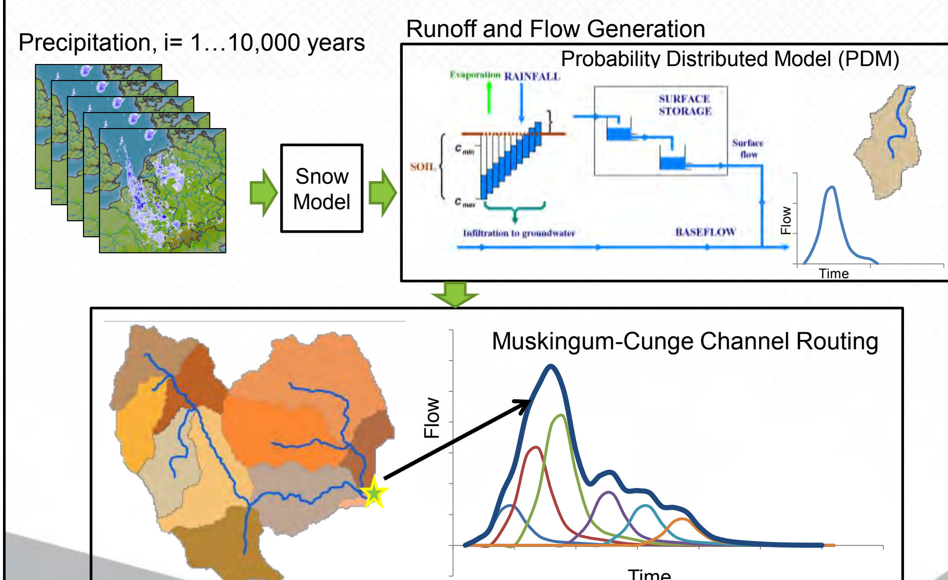
Coupling Global Circulation Models (GCMs) at global scale with mesoscale Numerical Weather Prediction (NWP) models at regional scale can provide coherent large-scale precipitation patterns



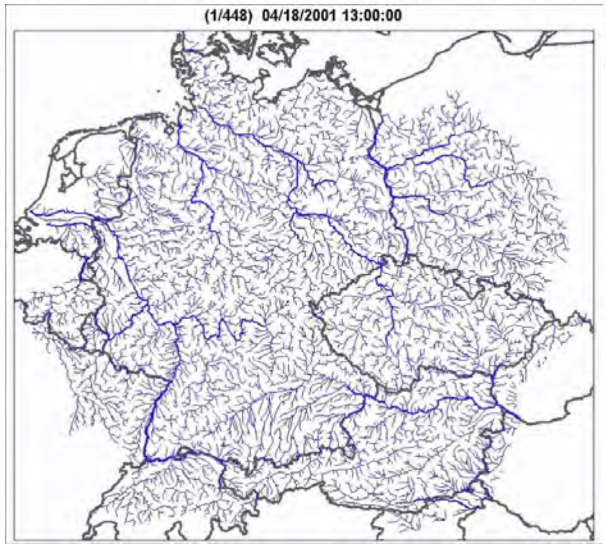
Advanced Downscaling Can Take Coarse Simulation Results and Generate Realistic Looking Precipitation Patterns



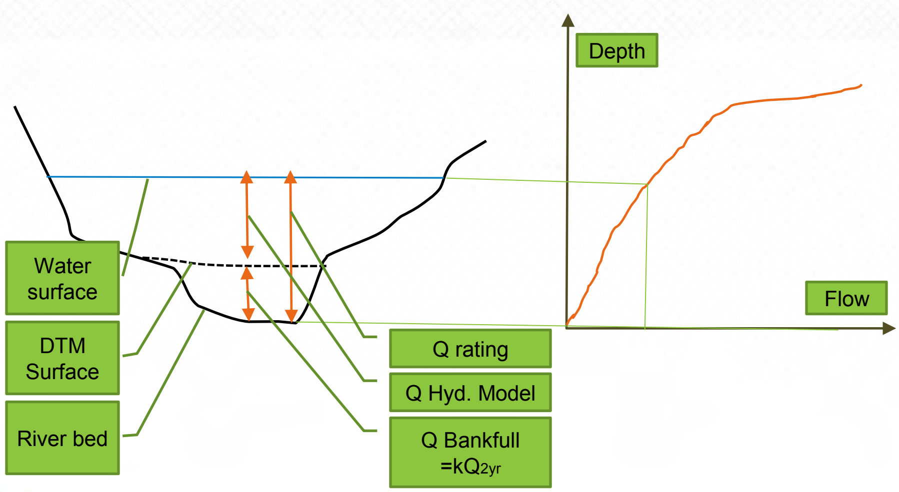
How to Transform Precipitation to Flow?



Precipitation Correlation Needs to be Preserved and Flow Calculated Over Large Distances



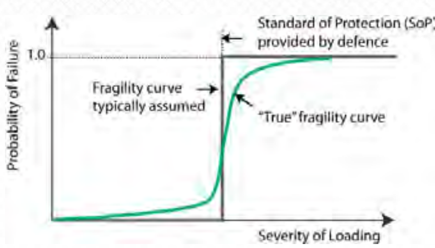
How to Estimate Water Level Along the River Network for Various Flows?

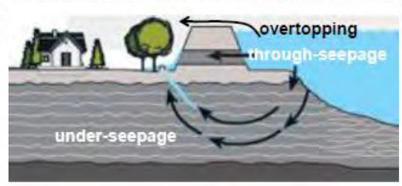


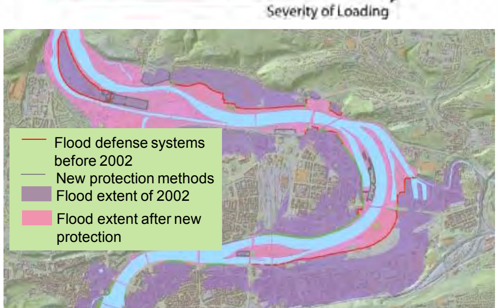
How to Determine Flood Extent Based on Water Level and Flow Results?

- Combination of hydraulic model with flood mapping provides a realistic flood extent
- Many flood extent layers can be created to account for the hazard more accurately

How to Take into Account Flood Defences and Their Potential Failure?

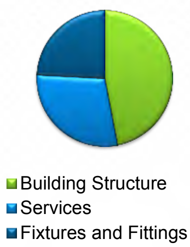


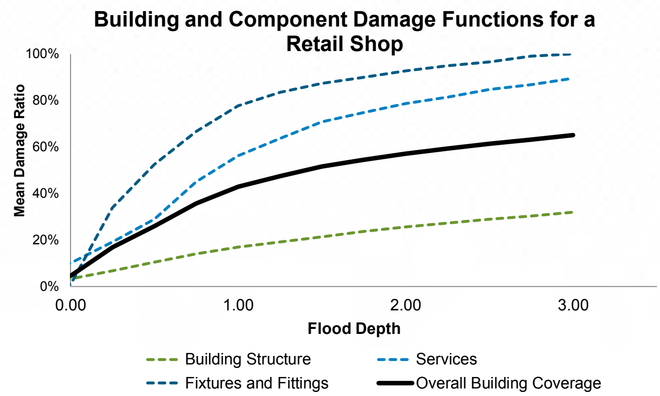




How to Model Vulnerability to Flood?

- Property is divided into key flood-vulnerable components
- Each component vulnerability is aggregated using component cost breakdown to determine the overall building vulnerability



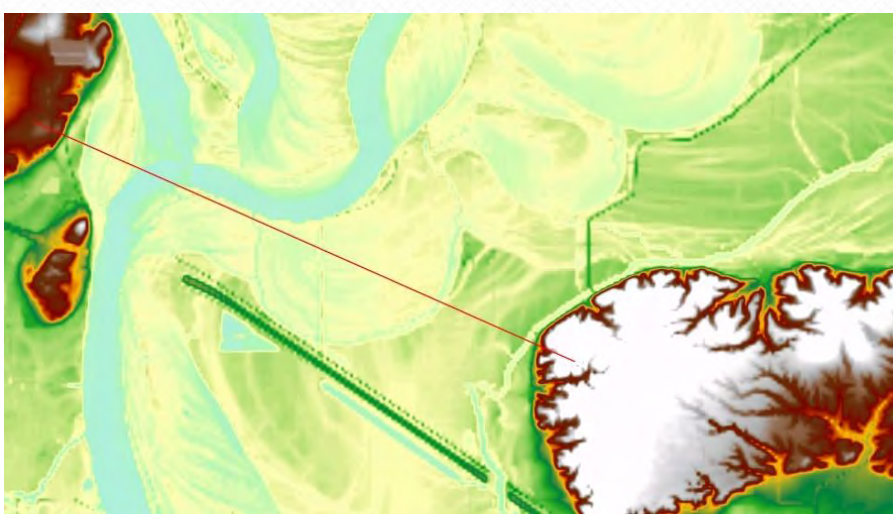


Remaining Challenges in Understanding Flood Risk

AIR

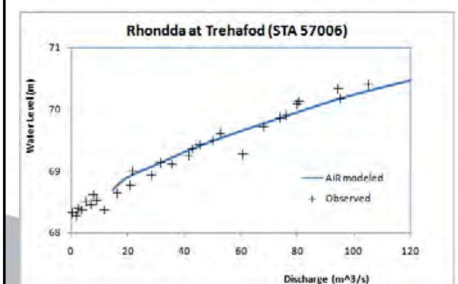
Reliable Flood Footprints are Still not Quickly and Readily Available

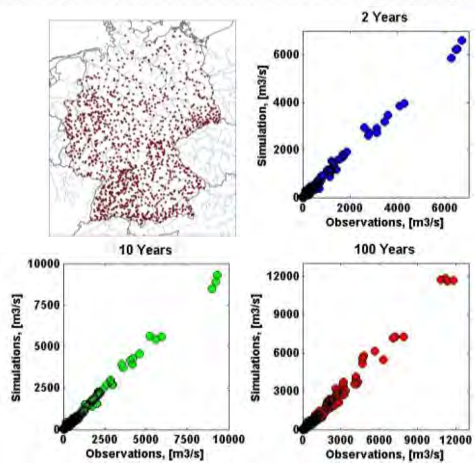
Availability, Quality and Choice of DTMs Can Play a Major Role in Understanding and Quantifying Flood Risk



Distance in Meters

Flow and Water Level Validation Requires More and Better Data





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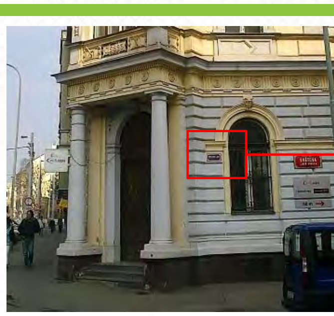
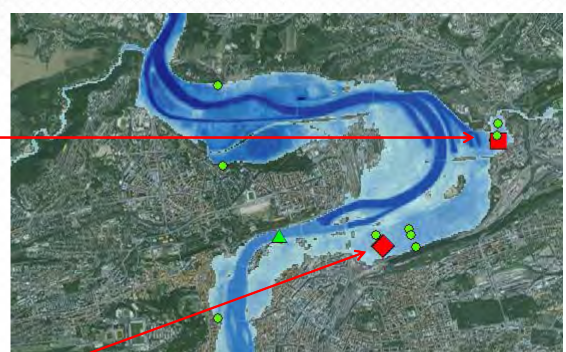
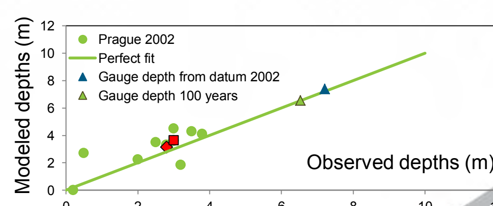
Watermarks Data Exist, but is not Collected, Stored and Available Consistently



Na Poste, Liben, ~ 3 m depth

Thámova, Karlín, ~ 3 m depth





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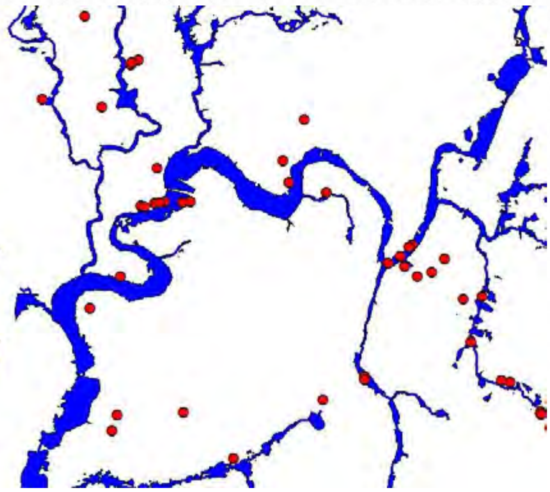
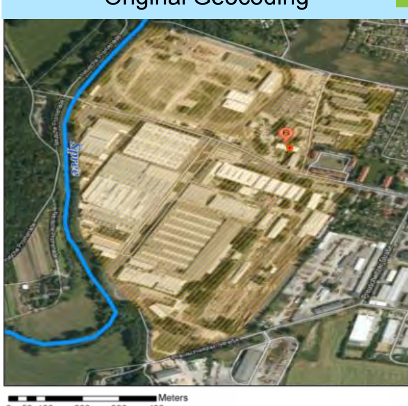
Understanding and Quantification of Off-flood Plain Losses Can Still be Improved

- On plain flood
- Off plain flood
  - Sewer backup
  - Sheet flow
  - Flash flooding
  - …



Geocoding Accuracy and its Treatment can Have Profound Impact on Quantification of Flood Losses

Original Geocoding

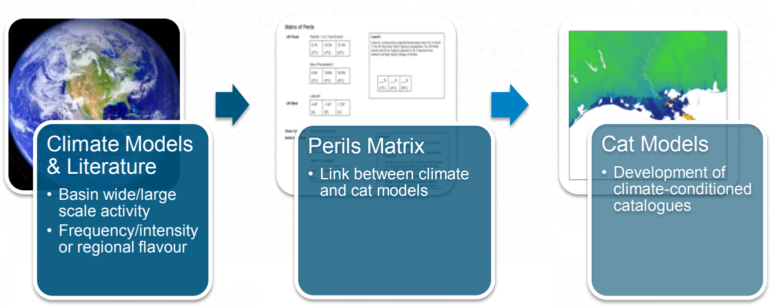


Best Estimate: Grid Geocoding

Accuracy of Flood Risk Assessment is Often Better at Aggregate Level

Ability to Deal With the Impact of Climate Change Within Flood Cat Models is Still Relatively Poorly Understood

- Coupling between Met Office's climate models and AIR's catastrophe models

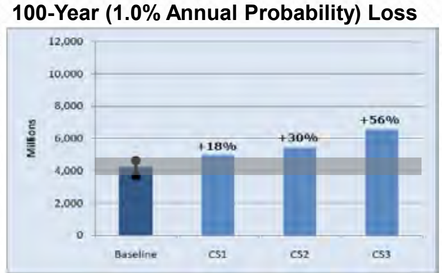


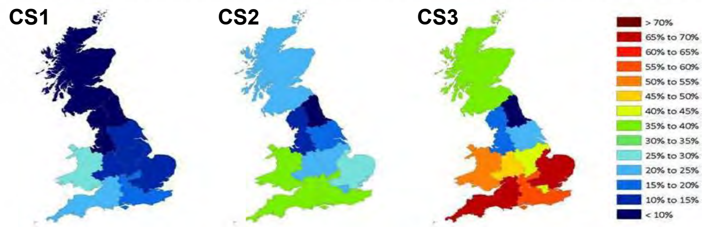
Association of British Insurers

Met Office Hadley Centre

Example Changes in 1.0% Exceedance Probability Loss Conditioned on Met Office Climate Scenarios

100-Year (1.0% Annual Probability) Loss





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