International Conference on Flood Management (ICFM) Webinar#5:
**VALUING WATER**
World Water Day 22 March, 2021

# The value of science in managing water crises, including climate change-induced hydrological extremes

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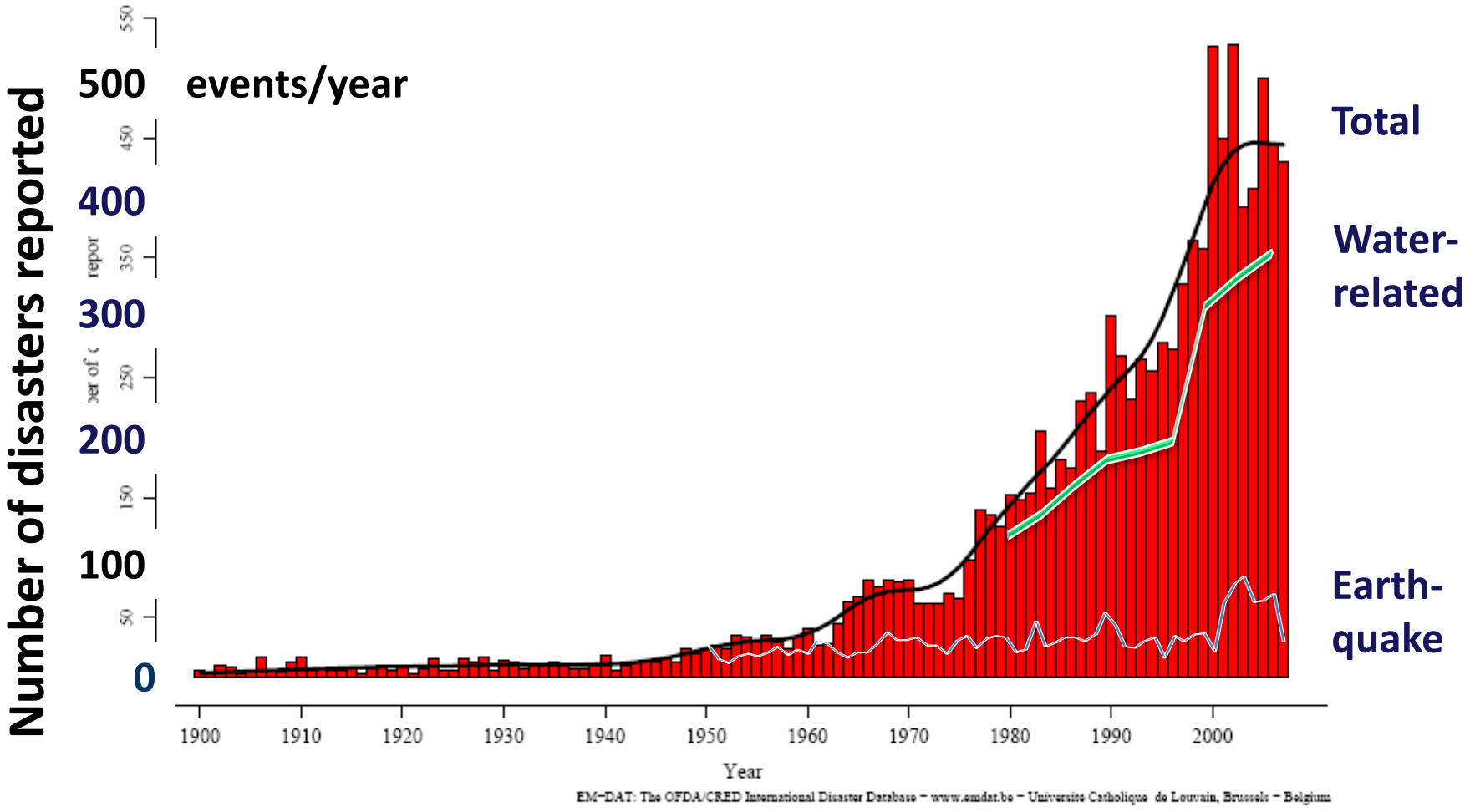
National University of Public Service (NKE), Budapest, Hungary;
Chair, Sustainable Water Futures Programme, Brisbane, Australia


MORE FLOODS
MORE NEGATIVE IMPACTS

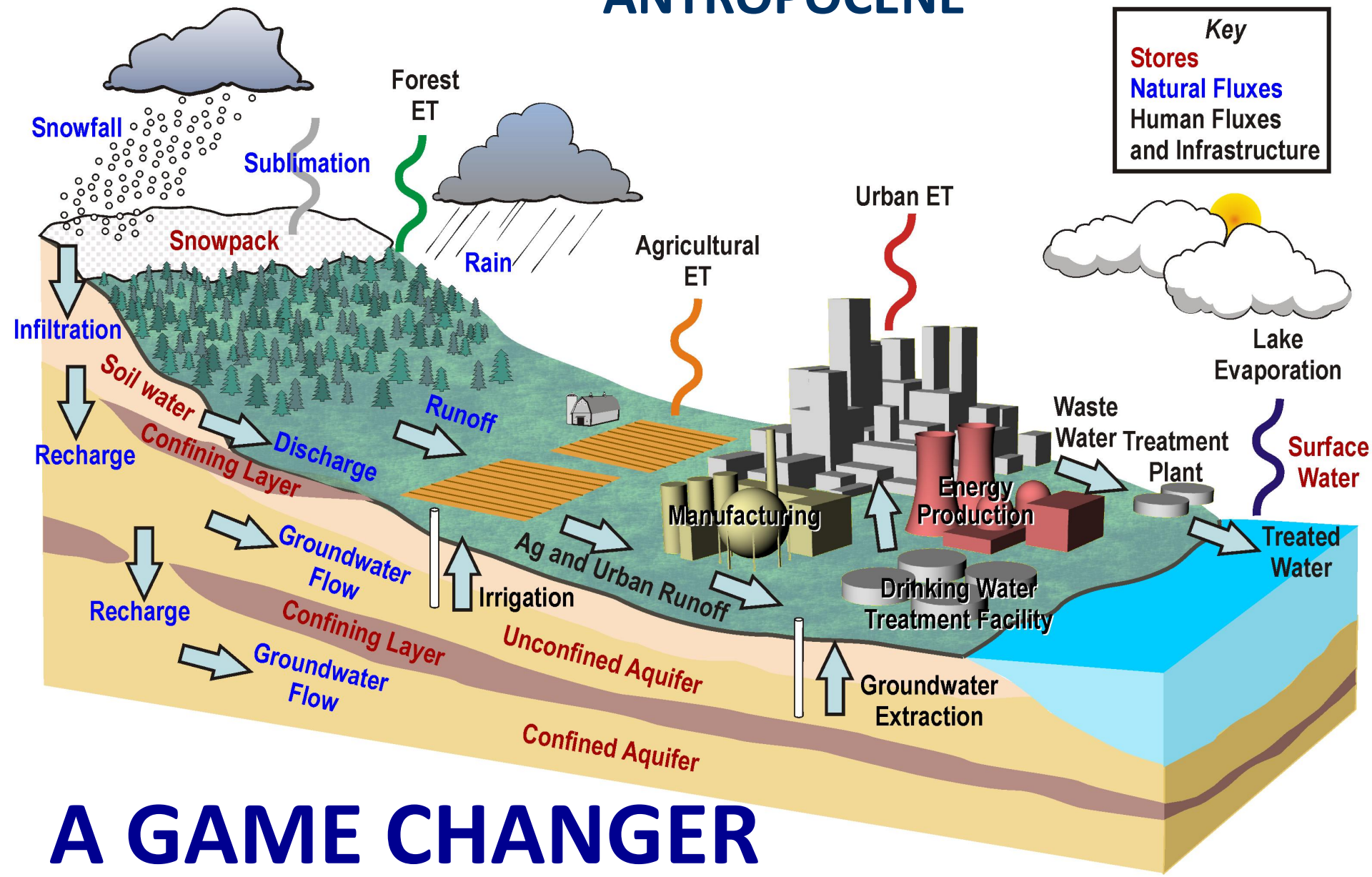
# 18 October, 2018: SOUTHERN FRANCE,
Aude département
**FLASH FLOOD**
IN 126 SETTLEMENTS
14 DEAD, 75 SERIOUSLY INJURED

**SEVEN MONTHS PRECIPITATION IN ONE DAY…**

# Number of natural disaster events since 1900 to 2007



# ANTROPOCENE




# A GAME CHANGER

SUPERIMPOSED ON ALL THIS …

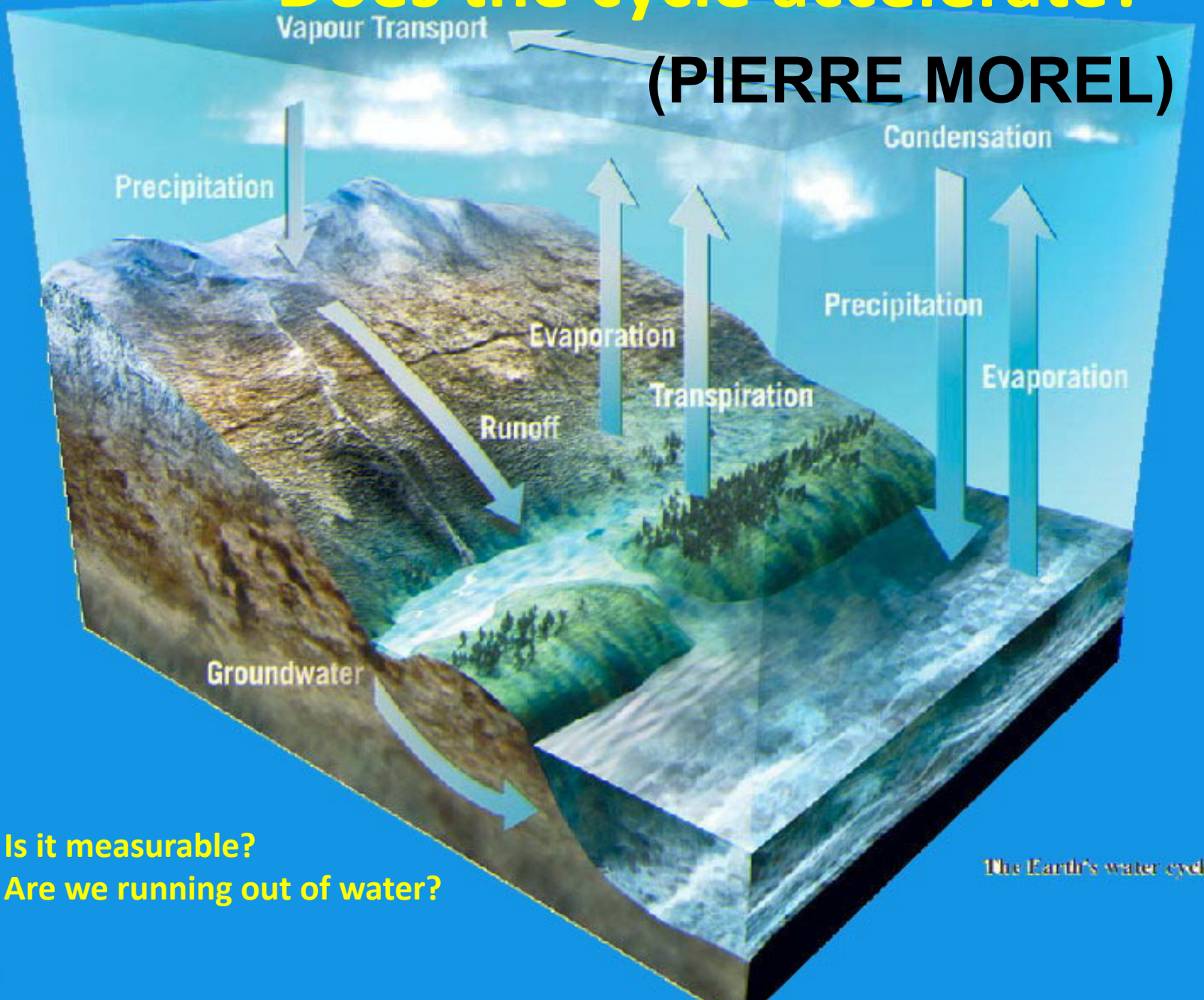
# HEADLINE NEWS!!!!!

# The climate is changing !!!

(Yap, for 4 billion years now …)

# Does the cycle accelerate?

## (PIERRE MOREL)




The Earth's water cycle

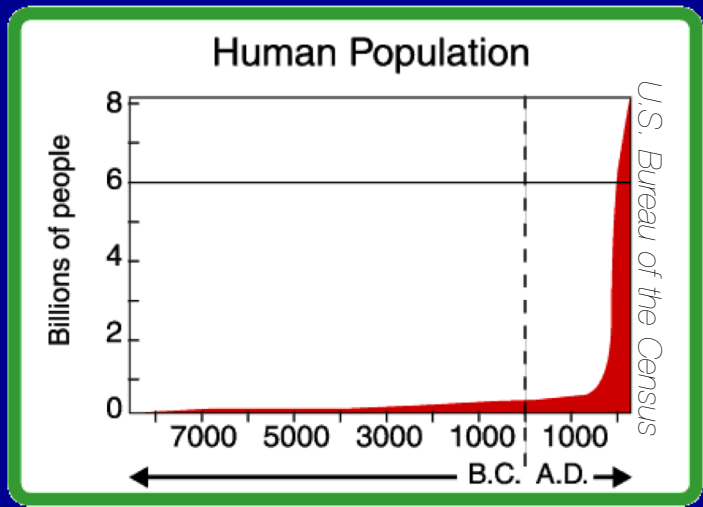
**Is it measurable?**
**Are we running out of water?**

# GLOBAL WATER CYCLE ISSUES

- Is the cycle changing?
- Increased risks?
- Growing vulnerability?
- More disasters ?
- Less water for people?
- Crisis is looming?
- What crisis?
- Resource?
- Governance?
- Global or local?

# Global change drivers in the last few centuries:

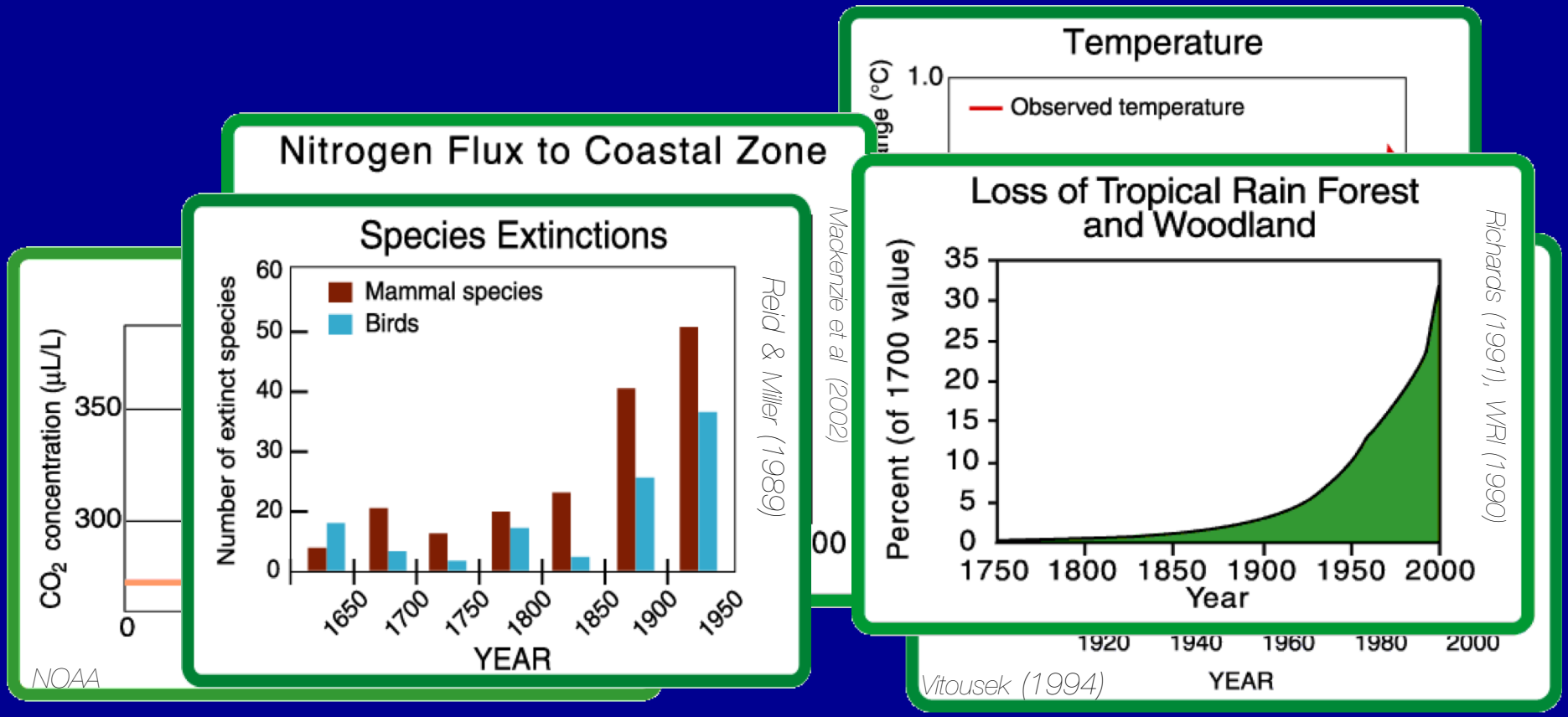
- **Population growth, movement and age structures**
- **Geo-political changes and realignments**
- **Trade and subsidies**
- **Technological changes**
- **Climate change**

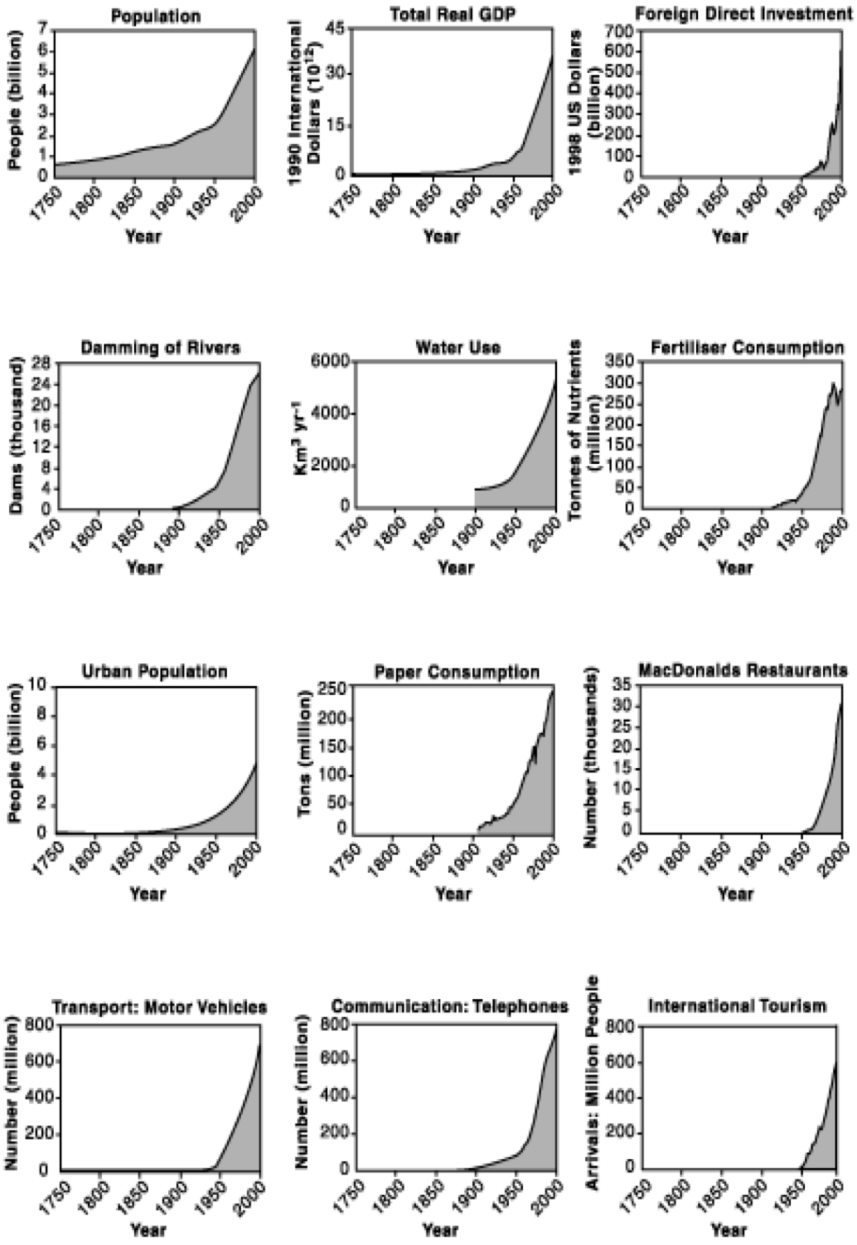


# Global change impacts

- Global change is more than global climate variability/change
- It has natural PLUS human/social dimensions
- A constellation of changes, many global in domain

*For example, we see large changes in:*






From: Steffen et al. 2004

# STATIONARITY IS DEAD

THE FUTURE WILL NOT BE THE SAME AS THE PAST

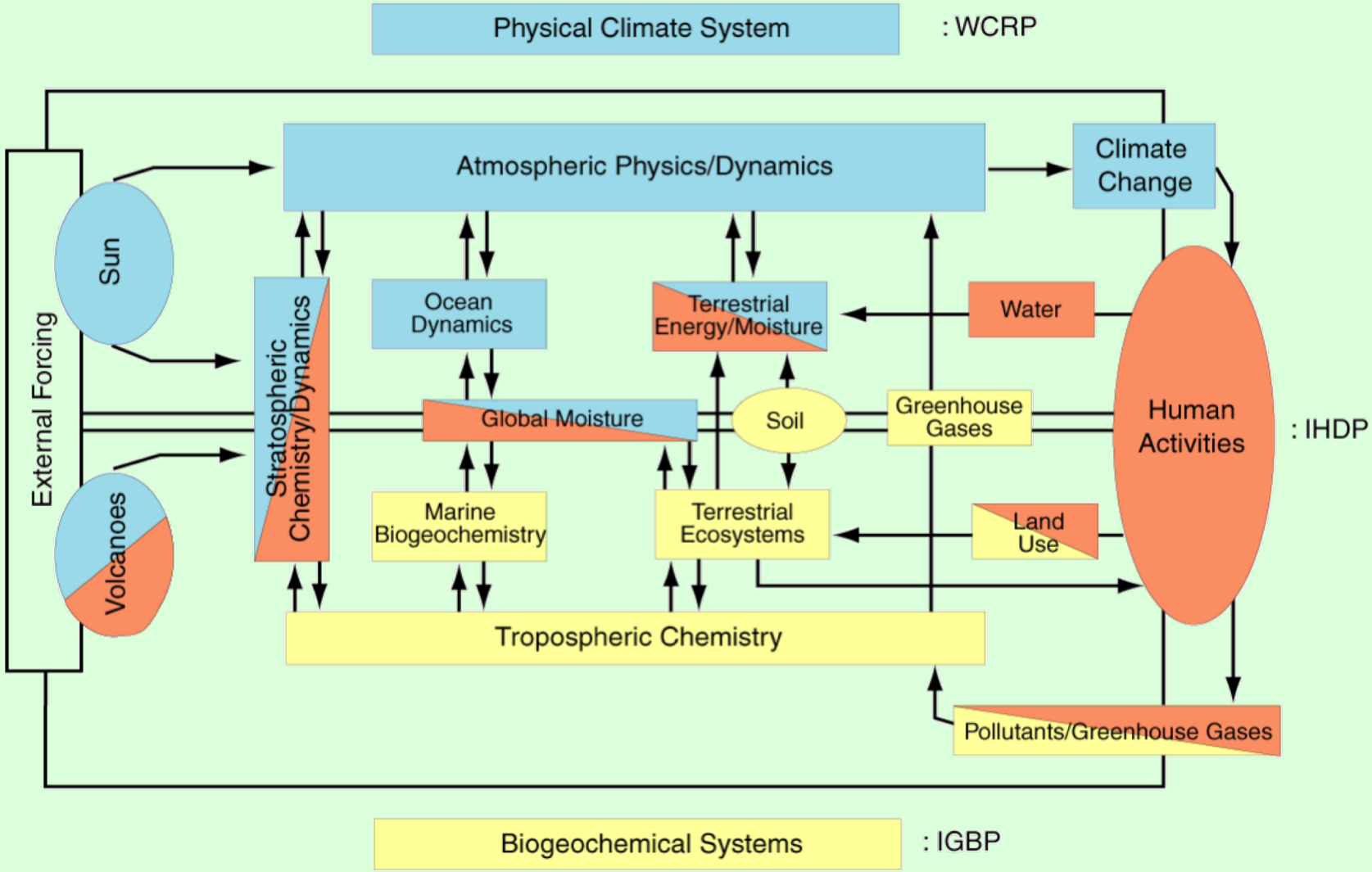
The story of the 200-year flood

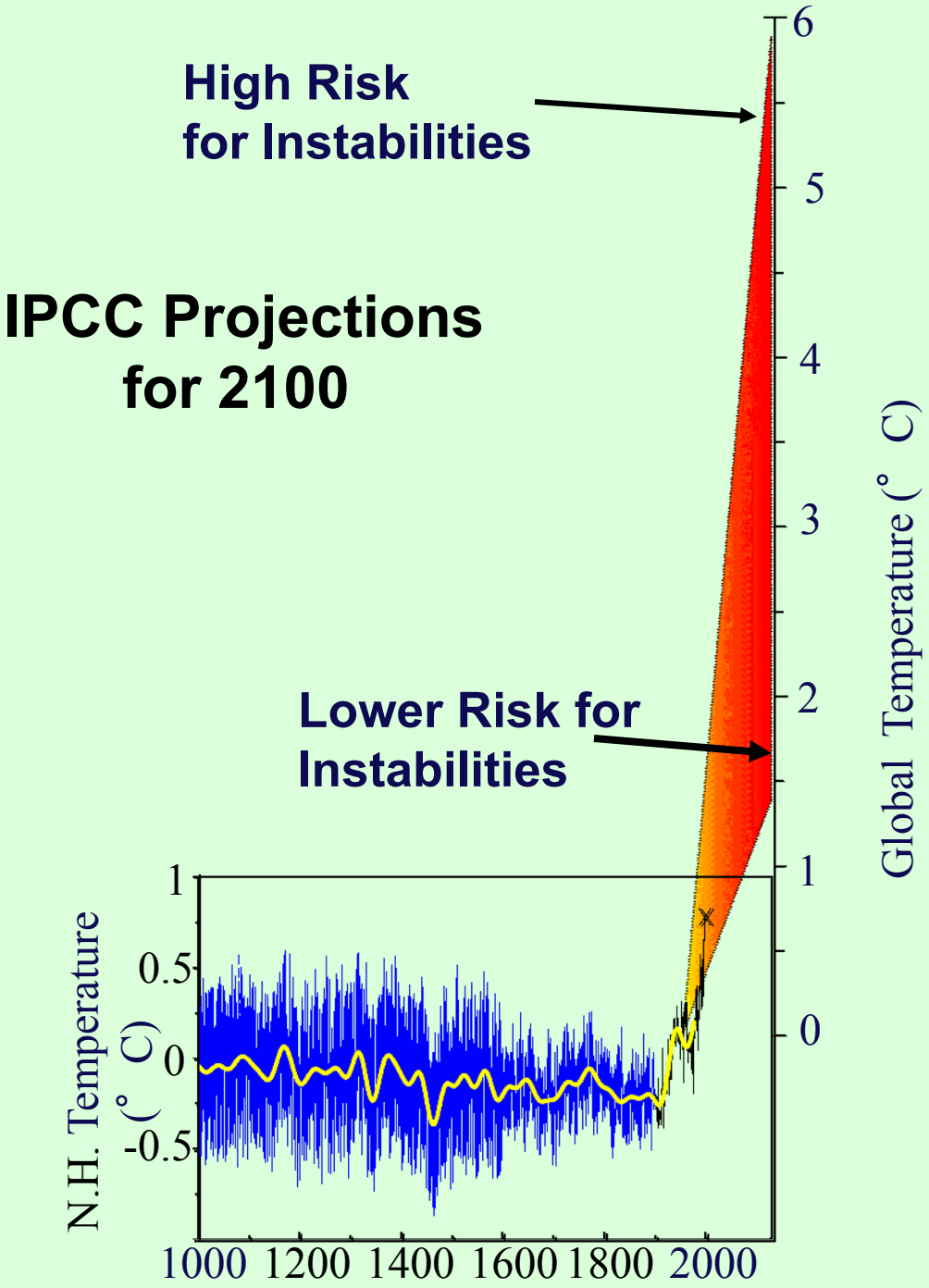
New technologies are needed

# WILL WE HAVE MORE FLOODS ?

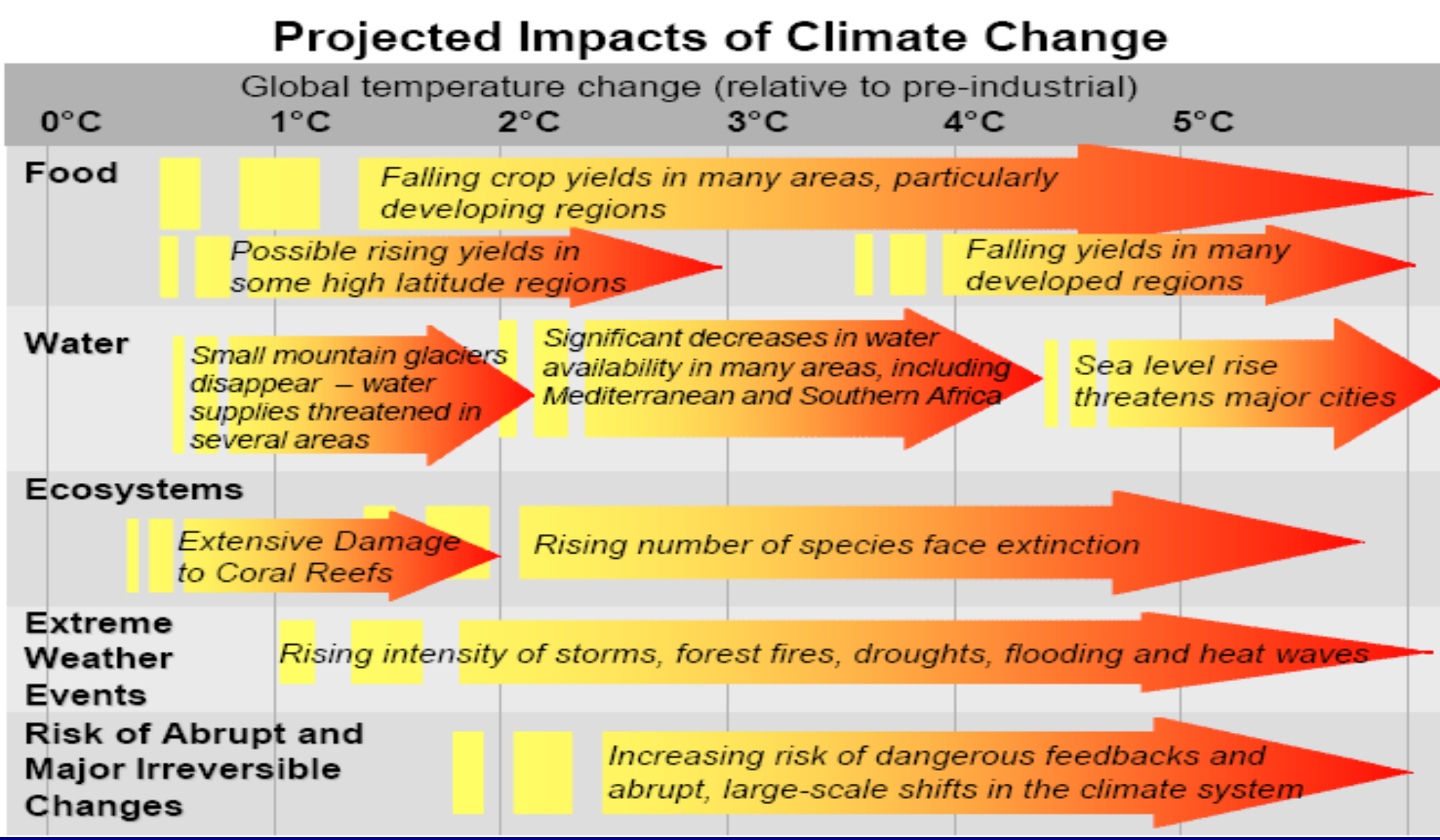
Expected Impacts of Global Changes on Water Resources

# The Earth System: Coupling the Physical, Biogeochemical and Human Components




High Risk
for Instabilities
IPCC Projections
for 2100
Lower Risk for
Instabilities
Global Temperature (° C)
6
5
4
3
2
1
0
N.H. Temperature
(° C)
1
0.5
0
-0.5
1000 1200 1400 1600 1800 2000

# Climate change is effecting our environment, our societies and our cultures

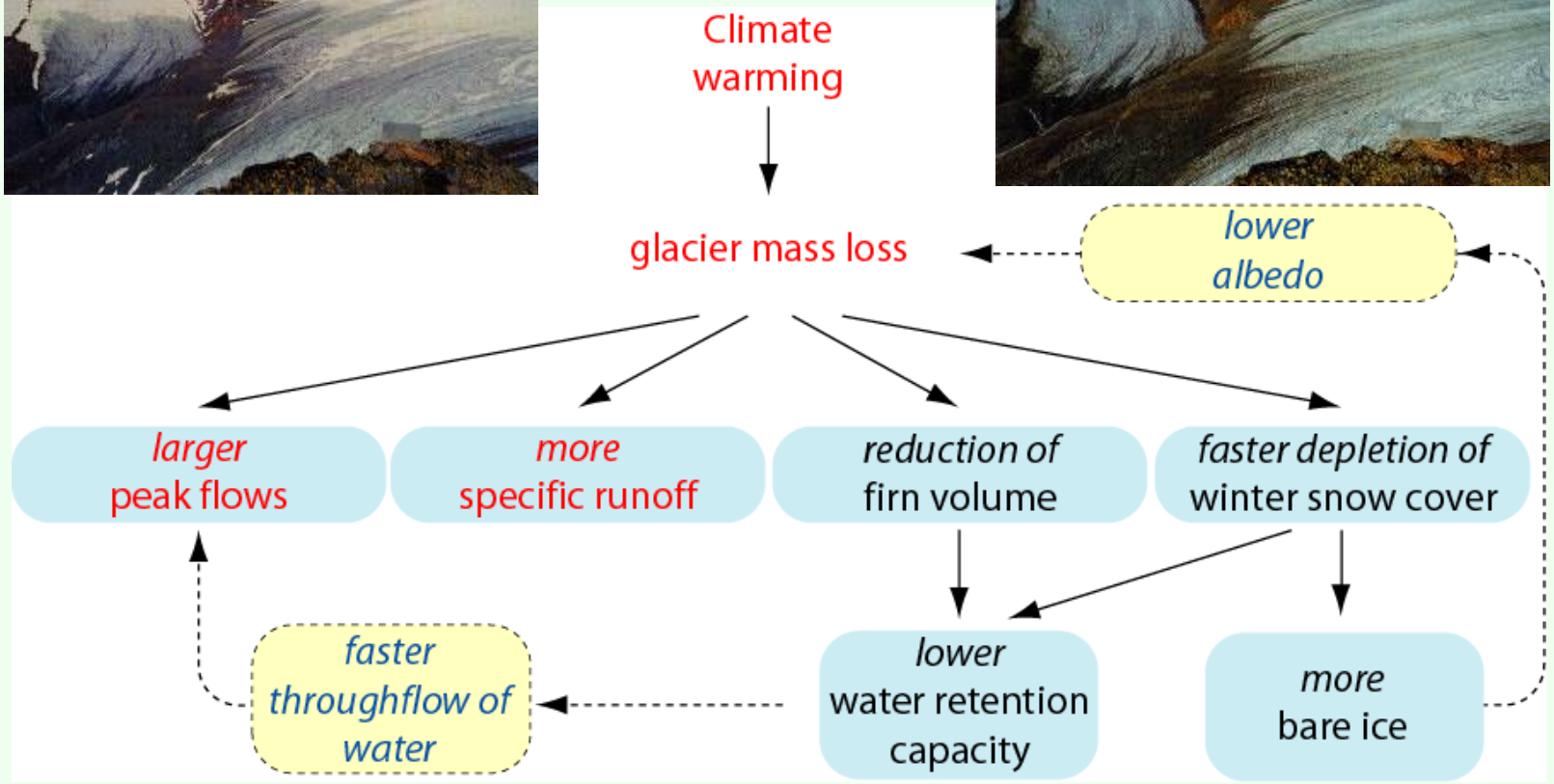



(Source: IPCC)

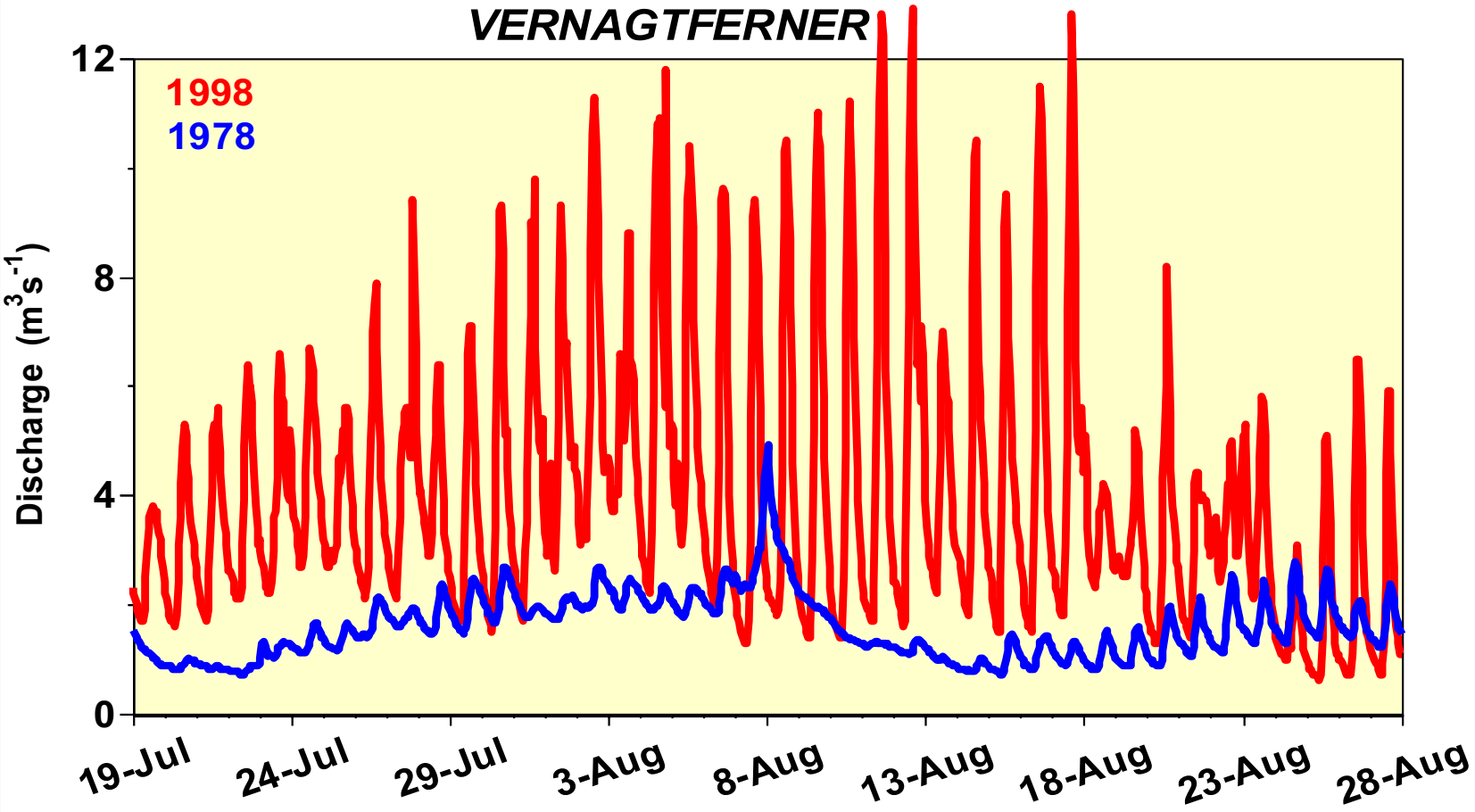
**POSITIVE FEEDBACK**

# Response to warming: Diurnal Variations





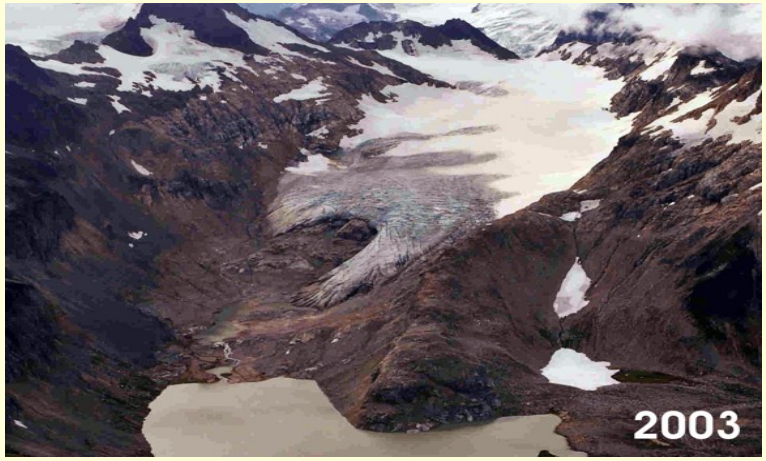

(©Gudfinna Aðalgeirsdóttir)



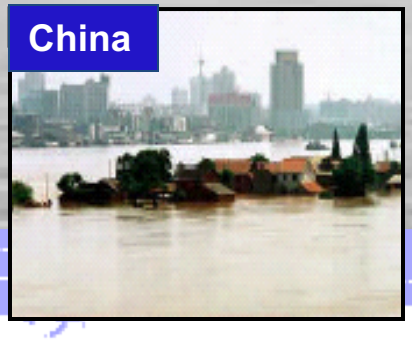

(Source: **Bayerische Akademie der Wissenschaften**, Glaziologische Kommission)

# South Cascade Glacier (Washington State, USA)

1928

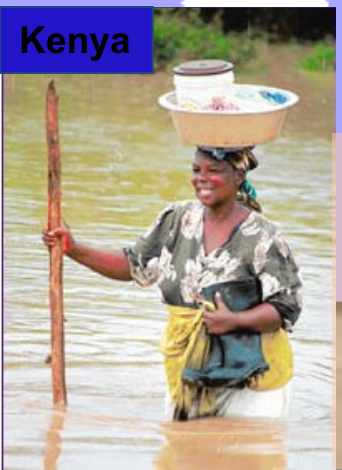
# Major floods and droughts worldwide



Flood Drought


Austria
Korea
Philippines
Vietnam
Sri Lanka
Micronesia
Haiti Jamaica
Peru
Uruguay




**There is pressing need to develop advanced risk management on water hazard in order to secure human life and ensure sustainable socio-economic development and poverty alleviation.**

# Water hazards and related nexi are / will be major challenges

- Intensifying and increasing occurrence of water related hazard in many part of the world
- Coupled impacts of climate change / extreme hydrologic events and sea level rising due to heat expansion



# Flood Disaster in Pakistan (August, 2010)


# Flood Disaster in Korea (September 21, 2010)

# FLASH FLOODS IN ASIA


# Danube at Budapest, 2006
## Parliament

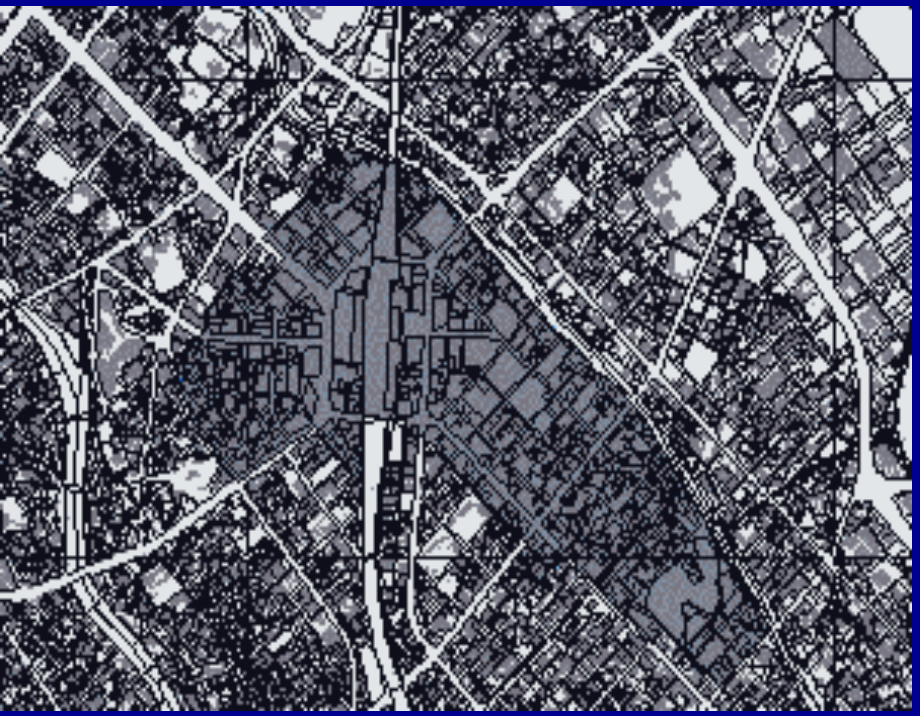

UNESCO-IHE
Institute for Water Education


I DON'T BELIEVE IN


Fukuoka Flood in 1999

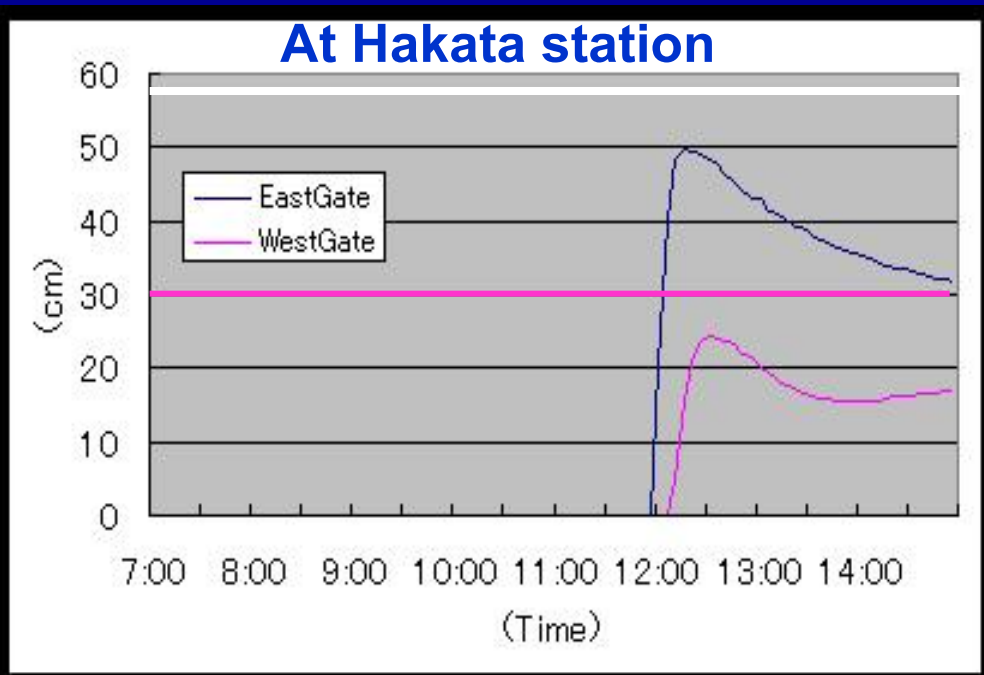
(Source : MLIT)

- Urban expansion taking place downward → Underground flood risk
- Recent developments → Long term risks are not experienced



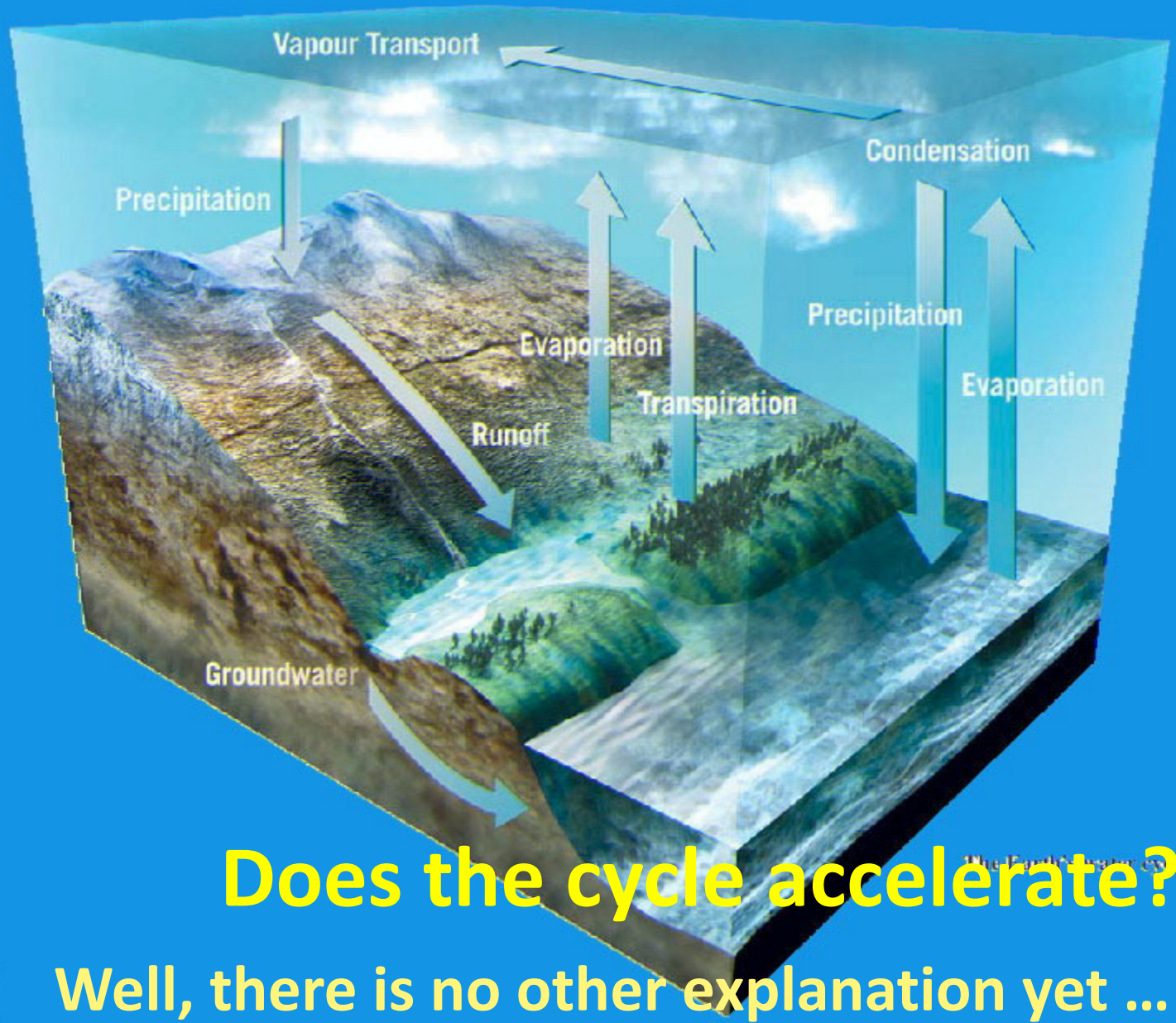
(Source: Herat, UNU)

Fukuoka flash flood simulation




Volume of water entered into underground space:

- 2,017 m3 (simulated volume)
- 1,320 m3 (total pumped water station)

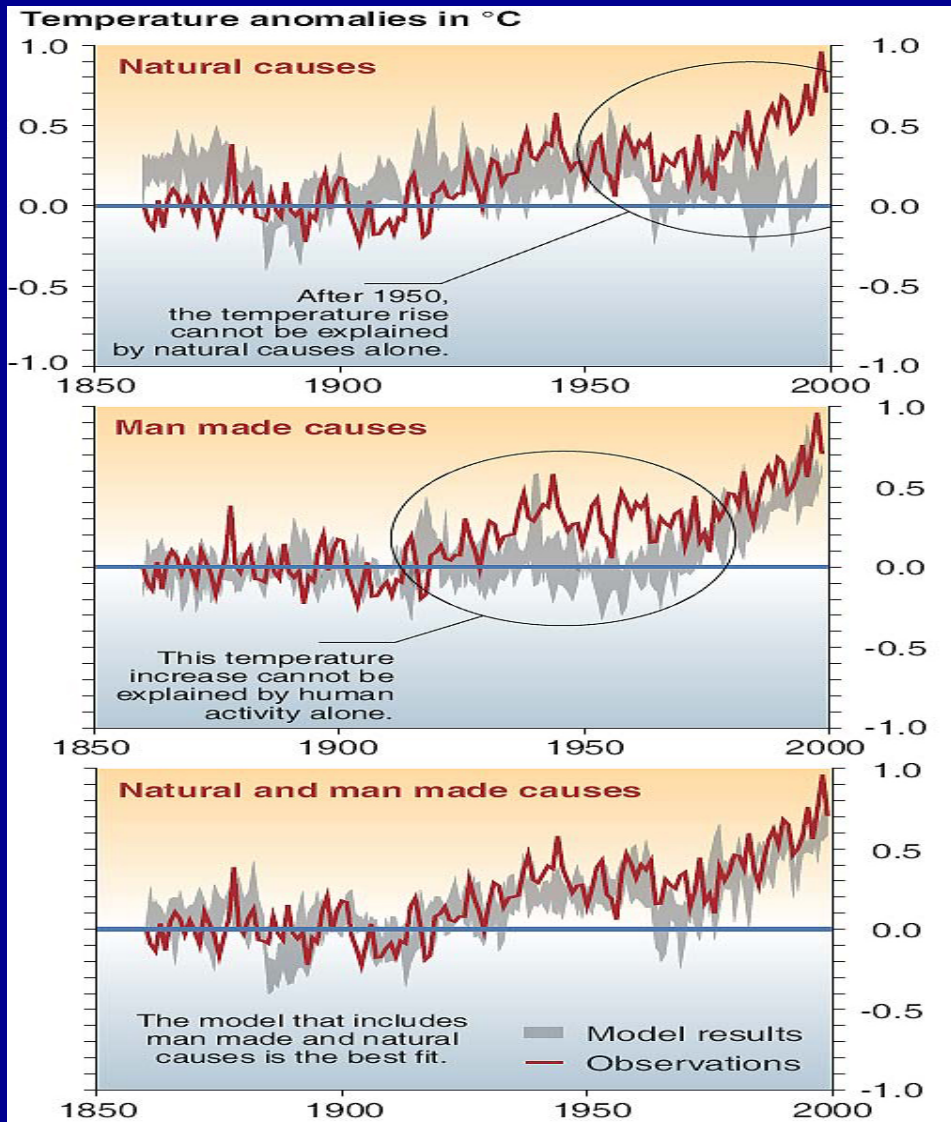



**Does the cycle accelerate?**

**Well, there is no other explanation yet …**

# Climate change: What do we know?

- **Global Mean Temperature have increased**
- **Greenhouse Gases play a role**
- **Reducing Emissions alone will not avoid impacts**



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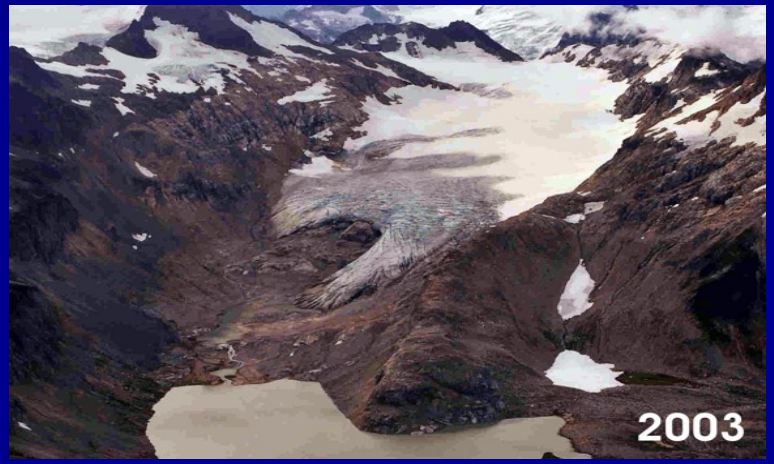
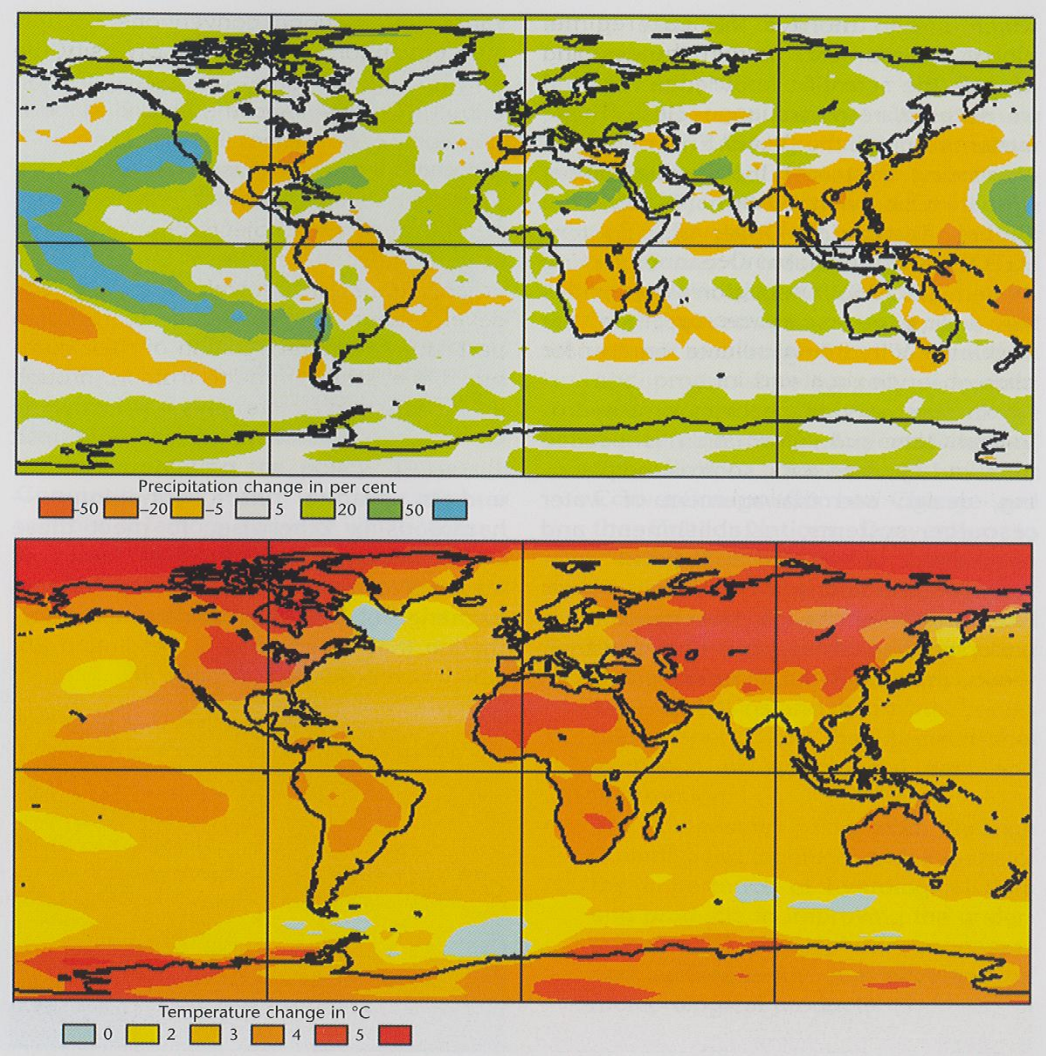


# ARIDITY

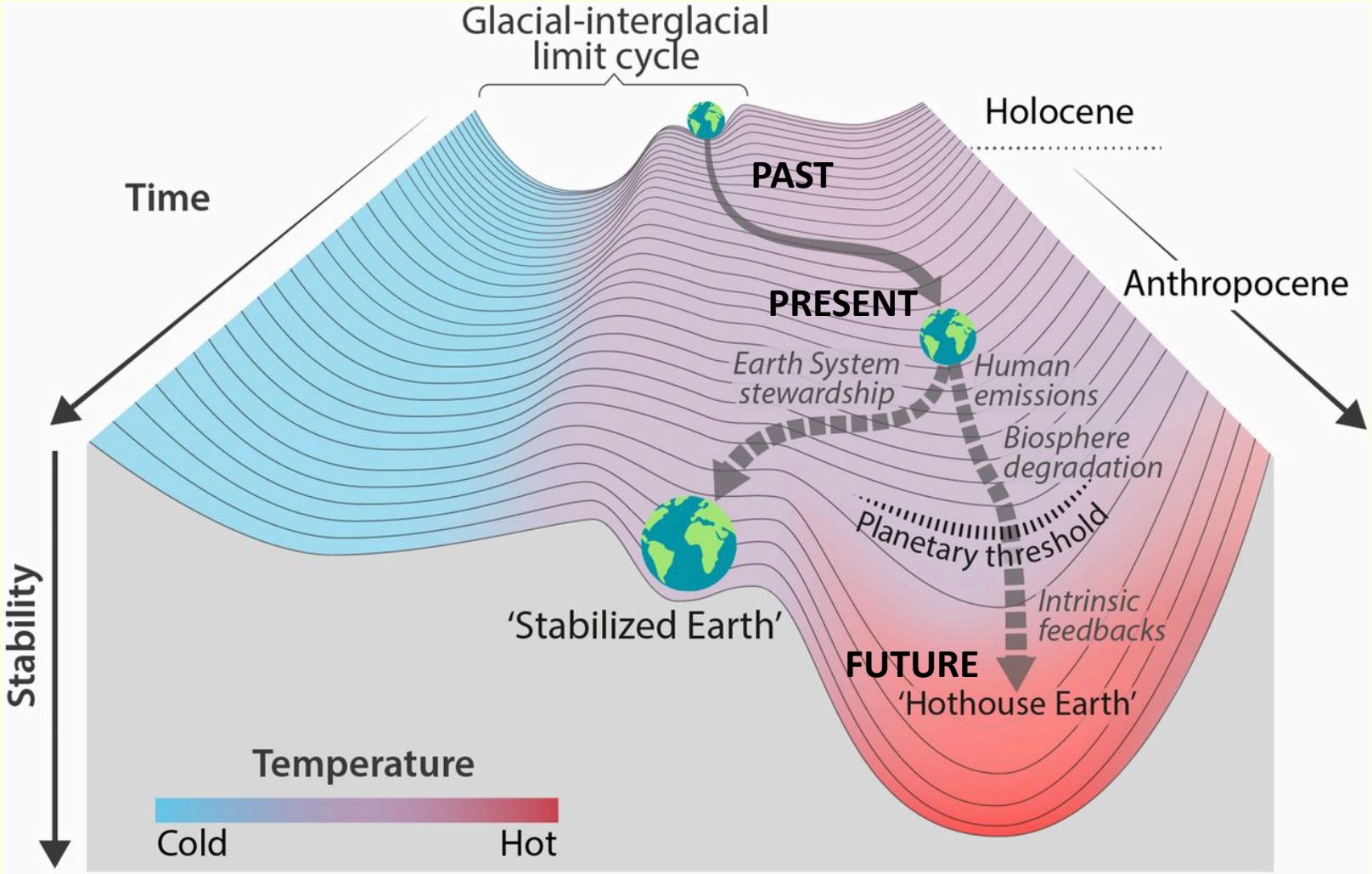
# NOT TOO MUCH HOPE ...

## UNLESS POLITICAL LEADERS STICK TO THE PARIS AGREEMENT




CLIMATE
SUMMIT
WHAT IF IT'S A BIG HOAX AND WE CREATE A BETTER WORLD FOR NOTHING?
• ENERGY INDEPENDENCE
• PRESERVE RAINFORESTS
• SUSTAINABILITY
• GREEN JOBS
• LIVABLE CITIES
• RENEWABLES
• CLEAN WATER, AIR
• HEALTHY CHILDREN
• ETC. ETC.
12/7/19 USATODAY
JOEL PETT

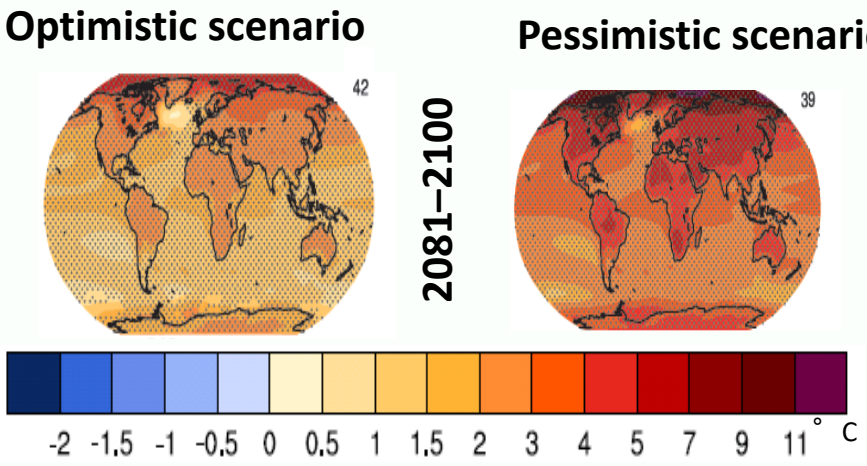
**Stability landscape showing the pathway of the Earth System out of the Holocene and thus, out of the glacial–interglacial limit cycle to its present position in the hotter Anthropocene.**




Will Steffen et al. PNAS 2018;115:33:8252-8259

**CRISIS NOW**

PNAS




## Expected global and European warming trends (annual averages)

Reference period: 1986–2005

**2046–2065:**

- Larger warming: Northern polar regions and in the central regions

**2081–2100:**

- Significant differences between the various options

- Greater warming in the continental areas of Europe: NE – WS gradient

# CONCLUSION

# CLIMATE CHANGE IS ALL ABOUT WATER

**80% OF THE CHANGE IS THROUGH WATER**

# URGENT NEED FOR

# CLIMATE ADAPTIVE WATER STRATEGIES

# DO WE HAVE A CHOICE AT ALL?

## WE NEED TO INCREASE THE

# RESILIENCE

## OF OUR SYSTEMS

# ADAPTATION OPTIONS:

- MORE STORAGE
- MORE HYDROPOWER
- MORE GROUNDWATER USE
- MORE INLAND NAVIGATION
- MORE CONSERVATION
- INTERBASIN WATER TRANSFER
- BETTER WATER GOVERNANCE
- INTEGRATED SYSTEMS

- BUT AREN'T THESE CONTRADICTORY?

# WE WILL NEED MORE STORAGE

STORAGE IS THE

CENTER OF THE VALUE CHAIN

BETWEEN

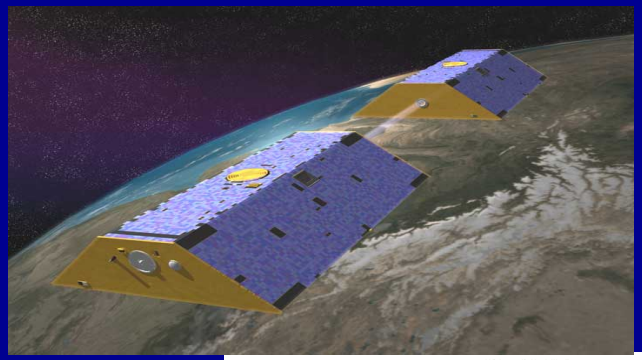
WATER / FOOD / ENERGY

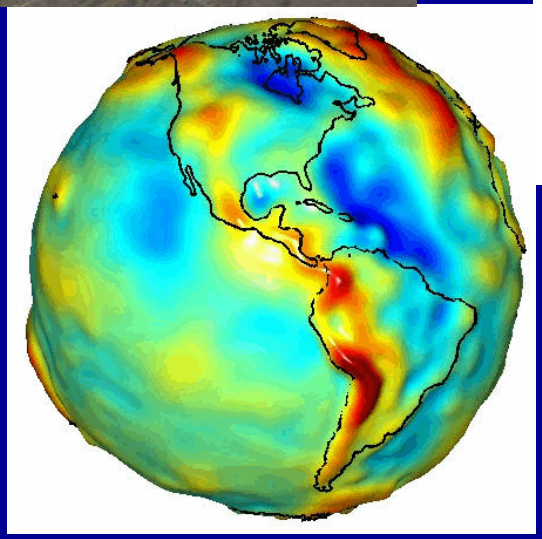
# THE VALUE OF OPERATIONAL HYDROLOGY

**IF YOU CAN'T MEASURE IT,**

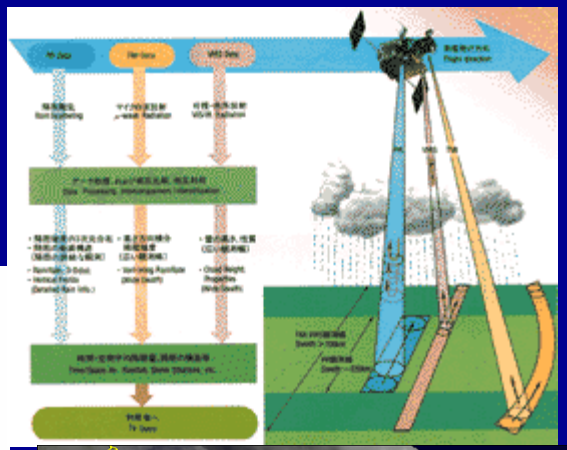
**YOU CAN'T MANAGE IT**

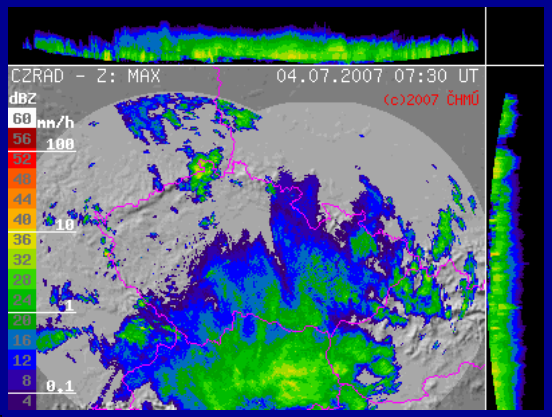
# Remotely sensed data

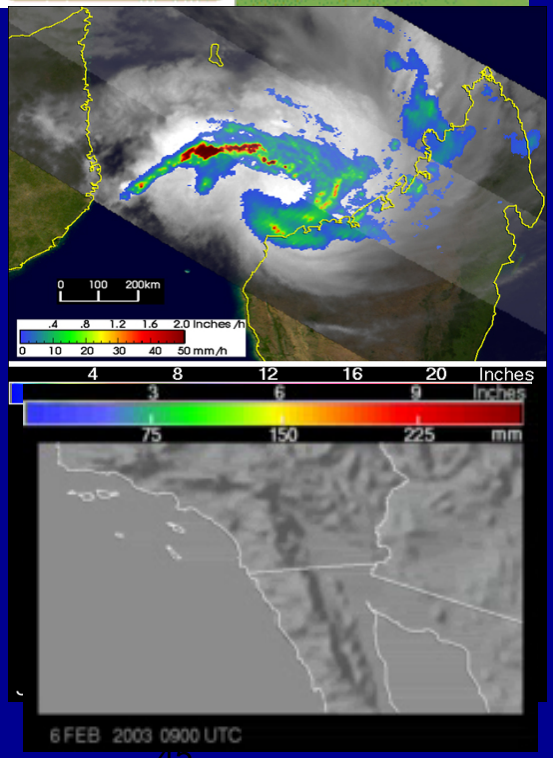


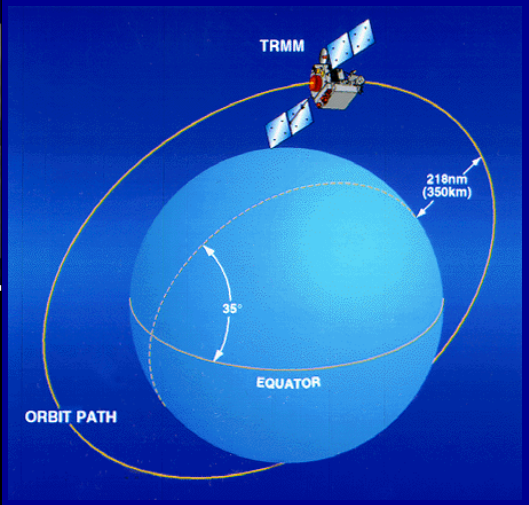


GRACE






(Source: D. Solomatine)

# Flow of information in a Hydroinformatics System

**Data → Models → Knowledge → Decisions**

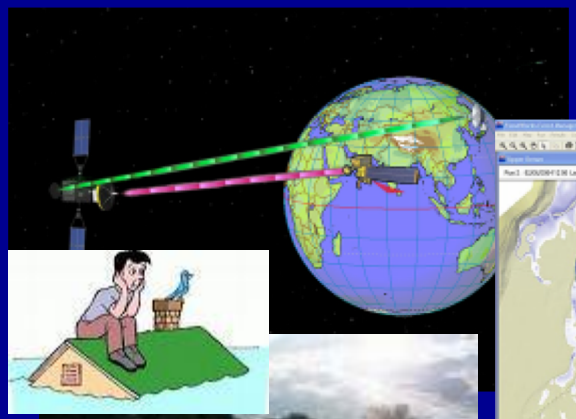
Earth observation, monitoring

Numerical Weather Prediction Models

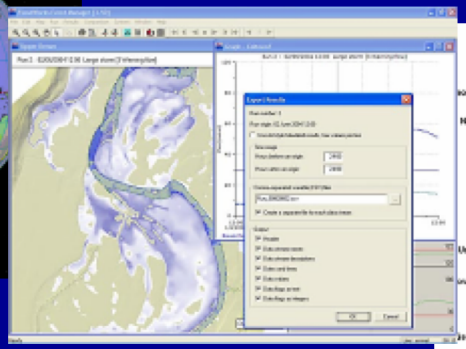
Data modelling, integration with hydrologic and hydraulic models

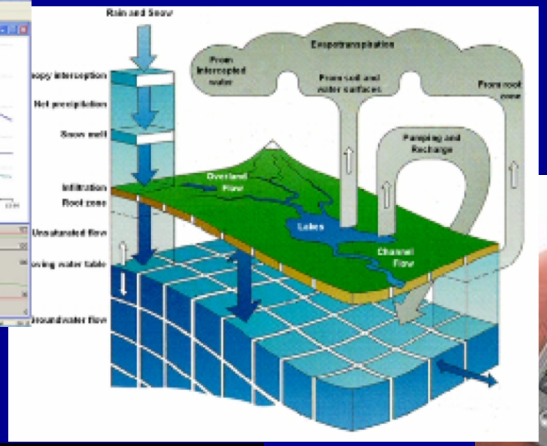
Access to modelling results

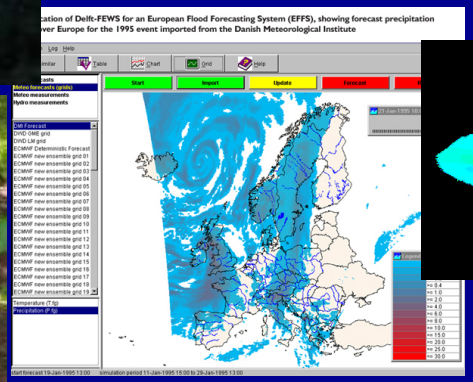
Decision support

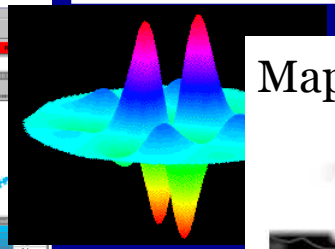


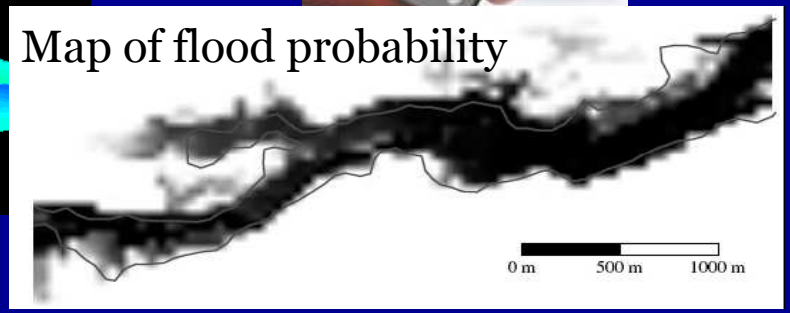






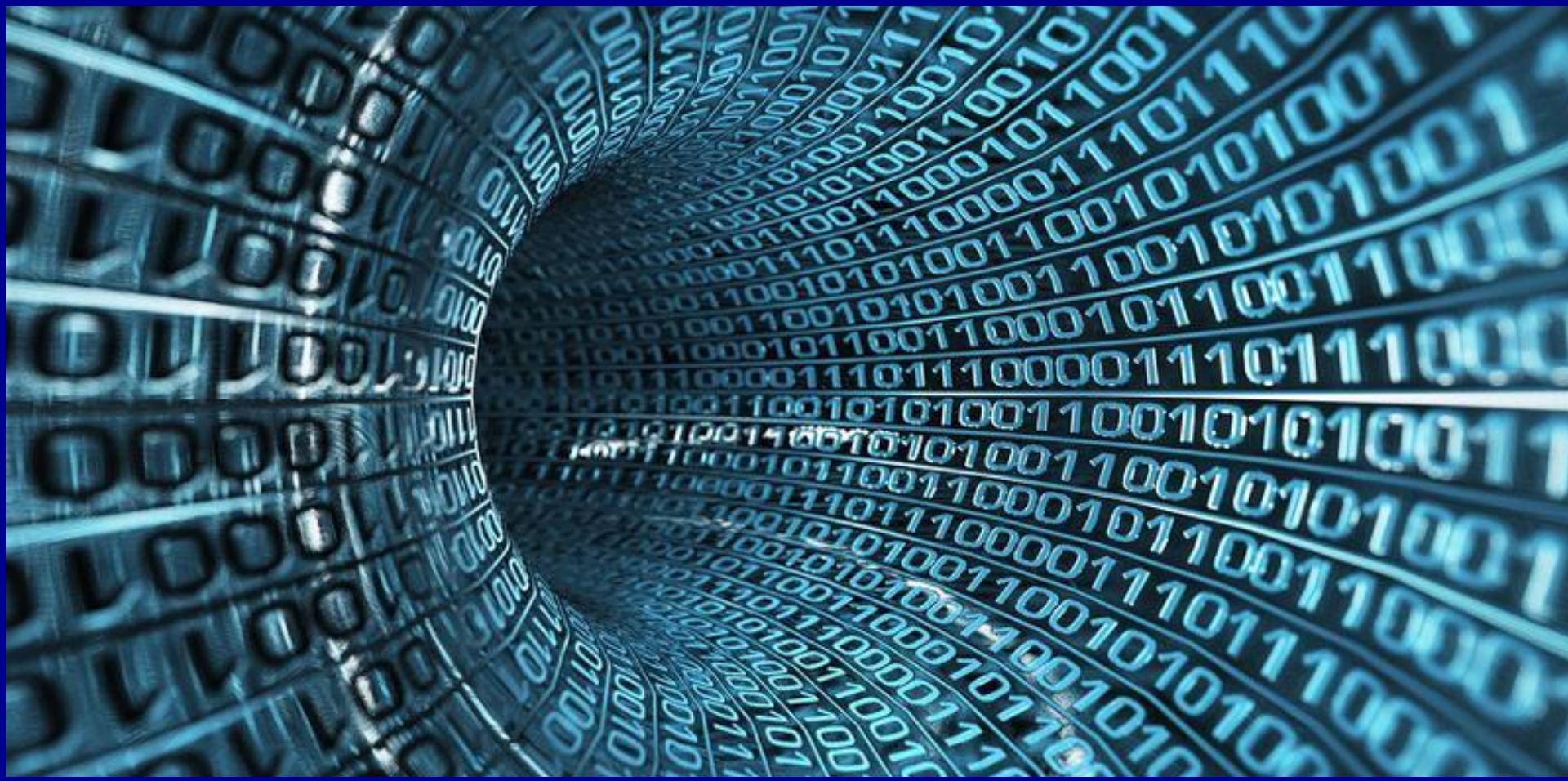








So urce: D. Solomatine

# BIG DATA



Data revolution:

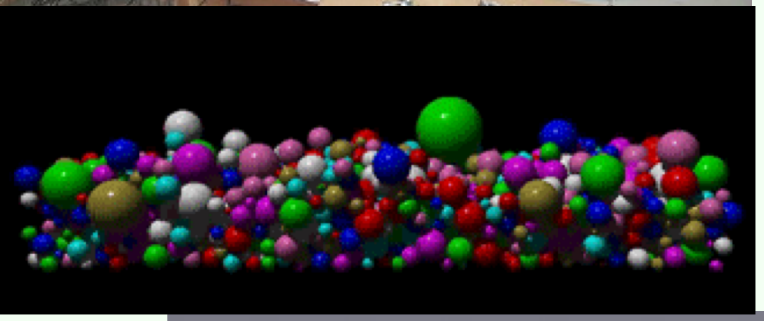
Terra bytes Petabytes Exabytes … Terra Hertz speed

# THE VALUE OF SCIENTIFIC HYDROLOGY

**IF YOU DON'T UNDERSTAND IT, YOU CAN'T MANAGE IT EITHER**

# DAILY PRAY OF THE HYDROLOGICAL MODELER 30 YEARS AGO:

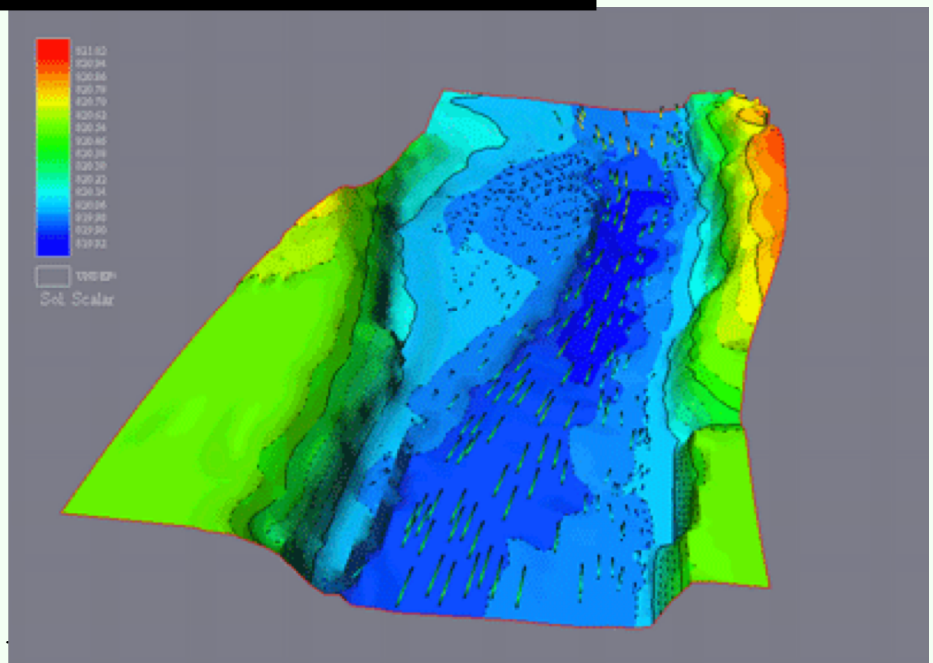
**OH, LORD, MAKE THE WORLD LINEAR AND NORMALLY DISTRIBUTED!**

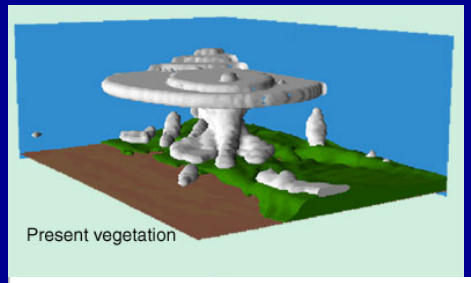


# Modelling is the heart of Hydroinformatics

- Technologies ensuring the whole information cycle, and *integrates data, models, and humans*

$$\frac{\partial Q}{\partial t}+\frac{\partial}{\partial x}\left(\frac{Q^2}{A}\right)+gA\frac{\partial h}{\partial x}-gAS_o+gAS_f=0$$

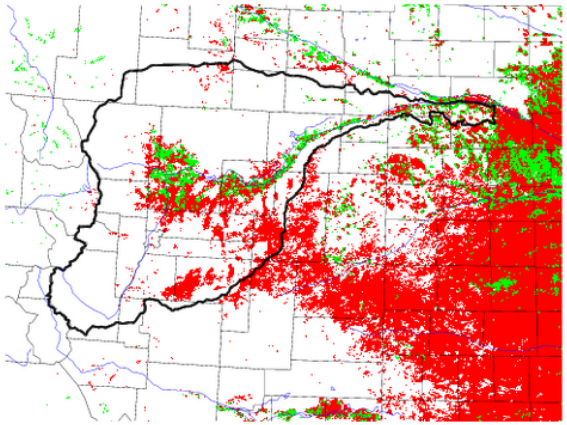


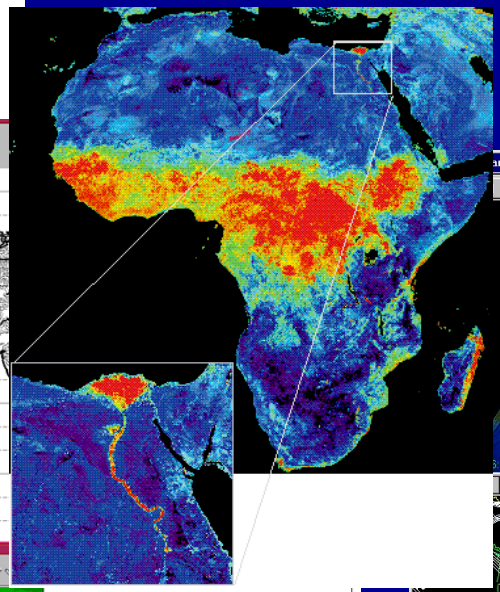


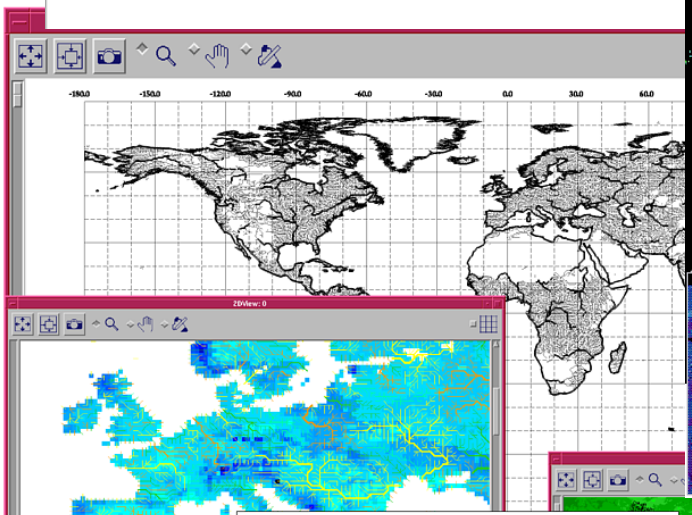

# Precision Earth Systems Tools

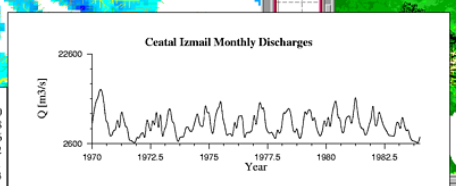
- Satellite data
- Data assimilation
- Simulation models
- Geospatial analysis / GIS

*Huge progress but…*

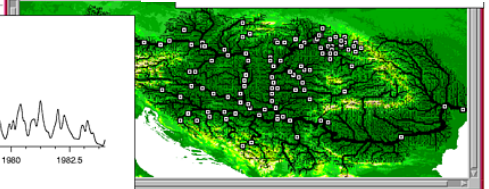


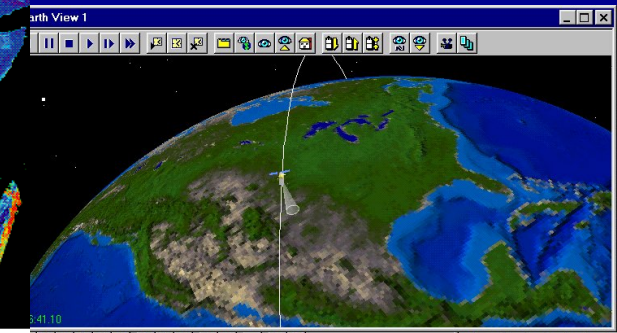


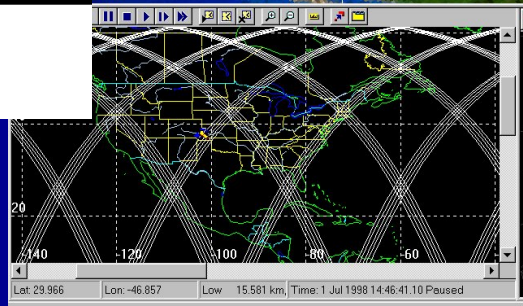


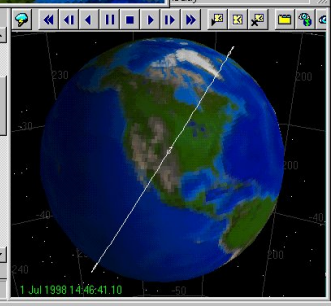



| FAO Soil Texture | Percentage |
|---|---|
| Medium (Loam) | 51.0 |
| Medium + Fine (Clay Loam) | 17.8 |
| Coarse + Medium (Sandy Loam) | 16.6 |
| Coarse + Fine (Loam) | 5.2 |
| Fine (Clay) | 5.1 |
| Coarse (Sand) | 4.3 |





# THE INDISPENSIBLE VALUE OF SCIENCE:

# NEW TOOLS ARE NEEDED

# WE NEED TO RE-TOOL OUR APPROACHES TO WATER BASED ON SCIENCE(S)

- MAINSTREAM GOVERNANCE, INCLUDE SOCIAL AND POLITICAL SCIENCE COMPONENTS
- GO BEYOND IWRM
- GO DIGITAL
- RE-INFORCE SYSTEM THINKING FROM DATA CAPTURING TO DISSEMINATION
- REDUCE THE GAP BETWEEN SCIENCE AND POLICY STUDIES
- GO TRANSDISCIPLINARY

# DIGITAL WATER MANAGEMENT INTEGRATED SYSTEMS

# (IoT, AI)

# WATER AS THE CENTER PIECE OF THE SDGs