The Role of Market Instruments
in Integrated Water Management

Future Scenarios: the Impact of Climate Change and Droughts on Transboundary Water Dispute and Management

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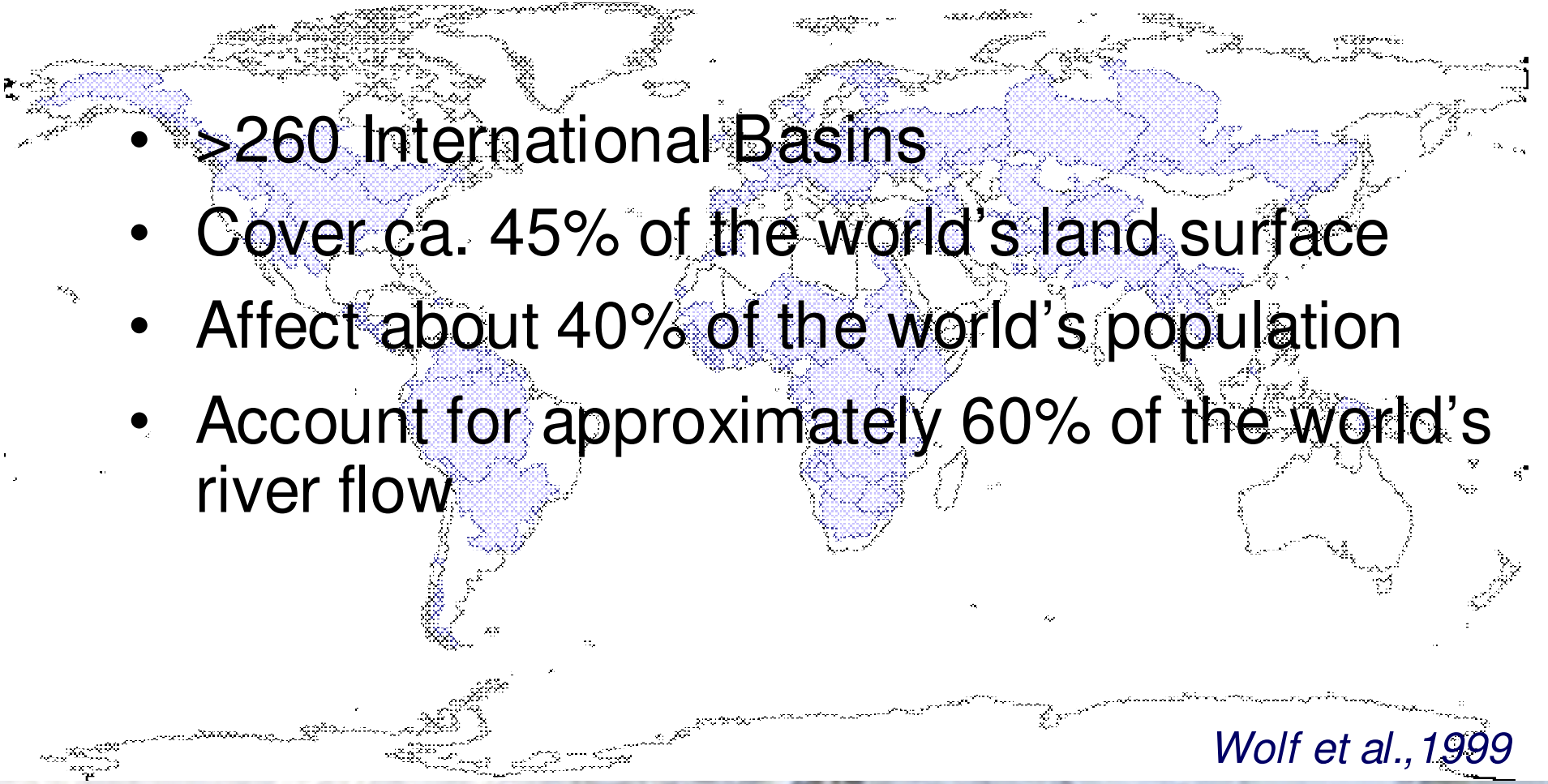
Zaragoza, 28 July 2008

Outline

- Background
  - Hydropolitics of transboundary rivers
  - Future change in climate and water demand
- Questions
- Data availability: past and future
- Analysis of
  - role of drought & hydro-climate in the past
  - Future prediction for particular basins
- Conclusions for Management

The World's International River Basins

- >260 International Basins
- Cover ca. 45% of the world's land surface
- Affect about 40% of the world's population
- Account for approximately 60% of the world's river flow



Wolf et al., 1999

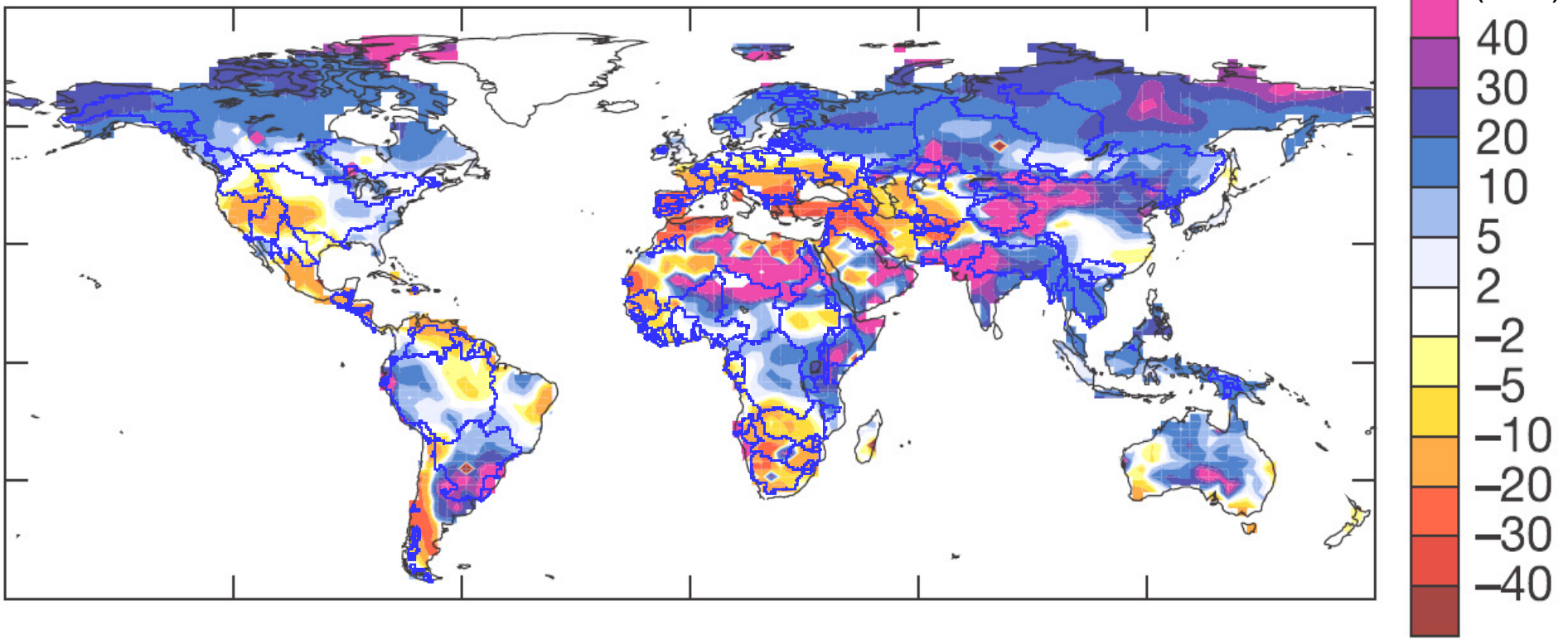
Map source: TFDD at www.transboundarywaters.orst.edu

Transboundary Hydropolitics

- Water Sharing & Equitable Allocation
- Conflicts globally
  - Change (Wolf, et al. 2003)
  - Hydroclimatic Variability (Stahl, 2005)
- Cooperation
  - Abundant (Yoffe, et. al, 2006)
  - "Scarperation" (Dinar and Dinar, 2005)
- Agreements and Treaties
- Joint, integrated basin management

Future Climate Change

Ensemble mean of relative change in runoff
(2041–2060 of SRESA1B to 1900–1970 of 20C3M experiments)



Map from *Milly et al., 2005, Nature*

Basins from *www.transboundarywaters.orst.edu*

IPCC, 2007/2008

- Climate change affects existing water infrastructure and management practices because it will aggravate the impact of other stresses such as population growth, changing economic activity, land use change and urbanisation, etc. which will increase water demand.
- Current management practices may not be robust enough to cope with the impacts of climate change on water supply, flood risk, health, agriculture, energy and aquatic ecosystems.“

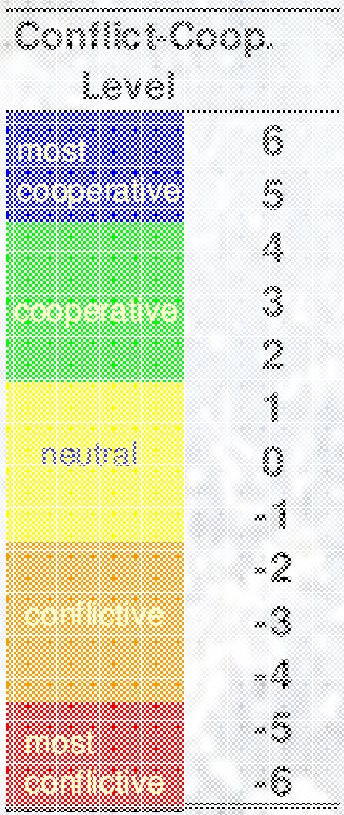
Questions

- Have drought and water demand influenced hydropolitics in the past?
- What are the predictions for future?
- How can management deal with the uncertainty?

TRANSBOUNDARY FRESHWATER DISPUTE DATABASE
www.transboundarywaters.orst.edu

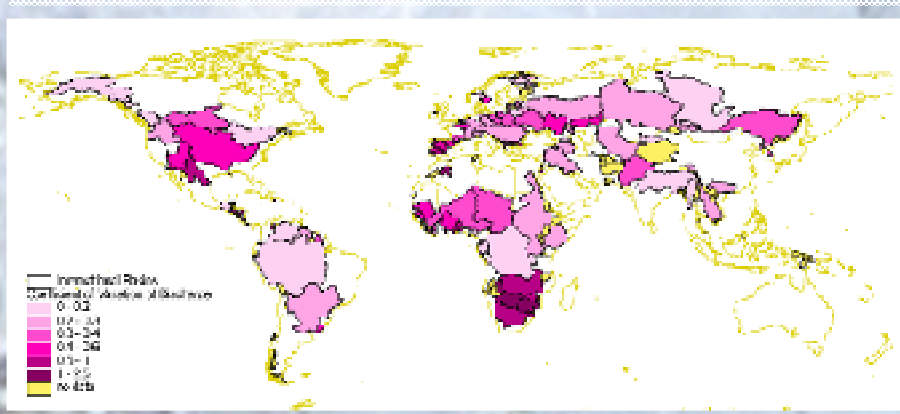
Data Availability

Treaties and events



GIS and hydroclimate

- Geo-socio-political
  - Basin size, location, GDP, population, etc.
- Hydroclimatic
  - Aridity, precipitation and streamflow variability



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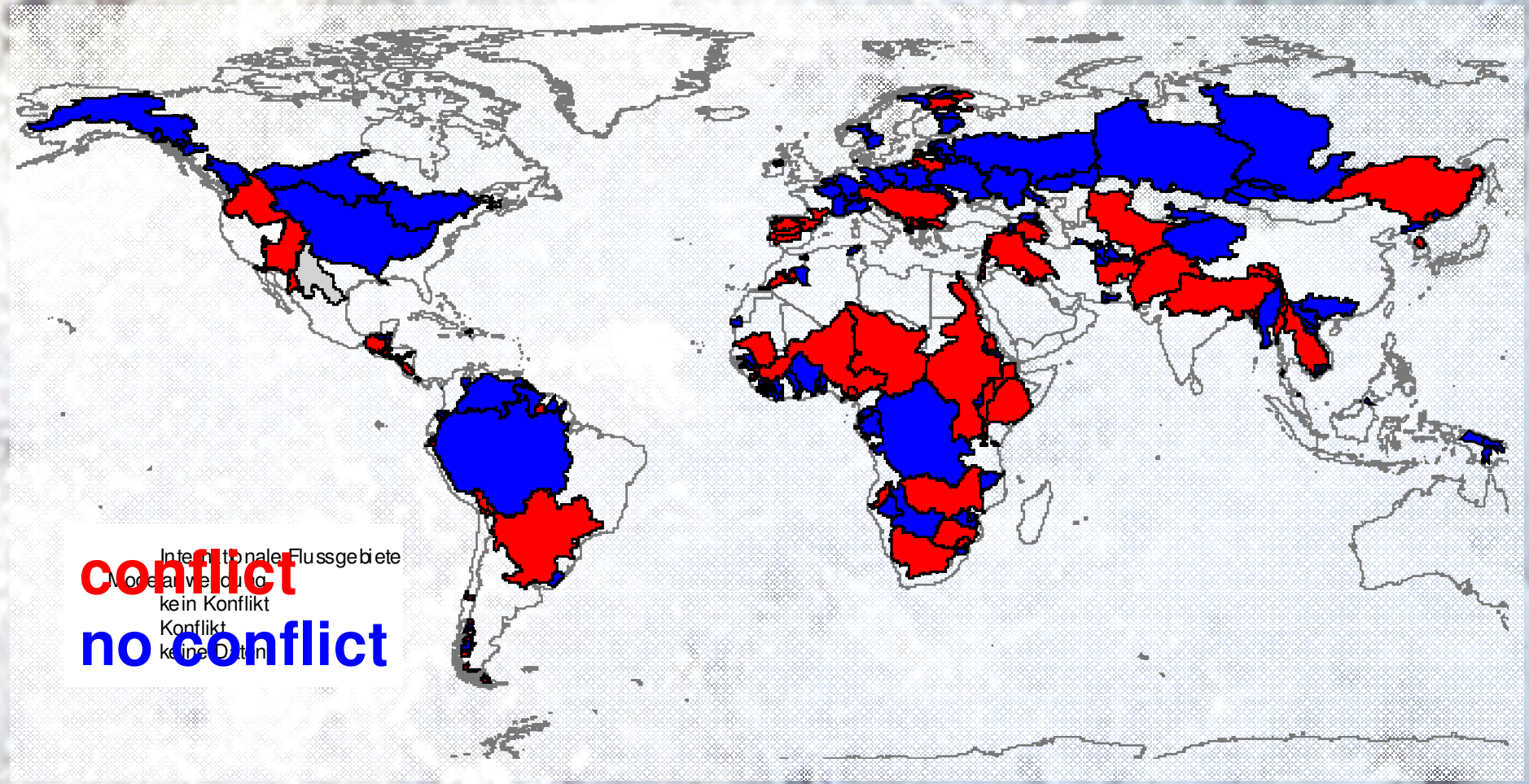
Approach

- Examples of drought-driven political events
  - Data mining of TFDD
- Analysis of drought as a driver for conflict and cooperation among other influences
  - Previous analyses
  - Statistical model of risk for conflict
- Assessment of future predictions for drivers
  - Review of climate change and future water demand predictions in particular basins

Drought events linked to political activity

Region	River Basin	Hydroclimatic Event	Linked political event
North America	Colorado	Drought in the 1960s	Dispute over salinity (1972)
		Drought in the early 90s, low annual floods	Dispute over renegotiation of treaty because of pollution and over allocation
Southern Europe	Guadiana	Drought in the early 1990s	Dispute over renegotiation of treaty because of pollution and over allocation
Southern African Region	Incomati	Drought 1982	Trilateral negotiations on water sharing
West Africa	Senegal	Trend and multi-year droughts	Conflict over projects and water rights in the 1990s
Middle East	Jordan	Moderate drought in 1994 Drought in 1999	Raising the need for treaty amendments conflict, particularly between Israel and Jordan
Southeast Asia	Mekong	Negative trend of annual flows and droughts in early 1990s	Increased political activity; drought of 1994 is the context for negotiations on river diversions for irrigation in Thailand

Global Application of Classification

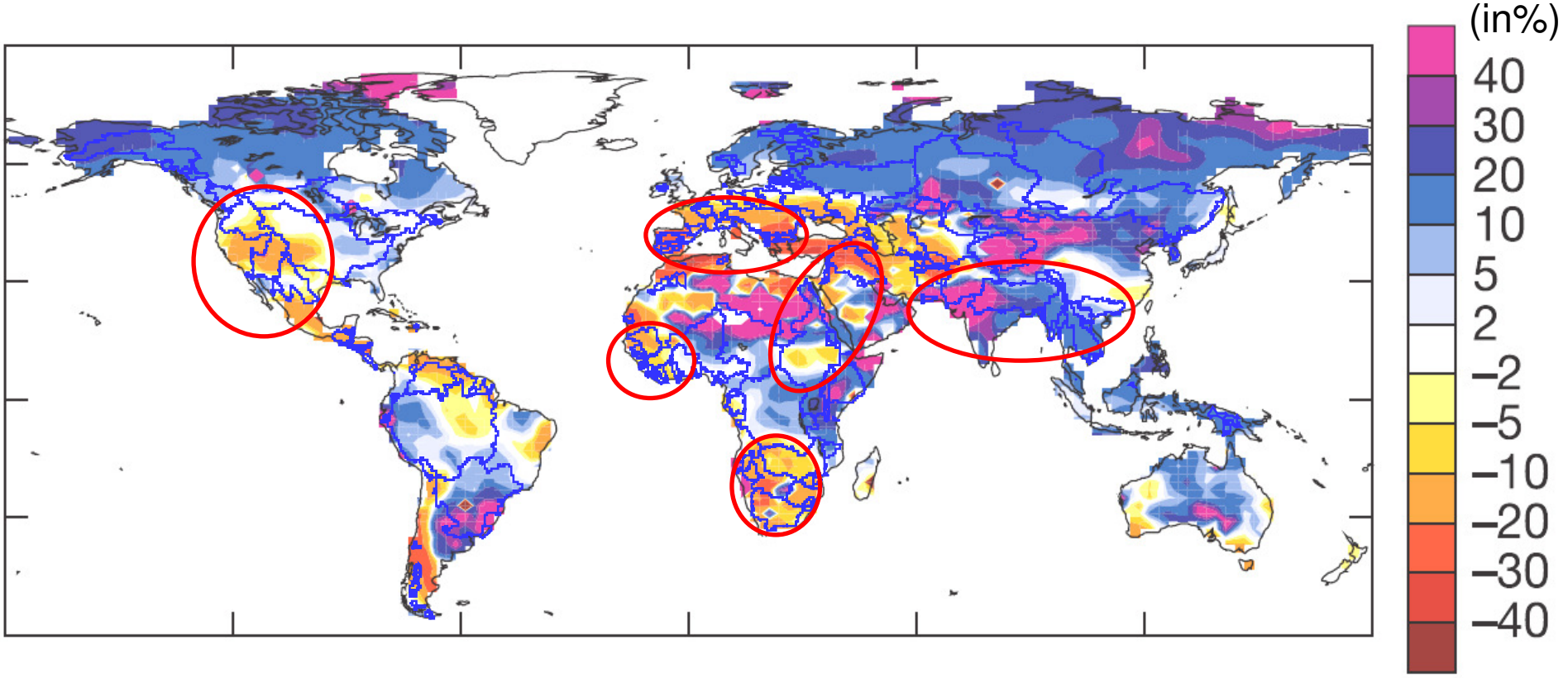


Summary: role of drought

- Mainly in transition climates (high variability)
- Considerable influence on conflict
  - Stress
  - Trigger (separation of natural cause and allocation issue difficult)
- But also initiation of cooperation
- Challenge for agreements and treaties
- Most previous research on water stress, not temporary ‚drought'

Future Change

relative change in runoff



Map from *Milly et al., 2005, Nature*

Basins from *www.transboundarywaters.orst.edu*

Region	International River Basin	Model predictions for 2050 compared to 20th Century			
		Milly et al. (2005)	Alcamo et al. (2007)		
		Annual runoff	Annual water availability	Increase of dry extremes	Future withdrawals
North America	Columbia	Decrease	Increase	no	Increase
	Colorado	Decrease	Decrease	yes	Decrease
	Rio Grande	Decrease	Increase	no	Mixed
Southwest Europe	Duero, Guadiana, etc.	Decrease	Decrease	yes	Decrease
Southeast Europe	Lower Danube tributaries, etc.	Decrease	Decrease	yes	Increase
Middle East	Jordan	Decrease	Decrease	yes	Increase
	Tigris-Euphrates	Decrease	Increase	no	Decrease
Central Asia	Aral Sea	Decrease	Increase	no	Mixed
South Asia	Indus, Ganges, etc. (Rivers originating from Himalayas)	Increase (decrease in headwaters)	Increase	no	Mixed, Increase
Southeast Asia	Mekong, Salween, etc.	Increase	Mixed	yes	Increase
West Africa	Senegal	Decrease	Increase	possibly	Increase
Southern African Region	Orange, Incomati, etc.	Decrease	West: decrease East: increase	yes no	Increase

Summary: predictability

- Many transboundary rivers in areas of decreasing water availability
- Global predictions give annual averages, agreements and allocations are seasonal
- Lack of predictions of change in
  - Variability
  - Extremes
- Uncertainty of water demand: predictions based on population and economic development

Conclusions for Management

- Separate effects of drought and misallocation
- Reduce uncertainty in predictions
  - Extremes
  - Demand
- Work out allocations and treaties robust to change and variability
- Make data public to allow progress cross-disciplinary research

Acknowledgements and Ongoing Projects

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