Water allocations and hydrological change:

assessing institutional resilience in global transboundary rivers

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based on a research project for the World Bank in collaboration with:

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Motivation

- Transboundary river treaties and river basin organizations are important institutions for defining how water is shared between countries
- However, there are concerns about allocations' vulnerability to predicted climate changes
- Hydrologic models that use climate change scenarios to simulate streamflow changes may be useful tools within an assessment of the ability of countries to meet treaty obligations in the future
  → important information to plan adaptation measures

Recent Studies

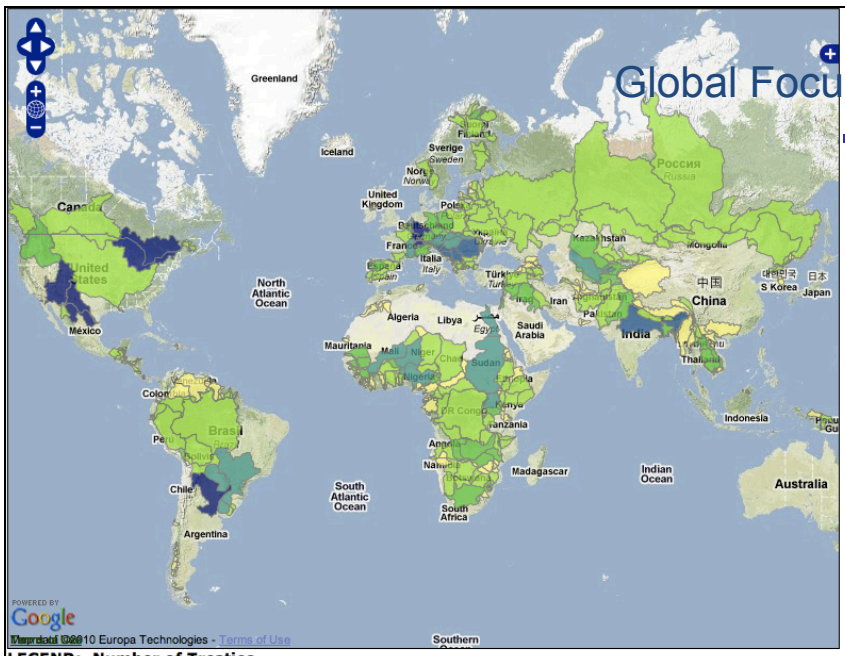
- Evaluation of the suitability of such predictions

Water allocation mechanisms globally *Source: Transboundary Freshwater Dispute Database (TFDD)*	↔	Ability of hydrologic modelling approaches *Source: literature considered in IPCC reports*

- Mapping global areas potentially at risk

Institutional vulnerability *Score based on treaty components and the existence of a river basin organisation*	↔	Hazard from exposure of transboundary river basins to hydrological change. *Example: inter-annual variability of runoff*

Global Focus



LEGEND: Number of Treaties

0 | 1-5 | 6-10 | 11-15 | 16-20 | > 20

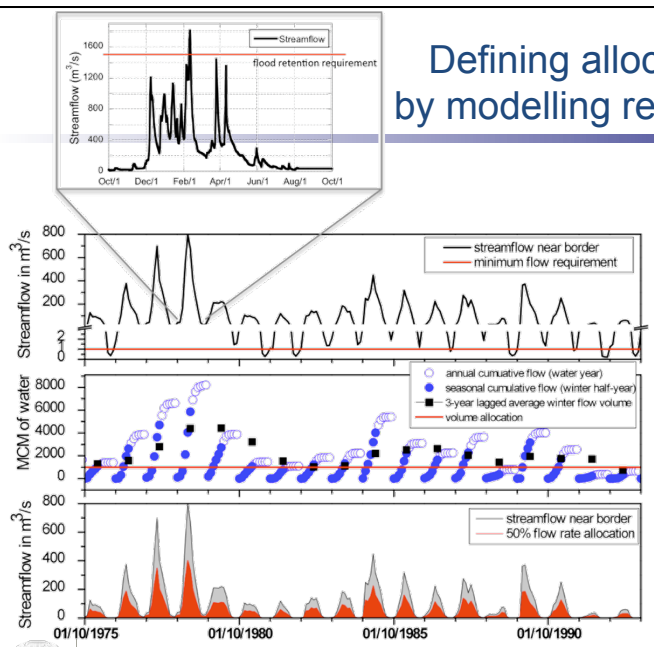
www.transboundarywaters.orst.edu

Allocation types and mechanisms

Type	Allocation mechanism (after Dinar et al. 2009)	Mechanism (after Drieschova et al. 2008)	Example
A	fixed quantity	direct allocations	country A must let a minimum flow of *x* m^3/s flow across the border at all or particular times
B	fixed quantity	direct allocations	country B receives *x* Million m^3 of water per year/season
B	fixed quantity varying by availability	direct allocations	country B receives *y1* Million m^3 of water per year if a min. of *x1* were available, *y2* if *x2* were avail., etc.
B	fixed quantity recouped later	direct allocations	country B receives *y* m^3 of water per t years
C	percentage	indirect allocations	country A and B each receive 50% of flow
C	entire river	indirect allocations	country A receives 100% of flow
C	prior approval	indirect allocations	an allocation of country A to B
C	consultation	principles for allocations	commission decides on allocation

Stahl et al., submitted to GEC

Defining allocation types by modelling requirements



Allocation type:

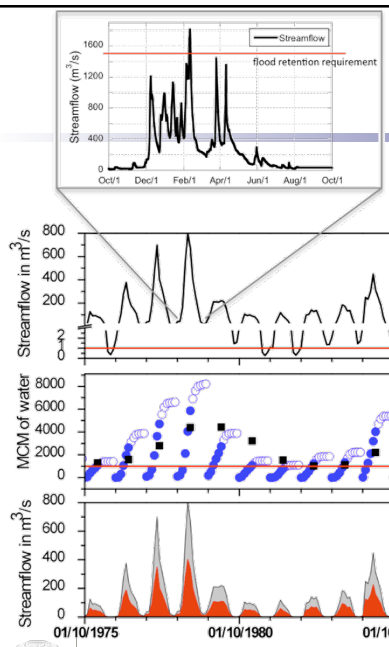
Type A: flow rate

Type B: flow volume/time

Type C: relative flow or volume

Stahl et al., submitted to GEC

Defining allocation types by modelling requirements



Model requirements:

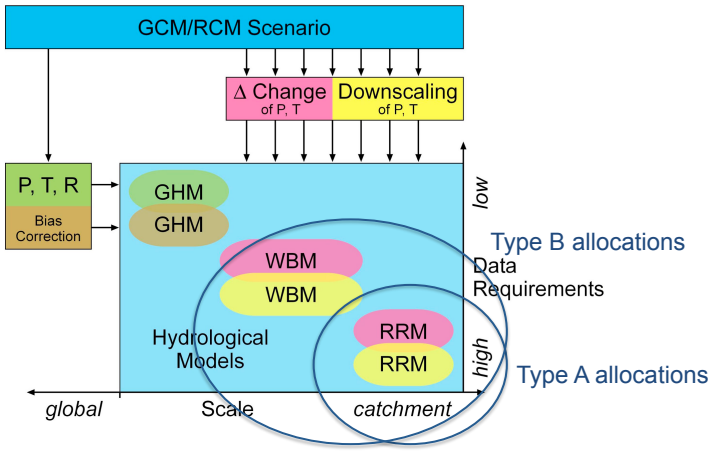
flow rate at allocation point, extremes
→high resolution

Seasonal to annual volumes, inter-annual variability
→lower resolution

→ irrelevant

Stahl et al., submitted to GEC

Approaches to model streamflow change as a result of climate change



GCM: Global Climate Model; RCM: Regional Climate Model; GHM: Global Hydrological Model; WBM: Water Balance Model; RRM: Rainfall Runoff Model, P: precipitation; T: temperature; R: runoff

Global Distribution of allocation types

450 treaties (TFDD) → 72 contain water allocation agreements → 56 considered

	River Type	A	B	C	total
Natural flow	**Nn**	0	0	1	1
Natural regime, but abstractions	**Na**	0	1	0	1
Regulated	**Rn**	10	3	13	26
Regulated with abstractions	**Ra**	4	11	13	28
	total	14	15	27	56

- Treaties with allocation agreements mostly in regulated rivers
  - ➢ impossible to model without data on regulation (past and future)

Stahl et al., submitted to GEC

Evaluation of model suitability

- Presently, many approaches do not necessarily capture the temporal resolution or spatial detail to determine water availability at the location where water is to be delivered or monitored
- This hampers a global assessment of the resilience of treaties that have explicit streamflow or water volume requirements
- Reliable predictions can only be obtained for a basin, where detailed observed data on
  - river flow and → **in Europe ok**
  - its regulation → **problem even in Europe**

  are available for model tuning

Recent Studies

- Evaluation of the suitability of such predictions

Water allocation mechanisms globally
Source: Transboundary Freshwater Dispute Database (TFDD)

↔

Capabilities of hydrologic modelling approaches
Source: literature considered in IPCC reports

- Mapping global areas potentially at risk

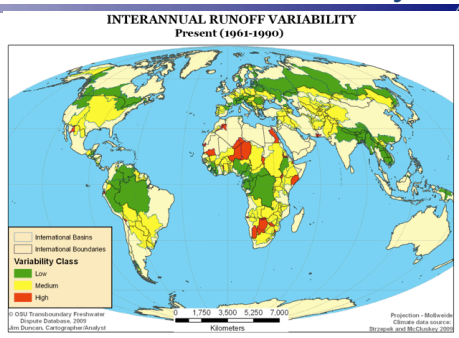
Institutional vulnerability
Score based on treaty components and the existence of a river basin organisation

↔

Hazard from exposure of transboundary river basins to hydrological change. *Example: inter-annual variability of runoff*

Mapping resilience to variability

Treaty/RBO Component	Possible Value
At least one water treaty	0/1
At least one treaty with an allocation mechanism	0/1
At least one treaty with a variability management mechanism	0/1
At least one treaty with a conflict resolution mechanism	0/1
At least one river basin organization	0/1
Total possible score for a country-basin unit	**0 to 5**



Institutional vulnerability
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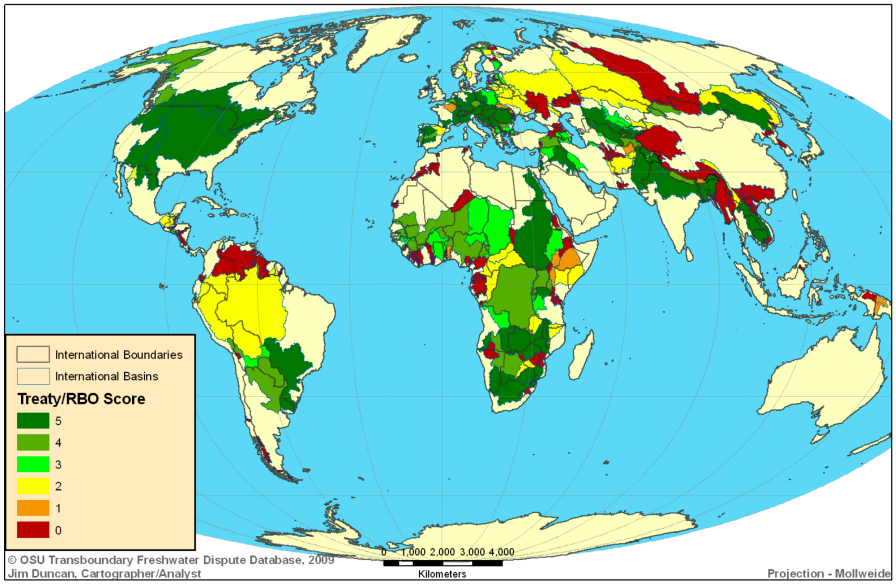
Hazard from exposure of transboundary river basins to hydrological change. *Example: inter-annual variability of runoff*

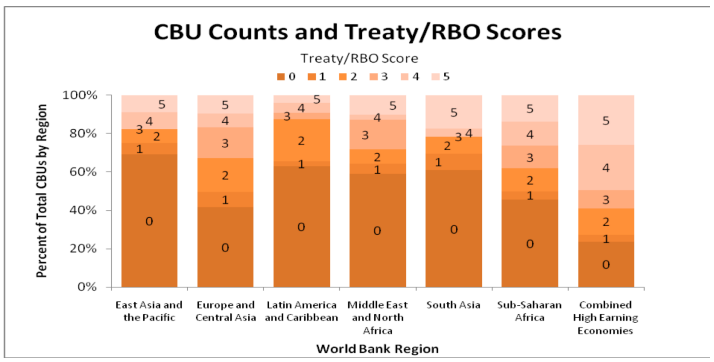
→ different levels of risk derived from combinations

Duncan et al. (submitted to JPR)

GLOBAL DISTRIBUTION OF TREATY AND RBO COVERAGE
COMBINED TREATY/RBO SCORE



Duncan et al. (submitted to JPR)



Duncan et al. (submitted to JPR)

Conclusions

- The comparison of allocation types with model prediction ability identified a mismatch between the details of transboundary water allocations and the requirements for and the uncertainty of hydrological change predictions
  - Europe: data, particularly on river regulation
- Empirical analysis of institutional capacity in terms of treaties and RBOs indicated that globally, hot spots are in Africa and Asia
  - Europe: unclear climate change signal