COLLEGE OF AGRICULTURE & LIFE SCIENCES
COOPERATIVE EXTENSION
WATER RESOURCES RESEARCH CENTER

Assessing Water Security at Global and Local Scales

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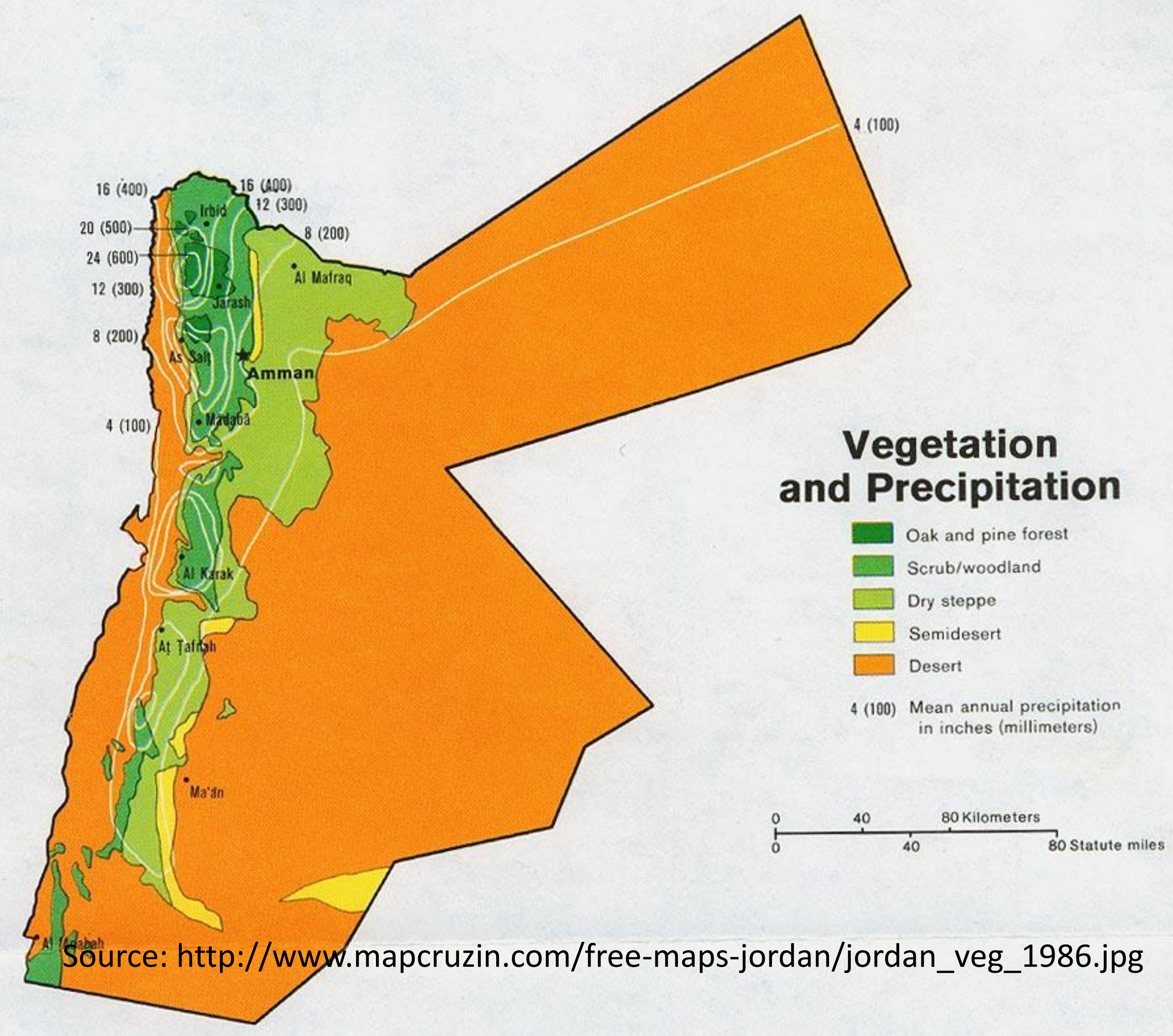
Jerash, Jordan

Water Situation in Jerash

- Receive water deliveries maybe once a week or once every two weeks
- 16% surface water, 84% groundwater
- Old infrastructure
- Big influx of refugee population, particularly from Syria

Source: http://www.lib.utexas.edu/maps/middle_east_and_asia/jordan_pol_2004.jpg



Source: http://www.mapcruzin.com/free-maps-jordan/jordan_veg_1986.jpg

What is water security?

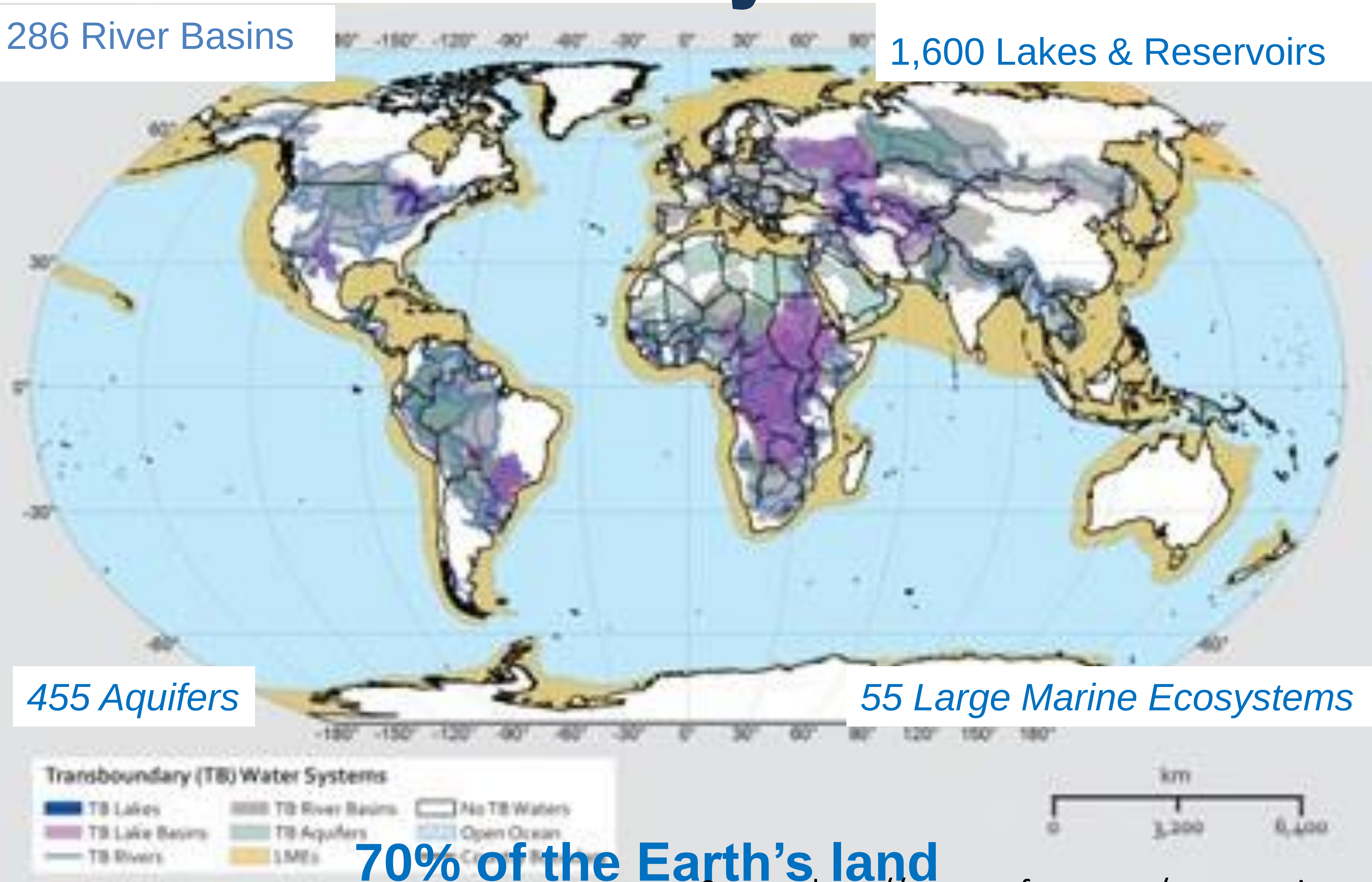
- Grey and Sadoff (2007): “ The *availability of an acceptable quantity and quality* of water for **health**, **livelihoods**, **ecosystems** and **production**, coupled with an *acceptable level of water-related risks* to **people**, **environments** and **economies**”.

- “Water security is the capacity of a population to *access sufficient water to meet all its needs* and to *limit the destructive aspects* of water. It involves both the **productivity** and **destructivity** of water.” – Michael Campana

Transboundary Waters

286 River Basins

1,600 Lakes & Reservoirs

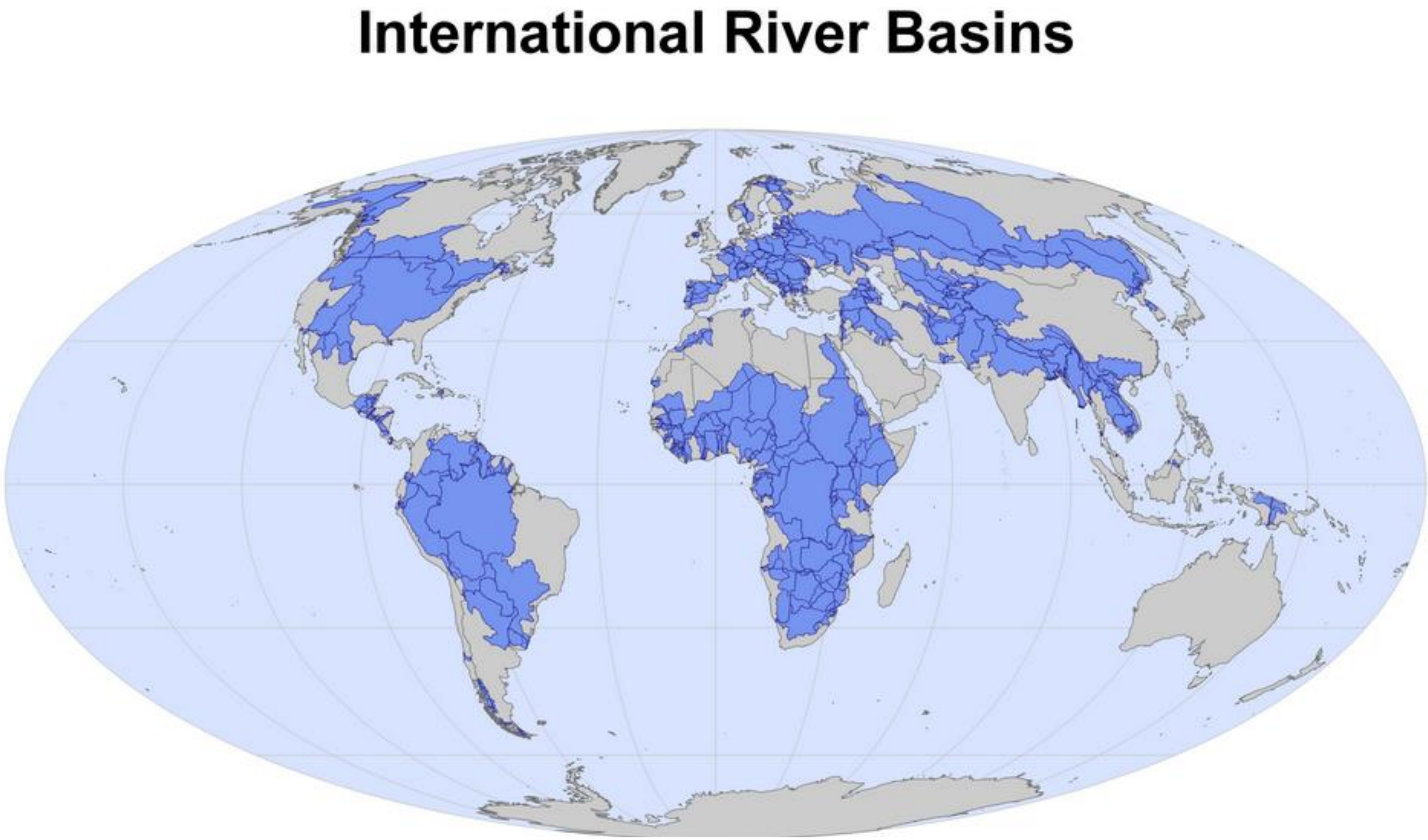


455 Aquifers

55 Large Marine Ecosystems

70% of the Earth's land

Source: http://www.geftwap.org/twap-project



286 River Basins, 796 BCUs

151 Countries

2.8 Billion People

42% of the Earth's land

54% of global discharge

Source: http://www.transboundarywaters.orst.edu/images/Images%20for%20image%20and%20map%20gallery/Global/Standard_world.jpg

UNEP

gef

UNEP-DHI PARTNERSHIP
Centre on Water and Environment

United Nations Educational, Scientific and Cultural Organization

International Hydrological Programme

United Nations Educational, Scientific and Cultural Organization

Intergovernmental Oceanographic Commission

ILEC

TWAP

TRANSBOUNDARY WATERS ASSESSMENT PROGRAMME

GROUNDWATER

LARGE MARINE ECOSYSTEMS

LAKES & RESERVOIRS

OPEN OCEAN

RIVER BASINS

UNEP-DHI PARTNERSHIP
Centre on Water and Environment

IUCN

SIWI

OSU Oregon State University

CESR Center for Environmental Systems Research

DeltAlliance

CUNY The City University of New York

GLOBAL IGBP CHANGE International Geosphere-Biosphere Programme

Center for International Earth Science Information Network
Earth Institute | Columbia University

TWAP - River Basins Component

Global

- Not a detailed state-of-the environment assessment for each basin
- Based on data that is available for the vast majority of basins
- Need for global modelling

Comparative Assessment

- Relative analysis based on relative risk to societies and ecosystems

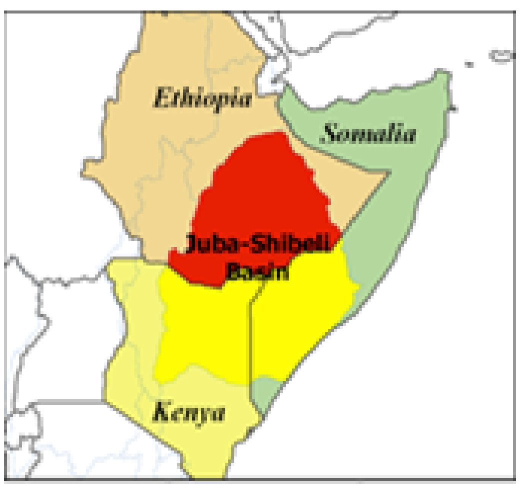
Baseline & Future Trends

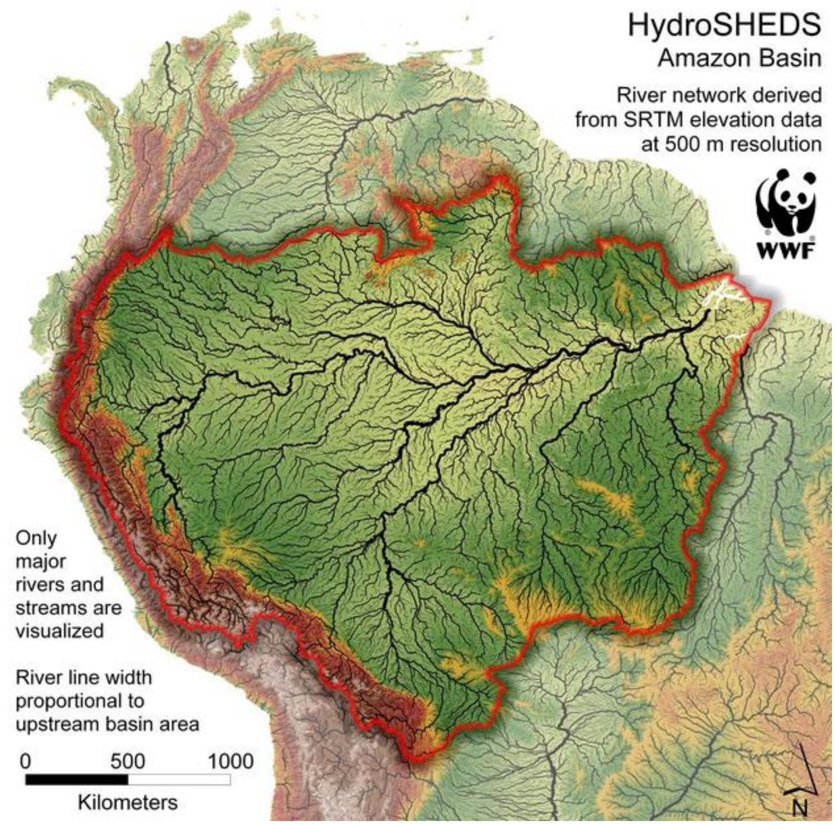
Relative Risk Category
1 Very low
2 Low
3 Moderate
4 High
5 Very high

Upgrade of the transboundary river basins map

HydroBASINS/
HydroSHEDS
+
FAO GAUL dataset

Basin Country Unit - BCU





River Basin value = BCU values weighted by population and area

Water Quantity

- Environmental water stress
- Human water stress
- Agricultural water stress

Water Quality

- Nutrient pollution
- Wastewater pollution

Socioeconomics

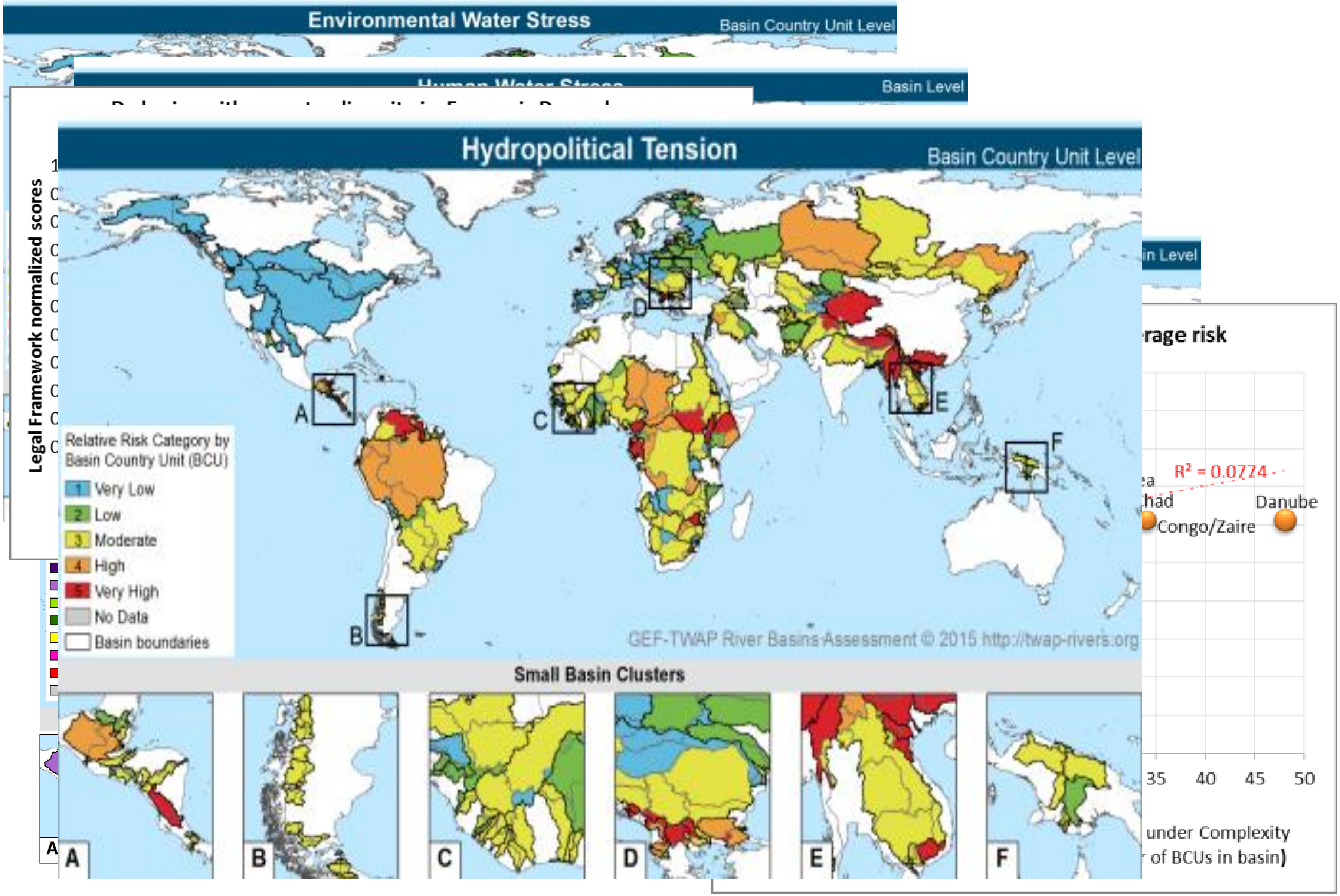
- Economic dependence on water resources
- Societal well-being
- Exposure to floods and droughts

Ecosystems

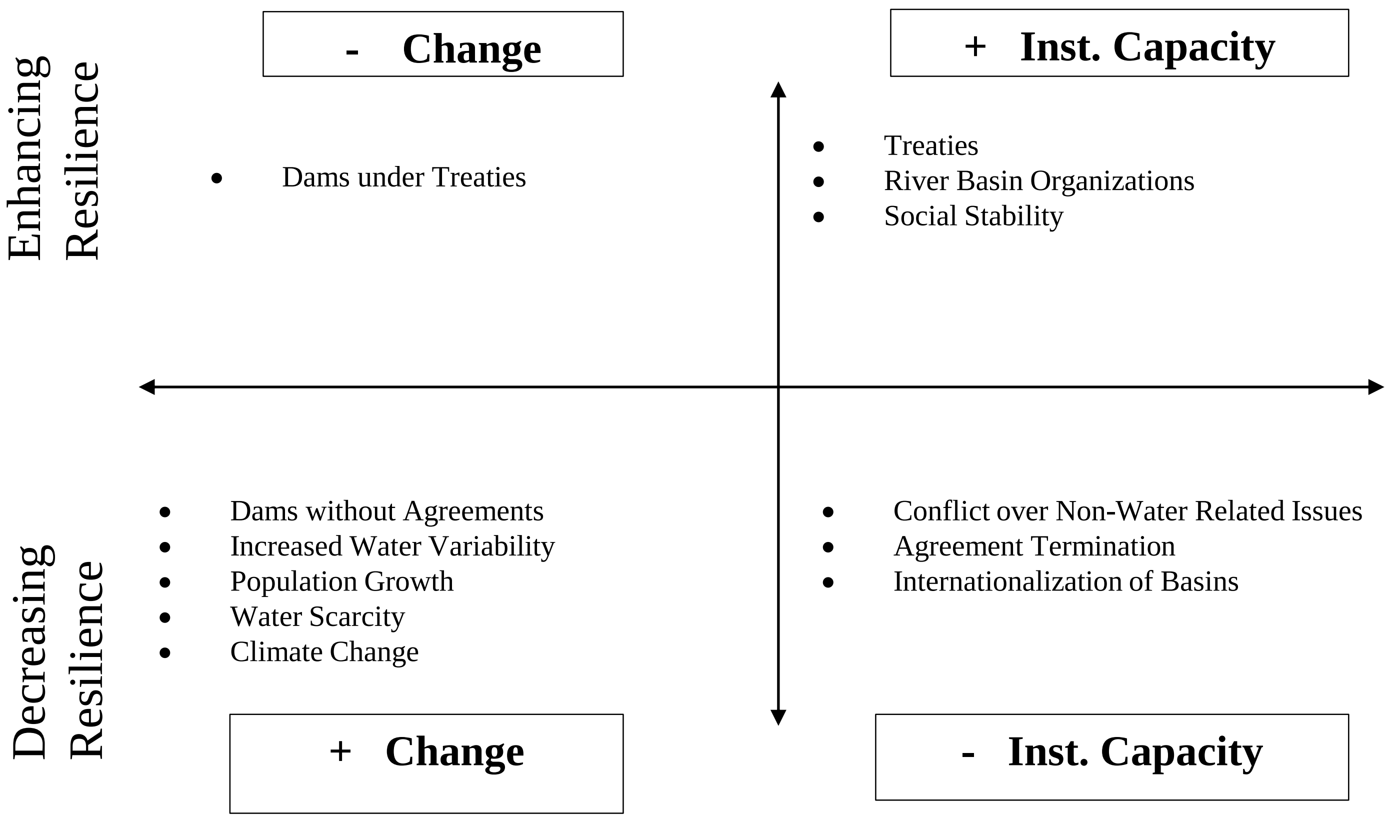
- Wetland disconnectivity
- Ecosystem impacts from dams
- Threat to fish
- Extinction risk

Governance

- Legal framework
- Hydropolitical tension
- Enabling environment


Environmental Water Stress
Basin Country Unit Level
Basin Level
Legal Framework normalized scores
Hydropolitical Tension
Basin Country Unit Level
Relative Risk Category by Basin Country Unit (BCU)
1 Very Low
2 Low
3 Moderate
4 High
5 Very High
No Data
Basin boundaries
GEF-TWAP River Basins Assessment © 2015 http://twap-rivers.org
Small Basin Clusters
A
B
C
D
E
F
rage risk
R² = 0.0774
Danube
Congo/Zaire
35
40
45
50
under Complexity
of BCUs in basin)

Indicators enhancing and decreasing hydropolitical resilience



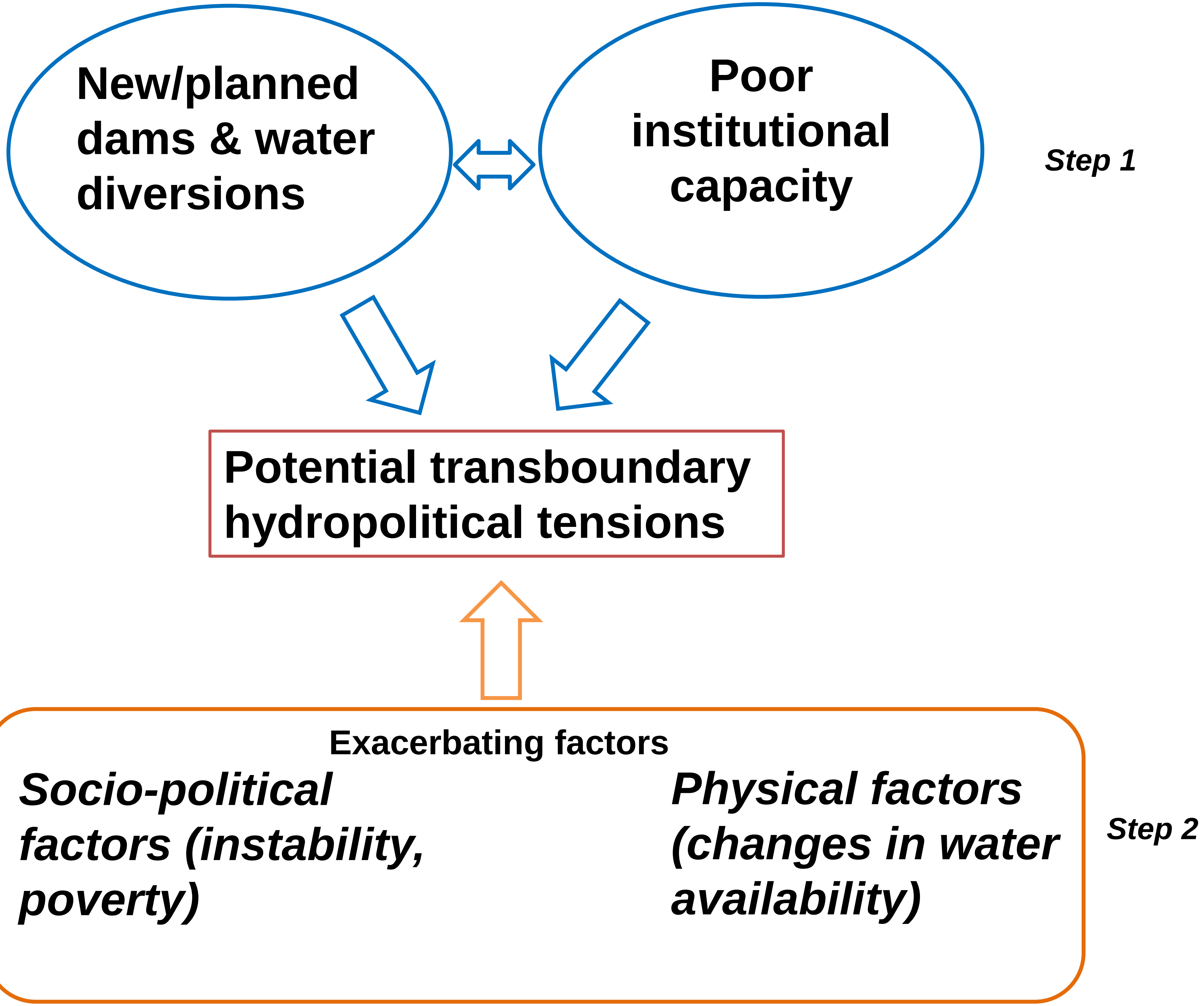
Source: Petersen-Perlman, 2014

Basins At Risk - *Working Hypothesis*

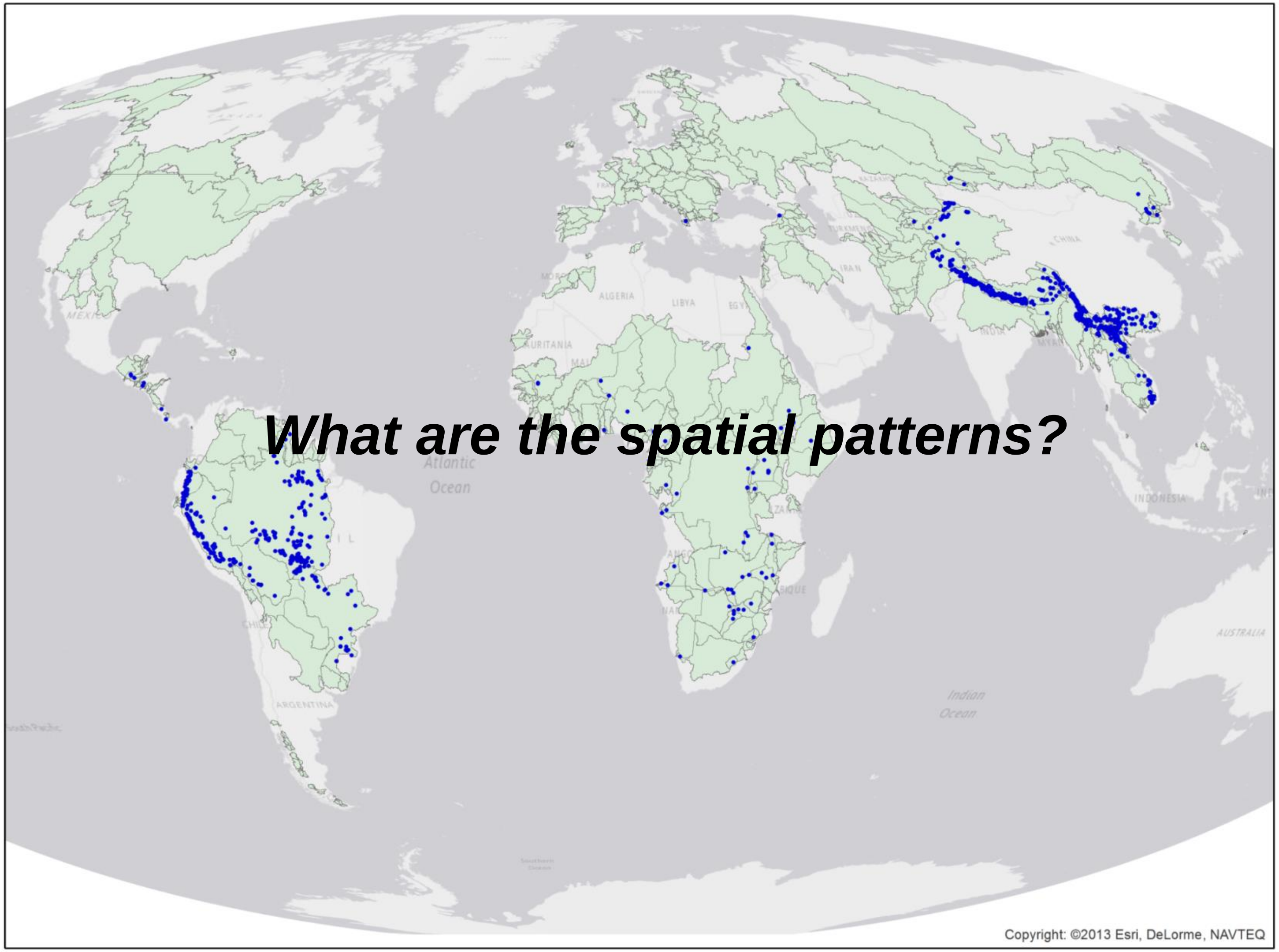
(Wolf, Yoffe and Giordano, 2003)

"***The likelihood of conflict rises as the rate of change within the basin exceeds the institutional capacity to absorb that change.***"

Sudden physical changes or lower institutional capacity are more conducive to disputes:
1) Uncoordinated development: a major project *in the absence* of a treaty or commission
2) "Internationalized basins"
3) General animosity

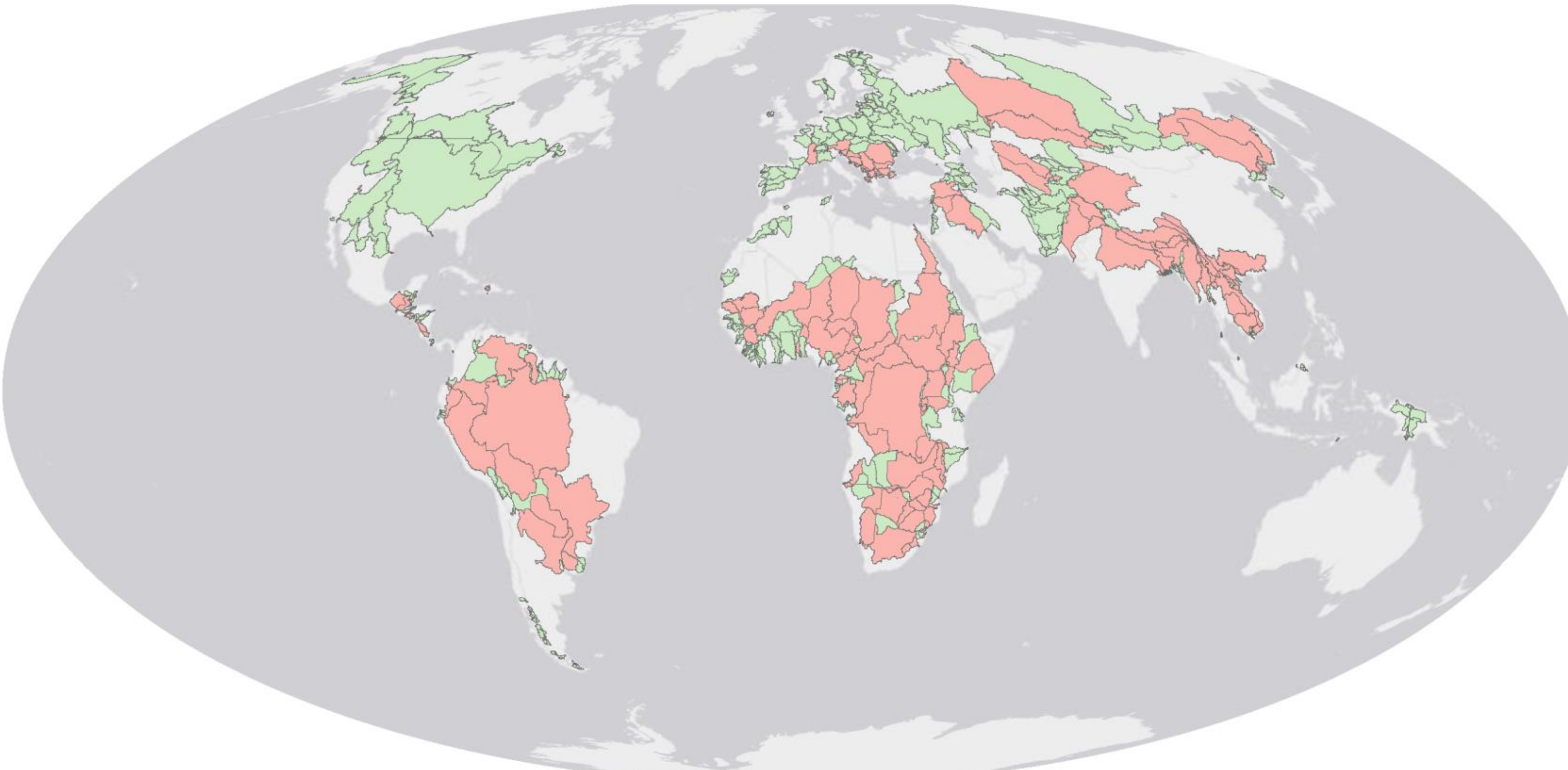

New/planned dams & water diversions
Poor institutional capacity
Step 1
Potential transboundary hydropolitical tensions
Exacerbating factors
Socio-political factors (instability, poverty)
Physical factors (changes in water availability)
Step 2

Ongoing or planned infrastructure projects



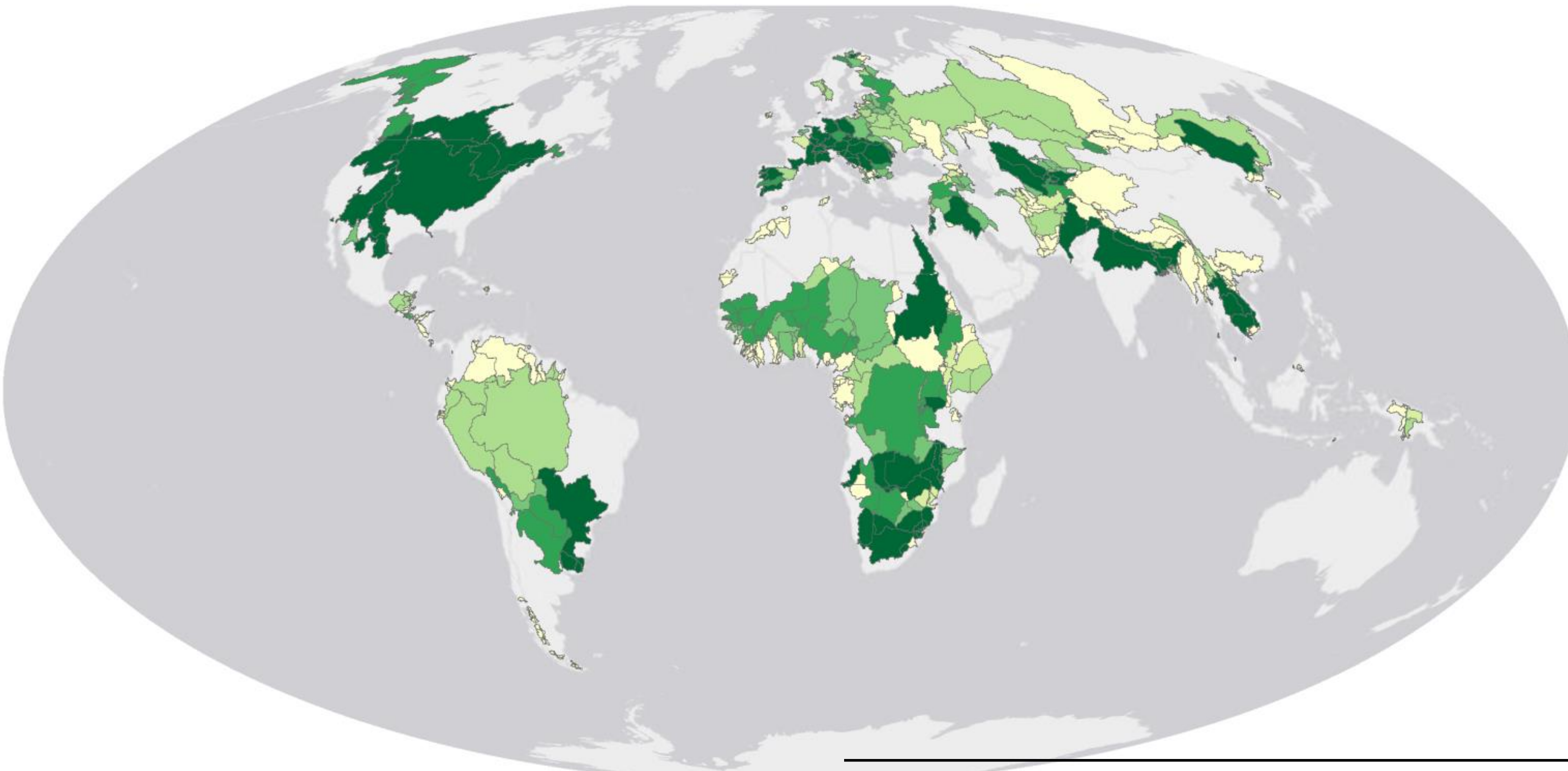
Sources: UN Framework Convention on Climate Change's Clean Development Mechanisms, International Rivers, the International Commission on Large Dams (ICOLD), websites of donors (Petersen-Perlman 2014)

Dams/diversions and downstream BCUs



Dams exceeding 10 Megawatts in capacity and diversion projects diverting quantities greater than 100,000 m^3/yr

Formal Transboundary Institutional Capacity



Resilience Value

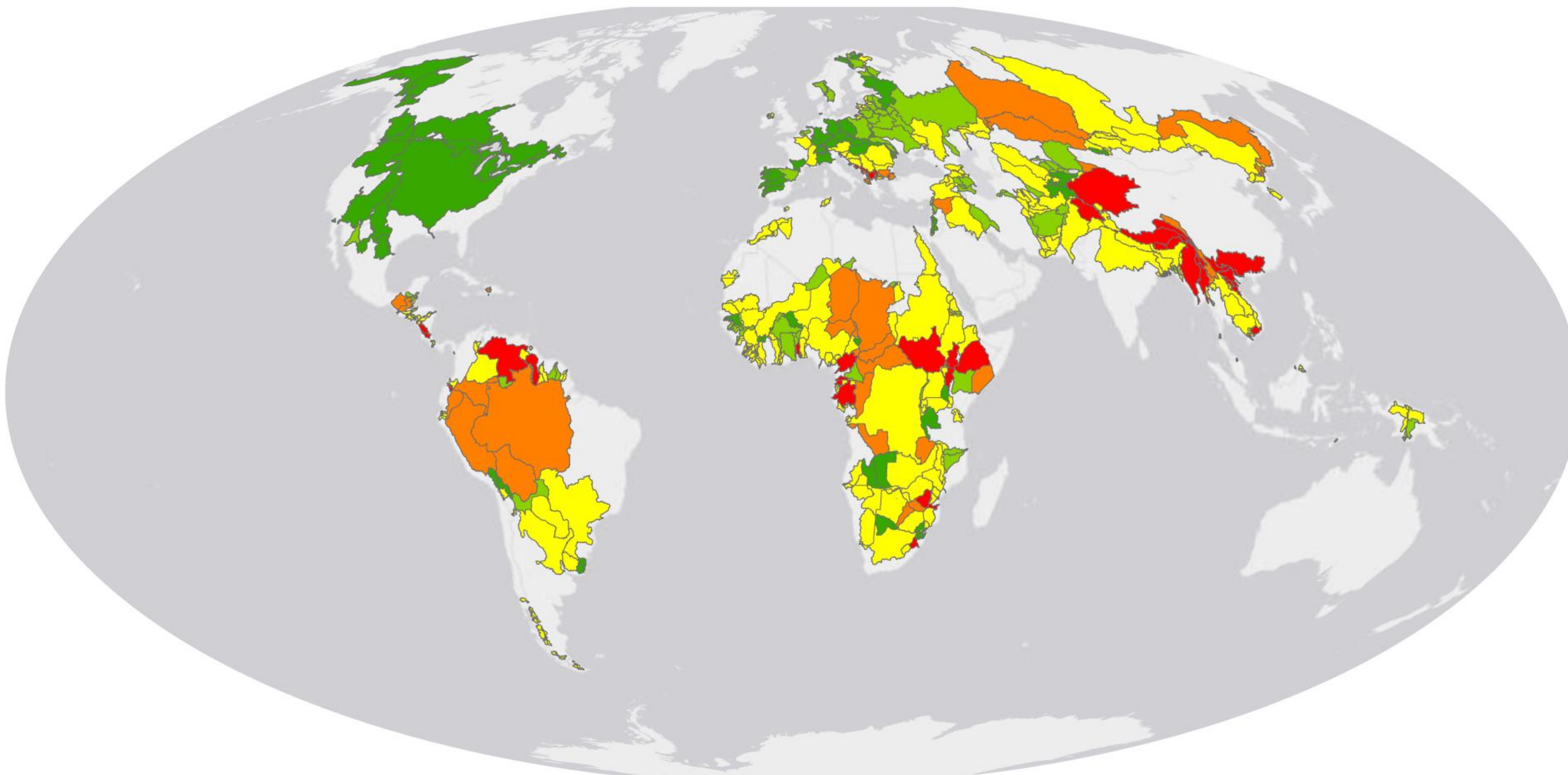
Treaty/RBO (Institutional Capacity)

- 0 Very low
- 1
- 2
- 3
- 4
- 5 Very high

(De Stefano et al., 2012)

At least one water treaty	*0/1*
At least one treaty with an allocation mechanism	*0/1*
At least one treaty with a flow variability management mechanism	*0/1*
At least one treaty/RBO with a conflict resolution mechanism	*0/1*
At least one river basin organization	*0/1*

Step 1 - Risk of Potential Hydropolitical Tensions



BCUs_BaselineIndicator_20140813

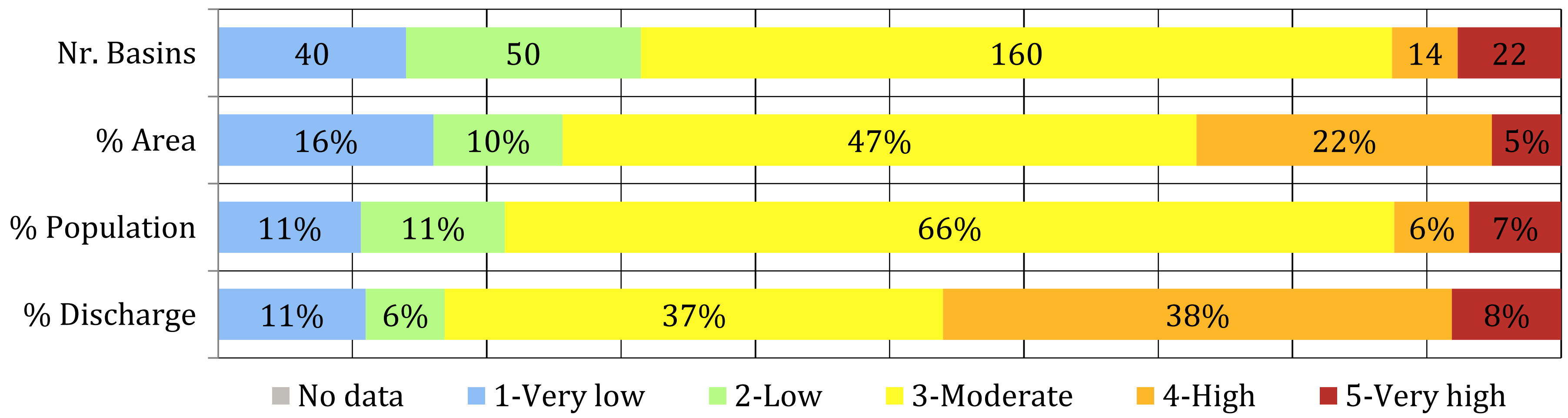
- 1 Very low
- 2
- 3
- 4
- 5 Very high

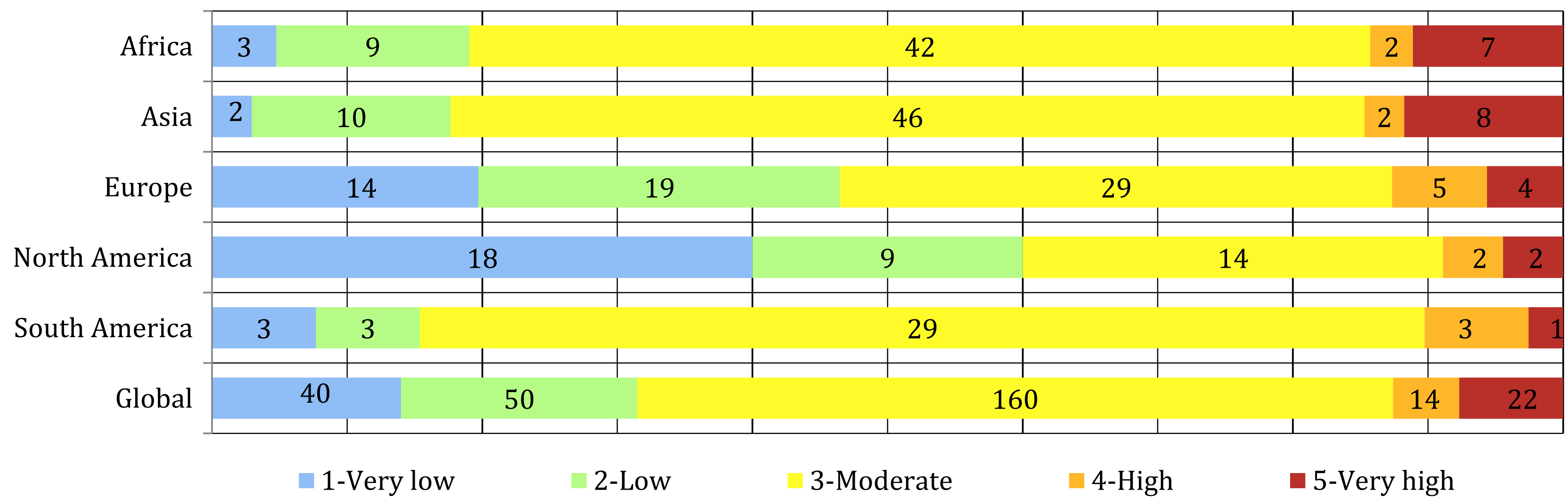
Resilience value (Treaty/RBO component)	Vulnerability to water availability changes
4, 5	1 (low V)
2, 3	2 (med V)
0, 1	3 (high V)

X

Large Dam Projects	Score ("hazard")
No presence (in the BCU or upstream)	1 - LOW
Presence (in the BCU or upstream)	3 - HIGH

Step 1 - Risk of Potential Hydropolitical Tensions





Exacerbating Factors

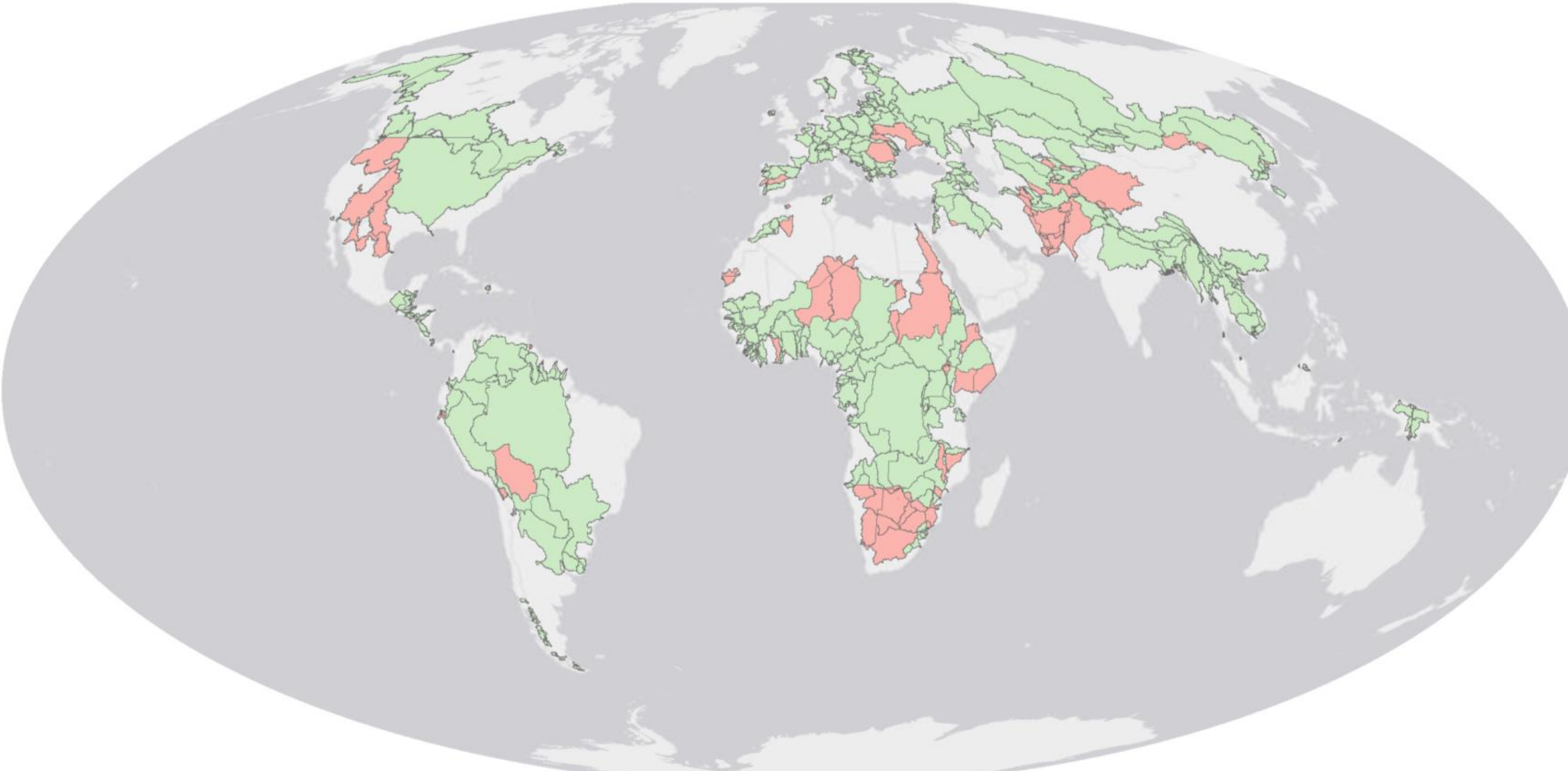
Socio-political:

- ***Intra-state armed conflicts:*** Minorities at Risk (2009)
- ***Inter-state armed conflicts***: UCDP/PRIO Armed Conflict Dataset (2013)
- ***Recent history of unfriendly relationships over water***: OSU TFDD Water Events (2000-08)
- ***Low gross national income per capita***: World Bank (2008-12)

Physical:

- ***High or increased climate-driven water variability:*** CV of annual runoff (present & projected)
- ***Recent negative trends in water reserves***: GRACE satellite data (2003-2013)

Climate-driven Water Variability



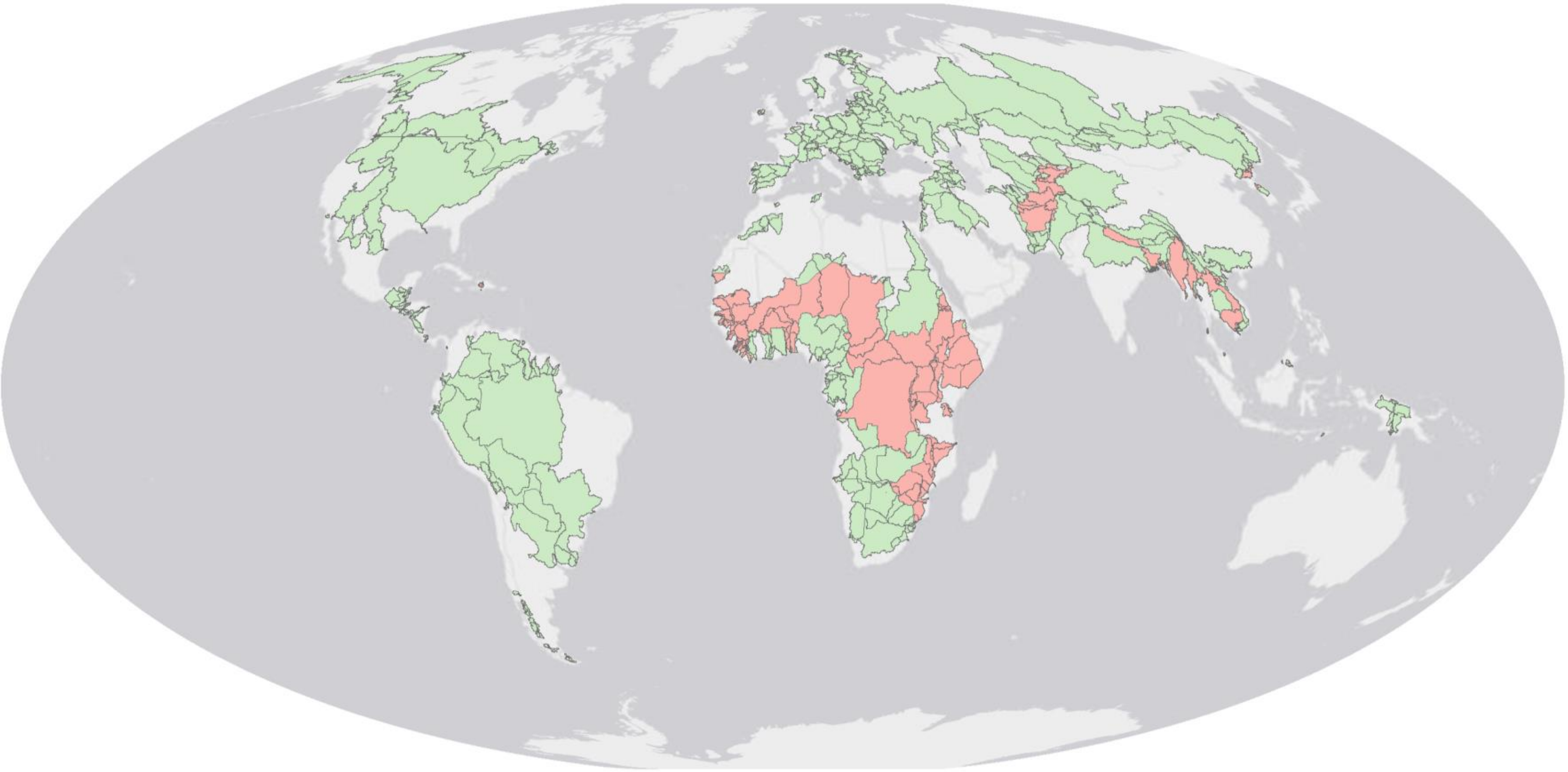
Exacerbating Factors

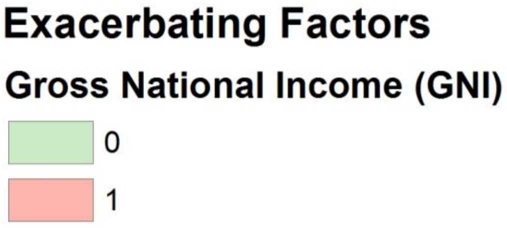
Climate-driven Water Variability (Change in Coefficient of Variation)

- 0
- 1

Water variability	Score
CV: No change/ decrease	0
CV: High present/ increase	1

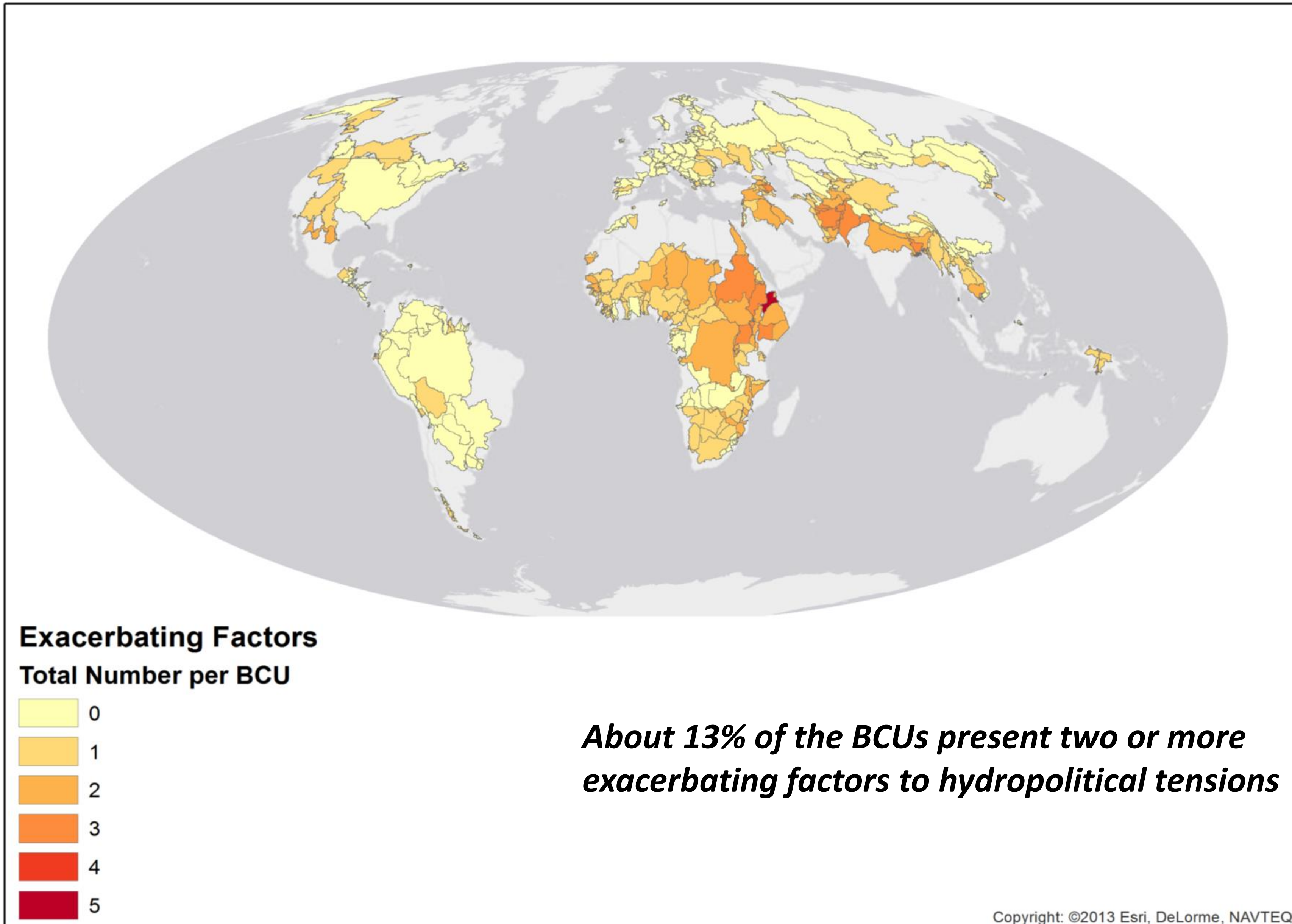
Gross National Income per capita





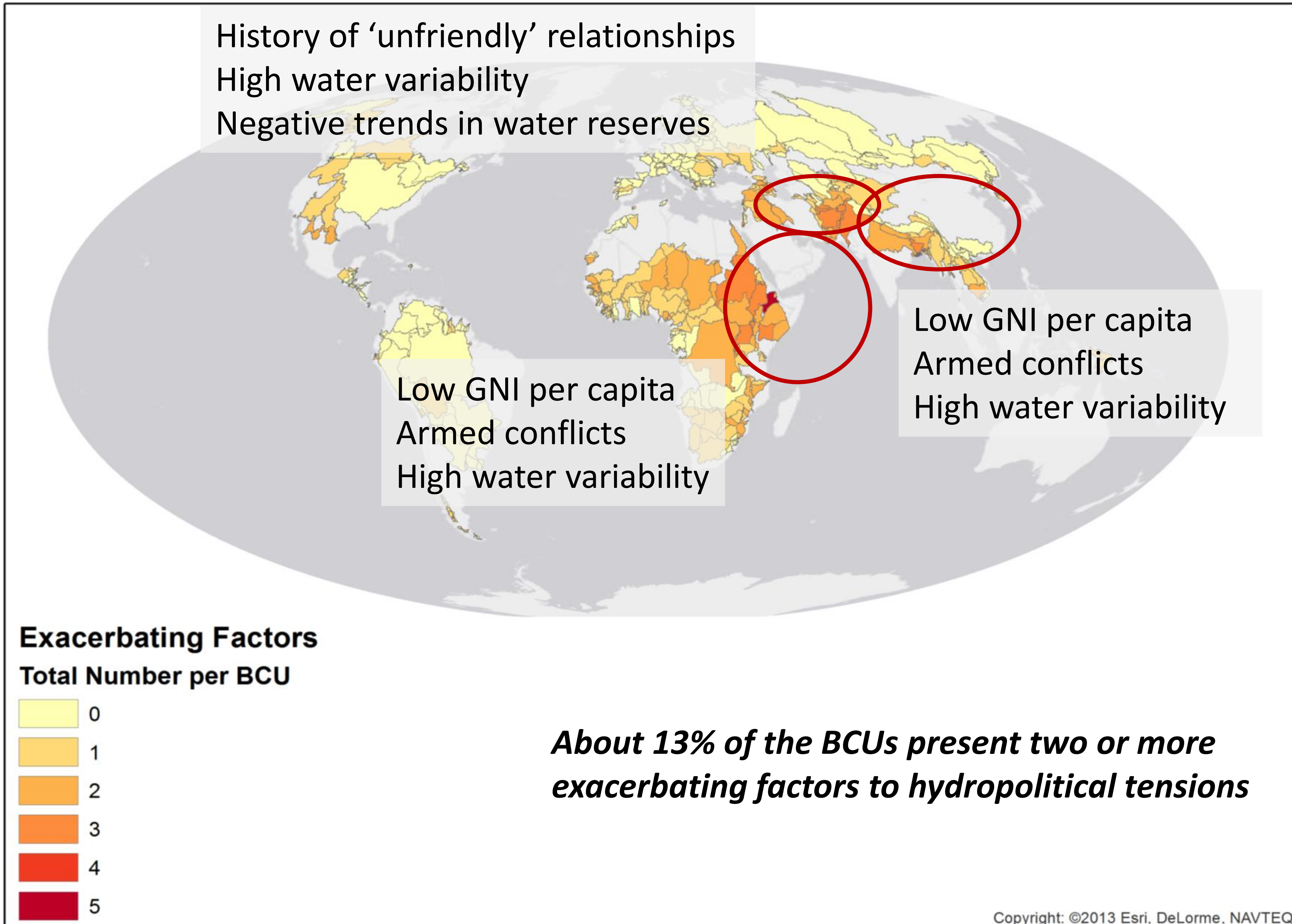
GNI per capita	Score
≥ 1035 $	0
< 1035 $	1

Concomitance of Exacerbating Factors



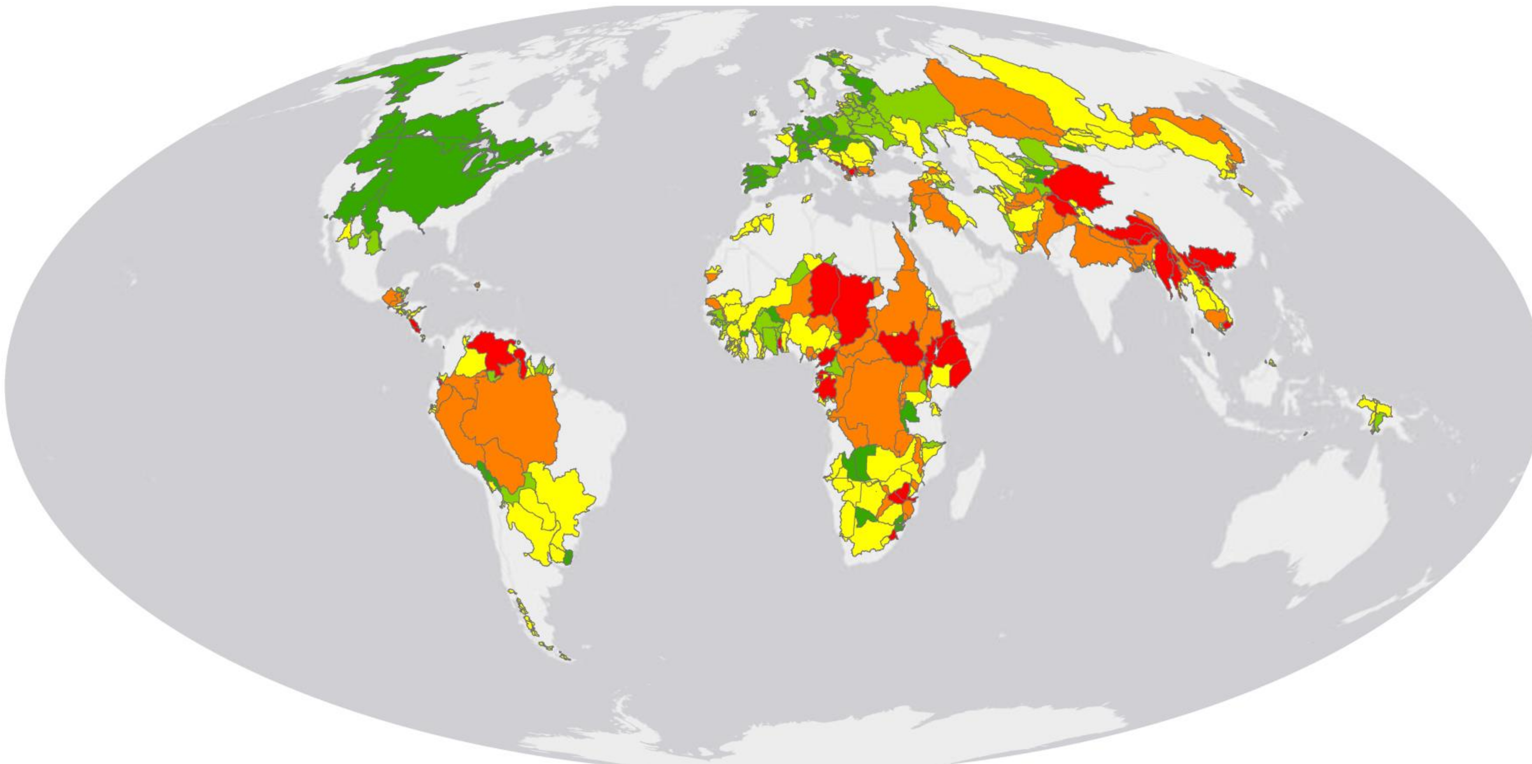
About 13% of the BCUs present two or more exacerbating factors to hydropolitical tensions

Concomitance of Exacerbating Factors



About 13% of the BCUs present two or more exacerbating factors to hydropolitical tensions

Step 2 - Risk of Potential Hydropolitical Tensions



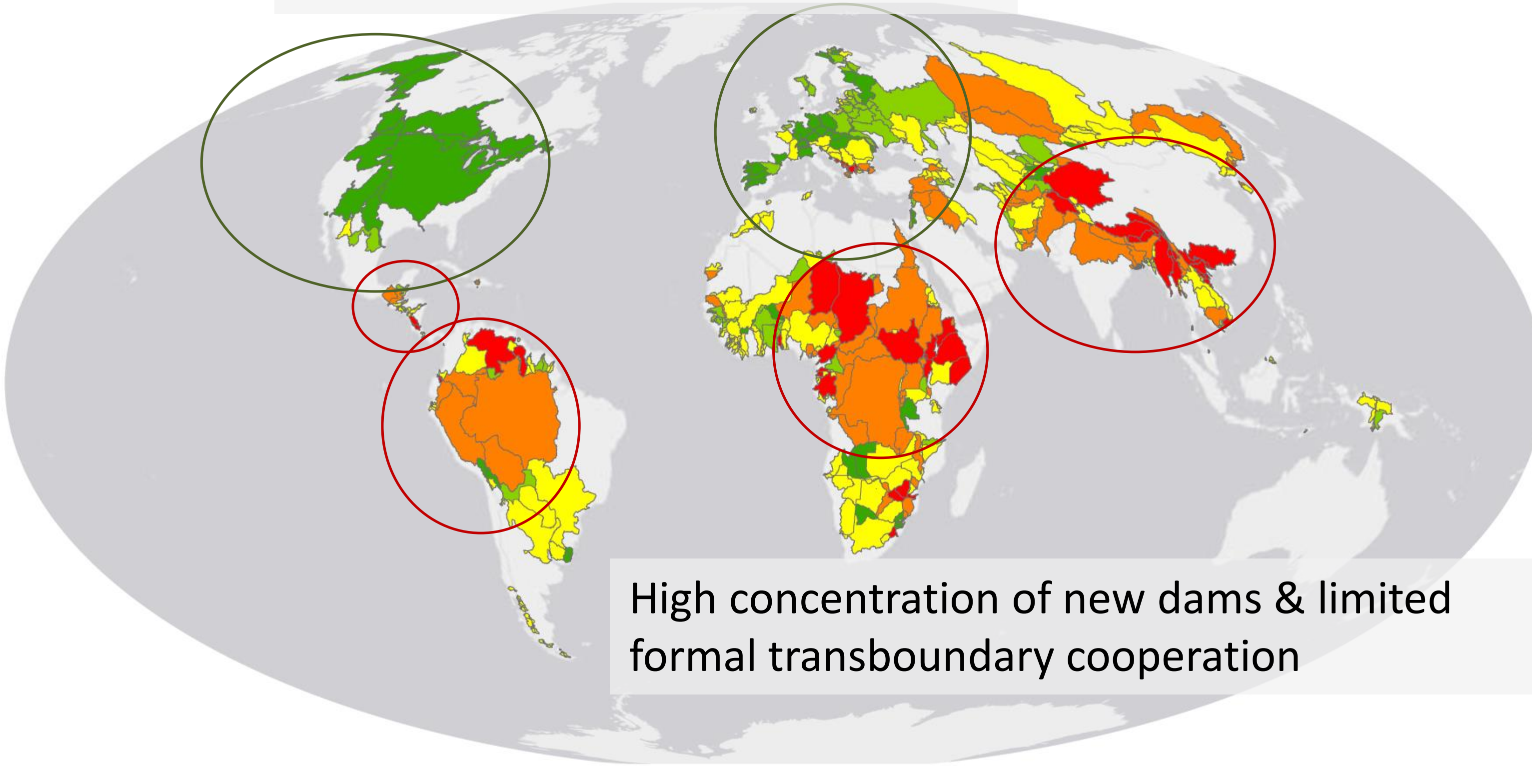
BCUs_ProjectedIndicator_20140813

- 1 Very low
- 2
- 3
- 4
- 5 Very high

104 BCUs are in the high or very high relative risk categories

Step 2 - Risk of Potential Hydropolitical Tensions

The least at risk are N. America & Europe, except for southern Balkans



High concentration of new dams & limited formal transboundary cooperation

BCUs_ProjectedIndicator_20140813

- 1 Very low
- 2
- 3
- 4
- 5 Very high

104 BCUs are in the high or very high relative risk categories

Specific Basins at Risk

- Amazon (H)
- Artibonite (H)
- Benito/Ntem (VH)
- Ca/Song-Koi (VH)
- Chiriqui (VH)
- Drin (VH)
- Essequibo (H)
- Grijalva (H)
- Bei Jiang/Hsi (VH)
- Irrawaddy (VH)
- Isonzo (H)
- Juba-Shibeli (H)
- Krka (VH)
- Lake Chad (H)
- Lake Prespa (H)
- Lake Turkana (VH)
- Ma (VH)
- Mira (VH)
- Maritsa (H)
- Mono (VH)
- Neretva (VH)
- Ob (H)
- Ogooue (VH)
- Orinoco (H)
- Red/Song Hong (VH)
- Sabi (VH)
- Saigon (VH)
- Salween (VH)
- Sanaga (VH)
- San Juan (VH)
- Struma (H)
- Thukela (VH)
- Tarim (VH)
- Tumen (H)
- Vijose (H)
- Vardar (VH)

Remarks

- TWAP is a global snapshot, with advantages and limitations of any global, indicator-based study
- There is no single issue which is the most important, and there are no basins with either ‘very low’ or ‘very high’ risk for the full range of issues.
- Focus on planned or ongoing infrastructure projects: clear opportunities but also sources of tension
- Where formal arrangements already exist but there are still disputes, need to work on improving other issues
- Baseline to be kept up to date and expanded to include other relevant aspects (e.g. water quality)

Remarks

- In three “basin at risk” studies (Wolf et al. 2003; Bernauer and Bohmelt 2014; and ours), only one basin appears in all three (Ob)
  - Most likely due to different variables used to calculate risk
- Very uneven distribution of new water infrastructure


SIDI ALI BEN AOUN
NEFZA
BIR MCHERGA
MATMATA
AL KARAK
JERASH
AL-SALT
AJLOUN

IUCN watersum SWEDEN

Steps in Local Water Security Assessment

- Defining the scale and scope (Activity 1, Step 1)
- Determine key water-related issues and values; Identify which components and indicators are important for substantive focus (Activity 1, Step 2)
- Identifying prior water-related studies and access to information (Activity 3, Step 6)
- Identifying data availability and accessibility; collecting information and data (Activity 3, Step 6)
- Indicator-based assessment (Activity 3, Step 6)

Indicator-based Assessment

COMPONENT	INDICATOR
Resource	Availability
	Supply
	Demand
Ecosystem Health	Stress
	Quality
	Fish
Infrastructure	Demand
	Condition
	Treatment
Human Health	Access
	Reliability
	Impact
Capacity	Financial
	Education
	Training

Five components

Fifteen Indicators

Resource	Availability	The amount of renewable freshwater that is available per person
	Supply	The vulnerability of the supply as caused by seasonal variations and/or depleting groundwater resources
	Demand	The level of demand for water use based on water licence allocations

Ecosystem Health	Stress	The amount of water that is removed from the ecosystem
	Quality	The Water Quality Index score for the protection of aquatic life
	Fish	Population trends for economically and culturally significant fish species

Infrastructure	Demand	How long before the capacity of water and wastewater services will be exceeded due to population growth
	Condition	The physical condition of water mains and sewers as reflected by system losses
	Treatment	The level of wastewater treatment

Human Health	Access	The amount of potable water that is accessible per person
	Reliability	The number of service disruption days per person
	Impact	The number of waterborne illness incidences

Capacities	Financial	The financial capacity of the community to manage water resources and respond to local challenges
	Education	The human capacity of the community to manage water resources and address local water issues
	Training	The level of training that water and wastewater operators have received

Example: Condition Indicator

- We use the following equation to calculate a score for the infrastructure condition indicator (I_C). A 25 percent system loss or greater receives a score of 0 and a 0 percent system loss receives a score of 100.

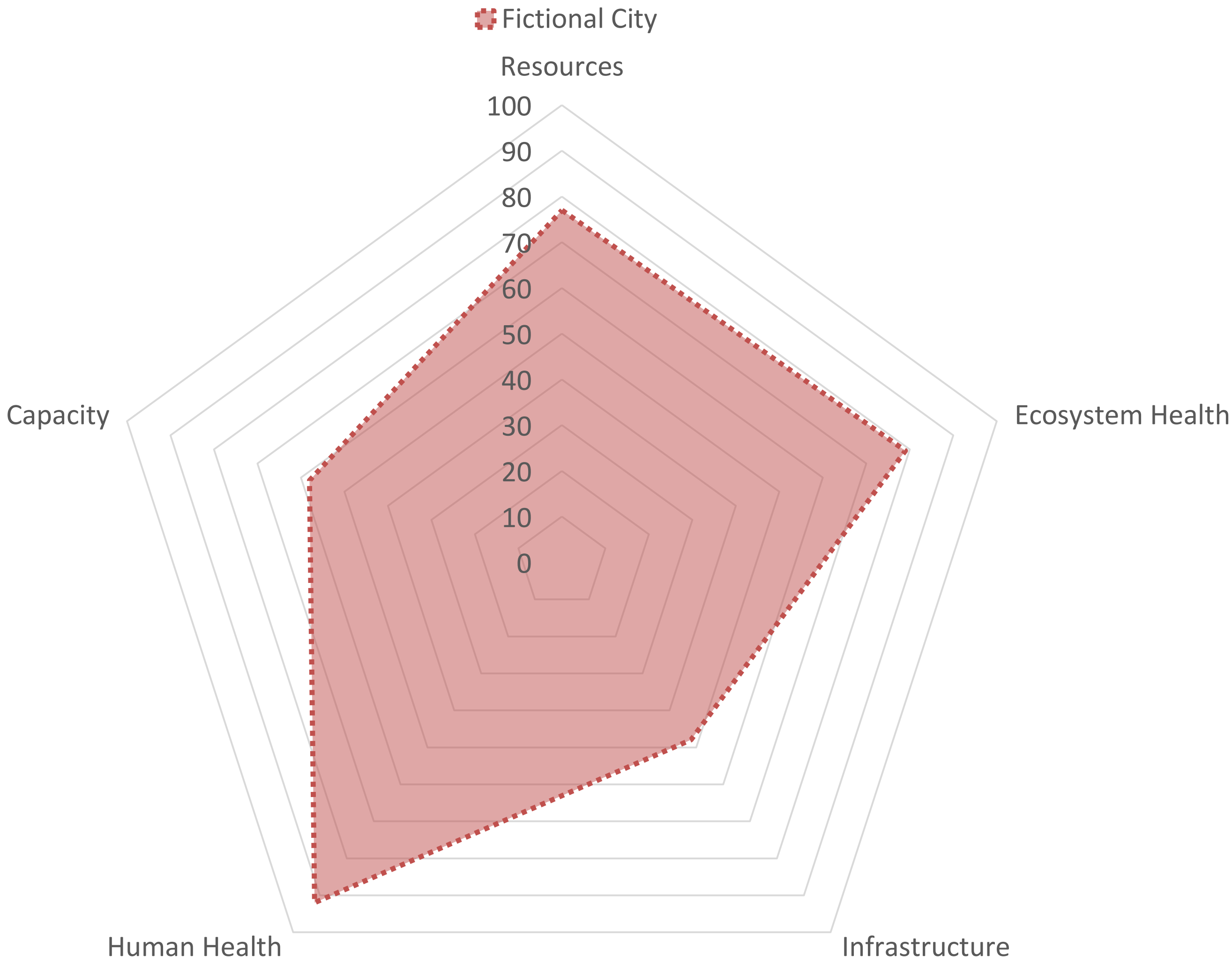
$$I_C = 100 - \left(\frac{L}{25} \times 100\right)$$

- Where: L = % system losses
- If $L \geq 25$, then $I_C = 0$
- If $L = 0$, then $I_C = 100$
- Determine system losses (L) for both water mains and sewers; the system with the highest loss percentage is used to calculate I_C.

Example: Condition Indicator

- EXAMPLE: If the water main system loss percentage is 15%, then I_C is:
  - $I_C = 100 - \left(\frac{15}{25} \times 100\right) = 40.$
- If the sewer system loss percentage is 10%, then I_C is:
  - $I_C = 100 - \left(\frac{10}{25} \times 100\right) = 60.$
- We use the system with the highest loss percentage, so the score is 40.

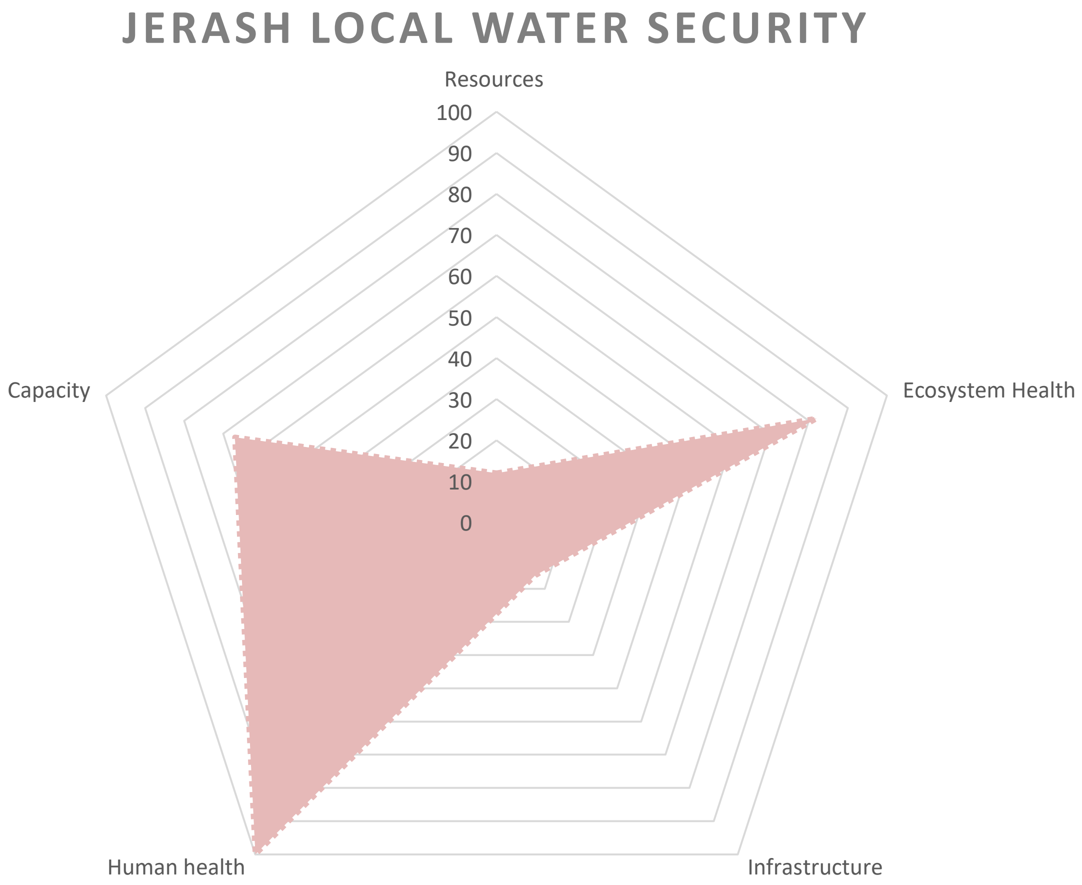
LOCAL WATER SECURITY ASSESSMENT SCORES



Preliminary Results

- JORDAN:
  - Water availability; infrastructure a constant issue
  - Generally good water quality; strong human health indicators
  - Infrastructure could use expansion and repair
- TUNISIA:
  - High water variability
  - Generally good water quality; strong human health indicators
  - Infrastructure could use expansion and repair

Results for Jerash



Jerash's proposed actions

- Replace and modernize small diameter water mains of 10% of existing water network
- Improve water efficiency use in households by 25%
- Promote water harvesting systems for 25% of population
- Water quality monitoring plan
- Increase population using sewerage network by 30%

Strengths of this approach

- Small scale
- Local capacity building
- Attempt at holistic approach of capturing water security
- Easy-to-understand scores

Weaknesses of this approach

- Some metrics don’t apply
- Scores only go so far – don’t explain everything
- Non-comprehensive

Water Security at Global vs. Local Scales

- Problem of scale
  - Perception of higher resilience at global scale, but smaller scale evidence may be contradictory
  - Scoring by BCU treats each BCU as a “closed system”; but boundaries are permeable
  - Impossible to incorporate all factors at any scale
  - Global indicators may point towards basins and BCUs of low water security, but on-the-ground research is needed

Acknowledgements

Work drawn from the following publications:

De Stefano, Lucia, Jacob D. Petersen-Perlman, Eric Sproles, Jim Eynard, & Aaron T. Wolf. “Global Assessment of Transboundary Rivers Basins for Potential Hydro-political Tensions.” *Under review; Global Environmental Change.*

R. Lausevic, S. Milutinovic, J. Petersen-Perlman, M. Reed, A. Graves, M. Bartula, S. Susic, & A. Popovic. 2016. *Local Water Security Action Planning Manual.* Regional Environmental Center, Szentendre, Hungary. ISBN 978-963-9638-69-3.

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Thank you! Questions?