Conflict Resolution in Water Resources: Global Perspective and Local Successes

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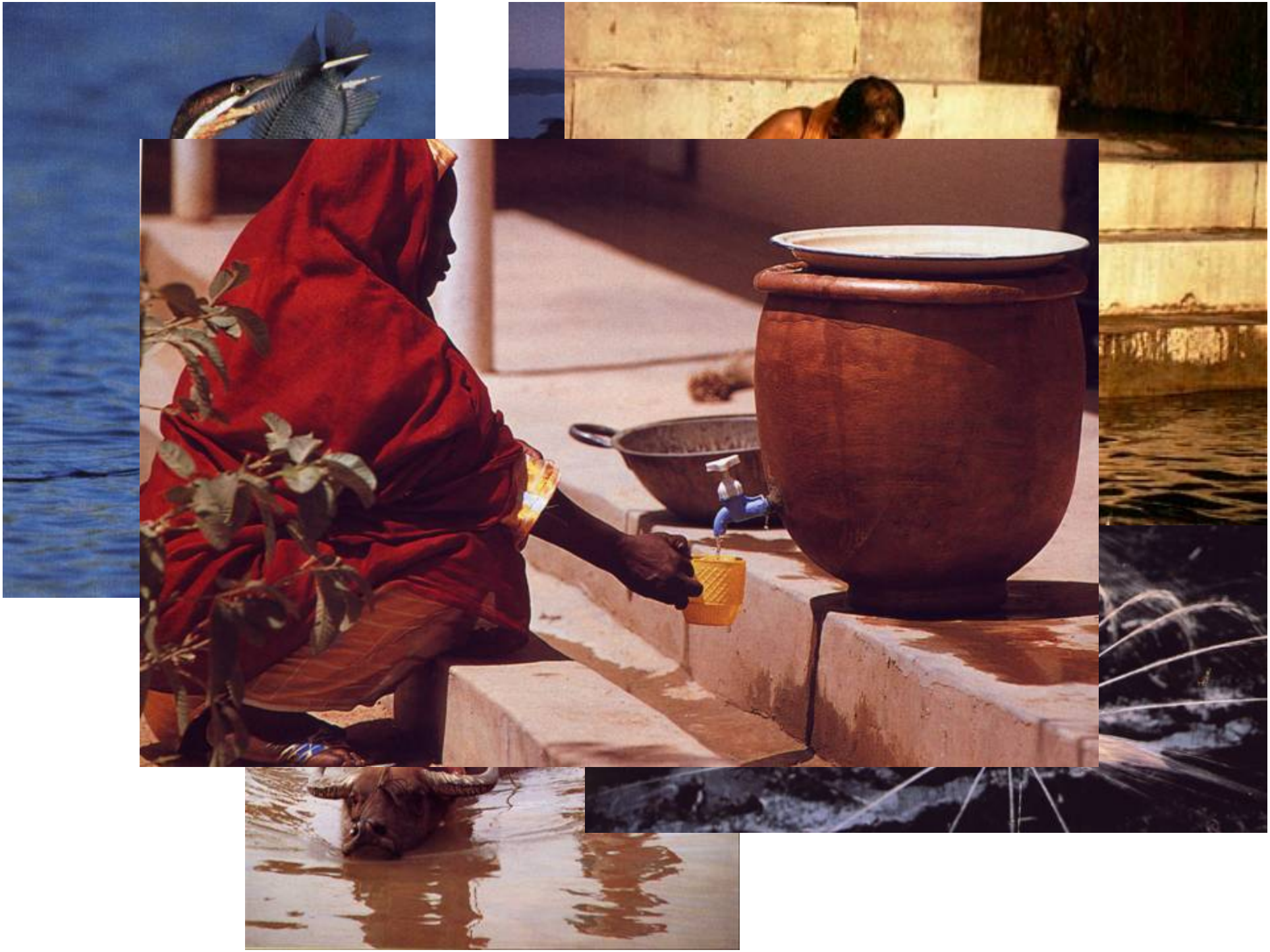
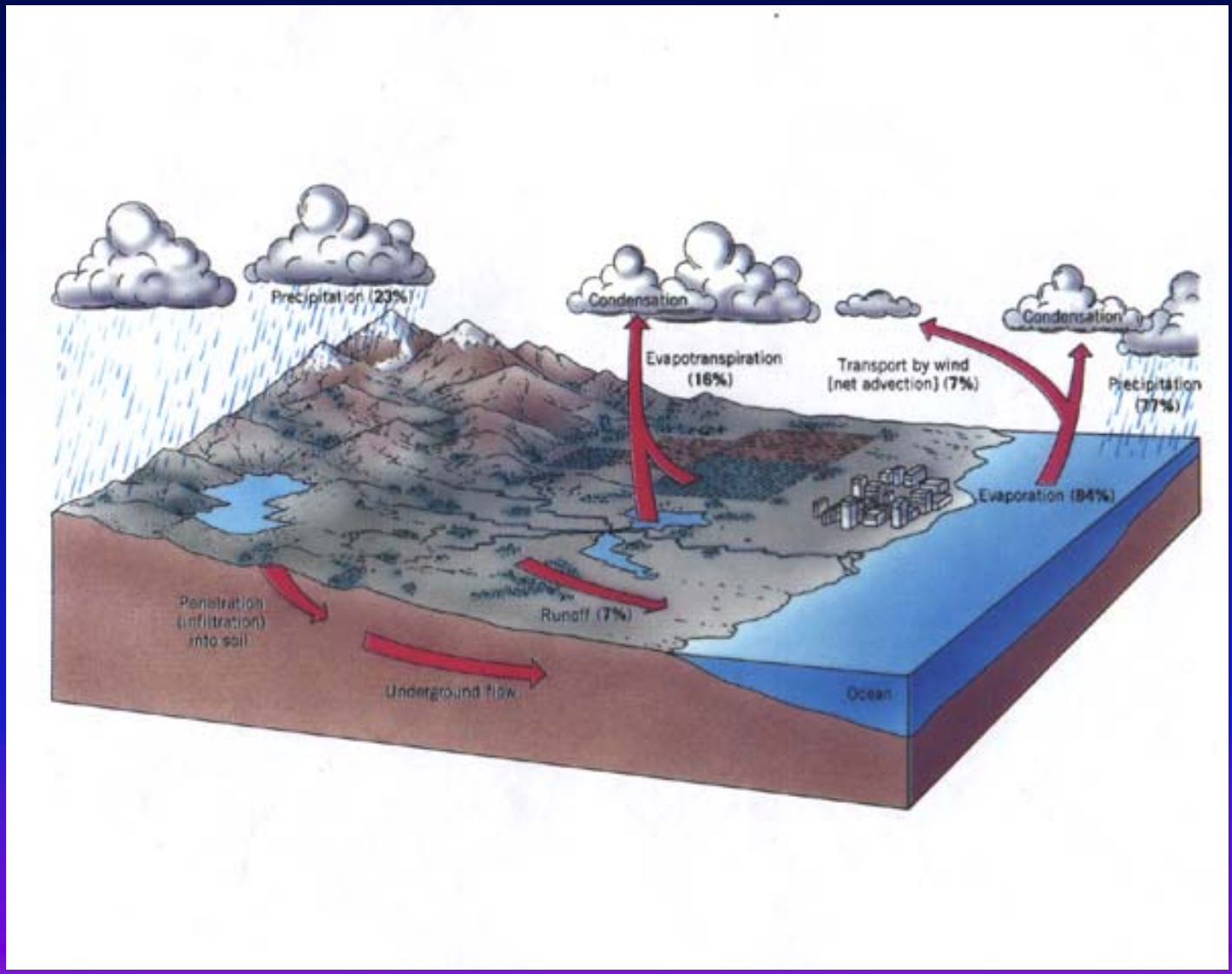
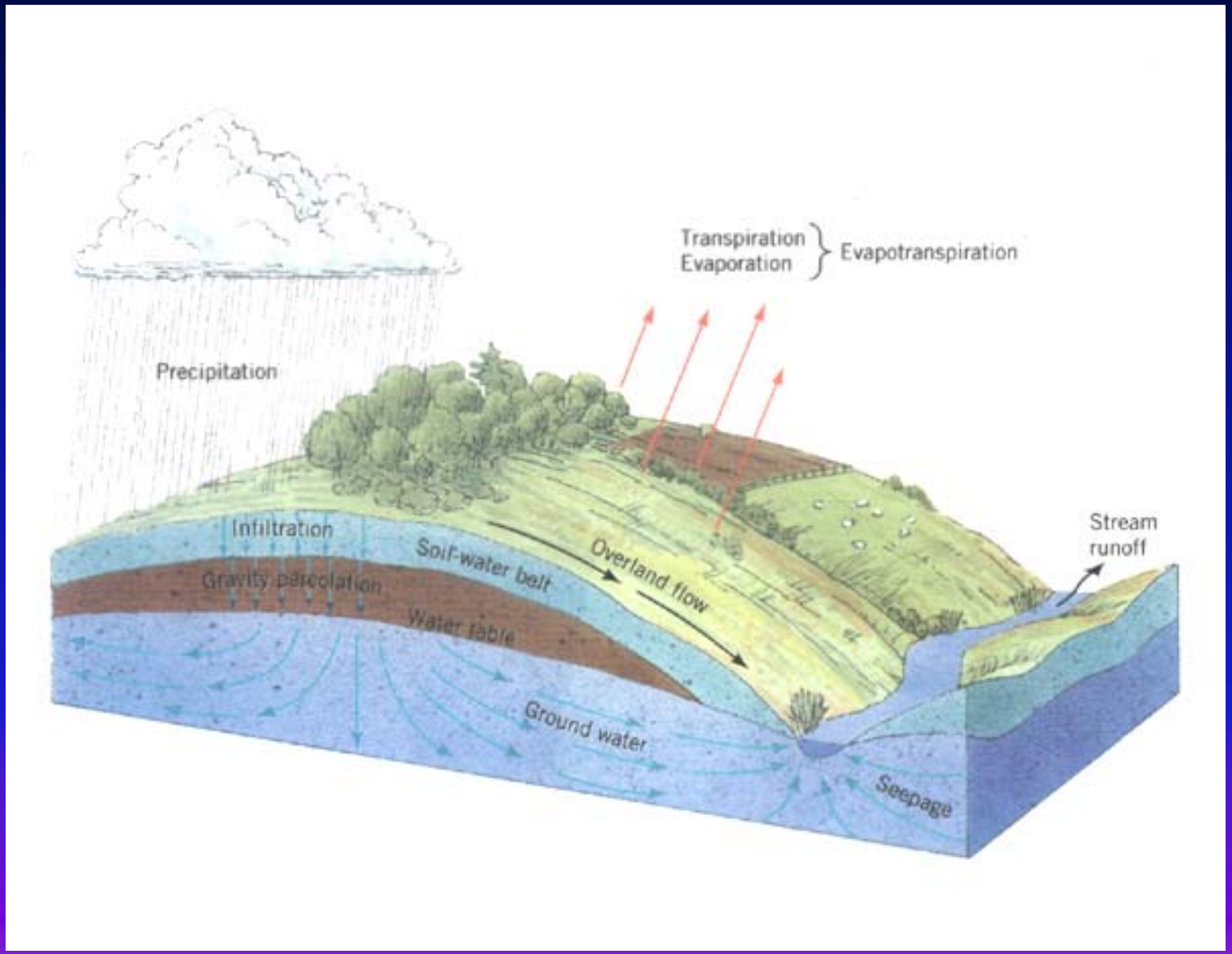
Global Water Crisis

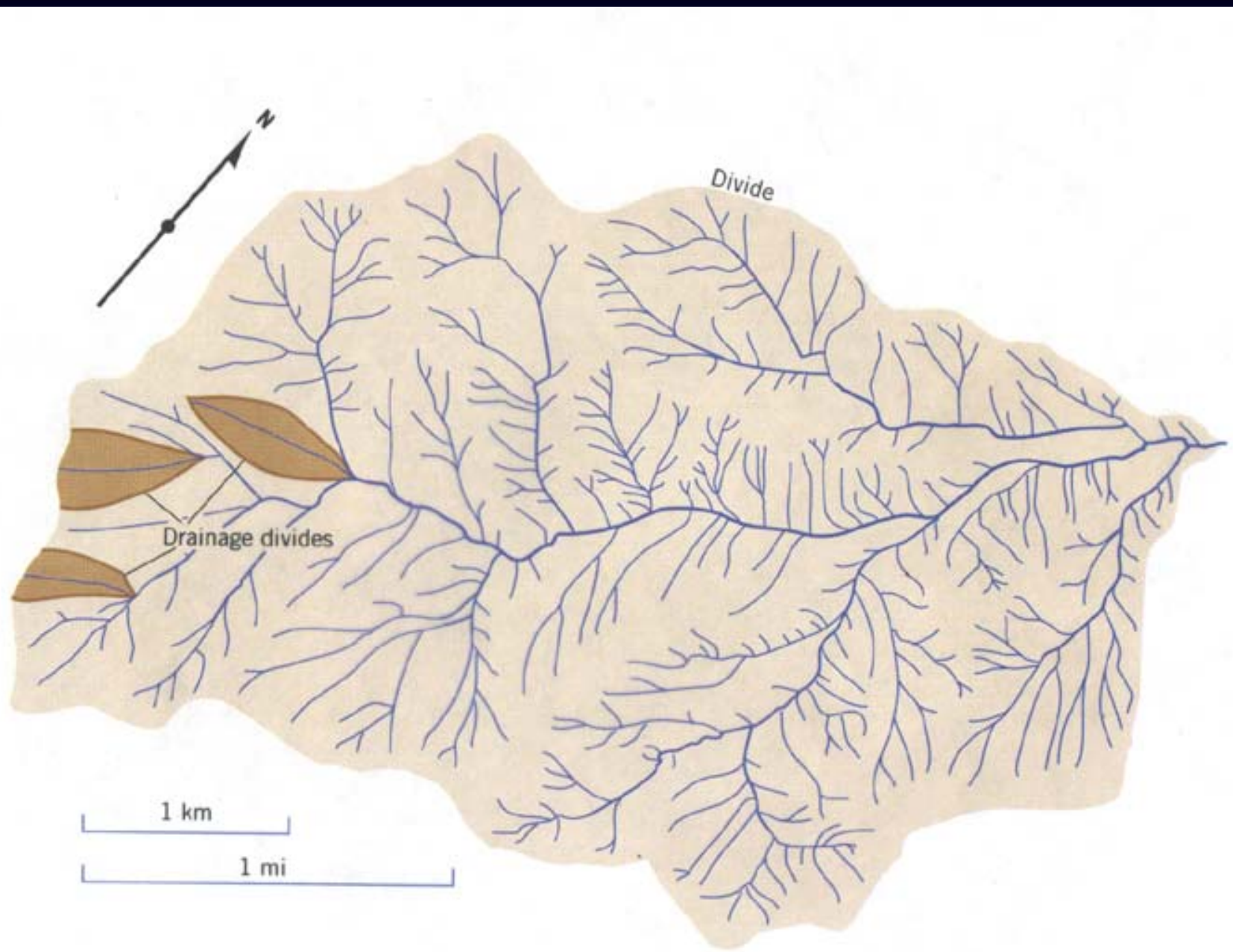
- 2.4 billion people lack access to adequate sanitation
- >1 billion people lack access to safe drinking water
- At least 250 million illnesses result
- 2.2 to 5 million deaths
- 20% of irrigated lands are salt-laden

- Water-related disease costs US$125 billion/yr.
- Would “only” cost US$7-50 billion/yr. to resolve

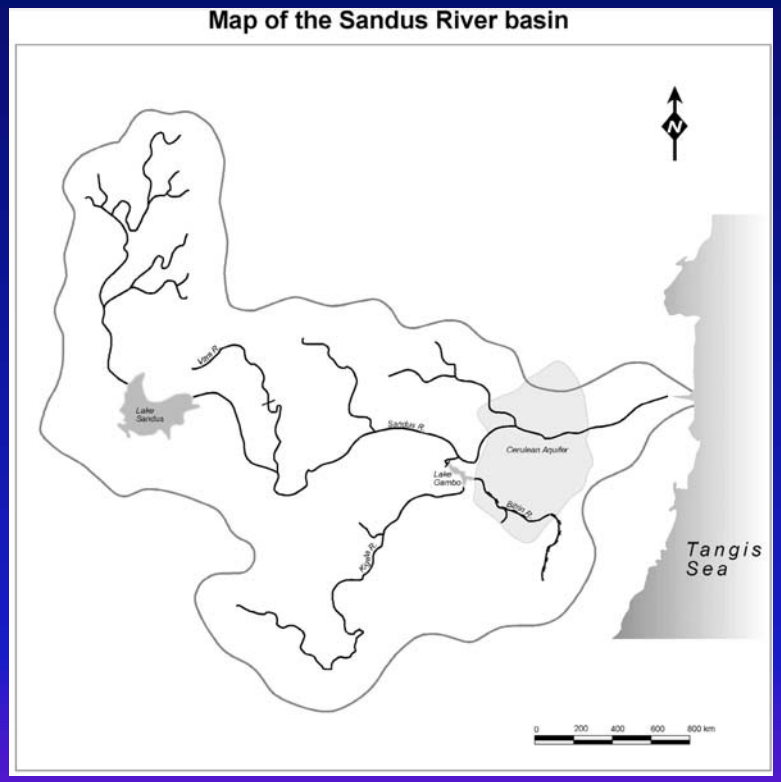


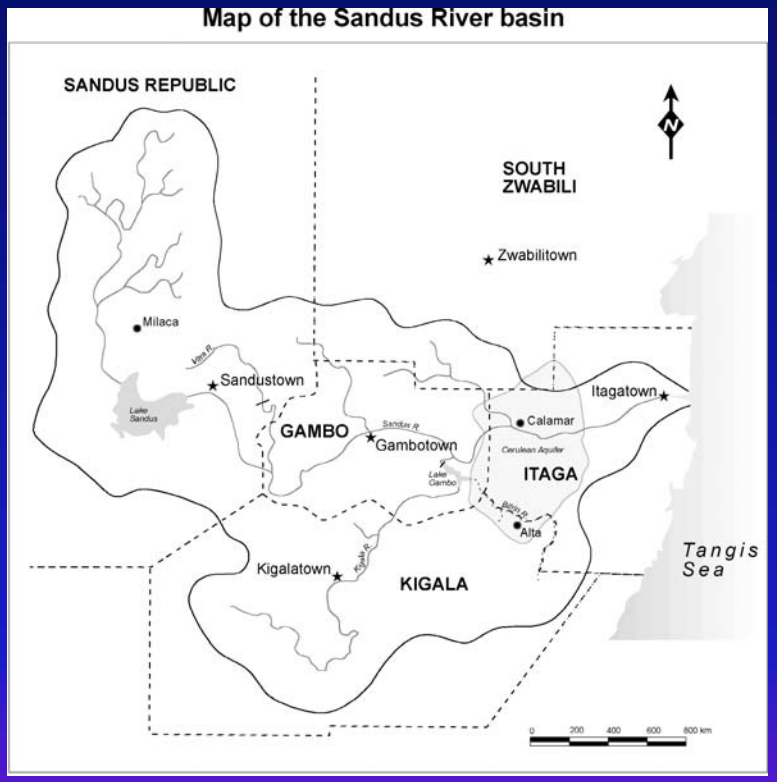

Precipitation (23%)
Condensation
Evapotranspiration (16%)
Transport by wind [net advection] (7%)
Condensation
Precipitation (77%)
Evaporation (84%)
Penetration (infiltration) into soil
Runoff (7%)
Underground flow
Ocean


Transpiration
Evaporation
Evapotranspiration
Precipitation
Infiltration
Gravity percolation
Soil-water belt
Water table
Overland flow
Stream runoff
Ground water
Seepage


N
Divide
Drainage divides
1 km
1 mi

What *is* Transboundary Water Conflict Management & Transformation??

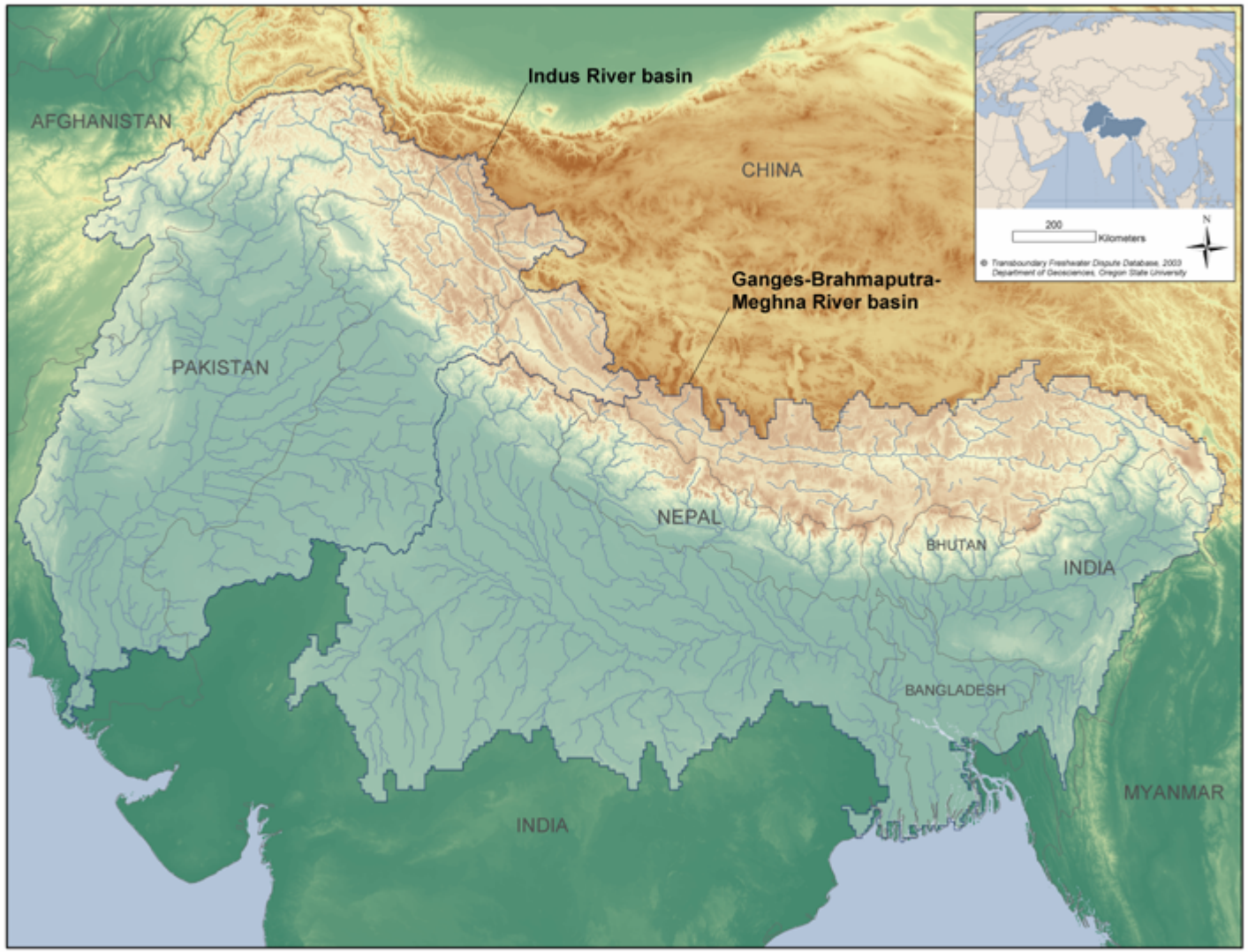




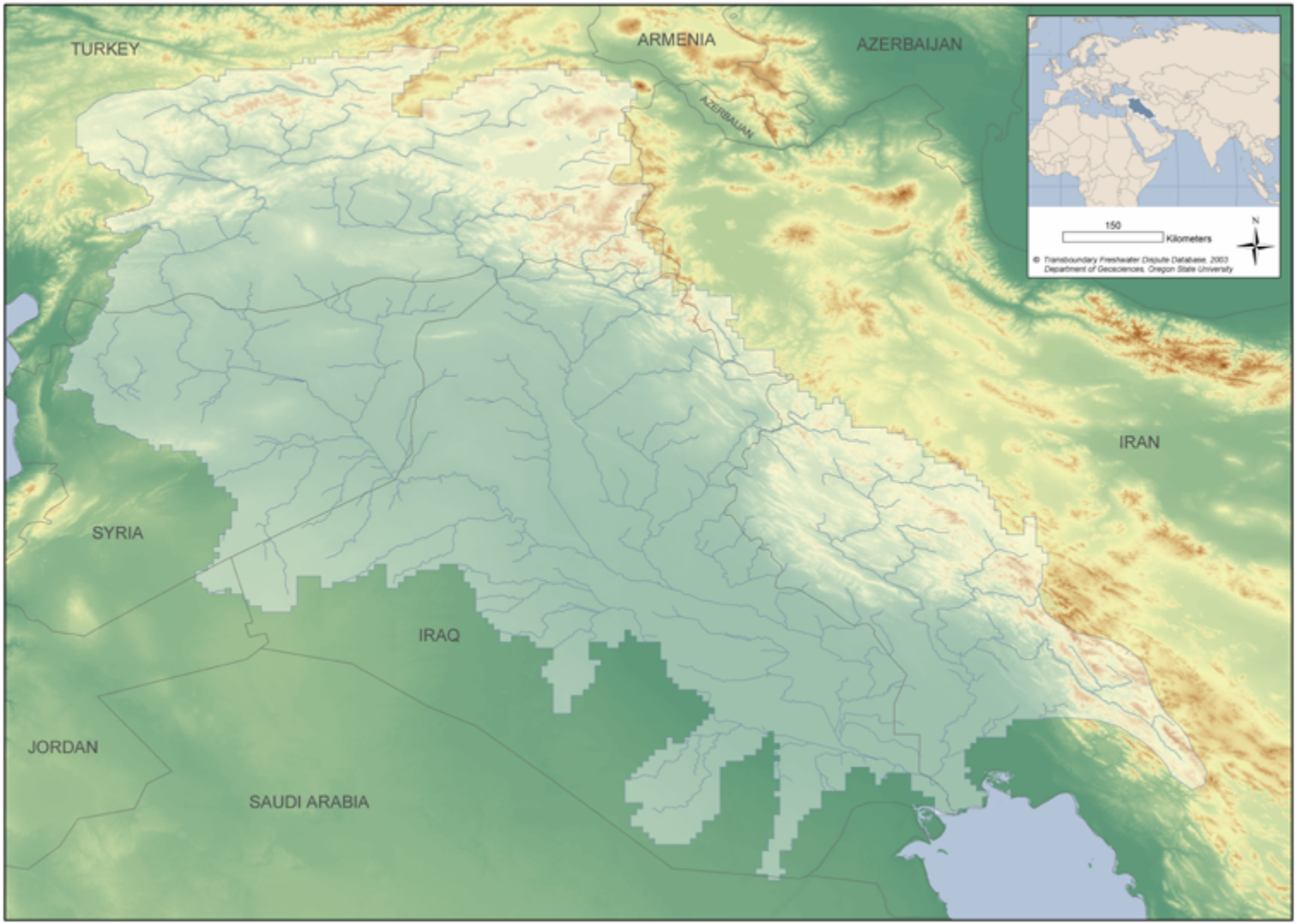
What changes when a border is present?

What capacity do we need to address the change?

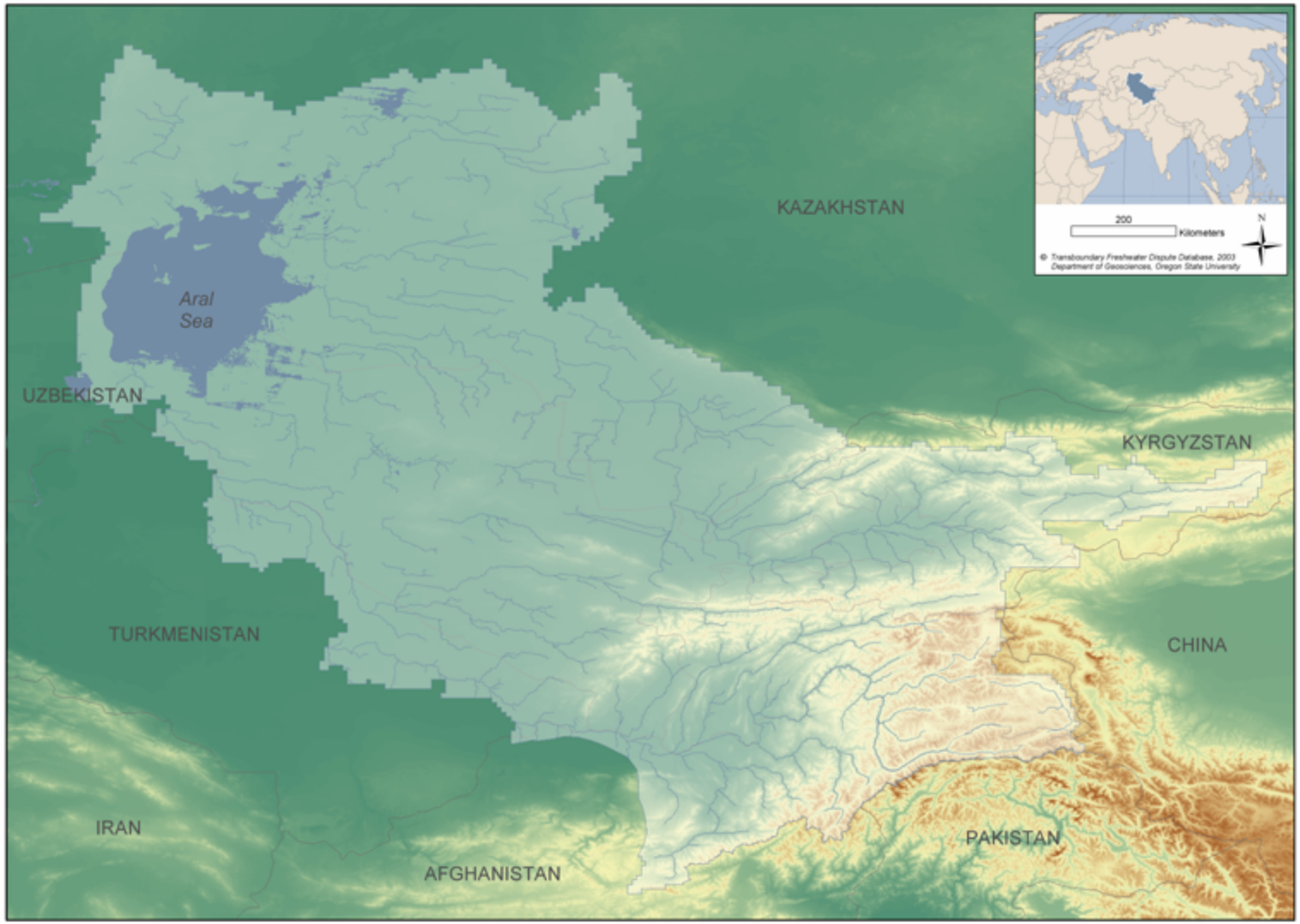
The Indus River and Ganges-Brahmaputra-Meghna River basins



The Tigris-Euphrates River basin

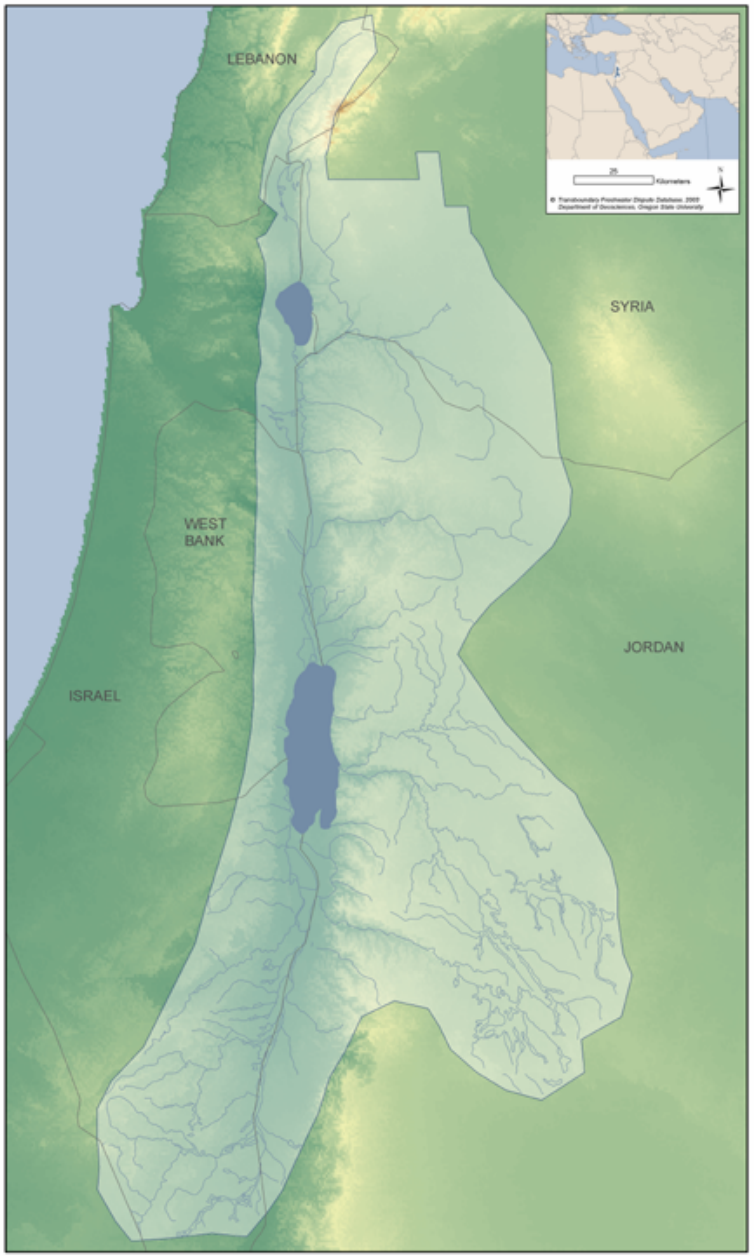


The Aral Sea basin



The Nile River basin

The Jordan River basin



Water and Conflict

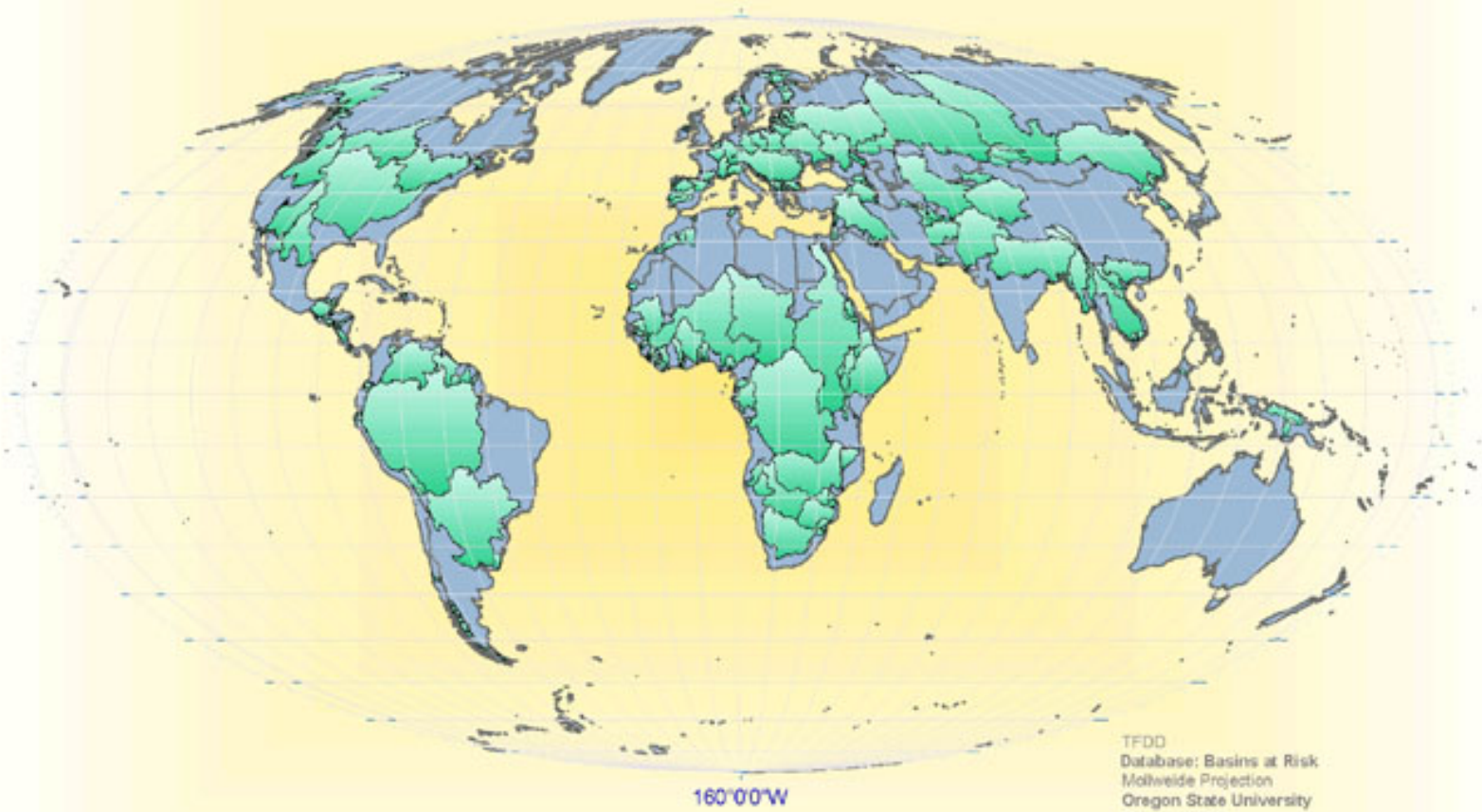
"Fierce competition for fresh water may well become a source of conflict and wars in the future."

- Kofi Annan, March 2001

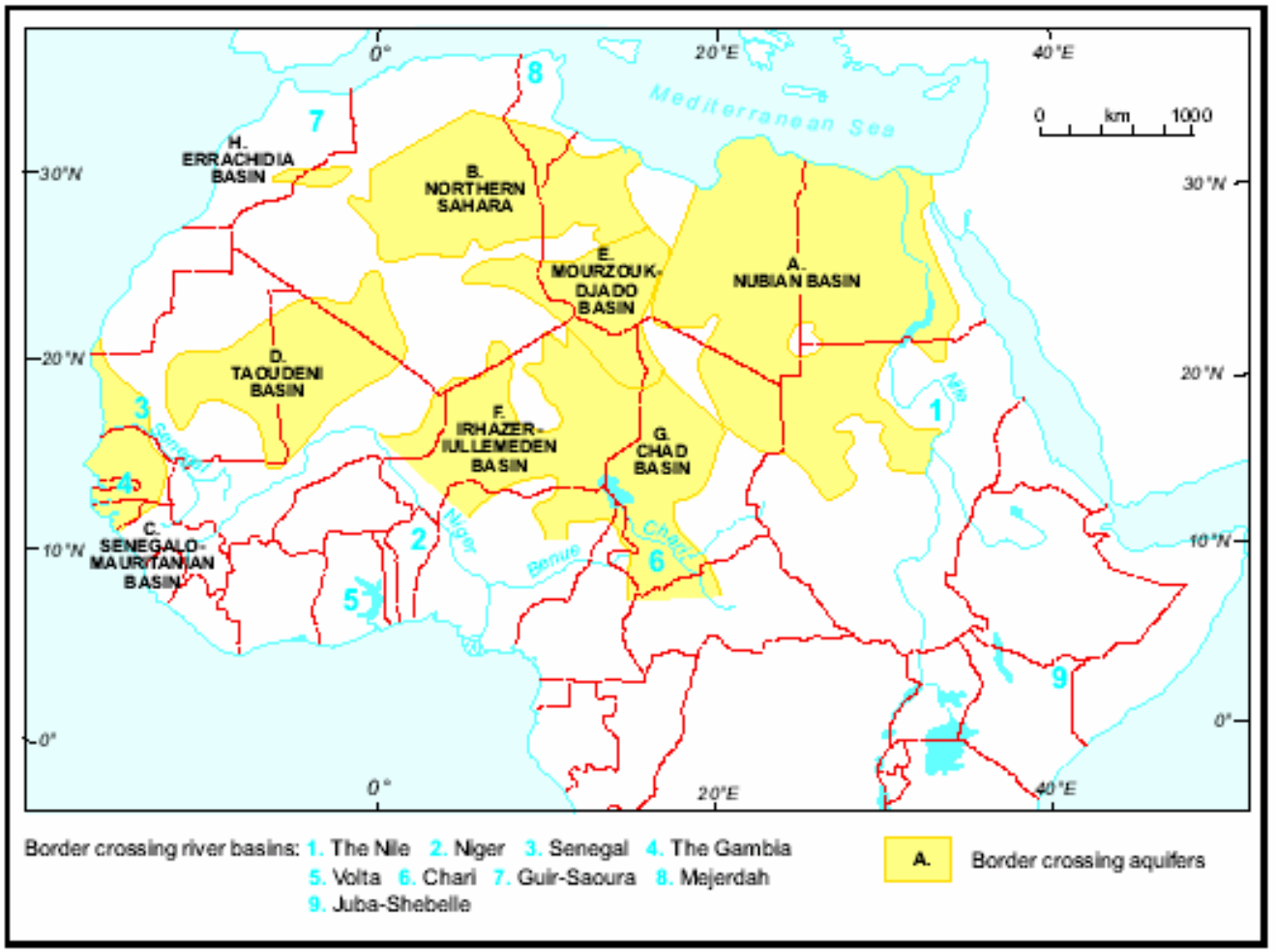
Water Myths and Water Facts

Myth 1:
Water Wars are Prevalent and Inevitable

International Basins of the World

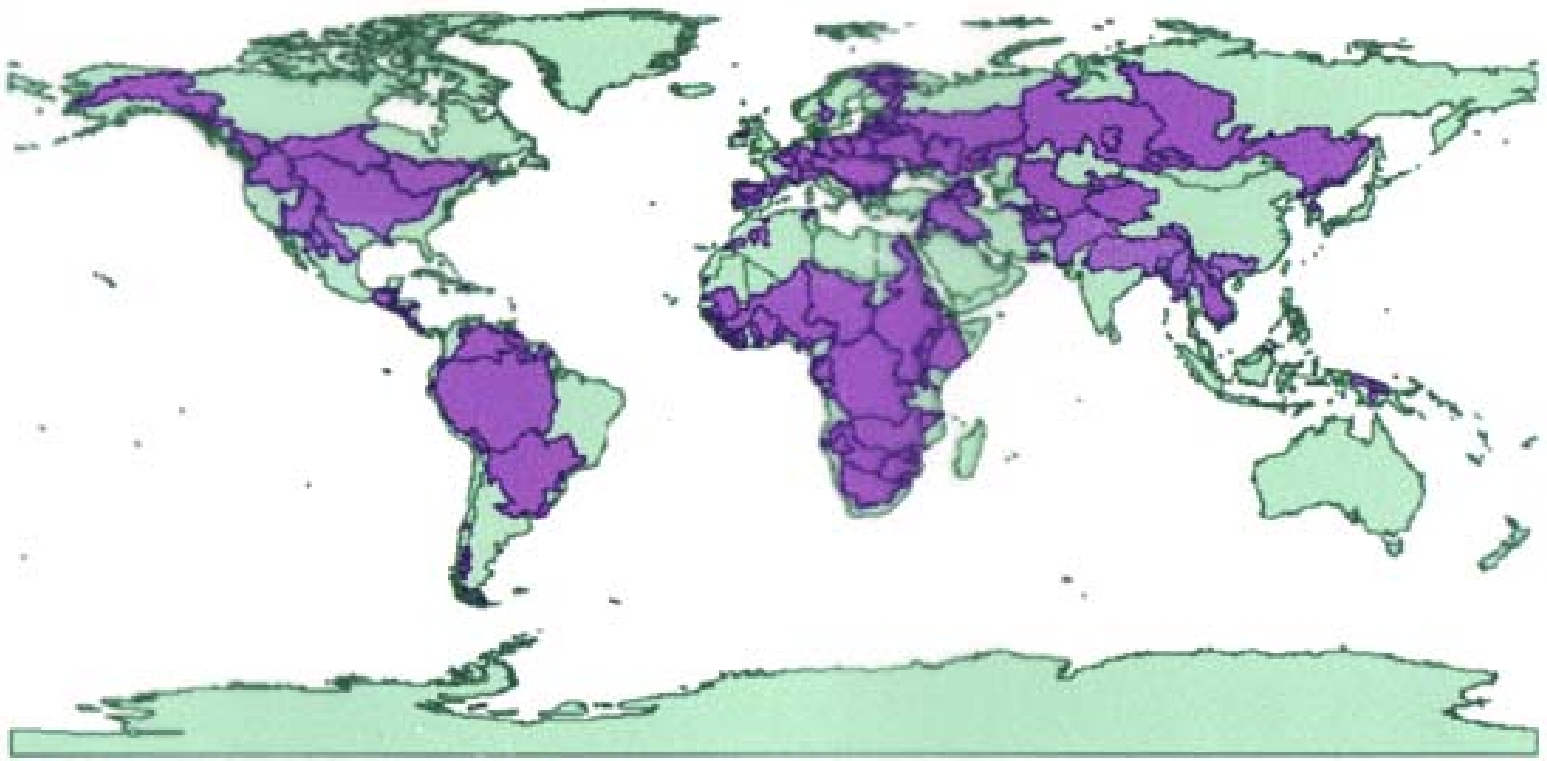


Challenges of Transboundary Aquifers



From Puri and others (2001).

Scale of Conflict

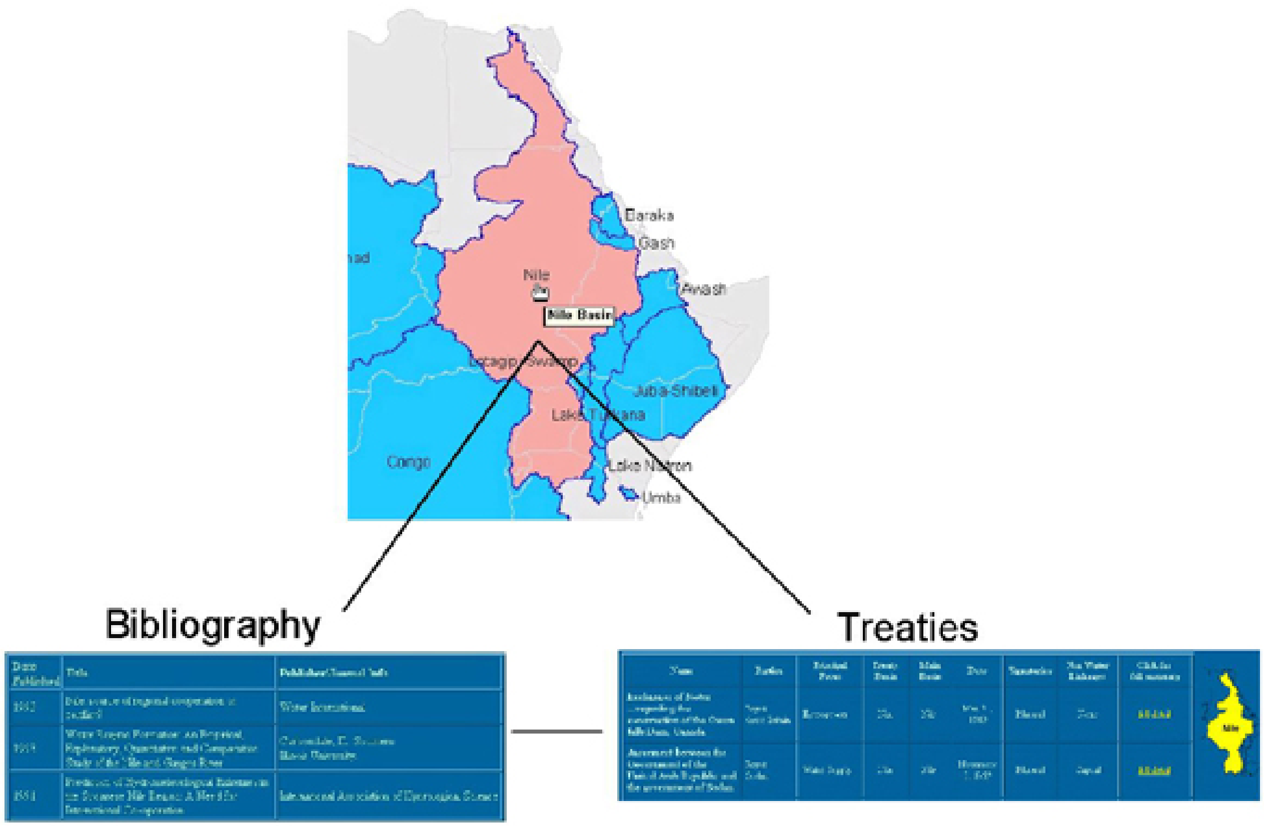


The Transboundary Freshwater Dispute Database

A Project of
Oregon State University
Department of Geosciences
and the Northwest Alliance for
Computational Science

- Reference to 3,600 water-related treaties (805-1997)
- Full-text of 400 treaties and 40 US compacts, entered in computer database
- Detailed negotiating notes (primary or secondary) from fourteen case-studies of water conflict resolution
- Annotated bibliography of “State of the Art” of water dispute resolution literature
- News files on cases of acute water-related disputes
- Indigenous methods of water dispute resolution

Interactive Search Interface



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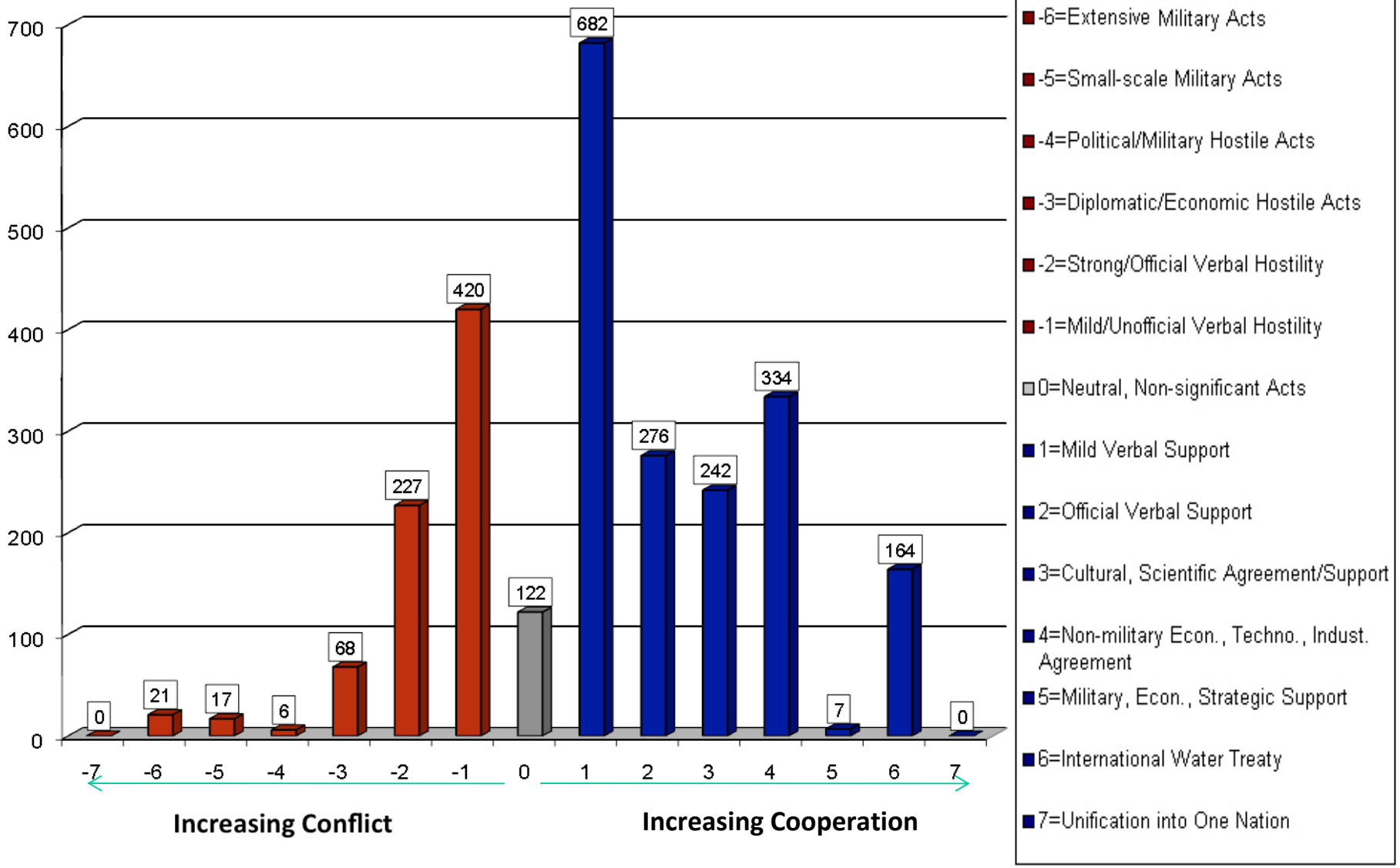
DATE	BASIN	COUNTRIES	BAR SCALE	EVENT SUMMARY	ISSUE TYPE
12/5/73	La Plata	Argentina--Paraguay	4	PRY AND ARG AGREE TO BUILD 1B DAM, HYDROELECTRIC PROJECT	Infrastructure
1/1/76	Ganges	Bangladesh--India--United Nations	-2	Bangladesh lodges a formal protest against India with the United Nations, which adopts a consensus statement encouraging the parties to meet urgently, at the level of minister, to arrive at a settlement.	Quantity
7/3/78	Amazon	Bolivia--Brazil--Colombia--Ecuador--Guyana--Peru--Suriname--Venezuela	6	Treaty for Amazonian Cooperation	Economic Development
4/7/95	Jordan	Israel--Jordan	4	Pipeline from Israel storage at Beit Zera to Abdullah Canal (East Ghor Canal) begins delivering water stipulated in Treaty (20 MCM summer, 10 MCM winter). The 10 mcm replaces the 10 mcm of desalinated water stipulated Annex II, Article 2d until desalinization plant completed	Quantity
6/1/99	Senegal	Mali--Mauritania	-3	13 people died in communal clashes in 6/99 along border between Maur. & Mali; conflict started when herdsmen in Missira-Samoura village in w. Mali, refused to allow Maur. horseman to use watering hole; horseman returned w/ some of his clansmen, attacking village on 6/20/99, causing 2 deaths; in retaliation that followed, 11 more died.	Quantity

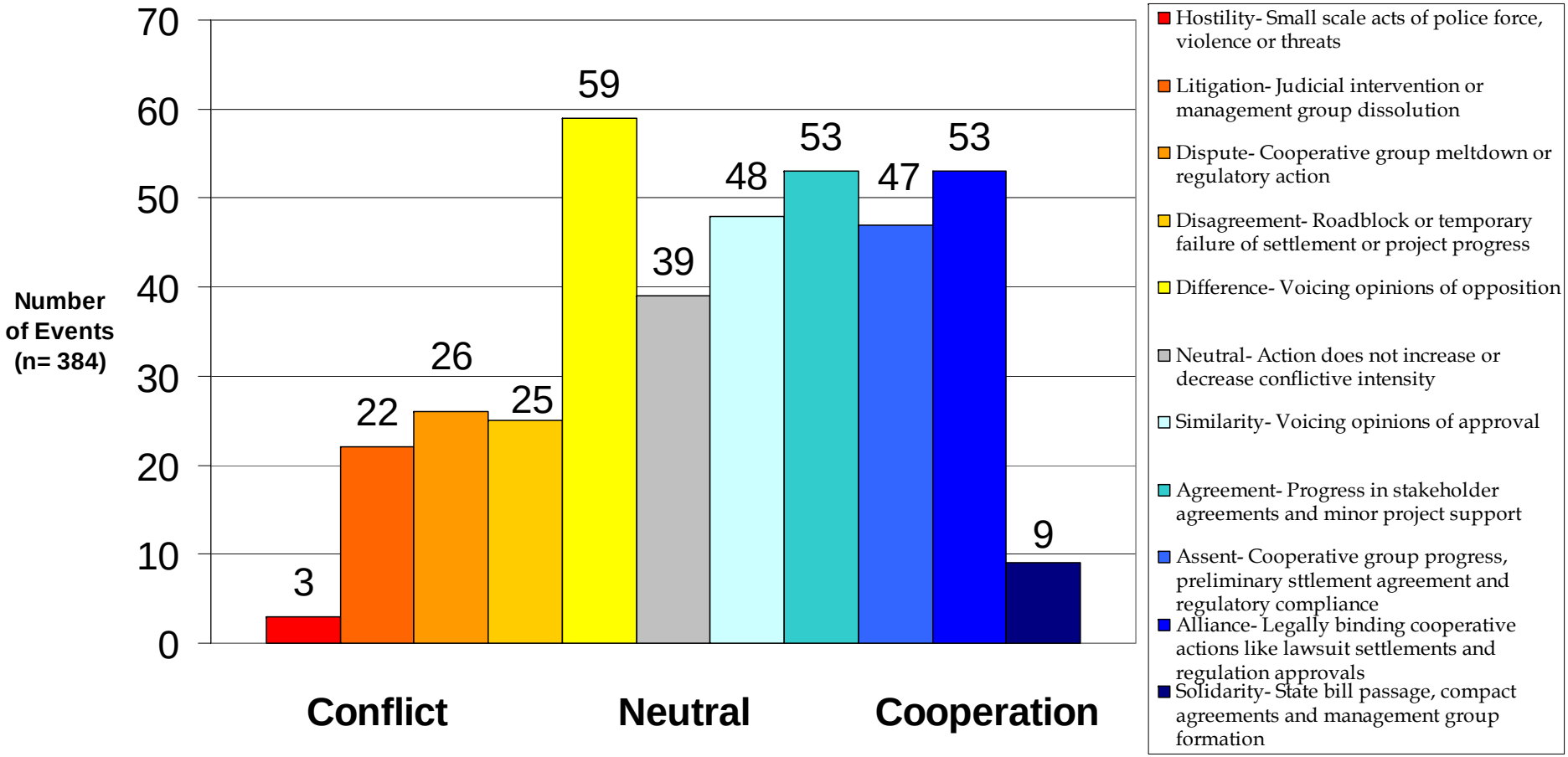
Events Database, Example

Number of Events by BAR Scale 1948-2008



Source: De Stefano, L., P. Edwards, L. de Silva and A. T. Wolf 2010. "Tracking Cooperation and Conflict in International Basins: Historic and Recent Trends." Water Policy. Vol 12 No 6 pp 871–884. Adapted with permission of the authors.

Number of Media Reported Events in Oregon along a Cooperation- Conflict Spectrum from 1990 to 2004



Source: Fesler, K. (2006) [Analysis of social interactions concerning Oregon's water resources between 1990 and 2004.] Unpublished Data.

Institutional Resiliency Argument

Transboundary water institutions are resilient over time, even between hostile riparians, even as conflict is waged over other issues:

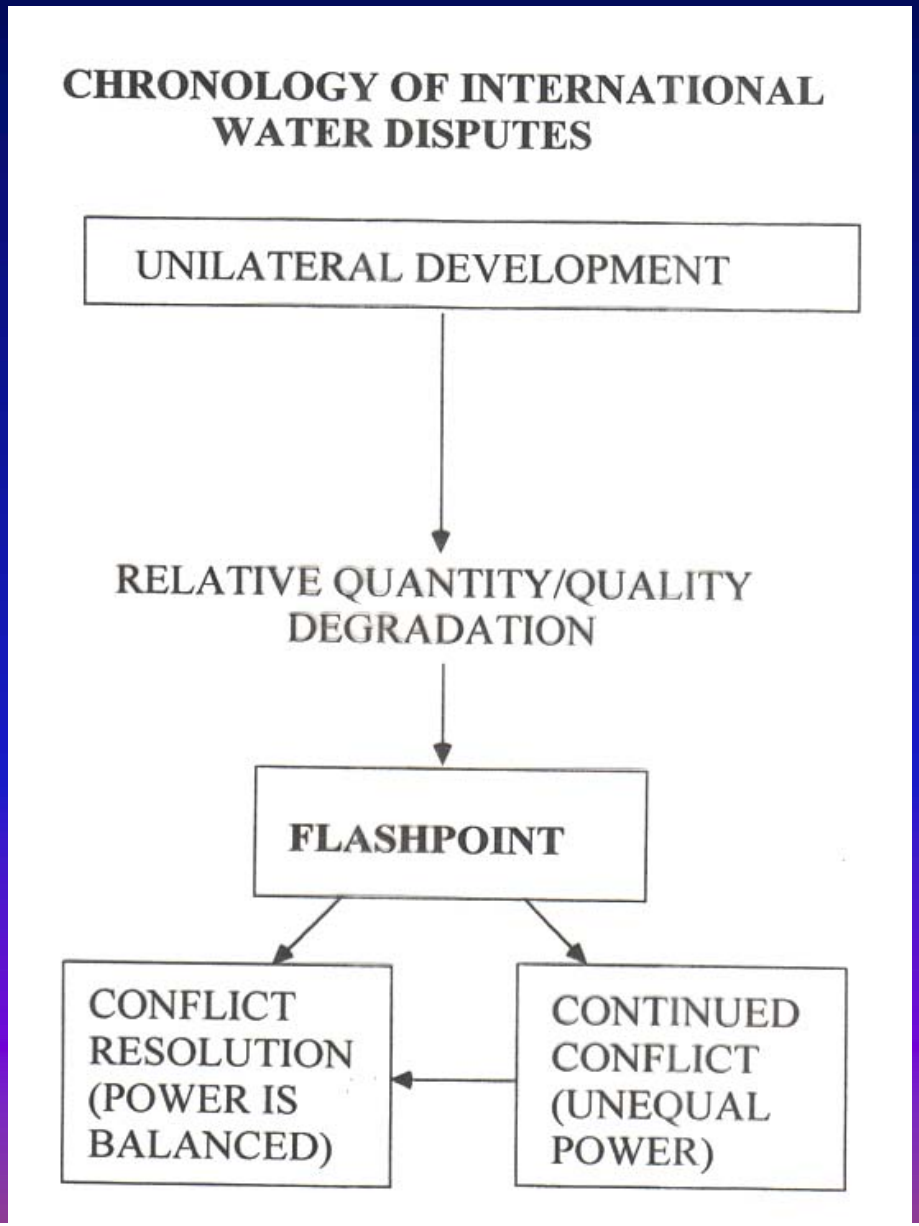
- **Picnic Table Talks**
- **Mekong Committee**
- **Indus River Commission**
- **Caucasus**
- **SADC Region**

Water Myths and Water Facts

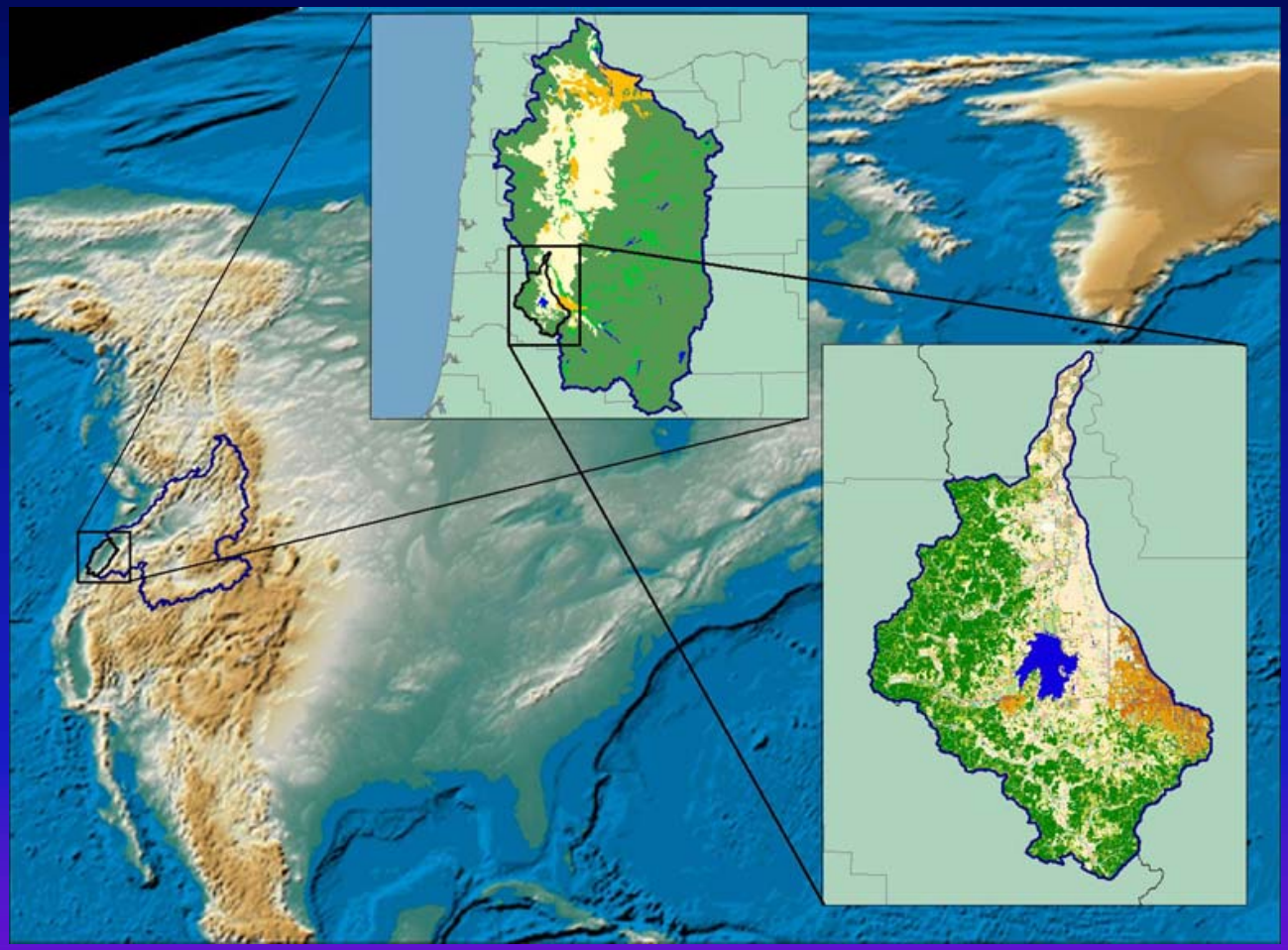
Myth 2:
Everything is OK

- Decades of tension, degradation, and inefficiency
- Conflict within and between multiple scales
- Regional instability in areas of security concern

Decades of Tension, Degradation, and Inefficiency

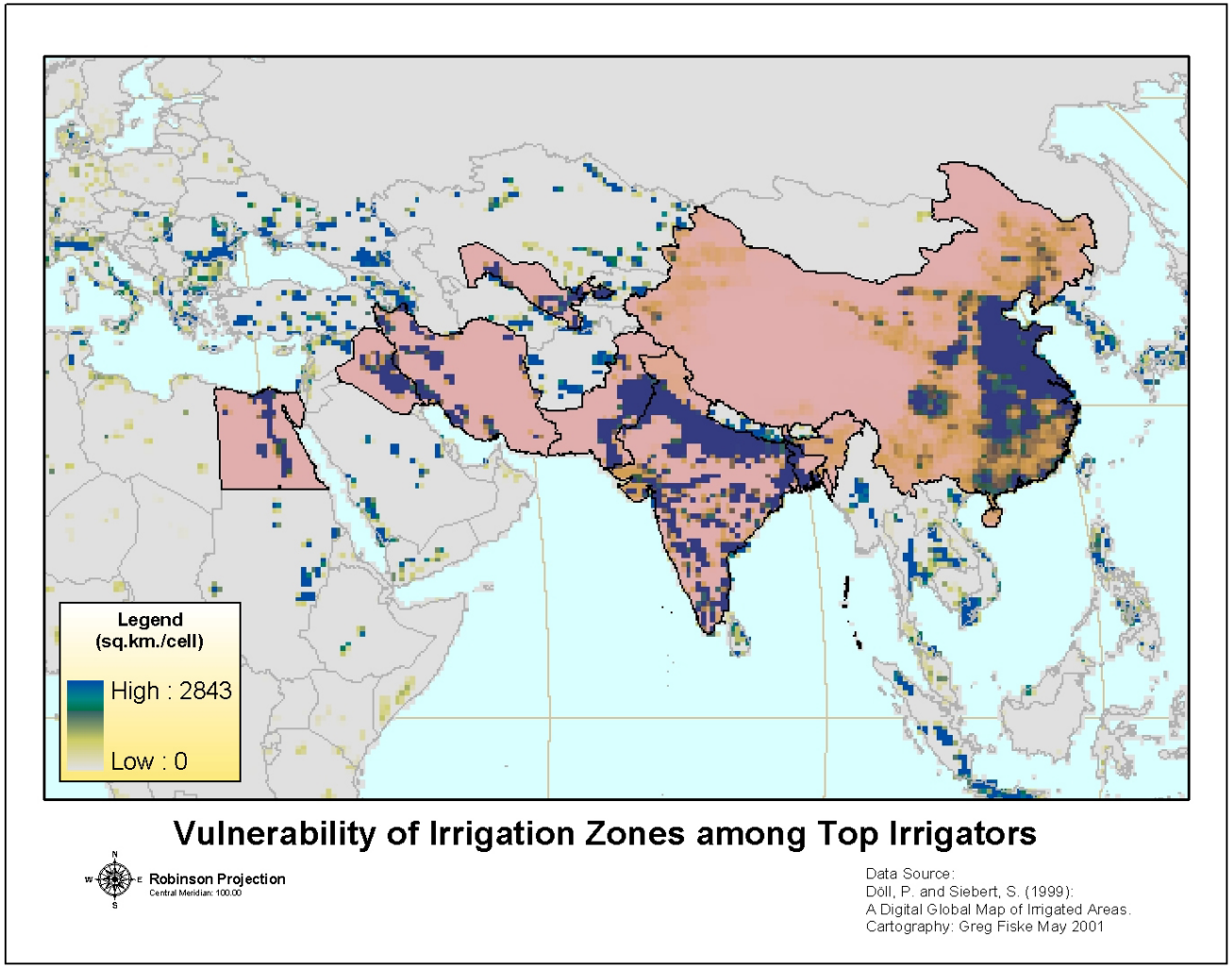


Conflict Within and Between Multiple Scales



The smaller the scale, the greater the likelihood of dispute.

Regional Instability in Areas of Security Concern



Water Myths and Water Facts

Myth 3:

Causes of conflict include:

-- **Climate**

-- **Water stress**

-- **Population**

-- **Level of development**

-- **Dependence on hydropower**

-- **Dams or development *per se***

-- **“Creeping” changes:**

- general degradation of quality
- climate change induced hydrologic variability

Basins at Risk

Conflict and Cooperation Over International Waters

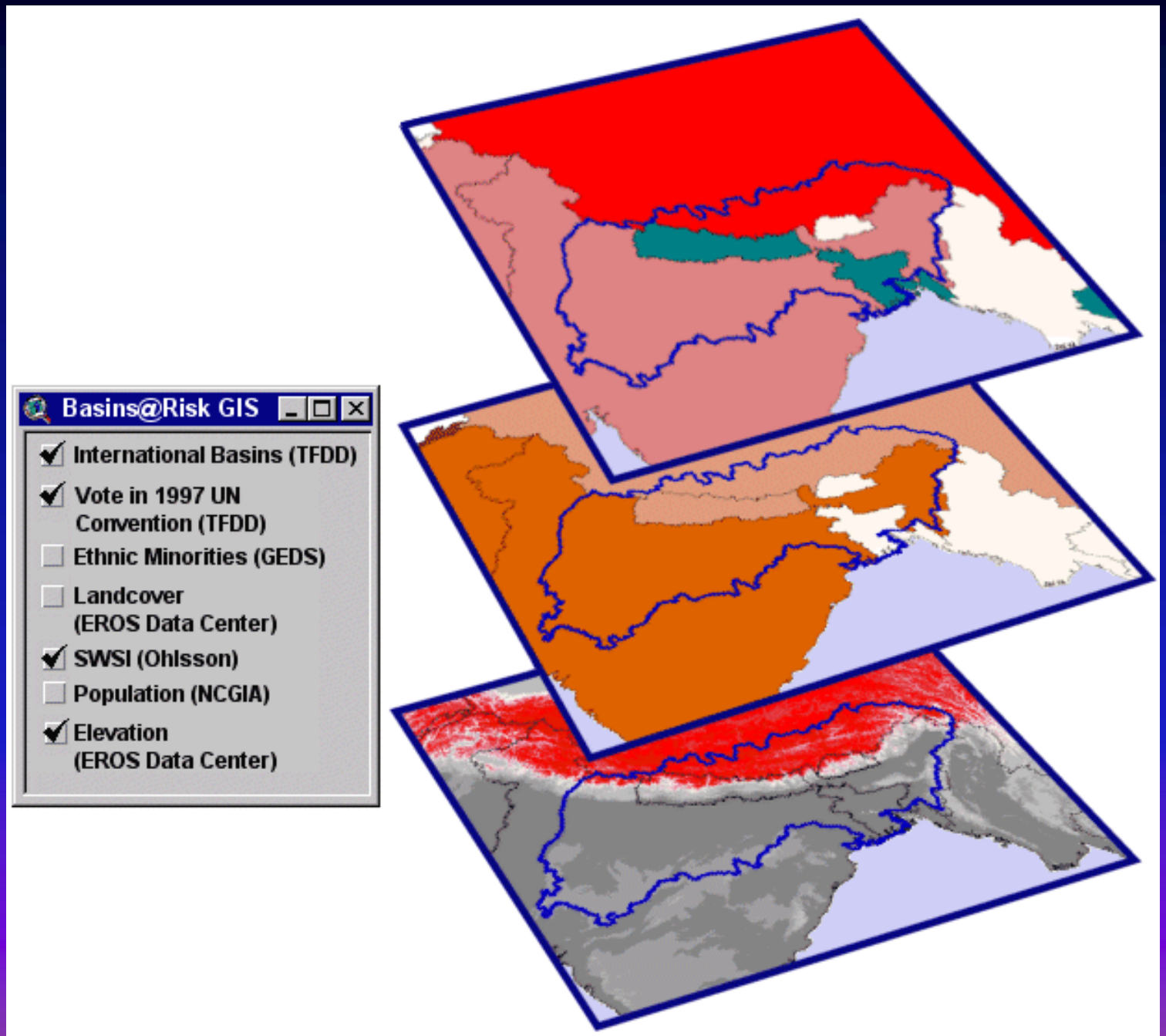
Principal Investigator:
Aaron T. Wolf PhD
Oregon State University

Research Associates:

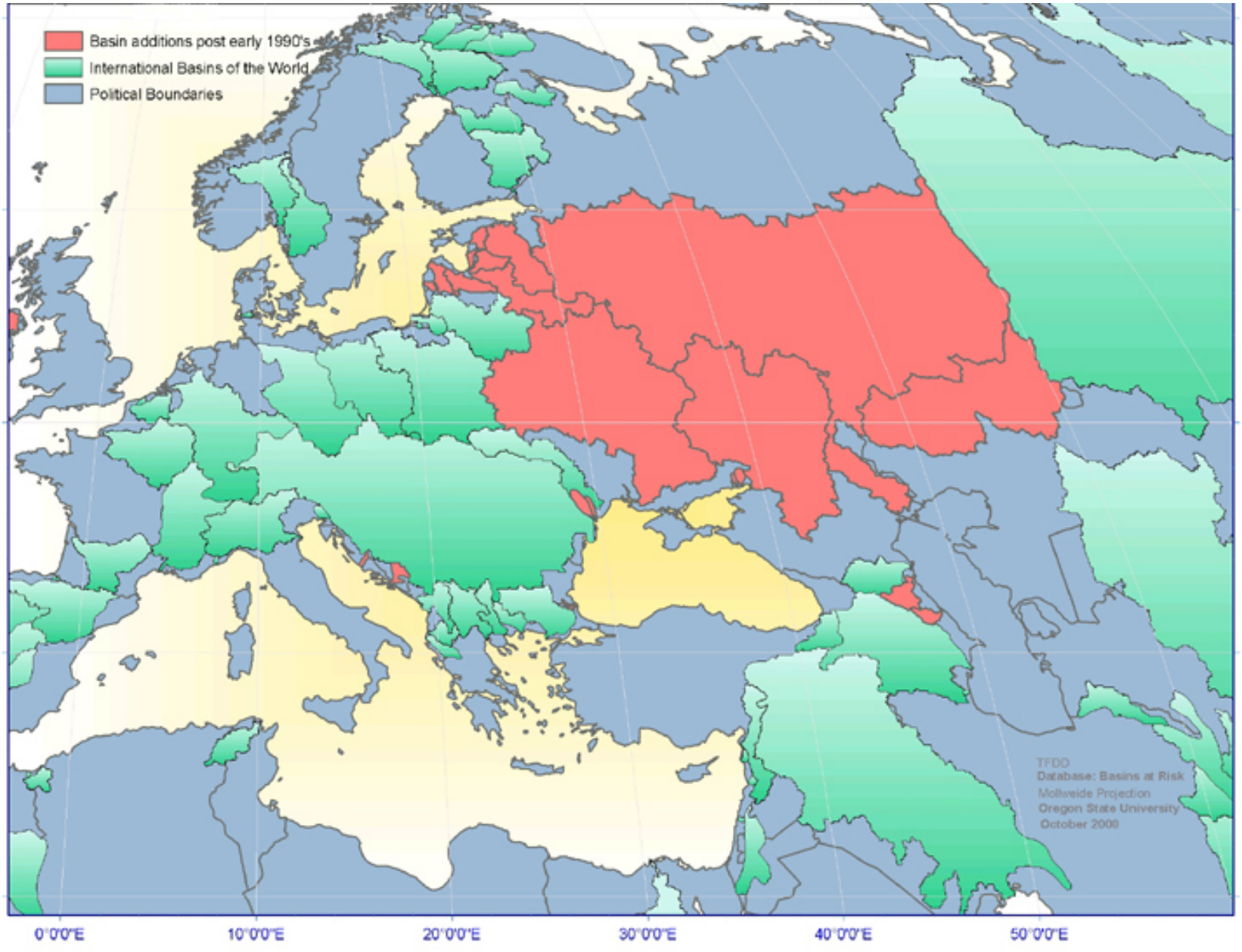
Shira Yoffe, Project Manager

Case Bowman
Kuuipo Burleigh
Greg Fiske
Mark Giordano
Meredith Giordano
Jeanne Hoadley
Kelli Larson
Kyoko Matsumoto
Marc Rothgery
Daniel Wise

TFDD: Basins at Risk
Department of Geosciences
Oregon State University


Basins@Risk GIS
International Basins (TFDD)
Vote in 1997 UN Convention (TFDD)
Ethnic Minorities (GEDS)
Landcover (EROS Data Center)
SWSI (Ohlsson)
Population (NCGIA)
Elevation (EROS Data Center)

New Countries due to Boundary Changes, 1989-1992



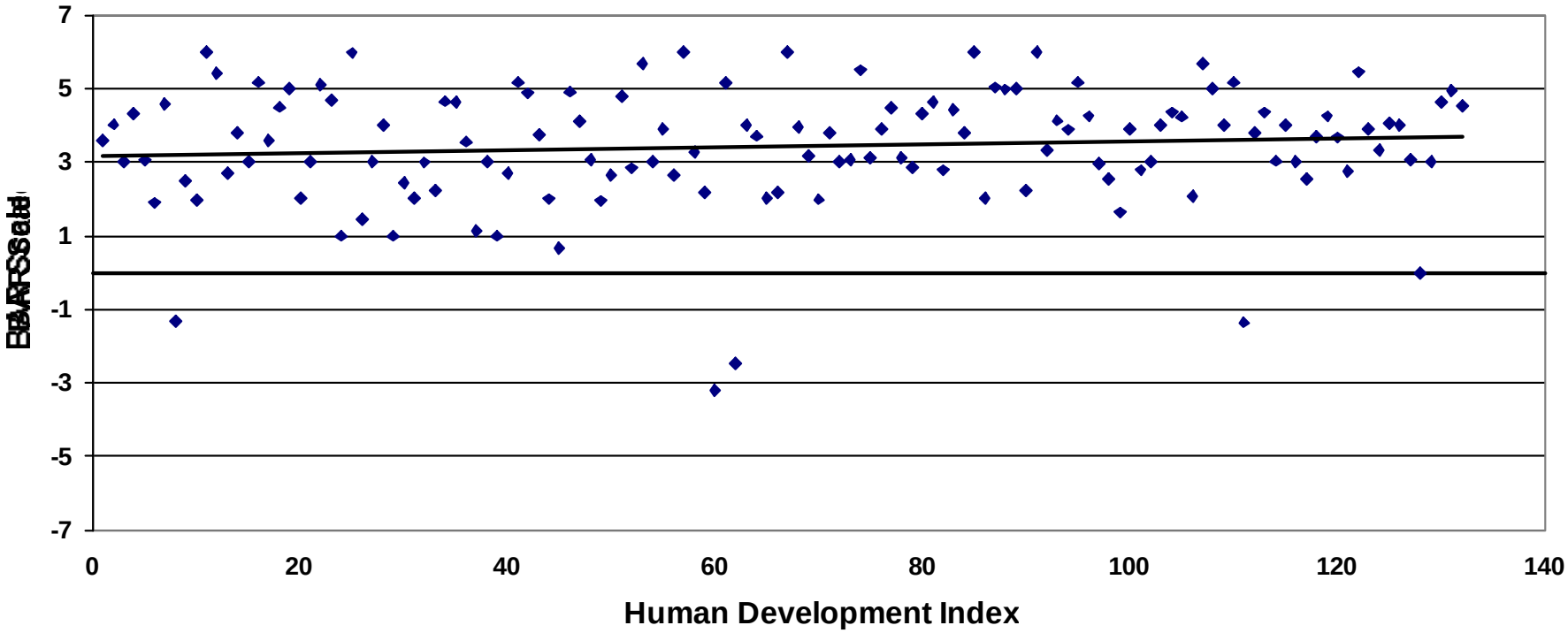
Excerpt of River Names File
Amazon River Basin

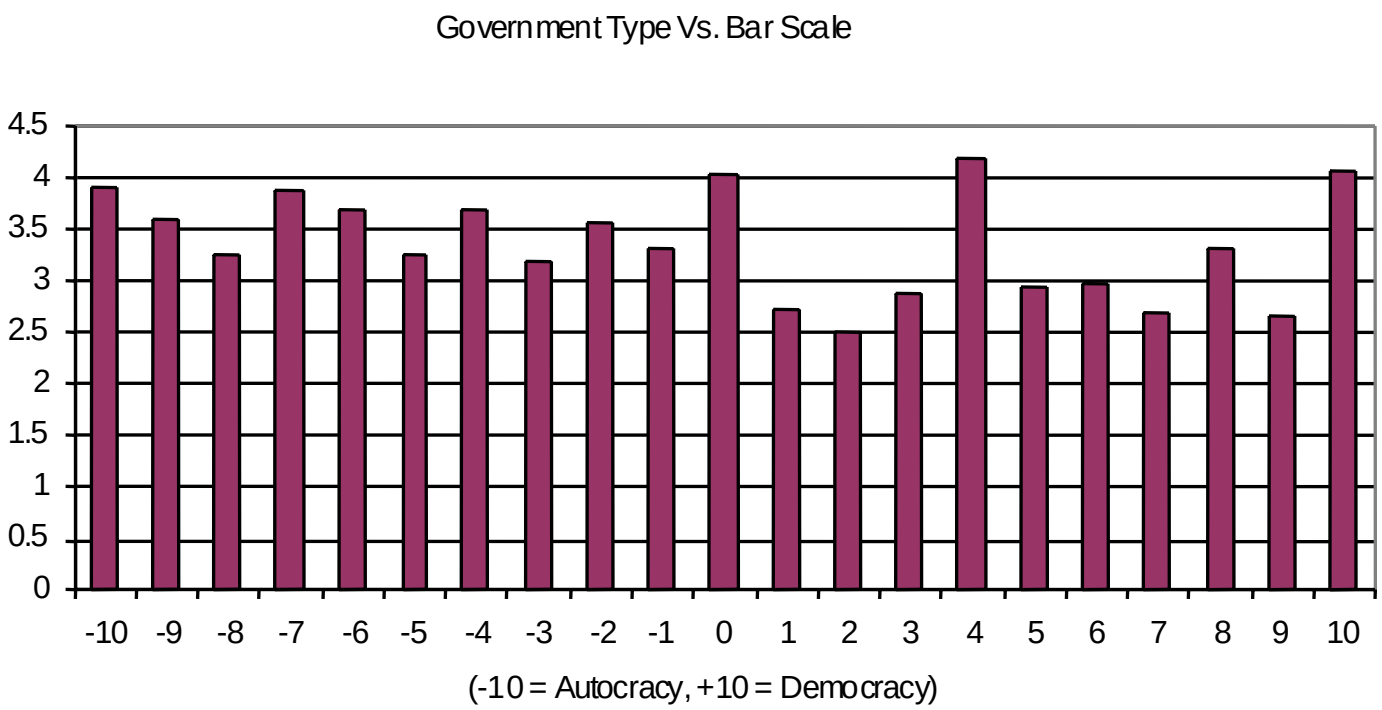
Basin/Country Polygons

River Names

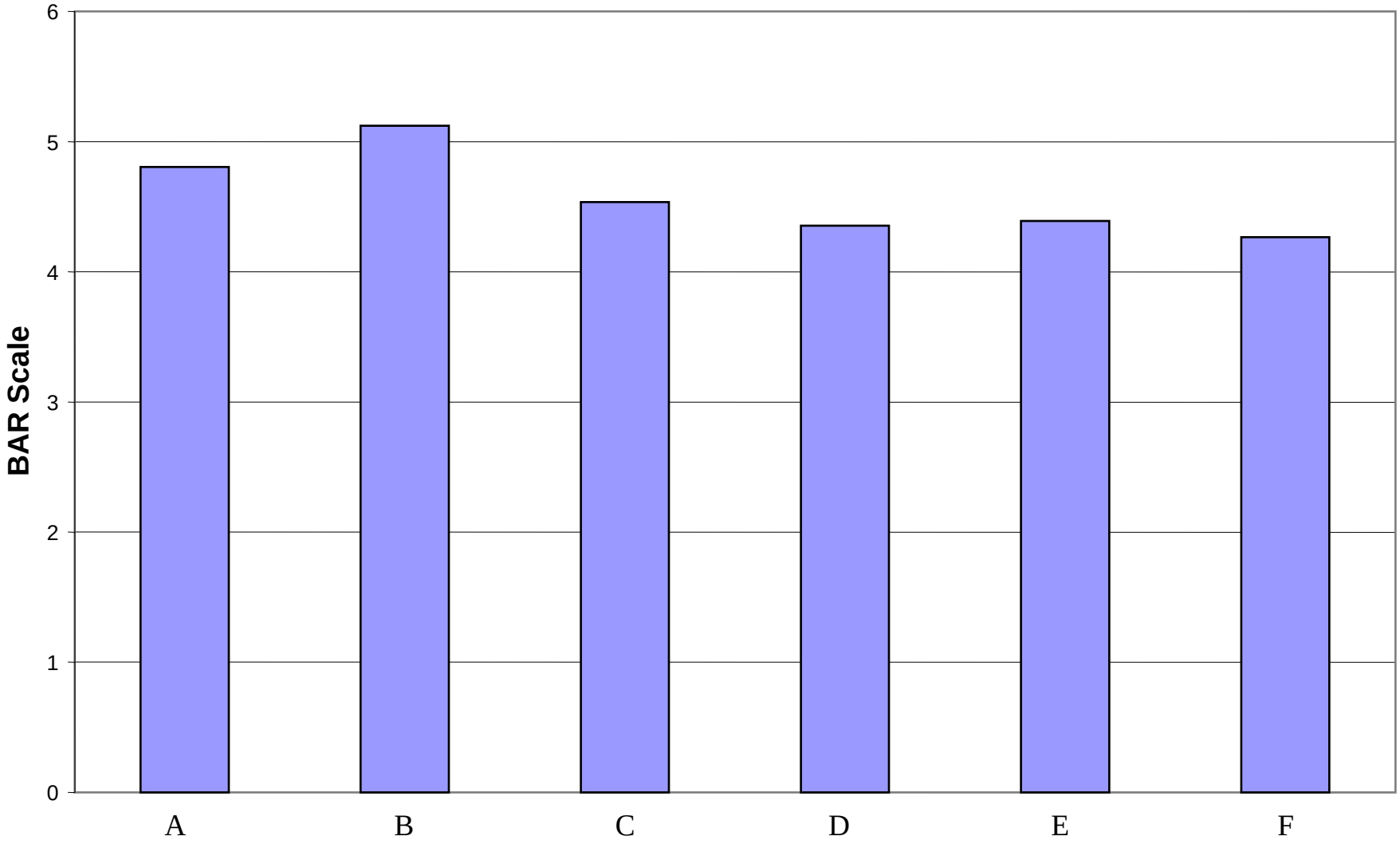
AMZN_BOL	AMZN_BRA	AMZN_COL	AMZN_ECU	AMZN_GUY	AMZN_PER	AMZN_SUR	AMZN_VEN
Abuna	Abacaxis	Ajaju	Acre	Cafuni	Acre	Trombetas	Bina
Apere	Abuna	Apaporis	Chandless	Ireng	Alto Purus		Casiquiare
Baures	Acalau	Caqueta	Corrientes	Tacutu	Apurimac		Concorochite
Beni	Acarai	Cuduyari	Curaray		Blanco		Grande
Blanco	Acre	Icana(Isasha)	Iaco		Chandless		Negro
Grande	Agua Preta	Papuri	Jarua		Chil		
Guapore	Ajuana	Quaina	Morancn		Corrientes		
Guapore Ben	Alalau	Raudal Yupur	Morona		Heath		
Heath	Anama	Tiquie	Napo		Huallaga		
Lago de San	Anaua	Traira	Postaza		Iaco		
Lago Rogaua	Andma	Uaupes	Tigre		Inamban		
Madidi	Apiaca	Yari	Yavari		Inuya		
Mamore	Apiau				Jarua		
Manu Madre	Apidia				Manu Madre de Dios		
Manuripi	Araca				Manuripi		
Negro	Araua				Maranon		
Orton	Arinos				Moranon		
Paragua	Anipuana				Napo		
Rapulo	Arracias				Orton		
San Martin	Arrainas				Pachitea		
San Miguel	Bacaja				Pampas?		
Secure	Bau				Postaza		
Yata	Bia				Putumayo		
	Brea				San Juan?		
	Bunct				Santa Ana?		
	Cach Do Tareraimbu				Santa Eulalia		
	Cachoer da Bacena				Santuario?		
	Cachoera Caracarai				Sheshea		

Human Development Index Vs. BAR Scale
(By Country)

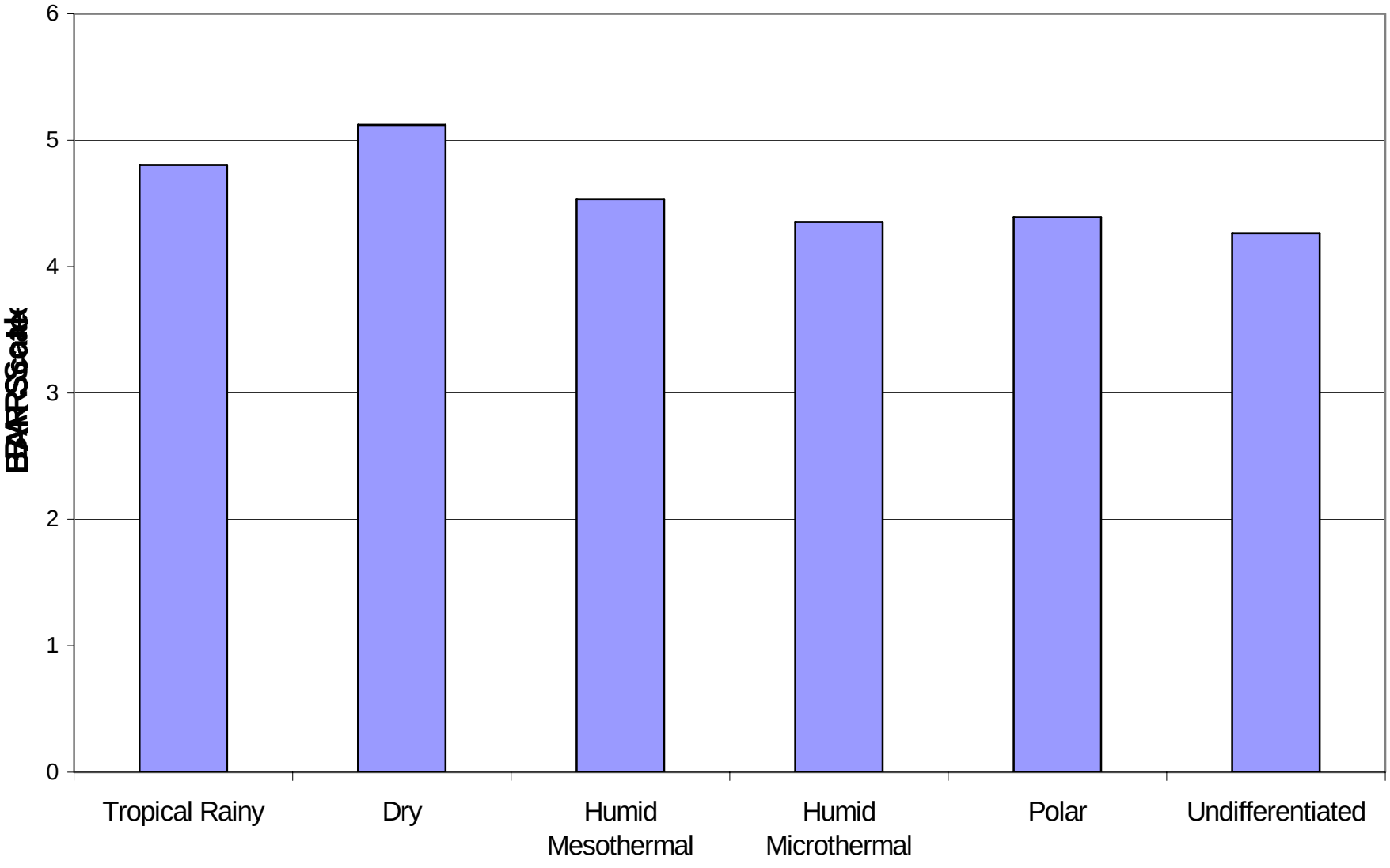



Government Type Vs. Bar Scale
4.5
4
3.5
3
2.5
2
1.5
1
0.5
0
-10 -9 -8 -7 -6 -5 -4 -3 -2 -1 0 1 2 3 4 5 6 7 8 9 10
(-10 = Autocracy, +10 = Democracy)

Primary Climate Type Vs. BAR Scale
(By Basin)



Primary Climate Type Vs. BAR Scale
(By Basin)



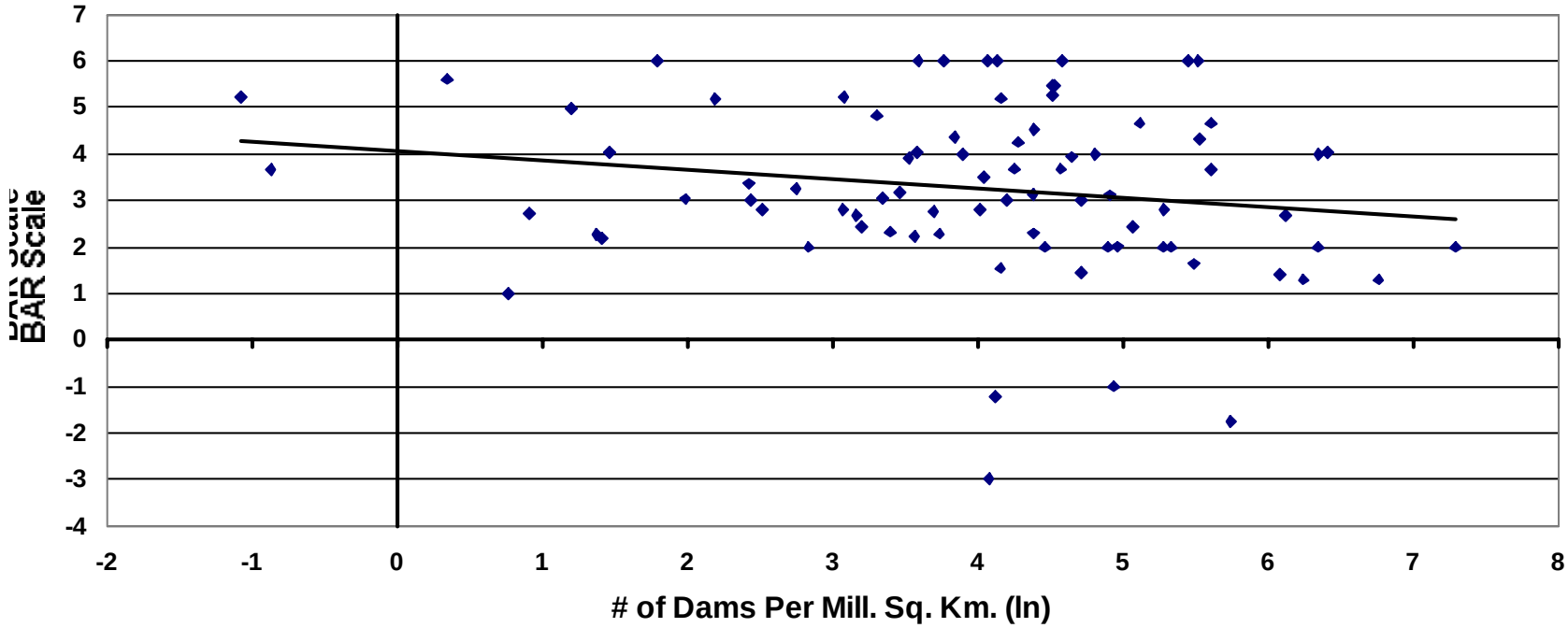
BASINS AT RISK: Working Hypothesis

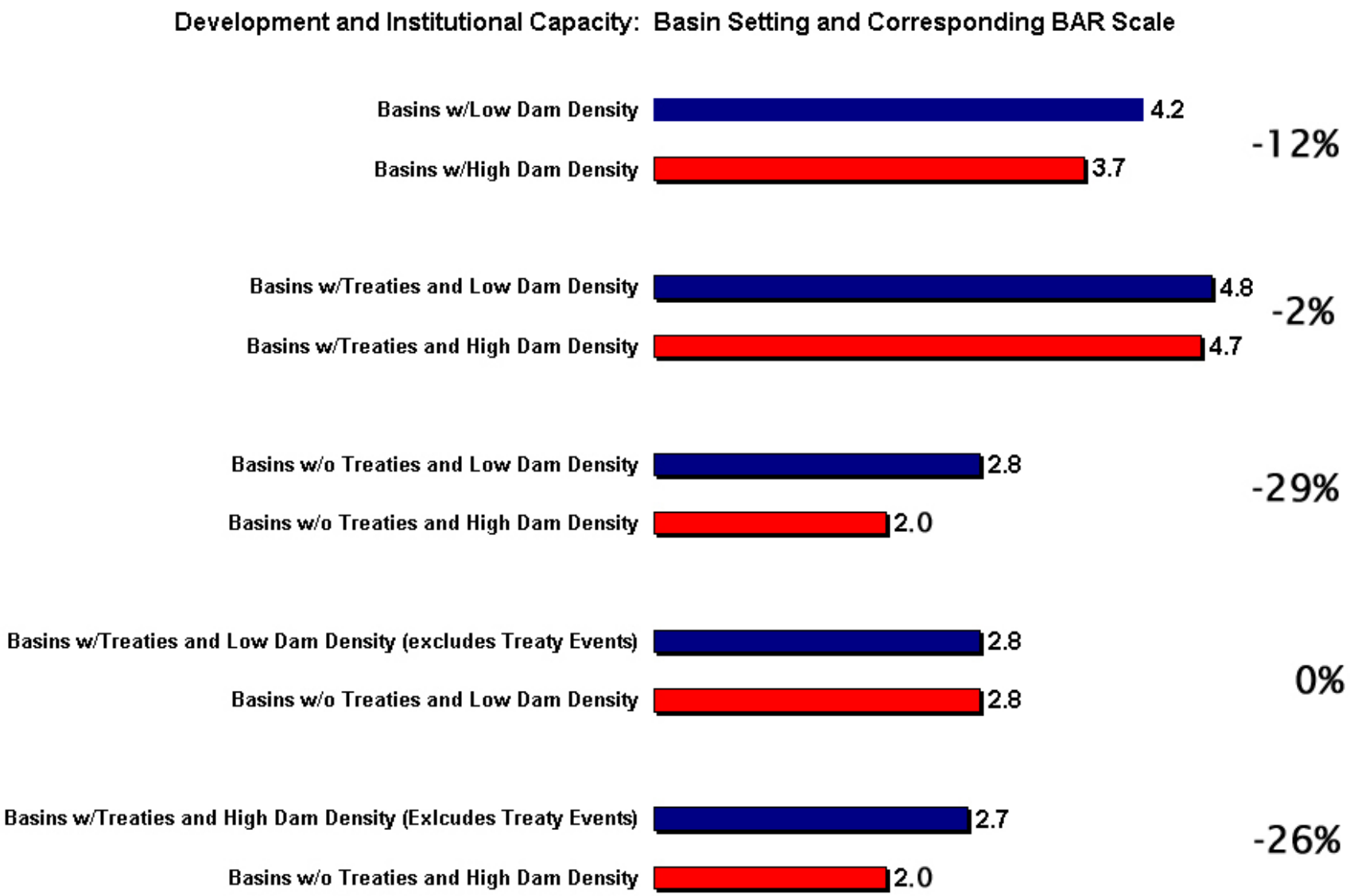
"The likelihood of conflict rises as the rate of change within the basin exceeds the institutional capacity to absorb that change."

Parameters which seem *not* to be indicators:

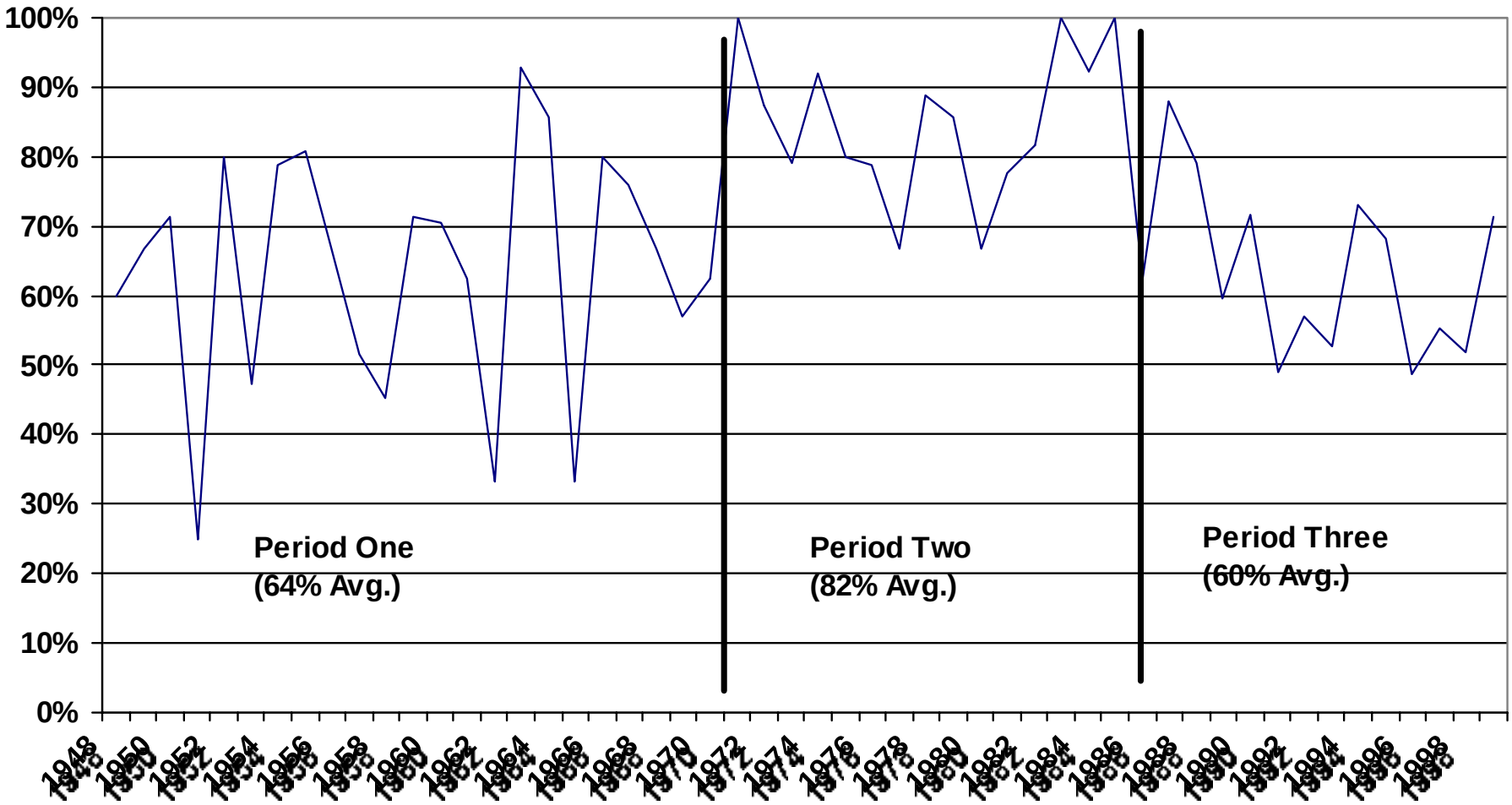
- **Climate**
- **Water stress**
- **Population**
- **Level of development**
- **Dependence on hydropower**
- **Dams or development *per se***
- **"Creeping" changes:**
  - general degradation of quality
  - climate change induced hydrologic variability

Dams Per Million Sq. Km. (ln) Vs. BAR Scale (By Basin)




Development and Institutional Capacity: Basin Setting and Corresponding BAR Scale
Basins w/Low Dam Density
4.2
Basins w/High Dam Density
3.7
-12%
Basins w/Treaties and Low Dam Density
4.8
Basins w/Treaties and High Dam Density
4.7
-2%
Basins w/o Treaties and Low Dam Density
2.8
Basins w/o Treaties and High Dam Density
2.0
-29%
Basins w/Treaties and Low Dam Density (excludes Treaty Events)
2.8
Basins w/o Treaties and Low Dam Density
2.8
0%
Basins w/Treaties and High Dam Density (Exlcudes Treaty Events)
2.7
Basins w/o Treaties and High Dam Density
2.0
-26%

Cooperative Events as a Percentage of Total Events



BASINS AT RISK: Working Hypothesis

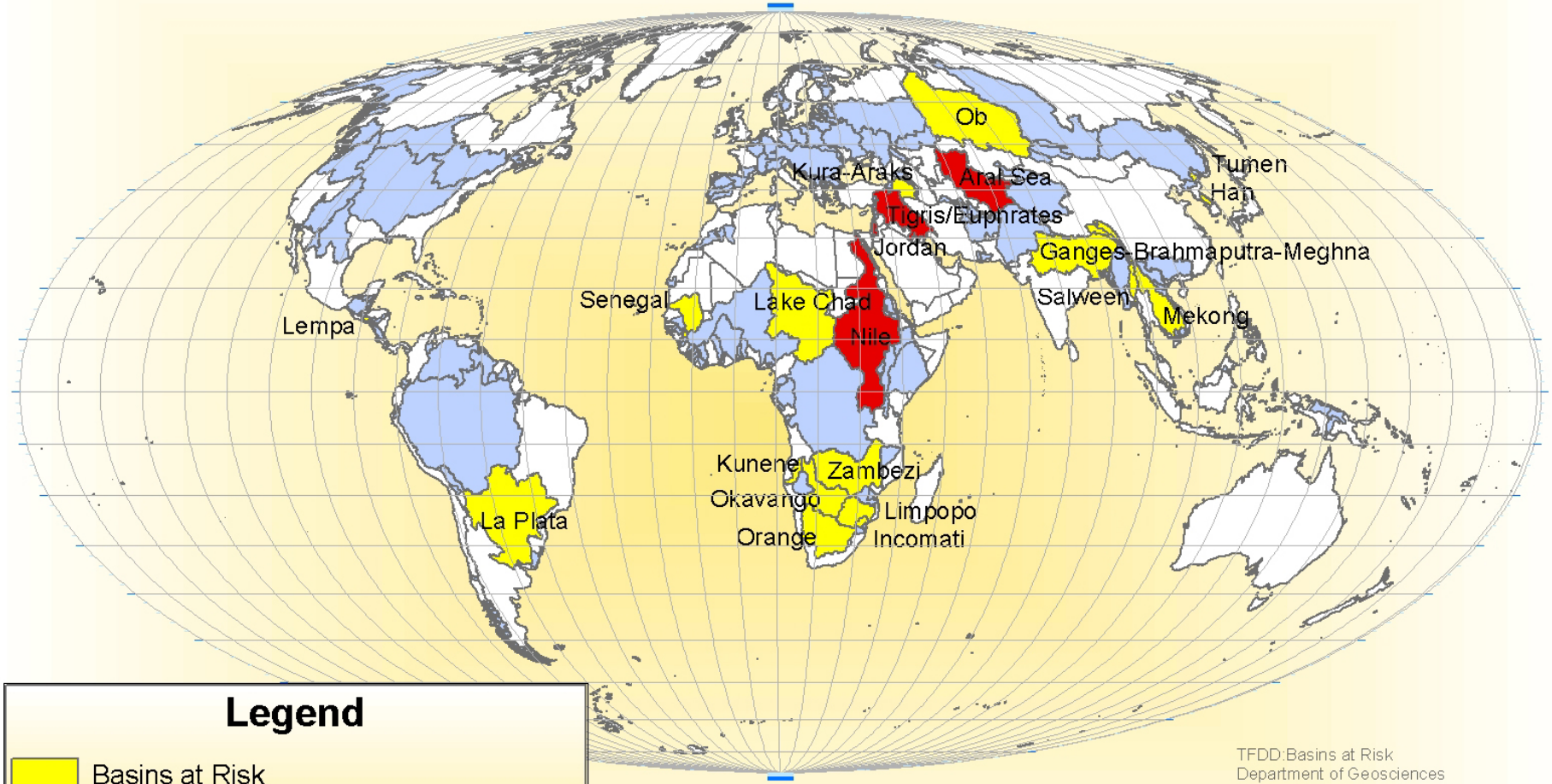
"The likelihood of conflict rises as the rate of change within the basin exceeds the institutional capacity to absorb that change."

What *are* indicators*?*

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

Basins at Risk

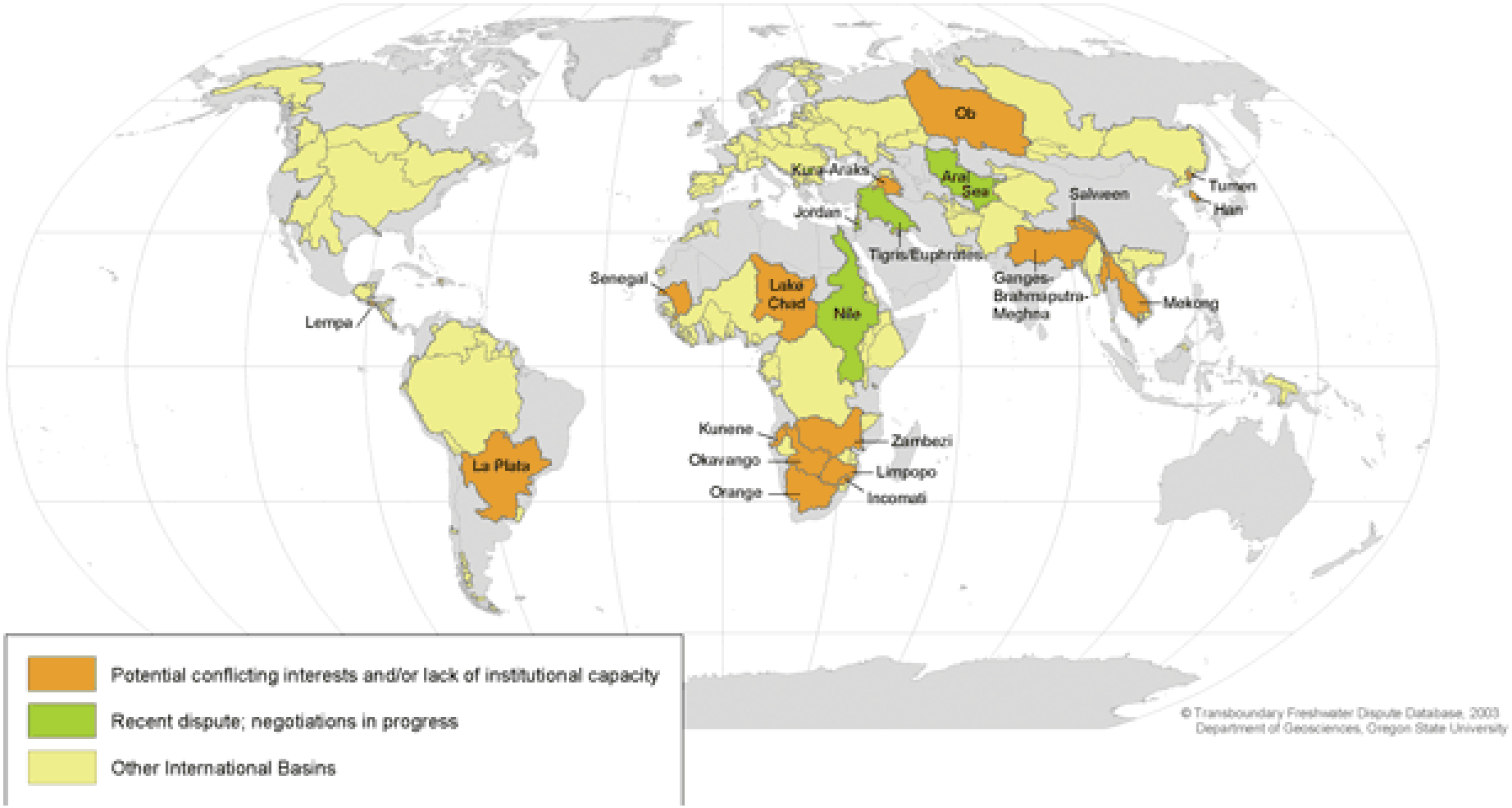


Legend

- Basins at Risk
- Political Boundaries
- International Basins
- Basins Currently in Dispute/Negotiations

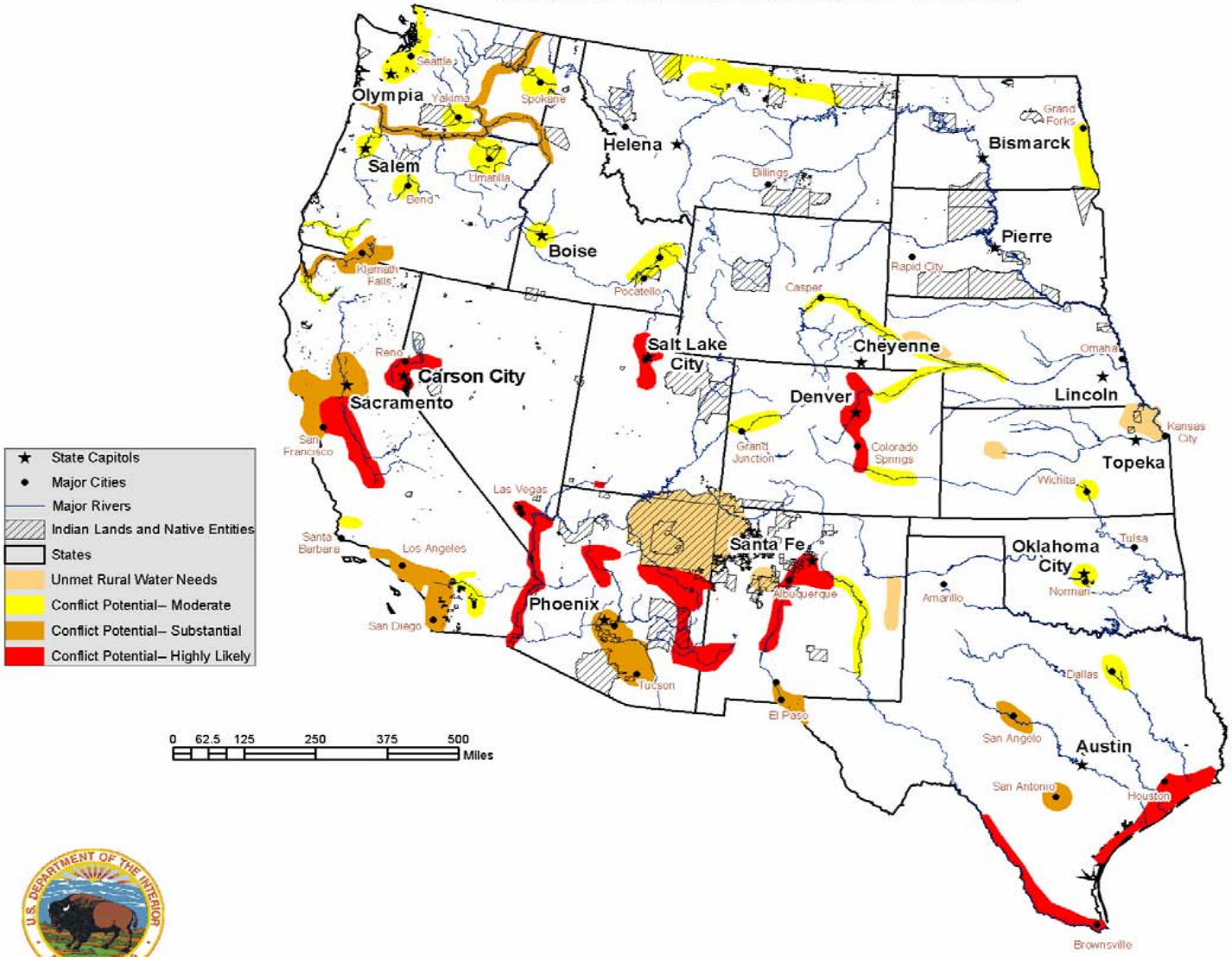
TFDD:Basins at Risk
Department of Geosciences
Oregon State University
Cartography: Greg Fiske
June 2001

Basins Under Observation

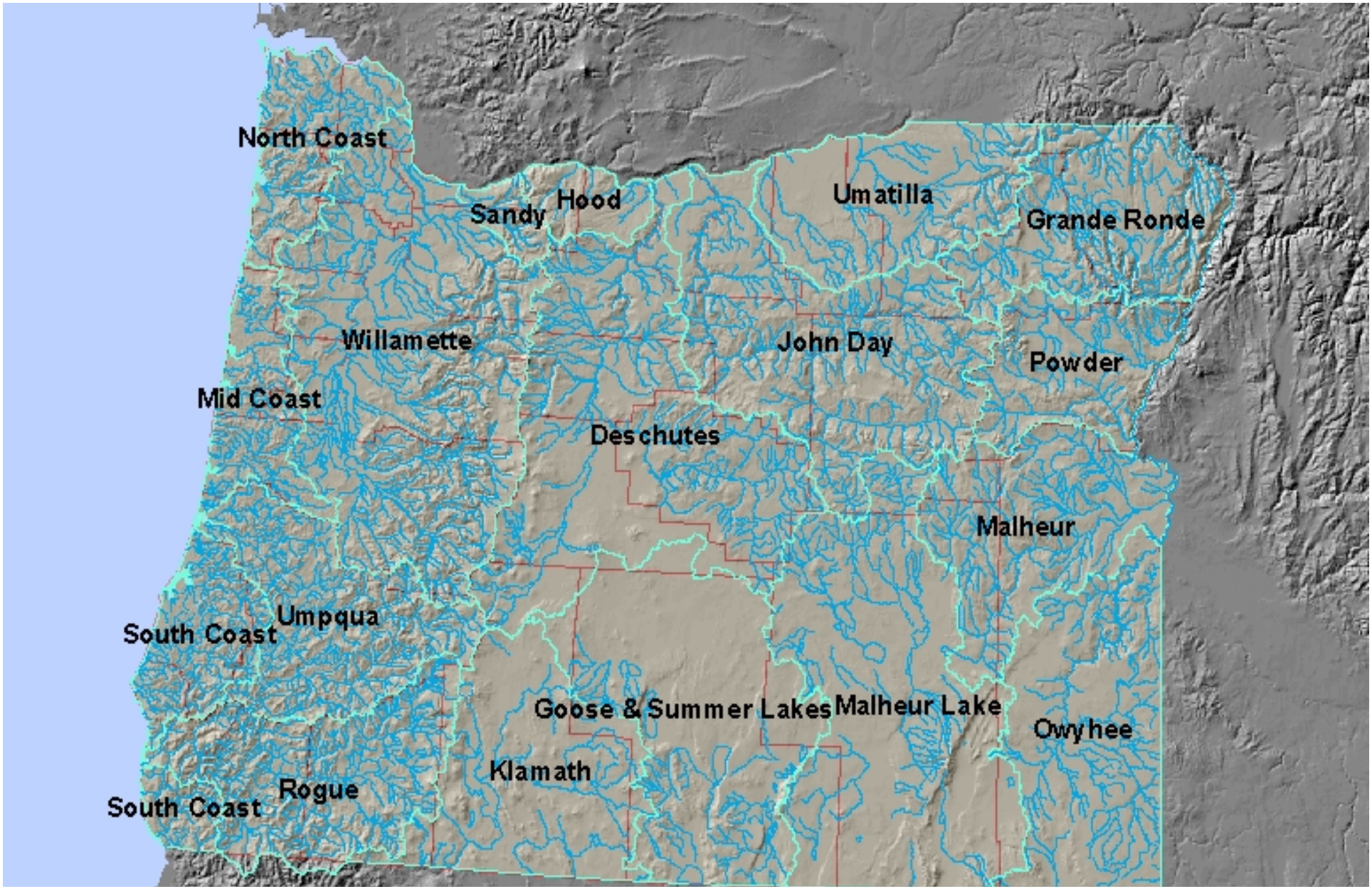


Potential Water Supply Crises by 2025

(Areas where existing supplies are not adequate to meet water demands for people, for farms, and for the environment)



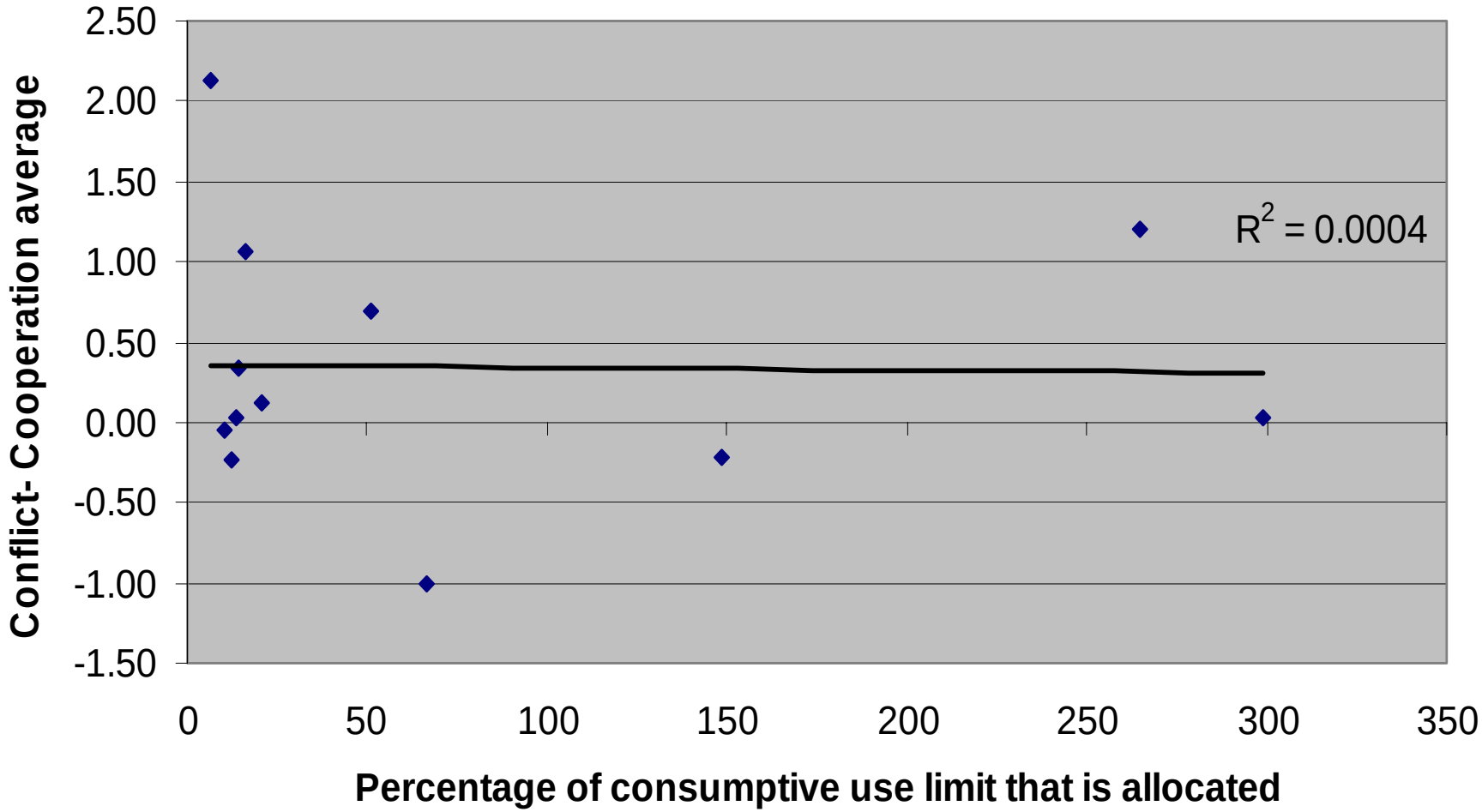
May 2003

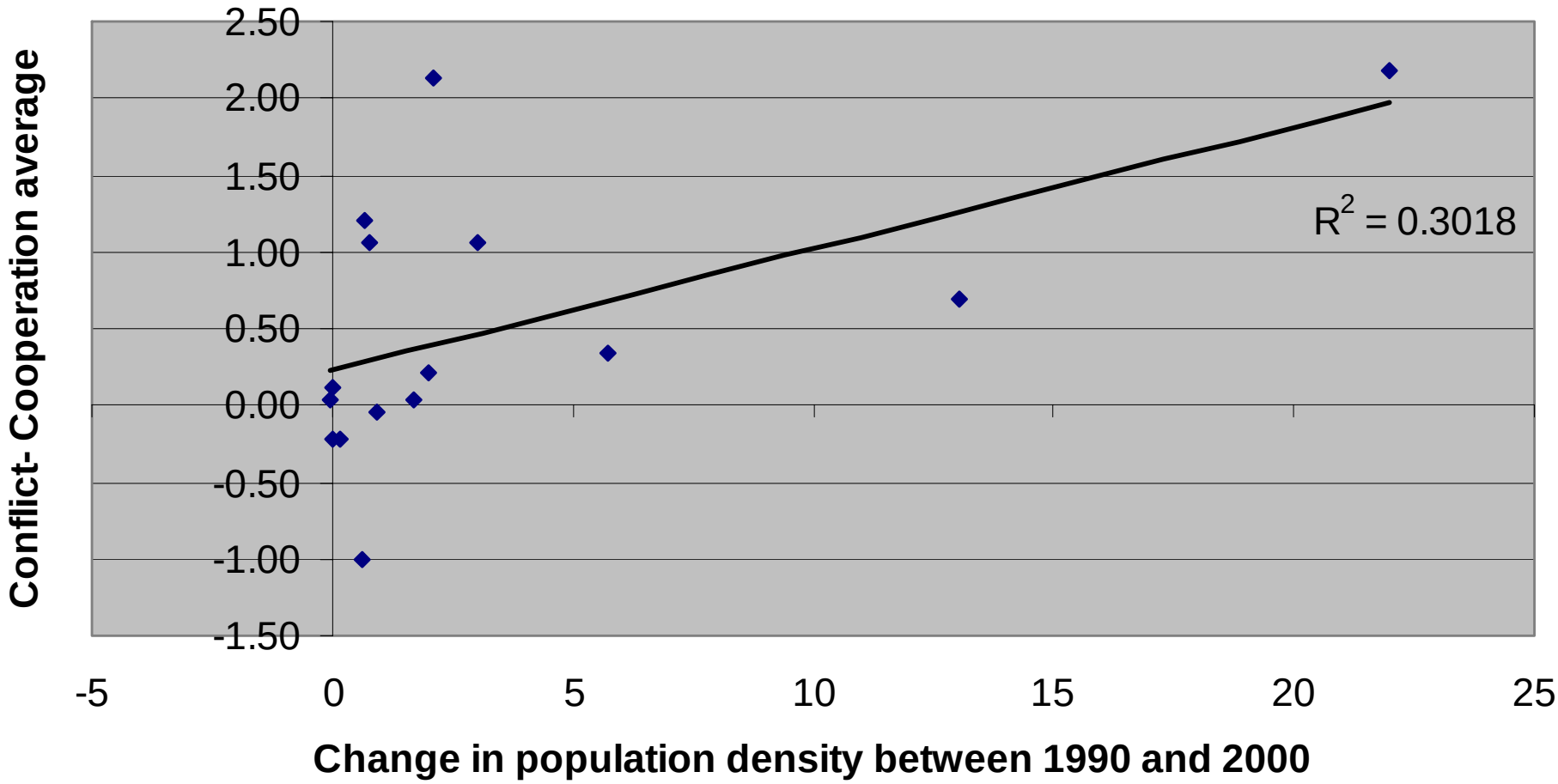

North Coast
Sandy
Hood
Umatilla
Grande Ronde
Willamette
John Day
Powder
Mid Coast
Deschutes
Malheur
Umpqua
South Coast
Goose & Summer Lakes
Malheur Lake
Owyhee
Klamath
Rogue
South Coast

Event Database Examples

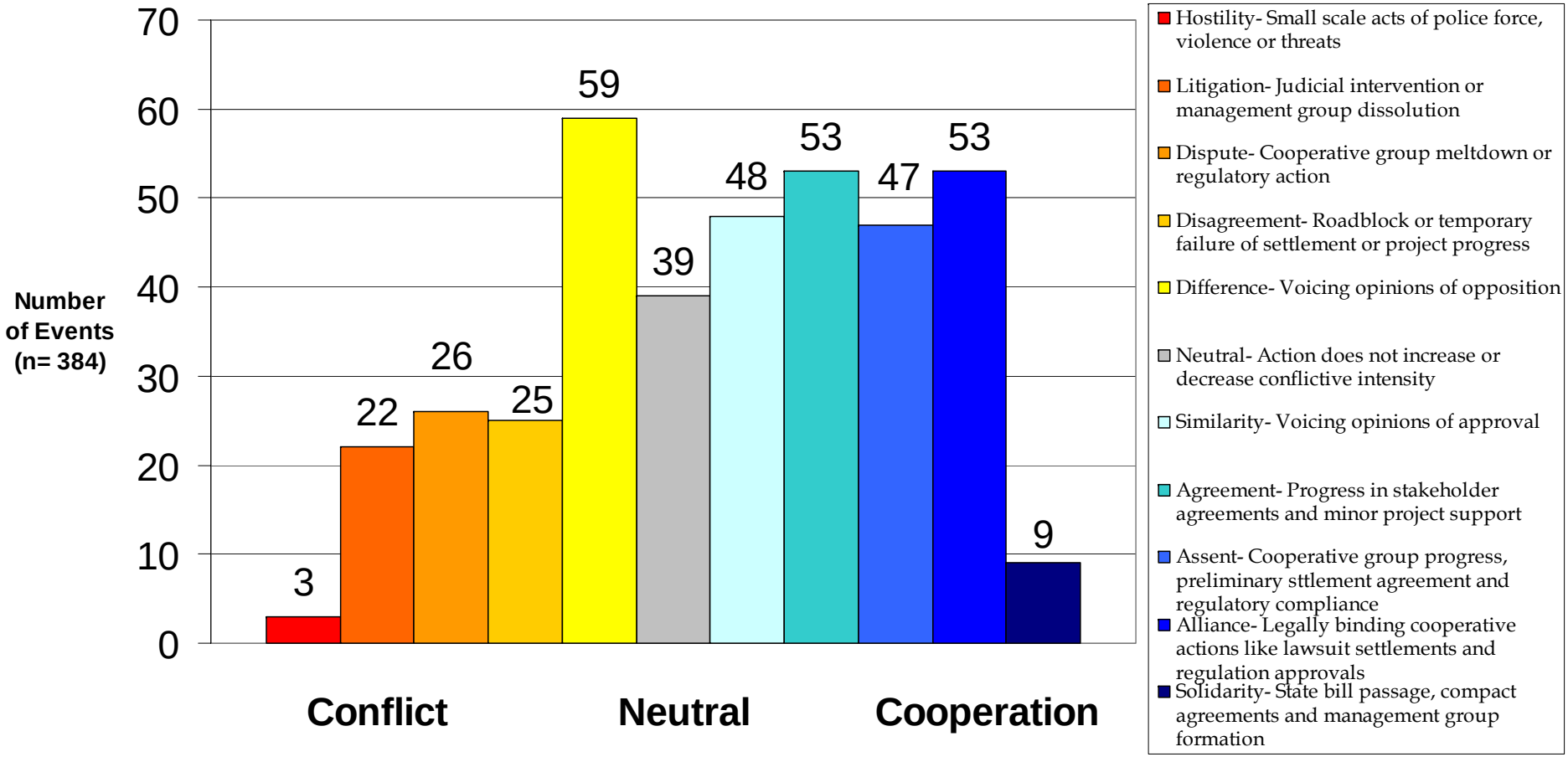
DATE	BASIN/ WATERBODY	EVENT SUMMARY	ISSUE TYPE	BAR SCALE
2/13/1990	Willamette	The Unified Sewerage Agency supports a proposed state mandated ban on phosphorus detergents.	Water Quality	1 Similarity
8/27/1998	Mid Coast/ Siuslaw River	The Oregon Shores Conservation Coalition has sued the city of Florence requesting a halt on all new sewer hookups in the city until a new sewer treatment plant can be put online.	Infrastructure	-4 Litigation
8/27/2004	Willamette	Presents how lawn fertilizers and pesticides damage water quality, compares area users and announces public awareness events.	Water Quality	0 Neutral
7/9/2001	Klamath	In protest of a federal decision to not release water for irrigation, dam head gates have been removed by area farmers.	Instream	-5 Hostility
4/21/2001	Umatilla/ North Fork	The city of Pendleton and the Umatilla Tribes reached a water rights agreement involving the city's point of diversion in the Umatilla's North Fork.	Water Rights	4 Alliance

Source: Fesler, K. (2006) [Analysis of social interactions concerning Oregon’s water resources between 1990 and 2004.] Unpublished Data.


Conflict- Cooperation average
2.50
2.00
1.50
1.00
0.50
0.00
-0.50
-1.00
-1.50
0
50
100
150
200
250
300
350
R^2 = 0.0004
Percentage of consumptive use limit that is allocated

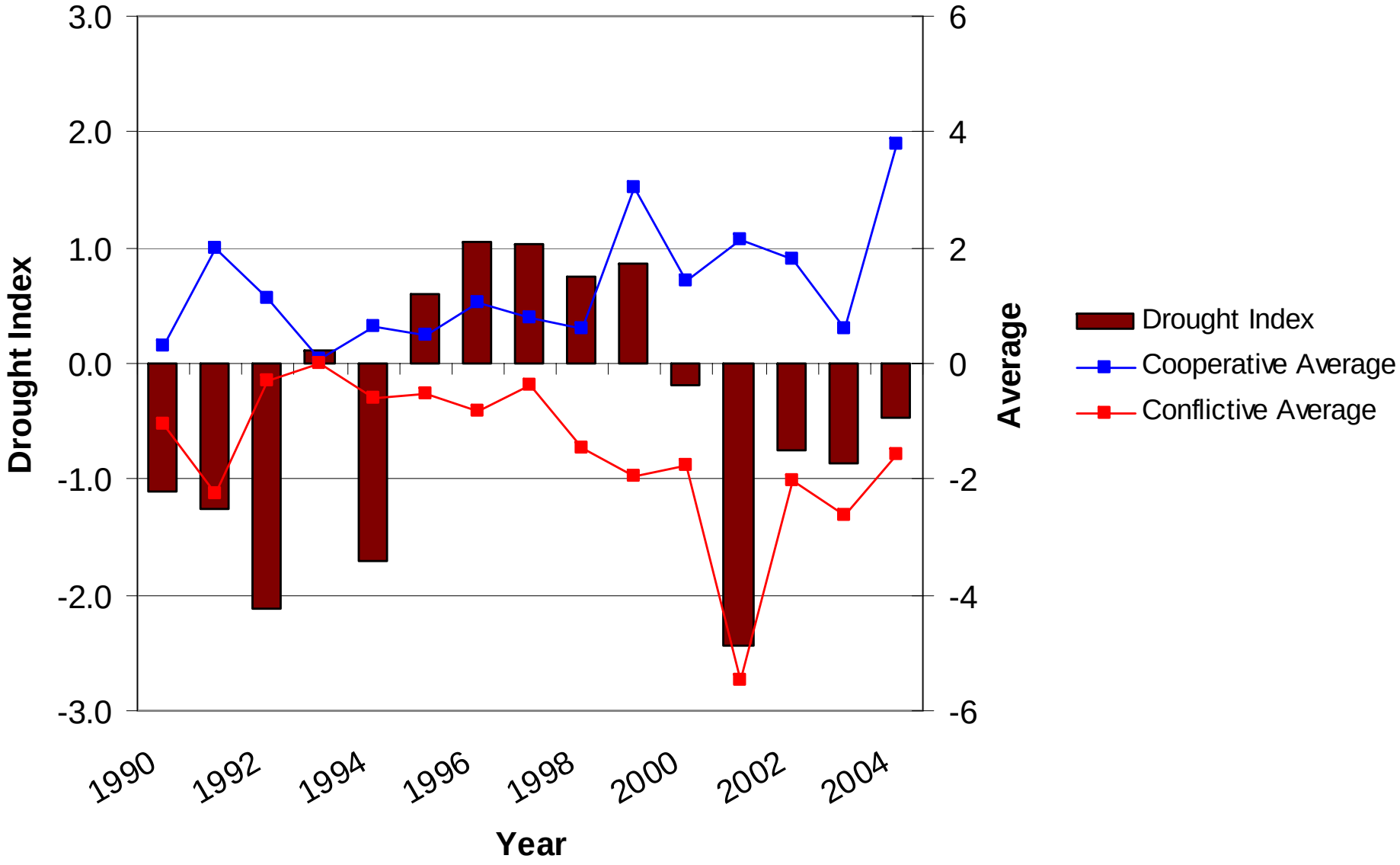

Conflict- Cooperation average
2.50
2.00
1.50
1.00
0.50
0.00
-0.50
-1.00
-1.50
R^2 = 0.3018
-5
0
5
10
15
20
25
Change in population density between 1990 and 2000

Number of Media Reported Events in Oregon along a Cooperation- Conflict Spectrum from 1990 to 2004



Source: Fesler, K. (2006) [Analysis of social interactions concerning Oregon's water resources between 1990 and 2004.] Unpublished Data.

Oregon Timeline



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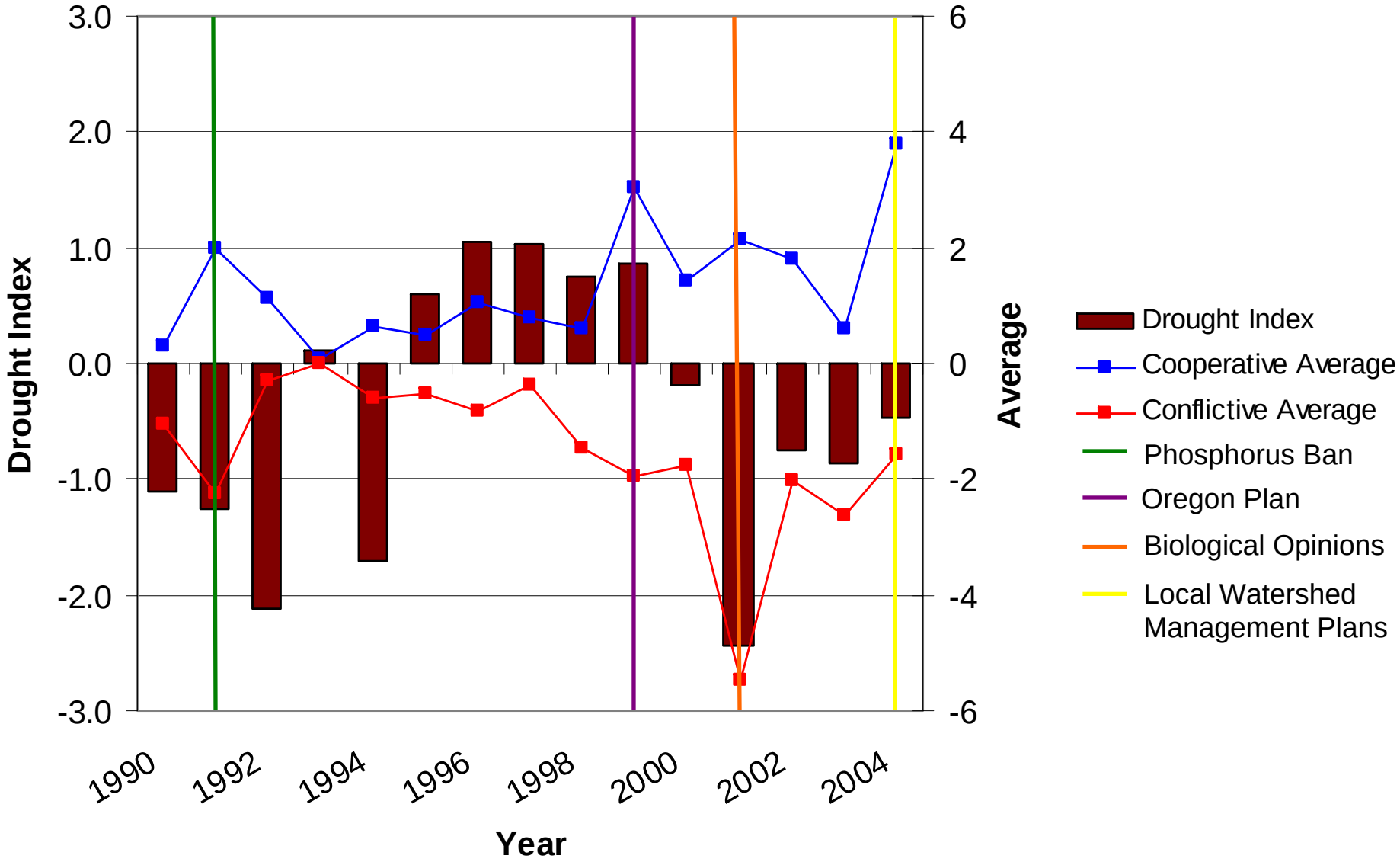
Oregon Timeline



Source: Fesler, K. (2006) [Analysis of social interactions concerning Oregon's water resources between 1990 and 2004.] Unpublished Data.

ARIA:
Four Paths in Negotiations

- **A**dversarial -- each side defines its positions, or *rights* (win-lose, zero-sum, distributive).
- **R**eflexive -- the *needs* of each side bringing them to their positions is addressed.
- **I**ntegrative -- negotiators brainstorm together to address each side's underlying *interests* (win-win, positive sum).
- **A**ction -- negotiators work on implementation and re-entry.

- Source: Rothman, J. 1991. Negotiation as Consolidation. Journal of International Relations. 13 (1).

Criteria for Water Allocations

Initial Positions:

- Rights-based: Geography vs. Chronology

Interim Positions:

- Needs-based plus recognition of historic use

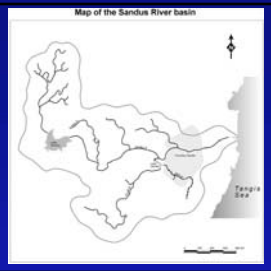
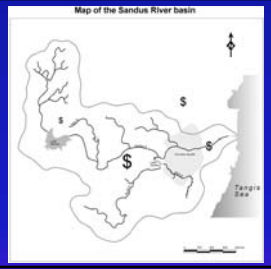
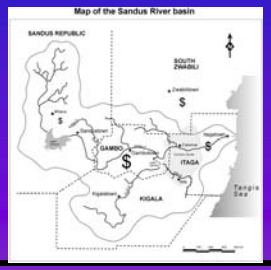
Final Agreement:

- Interest-based: Identification and assessment of “baskets” of benefits (perhaps beyond water)

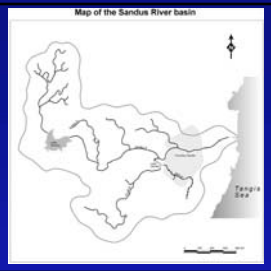
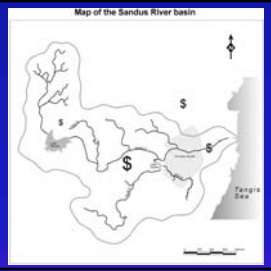
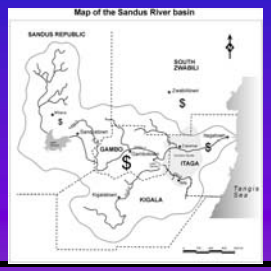
Implementation:

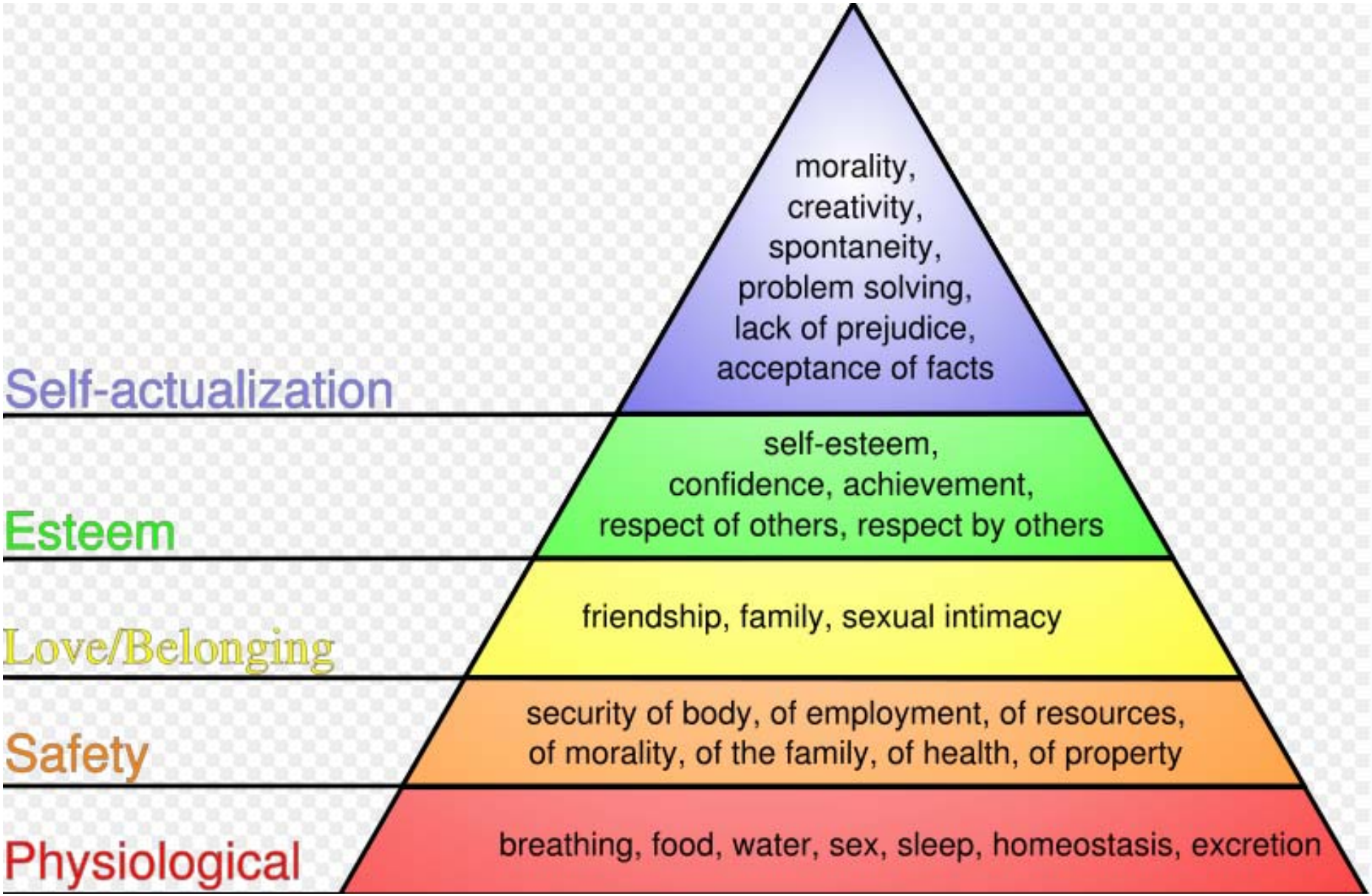
- Equitable distribution of benefits

WATER & FOUR WORLDS

Adversarial	**Rights**		
Reflexive	**Needs**		
Integrative	**Interests**		
Action	**Equity**		

WATER & FOUR WORLDS

Adversarial	Rights		Physical
Reflexive	Needs		Emotional
Integrative	Interests		Knowing
Action	Equity		Spiritual


morality,
creativity,
spontaneity,
problem solving,
lack of prejudice,
acceptance of facts
Self-actualization
self-esteem,
confidence, achievement,
respect of others, respect by others
Esteem
friendship, family, sexual intimacy
Love/Belonging
security of body, of employment, of resources,
of morality, of the family, of health, of property
Safety
breathing, food, water, sex, sleep, homeostasis, excretion
Physiological

The Universality of the Four Worlds

Rothman, Jay. ARIA. (1989, 1997)	Adversarial (Antagonistic)	Reflexive (Resonance)	Integrative (Invention)	Action
Water Resources (Wolf 1999)	Rights	Needs	Interests	Equity
Water Visual (Wolf et. al 2005)	Basin w-borders	Basin w-out borders	Enhanced benefits	Equitable distribution of benefits
Jewish levels of holiness (Sinai, Temple, prayer service)	Physical	Emotional	Intellectual	Spiritual
Textual Analysis	PÕshat	DÕrash	Remez	Sod
MaslowÕs (1954) Hierarchy of Needs	Physiologic	Safety	Belongingness & Love/ Esteem	Self-Actualization
Kabbalistic worlds (Zalman in Kemenetz pp. 16-17;	Assiyah (Actualization) It is perfect (h)	Yetzirah (formation) You are loved (v)	Beriyah (creation) All is clear (h)	Atzilut (emanation) I am holy (Y)
Kabbalah (cont. per Winkler, 2003)	West, Rafael, bull, earth	South, Michael, human, water	East, Gavriel, lion, wind	North, Uriel, eagle, fire
Parts of brain (Zalman, JÕlm 05)	reptilian	limbic	cortex	unused (85%)
Buddhism: Four Sights/Noble Truths/Four Jhannas	Sick/Dukkha (suffering)/physical joy	Aged/Tanha (desire)/rapture	Dead/Nirvana (a-suffering)/equanimity	Holy/8-fold path/lucidity

Allocating Scarce Resources

Allocating Scarce Resources

- Personal & Spiritual Needs

Allocating Scarce Resources

- Personal & Spiritual Needs
- Subsistence Agriculture
- Subsistence Industry

Allocating Scarce Resources

- Personal & Spiritual Needs
- Subsistence Agriculture
- Subsistence Industry
- Critical Ecosystems

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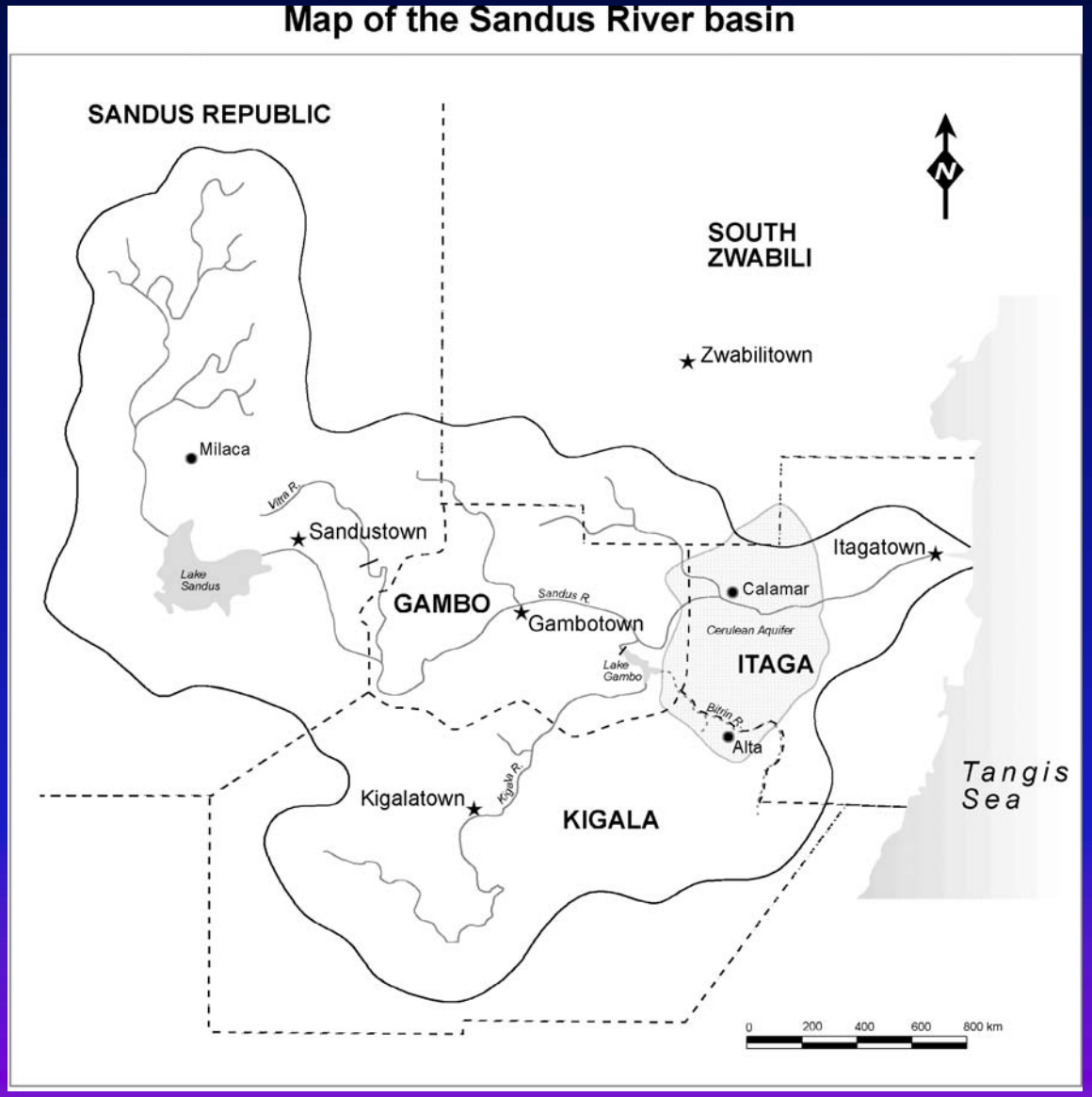
- Industrial Agriculture
- Commercial Industry

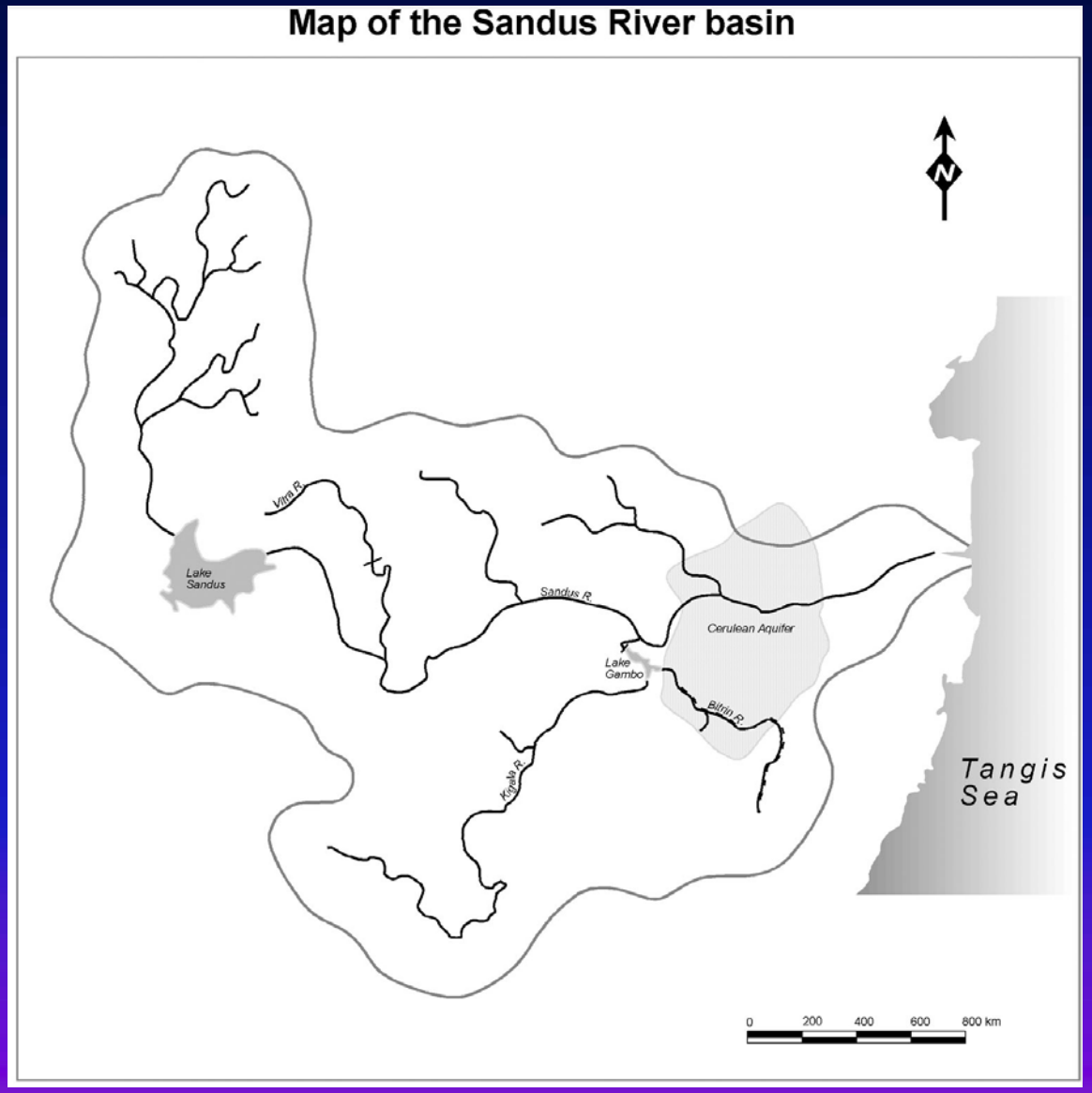
Allocating Scarce Resources

- Personal & Spiritual Needs
- Subsistence Agriculture
- Subsistence Industry
- Critical Ecosystems
- Industrial Agriculture
- Commercial Industry
- General Environment

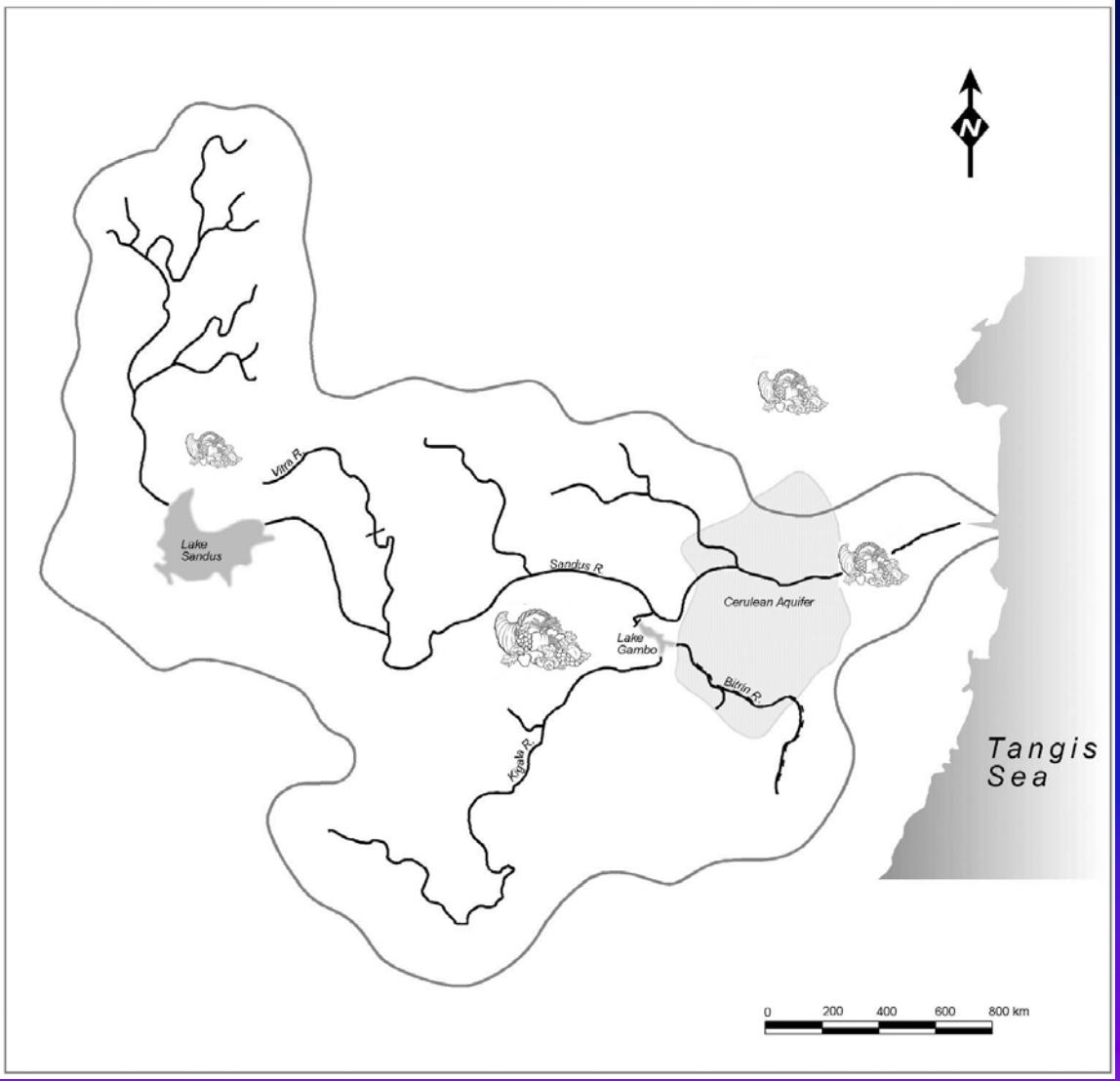
Map of the Sandus River basin

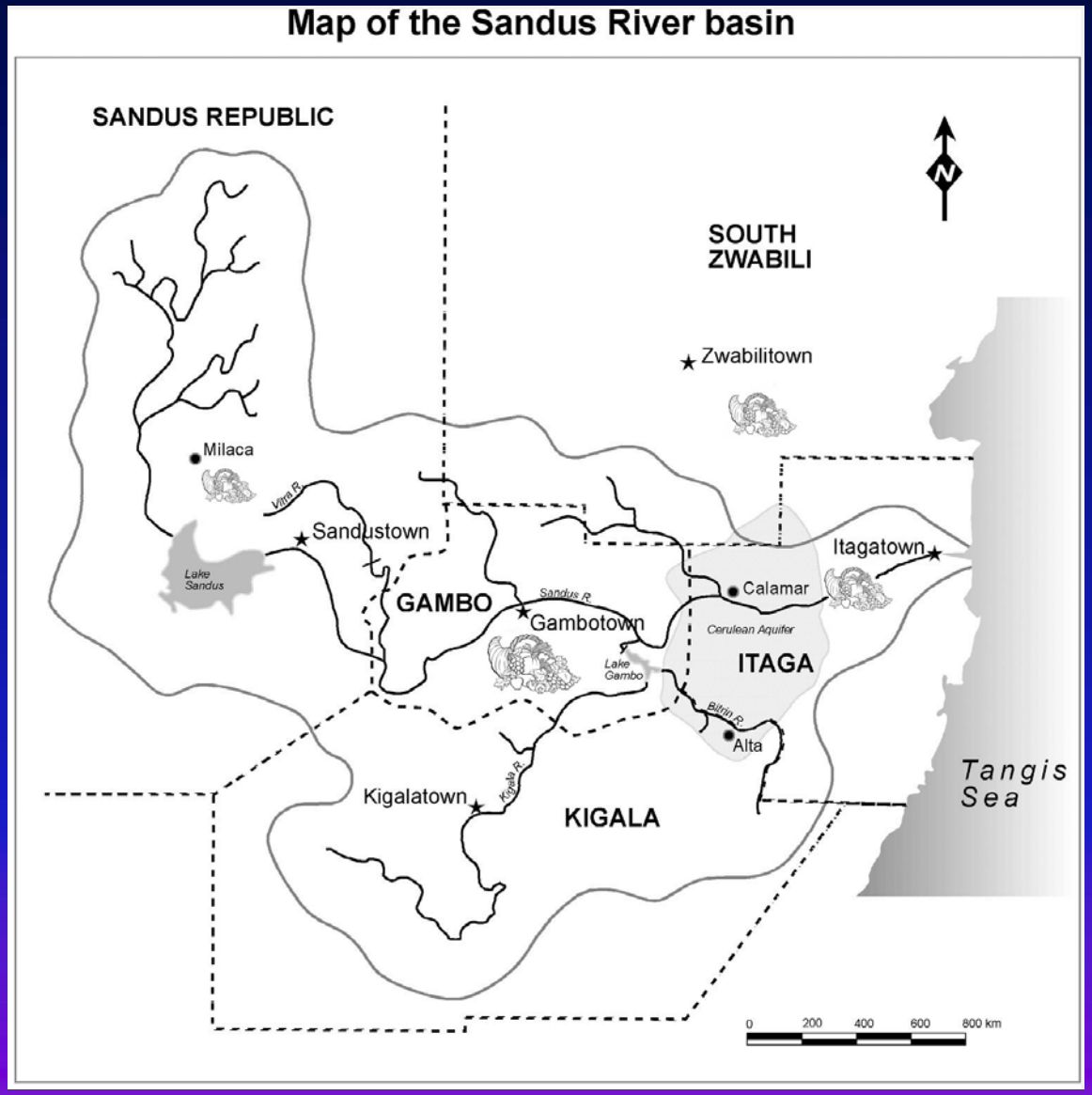


Map of the Sandus River basin

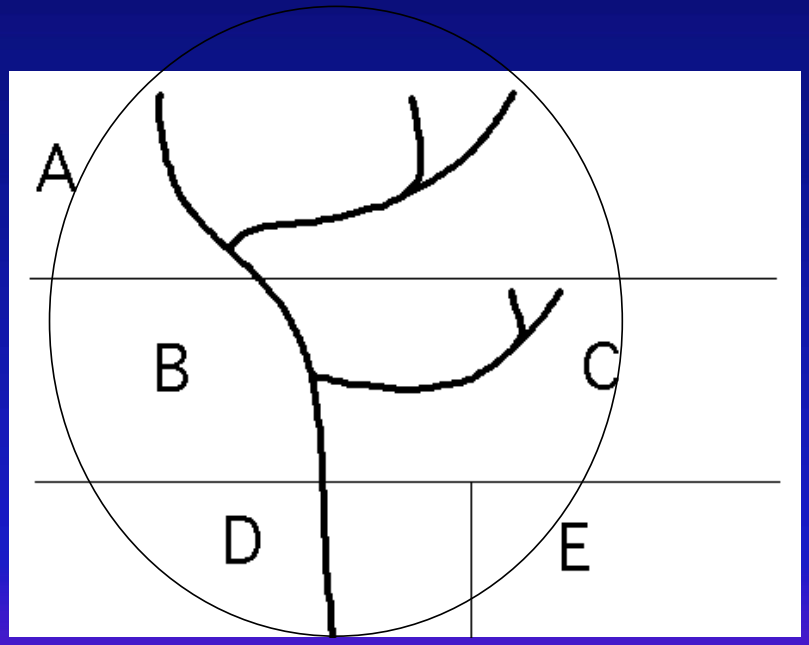


Map of the Sandus River basin



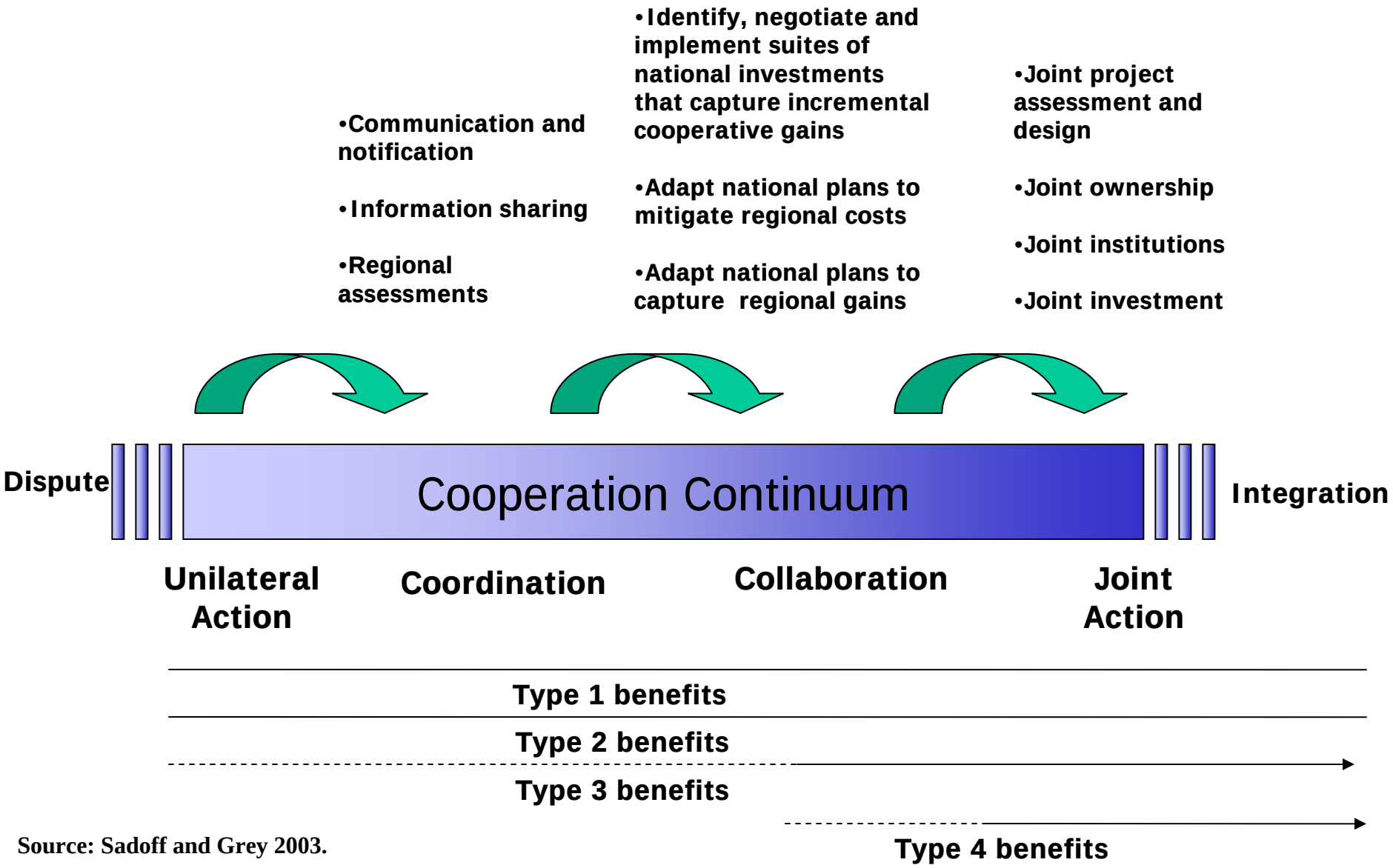

Map of the Sandus River basin
SANDUS REPUBLIC
SOUTH ZWABILI
N
Zwabilitown
Milaca
Vitra R.
Sandustown
Lake Sandus
GAMBO
Sandus R.
Gambotown
Calamar
Itagatown
Cerulean Aquifer
ITAGA
Lake Gambo
Bitrin R.
Alta
Kigalatown
Kigala R.
KIGALA
Tangis Sea
0 200 400 600 800 km

RIGHTS TO NEEDS
TO INTERESTS TO EQUITY



- Upstream/downstream interests
- eg. dams, agicultural land (Thailand/Laos, Lesotho/S. Africa, India/Nepal)
- Boundary waters (US/Canada)
- Unique interests (Water "loans", Iraq/Kuwait, Iran/USSR)
- BEYOND THE RIVER: Non-water benefits

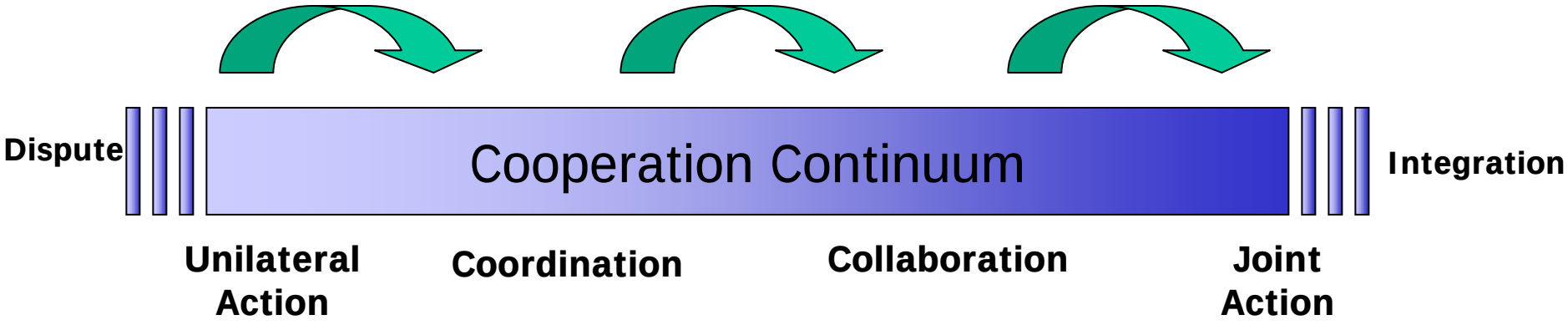
Types of Cooperation – a Cooperation Continuum



Source: Sadoff and Grey 2003.

Types of Cooperation – some examples

Indus	Jordan	Rhine	Orange	Senegal	River
commun-ication	info sharing, assessments	convergent national agendas	joint prep and investment	joint equity ownership	type of cooperation
1-3	1-4	1,3	2,3	1-4	type of benefit
	cost sharing	cost sharing	purchase agreement, financing	joint ownership	type of benefit sharing



Source: Sadoff and Grey 2003.

Sharing benefits: possible mechanisms

- **Water sharing**
  - **(Re)assigning rights**
- **Payments for water**
  - **Payment for use rights, bilateral sale or water markets**
- **Payments for benefits**
  - **Compensation for lost benefits, payments to allow new uses**
- **Purchase agreements – power, agriculture, etc.**
  - **Agreed price can effect a transfer of benefits**
- **Financing & ownership arrangements**
  - **Agreed terms can effect a transfer of benefits**
- **Bundling broader benefits**
  - **Trade, transport….**

Source: Sadoff and Grey 2003.

Water and Cooperation

"But the water problems of our world need not be only a cause of tension;
they can also be a catalyst for cooperation

....If we work together, a secure
and sustainable water future can be ours."

- Kofi Annan, February 2002