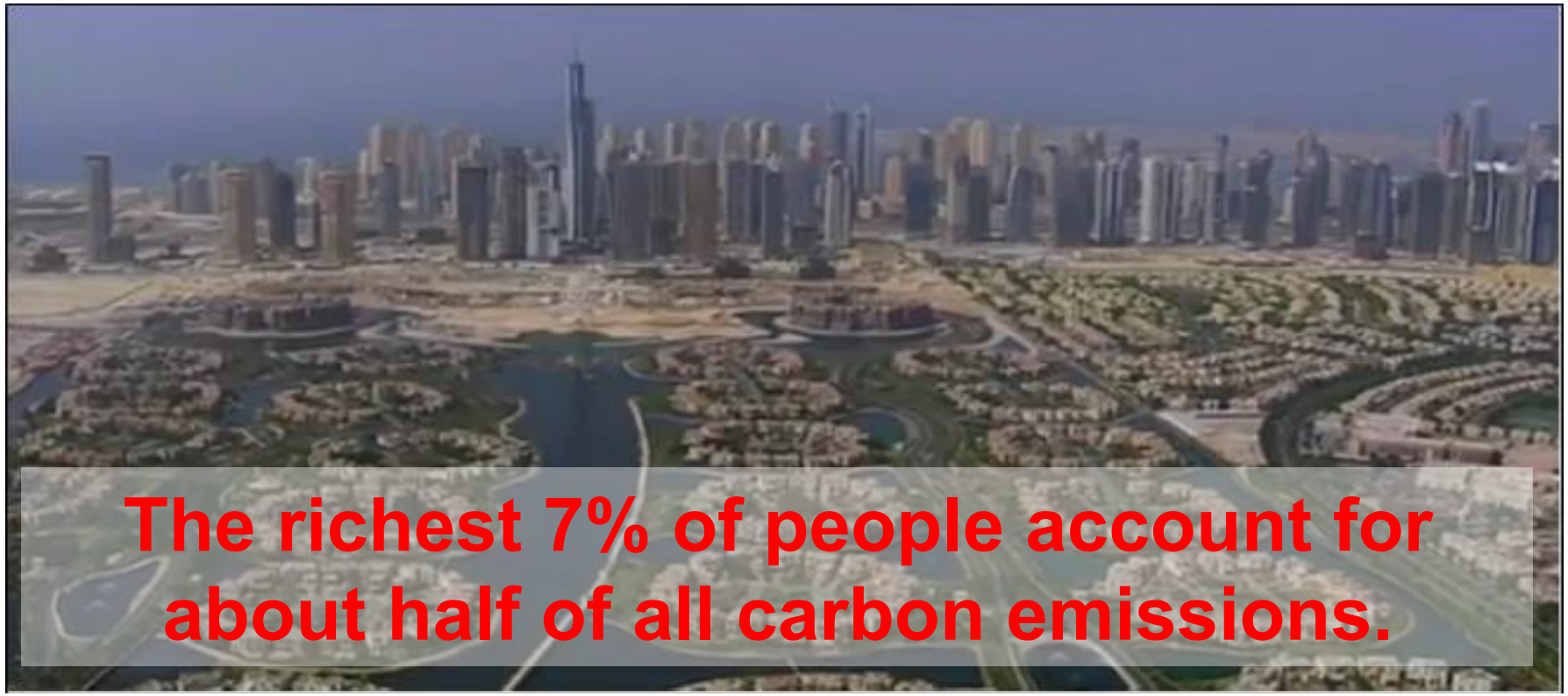
Healthy economies – healthy rivers?



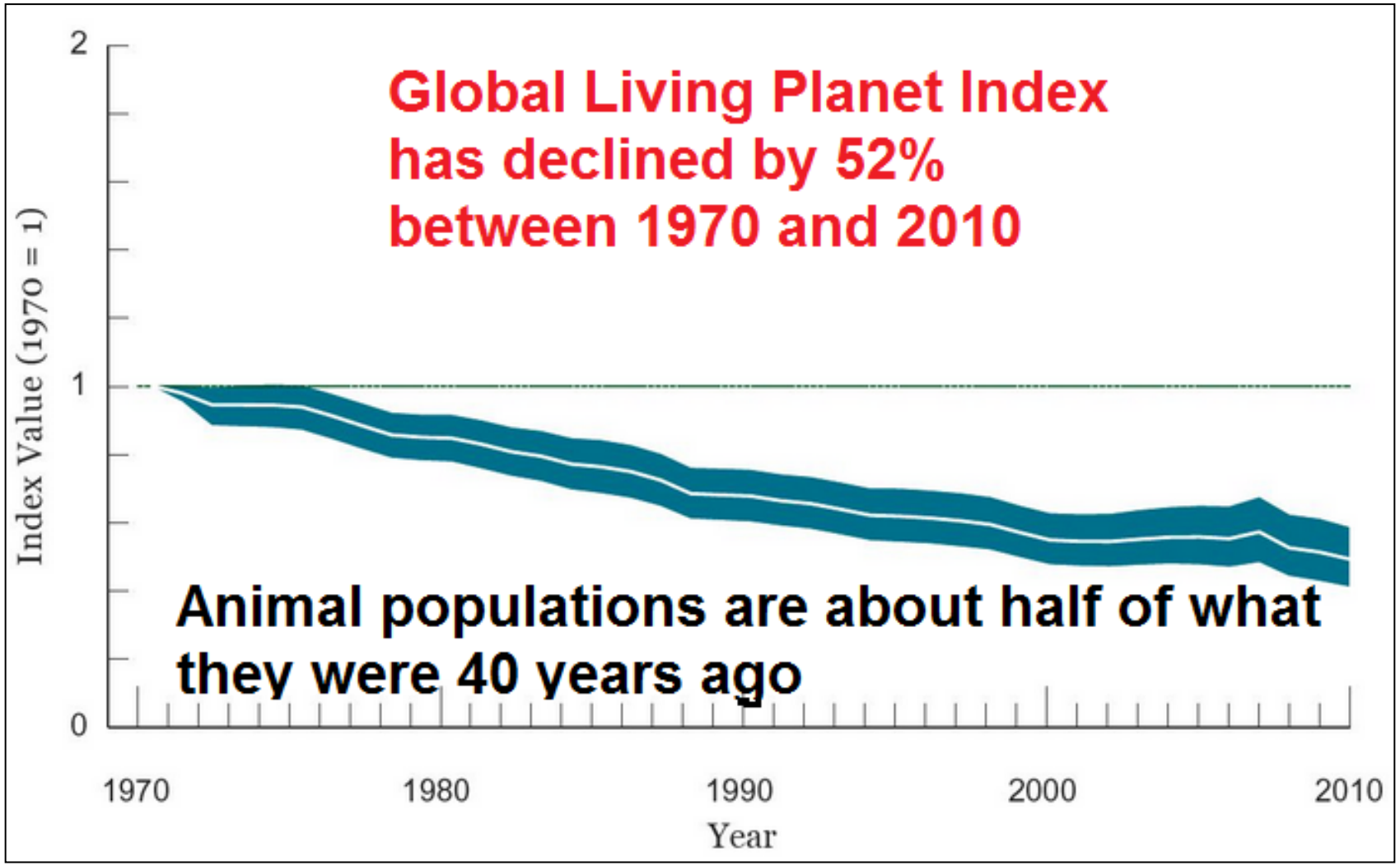
Dr Caroline Sullivan
Associate Professor of Environmental Economics and Policy
Southern Cross University, Australia

What makes a healthy river?

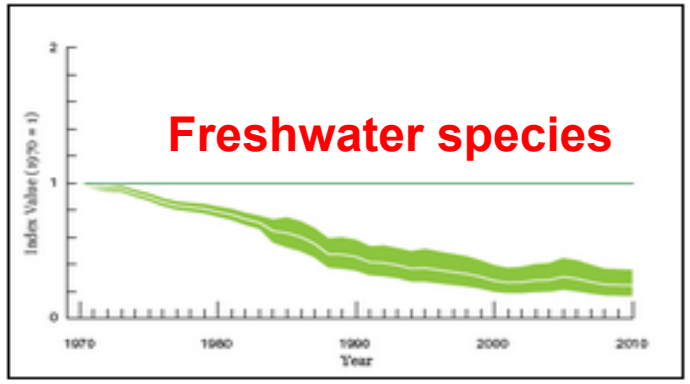
Caroline.sullivan@scu.edu.au

Caroline.sullivan@scu.edu.au

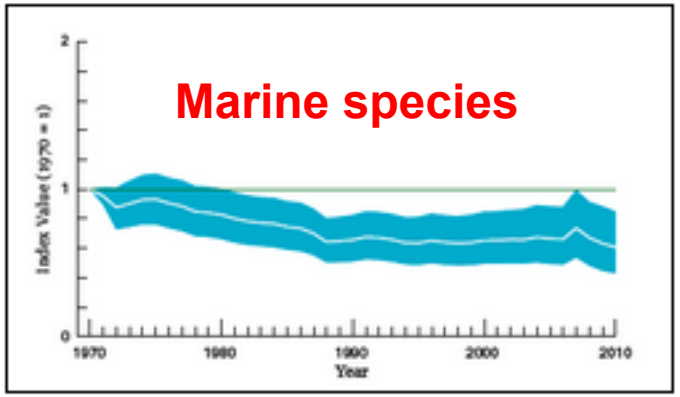
Why river health matters



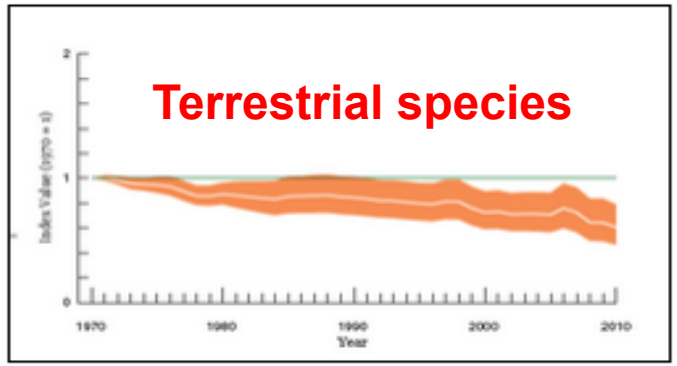
Caroline.sullivan@scu.edu.au



Freshwater species are the most threatened, declining by 76%, as a result of habitat loss, fragmentation, pollution and invasive species



Marine species decline by 39%, mostly in the tropics and the Southern Ocean –turtles, sharks, and large migratory seabirds like the albatross.



Terrestrial species decline by 39%, as a result of agriculture, hunting, urban development and energy production

Caroline.sullivan@scu.edu.au

What is considered a healthy economy?

- Increase in total and per capita national production and income (GDP)
- Stable level of prices
- Appropriate levels of infrastructure
- Adequate number of jobs to keep people in employment and generate enough government revenue
- Social and political stability

And sometimes non-depleting natural resource use

Caroline.sullivan@scu.edu.au

Indicators used to assess Economic Health

International indicators of economic growth

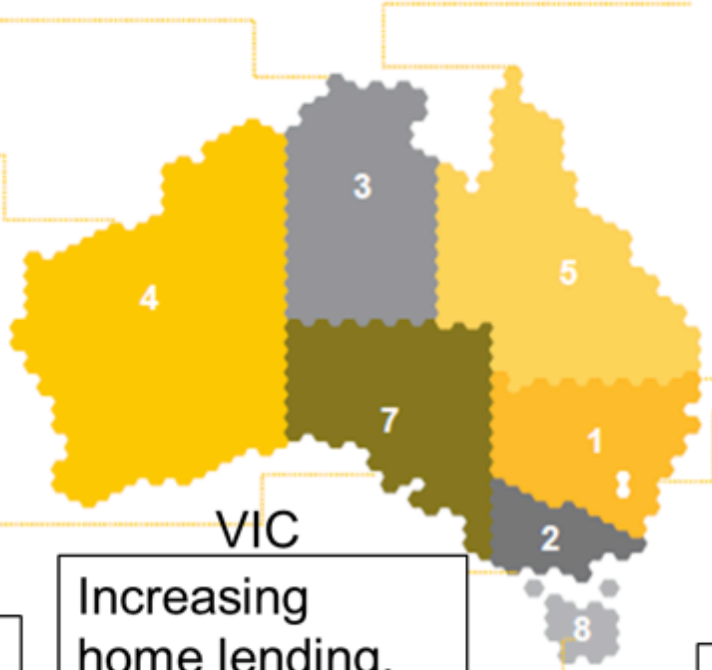
- Levels of Employment
- International Exchange Rates
- Gross National Product
- Per capita income
- Consumer borrowing
- International indebtedness
- Interest rates
- Change in prices

State of the States (Australia)

- Economic growth
- Retail spending
- Equipment investment
- Unemployment
- Construction work
- Population growth
- Housing finance
- Dwelling commencements

Caroline.sullivan@scu.edu.au

Economic Health in Australia, July 2015



Source: Comsec, 2015

Caroline.sullivan@scu.edu.au

Comparative measures of economic growth

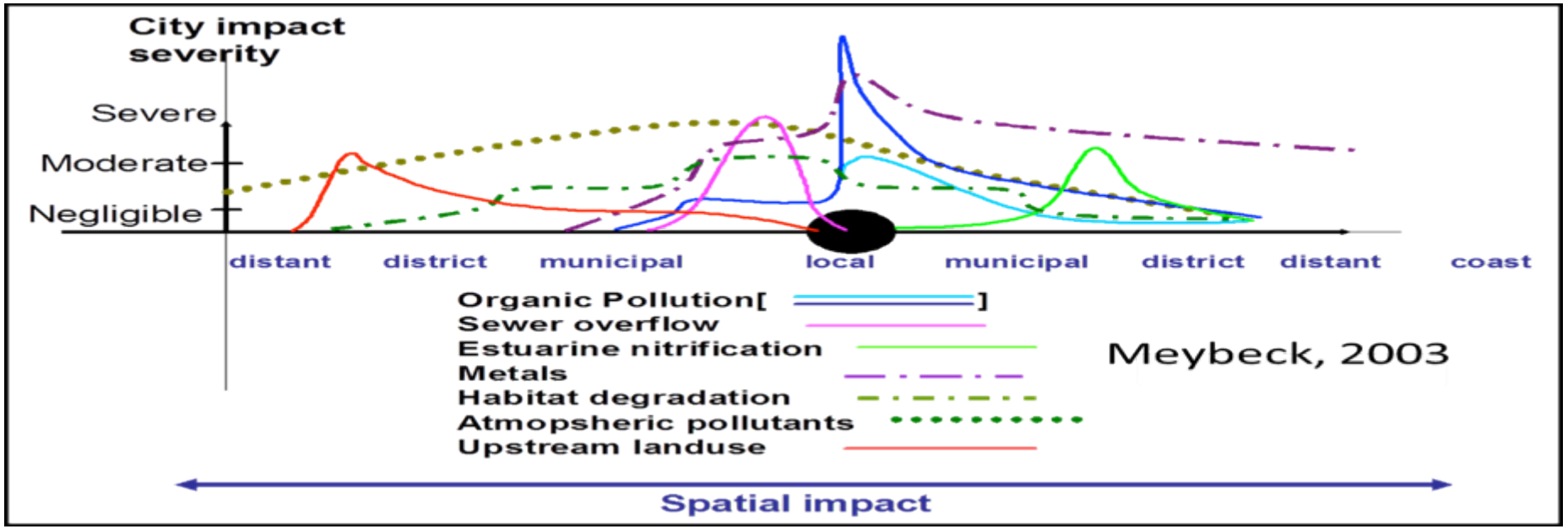
Richest 10% of global adult population accounts for 85% of the worlds wealth, whilst the bottom 50% accounts for 1% of the wealth.

Gross National Product (GNP)	Human Development Index (HDI)	Environmental Performance Index (EPI)
Consumption of goods and services	Health	Ecosystem Health
Gross Investment	Life expectancy at birth	Environmental Burden of Disease
Government purchases	Education	Water (effect on human health)
Exports/ Imports	Mean years of schooling	Air pollution (effect on human health)
	Expected years of schooling	Ecosystem Vitality
	Living standards	Air pollution (ecosystem effects)
	Gross national income per capita	Biodiversity and Habitat
		Forestry and Fisheries
		Agriculture
		Climate Change

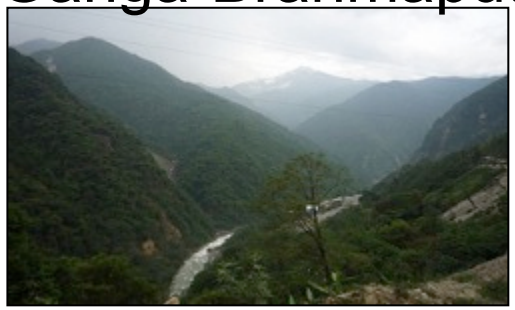
Caroline.sullivan@scu.edu.au

Our impacts on rivers

Water withdrawal, change in temperature, land cover, deposition of pollutants, change in river structure



Ganga-Brahmaputra



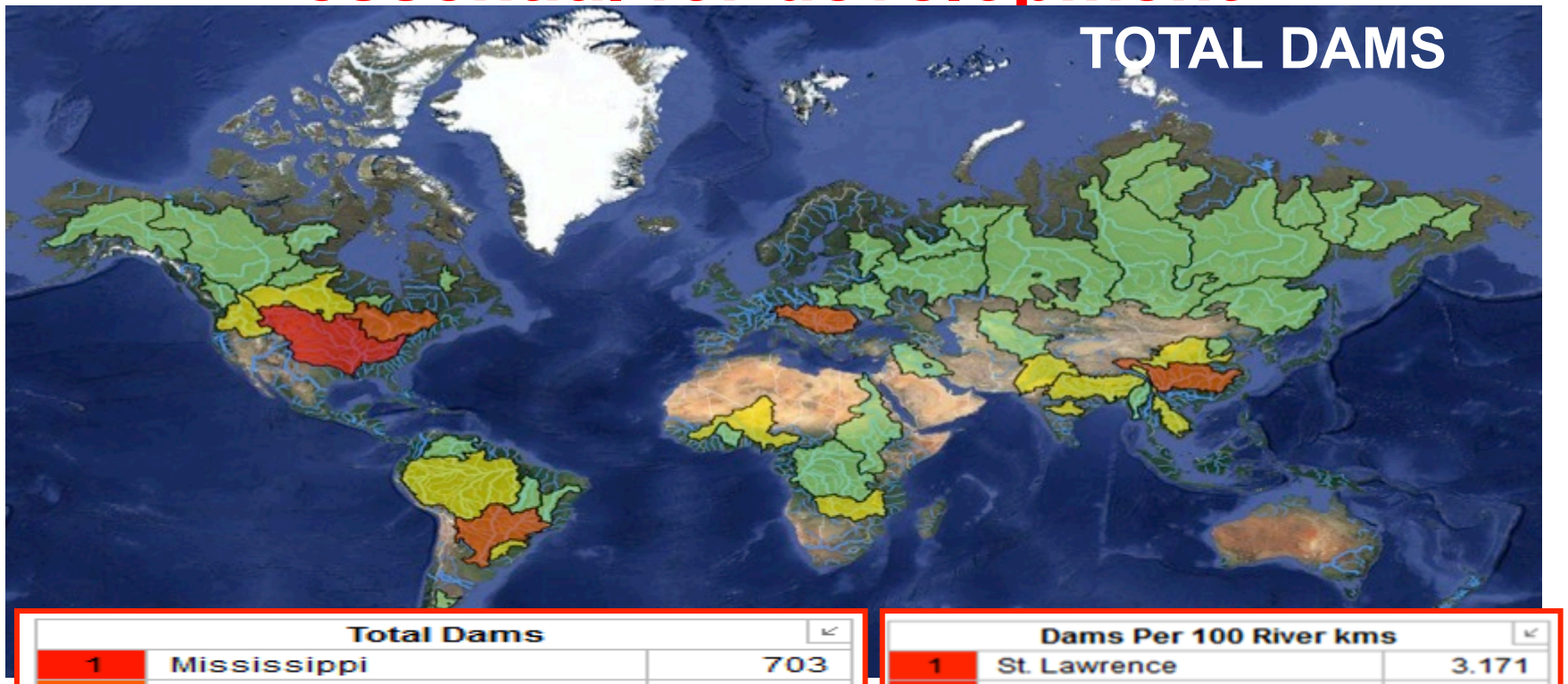
Amazon

Zambezi

Photos Internationalrivers.org

Caroline.sullivan@scu.edu.au

Water storage essential for development



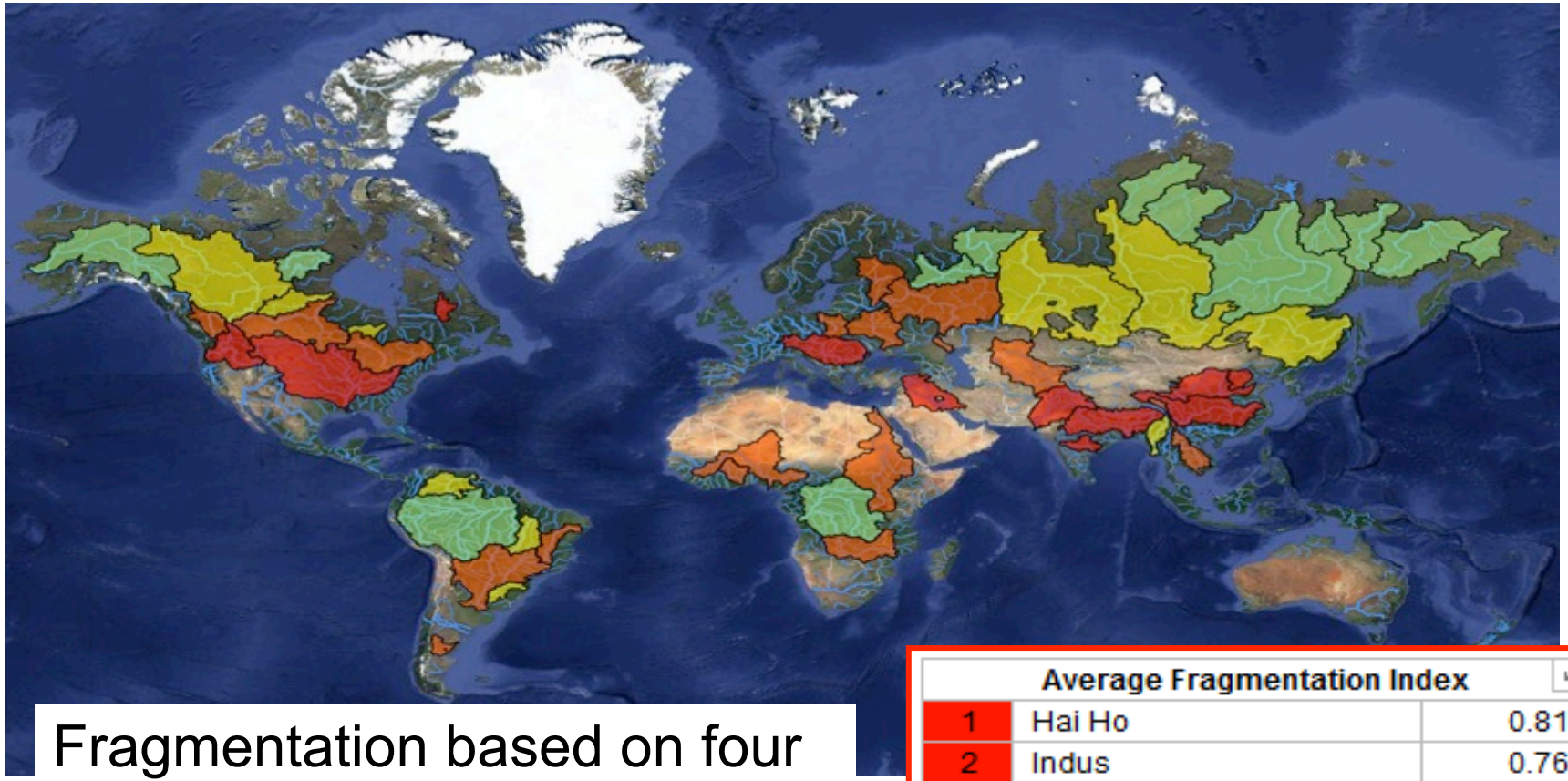
Source: Map http://www.internationalrivers.org/worldsrivers/
Dam data from Vörösmarty et al, 2010

Total Dams		
1	Mississippi	703
2	Yangtze	374
3	Parana	228
4	Danube	184
5	St. Lawrence	183
6	Columbia	130
7	Amazon	105
8	Nelson	91
9	Ganges-Brahmaputra	86
10	Mekong	82
	...	
	...	
	...	

Dams Per 100 River kms		
1	St. Lawrence	3.171
2	Hai Ho	2.506
3	Godavari	2.226
4	Uruguay	2.069
5	Yangtze	1.868
6	Mississippi	1.834
7	Columbia	1.645
8	Danube	1.420
9	São Francisco	1.216
10	Volta	1.111
	...	
	...	
	...	

Caroline.sullivan@scu.edu.au

River fragmentation



Source: Map http://www.internationalrivers.org/worldsrivers/
Data from Vörösmarty et al, 2010

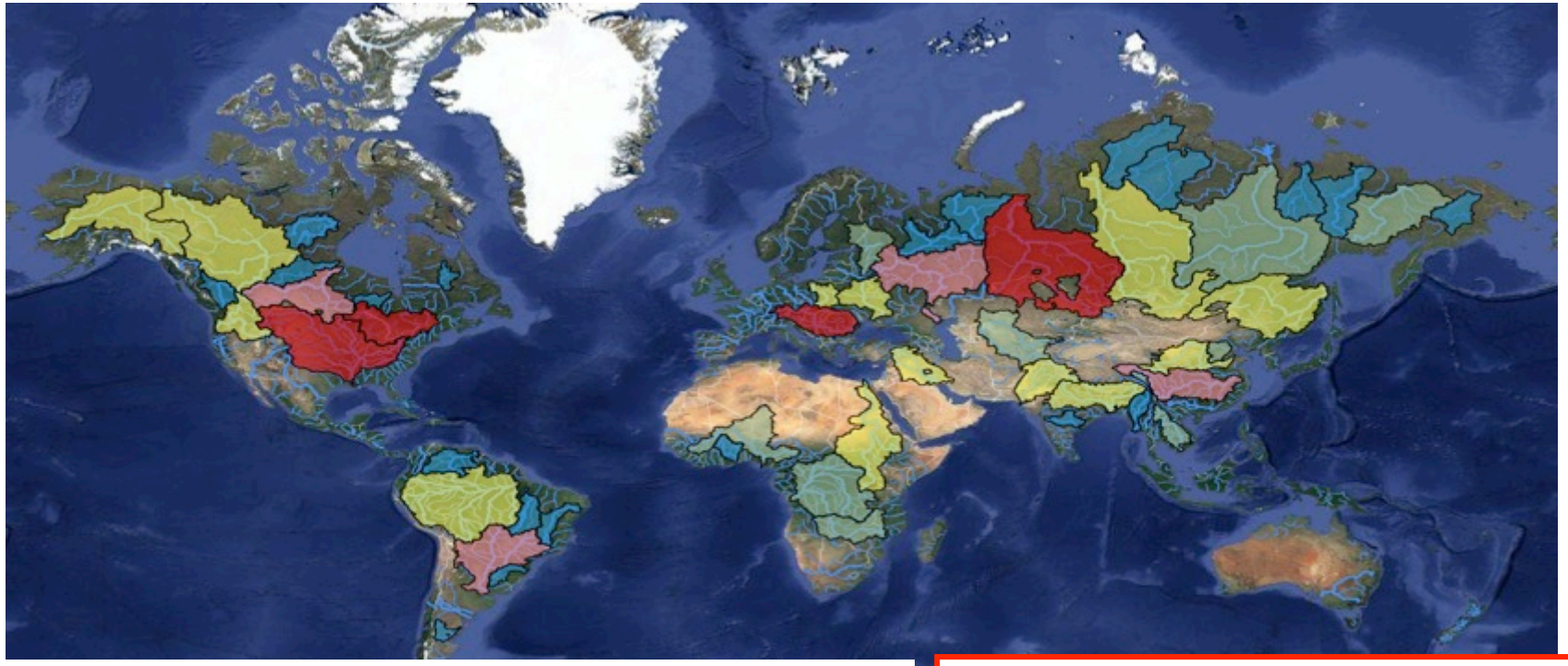
Fragmentation based on four equally-weighted variables:

- Dam density
- River fragmentation
- Consumptive water loss
- Flow disruption

	Average Fragmentation Index	
1	Hai Ho	0.81
2	Indus	0.76
3	Yellow	0.75
4	Tigris-Euphrates	0.73
5	Godavari	0.73
6	Mississippi	0.68
7	Yangtze	0.67
8	Columbia	0.67
9	Danube	0.65
10	Koksoak	0.63

Caroline.sullivan@scu.edu.au

Changing river temperatures



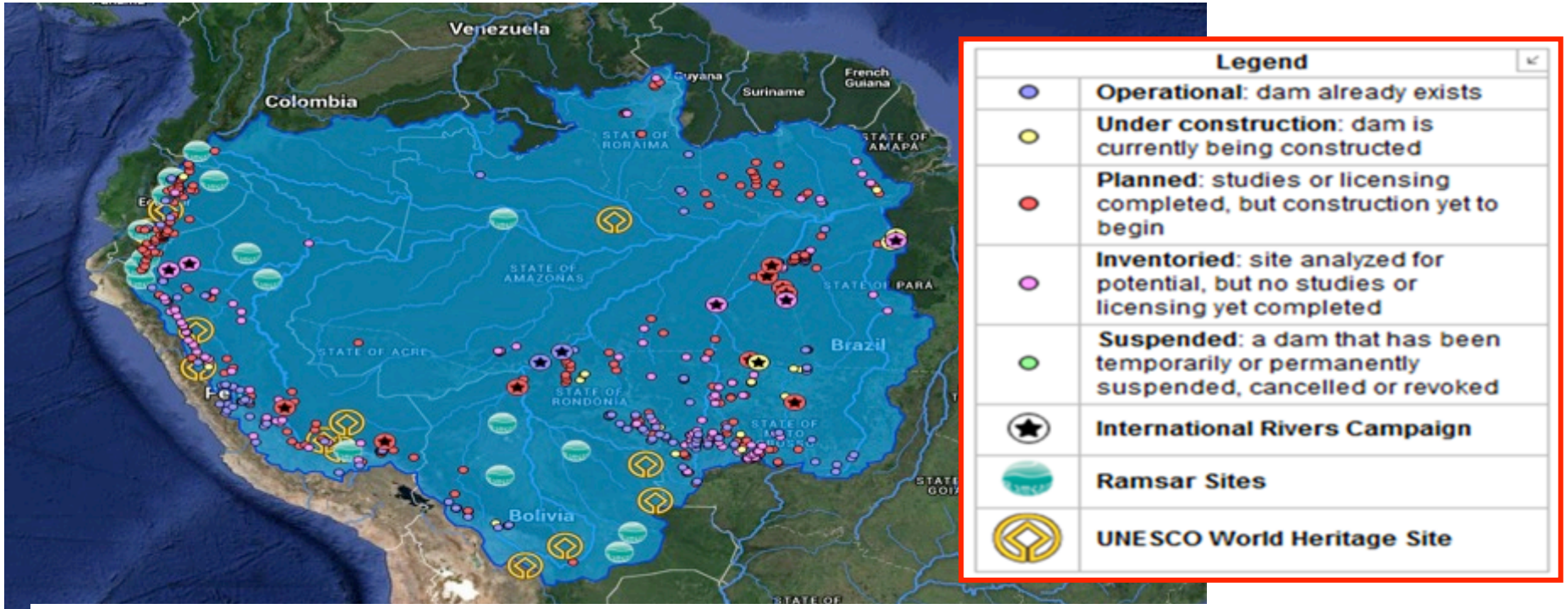
Source: Map http://www.internationalrivers.org/worldsrivers/
Temperature data from Vörösmarty et al, 2010

Changing river temperatures from changes in power generation, geomorphology, and other factors have a significant effect on river ecology.

	Thermal Index Sum	
1	Mississippi	498.99
2	St. Lawrence	200.12
3	Ob	182.35
4	Danube	158.74
5	Parana	134.19
6	Yangtze	130.91
7	Volga	121.25
8	Nelson	108.69
9	Amazon	99.52
10	Mackenzie	95.80

Caroline.sullivan@scu.edu.au

The Amazon



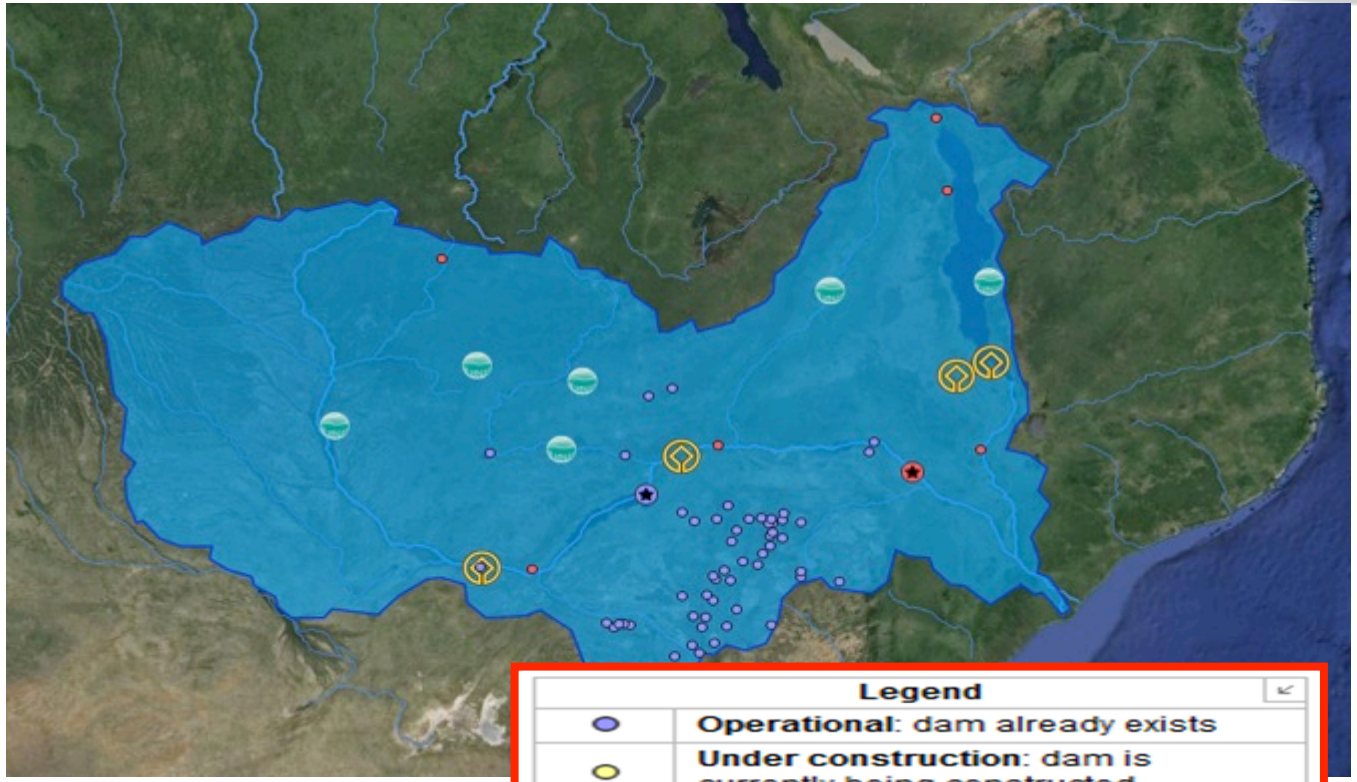
Source: http://www.internationalrivers.org/worldsrivers/

The Amazon Basin is the most biodiverse basin in the world, and supports about 10 million people. 105 dams exist in the Amazon Basin, and another 254 either under construction or planned. Roads, mining, logging and urban development are all taking their toll.

Caroline.sullivan@scu.edu.au

The Zambezi

1.39Mn km², the Zambezi is home to 30 million people and plays an important role in economies of eight riparian countries: Angola, Botswana, Malawi, Mozambique, Namibia, Tanzania, Zambia and Zimbabwe.



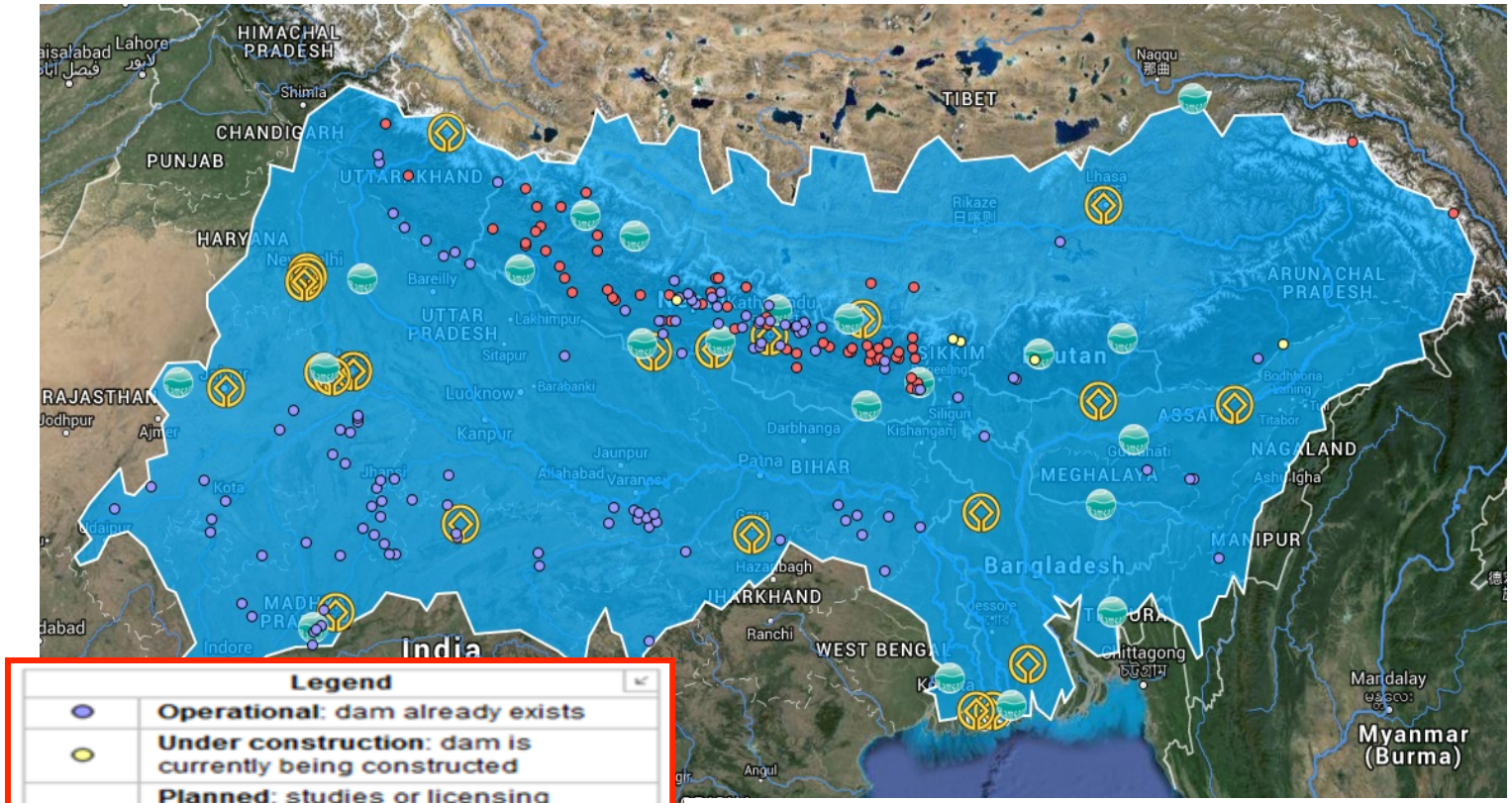
Legend	
	Operational: dam already exists
	Under construction: dam is currently being constructed
	Planned: studies or licensing completed, but construction yet to begin
	Inventoried: site analyzed for potential, but no studies or licensing yet completed
	Suspended: a dam that has been temporarily or permanently suspended, cancelled or revoked
	International Rivers Campaign
	Ramsar Sites
	UNESCO World Heritage Site

Source: http://www.internationalrivers.org/worldsrivers/

Caroline.sullivan@scu.edu.au

Ganga-Brahmaputra Basin

One of the world's largest river systems at 1.6 million Km^2. Currently only 86 dams built



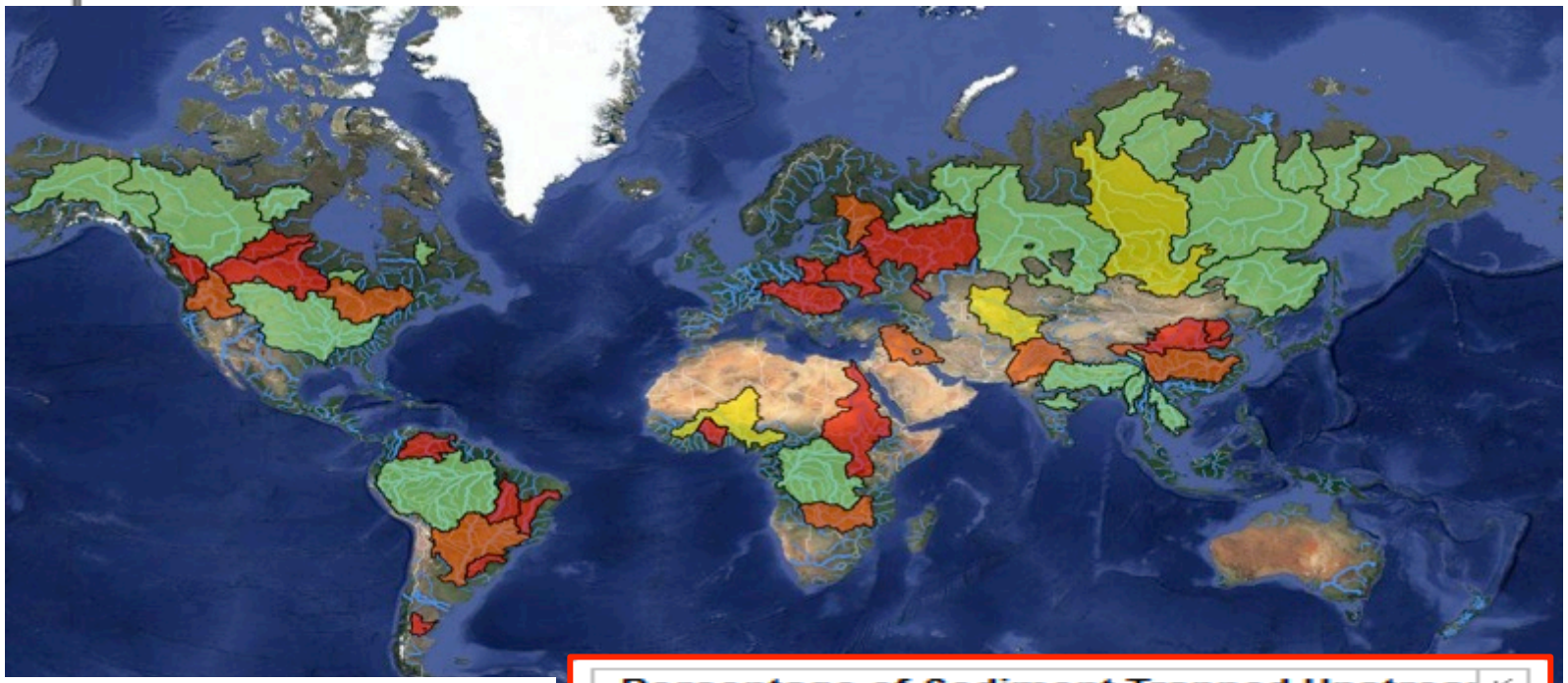
Source: http://www.internationalrivers.org/worldsrivers/

Legend	
	Operational: dam already exists
	Under construction: dam is currently being constructed
	Planned: studies or licensing completed, but construction yet to begin
	Inventoried: site analyzed for potential, but no studies or licensing yet completed
	Suspended: a dam that has been temporarily or permanently suspended, cancelled or revoked
	International Rivers Campaign
	Ramsar Sites
	UNESCO World Heritage Site

Supports more than 500 million people in Bangladesh, Bhutan, India and Nepal

Caroline.sullivan@scu.edu.au

River sedimentation



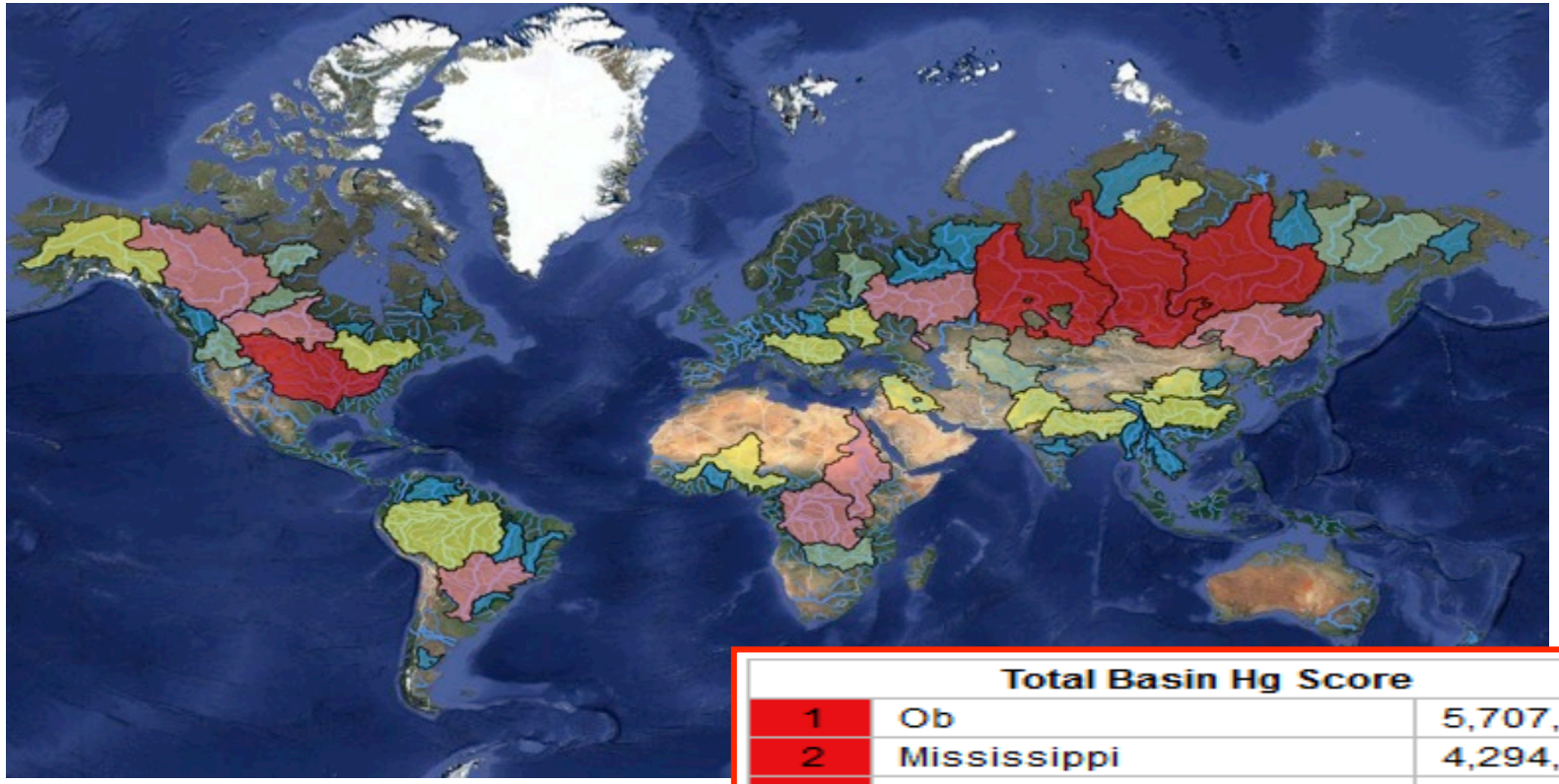
When sediment is trapped, nutrient transport through the basin is disturbed

	Percentage of Sediment Trapped Upstrear	
1	Churchill (Hudson Bay)	98%
2	Volta	97%
3	Yellow	95%
4	Hai Ho	95%
5	Dnepr	93%
6	Volga	92%
7	São Francisco	92%
8	Nile	91%
9	Nelson	89%
10	Fraser	86%
	...	
	...	
	...	

http://www.internationalrivers.org/rivers-in-crisis
Source: Global Water Atlas, developed for the World Water Development Report II. Dam data come from the GRanD Dams Database and International Rivers.

Caroline.sullivan@scu.edu.au

Levels of mercury



	Total Basin Hg Score	
1	Ob	5,707,605
2	Mississippi	4,294,344
3	Yenisei	3,866,005
4	Lena	3,698,872
5	Nile	2,864,931
6	Mackenzie	2,858,551
7	Volga	2,835,767
8	Amur	2,572,956
9	Congo	2,255,219
10	Nelson	2,094,905
	...	
	...	
	...	

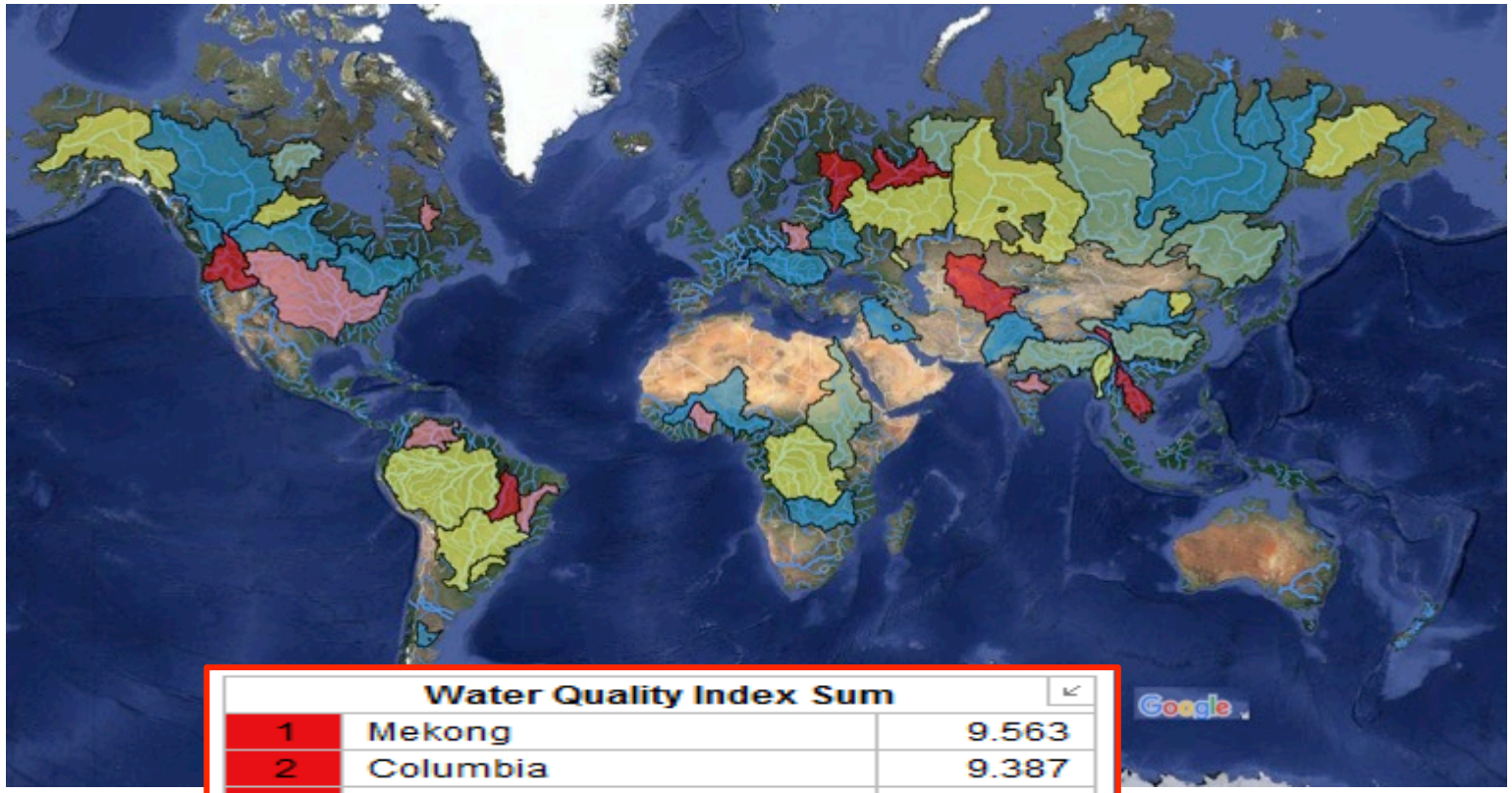
Source: NRDC

http://www.internationalrivers.org/rivers-in-crisis

Source: Map http://www.internationalrivers.org/worldsrivers/
Hg data from Vörösmarty et al, 2010

Caroline.sullivan@scu.edu.au

Overall water quality



Water Quality Index Sum		
1	Mekong	9.563
2	Columbia	9.387
3	Dvina	6.486
4	Neva	6.372
5	Amu-Darya	6.183
6	Tocantins	6.110
7	Mississippi	5.904
8	Orinoco	5.792
9	São Francisco	5.670
10	Wisla	5.614
	...	
	...	
	...	

Source: Map http://www.internationalrivers.org/worldsrivers/
Water Quality data from Vörösmarty et al, 2010, 9 quality parameters

Caroline.sullivan@scu.edu.au

Economic performance and water resources in the Nile

Country	Average Rainfall in the Basin Min (mm/year)	Average Rainfall in the Basin Max (mm/year)
Burundi	895	1,570
DR Congo	875	1,915
Egypt	0	120
Ethiopia	205	2,010
Kenya	505	1,790
Rwanda	840	1,935
Sudan	0	1,610
Tanzania	625	1,630
Uganda	395	2,060

Source: Karabwite, 1999

Country	Population 2005 millions (Estimated)	Rural population below national poverty line (%)	Per capita GDP (constant 1995 $US) 2001
Burundi	7.48	36.2	140.7
DR Congo	58.36		85.1
Egypt	69.91	23.3	1228.9
Ethiopia	71.89	45	120.5
Kenya	32.94	46.4	325.1
Rwanda	9.24	51.2	253.1
Sudan	34.84		328.4
Tanzania	37.22	49.7	196.9
Uganda	25.29	55	354.8

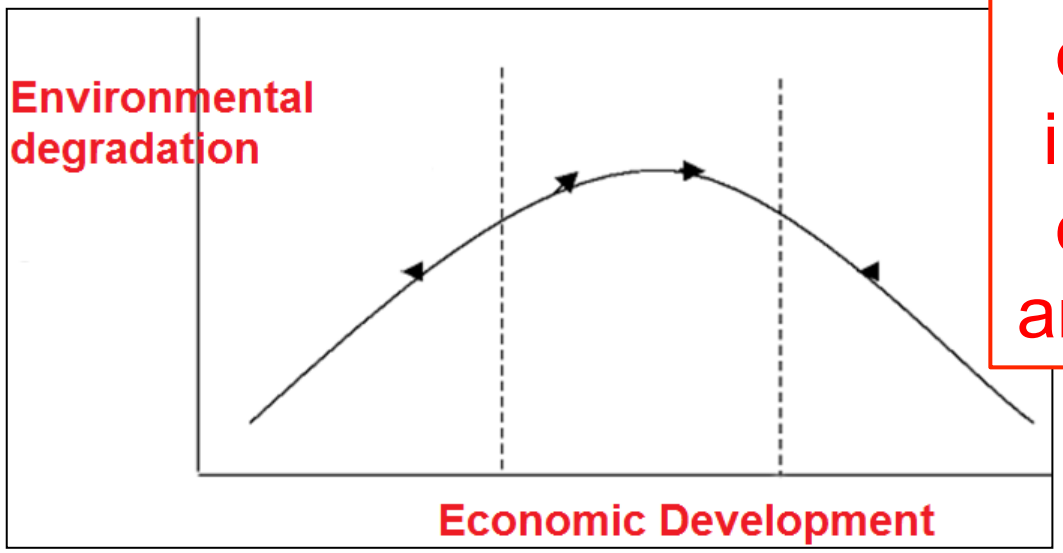
Source:WDR 2004

Economies highly dependent on agriculture may be very vulnerable economically to changes in weather conditions (Grey 2003), but this is not always the case

Caroline.sullivan@scu.edu.au

The Kuznets Curve

- Suggests a relationship exists between the level of economic development and the level of environmental degradation
- Assumed to rise initially as development rises
- Levels off as the economy matures and policies are put in place
- Suggests for highly developed economies, the level of degradation will decline



In almost all developed economies, problems of ill-defined property rights exist, and resource use and pollution is subsidised

Almost nowhere are the externalities internalised

Caroline.sullivan@scu.edu.au

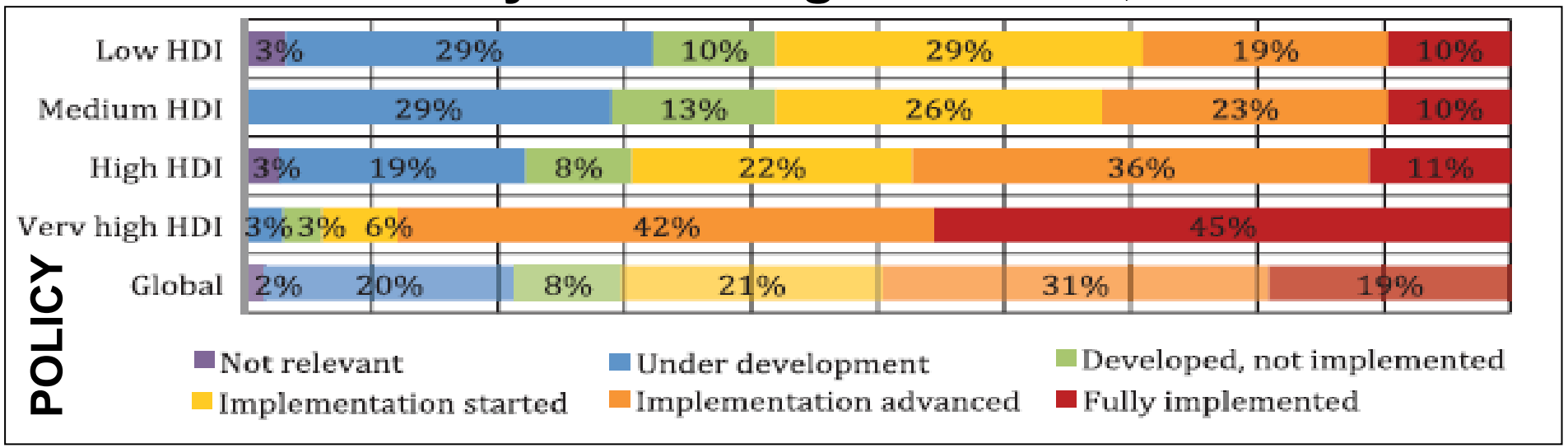
If the Kuznets's curve exists, why is it difficult to demonstrate?

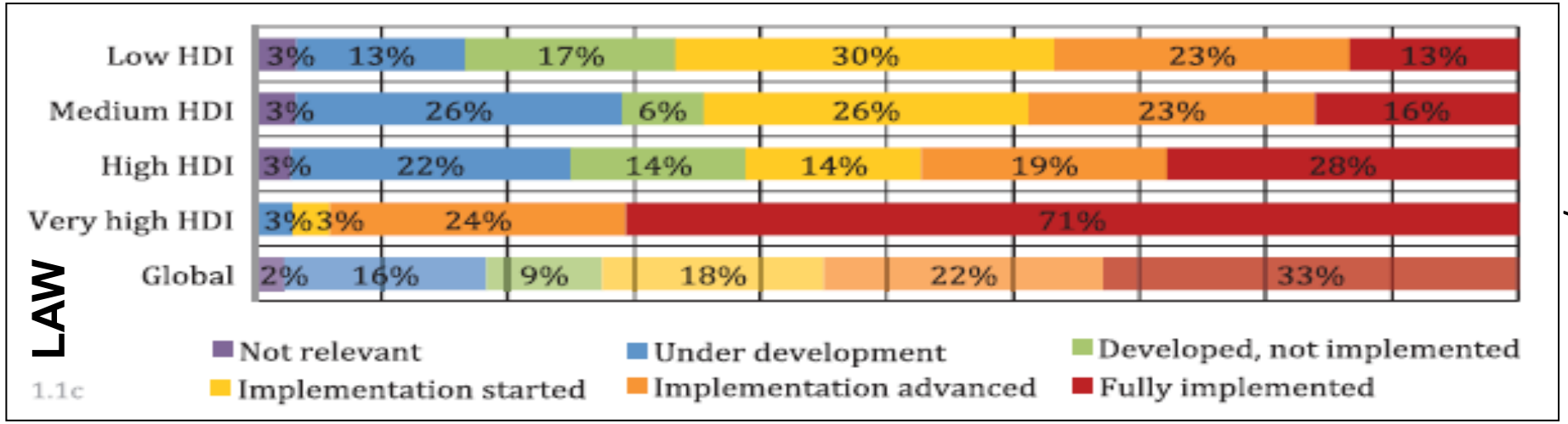
- Lack of consistent data within & between countries
- Data may be inaccurate, differently defined, taken from unrepresentative sites
- Theory assumes political will to take action
- Potential response to environmental pollution depends on societal preferences, technology, type of economy
- Impacts of poor environmental conditions are felt very unevenly throughout society, poor are most vulnerable
- Theory suggests the marginal benefit from environmental improvements increases as incomes rise. Income inequalities & multinationals prevent this
- Willingness to pay for environmental improvement may not be reflected by *capacity* to pay
- legislation and policies are not always well enforced

Caroline.sullivan@scu.edu.au

Effectiveness of national water resources law and policy

2012 UNEP survey on water governance, 133 countries

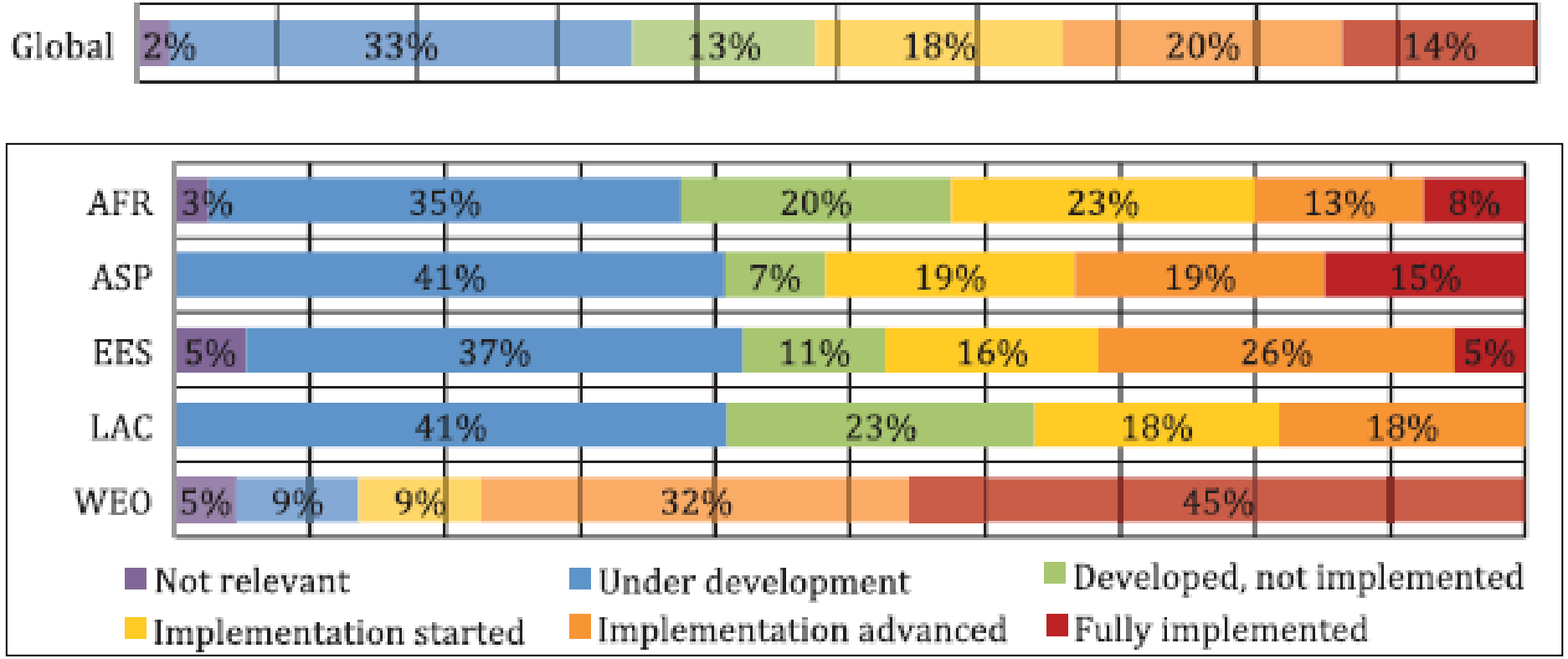




Source UNEP/DHI 2012

Caroline.sullivan@scu.edu.au

The state of integrated water resources management plans by region



Key: AFR = Africa; ASP = Asia and Pacific; EES = Eastern European States; LAC = Latin America and the Caribbean; WEO = Western Europe and Others.

Caroline.sullivan@scu.edu.au

Looking Back: Brisbane declaration 2007

- Environmental Flows are Essential for Freshwater Ecosystem Health and Human Well-Being
- Freshwater ecosystems are the foundation of our social, cultural, and economic well-being. Healthy freshwater ecosystems – rivers, lakes, floodplains, wetlands, and estuaries – provide clean water, food, fibre, energy and many other benefits that support economies and livelihoods around the world. They are essential to human health and well-being.
- Water flowing to the sea is not wasted
- Need to establish institutional frameworks
- Integrate water quality management
- Climate change intensifies the urgency

Caroline.sullivan@scu.edu.au

Looking forward: Options for action

- Encourage more rapid development of laws and policies to control impacts on river systems
- Standardise and improve monitoring and data storage
- Ensure adequate resources are allocated to enforcement
- Ensure green infrastructure (ecosystem services) are recognised and valued
- Develop international support schemes for low income countries where action is held back by lack of finance
- Build societal preferences for healthy rivers through awareness raising

(more river symposia!)

Caroline.sullivan@scu.edu.au