Estimating Drivers of Change

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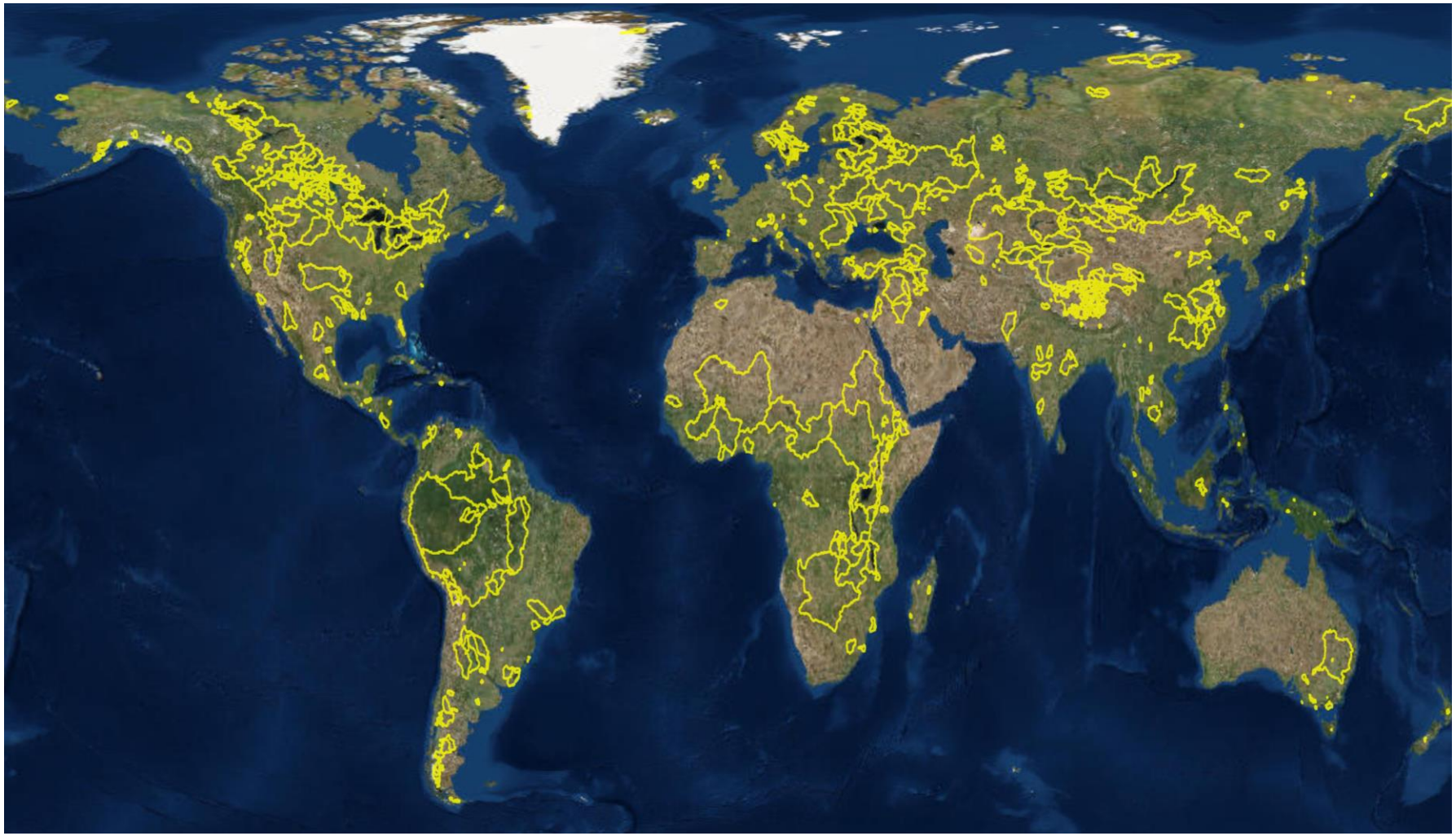
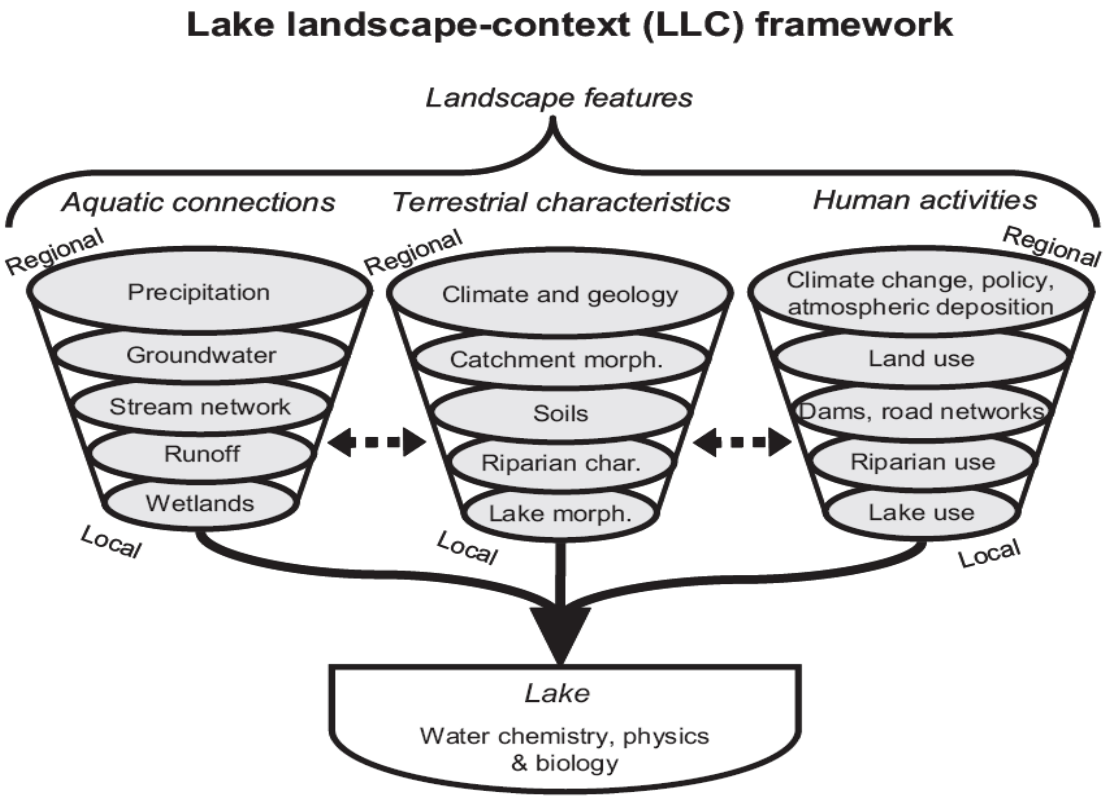
Lake Catchments



- Our ‘GloboLakes’ integrate responses from a vast proportion of the Earths terrestrial surface
- Total GloboLakes Catchment Area (cumulative) ~ 131,180,824 km^2

Lake Landscape Context

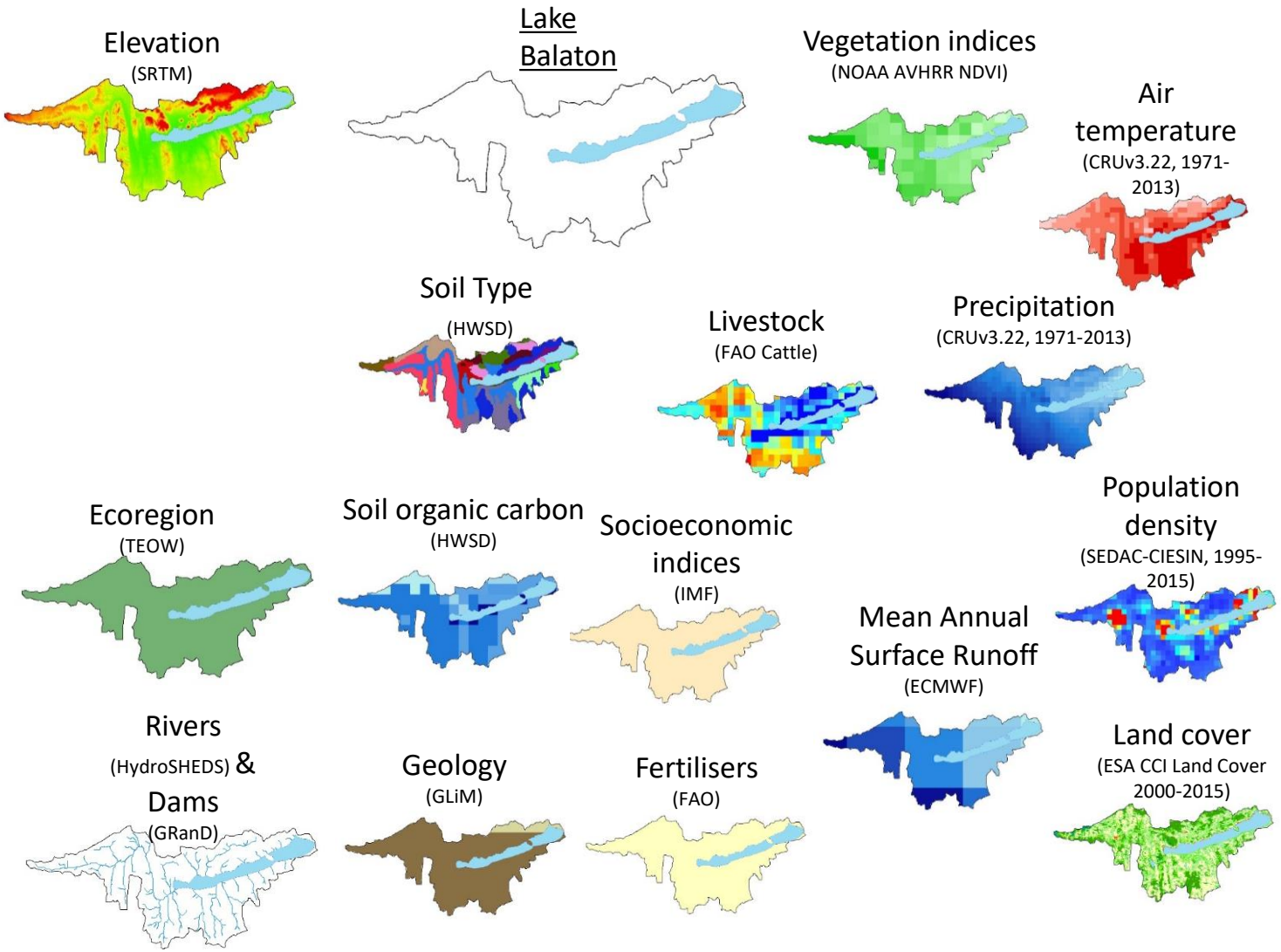
- To explain and interpret change in lake behaviour we need to understand the drivers of change
- To do this globally requires bringing together global standardised datasets and information
  - GloboLakes Catchment database
  - Mixture of pre-existing datasets, literature-derived and modelled data for our 997 Globolakes



(Sorrano *et al.*, 2009)

Lake Landscape Context

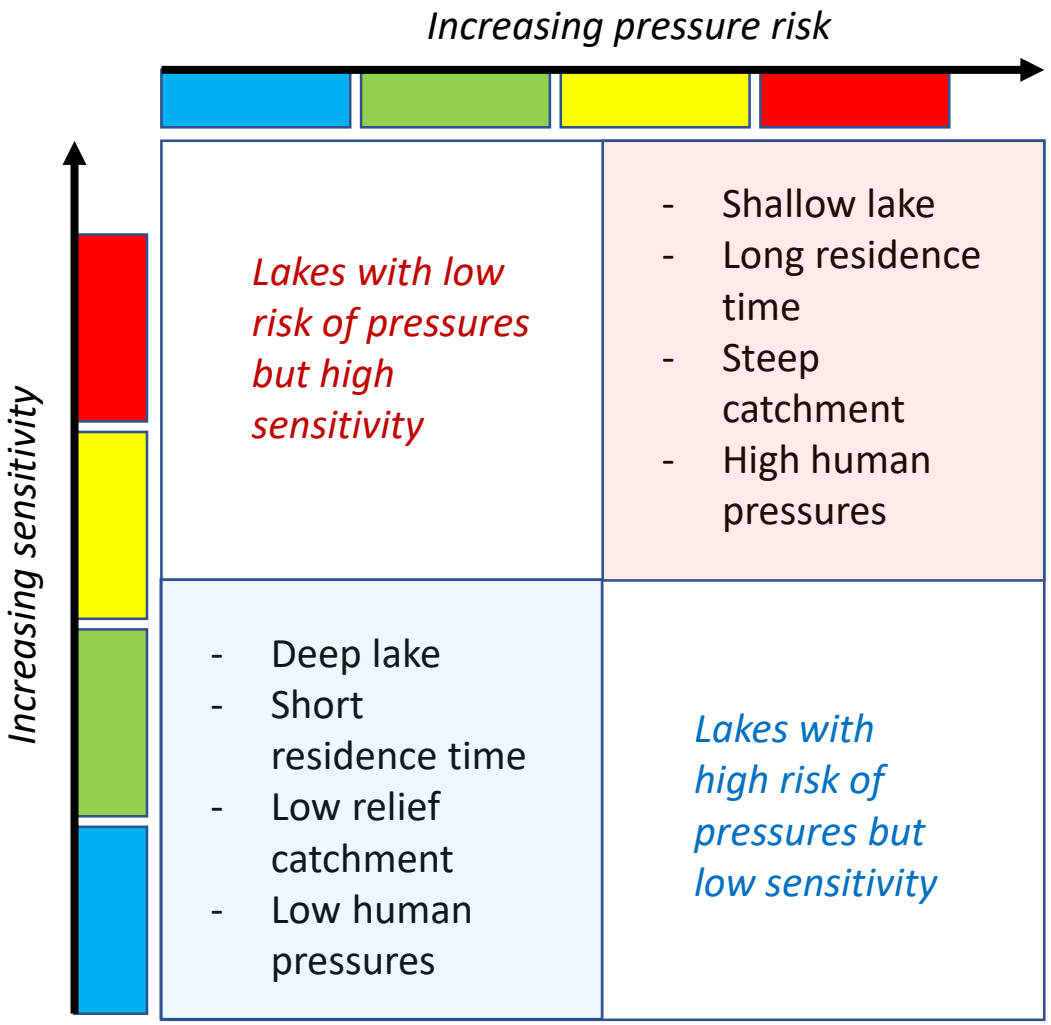
- Sensitivity factors
  - Lake morphometry
  - Lake location, residence time etc
  - Geology/soils/river network
- Spatio-temporal variable drivers
  - Atmospheric (e.g. air temp)
  - Catchment (e.g. productivity, land cover, population)



Lake vulnerability – our conceptual approach

Aim of study:

- To estimate global lake vulnerability based on human pressures in the catchment and lake/catchment system characteristics.
- Exploitation of the GloboLakes Catchment Database v2.1



Lake vulnerability at global scales

RISK FACTOR

- **Human Pressures** - Data used*:
  - Population density (2000-2015)
  - Dominant Catchment Land cover (2010)
  - GDP (2000-2012)
  - Fertilisers (Nitrogen + Phosphate) (2002-2010)
  - Total livestock (2000-2010)

LAKE SENSITIVITY TO CHANGE

- **Lake/Catchment system** – Data used:
  - Mean depth
  - Volume-to-Shoreline-length ratio
  - Residence time
  - Ohle's index (i.e., catchment surface area over the lake surface area)
  - Catchment relief ratio

Risk factor + Lake sensitivity = Lake vulnerability

Lake vulnerability at global scales

Scoring approach*:

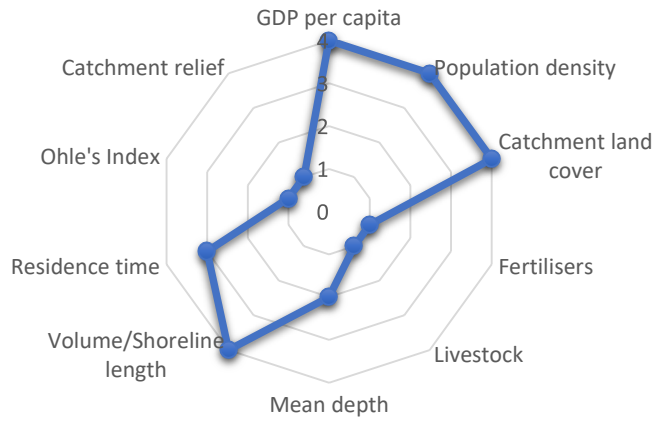
Step 1: Current condition (“the present”)

Low	Medium	High	Very high	No data

**Variables classified into classes according to statistical properties, reference to WFD, World reference standards and literature*

		SCORE	SCORE	SCORE	SCORE	SCORE	SCORE	SCORE	SCORE	SCORE	SCORE
Lake Name and Country	GloboLID	GDP per capita	Population density	Catchment land cover	Fertilisers	Livestock	Mean depth	Volume/Shoreline length	Residence time	Ohle's Index	Catchment relief
Lake SUPERIOR,	2	2	1	1	2	1	1	2	4	1	1
Lake VICTORIA,	3	4	4	4	1	1	2	4	3	1	1
Lake ARAL Sea,	4	3	2	2	1	1	2	4	1	2	1
Lake HURON, Ca	5	2	3	2	2	2	2	4	3	1	1
Lake MICHIGAN	6	2	3	3	2	2	2	3	3	1	1
Lake TANGANYII	7	4								1	1
Lake BAYKAL/BA	8	3								2	1
GREAT BEAR Lak	9	2								1	
Lake MALAWI/N	10	4								1	1
GREAT SLAVE La	11	2								2	
Lake ERIE, Cana	12	2								2	1
Lake WINNIPEG	13	2								3	1
Lake CHAD, Cha	14	4								3	1
Lake ONTARIO,	15	2								2	1
Lake LADOGA, R	16	3								2	
Lake BALQASH, I	17	3								2	1
Lake ONEGA, Ru	18	3								1	
Lake TITICACA, F	20	3								1	1
Lake NICARAGU	21	4								1	1
Lake TURKANA,	22	4								2	1
Lake ATHABASC	23	2								2	
Lake VOLTA (Res	24	4								3	1
Lake ISSYK KUL,	25	4								1	2
GREAT SALT Lak	26	2								2	1
REINDEER Lake,	28	2	1	1	2	1	2	4	2	1	1
Lake VÄNERN, S	29	2	2	1	2	1	2	4	2	2	
Lake ALBERT, Ug	30	4	4	4	1	1	2	4	2	3	1
Lake WINNIPEG	31	2	1	3	2	1	3	4	2	2	1
Lake KUYBYSHEV	33	3	2	2	1	1	3	4	1	4	
Lake URMIA, Ira	34	3	3	2	2	3	3	4	1	2	1

Lake VICTORIA, Tanzania; Uganda; Kenya



Lake vulnerability at global scales

Scoring approach:

Step 1: Current condition ("the present")

Low	Medium	High	Very high	No data

Step 2: Past trend (magnitude of change in last decade)

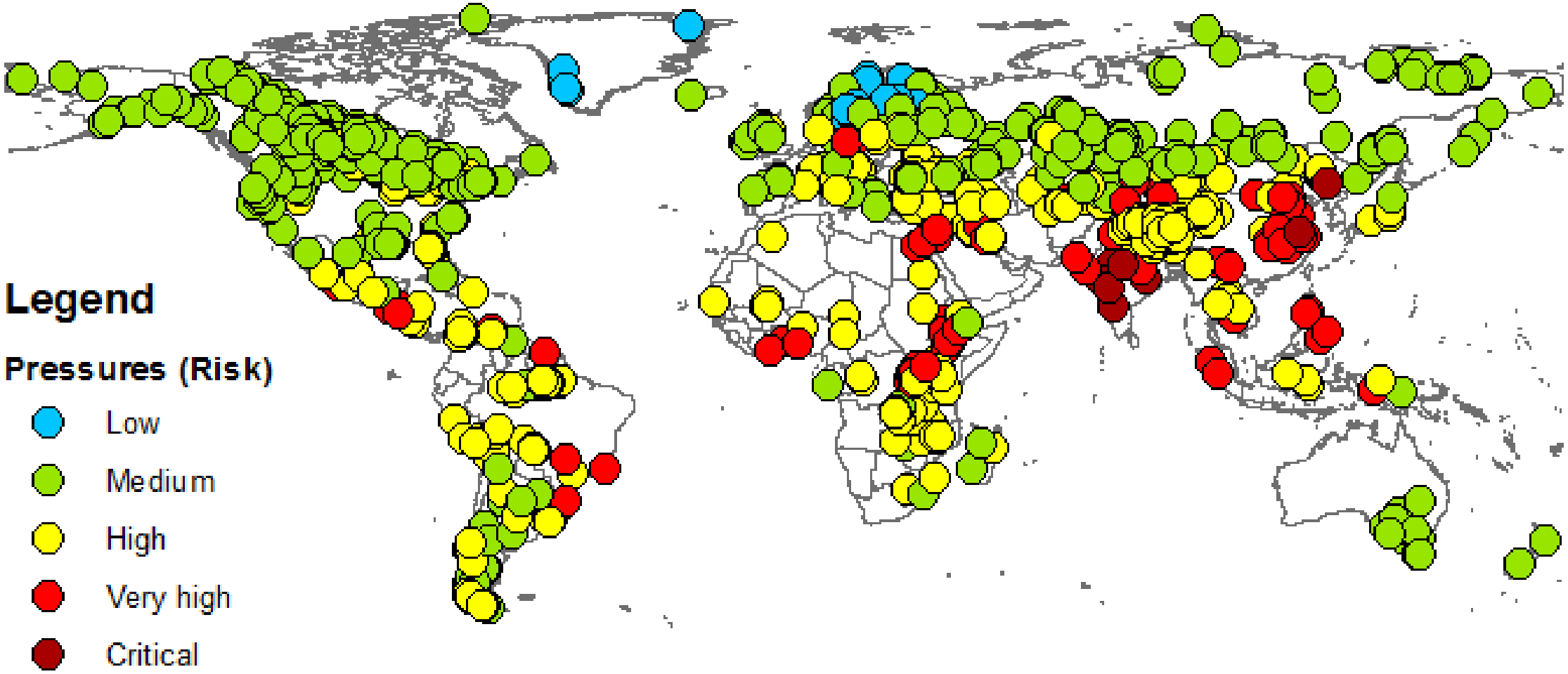
+ / -	Slow increase/decrease
++ / --	Fast increase/decrease
+++ / ---	Very fast increase/decrease
0	No change

RISK FACTOR

	SCORE	SCORE	SCORE	SCORE	SCORE
GloboLID	GDP per capita (2000-2012)	population density (2000-2015)	Land Cover 2010	Fertilisers (2002-2010)	Livestock (2000-2010)
2	++	-		+	+
3	++	++		++	+
4	++	++		++	++
5	+	+		+	+
6	+	+		+	+
7	++	+++		++	+
8	++	++		++	+
9	++	--		+	+
10	+	+++		+	+
11	++	++		+	+
12	+	+		+	+
13	++	++		+	+
14	++	+++			+
15	+	+		+	+
16	++	--		++	+
17	++	+		++	++
18	++	---		++	+
20	++	++		+	++
21	+	+++		-	++
22	++	+++		-	+
23	++	++		+	+
24	++	+++		+++	++
25	++	--		+++	++
26	+	++		+	+
28	++	-		+	+
29	+	--		-	+
30	++	+++		++	+
31	++	--		+	+
33	++	-		++	+
34	++	++		--	+++

Weighted average classified into five classes: low, medium, high, very high & critical

Lake Risk Factor



Lake vulnerability at global scales

Step 3: Integrate risk and sensitivity

Scoring approach:

Step 1: Current condition ("the present")

Low	Medium	High	Very high	No data

Step 2: Past trend (magnitude of change in last decade)

+ / -	Slow increase/decrease
++ / --	Fast increase/decrease
+++ / ---	Very fast increase/decrease
0	No change

RISK FACTOR

	SCORE	SCORE	SCORE	SCORE	SCORE
GloboLID	GDP per capita (2000-2012)	population density (2000-2015)	Land Cover 2010	Fertilisers (2002-2010)	Livestock (2000-2010)
2	++	-		+	+
3	++	++		++	+
4	++	++		++	++
5	+	+		+	+
6	+	+		+	+
7	++	+++		++	+
8	++	++		++	+
9	++	--		+	+
10	+	+++		+	+
11	++	++		+	+
12	+	+		+	+
13	++	++		+	+
14	++	+++			+
15	+	+		+	+
16	++	--		++	+
17	++	+		++	++
18	++	---		++	+
20	++	++		+	++
21	+	+++		-	++
22	++	+++		-	+
23	++	++		+	+
24	++	+++		+++	++
25	++	--		+++	++
26	+	++		+	+
28	++	-		+	+
29	+	--		-	+
30	++	+++		++	+
31	++	--		+	+
33	++	-		++	+
34	++	++		--	+++

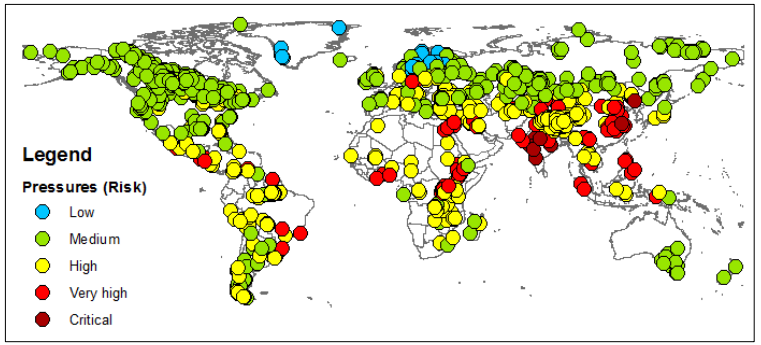
+

LAKE SENSITIVITY

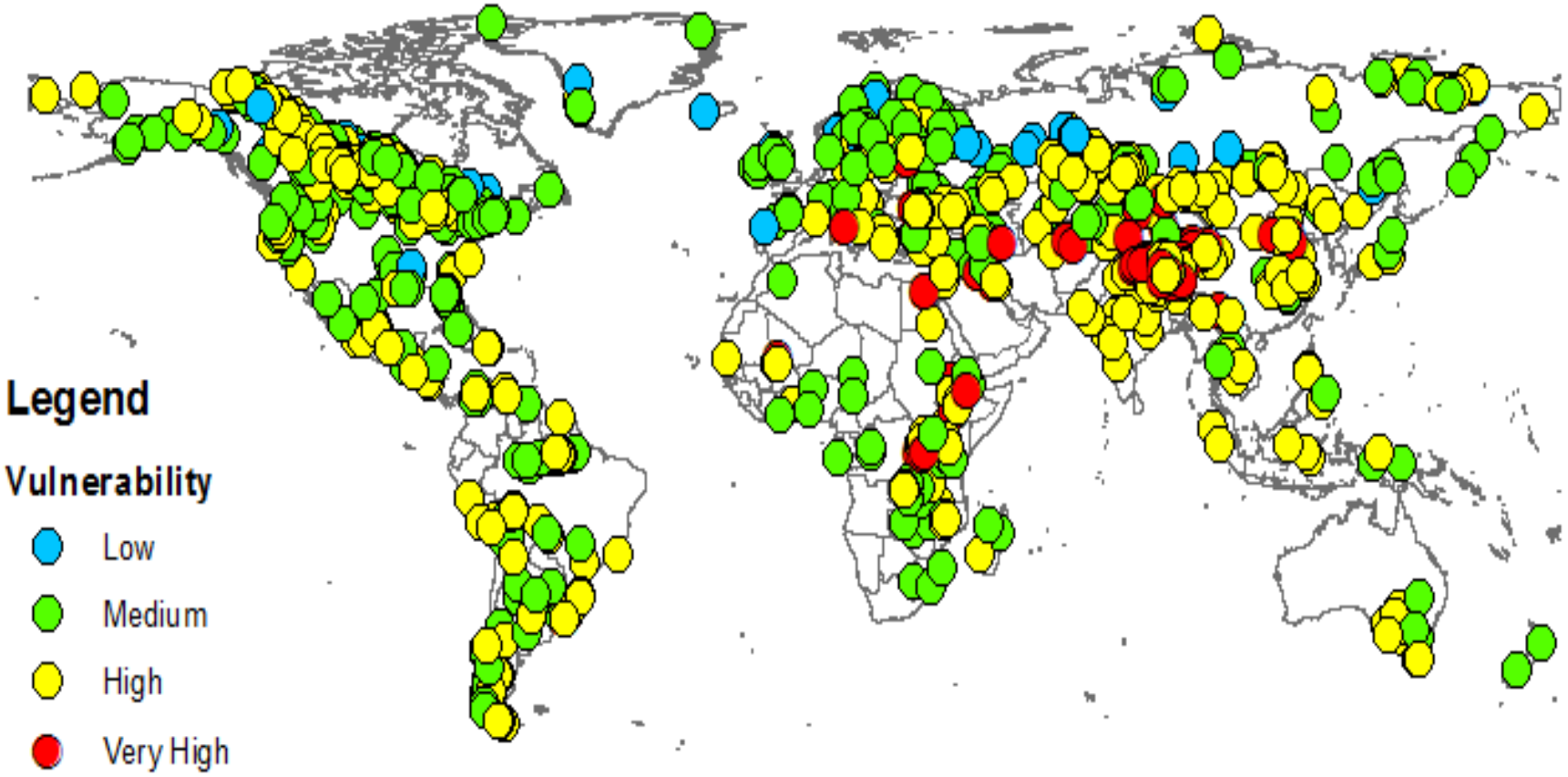
Zmean/Residence time ratio groups	Weighted Average - Vulnerability
4	3
3	3
1	2
2	2
3	3
3	3
3	2
4	3
3	3
2	2
2	2
2	2
1	2
2	2
2	2
4	3
2	2
4	4
4	3
2	3
2	2
2	3
4	3
3	3
3	2
2	2
2	3
4	3
1	2
1	2
2	2
2	2
4	3
2	2
2	2
3	3

Lake (risk and) vulnerability at global scales

Risk Factor



Lake vulnerability



Key Messages

- We have put together a lake / catchment database of lake properties and drivers of change
  - Global datasets
  - Sensitivity factors (lake properties) and climatic and terrestrial spatio-temporal variables
- Aim is to release this in an appropriate format to the community in due course

- Understanding patterns of lake vulnerability important for societal response and resilience to environmental change (especially in the context of SDGs)
- We have modelled lake vulnerability by analysing 'human pressure risk' and 'lake sensitivity'
- At an early stage, but:
  - Hot spots of lake vulnerability
- Requires integration with observed responses and analytical/empirical analysis…..more on that after lunch!

Thank you

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Lake vulnerability at global scales