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Comprehensive indicators for eutrophication in lakes

Let's improve water quality management and policy making!

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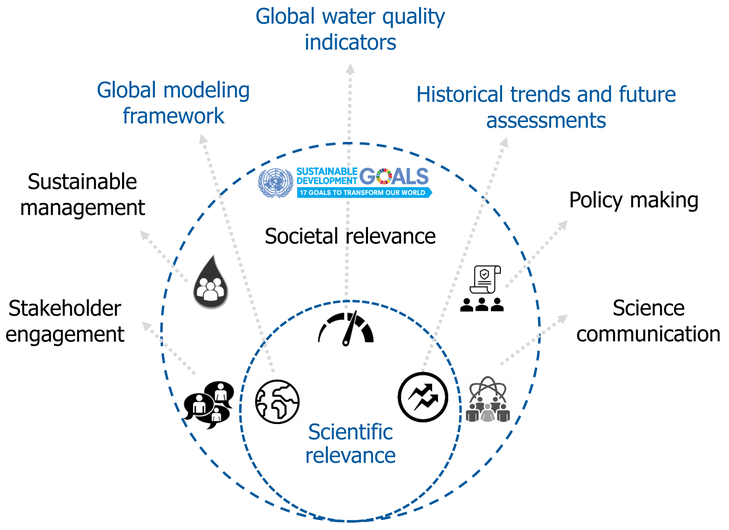
1) The issue is..

- Eutrophication → Increase in nitrogen and phosphorus → algal bloom, hypoxia, fish kills → ? water security
- Current monitoring → **quality within lake only** of e.g., total phosphorus, total nitrogen → not enough to explain the whole story of causes and effects.
- Input of nutrients to lake → **interact with climate, land use, hydrology, anthropogenic emissions** influence → response and extent of impacts.
- Monitoring data scarcity

2) Relevance..

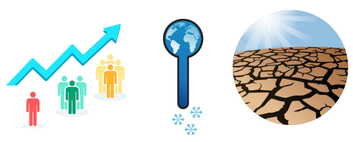


3) In this study..

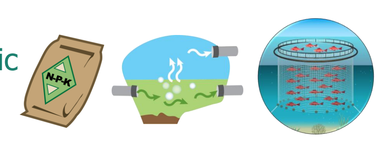
- Based on literature review, **synthesis of comprehensive indicators** for lake eutrophication using **d**rivers, **p**ressures, **s**tate, **i**mpact, **r**esponses (D-P-S-I-R).
- **Complex** cause-effect interactions of the indicators using the indicators of drivers and pressures.
- Why? To promote **holistic** assessments assessment and monitoring.

4) D-P-S-I-R indicators

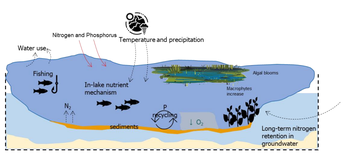
Activities (sources and sectors) causing nutrient enrichment
Drivers



Nutrient flows and pathways from specific sources
Pressures

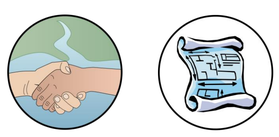


Physical, chemical, biological or ecological changes in lakes
States

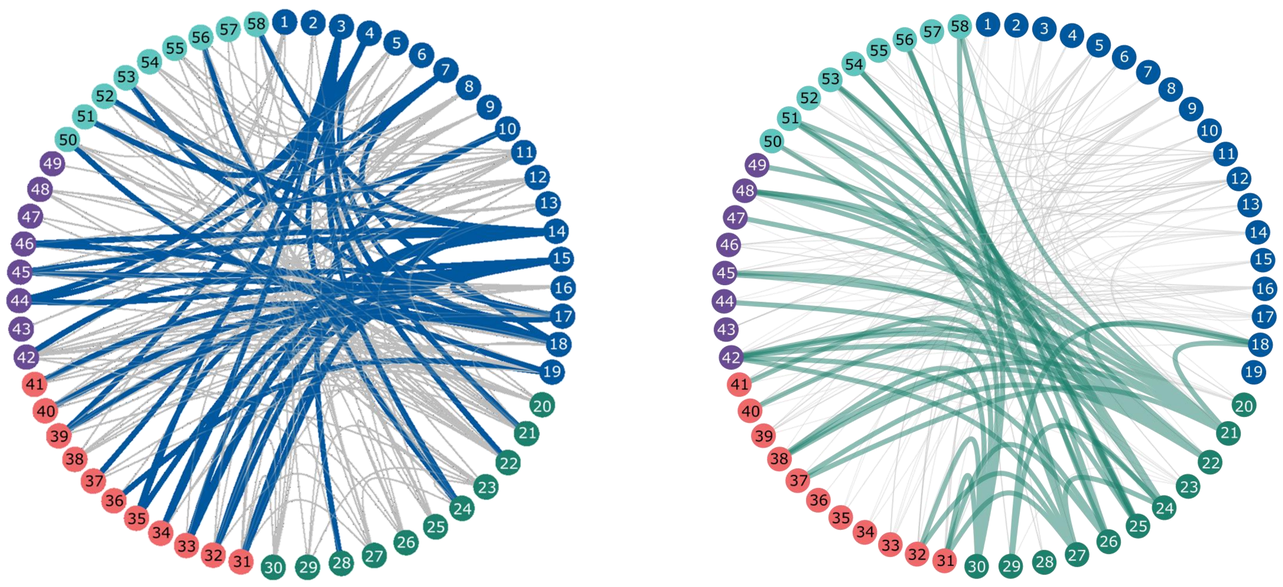


Effects on people and environment
Impacts

Actions of management, policy making to protect people and environment
Responses



5) Cause-effect interactions of drivers and pressures



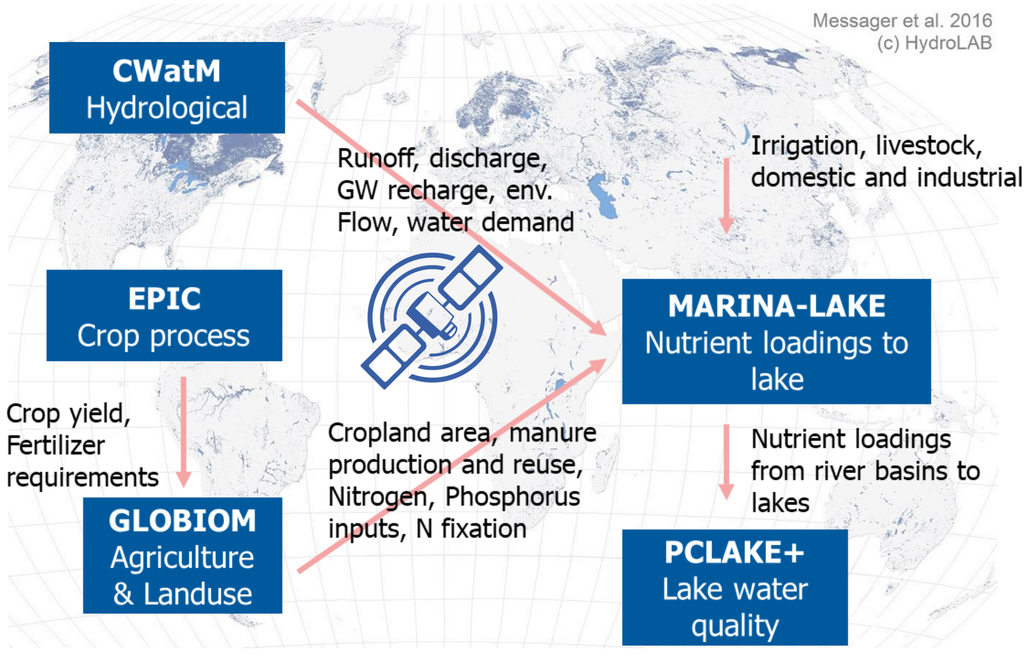
1. Temperature; 2. Precipitation; 3. Floods; 4. Droughts; 5. Population; 6. GDP; 7. Water use; 8. Crop yield; 9. Irrigation eff.; 10. Dietary pattern; 11. Fish catch; 12. Agri. Landuse (LU); 13. Urban land; 14. Natural land; 15. River connectivity; 16. Light available; 17. Residence time; 18. NP ratio; 19. Lake depth; 20. Land nutrient input; 21. Sanitation; 22. Wastewater treatment; 23. Fertilizer use(FU); 24. Soil NP surplus; 25. NP leaching 26. Groundwater(GW) nutrient storage; 27. FU eff. 28. Livestock density; 29. Atm. deposition of N; 30. Aquaculture effluent; Total- 31. N; 32. P; 33. carbon; 34. Sediments; 35. Water level; 36. Stratification; 37. Water transparency; 38. Oxygen depletion; 39. Macrophytes; 40. Phytoplanktons; 41. Zooplanktons; 42. Algal blooms; 43. Food security; 44. Water availability; 45. Water quality(WQ); 46. Ecosystem imbalance; 47. Recreational value; 48. Human health; 49. Fish kills; 50. WQ monitoring; 51. Soil management; 52. Conservation and restoration; 53. Agri. Management; 54. GW protection; 55. Education and awareness; 56. Regional directives; 57. LU policy and management; 58. Global actions like SDGs.

Key messages

- **Driver and pressure indicators can be proxies to monitor water quality status and impacts.**
- **Comprehensive indicators allow systematic understanding of nutrient dynamics and promote consideration of sources of emission.**
- **Fill the gap in water quality monitoring data, especially in the emerging economies of the world.**

Future research step is..

Integrated modeling framework to assess the indicators and response of lakes



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ASPIRE – Shared values to define what IIASA stands for

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