# Recent advancement in water quality indicators for eutrophication in global freshwater lakes

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## Introduction

Most of the current approaches **focus on in-lake monitoring** to assess eutrophication status in lakes, which is needed, but not enough to explain the story of causes and effects.

The feedback of anthropogenic influences that include **interactions of nutrient inputs** with climate, landuse, hydrology is necessary to evaluate trophic status and to set realistic water quality targets.
Indicators that represent these characteristics in a holistic way can **help to better understand** and monitor the responses and extent of impacts.

**Goal**: Synthesize the main indicators to improve mechanistic and holistic understanding of nutrient dynamics

**Research objective**: A new causal network to map the cause-effects and highlight the complex system interactions in lake basins

**Research objective**: Interdisciplinary overview of the influencing role of drivers and pressures using seven cross-cutting themes.

## Review method and D-P-S-I-R framework

Existing evidence of DPSIR studies to identify and categorize the potential indicators

Mapping the interactions of these indicators to form causal network instead of DPSIR causal chain

Review of nutrient-specific mechanisms for drivers and pressures to identify future research opportunities

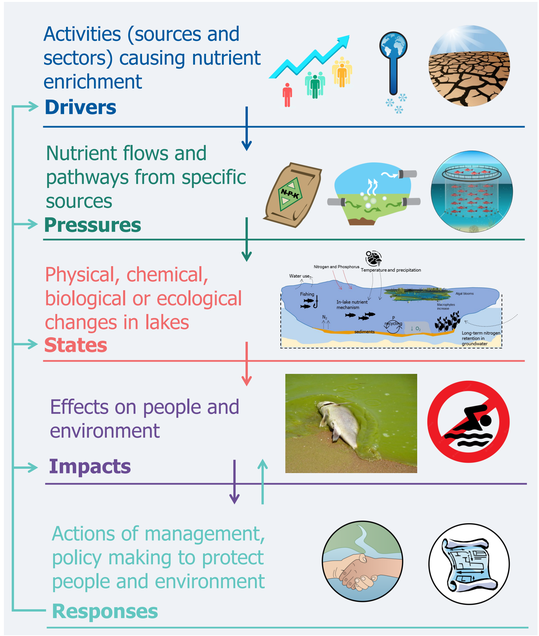


Figure 1: (left) Review method; (right) DPSIR conceptual framework for eutrophication. It was developed (EEA, 1999) to design integrated management solutions. Deliberation of interventions could either be to regulate drivers, pressures, states or impacts (solid lines from response) while D-P-S-I (solid lines) are one-way cause-effect chain.

## Causal network for drivers and pressures

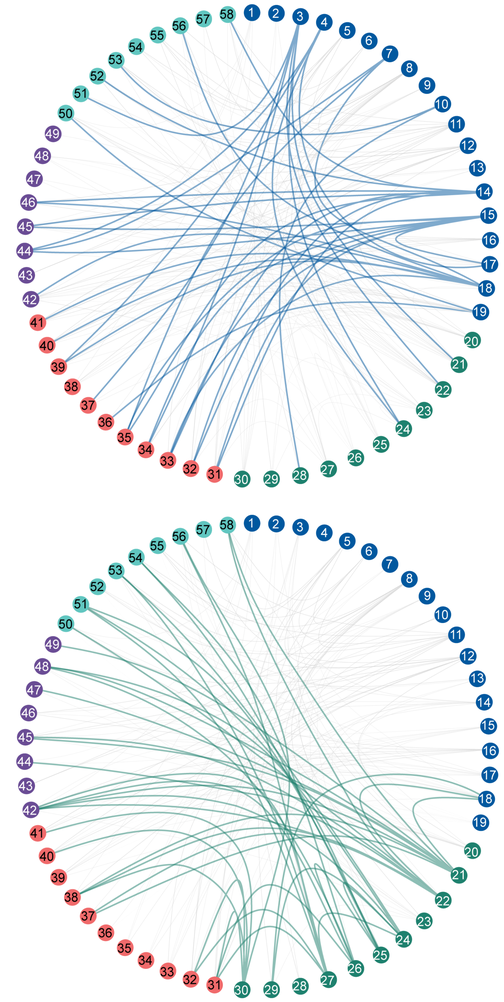

Figure 2: The new causal network of DPSIR framework with 58 selected indicators. (top) Highlighted network connections for selected drivers and (bottom) pressure indicators.

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.

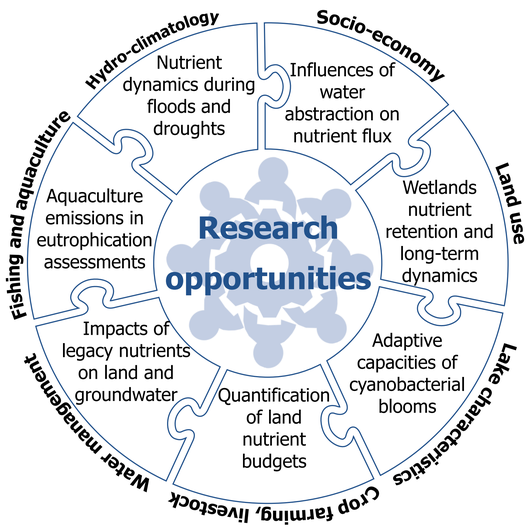


Figure 3: Highlights of research gaps categorized for the seven-cross cutting themes of driver and pressure indicators.

## Discussion

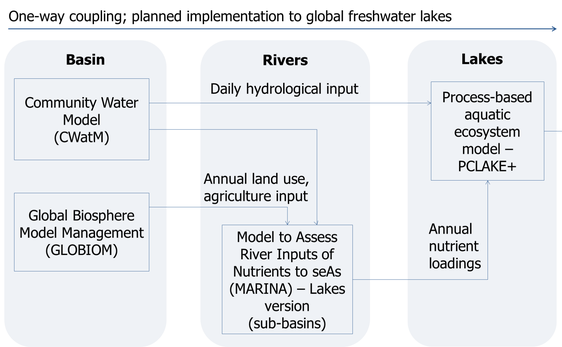


Figure 4: Integrated modeling framework to quantify the indicators and better understand the drivers and pressures causing impacts of global changes in freshwater lakes.

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**Abstract:**

This poster is based on accepted review article, "*Recent advancement in water quality indicators for eutrophication in global freshwater lakes" (Suresh et al)*

**ASPIRE – Shared values to define what IIASA stands for**

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