

Sustainability of lakes and reservoirs in relation to the Sustainable Development Goals (SDGs)

Long Ho^{1*}, Peter Goethals¹

¹ Department of Animal Sciences, Ghent University, Gent, Belgium

*Corresponding author. Email: Long.TuanHo@UGent.be

Abstract

Emerging global threats, such as biological invasions, climate change, land use intensification, and water depletion, endanger the sustainable future of lakes and reservoirs. To deal with these threats, a multidimensional view on the protection and exploitation of lakes and reservoirs is needed. This study provides a comprehensive review on the sustainable development lakes and reservoirs via a critical analysis on their contribution to the Sustainable Development Goals (SDGs) combining with bibliometric analysis. Common bibliometric indicators showed that the number of publications sustained a rapid growth rate with an increasing global interest from middle-income countries. Taking a closer look into research hotspots, management and policy were the main topics for reservoir systems in contrast to status in lake-related publications. This reflected the higher number of human interventions in man-made reservoirs, whose major purposes are to supply renewable energy and water resource. In fact, the number of published research on reservoirs design and operation, waterborne diseases, and emerging contaminants occupied around 20% of the total research on these water bodies. Instead, the impacts of eutrophication, heavy metals, pollutions, and climate change have become more severe in natural lakes with the increase of species extinction and biodiversity loss, leading to the urgent requirement for rehabilitation and restoration. In relation to the SDGs, the actions for achieving the sustainability of lakes and reservoirs have positive links with the SDGs related to environmental dimensions as they are mutually reinforcing each other. On the other hand, these actions have direct potential conflicts with the SDGs related to social and economic dimensions.

Keywords: Reservoirs; Lakes; Sustainable Development Goals;

1. Introduction

Natural lakes and artificial reservoirs cover only a small fraction of the earth's surface, around five million km². However, they largely contribute to the biogeochemical activities of freshwater on Earth despite being considered a minor element of the biosphere. New findings indicated their significant roles in global biogeochemical cycles, especially in terrestrial greenhouse gas balance as a result of their organic carbon storage, CO₂ and CH₄ emissions²⁻⁵. This role of small continental waters has received more appreciation in global processes which is contradictory with the traditional omission of these waterbodies from maps and lake registers⁶. Their major threats, closely linked to anthropogenic pressures, are land-use intensification, nutrient enrichment, hydrological modification, aquaculture, and fisheries. These pressures have caused habitat loss and degradation, eutrophication and pollution, food-web alteration, and physical degradation, in many inland water bodies. As such, this study investigates the interlinkages between the necessary implementation for achieving a better and more sustainable future of lakes and reservoirs and the actions in the framework of the SDGs. Moreover, a complete picture of their research hotspots and current will be investigated via a bibliometric analysis.

2. Results

2.1 Bibliographic analysis

To illustrate the whole picture of publications related to the sustainable development of lakes and reservoirs, three research lines were made, including (1) Status; (2) Ecosystem services; (3) Management and Policy (Fig. 1)

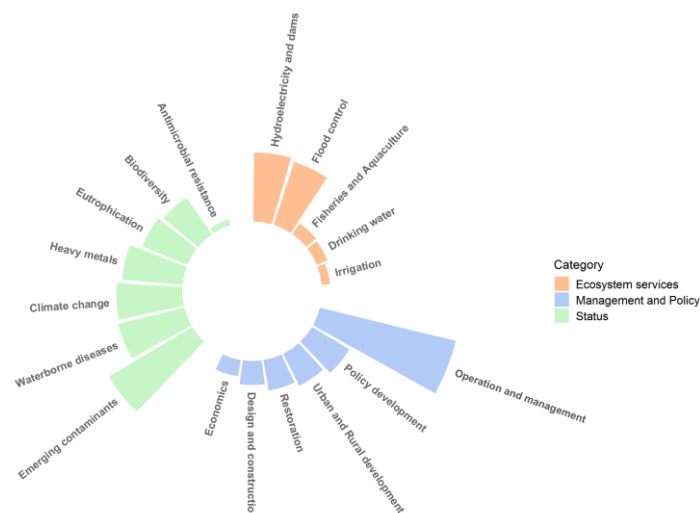


Fig. 1. The number of publications in three research lines with topics related to lakes sustainability from 2009 to 2018.

These three research lines cover 18 major research topics, which play important roles in their sustainable development. Regarding the status, a high number of publications has been dedicated to urgent issues in environmental and human health, i.e. emerging contaminants and water-borne diseases. Besides, biodiversity and climate change have been increasingly investigated in lakes in line with trends in species extinction and the global biodiversity crisis. Climate change's impacts on lake systems got more scientific attention during the past years. Eutrophication and heavy metals remain constant problems in these stagnant waters due to the long impact of intensive agricultural and industrial activities. Hydropower has attracted considerable attention from both studies to business areas, however, the eventual contribution of this renewable energy resource to the future clean energy are increasingly questioning. Besides flood control as a constant benefit of lakes from the ancient time, fisheries and drinking water are increasingly exploited as the growing needs from the expanded populations.

2.2 The interlinkages between lake sustainability and the SDGs

The 2030 Agenda for Sustainable Development is a plan of action for people, planet, and prosperity with a principal objective of leaving no one behind⁸. This Agenda contains 17 Sustainable Development Goals (SDGs), integrating the 5Ps: people, planet, prosperity, peace, and partnership (Fig. 2), which highlights the interdependence of the targets and the requirement of integrated and coordinated implementation of the goals⁹. Despite being not legally binding, the Agenda developed a Global Indicator Framework, which is being used in many countries to achieve their clean, green and sustainable future. Figure 2 shows the summary of the interlinkages between the necessary implementation for achieving a better and more sustainable future of lakes and reservoirs and the actions in the framework of the SDGs. Two types of interlinkages are concerned, i.e. synergy and potential conflict. While the synergic interlinkages demonstrate two actions sharing a mutually supportive relationship, potential conflicts indicate the potential trade-offs and/or constraints of two actions on each other.



Fig. 2. The summary of the contributions of lakes and reservoirs in support of the achievement of the SDGs

3. References

- 1 Verpoorter, C., Kutser, T., Seekell, D. A. & Tranvik, L. J. A global inventory of lakes based on high-resolution satellite imagery. *Geophys Res Lett* **41**, 6396-6402, (2014).
- 2 Cole, J. J. & Caraco, N. F. Carbon in catchments: connecting terrestrial carbon losses with aquatic metabolism. *Mar Freshwater Res* **52**, 101-110, (2001).
- 3 Sobek, S., Algesten, G., Bergstrom, A. K., Jansson, M. & Tranvik, L. J. The catchment and climate regulation of pCO₂ in boreal lakes. *Global Change Biol* **9**, 630-641, (2003).
- 4 Bastviken, D., Cole, J., Pace, M. & Tranvik, L. Methane emissions from lakes: Dependence of lake characteristics, two regional assessments, and a global estimate. *Global Biogeochem Cy* **18**, (2004).
- 5 Raymond, P. A. *et al.* Global carbon dioxide emissions from inland waters. *Nature* **503**, 355-359, (2013).
- 6 Downing, J. A. *et al.* The global abundance and size distribution of lakes, ponds, and impoundments. *Limnol Oceanogr* **51**, (2006).
- 7 Sanderson, E. W. *et al.* The human footprint and the last of the wild. *Bioscience* **52**, 891-904, (2002).
- 8 UN General Assembly. The 2030 Agenda for Sustainable Development. (2015).
- 9 OECD. *Measuring Distance to the SDG Targets 2017*. (2018).