Appendices

Opportunities and challenges for the sustainability of lakes and reservoirs in relation to the SDGs

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1. Supplementary Material A: Methodology of the bibliometric analysis

Data were extracted from the online database of the Science Citation Index Expanded (SCI-Expanded) which covers 11,655 outstanding journals across 234 research categories and 80 countries according to Journal Citation Reports 2018 (JCR). The data were collected on January 24, 2019, in the Web of Science from Clarivate Analytics. 65,000 document types were collected from 2009 to 2018. Since publications with topics on the sustainable development of lakes and reservoirs are very interdisciplinary and evolving, hence it is a matter of debate as to what should be included. We categorized these publications on three research lines, in which we further divided into 18 major research topics, which play important roles in the sustainable development of lakes and reservoirs. The details of the topics and their search query in the Web of Science can be found in Table S1. We identified the keyword queries for each research topic based on our expertise and previous bibliometric analyses whose topics are comparable [1-17]. Moreover, different keywords queries were applied for lakes and reservoirs to distinguish the studies on lakes from the studies on reservoirs and small lakes.

Table S1. Research topics and their search query in the Web of Science. The search query in each research topic is combined with the search query for lakes or reservoirs to search the publications in that research line under the context of lakes or reservoirs, respectively.

Research lines	Topics	Search queries in the Web of Science	References
Lakes		TI =(Lake*) NOT TI=(("small lake*") OR ("shallow lake*"))	
Reservoirs		TI =(Reservoir* OR Pond*) NOT TI=((petroleum*) OR (oil*) OR ("gas reservoir*")) OR TI=(("small lake*") OR ("shallow lake*")) Refined by: **[excluding]: Organizations-Enhanced**: (China University of Petroleum OR United States Department of Energy DOE OR China National Petroleum Corporation OR Southwest Petroleum University OR Universidad Nacional Autonoma De Mexico OR Sinopec OR Exxon Mobil Corporation OR IFP Energies Nouvelles) AND **[excluding]: Web of Science Categories:** (Energy Fuels OR Engineering Petroleum)	
Management and Policy	Operation and maintenance	TI = (monitor* OR control* OR supervi* OR operat* OR manage* OR maintain* OR maintenance* OR "operating manual*"OR diagnos* OR interven*)	Ho, Van Echelpoel and Goethals [17]
	Policy development	TI=(polic* OR govern* OR decis* OR feder* OR institu* OR polit* OR decision-mak* OR "decision mak*" OR decisionmak* OR articl* OR interest* OR issu* OR DPSIR OR policymak* OR regulat* OR law* OR guideline* OR strateg* NOT retraction*)	Hassan, Haddawy and Zhu [13]
	Economics	TI= (cost OR costs OR market* OR pric* OR invest* OR investment* OR financi* OR compan* OR profit* OR privat* OR sector* OR stock* OR incooperat*) NOT TI =(investigat*)	Hassan, Haddawy and Zhu [13]
	Urban and rural development	TI = (urban* OR suburban* OR city OR cities OR metropolitan* OR rural*)	Hassan, Haddawy and Zhu [13]
	Restoration	TI = (restor* OR repair* OR renov* OR reconstruct* OR rehabi* OR recondition* OR redecorat* OR rebuild* OR refurbish*)	Sondergaard and Jeppesen [18]
	Design and construction	TI = (design* OR construct* OR build* OR built * OR seal* configurat*)	Ho, Van Echelpoel and Goethals [17])
Status	Emerging contaminants	TI =(pharmac* OR medicin* OR "personal care*" OR "endocrine disrupt*" OR pesticid* OR perfluorinat* OR sweeten* OR drug* OR "flame retardant*" OR "corros* inhibit*" OR plastic* OR surfactant* OR microplastic* OR (nano* AND (pesticide* OR fertilizer*)) OR steroid* OR "food additive*" OR preservative* OR "metabolic	Zhao, Deng, Sun, Liu, Ji, Nakada, Qiao, Tanaka and Yang [1], Qian, He,

		regulator*" OR detergent* OR antioxidant* OR "industrial compound*" OR caffeine* OR nicotine* OR antibiot* OR (emerging* AND (contamina* OR pollut*)))	Song, Tysklind and Wu [2]
	Climate change	TI= ("climate change"* OR "global warming"* OR "climate variab"* OR "climate warming"* OR "kyoto protocol"* OR "paris agreement" OR palaeoclimat* OR "climate policy"* OR ("carbon sequestration"* AND climat*))	Wang, Pan, Ke, Wang and Wei [3]
	Eutrophication	TI = (eutrophic* OR (enrich* AND (mineral* OR nutrient* OR nitrogen* OR phosph*))	Vincon-Leite and Casenave [4], Yao, Zhang, Zhang and Zhou [6]
	Heavy metals	TI= ("heavy metal*" OR mercury* OR lead* OR cadimum* OR copper* OR chromium* OR nickel* OR arsenic* OR manganese* OR cobalt* or zinc* OR selenium* OR silver* OR antimony* OR thallium*)	Tchounwou, Yedjou, Patlolla and Sutton [5]
	Biodiversity	TI = (biodivers* OR diversit*) OR SO = ("Biodiversity and Conservation" OR "Systematics and Biodiversity" OR "Biological Conservation" OR "Conservation Biology" OR "Journal of Soil and Water Conservation" OR "Resources Conservation and Recycling")	Liu, Zhang and Hong [8]
	Antimicrobial resistance	TI = (beta-Lactamases* OR Carbapenemas* OR “Imipenem-hydrolyzing beta-lactamase” OR “beta-lactamase*” OR “Methicillin Resistan*” OR “Vancomycin Resistan*” OR “Fluoroquinolone-resistan*” OR “ciprofloxacin-resistan*” OR “Fleroxacin-resistan*” OR “Enoxacin-resistan*” OR “Pefloxacin-resistan*” OR “Ofloxacin-resistan*” OR “Norfloxacin-resistan*” OR “Drug Resistan*” OR Tetracyclines* OR “Penicillin Resistan*” OR “Tetracycline Resistan*” OR “Erythromycin resistant” OR “Erythromycin-resistant” OR “Erythromycin resistance” OR “Erythromycin-resistance” OR “Methicillin Resistan*” OR “Vancomycin Resistan*” OR “Gentamicin resistant” OR “gentamicin-resistant” OR “gentamicin resistance” OR “Gentamicin-resistance” OR “levofloxacin resistant” OR “levofloxacin-resistant” OR “levofloxacin resistance” OR “levofloxacin-resistance” OR “linezolid resistant” OR “linezolid-resistant” OR “linezolid resistance” OR “linezolid-resistance” OR “ESBL” OR “extended spectrum beta-lactamase” OR “extended spectrum beta lactamase” OR “extended spectrum β-lactamase” OR “Cephalosporin Resistance”)	Brandt, Makarewicz, Fischer, Stein, Pfeifer, Werner and Pletz [10]

	Waterborne diseases	TI=(disease* OR ill* OR outbreak* OR epidem* OR erupt* OR contagi* OR infect* OR plague* OR coli* OR diarrhoea* OR diarrhea* OR cancer* OR virus* OR sick* OR syndrome* OR endemic* OR pathogen* OR hygien*)	Sweileh, Zyoud, Al-Jabi, Sawalha and Shraim [9]
Ecosystem services	Drinking water	TI=(drink* OR tap* OR "potable"* OR "human consum"*)	Sweileh, Zyoud, Al-Jabi, Sawalha and Shraim [9]
	Hydroelectricity and dams	TI = (hydropower* OR hydroelectric* OR "hydro power*" OR dam* OR weir* OR embankment* OR dike* OR ditch* OR wall* OR barrier* OR levee* OR bank*)	Jiang, Qiang and Lin [14], Ding, Chen, Ding and Tao [15]
	Fisheries and aquaculture	TI = ((fish* AND yield*) OR (fish* AND harvest*) OR (fish* AND sustainab*) OR (fish* AND stock* OR aquacultur* OR aquafarm*))	Jaric, Cvijanovic, Knezevic-Jaric and Lenhardt [12], Nikolic, Bagliniere, Rigaud, Gardes, Masquilier and Taverny [11]
	Flood control	TI = (flood* OR deluge* OR glut* OR tsunami* OR wave* OR tide* OR rain OR rains OR downpour* OR torrent* OR typhoon* OR hurricane* OR storm* OR tornado* OR cyclone*)	Emmer [16]
	Irrigation	TI = (irrigat*)	

2. Supplementary Material B: Overview of indirect interlinkages between the sustainable development of lakes and reservoirs and the SDGs

Table S2. Overview of indirect interlinkages between the sustainable development of lakes and reservoirs and the SDGs

SDGs	Type of the interlinkages	Roles of lakes and (hydropower) reservoirs	Impact of potential actions on lake sustainability
SDG 4-Quality education	Indirect synergy	• Clean water access via lakes and reservoirs is needed for increasing the chance for better education of children in developing countries [19]. • The study of Nauges and Strand [20] found that by reducing the time of collecting water, a higher number of girls can attend school. • Furthermore, water pollution creating health problems for young children can cause a major obstacle for children to get proper education due to their absence and decrease in cognitive abilities [21].	• Good educational quality can promote active future engagement in biodiversity conservation and waste management due to higher knowledge, attitudes, and skills of trained students. • Alexandar and Poyyamoli [22] shows the benefits of the active teaching-learning approach to sustainable development via an experiment in an Indian school. • A better education system can be important for the sustainability of lakes and reservoirs in the long term.
SDG 5-Gender equality	Indirect synergy	• **Women and girls are considered "water haulers" of the world** as women spend a combined total of at least 16 million hours each day collecting drinking water according to UNICEF [23]. This greatly reduces the time of productive work and school hours, leading to a bigger gap in gender equality in many places [24]. • water availability from freshwater bodies can contribute to reducing the uneven burden and high risk of maternal mortality and sexual harassment on women.	• The impact of the actions for achieving SDG 5 may generate some minor indirect impacts on the development of lakes and reservoirs. • For example, higher gender equality means a better education for girls and women, which can lead to their higher awareness of environmental protection, which eventually benefits the well-being of lakes and reservoirs' ecosystems [21].
SDG 9-Industry, innovation and infrastructure	Indirect synergy	• Lakes and reservoirs are a natural buffer against the increasing number of natural disasters as the role of lakes and reservoirs to the achievement of SDG 9.	• The increase of cleaner technology using less energy and more efficient water use means their less dependence on water availability in lakes and reservoirs. • To protect water resources, United Nations Industrial Development Organization (UNIDO) includes building capacity in the industrial sector to improve water productivity, reuse, and recycling, as well as the adoption of the ecosystem approach and the

			sustainable use of its living resources at the institutional level [25].
SDG 10- Reduced inequalities	Indirect synergy	• In support of target 10.1, the income growth of the bottom 40 percent of the population can be achieved by exploiting substantial benefits from the ecosystem services of lakes and reservoirs in a sustainable and holistic approach. • Fairtrade from the products deriving from lakes and reservoirs among and within countries can free that millions of the world's poorest citizens languish in undeserved misery [25].	• The large portion of untreated wastewater discharge mostly happens in developed countries with rapid population growth and low standards of living [26]. As such, the promotion of reducing inequality among and within nations can lead to healthier water quality and ecosystems in lakes and reservoirs in the developing world.
SDG 11- Sustainable cities and communities	Indirect synergy and potential conflict	• Target 11.1: Inland water bodies provide substantial water resources and economic benefits, which are essential to achieve "safe and affordable housing and basic services and upgrade slums". • Targets 11.5 and 11.6: The resilience of these water storage systems, which can serve as flood control and drought prevention, is able to "reduce the adverse per capita environmental impact of cities" [27].	• Better planning for sustainable urbanization (target 11.3), protecting natural heritage (target 11.4), and supporting positive environmental links between urban, peri-urban, and rural areas (target 11.a) can be indirectly beneficial to reduce the anthropogenic pressures on lakes and reservoirs. • However, it is important to keep in mind a potential conflict of providing sufficient means including water access to achieve the first target 11.1 can lead to water overexploitation in lakes and reservoirs.
SDG 12- Responsible consumption and production	Indirect synergy	• The role of lakes and reservoirs are directly limited to achieve this SDG. • However, its significant linkages with energy (SDG 7), food (SDGs 2 and 14), climate change (SDG 13), life on land (SDG 15), and water (SDG 6) can affect environmental changes which can fasten the responsible consumption and production [28,29]	• By promoting a healthy consumption and production in the 'circular economy', the SDG aims to minimize the negative impacts of mass production on the environment and human health [30]. As a result, fewer pollutants and more efficient resource use will be beneficial to the preservation of lakes and reservoirs.
SDG 16- Peace, justice and strong institutions	Indirect synergy	• Violence related to water is not as rare as the lack of assessing water can fuel conflict and threaten peace and stability [31]. It is estimated that 1.8 billion people will suffer from water shortage in 2025. Besides, to feed the growing population, it is predicted that agricultural	• Corruption is at the core of the governance crisis in the water sector. According to the World Bank [34], 20% to 40% of water sector finances were lost to corruption and bribery. Around 800 million people lived without proper sanitation services and one-fourth of them

		activities must increase by 70% by 2050, leading to much higher demand for irrigation water which already accounts for about 70% of the world's freshwater withdrawals [32,33]. • As such, advancing the water quantity and quality can reduce the violence and conflict between parties sharing water resources, which is the aim of the target 16.1 defined as "Significantly reduce all forms of violence and related death rates everywhere".	lacked treated drinking water in South Asia whose many countries ranked in the lowest quartile of Transparency International's Corruption Index (2001) [35]. • Target 16.5 ("Substantially reduce corruption and bribery in all their forms") will improve the transparency and effectiveness of water governance.
SDG 17-Partnership for the goals	Indirect synergy	• Recently, there has been an increase in international conflicts over freshwater resources, especially related to hydropower dams [36,37]. New HPs can lead to significant modifications at the downstream of a river, hence, creating potential conflicts between different regions [38]. • As such, the sustainable development towards eco-friendly small HPs can reduce these tensions and would be beneficial for energy, water, and environmental security [39].	• Many lakes located at the borders of multiple countries, such as Aral Sea, Lake Michigan–Huron, Lake Victoria, Lake Tanganyika, and Lake Superior. To have comprehensive management of these inland water bodies, partnerships between different countries are needed. • The scientific cooperation North-South, South-South, and triangular cooperation can be very beneficial for all participants (targets 17.1, 17.2, 17.6, and 17.9).

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