Supplementary S4 to "Impounding reservoirs – benefits and risks"
Extended summary of scientific publications on water quality in reservoirs

Research paper	Size of the reservoir under analysis	Study area	Result
C4.1 - Reservoir water quality			
[96]	12 reservoirs, mostly with a large capacity.	Based on a study of the type and land-use changes of the catchment areas of 12 reservoirs in China, changes in selected water quality parameters were analysed for the years 2005, 2010 and 2015.	Degradation of "ecological" land, mainly through development, was shown to have a significant impact on the increase in chemical oxygen demand and nitrogen and phosphorus concentrations, as well as the decrease in dissolved oxygen in the water of the study reservoirs. Based on redundancy analysis, land degradation was found to explain up to 58.6% of water quality changes in the reservoirs.
[97]	A reservoir with a large capacity.	Based on data from 1990 to 2020 collected using remote sensing and Geographic Information Systems (GIS), land use changes and their impact on the water quality of Los Molinos Reservoir (the Argentine) were assessed.	The study region showed a significant trend of growth in agricultural and urbanised areas. The built-up area in the immediate vicinity of the reservoir grew at 18.02% per year between 2010 and 2020, and at the end of this period represented 30.71% of the area within 1 km of the site boundary. Agricultural land in this area was estimated at 46.40%, and the development changes taking place are correlated with the deteriorating water quality of the reservoir and the increased incidence of eutrophication.
[98]	5 reservoirs with a small capacity.	The publication presents water quality studies of five small reservoirs in forested areas in Poland. The total area of these sites is approximately 0.93 ha. Water samples were taken twice in December 2014 and May 2015.	The study indicated that small reservoirs in forest-dominated catchments exhibit good water quality parameters, especially concentrations of nitrates, nitrites, dissolved oxygen, chemical oxygen demand (COD), electrolytic conductivity and total hardness. These parameters qualify the studied sites for the highest surface water quality class according to Polish law.
[99]	A reservoir with a large capacity.	This publication describes a study of the effect of phosphorus release rates from bottom sediments in Euiam Reservoir (South Korea) on eutrophication. A three-dimensional hydrodynamic model based on data from a field experiment was used.	Based on nutrient concentration estimates and modelling results, it was shown that increased phosphorus release from bottom sediments significantly intensifies algal growth, which may result in a prolonged eutrophication event in spring or autumn.
[100]	A reservoir with a large capacity.	Based on a physico-chemical study carried out for the Ridracoli potable water reservoir (Italy), the frequency of the stratification process as a result of seasonal temperature changes and its impact on water quality was assessed.	Stratification was found to occur only during the months of August to November, when the volume of water collected is lowest. Stratification has been shown to cause unfavourable mobility of heavy metals, particularly iron and manganese, and an increase in nitrogen concentration, which translates into the quality of water going to treatment generating higher costs for the process.
[101]	A review article based on a large dataset.	Based on an analysis of scientific sources and media reports, the geographical	Algal blooms were found to occur in all areas and climatic zones of Russia. Cyanobacteria were identified as the algae most frequently occurring in freshwater continental reservoirs.

		distribution of surface waters in Russia for which eutrophication occurred in 2016–2018 was determined.	For such a broad spectrum of studies, no significant correlation was identified between the occurrence of eutrophication and population, area of agricultural and livestock land or average temperature in the region.
[102]	A reservoir with a large capacity.	The publication describes a combination of laboratory, field, and remote sensing studies to monitor cyanobacterial blooms in Occhito Reservoir (Italy). The spatial distribution of cyanobacteria in the reservoir and in the irrigation system below the dam cross-section was assessed.	It was found that Planktothrix rubescens has good conditions to thrive in the studied reservoir, however, outside its environment the population is reduced in correlation with the distance from the site. The importance of the synergy of the different survey methods was highlighted. However, it was noted that the methodology adopted can only be used for other reservoirs in a general scheme and the algorithms need to be redefined depending on the individual site environment.
[103]	A reservoir with a large capacity.	A three-dimensional hydrodynamic model coupled to a water quality model was used to assess the ecological potential of the Sulejów Reservoir (Poland). Data for the model came from two submerged probes, and an instrument measuring the velocity of water current movement–Acoustic Doppler Current Profiler (ADCP)–was used to calibrate the model.	A relatively small (max. 15%) error in the water velocity results obtained by the model was confirmed from the field tests. The highest algal blooms were observed in the summer months, when chlorophyll concentrations reached 0.02 mg/L, which was correlated with high water temperatures (above 25°C). The model assumed a scenario of a 50% reduction in biogens influx from agricultural land and septic tanks. It was shown that the actual implementation of such measures would significantly reduce the risk of eutrophication in the reservoir.
[104]	A reservoir with a very large capacity.	The publication reviews methods for assessing eutrophication potential in surface waters, with the aim of isolating an optimal and effective methodology for water quality analysis given the type of site under study.	Three groups were identified: natural lakes, rivers, and wetlands and artificial reservoirs. For the latter, it was suggested to use a Trophic State Index (TSI) method focusing on the comparison of water quality between the study water and its water functional area. It was pointed out that innovative monitoring tools such as remote sensing and unmanned survey vessels should also be used in research.
[105]	A reservoir with a very large capacity.	To assess the total organic carbon contamination of Danjuangkou Reservoir (China) water, 19 surface water sampling sites surveyed quarterly from 2020 to 2021 were determined. A Generalised Additive Model (GAM) was used to spatially analyse the results.	The spatial distribution of total organic carbon (TOC) concentration was found to be seasonally dependent, and there was a significant correlation with the value of other water quality parameters. Environmental factors influencing total organic carbon concentration were water temperature, nitrogen, phosphorus, and chlorophyll concentrations. The organic carbon concentration parameter has been identified as a key parameter in the water quality management of a water body for domestic use.
[106]	A reservoir with a very large capacity.	Twenty sampling sites were mapped to determine the concentration and spatial	The results indicated that the movement of water in the reservoir has a significant impact on the distribution of biogenic substances, causing their high accumulation mainly in the

		distribution of biogens and heavy metals in the sediments of the Suyahu Plain Reservoir (China).	northern part of the reservoir. Heavy metals, on the other hand, accumulate mainly in the middle of the reservoir in the upper sediment layers. Cadmium and mercury were identified as elements accounting for almost 80% of the value of total metal pollution.
[107]	A reservoir with a large capacity.	Heavy metal contamination of the Sablan reservoir (Iran), a source of potable water, was studied. Different scenarios/locations of water intake were adopted to determine its daily consumption and carcinogenic consequences.	The water and sediments of the reservoir were found to be heavily contaminated with arsenic as a potential carcinogen. Due to the uneven distribution of concentrations of this element, as well as other metals, the location of the water intake was identified as key to reducing the risk of disease–the deeper, the greater the risk.
[108]	A review article based on a large dataset.	This paper reviews and meta-analyses publications on studies of microplastic contamination of retention reservoirs. A total of 440 samples from 43 sites from around the world were analysed.	The presence of microplastics in the reservoirs was found to vary greatly and depended primarily on the geographical location and land use of the catchment. In addition, a different type of microplastic floated in the water than was deposited in the bottom sediments, and about 60% of all elements were < 1 mm in size. It was also pointed out that reservoirs in Asia are most at risk, and there is a lack of appropriate regulation to mitigate the scale of this pollution.
C4.2 - Impact on river water quality			
[109]	A reservoir with a small capacity.	The impact of the small reservoir Komorów (Poland) on selected water quality parameters in the watercourse below the dam was analysed based on samples taken once a month during the year.	A high level of biogenic pollution was found along the entire stretch of the study river, while the reservoir had no significant effect on nitrogen concentrations. Regardless, the results indicated a favourable effect of the reservoir on the increase in dissolved oxygen concentrations, the reduction in total phosphorus content and the temperature regulation in the watercourse below the dam compared to the readings for the tributary.
[110]	4 reservoirs with a small capacity.	The effect of stormwater inflow on benthic macroinvertebrates occurring in the Cybina River (Poland) and four small reservoirs located along its course was studied. Benthos samples were taken four times a year between 2009 and 2010.	In the catchment area of the studied watercourse and reservoirs, a high proportion of residential and industrial areas were found. The influx of stormwater, a source of heavy metal and organic matter pollution, caused intense changes in the abundance and proportion of benthic macroinvertebrate species. Species were characterised by varying degrees of resilience, with those in the reservoirs being more vulnerable than those in the river. The reservoirs were effective in retaining pollutants by improving the water quality of the watercourse.
[111]	A reservoir with a small capacity.	The publication investigated selected physico-chemical parameters of water in the tributary, in Michalice Reservoir (Poland) and below the cross-section of the	The results indicated slight differences in some water quality parameters at the study locations. Below the dam cross-section, higher concentrations of PO_4 and NH_4 and higher water turbidity were found compared to samples below the hydroelectric power station.

		dam equipped with a hydroelectric power station.	
[112]	A review article based on a large dataset.	Using a mathematical model that considers the biogeochemical transformation of phosphorus in reservoirs, the global impact of reservoirs on phosphorus transport in drainage systems was estimated.	Based on the calculations carried out, it was concluded that the total amount of phosphorus stored in retention basins increased significantly over the period 1970–2000 reaching a value of 12% of the total phosphorus in inland surface waters. An increase to 17% of this value was estimated for 2030. The amount of phosphorus retained was shown to decrease with the residence time of the water in the reservoir.
[113]	A review article based on a large dataset.	A literature review of 54 large reservoirs located at low latitudes was carried out, with a focus on stratification and sedimentation phenomena as factors influencing changes in water quality.	Stratification has been found to occur at least seasonally in all of the reservoirs studied, resulting in the introduction of hypoxic and cooler deep ocean water into the river, negatively affecting the physico-chemical parameters of the water downstream of the dam cross-section. In addition, sediment retention may result in environmentally damaging oligotrophication of the lower reaches of the river..
[114]	A reservoir with a very large capacity.	Using the example of the large Ferreira Gomes reservoir (Brazil), the effect of filling the facility on parameters characterising water quality in the reservoir and in the watercourse below the dam cross-section was studied.	The point immediately downstream of the dam cross-section was identified as an ecologically vulnerable area. The greatest spatial variability was for dissolved oxygen, and exceedances of permitted standards were noted for coliform bacteria, pH, and water colour. It was concluded that the increase in the presence of coliform bacteria could be caused by the discharge of waste water from residential areas. Overall, the site has relatively good water quality due to the hydrological conditions and the short residence time of the water in the reservoir.
C4.3 - Methods to improve water quality			
[115]	A reservoir with a small capacity.	Using literature sources and data on water quality parameters in the Paprocany reservoir (Poland), as well as using 3D modelling, an analysis of the potential for improving the ecosystem condition of the study site was carried out.	The poor state of water quality in the reservoir was found to be mainly influenced by the highly urbanised catchment area, the influx of highly saline water from coal mines and high concentrations of biogenic elements. Reducing the residence time of water in the reservoir, restoration of the existing 19th century water treatment plant and restoration/revitalization of wetlands and reed beds were identified as possible remedial measures.
[116]	A review article based on a large dataset.	The publication reviews the effectiveness of using artificial floating islands to remove pollutants from surface water and the remaining potential of these structures.	Based on the studies analysed, the significant potential of artificial floating islands in terms of reducing various types of pollution has been identified. If sustainably managed and equipped with an individual energy source, the islands could have a wide range of applications depending on the needs of the site and the region. However, the need for larger-scale field studies and the impossibility of adopting one-size-fits-all solutions was highlighted.
[117]	A reservoir with a small capacity.	Changes in water quality in Lake Raczyński (Poland) were analysed after	A decrease in chlorophyll, nitrogen and an overall increase in oxygenation and water transparency was observed. Cyanobacteria abundance was determined to be

		two years of measures in the form of chemical phosphorus inactivation and a reduction in the number of cyprinid fish with the simultaneous introduction of predatory species.	approximately twice as low. It was noted, however, that a reduction in the number of phosphorus inactivation treatments resulted in a rapid deterioration of the parameters studied. Therefore, a period of two years was considered too short for effective and sustainable results of water quality improvement and sustainable land restoration.
[118]	A reservoir with a large capacity.	The application of the Water Quality Improvement Installation ("WOPR"), based on the removal of biogenic compounds thanks to ion exchange resins, was assessed and its impact on the water quality of a section of the Turawa reservoir (Poland) was analysed.	The WOPR was found to have a significant effect on improving water quality in the study area, resulting in average reductions in nitrate nitrogen and phosphate phosphorus concentrations of 39.54% and 55.12%, respectively. The possibility of using this technology for local purification of water from biogenic compounds, e.g. in tourist and recreational areas, was indicated.
[119]	A reservoir with a small capacity.	The publication presents changes in the water quality of the Pławniowice reservoir (Poland) over a period of eight years as a result of deoxygenated hypolimnion discharge technology.	During the study period, there was a significant reduction in the concentration of orthophosphate and ammonium nitrogen in the hypolimnion of the reservoir. In addition, the rate of enrichment of the waters with these biogenic compounds also decreased. It was estimated that the phosphorus abundance of the reservoir decreased by 28 Mg and the average pH was reduced from an unfavourable 9.3 to 8.22. This method was indicated as being of low cost and applicable primarily to smaller reservoirs.
[120]	A reservoir with a small capacity.	The water quality of the Mściwojów (Poland) reservoir, which has an initial (pre-dam) reservoir with aquatic vegetation that absorbs biogenic compounds from the water flowing into the main facility, was studied. Seven sampling points were established between 2006 and 2008.	The size of the initial reservoir, is 14 ha, which is about 40% of the main reservoir. The results of the study indicated a significant impact of the initial reservoir on the water quality below it. Compared to the values at the tributary, the concentration of various forms of nitrogen decreased between 62.9 and 69.9%, and phosphate by 32.9%. Dissolved oxygen content and water pH also increased.