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A brief overview of the GLObal RIver CHemistry Database, GLORICH

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Abstract

Over the last decade the number of regional to global scale studies of river chemical fluxes and their steering factors increased rapidly, entailing a growing demand for appropriate databases to calculate mass budgets, to calibrate models, or to test hypotheses. We present a short overview of the recently established GLObal RIver CHemistry database GLORICH, which combines an assemblage of hydrochemical data from varying sources with catchment characteristics of the sampling locations. The information provided include e.g. catchment size, lithology, soil, climate, land cover, net primary production, population density and average slope gradient. The data base comprises 1.27 million samples distributed over 17,000 sampling locations.

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Keywords: river, hydrochemistry, water quality, global database

1. Introduction

River chemical data have been reported since the 19th century [1-3] and were often used as base reference to estimate global fluvial exports of dissolved and particulate matter to the coastal zone [4-6]. The GLORI-database assembled by Michel Meybeck was particularly influential and often used to evaluate or calibrate models. However,

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the growing model complexity in the past years increased the demand for river chemical data, e.g., to study the fluxes of nutrients, carbon or geogenic matter and quantify the factors steering the observed fluxes. Further, as the availability of high resolution geodata on river networks (Hydro1k, Hydrosheds) and important river catchment properties like e.g., climate [7] and lithology [8] increased, the detailed analysis of Earth Surface processes at extensive scales and high resolution has become feasible. While earlier global scale studies were based mainly on data from the mouths of large rivers [e.g., 9], a series of more recent studies [e.g., 10] proved the value of small catchments covering a wide variety of catchment properties, to more efficiently elucidate the spatial heterogeneity of Earth Surface processes and their controls on lateral matter fluxes and identifying hotspots

To meet the increasing demand of hydrochemical data, the new GLObal RIver CHemistry database GLORICH was established, which comprises 1.27 million samples distributed over 17,000 sampling locations. The reported hydrochemical parameters include concentrations of major ions, nutrients (N, P, Si), organic and inorganic carbon, alkalinity, pH, dissolved oxygen and water temperature (Table 1). For 15,500 sampling locations, the catchments could be derived, ranging in size from < 0.6 km² to > 5.3 million km² (Figure 1). A suite of geodata was used to calculate catchment properties covering climate, terrain, lithology, soils, land cover, net primary production, and population density.

2. Methods, Results, and Discussion

Hydrochemical data (Table 1) were mostly gathered from environmental monitoring programs, but also from scientific literature. The data were homogenized and test routines for the feasibility of data helped to identify erroneous or implausible data. The sampling locations were georeferenced and adjusted to the hydrological routing schemes Hydrosheds [11] or, for latitudes above 60°N, Hydro1K [12]. These routing schemes were then used to delineate the catchment boundaries, based on which finally the catchment properties were calculated, including lithological composition [8], soil properties [13], climate [7], runoff [14], lake abundance [15], average relief based on the SRTM digital elevation model [16], land cover [17], permafrost occurrence [18], wind speed [19], net primary production [20] and population density [21]. Some of the catchment property data with seasonal variability are available on monthly basis, e.g. climate or runoff. For all geoprocessing the software ArcGIS 10 by ESRI was used.

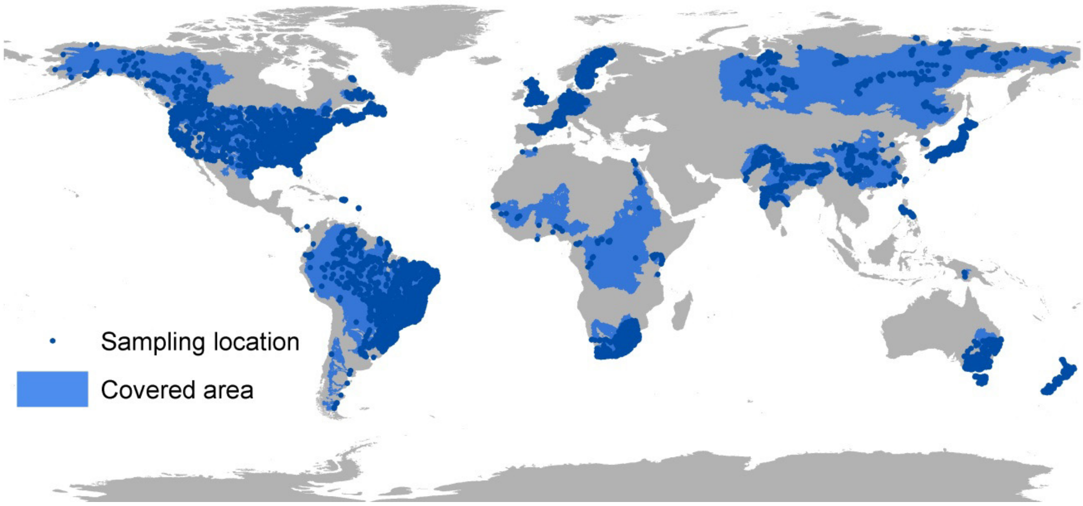

Figure 1: Sampling locations and covered catchment areas of the monitoring stations included in GLORICH.

Table 1: Included variables per sampling location and count of sampling locations and individual samples per parameter. For all georeferenced sampling locations catchment area attributes are provided as described in the text.

Description	**Parameter abbreviation in database**	**Unit**	**No. of sampling locations**	**No. of samples**
ID of the sampling location				
Date and time of the sampling				
Type of sampling (single sample, mixed samples collected over specific periods, averages from different samples)				
Reference				
Discharge, if not flagged, this refers to instantaneous discharge at time of sampling		$m^3 s^{-1}$	4,817	353,388
Water temperature		°C	13,970	549,899
pH	pH		17,437	889,355
Dissolved oxygen concentration	DO_mgL	mg O_2 L^{-1}	3,785	152,319
Oxygen saturation	DOSAT	%	7,110	170,369
Specific conductivity	SpecCond25C	µS cm-1	14,963	919,916
Suspended matter concentration	SPM	mg L^{-1}	6,000	241,656
Alkalinity	Alkalinity	µeq L^{-1}	12,931	639,259
Bicarbonate ion concentration	HCO3	µmol L^{-1}	6,554	144,979
Carbonate ion concentration	CO3	µmol L^{-1}	2,344	82,616
Calcium concentration, dissolved	Ca	µmol L^{-1}	12,154	615,500
Magnesium concentration, dissolved	Mg	µmol L^{-1}	12,081	613,108
Sodium concentration, dissolved	Na	µmol L^{-1}	11,802	598,367
Potassium concentration, dissolved	K	µmol L^{-1}	11,642	594,157
Silica concentration, dissolved	SiO2	µmol L^{-1}	9,880	624,877
Chloride concentration, dissolved	Cl	µmol L^{-1}	12,600	742,662
Sulphate concentration, dissolved	SO4	µmol L^{-1}	12,629	663,739
Fluoride concentration, dissolved	F	µmol L^{-1}	6,551	486,010
Strontium concentration, dissolved	DSr	µmol L^{-1}	2,200	30,839
Total carbon concentration	TC	µmol L^{-1}	86	2,245
Total inorganic carbon concentration	TIC	µmol L^{-1}	670	14,162
Dissolved inorganic carbon concentration	DIC	µmol L^{-1}	666	18,409
Particulate inorganic carbon concentration	PIC	µmol L^{-1}	540	3,536
Total organic carbon concentration	TOC	µmol L^{-1}	3,541	117,301
Dissolved organic carbon concentration	DOC	µmol L^{-1}	6,771	201,401
Particulate organic carbon concentration	POC	µmol L^{-1}	2,677	32,732
Total nitrogen concentration	TN	µmol L^{-1}	4,685	267,069
Dissolved nitrogen concentration	DN	µmol L^{-1}	855	35,201
Particulate nitrogen concentration	PN	µmol L^{-1}	57	445
Total inorganic nitrogen concentration	TIN	µmol L^{-1}	73	13,124
Dissolved inorganic nitrogen concentration	DIN	µmol L^{-1}	121	8,009
Total organic nitrogen concentration	TON	µmol L^{-1}	211	13,846
Dissolved organic nitrogen concentration	DON	µmol L^{-1}	29	571
Particulate organic nitrogen concentration	PON	µmol L^{-1}	4	64
Total Kjeldahl nitrogen	TKN	µmol L^{-1}	7,092	299,198
Dissolved Kjeldahl nitrogen	DKN	µmol L^{-1}	3,049	52,759
Nitrate concentration, dissolved	NO3	µmol L^{-1}	7,200	208,229
Nitrite concentration, dissolved	NO2	µmol L^{-1}	8,393	240,300
Nitrate+Nitrite concentration, dissolved	NO2_NO3	µmol L^{-1}	7,413	583,839
Ammonium concentration, total	TNH4	µmol L^{-1}	1,512	75,987
Ammonium concentration, dissolved	DNH4	µmol L^{-1}	11,350	609,307
Total phosphorous concentration	TP	µmol L^{-1}	10,540	484,825
Dissolved phosphorous concentration	DP	µmol L^{-1}	3,296	105,999
Particulate phosphorous concentration	PP	µmol L^{-1}	18	613
Total inorganic phosphorous concentration	TIP	µmol L^{-1}	1,037	26,841
Dissolved inorganic phosphorous concentration	DIP	µmol L^{-1}	11,844	661,267
Particulate sulphur concentration	PS	µmol L^{-1}	8	98

Parts of the GLORICH database have been used to study fluxes and controlling factors on dissolved silica and inorganic carbon fluxes [22-25], chemical weathering rates and associated phosphorus release [10, 26], dissolved carbon fluxes [27], controls on the carbonate system of fluvial systems [28], as well as the global CO_2-evasion from aquatic systems [29].

3. Conclusion

The combination of hydrochemical parameters and catchment properties render GLORICH a valuable tool for a wide spectrum of research related to chemical as well as physical denudation, biogeochemistry of river ecosystems and fluvial exports of nutrients, carbon and sediments to coastal ecosystems. The data base is of particular interest to assess terrestrial matter inputs to head water streams, as a large number of small catchments are included. In the future, the database will be steadily extended by integrating new data (sampling locations as well as parameters like trace elements or isotopes) to provide an evolving tool for the scientific community.

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