Data Article

Dataset of hydrological records in 5 min resolution of tributaries in the Mueglitz River Basin, Germany

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**Abstract**

We present a new hydrometric dataset that comprises water level and discharge time series measured at five tributaries draining sub-catchments of the mountainous Mueglitz River Basin in Germany. The monitoring sites were set up as far downstream as possible, taking into account technical and access restrictions. In total, 746,211 records of absolute pressure, electric conductivity, and water temperature were measured over 1.5 years (2019/04/24–2020/10/09) at a temporal resolution of 5 min using automatized dataloggers deployed at the streambed. The data was processed and is available for each site at various levels ranging from level 1–3. The level 1 data product contains merged and cleaned raw data, level 2 consists of water level time series based on local air pressure and surveying data measured on-site, and level 3 data includes stream discharge estimated by using the Manning formula. The data processing was performed with a generic workflow written in Python 3 which is referred to in this article for public use. The time series can be used to analyze extreme runoff events and catchment water balances,

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validate hydrological models, and for the planning of own measurement campaigns with similar objectives.

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### Specifications Table

| Subject                  | Hydrology and Water quality |
|--------------------------|-----------------------------|
| Specific subject area    | High temporal resolution hydrometric measurements in small rivers |
| Type of data             | Table                       |
| How the data were acquired | Data was collected from measurements in-situ with deployed dataloggers of type: Solinst Levelogger 5 Junior Solinst Levelogger 5 LTC Solinst Levelogger Edge Solinst Barologger 5 Data was read out every 2–3 months on-site using Levelogger Software provided by Solinst The collection of raw data and site metadata followed a standardized protocol (Supplementary document 1) to ensure data quality. Surveying data were obtained using a laser tachymeter (Trimble GPS R8) |
| Data format              | Raw                        |
|                         | Analyzed                   |
|                         | Filtered                   |
| Description of data collection | Surface water level, water temperature, air pressure, and electric conductivity were collected in intervals of 5 min in 5 tributaries of the Mueglitz River in Saxony, Germany. Data were collected over 1.5 years between April 2019 and October 2020. |
| Data source location     | Institution: Helmholtz centre for Environmental Research City/Town/Region: Saxony Country: Germany Latitude and longitude for collected samples/data: • Dittersdorfer Bach: 13.7964, 50.8470 (50°50'49.275"N 13°47'46.9356"E) • Trebnitz: 13.8159, 50.8652 (50°51'54.7266"N 13°48'57.0738"E) • Gr. Kohlbach: 13.7923, 50.8407 (50°50'26.6706"N 13°47'32.0994"E) • Ostbach: 13.8241, 50.8247 (50°49'29.0388"N 13°49'26.835"E) • Westbach: 13.7951, 50.8104 (50°48'37.281"N 13°47'42.4248"E) |
| Data accessibility       | Repository name: Pangaea. Data identification number: https://doi.org/10.1594/PANGAEA.927741 Direct URL to data: https://doi.pangaea.de/10.1594/PANGAEA.927741 |

### Value of the Data

- High-resolution measurements of water level for long periods in small tributaries are sparse.
- This data can improve the understanding of runoff generation in a fast responsive and dynamic river catchment regularly affected by flash floods and may help to evaluate decentralized integrated flood protection strategies in the headwaters of river basins.
- The data could be used by other researchers to design sensor networks for small catchments, as input data or validation data for rainfall-runoff models, and to improve the understanding of water balance dynamics.
1. Data Description

We share data from April 2019 to October 2020 of surface water level, water temperature, and electric conductivity records, obtained from raw data measured by dataloggers [1] at 5 small streams in intervals of 5 min. The dataset is split into 3 different product levels for each location to consider the processing of the raw data (Table 1). Level 1 includes the stacked and cleaned time series of water temperature (°C), absolute pressure (mH₂O), and electric conductivity (μS cm⁻¹) for each monitoring location (Fig. 1). Level 2 adds a data column “level”, which describes the time-dependent water level (m) of each stream at the logger location (Fig. 2). Level 3 provides time series of surface water discharge (m³ s⁻¹) derived from level 2 data (Fig. 3) by applying the Manning formula [2]. Manning coefficients were computed from manual discharge measurements using a handheld electromagnetic water flow meter with automatic discharge calculation [3] and stream cross-sectional area at the measurement locations using a laser tachymeter of type Trimble GPS R8 [4]. Hydraulic diameter (m) and Cross-sectional area (m²) calculated with this routine are also provided with the level 3 data.

With this article, a template of a measurement protocol is published, which was developed for device maintenance. The protocol contains a list of required tools, instructions for the read-out and manual measurements as well as text fields for metadata obtained on-site.

2. Experimental Design, Materials and Methods

2.1. Study area description

The Mueglitz River located in the Ore Mountains south-east of Dresden has a length of 50 km and drains an area of 209 km². It springs at the border between Saxony and the Czech Republic at 749 m above sea level and flows into the Elbe near the city of Heidenau at 113 m above sea level. The focus site is about five kilometers southeast of the city of Glashuette. It is located on a plateau east of the Mueglitz Valley and is predominantly used for intensive agriculture.

The climate in the study area is continental with distinct seasons. The average annual temperatures are strongly dependent on altitude and range between 6.7 °C in the Eastern Ore Mountains in the southern part of the study area and up to 9 °C in the areas near the Elbe. Precipitation varies between 600 and 750 mm per year and generally increases from north to south. The catchment is frequently affected by heavy precipitation due to the formation of Vb weather systems [5]. These occur when water-saturated low-pressure areas move northeastward from the Mediterranean region. In a Vb weather situation, a low pressure initially forms over upper Italy, supported by the lee effect of the Alps. The Vb low then shifts northward or northeastward, carrying warm and humid sea air that meets a cold front. In this border area develops heavy precipitation with a long duration [6].

The Mueglitz Catchment can be geologically divided into three zones. The southern and, in terms of area, the largest part can be assigned to the Eastern Ore Mountains. Thus, different impermeable gneisses (Two-mica-Gneiss, Muscovite-Biotite-Orthogneis) and Rhyolites are the

| Level | Description | Variables |
|-------|-------------|-----------|
| 1     | Cleaned and merged raw data | Absolute pressure, water temperature, electric conductivity |
| 2     | Water levels derived from pressure time series | Water level, water temperature, electric conductivity |
| 3     | Calculated discharge based on Manning formula | Water level, water temperature, electric conductivity. Hydraulic diameter, cross-sectional area, discharge |
Fig. 1. Level 1 data for location Kohlbach (Pressure (mH₂O), electric conductivity (μS cm⁻¹) and temperature (°C).
Fig. 2. Level 2 data for location Kohlbach (Water level (m)).
Fig. 3. Level 3 data for location Kohlbach (discharge (m³ s⁻¹)).
predominant rocks. The zone of the Eastern Ore Mountains is joined by the Elbe Valley Zone, which is separated from the Ore Mountains by the Middle Saxon Fault. Here the Erzgebirge Gneisses border on various Phyllites and Clay Schists. The northernmost part, delimited by the Weesenstein Fault, belongs to the Elbe zone. The fault is initially followed mainly by graywackes and the Dohna-Granodiorite. Towards the mouth of the Mueglitz into the Elbe, the area is characterized by the occurrence of marine sedimentary rocks such as sandstones and marls of the Cretaceous. The study area is characterized by a dominant occurrence of cambisols. In the southern and eastern parts of the area, which is mainly characterized by granites and rhyolites, there are transitional forms of cambisols to podzols, which have developed from green sands. In the northern lower slopes between 200 and 300 m above sea level, planosols and planosol subtypes occur more frequently due to the influence of backwater. The different rocks such as sandstone and granite, which occur mainly northeast of Dippoldiswalde, lead to a narrow alternation of cambisols, podzols, and planosols [7].

The presence of mostly impermeable bedrock covered by predominantly loamy soils leads to a highly dynamic run-off behavior in the Mueglitz Catchment. In the past, the region was often affected by extreme precipitation events which in combination with the catchment properties and missing natural and artificial retention areas lead to severe flash floods, resulting in severe damage. Automatic dataloggers were installed near the outflow of 5 tributaries which drain parts of a plateau area in the central part of the basin (Fig. 4). The exact locations and catchment areas are listed in Table 2.

### 2.2. Installation and data readout

Within the Mueglitz Catchment, dataloggers with a piezoresistive sensor for pressure measurement, a resistance temperature detector, and a 4-Electrode Platinum electric conductivity sensor were installed in five sub-catchments. The sensors were mounted on flat metal rails which were fixed to the stream bed a few centimeters above the stream bed. Additionally, a barometer was installed in a tree to measure the local air pressure, which was used to obtain the effective water level height of the streams. Due to storage and battery limitations, the devices were read out every two to three months and the functionality was controlled (checking the installation, removing leaves and deadwood). The devices were removed, and the data was read out on-site using the official Levelogger Software from the manufacturer [8]. For regular maintenance, a measurement protocol was developed to ensure consistent data quality. The reports include a template of the measurement protocol that was submitted with this article. Within the measurement period of 18 months, 14 different dataloggers have been used at the five monitoring locations due to device maintenance intervals and failures. The metadata information of each device as well as its deployment history is available at https://sensor.awi.de/?site=path&device=station:mueglitz.

### 2.3. Data processing

To generate the level 1 data, we removed all data points which were generated during the data transfer, since the devices were outside of the water during readout. The raw data series

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**Table 2**

| No | Site name | Catchment area (km²) | Lon/Lat          |
|----|-----------|----------------------|-----------------|
| 1  | Dittersdorf | 2.6             | 13.7964, 50.8470 |
| 2  | Kohlbach  | 1.6             | 13.7923, 50.8407 |
| 3  | Ostbach   | 0.9             | 13.8241, 50.8247 |
| 4  | Trebnitz  | 17.3            | 13.8159, 50.8652 |
| 5  | Westbach  | 1.2             | 13.7951, 50.8103 |
Fig. 4. Mueglitz Catchment showing measuring sites (red points) in the 5 sub-catchments (blue filled areas) in local coordinate system UTM33N.
obtained at each readout were merged to generate continuous time series covering the entire observation period. To improve data quality, data records containing negative pressures were automatically removed from the dataset. Additional quality control measures were conducted manually by comparing time-synchronous records between the sensors and removing individual outliers, if applicable.

Level 2 data contains the stream water levels based on the pressure time series of level 1. In the following, the calculation of the absolute water levels and the applied correction methods are described.

2.4. Barometric compensation

The datalogger measures the pressure head of the water and the air above. To obtain the pressure head of the water $h_w$, the local air pressure is subtracted Eq. (1).

$$h_w = \frac{\rho_wgh - p_{\text{air}}}{\rho_wg}$$

where $\rho_w$ represents the density of water, $g$ the gravitational acceleration, $h$ the pressure head measured by the logger $p_{\text{air}}$ the local air pressure.

The local air pressure was obtained from a barometric pressure logger installed in the Mueglitz Catchment. Since the time series of measured air pressure did not cover the full duration of the measuring campaign, the air pressure of the closest weather station Dresden-Klotzsche from the German Weather Service (DWD) was used for the whole time series instead. To account for the height difference between the weather station and the barometric pressure sensors, the mean deviation between the local air pressure sensor and the weather station was added to the time series.

2.5. Height correction

Since the sensors were installed inside of the water body, the height between the stream bed and the sensors were measured manually at each readout and added to the related time series to obtain the full surface water levels.

Some of the smaller streams dried out for short times during the summer season of the measurement period. Due to the elevated position of the sensors, it may not be possible to tell if there was only a small water level or no water underneath the sensors. In these cases, the electric conductivity was considered. If the electric conductivity for a record was below a threshold of 10 $\mu$S cm$^{-1}$, we assumed that the water level was 0 and the pressure record was removed before the generation of the level 2 data product.

The level 3 data contains discharge time series based on the level 2 water level data and the Manning formula Eq. (2).

$$v_m = k_{st} \frac{R^{2/3} \cdot I^{1/2}}{3}$$

where $v_m$ is the average velocity of a flow, $k_{st}$ is the Strickler coefficient, $R$ is the hydraulic radius, and $I$ is the slope. The hydraulic radius $R$ and the cross-sectional area $A$ were estimated based on the stream profile measured on-site. The ratio of Mannings’ coefficient and slope at each monitoring site were calibrated from manual discharge measurements using a portable flow meter and by inverting the Manning formula. Discharge measurements were conducted for each site with a total of 15 measurements. The runoff $Q$ was calculated by multiplying the flow velocity derived by Eq. (2) with the cross-sectional area of the water body Eq. (3).

$$Q = v_m \cdot A$$
the detection and flagging of errors and outliers by using the SaQC Python library [9]. This gives users of the dataset the flexibility to adapt the data processing steps and to set quality flags depending on their requirements. The scripts can be found in the following public repository: https://git.ufz.de/nixdorf/datalogger-data-processing-tool.

Ethics Statements

The work does not involve the subject of humans, animals, or data from social media platforms.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

CRediT Author Statement

Marco Hannemann: Data curation, Software, Writing – original draft; Erik Nixdorf: Conceptualization, Methodology, Supervision, Writing – review & editing; Manuel Kreck: Investigation, Data curation; Andreas Schoßland: Investigation; Peter Dietrich: Conceptualization, Project administration, Funding acquisition.

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Supplementary Materials

Supplementary material associated with this article can be found in the online version at doi:10.1016/j.dib.2022.107832.

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