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Data Article

Dataset of a flow intermittency study: Benthic communities of 13 alpine intermittent rivers

Laura Gruppuso[a,*], Elisa Falasco[a], Stefano Fenoglio[a], Anna Marino[a], Daniele Nizzoli[b], Elena Piano[a], Francesca Bona[a]

[a] *Department of Life Sciences and Systems Biology, Università degli Studi di Torino, Via A. Albertina, 13, 10123 Torino, Italy and ALPSTREAM—Alpine Stream Research Center/Parco del Monviso, 12030 Ostana, (CN), Italy*
[b] *Department of Chemical Sciences, Life Sciences and Environmental Sustainability, Università degli Studi di Parma, Parco Area delle Scienze 11/a, 43124 Parma, Italy*

A R T I C L E I N F O

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A B S T R A C T

In the last few decades, perennial mountain streams are becoming increasingly intermittent, due to global climate change and anthropogenic pressures. This phenomenon leads to negative effects on benthic communities' biodiversity and river ecosystems functionality. However, the impact of flow intermittency in previously perennial Alpine streams is still poorly investigated. This dataset consists of all the data collected during a spring sampling campaign performed in April-May 2017 along 13 mountain streams located in the SW Italian Alps. These watercourses have been selected because it was possible to identify two different sampling sites: one perennial, where water has always been flowing throughout the years, and one intermittent, which showed flowing water during the sampling campaign but, in the last decade, has experienced summer dry phases. All the sites have been characterized defining the microhabitats in which samples were retrieved, and physico-chemical data were collected at each site. Biological sampling included benthic macroinvertebrates and diatoms. Therefore, the present dataset offers various biological, ecological and physico-chemical information regarding Alpine streams which have recently become intermittent. Potentially, it could be used for comparisons with different benthic communities present in mountain rivers worldwide

* Corresponding author.
E-mail address: laura.gruppuso@unito.it (L. Gruppuso).
Social media: @LauraGruppuso,@dbiosunito (L. Gruppuso), @ElenaPiano2 (E. Piano)

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which are facing drying events too. The broad range of information present in this dataset offers the possibility to examine only the perennial sites themselves, as an example of good river functionality due to continuous flowing water, or only the intermittent ones, to better understand the effects of drying events on these peculiar ecosystems.

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Specifications Table

Subject	Environmental Science – Ecology – Global and Planetary Change
Specific subject area	Assessing the response of benthic macroinvertebrates and diatoms to riverbed drying. Samples collected in perennial and intermittent sites along 13 low order streams belonging to the SW Alps hydroecoregion (HER 4, Piemonte, NW Italy), along with physico-chemical and environmental data.
Type of data	Raw Table
Data collection	Macroinvertebrates were collected using a Surber sampler (250 µm mesh size, 0.062 m^2 area) and samples preserved in 75 % ethanol. In the laboratory, taxonomical identification was performed at family and genus level following [2,3] and counted, using a stereomicroscope (Leica EZ4).Regarding benthic diatoms, one sample for each stretch was collected, following the European standard methods [4] and then preserved in ethanol. In the laboratory, after cleaning with hydrogen peroxide (30 %) and HCl (1 N), slides were mounted with Naphrax® resin. In each sample, at least 400 valves were counted according to the standard procedure [4]. Identification at species level was based on the most recent diatom floras and taxonomic papers [1] and performed by using a light microscope (Leica DM2500 LED, 1000x magnification). Diatom identification and counts were then uploaded into OMNIDIA 6.1 [5], where a single identification code (for example ACAF for *Achnanthidium affine*) is assigned to each species. Physico-chemical data: - Water dissolved oxygen (mg/L), oxygen saturation (%), pH, water temperature (°C), conductivity (µS/cm): Hydrolab mod. Quanta multiparametric probe. - Soluble reactive and total phosphorus (SRP and TP, µg/L), ammonium ($N–NH_4^+$, µg/L), nitrate ($N–NO_3^-$, µg/L), total nitrogen (TN, µg/L) and silicium (Si, µg/L): Perkin Elmer, Lambda 35 spectrophotometer. Microhabitat data: - Depth (cm), velocity (m/s): Hydro-bios Kiel current meter. - Granulometry: determined by visually estimating% of classes of substratum (boulders, pebbles, gravel, sand)
Data source location	Institution: Department of Life Sciences and Systems Biology, University of Turin. Region: Piemonte Country: Italy GPS Coordinates (WGS84): - Po River. Perennial: 49.459.51 lat., 3.671.19 long. Altitude 474 m. Intermittent: 49.431.03 lat., 3.729.59 long. Altitude 359 m - Pellice River. Perennial: 49.631.23 lat., 3.642.93 long. Altitude 422 m. Intermittent: 49.640.43 lat., 3.666.38 long. Altitude 378 m. - Varaita River. Perennial: 44.564.86 lat., 7.479.41 long. Altitude 448 m. Intermittent: 49.377.57 lat., 3.828.86 long. Altitude 398 m. - Stura River: Perennial 44.354.53 lat., 7.489.33 long. Altitude 630 m. Intermittent: 44.394.174 lat., 7.538.191 long. Altitude 534 m.

(*continued on next page*)

	- Gesso River: Perennial: 49.092.52 lat., 3.806.19 long. Altitude 611 m. Intermittent: 49.162.91 lat., 3.850.94 long. Altitude 495 m. - Maira River. Perennial: 49.301.92 lat., 3.792.88 long. Altitude 690 m. Intermittent: 49.341.37 lat., 3.844.09 long. Altitude 418 m. - Grana River. Perennial: 49.187.48 lat., 3.710.58 long. Altitude 679 m. Intermittent: 49.186.14 lat., 3.472.01 long. Altitude 591 m. - Chisone River. Perennial: 49.698.06 lat., 3.678.82 long. Altitude 365 m. Intermittent: 49.668.09 lat., 3.722.32 long. Altitude 308 m. - Pesio River. Perennial: 49.048.22 lat., 3.938.93 long. Altitude 670 m. Intermittent: 49.059.45 lat., 3.944.61 long. Altitude 649 m. - Colla River. Perennial: 49.096.94 lat., 3.853.83 long. Altitude 592 m. Intermittent: 49.140.54 lat., 3.906.55 long. Altitude 499 m. - Pissaglio River. Perennial: 50.009.47 lat., 3.579.59 long. Altitude 480 m. Intermittent: 50.008.22 lat., 3.573.68 long. Altitude 445 m. - Gravio di Condove River. Perennial: 49.967.11 lat., 3.600.39 long. Altitude 847 m. Intermittent: 49.977.11 lat., 3.601.75 long. Altitude 376 m. - Gravio di Villar River. Perennial: 49.994.76 lat., 3.652.47 long. Altitude 538 m. Intermittent: 49.972.19 lat., 3.661.87 long. Altitude 418 m.
Data accessibility	The dataset described in this data article is accessible as open file in the Zenodo repository as single excel file. Repository name: https://zenodo.org/ Direct URL to data: https://doi.org/10.5281/zenodo.10925294
Related research article	[1] E. Piano, A. Doretto, E. Falasco, S. Fenoglio, L. Gruppuso, D. Nizzoli, P. Viaroli & F. Bona, If Alpine streams run dry: the drought memory of benthic communities. Aquat. Sci. 81, 32 (2019). https://doi.org/10.1007/s00027-019-0629-0

1. Value of the Data

- These data assess a highly studied phenomenon nowadays, i.e. hydrological variation and effects of global climate change at river ecosystems scale. Studying the effects of drying events on benthic macroinvertebrates and diatoms is a key issue, in order to assess biodiversity loss as well as understanding their response to flow intermittency.
- The geographic area is of primary interest as Alpine rivers are among the most affected by climate change [6]. Study on flow intermittency in Alpine rivers are still very limited.
- The two investigated communities are the most important and commonly used in biomonitoring as bioindicators, giving important information about river quality and functioning.
- This dataset provides information regarding physico-chemical parameters, environmental variables, benthic macroinvertebrates taxa richness and abundance and diatoms community identified at species level along with their OMNIDIA software code [5]. All the previously mentioned information is available for both perennial and intermittent sampling sites.
- This subset, collected in 2017, could be useful as historical information regarding macroinvertebrate and diatom communities, integrated with physico-chemical and environmental data. This dataset offers valuable insights in order to understand the response of benthic communities to climate change on a long-term perspective, giving the possibility to compare these data with more recent and future ones.
- The provided data can be statistically analyzed through univariate, bivariate and multivariate methods. Furthermore, functional feeding groups and eco-morphotypes can be addressed, along with community composition studies. This makes this dataset suitable for both biological and ecological studies.

2. Background

The phenomenon of flow intermittency has gained increasing attention from researchers worldwide [7–9], due to the extreme sensitivity of river ecosystems to climate change [10,11].

Moreover, mountain streams in general, are becoming increasingly affected by this phenomenon [12,13], as a result of heavy flow regulation, hydropower and water abstraction along with global climate change. This is causing a shift from perennial to intermittent watercourses, leading to biodiversity loss and reduced river functionality [14]. The dataset has been generated sampling 13 mountain streams in the SW Italian Alps, which proved to be facing flow intermittency. The original study [1] focused on assessing the effects of droughts on alpine streams benthic communities (macroinvertebrates and diatoms). Due to climate change and anthropogenic pressures, the phenomenon of riverbed drying is increasingly frequent, especially in those mountain streams that were previously considered perennial. Our dataset will then be useful to other researchers addressing this topic, providing biological, physico-chemical and environmental data regarding mountain streams. This could help generating useful comparisons with streams and rivers worldwide. Moreover, we think that sharing data regarding flow intermittency will be of primary importance in order to make future predictions on the effects of climate change in river ecosystems.

3. Data Description

The dataset is available for download from the Zenodo data repository. All the data are stored in a single Excel file consisting of three data sheets.

The first data sheet is named “Macroinvertebrates data”. Each row represents the data regarding a surber sample with related measurements and macroinvertebrates number of individuals per each taxon. In the column “Replicate”, the number of replicates per each river can be found, which are a total of 20 replicates, 10 for perennial and 10 for intermittent sampling sites. The column “Sample_point” provides the sample identification point, consisting in the abbreviation of the river name and “P” for perennial and “INT” for intermittent sampling sites. Moreover, the column “Sample_Code” provide the sample code used for labeling each sample, consisting in the river name abbreviation, “P” for perennial and “INT” for intermittent sampling sites plus the ordination number of the surber itself. Sampling dates are reported in the format day/month/year. All the physico-chemical (i.e. conductivity, DO, pH, water temperature = 1 measurement with multiparametric probe; SRP, TP, $N–NH_4^+$, $N–NO_3^-$, TN, Si = 1 measurement collecting 1 sample of water, for further processing) and environmental parameters (depth, velocity,% of Boulders, Pebbles, Gravel and Sand) are organized in columns, along with the respective units reported in brackets. Non-available data are identified by the code “N/A”. Regarding macroinvertebrates community, each column reports a different taxon (identified at family/genus level) and the number of individuals per taxon in each sample. At the end of the taxa columns, two more columns are present, reporting taxa richness (S) and abundance (N).

The second data sheet is named “Diatoms Data”. Here, the first row is empty because it only contains the OMNIDIA codes [5] for the taxonomically identified diatoms; this code consists in the abbreviation of the taxonomical identification of each diatom species (for example: ACAF is the OMNIDIA Code for *Achnanthidium affine*). Then, each row represents the data regarding a unique diatoms sample (one for the perennial and one for the intermittent site per each river) with related measurements and diatoms number of individuals per each species. The column “Sample_point” provides the sample identification point, consisting in the abbreviation of the river name and “P” for perennial and “INT” for intermittent sampling sites. Sampling dates are reported in the format day/month/year. All the physico-chemical (i.e. conductivity, DO, pH, water temperature, SRP, TP, $N–NH_4^+$, $N–NO_3^-$, TN, Si) and hydro-morphological (depth, velocity) data are organized in columns, along with the respective units reported in brackets. Regarding diatoms community, each column reports, for each species, the number of individuals counting at least 400 valves, along with the abbreviation of the taxonomical identification reference.

The third data sheet is named “Summary”. It reports the total number samples and the total number of physico-chemical and microhabitat data collected for both macroinvertebrates and diatoms.

4. Experimental Design, Materials and Methods

4.1. Experimental design

Data were collected in thirteen low order streams located in Piemonte, NW Italy (SW Italian Alps hydroecoregion HER 4 "Southern Alps") with comparable geology, climate and altitude, in order to reduce confounding factors. We selected two sampling sites for each stream, one perennial, i.e. with water present during the whole sampling campaign, and one intermittent, which experienced non-flow periods during summer. Moreover, sampling sites defined as perennial were located upstream, being thus a potential source of organisms for the intermittent sites after flow resumption. Our sampling campaign was performed in April-May 2017 (approximately 6 months after the drying phase in 2016, see Arpa Piemonte's Hydrological bulletins [15] and [16]), in order to characterize benthic communities after complete flow resumption. During the sampling campaign, moderate flow occurred in both sampling sections of all the 13 streams.

Along with macroinvertebrates and diatoms samplings, we collected abiotic data, regarding physico-chemical parameters (conductivity, DO, pH, temperature, SRP, TP, $N–NH_4^+$, $N–NO_3^-$, TN and Si) and microhabitat variables (water depth, velocity, granulometry percentages).

5. Materials and Methods

In-situ abiotic parameters were collected per each sampling station using a current meter (Hydro-bios Kiel) for flow velocity (0.05 m from the bottom) and depth and a multiparametric probe (Hydrolab mod. Quanta). The probe was previously calibrated in laboratory by using the procedure reported in the Operating Manual of the Hydrolab Company. In detail, after cleaning and rinsing the sensors with deionized water, the specific conductance was calibrated by using the specific standard provided by the Hydrolab Company. The pH sensor was prepared by dropping two KCl salt pellets into the sleeve and refilling it with a reference electrolyte solution. Calibration was then performed by using a pH 7 and a pH 4 buffer solution provided by the Hydrolab Company. Dissolved oxygen sensor was rinsed and refilled with DO electrolyte liquid provided by the Hydrolab Company and finally covered with a membrane, secured with an o-ring. Calibration was then performed through a saturated-air method. Temperature was factory-set and no recalibration was required The calibration of the probe was performed at the beginning of the sampling campaign (Table 1).

For chemical analyses one sample per sampling site was collected from the middle of the watercourse using a 1 L glass bottle, immediately put in a refrigerated box and transported to the laboratory within 6 h. In the laboratory, an aliquot for each sample was filtered (Whatman GF/F) and stored in polyethylene vials and in glass vials, the former ready for ammonium ($N–NH_4^+$), nitrate + nitrite ($N–NO_3^-$) and dissolved reactive silica (Si) analyses, and the latter for soluble reactive phosphorus (SRP). An additional known volume of unfiltered and homogenized sample was transferred into glass vials for total phosphorus (TP) and total nitrogen (TN) analysis. All the samples were preserved at 4 °C until analyses that were performed within 48 h. Nutrients were determined using standard colorimetric methods using a Perkin Elmer, Lambda 35 spectrophotometer: indophenol reaction for N–NH4+, azo dye reaction for N–NO3-, molybdate reaction for SRP, molybdate-stannous chloride reaction for Si [17]. TN and TP were analyzed as N–NO3- and SRP respectively after wet alkaline peroxydisulfate oxidation [18,19]. In order to assure a high quality standard and reproducibility of the nutrients concentrations the sampling protocol, sample handling and analysis were performed according to standard methods [18]. The quality control of the analyses was performed by constantly evaluating the performance of the full analytical procedures. In order to avoid cross contamination, all sampling containers were pre washed by soaking them overnight in a 10 % HCl solution and then rinsed twice with distilled water. All chemicals for reagents and standards preparation met the analytical reagent grade quality. Three analytical blanks undergoing the same procedure as the samples, including filtration, were always analyzed to correct for sample contamination. Verification of the

Table 1
An overview of the collected data (variables and sampling dates) for benthic macroinvertebrates dataset.

River	Regime	Sampling Date	N Surber	N Physico-Chemical data	N Microhabitat data	Taxa Richness
Po	Perennial	19/04/2017	10	1 × 11 parameters	5 × 3 parameters	69
Po	Intermittent	19/04/2017	10	1 × 11 parameters	4 × 3 parameters	43
Pellice	Perennial	19/04/2017	10	1 × 11 parameters	4 × 3 parameters	44
Pellice	Intermittent	19/04/2017	10	1 × 11 parameters	5 × 3 parameters	45
Maira	Perennial	20/04/2017	10	1 × 11 parameters	5 × 3 parameters	122
Maira	Intermittent	20/04/2017	10	1 × 11 parameters	5 × 3 parameters	78
Pesio	Perennial	21/04/2017	10	1 × 11 parameters	5 × 3 parameters	85
Pesio	Intermittent	21/04/2017	10	1 × 11 parameters	5 × 3 parameters	72
Colla	Perennial	21/04/2017	10	1 × 11 parameters	4 × 3 parameters	76
Colla	Intermittent	21/04/2017	10	1 × 11 parameters	3 × 3 parameters	46
Grana	Perennial	27/04/2017	10	1 × 11 parameters	5 × 3 parameters	149
Grana	Intermittent	27/04/2017	10	1 × 11 parameters	5 × 3 parameters	74
Varaita	Perennial	27/04/2017	10	1 × 11 parameters	5 × 3 parameters	60
Varaita	Intermittent	27/04/2017	10	1 × 11 parameters	5 × 3 parameters	76
Stura	Perennial	27/04/2017	10	1 × 11 parameters	5 × 3 parameters	138
Stura	Intermittent	27/04/2017	10	1 × 11 parameters	5 × 3 parameters	82
Gesso	Perennial	27/04/2017	10	1 × 11 parameters	5 × 3 parameters	89
Gesso	Intermittent	27/04/2017	10	1 × 11 parameters	5 × 3 parameters	53
Chisone	Perennial	28/04/2017	10	1 × 11 parameters	5 × 3 parameters	55
Chisone	Intermittent	28/04/2017	10	1 × 11 parameters	5 × 3 parameters	63
Pissaglio	Perennial	10/05/2017	10	1 × 11 parameters	5 × 3 parameters	105
Pissaglio	Intermittent	10/05/2017	10	1 × 11 parameters	5 × 3 parameters	34
Gravio di Condove	Perennial	10/05/2017	10	1 × 11 parameters	5 × 3 parameters	58
Gravio di Condove	Intermittent	10/05/2017	10	1 × 11 parameters	5 × 3 parameters	53
Gravio di Villar	Perennial	10/05/2017	10	1 × 11 parameters	5 × 3 parameters	56
Gravio di Villar	Intermittent	10/05/2017	10	1 × 11 parameters	5 × 3 parameters	34

Table 2
An overview of the collected data (variables and sampling dates) for diatoms dataset.

River	Regime	Sampling Date	N Samples	N Physico-Chemical data	Species Richness
Po	Perennial	19/04/2017	1	1 × 11 parameters	23
Po	Intermittent	19/04/2017	1	1 × 11 parameters	19
Pellice	Perennial	19/04/2017	1	1 × 11 parameters	10
Pellice	Intermittent	19/04/2017	1	1 × 11 parameters	17
Maira	Perennial	20/04/2017	1	1 × 11 parameters	13
Maira	Intermittent	20/04/2017	1	1 × 11 parameters	14
Pesio	Perennial	21/04/2017	1	1 × 11 parameters	11
Pesio	Intermittent	21/04/2017	1	1 × 11 parameters	16
Colla	Perennial	21/04/2017	1	1 × 11 parameters	20
Colla	Intermittent	21/04/2017	1	1 × 11 parameters	37
Grana	Perennial	27/04/2017	1	1 × 11 parameters	14
Grana	Intermittent	27/04/2017	1	1 × 11 parameters	8
Varaita	Perennial	27/04/2017	1	1 × 11 parameters	13
Varaita	Intermittent	27/04/2017	1	1 × 11 parameters	15
Stura	Perennial	27/04/2017	1	1 × 11 parameters	26
Stura	Intermittent	27/04/2017	1	1 × 11 parameters	14
Gesso	Perennial	27/04/2017	1	1 × 11 parameters	21
Gesso	Intermittent	27/04/2017	1	1 × 11 parameters	11
Chisone	Perennial	28/04/2017	1	1 × 11 parameters	24
Chisone	Intermittent	28/04/2017	1	1 × 11 parameters	20
Pissaglio	Perennial	10/05/2017	1	1 × 11 parameters	16
Pissaglio	Intermittent	10/05/2017	1	1 × 11 parameters	23
Gravio di Condove	Perennial	10/05/2017	1	1 × 11parameters	20
Gravio di Condove	Intermittent	10/05/2017	1	1 × 11parameters	29
Gravio di Villar	Perennial	10/05/2017	1	1 × 11parameters	23
Gravio di Villar	Intermittent	10/05/2017	1	1 × 11parameters	27

analytical method performance was carried out by analyzing, at each sampling event, 3 analytical standards. The spectrophotometer was regularly calibrated (bimonthly) by means of calibration curves made of six standard concentrations. Each standard concentration was prepared in triplicate (Table 2).

Five microhabitats spaced at least 5 m apart were selected in each stretch, following the Italian multihabitat sampling method [20] and we visually estimated the% of substratum classes (boulders, pebbles, gravel and sand).

Macroinvertebrates were collected using a Surber sampler (250 µm mesh size, 0.062 m^2 area) and samples preserved in 75 % ethanol. In the laboratory, taxonomical identification was performed at family and genus level following [2,3] and counted, using a stereomicroscope (Leica EZ4). The identification of macroinvertebrates was performed by experts included among the authors of this article, who have participated as instructors in national and/or international courses and published numerous papers on this topic.

Regarding benthic diatoms, one sample for each stretch was collected, following the European standard methods [4] and then preserved in ethanol. In the laboratory, after cleaning with hydrogen peroxide (30 %) and HCl (1 N), slides were mounted with Naphrax® resin. In each sample, at least 400 valves were counted according to the standard procedure [4]. Identification at species level was based on the most recent diatom floras and taxonomic papers [1] and performed by using a light microscope (Leica DM2500 LED, 1000x magnification). The identification of diatoms was performed by experts included among the authors of this article, who have participated as instructors in national and/or international courses and published numerous papers on this topic.

Limitations

A limitation of this type of studies could be represented by the difficulty of finding a good number of rivers to sample that have these characteristics: a sampling site which has

flowing water during the whole experiment and one which has flowing water during the sampling campaign but has faced drying events at least in the previous six months. Unfortunately, due to climate change and hydrological cycles disruption, sampling in intermittent streams or sections is increasingly difficult because of more and more frequent prolonged droughts or heavy floods due to occasionally intense and short-term rainfalls. Another limitation could be represented by the fact that taxonomical identifications have been performed by means of light and stereo microscopy. Indeed, especially for benthic invertebrates, identifications have been carried out at family/genus level. Nowadays, thanks to the progresses made with modern molecular procedures, these organisms could be identified at species level using DNA metabarcoding and high throughput sequencing techniques. In terms of duration, this type of work could have also been conducted in a longer time-span, to better assess what happens in those particular river ecosystems throughout the years or follow the recolonization after the dry phase.

Ethics Statement

The authors have read and follow the ethical requirements for publication in Data in Brief and confirm that the current work does not involve human subjects, animal experiments, or any data collected from social media platforms.

Data Availability

Dataset_Alpine_Intermittent_Rivers (Original data) (Zenodo).

CRediT Author Statement

Laura Gruppuso: Conceptualization, Data curation, Visualization, Writing – original draft, Writing – review & editing; **Elisa Falasco:** Methodology, Data curation, Visualization, Writing – review & editing; **Stefano Fenoglio:** Methodology, Data curation, Resources, Visualization, Writing – review & editing, Project administration, Funding acquisition; **Anna Marino:** Data curation, Visualization, Writing – review & editing; **Daniele Nizzoli:** Methodology, Data curation, Visualization, Writing – review & editing; **Elena Piano:** Data curation, Visualization, Writing – review & editing; **Francesca Bona:** Conceptualization, Methodology, Resources, Visualization, Supervision, Writing – review & editing, Project administration, Funding acquisition.

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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.

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