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Data Article

A macromodel dns/swat dataset for the sediment yield analysis in the raba river basin (Carpathian mts.)

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ABSTRACT

A database has been created as a result of the Raba River basin (Carpathian Mts., Poland) mapping/projection in the Macromodel DNS/SWAT. The sediment yield simulations (SYLD) in each of the 36 designated sub-basins have been performed, taking also into account seasonal variability. The model subsequently has been used as a reference/baseline for subsequent variant scenarios, simulating forecasted changes in the environment. The generated data ultimately allowed for creation of the current dataset. The impact of 20 variant scenarios, simulating forecasted climate and land use changes, on the sediment yield values was analyzed. The applied scenarios took into account various possibilities, from hypothetical ones, where only one parameter has been changed, to combined ones, which included simultaneous change of selected parameters. Short-term (2021–2050) and long-term (2071–2100) time horizons have also been included in this analysis. Sediment yield values and their variability, depending on the season, can be successfully used as reference values for the other mountain and sub-mountainous catchments, both in the Carpathian Mts., and throughout central Europe. Due to the permanent lack of monitoring data on the sediment yields, not only in Poland, the presented database is a valuable source of information. Moreover, spatial and temporal predictions of sediment yield changes are necessary to decide on actions which should be

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taken to reduce impact of climate changes at the basin scale. This data can be also used as a basis for further research related to the transport of pollutants adsorbed on sediment particles.

Specifications Table

Subject	Ecological Modelling
Specific subject area	The environmental model to analyze impact of single and combined climate and land use scenarios on the sediment yield at the sub-basin level.
Type of data	Table Chart Figure
How data were acquired	Macromodel DNS (Discharge–Nutrient–Sea) combined with the SWAT module (Soil and Water Assessment Tool)
Data format	Raw Analyzed Filtered The raw and analyzed datasets in the form of tables and pivot column charts are made available in the formats XLS.
Parameters for data collection	The problem of surface erosion and soil leaching is significant for environmental and agricultural reasons. Identification of vulnerable areas becomes complicated due to climate and land use changes and their influence on sediment yield assessments, and its spatial differentiation. It is necessary to expand knowledge about the response of various areas to these forecasts.
Description of data collection	The dataset originates from the Macromodel DNS/SWAT built for the Raba river basin. The data set includes: location of individual sub-basins and main features: land use, slopes, and soil classes share in each sub-basin area; • list of all scenarios used for climate change and land use predictions, together with their description; • results of the individual scenarios impact on the sediment yield; • sediment yield change values for each scenario in t / ha and in% • average sediment yields for each season from 2005 to 2017 for each of the 36 sub-basins.
Data source location	Model of Raba River Basin located in: Małopolska Voivodeship Country: Poland 49°31′20″N 19°57′34″E - river source 50°08′15″N 20°30′33″E - river outlet
Data accessibility	In a public repository: Repository name: [Mendeley Data] Data identification number: [http://dx.doi.org/10.17632/rft94c75zb.3] Direct URL to data: [https://data.mendeley.com/datasets/rft94c75zb/3]
Related research article	Orlińska-Woźniak, P., Szalińska, E., Wilk, P., Do Land Use Changes Balance out Sediment Yields under Climate Change Predictions on the Sub-Basin Scale? The Carpathian Basin as an Example, Water 2020, 12(5), 1499; https://doi.org/10.3390/w12051499

Value of the Data

- The dataset expands the knowledge of basin soil leaching processes and their response in terms of sediment yields when different land and climate predictions are taken into consideration.
- This dataset can be used by researchers and policy makers to further develop the field of sediment modeling to include more effective actions into basin management plans.
- The content of this dataset creates a source of extensive and useful information on soil particle movement, and its changes under climate and land use predictions which can be re-used in similar Carpathian or mountainous basins.
- Since soil leaching, as a result of water erosion entails reduction of soil's production, identification of susceptible areas is essential.
- The dataset also enables the user to trace variability of sub-basin responses with the wide spectrum of basin features and climate and land use changes, which is an introduction to the analysis of the impact of basin characteristics on reaction to forecasts.

1. Data Description

The article presents the dataset on average sediment yields (SYLD) for each of the 36 sub-basins in the analyzed area (sheet 1) taking into account seasonal variability. The dataset results from simulations performed with use of the Macromodel DNS/SWAT (Discharge–Nutrient–Sea/Soil and Water Assessment Tool) [1–6]. During the Macromodel simulations a total of 20 variant scenarios, based on future climate and land use change predictions have been adopted (sheet 2). The simulation results present the impact of these scenarios on sediment yields and their comparison to the baseline scenario (sheets 3–6). Dataset sheets (Raba_SYLD) have been divided into three groups: i) informational; ii) functional; and iii) output.

The first two sheets act as information sheets. The user will find there information on the location and division of the Raba River basin into sub-basins, along with the parameters characterizing them (land use, slopes, and soil type), as well as a list of all the used variant scenarios. The selection of the appropriate sub-basin or their group is a base for navigating through the next functional sheets.

- **Sheet 1. sub-basins features** - location of individual sub-basins, their numbers in the Raba River basin and main features: land use, slopes and soils classes share in the sub-basin area;
- **Sheet 2. scenarios** - list of the variant scenarios together with their description.

The next three sheets are considered the functional ones. They allow the user to track and analyze the volume of sediment production (SYLD) in any selected sub-basin of the analyzed area, taking into account the influence of individual seasons. When working with data in these sheets, the user has a wide range of possibilities of their visualization in almost any configuration depending on the needs. This functionality, combined with the specificity of a selected pilot basin representing both mountain and sub-mountain areas, allows for a wide application of this dataset.

- **Sheet 3. results_plot** - results of the individual scenarios impact on the sediment yield in the selected sub-basins and/or seasons, the data is presented in the form of a pivot column chart. Functionality: by using the "Select sub-basin and/or season" buttons, the user can filter any sub-basin and season values.
- **Sheet 4. changes_plot (t/ha)** - sediment yield change for each scenario in comparison to baseline scenario in t/ha (functionality like the previous sheet)
- **Sheet 5. changes_plot (%)** - sediment yield change for each scenario sediment yield change for each scenario in t/ha in comparison to baseline scenario in% (functionality like the previous sheet)

The last sheet contains the final data and allows for locating, tracking and, if necessary, downloading individual data, which are used as a base for the visualization in the functional sheets.

- **Sheet 6. output** - output from the model for all scenarios (see sheet 2. scenarios), average values of sediment yield for each season of data from 2005 to 2017 for 36 sub-basins in t/month

2. Experimental Design, Materials and Methods

To create a dataset for sediment yields, firstly the Macromodel DNS/SWAT was built for the Raba River basin based on the following input data:

- map of Poland hydrographical divisions, scale of 1:10,000 (source: Institute of Meteorology and Water Management - National Research Institute (IMGW-PIB), resolution: 5 m) https://dane.gov.pl/dataset/869,komputerowa-mapa-podziau-hydrograficznego-polski;
- digital elevation model (DEM), scale of 1:20,000 (source: IMGW-PIB, resolution: 10 m) http://www.gugik.gov.pl/pzgik/dane-bez-oplat/dane-dotyczace-numerycznego-modelu-terenu-o-interwale-siatki-co-najmniej-100-m-nmt_100;
- land use map - based on Corine Land Cover (CLC 2012) http://clc.gios.gov.pl/index.php/clc-2012/o-clc2012 (sheet 5), and agrotechnical data from the Local Data Bank (source: Copernicus Programme, resolution 20 m) https://bdl.stat.gov.pl/BDL/start;
- soil map - detailed data on soil types, scale of 1:5000 (source: Institute of Soil Science and Plant Cultivation, resolution 2.5 m) (sheet 1) http://www.iung.pulawy.pl/eng/;
- meteorological data (1992–2016, e.g., precipitation and temperature) for 75 stations located directly in the basin, and within 20 km from its borders (source: IMGW-PIB) https://dane.imgw.pl/data/dane_pomiarowo_obserwacyjne/dane_hydrologiczne/;
- surface water quality data for suspended sediment (source: Polish State Monitoring System) http://www.gios.gov.pl/en/.

The current dataset (Raba_SYLD) contains the extensive sediment yield analyses, for the SYLD parameter, i.e. sediment from the hydrologic response unit (HRU) that is transported into the main channel. The value of the SYLD parameter was determined using the Macromodel DNS/SWAT using the pattern [7, 8]:

$$sed = 11.8 \times \left(Q_{surf} \times q_{peak} \times area_{HRU}\right)^{0.56} \times K_{USLE} \times C_{USLE} \times P_{USLE} \times LS_{USLE} \times CFRG$$

where: *sed* is the sediment yield on a given day (metric tons), Q_{surf} is the surface runoff volume (mm H_2O/ha), q_{peak} is the peak runoff rate (m^3/s), $area_{HRU}$ is the area of the HRU (ha), K_{USLE} is the USLE soil erodibility factor (0.013 t m^2hr/(m^3-metric ton cm)), C_{USLE} is the USLE cover and management factor, P_{USLE} is the USLE support practice factor, LS_{USLE} is the USLE topographic factor, *CFRG* is the coarse fragment factor.

The model simulations have been performed with a monthly time step and subsequently presented as a seasonal average, i.e. winter (December, January, and February), spring (March, April, and May), summer (June, July, and August), and autumn (September, October, and November). The study area of the Raba River basin (151,700 ha), located in the southern part of Poland at the Carpathian Mts., has been divided into 36 sub-basins assembled into two groups (sheet 1), due to the dual character of the basin:

- the upper Raba River basin (17 sub-basins) with a typical mountain character - large slopes, a significant advantage of forest areas over agricultural areas, and soils with large amounts of clay (sheet 1);
- the lower Raba River basin (19 sub-basins) with a sub-montane character - lower slopes, agricultural areas occupy most of this area; loess soils predominate (sheet 1).

The SWAT-CUP software [9] was used to calibrate and verify the model using flow data obtained from the Institute of Meteorology and Water Management, and the total suspended sediment concentrations from the state monitoring system. The SUFI-2 algorithm [10] was used to investigate the sensitivity and uncertainty in the prediction of the flux flow. The calibration, verification, and validation results for all applied statistical measures (R2, NSE, PBIAS, and KGE) revealed satisfactory model performance [11–13]. The calibrated and verified basin model served as a baseline scenario, and was used as a benchmark for later imposed climate and land use scenarios:

- climate scenarios - the climate change scenarios were prepared using temperature and precipitation projections from the EuroCORDEX regional climate [14] https://euro-cordex.net/060378/index.php.en and CMIP5 general circulation models [15] https://esgf-node.llnl.gov/projects/cmip5/, http://climateimpact.sggw.pl/map/proj/. Climate scenarios were built based on RCP 4.5 and 8.5 for short (2021–2050) and a long-time perspective (2071–2100). High data resolution allowed for obtaining climate change forecasts for the Myślenice profile (closing the upper Raba basin), and the Proszówki profile (closing the lower Raba), which were subsequently used for the upper and lower parts of the basin (sheet 4 and 5). The database contains a total of 12 scenarios belonging to this group. 8 single (hypothetical) scenarios for precipitation and temperature marked as Hp1.1 - Hp2.2, and Ht1.1 - Ht2.2 respectively, and four scenarios combining both these parameters marked as C1.1 - C2.2 (sheet 2);
- land use scenarios (LU) - a group of land use scenarios were developed based on the results of the FORECOM project http://www.gis.geo.uj.edu.pl/forecom/. The database contains a total of 3 scenarios belonging to this group. 2 single (hypothetical) scenarios for the two different types of land use: forest (FR) and urban (UR), and one scenario combining both these parameters marked as LU (sheet 2). The hypothetical FR assumes an increase of forest areas by 23% and 30%, respectively, depending on the location of the sub-basin. The hypothetical UR scenario assumes three options for residential med/low density areas - no increase, increase by 10%, and increase by 15% (sheet 2);
- combined scenarios - group of four scenarios (C1.1+LU, C1.2+LU, C2.1+LU and C2.2+ LU) (sheet 2) in which changes LU scenario has been imposed on climate change scenarios. In this way, it was possible to simulate the sediment yield for all sub-basins, taking into account the forecast changes in all the most important factors that may affect it in both the short- and long-term. The data generated in this way allows for precise analyzes of the size of sediment yield for any selected place located in the area selected for research.

Credit author statement

Paulina Orlińska-Woźniak: Conceptualization, Software, Validation, Formal Analysis, Writing-Review & Editing, Visualization **Ewa Szalińska**: Methodology, Formal Analysis, Investigation, Writing-Review & Editing, Supervision **Paweł Wilk**: Methodology, Formal Analysis, Resources, Data Curation, Writing-Review & Editing

All authors have read and agreed to the published version of the manuscript.

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.

Data Availability

A database for a sediment yield analysis in the Raba River basin (Carpathian Mts) (Original data) (Mendeley Data)

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