Pan-European Catchment Modelling: An Open Data Analysis

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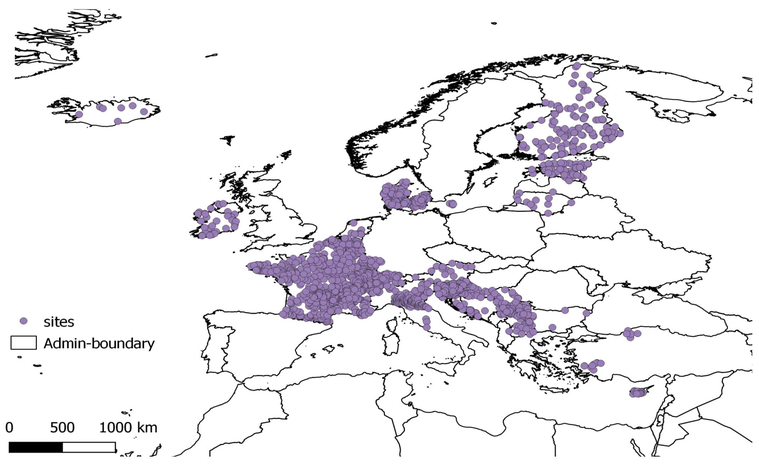
1. Introduction

The European Environment Agency (EEA) provides publicly available geo-data which can be used for environmental modelling in the EU. In the case of water quality data provided by the Water Information System in Europe (WISE) - which was created applying the Water Framework Directive (WFD) - has the potential to be used for higher tier aquatic risk assessment. Notably the discharge time series can be used for setting up hydrological models. In this study we present an application of the WISE dataset combined with additional EU wide data of climate (MARS), hydrological catchments (CCM2) and land use (Capri) for the Meuse basin as an example.

2. Datasets & Methods

Dataset	Data type	Source
Waterbase_v2018_1_T_WISE3_MonitoringData.csv **Waterbase_v2018_1_WISE3_MonitoringSite_DerivedData.csv**	Surface water discharge records with full dates Locations of monitoring sites	EEA 2019
CCM version 2.1	Catchment polygons and river segment lines	De Jager et al. 2007
MARS-AGRI4CAST: Gridded Agro-Meteorological Data in Europe	Precipitation (P) and Potential Evapotranspiration (PET) from crop canopy.	MARS-AGRI4CAST 2019
EFSA Spatial Data Version 1.1 - Capri land use maps	Land use	Panagos et al. 2012

2.1 WISE Dataset



Countries	Monitoring stations with full records	Record period
Austria	22	2007-2014
Belgium	98	2009-2017
Bulgaria	4	2010-2011
Switzerland	81	2009-2017
Cyprus	16	1998-2017
Denmark	196	2010
Estonia	71	2011-2015
Finland	136	2009-2017
France	544	2001-2012
Croatia	83	1985-2017
Ireland	32	1975-2017
Iceland	7	2011
Italy	134	2013-2015
Lichtenstein	1	2009-2011
Lithuania	12	2009-2011
North Macedonia	10	2005-2009
Netherlands	11	2009-2011
Serbia	91	2009-2017
Slovenia	164	1961-2015
Turkey	14	2006-2009

Gauging stations with continuous daily records for a minimum period of one year are shown on the map and the table. In order to assure at least one full cropping season, at least a time series of a fully completed year is required. Therefore, all other records not fulfilling this criteria have been excluded.

2.2 CCM2

The CCM2 catchment dataset uses a hierarchical data model describing the hydrological catchments in Europe.

The smallest subunit (WSO1) is appropiate to aggregate catchments for the individual gauging locations of the WISE dataset in order to derive the corresponding watershed area of the gauging stations. For all these resulting catchments the area specific discharge was calculated.

The complete WISE dataset covers 483 drainage basins with a mean size of 925 km². The largest catchment has a size of 39,956 km² and is located in Finland.

2.3 MARS Dataset

In order to compare the specific discharge of the gauging stations, we further calculated the area specific discharge for the catchment with a simple water balance equation (P - AET). Actual evapotranspiration was calculated from the meteorological variables precipitation and potential evapotranspiration, which were both derived from the MARS dataset. As calculation methodology we used the modified Turc (1955) formula and the parametrisation by Pistocchi et al. (2008) with α=1 and β=1.5:

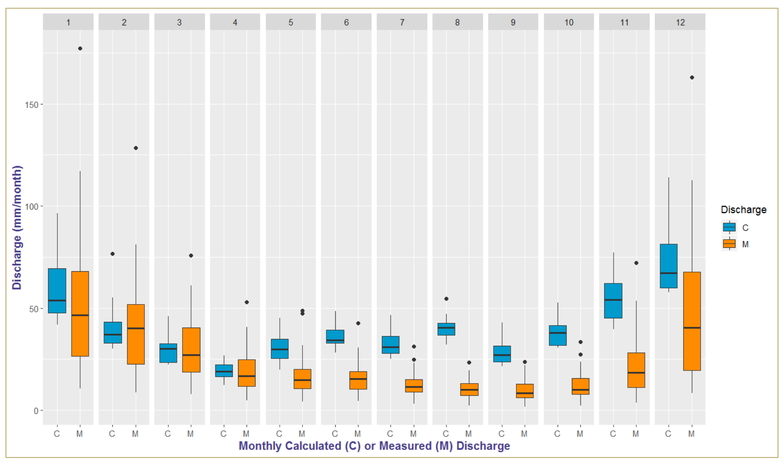
$$AET = \frac{P}{\left(\alpha + \left(\frac{P}{PET}\right)^{\beta}\right)^{\frac{1}{\beta}}}$$

3. Case Study: The Meuse Basin

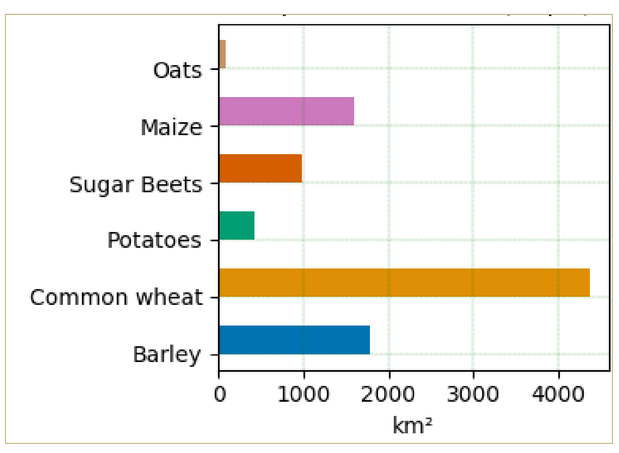
The Meuse basin drains from France through Belgium to the Netherlands. The WISE dataset contains 54 gauging stations with daily discharge records across the catchment. Most of the gauges are located in Belgium (43), 9 in France and two in the Netherlands. By comparing the monthly calculated specific discharge values to the observed ones, the calculated values show a good correlation with the observed values from January through April, while during the rest of the year discharge is overestimated. This could be due to the simplified water balance equation and the simplistic AET calculation methodology.

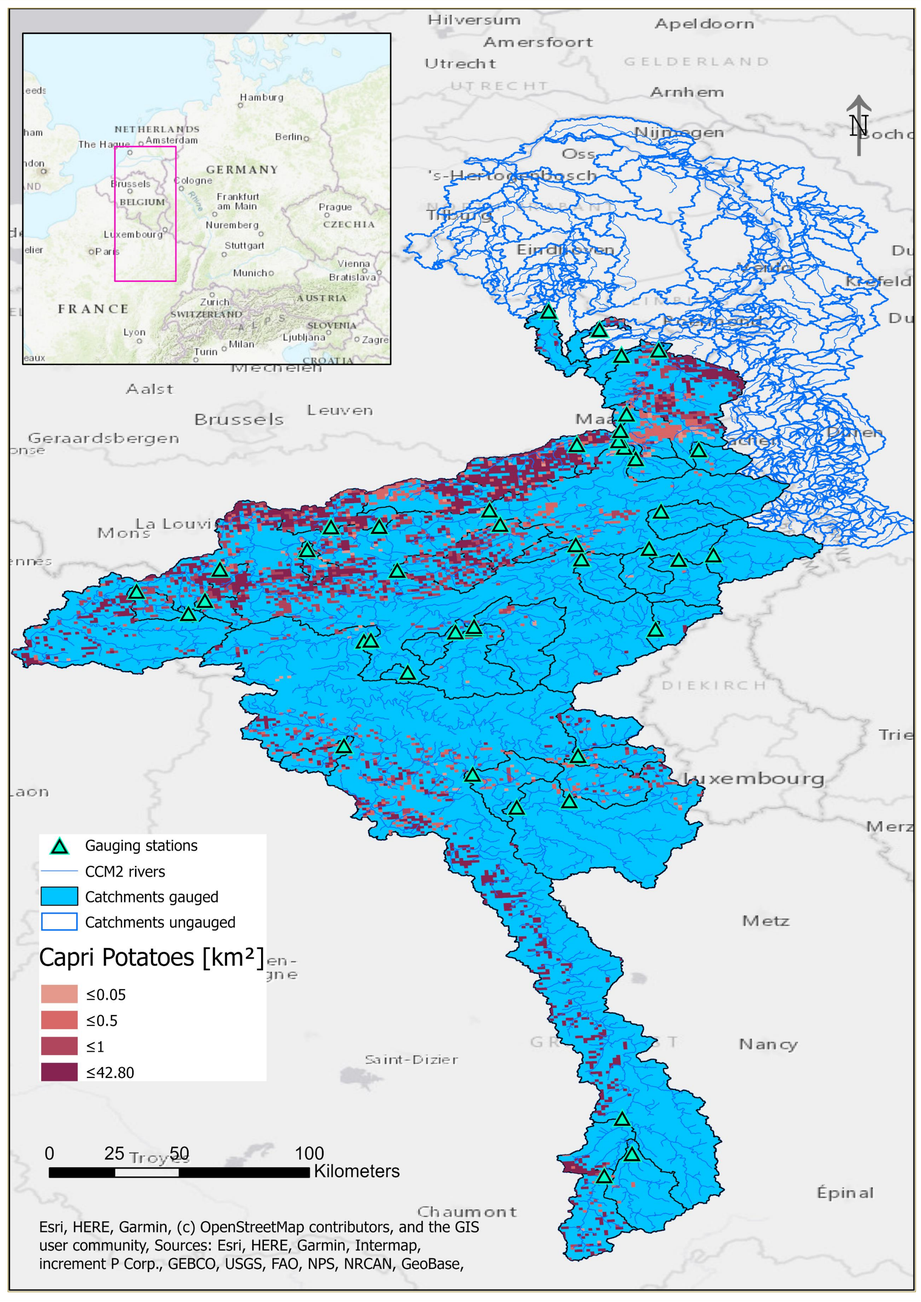
The map on the right shows the gauged catchments (total size: 22,648 km²) and the crop area for potatoes. We selected potatoes as the example for this analysis as their coverage is limited to several specific patches in the catchments compared to the other more extensivly planted crops. By combining all spatial data layers, the potential locations for catchment monitoring/modelling are identified especially in the north-west of the basin. These catchments could become higly interesting objects for further research regarding their suitability for modelling in accordance to the specific exposure pathway criterias (e.g. pedoclimatic conditions).

Calculated vs. Measured Discharge by Month



Crop Area for gauged Catchments (Capri)





4. Discussion & Conclusions

The results of the comparison between the calculated and the measured discharges show differences, possibly due to a simplified and not process based calculation methodology. Suggesting that the gauging data as well as the meteorological parameters provided by MARS are sufficiently reliable for hydrological modelling and further calibration efforts, we consider the magnitude of the observed deviations to be acceptable. Moreover, we demonstrated feasibiliy to identify candidate locations for setting up a catchment model for a given crop by combining information from WISE, CCM2 and the Capri Land use map. For a suitable hydrologic catchment model, see the companion poster by Krebs et. al (3.10P.13).

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De Jager et al. 2007, European Commission, Joint Research Centre (JRC)
EEA 2019, https://www.eea.europa.eu/
MARS-AGRI4CAST, 2019, European Commission's Joint Research Centre (JRC)
Panagos et al., 2012, Land Use Policy, 29 (2), pp. 329-338
Pistocchi et al., 2008, Water Resources Research, 44(12)