Development of soil and land cover databases for use in the Soil Water Assessment Tool from Irish National Soil Maps and CORINE Land Cover Maps for Ireland

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Abstract. Soil Water Assessment Tool (SWAT) is being extensively used by hydrologists and environmentalists to simulate river discharge and water quality at watershed/basin scale across the world. The SWAT is a physically-based semi-

10   distributed rainfall-runoff model and requires watershed related characteristics (elevation, land cover, and soil information for the entire river basin) and meteorological variables (rainfall, temperature, relative humidity, solar radiation, and wind speed) information to simulate runoff and water quality data at the basin outlet. One drawback of SWAT is that the default database for the model is available for the United States and the modeller needs to develop a separate database to implement the model at river basins located outside the USA. This study generates a soil and landcover database that can be used for the

15   SWAT modelling for river basins located in Ireland. The soil database has been created based on soil testing experiments conducted during the STRIVE programme by Teagasc and Environmental Protection Agency Ireland. The landcover database has been created by relating the landcover data obtained from the CORINE database with the default SWAT landcover database. Furthermore, detailed information on the five meteorological data covering Ireland has been provided. A newly created SWAT geodatabase has been generated that can be used as a replacement from the default SWAT database for

20   simulating runoff and water quality at river basins in Ireland. The database contains a digital elevation model, soil and landcover maps along with river network and river subbasins for Ireland and is publicly available at: https://doi.org/10.5281/zenodo.4767926 (Basu, 2021).

Keywords: SWAT database; Ireland; Soil map; Landcover map; SWAT2012.mdb

1 Introduction

25   The soil properties and land cover information are being used for a wide range of studies ranging from agricultural and yield management, environmental and urbanization studies, archaeological and heritage conservancy, biodiversity and forest protection, and environmental policy decisions (Kempen et al., 2009). The soil and land cover data are vital for identifying the changes in the dynamics of hydrological systems, which are often synthesized through process-based hydrologic modelling (Ahuja et al., 2007; Cordeiro et al., 2018). A popular hydrological model to simulate streamflow/runoff at a

30   basin/watershed outlet is the Soil and Water Assessment Tool (SWAT). The SWAT model is a conceptual semi-distributed continuous-time hydrological model developed by the United States Department of Agriculture to simulate the water transport at a watershed scale on a daily/sub-daily time scale (Arnold et al., 1993; Arnold et al., 1998). The model is useful in the assessment of several environmental phenomena such as land management, hydrological processes and water use, bacteria and pathogen transport, pollution apportionment in rivers (Santhi et al., 2005; Ghaffari et al., 2010; Baker and

35   Miller, 2013). SWAT is widely reported in databases used for tillage and crop management practices (Liu et al., 2013; Ulrich and Volk, 2009). The SWAT model has been extensively used globally for river basin scale modelling as well as for water quality analysis (Tuppad et al., 2011). The SWAT model requires information on the elevation, land cover, and soil attributes from the watershed along with the meteorological variables in the region (Arnold et al., 1993; Arnold et al., 1998). The preparation of soil and land-use database for running the SWAT model requires the soil and land classes information to

40   be segregated and accumulated from various reports (Cordeiro et al., 2018). As part of the pre-processing information, publicly available information can be useful for the preparation of soil and land cover databases for the SWAT model (Pflugmacher et al., 2019). The State Soil and Geographic database (STATSGO) and Soil Survey Geographic database (SSURGO) developed by the US Department of Agriculture for the United States is the publicly available national soil databases that can readily be used with the SWAT model (Geza and Mccray, 2008). The Soil Landscapes of Canada (SLC)

45   database published by Agriculture and AgriFood Canada is another publicly used database used for SWAT applications for Canadian watersheds (Cordeiro et al., 2018). This study develops a soil database that is compatible with the SWAT model for Ireland. The database was prepared based on the publicly available soil information created via the Teagasc-EPA Soils and Subsoils Mapping Project (Fealy, 2009) for Ireland. This soil database has various soil associations which were categorized and have relative ranking along with the extent of the soil (Fealy, 2009).

50   The CORINE landcover database classifies various land classes for Pan-Europe into areas such as urban land, forestry, vegetation, water bodies, etc. (Feranec et al., 2016) and is being used for Ireland. Since the available soil and landcover data for Ireland cannot readily be used with the SWAT model, this paper aims to develop a framework to create a new soil database for Ireland that can be used as a substitute to the SWAT model's default soil database. The landcover classes available in the CORINE map have been reclassified into landcover classes that are recognisable by the SWAT model.

55   Furthermore, the elevation and meteorological data file needed to simulate the model has been generated for Ireland that can readily be loaded in the model. Location of the sub-basins and the river network for Ireland is shown in Figure 1. Sections 2, 3, 4, and 5 provide details on the soil, land cover, elevation, and meteorological data respectively for Ireland while section 6 provides details on the steps needed to provide the data into the SWAT model and integrate the newly developed soil database into the model.

2 Soil database

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The soil parameter values of the SWAT model for the soil map of Ireland have been estimated and a soil database was developed to be used for SWAT analysis at river basins in Ireland. Details of the Ireland soil map, SWAT soil database, and the steps used to create the SWAT database for Ireland are provided below.

2.1 Ireland Soil Map

65 The Irish National Soil Map was developed as part of the Irish Soil Information System project funded under the Science, Technology and Research & Innovation for the Environment (STRIVE) programme. The project was co-funded by Teagasc and Environmental Protection Agency (EPA) Ireland and was led by Teagasc, Cranfield University from the United Kingdom, and University College Dublin, Ireland for the period 2007-2013. A 1:250,000 scale national soil map covering entire Ireland was developed that replaced the previously available 1:575,000 soil map for the country. The soil map is
70 available via the following link: http://gis.teagasc.ie/soils/

Based on the soil data collected during the project, a total of 213 different types of soil data present in the topsoil layer as well as subsoil layer were identified. Based on the types of soils, Ireland's topsoil has been subdivided into 69 classes and is shown in Figure 2. A set of soil characteristics namely soil colour, texture, Munsell colour value, structure, consistency, presence of roots, Hydrochloric acid reaction, pH, percentage of Nitrogen and Carbon, percentage of free Iron, carbon
75 exchange capacity, percentage of sand, silt and clay, unsaturated bulk density were estimated form those soil types using laboratory tests (Simo et al., 2007). Values of those characteristics are provided in http://gis.teagasc.ie/soils/soilguide.php. Out of those characteristics, soil depth, organic carbon, sand, silt, clay and rock percentage content and Munsell values were used to develop the soil database for SWAT modelling.

2.2 SWAT soil database

80 The SWAT model has a default "usersoil" database developed for United States of America (USA) soil maps. Each row in the database denotes each soil type. The soil database table has a total of 152 columns where the first column is a OBJECTID field that provides a unique identification to a soil type. The second column is called map unit identifier (MUID) which is used to map areas with the same soil characteristics. In situations where more than one soil types are present in the same MUID, a different sequence number (SEQN) was provided in the third column (Cordeiro et al., 2018). The fourth, fifth
85 and sixth column records the soil name (SNAM), soil interpretation record (S5ID) and percent of each soil component (CMPPCT) of the State Soil Geographic (STATSGO) soils data developed for USA (Sheshukov et al., 2009). Column 7 to 12 stores important soil-related information in which column 7 records the number of layers present in the subsoil (NLAYERS), column 8 record the type of hydrological soil group (HYDGRP), column 9 note the maximum rooting depth of the soil profile (SOL_ZMX), column 10 records the fractional value of the soil porosity from which anions are excluded

90   (ANION_EXCL), column 11 contain potential/maximum crack volume of the soil profile in fraction of total soil volume (SOL_CRK), and column 12 records the soil layer texture (TEXTURE).

The SWAT soil database can account for a total of 10 different soil and subsoil layers. Corresponding to each layer 12 soil-related parameters needs to be recorded in the usersoil database (Arnold et al., 2013). The next 120 columns starting from column 13 till column 132 has the provision to record the soil characteristics of 10 soil layers. In situations where the

95   number of soil layers is less than 10, the soil parameter values higher than the soil layer numbers NLAYERS are considered to be zero. The 12 soil parameters recorded in the database are i) depth of the soil layer in mm (SOL_Z), ii) moist bulk density in gm/cm3 (SOL_BD), iii) available water capacity of the soil layer in mm H20/mm soil (SOL_AWC), iv) saturated hydraulic conductivity in mm/hr (SOL_K), v) organic carbon content in percentage of soil weight (SOL_CBN), vi) clay content in percentage of soil weight (CLAY), vii) silt content in percentage of soil weight (SILT), viii) sand content in

100   percentage of soil weight (SAND), ix) rock fragment content in percentage of the total weight of that layer (ROCK), x) moist soil albedo (SOL_ALB) only for the topsoil layer, xi) soil erodibility factor K in (metric ton m2 hr)/(m3 metric ton cm) estimated using the Universal Soil Loss Equation (USLE_K), and xii) electrical conductivity in dS/m (SOL_EC). The electrical conductivity SOL_EC is currently inactive in the SWAT model and assigned a value zero for all layers. The SWAT database also considers the CaCO3 and pH values of the 10 soil layers from columns 133 to 152 respectively.

105   However, at the current state, those two parameters are also inactive in the SWAT model and hence assigned a zero value.

2.3 Development of soil database in Ireland for Irish National Soil Map

Based on the Irish National Soil Map, Ireland can be subdivided into 69 different soil classes. Each of those soil classes has 1-6 number of layers and covers 213 different soil types. In the new database those soil classes are provided a unique OBJECTID ranging from 1 to 69 and the MUID and SNAM were provided as D1 to D69, respectively. The soil classes were

110   categorized into one of the four hydrological soil groups A, B, C or D based on the infiltration characteristics.

Based on the SWAT manual (Arnold et al., 2013) and Gijsman et al. (2007) the hydrological soil groups for the 69 soil classes of Ireland were selected as follows:

Hydrological group A: Sandier, deeper soils (% sand > 86, depth >= 1500 mm)

Hydrological group B: Fairly sandy, mid-depth soils (% sand >50, % clay < 35, and depth > 500 mm)

115   Hydrological group C: Soils having slightly more clay than sand, fairly shallow depth (% clay >= 28, % sand <= 44, and depth <= 800 mm)

Hydrological group D: Very clay soils (% clay >= 50)

In situations where a soil class cannot readily be classified into one of the four classes, a default value of B is provided. The infiltration rate is highest for hydrological group A, gradually reduces and takes the least value for group D. Map of Ireland

120   in terms of hydrological group is shown in Figure 3.

The number of soil layers and the maximum soil depth for each of the 69 soil classes are obtained based on the Irish Soil Information System Soil profile handbook prepared by Simo et al. (2007). Out of the 11 soil-related parameters (excluding

SOL_EC) for each soil layer, 6 parameters SOL_Z, SOL_CBN, CLAY, SILT, SAND, and ROCK were obtained from Simo
et al. (2007). Three parameters SOL_BD (ρ_B in equation), SOL_AWC ($\theta_{(S-33)DF}$ in equation) and SOL_K (K_S in

125 equation) were estimated for each layer based on the organic carbon content SOL_CBN (OM in equations), and CLAY (C in
equations), SAND (S in equations), and ROCK (R in equations) content percentage using the equations derived by Saxton
and Rawls (2006) that were subsequently used to develop the Soil-Plant-Air-Water (SPAW) simulation model by United
States Department of Agriculture. The equations for estimation of the three parameters are provided below.

$$\theta_{1500t} = -0.024 \times S + 0.487 \times C + 0.006 \times OM + 0.005 \times S \times OM - 0.013 \times C \times OM$$

130
$$+ 0.068 \times S \times C + 0.031$$

$$\theta_{1500} = \theta_{1500t} + 0.14 \times \theta_{1500t} - 0.02$$

$$\theta_{33t} = -0.251 \times S + 0.195 \times C + 0.011 \times OM + 0.006 \times S \times OM - 0.027 \times C \times OM$$

$$+ 0.452 \times S \times C + 0.299$$

$$\theta_{33} = \theta_{33t} + 1.283 \times (\theta_{33t})^2 - 0.374 \times \theta_{33t} - 0.015$$

135
$$\theta_{(S-33)t} = 0.278 \times S + 0.034 \times C + 0.022 \times OM - 0.018 \times S \times OM - 0.027 \times C \times OM$$

$$- 0.584 \times S \times C + 0.078$$

$$\theta_{(S-33)} = \theta_{(S-33)t} + 0.636 \times \theta_{(S-33)t} - 0.107$$

$$\theta_S = \theta_{33} + \theta_{(S-33)} - 0.097 \times S = 0.043$$

$$\rho_N = (1 - \theta_S) \times 2.65$$

140
$$\rho_{DF} = \rho_N \times DF$$

$$\theta_{S-DF} = 1 - \rho_{DF}/2.65$$

$$\theta_{33-DF} = \theta_{33} - 0.2 \times (\theta_S - \theta_{S-DF})$$

$$\theta_{(S-33)DF} = \theta_{S-DF} - \theta_{33-DF}$$

$$R_v = \frac{\rho_N \times R/2.65}{1 - R \times (1 - \rho_N/2.65)}$$

$$\rho_B = \rho_N \times (1 - R_v) + R_v \times 2.65$$

$$\lambda = [ln(\theta_{33}) - ln(\theta_{1500})]/[ln(1500) - ln(33)]$$

$$K_S = 1930 \times (\theta_S - \theta_{33})^{3-\lambda}$$

Details on the intermediate terms in the set of equations are provided in Saxton and Rawls (2006).

The albedo of the topsoil SOL_ALB has been estimated using the Munsell colour value (M in the equation) provided in Simo et al. (2007) based on the regression relationship developed by Post et al. (2000). The albedo SOL_ALB (α in the equation) was estimated as,

α=0.069×M-0.114

In situations where the Munsell value is unknown, the albedo was taken as 0.13 (Gies and Merwade, 2015).

The Universal Soil Loss Equation (USLE) factor used to estimate the soil erodibility was developed by the Food and Agriculture Organization (FAO) of the United Nations (Gies and Merwade, 2015). The equation is given as follows.

$$ULSE\_K = f_{c-sand} \times f_{cl-si} \times f_{orgc} \times f_{hi-sand}$$

$$f_{c-sand} = 0.2 + 0.3 \times exp[-0.256 \times S \times (1 - SILT/100)]$$

$$f_{cl-si} = \left(\frac{SILT}{C + SILT}\right)^{0.3}$$

$$f_{orgc} = 1 - \frac{0.0256 \times OM}{OM + exp[-5.51 + 22.9 \times (1 - S/100)]}$$

$$f_{hi-sand} = 1 - \frac{0.7 \times (1 - S/100)}{(1 - S/100) + exp[-5.51 + 22.9 \times (1 - S/100)]}$$

3 Land cover database

The land cover maps for Ireland can be obtained from the CORINE land cover inventory (https://land.copernicus.eu/pan-european/corine-land-cover). The land cover maps were prepared for Pan European countries using visual interpretation of high-resolution satellite imageries. The land cover maps are available for the years 1990, 2000, 2006, 2012, and 2018 and the spatial resolution of each of those maps is 100 meters. Landsat-5 satellite data obtained from 1986-1998 were used to create the land cover map for 1990; Landsat-7 satellite data collected for 1999-2001 were used to develop 2000 land cover maps; land cover maps for the year 2006 was generated using STOP-4, SPOT-5, and IRS P6 satellite images collected for the period 2005-2007; IRS P6 and RapidEye satellite data obtained from 2011-2012 were used to create 2012 land cover maps;

whereas Sentinel-2 and Landsat-8 satellite data collected for 2017-2018 were used to generate 2018 land cover images. The
170   CORINE land cover maps for Europe consist of 44 different land cover classes, shown in Table 1. The default land use and
land cover classes available in the SWAT database do not completely match with the land cover classes present in each of
the CORINE land cover maps. Hence, a relationship between the CORINE land cover classes with the default SWAT model
land use and land cover classes is necessary. In Table 1 each of the CORINE land cover classes is linked with the default
land cover classes that are recognizable by the SWAT model. In order to run the SWAT model, a user-defined land cover
175   file needs to be loaded that has been prepared based on Table 1. For brevity, the CORINE land cover map for the year 2018
and the reclassified land cover map compatible with SWAT classification for Ireland are shown in Figure 4. Out of these 44
land cover classes, Ireland has 35 land cover classes present from the CORINE database.

4 Digital Elevation Model data

The SWAT model requires elevation information along with the soil and land cover information for analysis. For a large
180   study area, Digital Elevation Model (DEM) is a reliable source of elevation data. Presently, four DEM data sources are
available for Ireland. They are the Shuttle Radar Topographic Mission (SRTM) DEM with 90m resolution
(http://srtm.csi.cgiar.org/), the Advanced Spaceborne Thermal Emission and Reflection Radiometer (ASTER) DEM with
30m   resolution   (https://ssl.jspacesystems.or.jp/ersdac/GDEM/E/),   the   EU   DEM   with   25m   resolution
(https://www.eea.europa.eu/data-and-maps/data/copernicus-land-monitoring-service-eu-dem) and the Bluesky DEM having
185   a resolution of 1m (https://www.bluesky-world.com/standard-height-data). The DEM is one of the most important data
needed for the SWAT model as it is used to delineate the watershed/basin boundary, develop the stream network in the
watershed, and estimate the slope of the watershed. Fine resolution DEM can delineate the watershed and generate the
stream network with considerable accuracy, which is important to simulate surface runoff at the basin outlet. The EU-DEM
was generated for 39 countries across Europe by DHI GRAS Geocenter Denmark (DHI GRAS, 2014) as a hybrid DEM
190   based on STRM DEM, ASTER DEM, and publicly available topographic maps, and hence was found to have better
accuracy than both STRM and ASTER. However, even though the Bluesky DEM has the finest resolution, it is available
only for a portion of Ireland and is not open-source data, unlike the other three datasets. For this reason, the EU-DEM has
been suggested for analysis with the SWAT model. It needs to be noted that even though for the majority of the watersheds
the EU-DEM can be considered to be accurate enough since they are mainly generated based on satellite imagery, the
195   elevation values at certain pixels (where each pixel is of the size of 25m x 25m) can be erroneous due to the presence of
sudden changes of elevations al local scale, which can lead to a generation of discontinuous river networks in the river basin
using SWAT model. One option is to perform a filling of the EU-DEM before using it for modelling. The filled DEM values
for Ireland have been provided in Figure 5.

5 Meteorological variables

200 Along with the three watershed-related variables soil, land cover, and DEM, the SWAT model requires time series data of five meteorological variables at daily/sub-daily time scale covering the entire time period for which the model outputs are required. The five meteorological variables are rainfall, daily maximum and minimum temperature, daily average relative humidity (RH), daily average wind speed (WS), and daily average solar radiation (SR). The rainfall data can be at a daily scale or an hourly scale. The SWAT model output will be of the same time scale as that of the rainfall data. The five

205 meteorological variables time series data available at locations within or surrounding the river basin are used by the SWAT model to simulate runoff. The SWAT model output is highly dependent on the accuracy of those meteorological variables' inputs, particularly the rainfall data. For this reason, it is advisable to provide observed meteorological data (Arnold et al., 2013). However, in situations where the watershed is large in area and a relatively small number of rain gauges, temperature gauges, and weather stations measuring RH, WS, and SR are located inside or in the near vicinity of the watershed,

210 alternative databases need to be considered for modelling purposes. Figure 6 provides the locations of the rain gauges, temperature gauges, and weather stations in Ireland. Those gauges/stations are maintained by the Met Eireann office, which is a government organization that provides meteorological services to the Republic of Ireland. It needs to be noted that some of those gauges/stations have considerable missing data and/or not active at the present state. In situations where considerable gauges/stations are located in close proximity to the target watershed selected for analysis, the historical

215 meteorological data can be readily used. However, when the number of gauges/stations is less, or considerable data in those stations are missing, then alternate data sources need to be considered for the development of the SWAT model. It can be noted from Figure 6 that apart from the rain gauges, the number of temperature gauges and the weather stations is considerably low for Ireland.

A readily available data source of the meteorological variables is the COPERNICUS E-OBS dataset. The dataset was

220 generated based on a network of station data observations from European National Meteorological and Hydrological Services and other European database centres. The dataset covers the majority of Europe and provides rainfall, maximum and minimum temperature, relative humidity, and shortwave solar radiation at 0.1° grids spacing at a daily time scale from the year 1950 till the present time. The data can be obtained from the following link: https://cds.climate.copernicus.eu/cdsapp#!/dataset/insitu-gridded-observations-europe?tab=form. It can be noted that wind

225 speed is not available in this dataset. The ERA5-Land data from the COPERNICUS database can be another alternative data source where four out of five meteorological variables (excluding relative humidity) are available from 1981 to the present date at hourly time scale, available from https://cds.climate.copernicus.eu/cdsapp#!/dataset/reanalysis-era5-land?tab=form. It can be noted that the dew point temperature is available in the ERA5-Land database, which can be used to estimate the relative humidity. The grid spacing for ERA5-Land data is equal to 0.1° covering the entire globe. Locations of the E-OBS

230 grids and the ERA5 grids for Ireland are shown in Figure 7.

6 Database for Ireland and steps to link the database with SWAT model and loading the data

The soil, land cover, and filled DEM maps that can readily be used with the SWAT model for Ireland are provided in the following link: https://doi.org/10.5281/zenodo.4767926 with a DOI: 10.5281/zenodo.4767926 (Basu, 2021). In the data folder, the following data and databases are available: i) SWAT2012.mdb, ii) DEM_IRL_ITM.tif, iii)
235   WFD_Rivers_ITM.shp, iv) WFD_SubBasins_ITM.shp, v) LULC2018_IRL_ITM.tif, vi) lulc_classes.txt, vii) SOIL_IRL_ITM.tif, and viii) soillookup.txt.

The newly developed soil database is integrated into SWAT geodatabase SWAT2012.mdb. Once the SWAT model is set up, the default SWAT2012.mdb needs to be replaced by the newly created SWAT2012.mdb before processing the model development. The filled DEM for Ireland (DEM_IRL_ITM.tif) can be used to generate the stream network, delineate
240   watershed boundary and create the basin slope. The river network and the sub-watersheds/subbasins for Ireland were developed by the Environmental Protection Agency Ireland under Water Framework Directive (WFD) as open data. The river and subbasin network were provided as shapefile (WFD_Rivers_ITM.shp and WFD_SubBasins_ITM.shp). The landcover map for Ireland (LULC2018_IRL_ITM.tif) has the available 35 landcover classes, while the soil map (SOIL_IRL_ITM.tif) has 69 soil classes. It should be noted that the SWAT model requires the DEM, landcover, and soil
245   maps in a projected coordinate system. All the maps and shapefiles in the database have been projected into the Irish Transverse Mercator coordinate system with an EPSG code of 2157. The landcover map should be reclassified using the landcover classes shown in Table 1 in order to relate the CORINE landcover classifications with landcover classes recognized by the SWAT model. This can be performed using the landcover lookup table (*lulc_classes.txt*). Similarly, the soil map needs to be reclassified using the soil lookup table (*soillookup.txt*).

250   ## 7 Data availability

ZENODO is a general-purpose open-access repository developed under the European OpenAIRE program and operated by CERN, which allows researchers to archive research papers, data sets, research software, and reports. The entire dataset developed in this study (Basu, 2021) has been published and archived in the ZENODO database (https://doi.org/10.5281/zenodo.4767926) under CC BY 4.0 International license, where the user must give appropriate
255   credit, provide a link to the license, and indicate if changes are made.

8 Conclusions

A new soil and landcover database have been prepared to integrate with the SWAT model for Ireland. The database is publicly available for use using the following link: https://doi.org/10.5281/zenodo.4767926. The soil map for Ireland was obtained from Teagasc while the landcover map was obtained from the COPERNICUS CORINE database. Both the
260   databases are publicly available as per the open data policy. In order to link the soil map with the SWAT model, this research

developed a new soil database based on soil testing experiments conducted during the STRIVE programme by Teagasc and Environmental Protection Agency Ireland, while the landcover database has been created to link the landcover classes in CORINE map with the landcover classes recognisable by SWAT model.

Author contribution

265   Basu has created the database and prepared the manuscript.

Competing Interests

The authors declare that they have no conflict of interest.

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270   meteorological data for public use under open data policy.

References

Ahuja, L.R., Andales, A.A., Ma, L. and Saseendran, S.A.: Whole-system integration and modeling essential to agricultural science and technology for the 21st century. Journal of Crop Improvement, 19(1-2), 73-103, 2007.

Arnold, J.G., Allen, P.M. and Bernhardt, G.: A comprehensive surface-groundwater flow model. Journal of hydrology,
275   142(1-4), 47-69, 1993.

Arnold, J.G., Kiniry, J.R., Srinivasan, R., Williams, J.R., Haney, E.B. and Neitsch, S.L.: SWAT 2012 input/output documentation. Texas Water Resources Institute, 2013.

Arnold, J.G., Srinivasan, R., Muttiah, R.S. and Williams, J.R.: Large area hydrologic modeling and assessment part I: model development 1. JAWRA Journal of the American Water Resources Association, 34(1), 73-89, 1998.

280   Baker, T.J. and Miller, S.N.: Using the Soil and Water Assessment Tool (SWAT) to assess land use impact on water resources in an East African watershed. Journal of hydrology, 486, 100-111, 2013.

Basu, B: Soil, Landcover and DEM database for Ireland to be used with SWAT model, ZENODO, https://doi.org/10.5281/zenodo.4767926, 2021.

Cordeiro, M.R., Lelyk, G., Kröbel, R., Legesse, G., Faramarzi, M., Masud, M.B. and McAllister, T.: Deriving a dataset for
285   agriculturally relevant soils from the Soil Landscapes of Canada (SLC) database for use in Soil and Water Assessment Tool (SWAT) simulations. Earth System Science Data, 10(3), 1673-1686. 2018.

DHI GRAS: EU-DEM Statistical Validation. European Environment Agency, 2014.

Fealy, R.: Teagasc-EPA Soils and Subsoils mapping project: Final report V. 1. Teagasc; Environmental Protection Agency, 2009.

290 Feranec, J., Soukup, T., Hazeu, G. and Jaffrain, G. eds.: European landscape dynamics: CORINE land cover data. CRC Press, 2016.

Geza, M. and McCray, J.E.: Effects of soil data resolution on SWAT model stream flow and water quality predictions. Journal of environmental management, 88(3), 393-406, 2008.

Ghaffari, G., Keesstra, S., Ghodousi, J. and Ahmadi, H.: SWAT-simulated hydrological impact of land-use change in the 295 Zanjanrood basin, Northwest Iran. Hydrological Processes: An International Journal, 24(7), 892-903, 2010.

Gies, L. and Merwade, V.: Creating SWAT Soil Database using FAO Soil and Terrain Database of East Africa (SOTER) Data. Civil Engineering. Purdue University. West Lafayette, Indiana, 2015.

Gijsman, A.J., Thornton, P.K. and Hoogenboom, G.: Using the WISE database to parameterize soil inputs for crop simulation models. Computers and Electronics in Agriculture, 56(2), 85-100, 2007.

300 Kempen, B., Brus, D.J., Heuvelink, G.B. and Stoorvogel, J.J.: Updating the 1: 50,000 Dutch soil map using legacy soil data: A multinomial logistic regression approach. Geoderma, 151(3-4), 311-326, 2009.

Liu, R., Zhang, P., Wang, X., Chen, Y. and Shen, Z.: Assessment of effects of best management practices on agricultural non-point source pollution in Xiangxi River watershed. Agricultural Water Management, 117, 9-18, 2013.

Pflugmacher, D., Rabe, A., Peters, M. and Hostert, P.: Mapping pan-European land cover using Landsat spectral-temporal 305 metrics and the European LUCAS survey. Remote sensing of environment, 221, 583-595, 2019.

Post, D.F., Fimbres, A., Matthias, A.D., Sano, E.E., Accioly, L., Batchily, A.K. and Ferreira, L.G.: Predicting soil albedo from soil color and spectral reflectance data. Soil Science Society of America Journal, 64(3), 1027-1034, 2000.

Santhi, C., Muttiah, R.S., Arnold, J.G. and Srinivasan, R.: A GIS-based regional planning tool for irrigation demand assessment and savings using SWAT. Transactions of the ASAE, 48(1), 137-147, 2005.

310 Saxton, K.E. and Rawls, W.J.: Soil water characteristic estimates by texture and organic matter for hydrologic solutions. Soil science society of America Journal, 70(5), 1569-1578, 2006.

Sheshukov, A., Daggupati, P., Lee, M.C. and Douglas-Mankin, K.: ArcMap tool for pre-processing SSURGO soil database for ArcSWAT. In Proceedings of the 5th International SWAT Conference, 5-7, August 2009.

Simo, I., Creamer, R., Reidy, B., Jahns, G., Massey, P., Hamilton, B., Hannam, J., McDonald, E., Sills, P. and Spaargaren, 315 O.: Irish Soil Information System Soil profile handbook, 2007.

Tuppad, P., Douglas-Mankin, K.R., Lee, T., Srinivasan, R. and Arnold, J.G.: Soil and Water Assessment Tool (SWAT) hydrologic/water quality model: Extended capability and wider adoption. Transactions of the ASABE, 54(5), 1677-1684, 2011.

Ullrich, A. and Volk, M.: Application of the Soil and Water Assessment Tool (SWAT) to predict the impact of alternative 320 management practices on water quality and quantity. Agricultural Water Management, 96(8), 1207-1217, 2009.
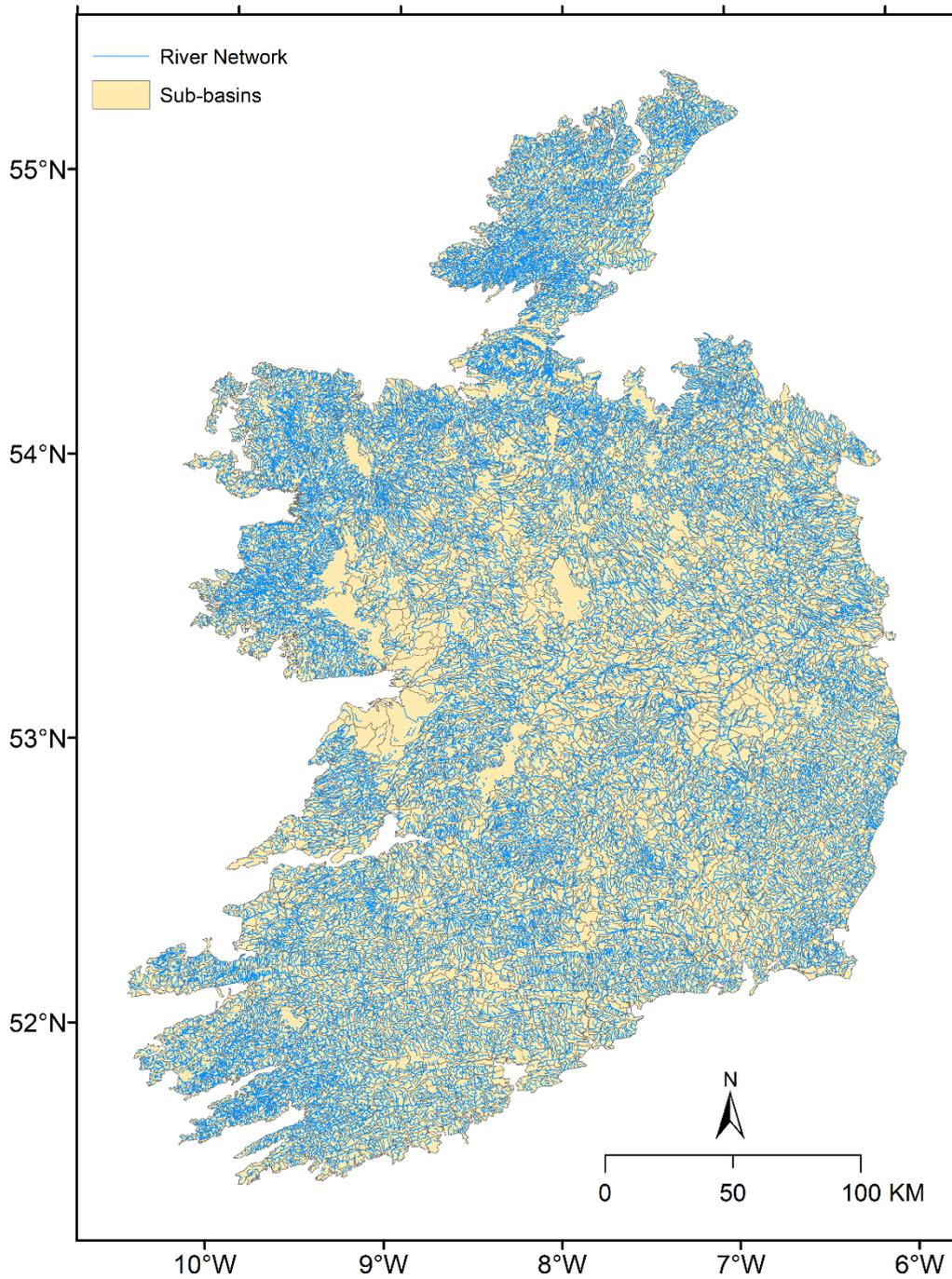
Figure 1: Map of Ireland showing the rivers and sub-basins.
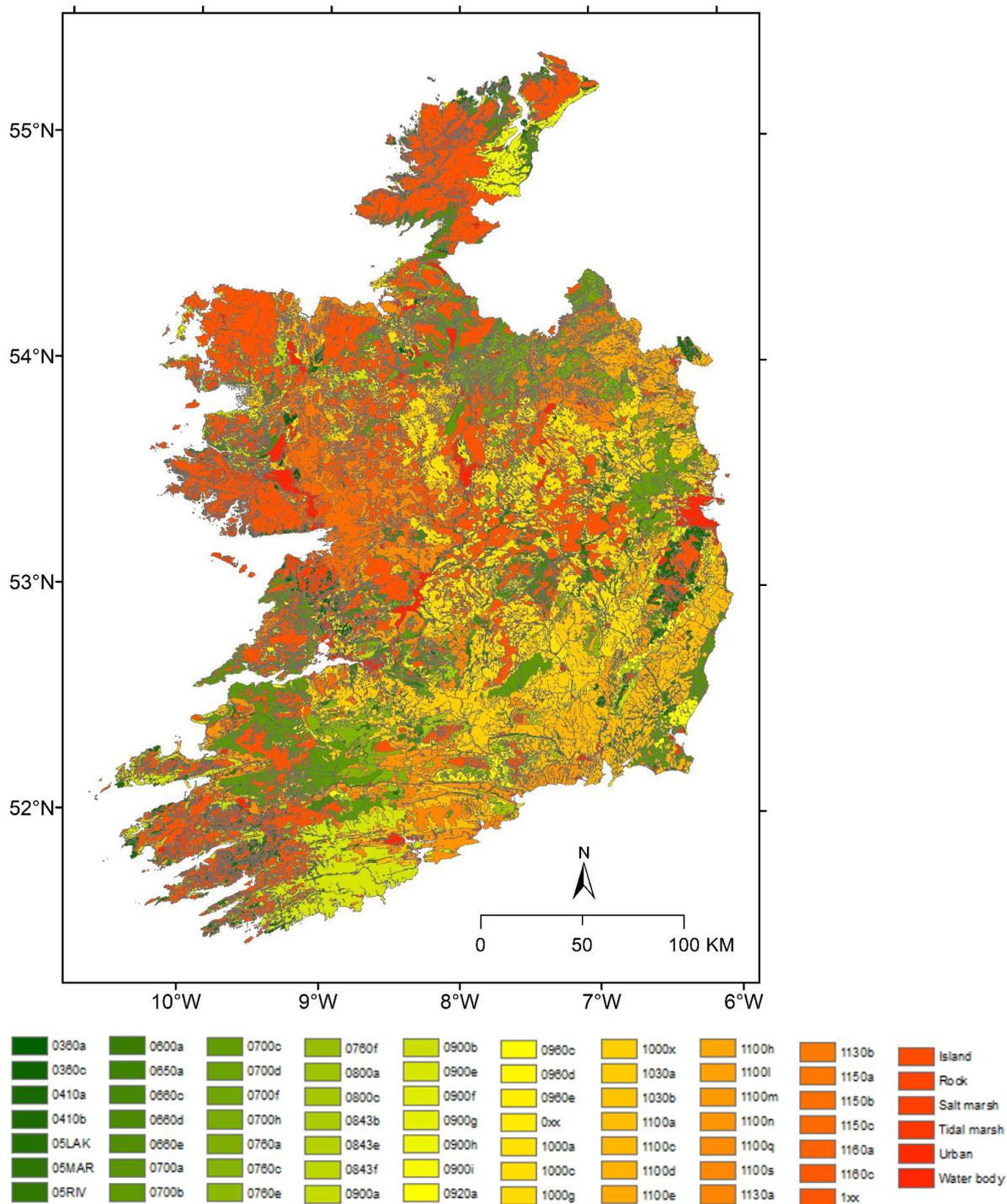
Figure 2: Ireland National Soil Map.
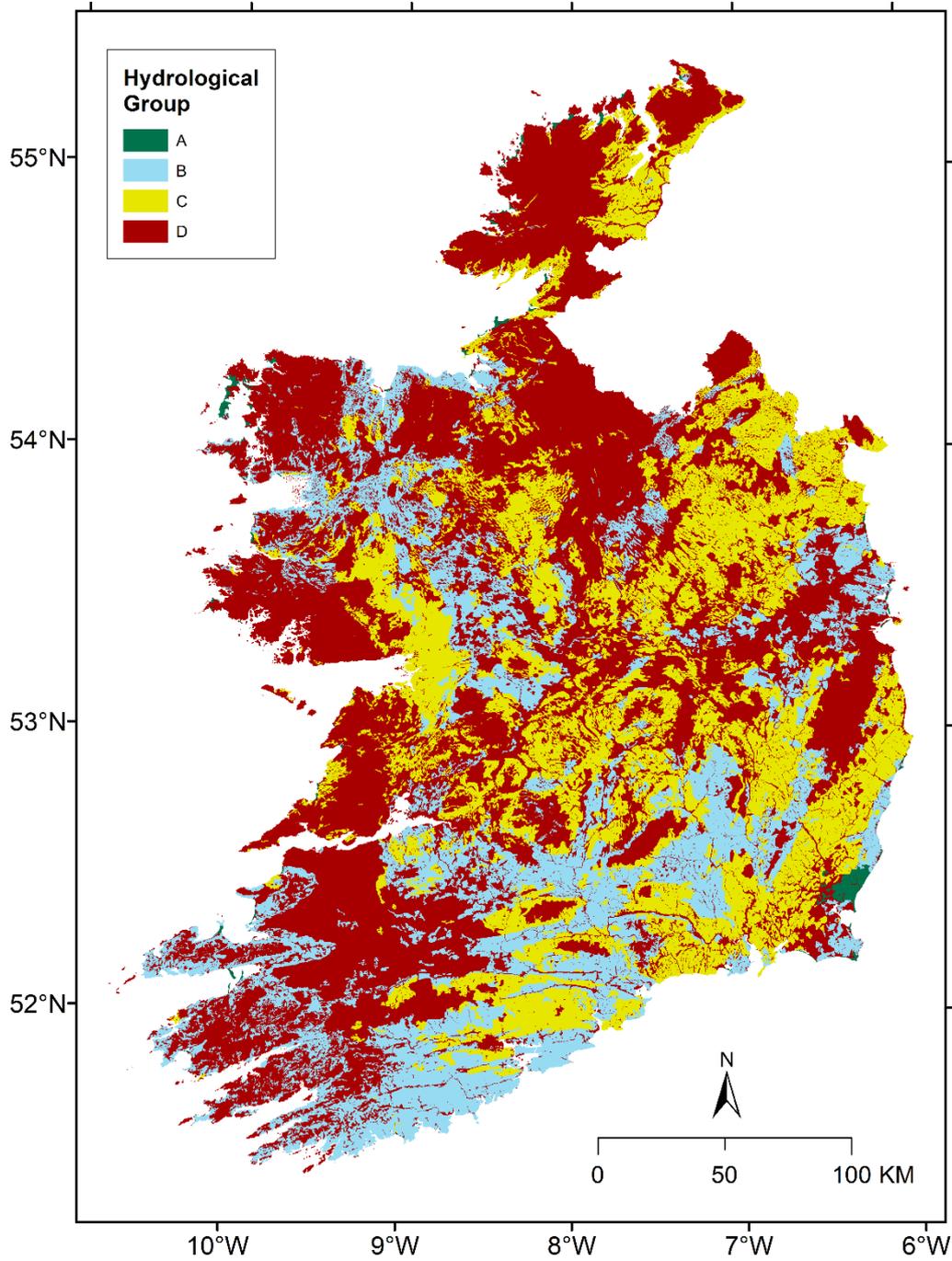
Figure 3: Ireland soil hydrological group.

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a)

b)

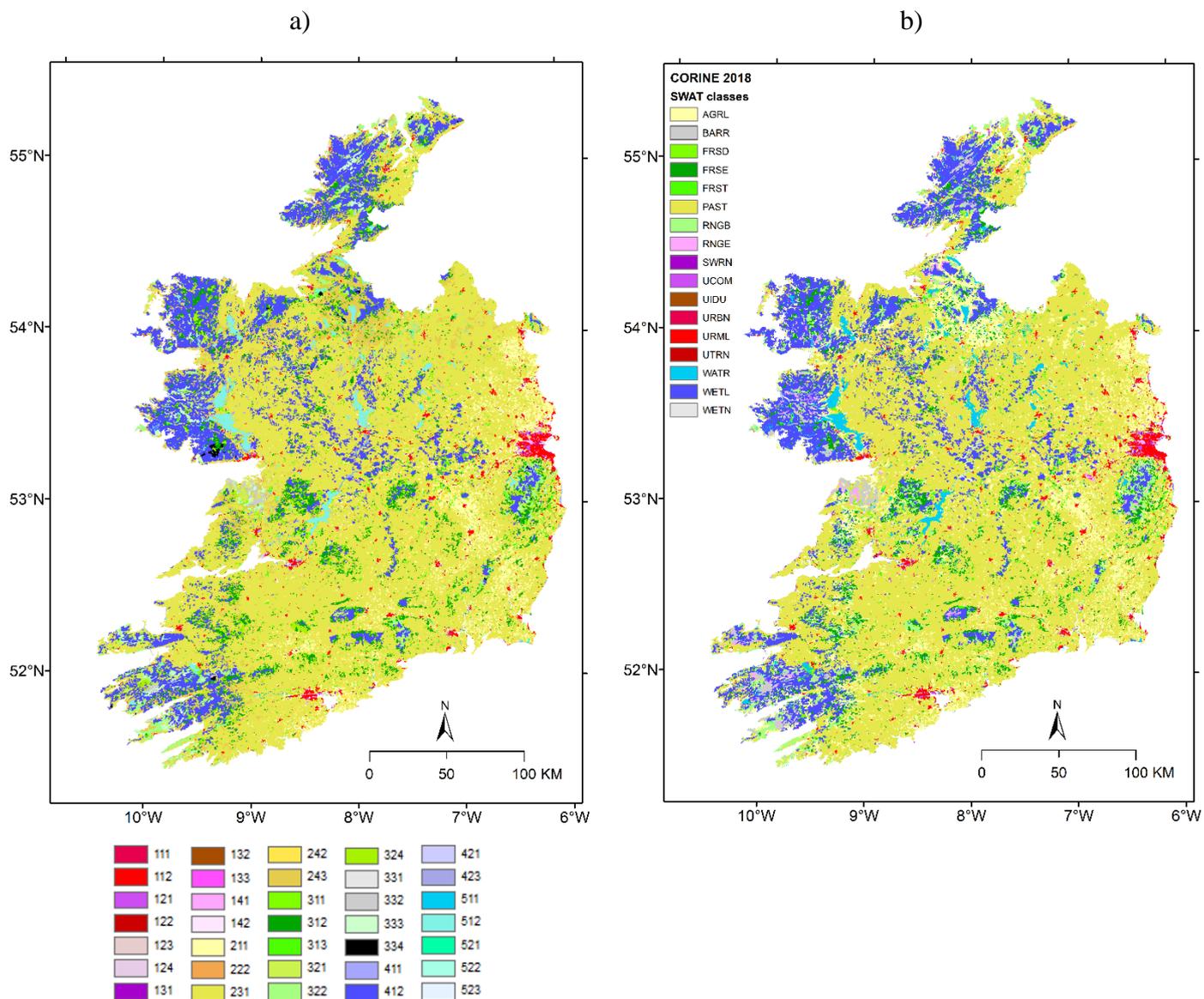



Figure 4: CORINE Land cover map of Ireland for 2018 using a) CORINE land cover classes and b) transformed land cover classes compatible with SWAT model.

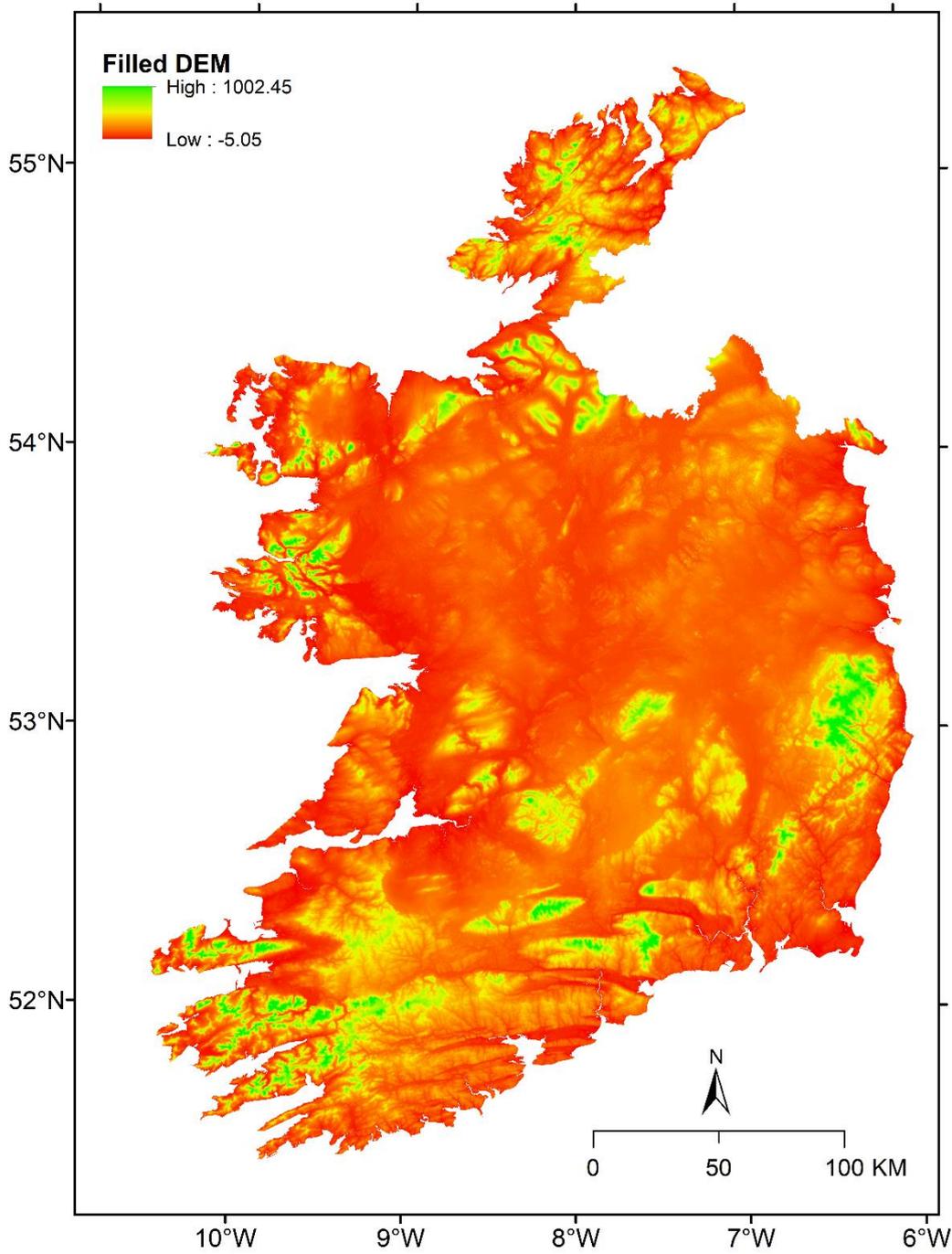



Figure 5: Filled EU-DEM for Ireland.

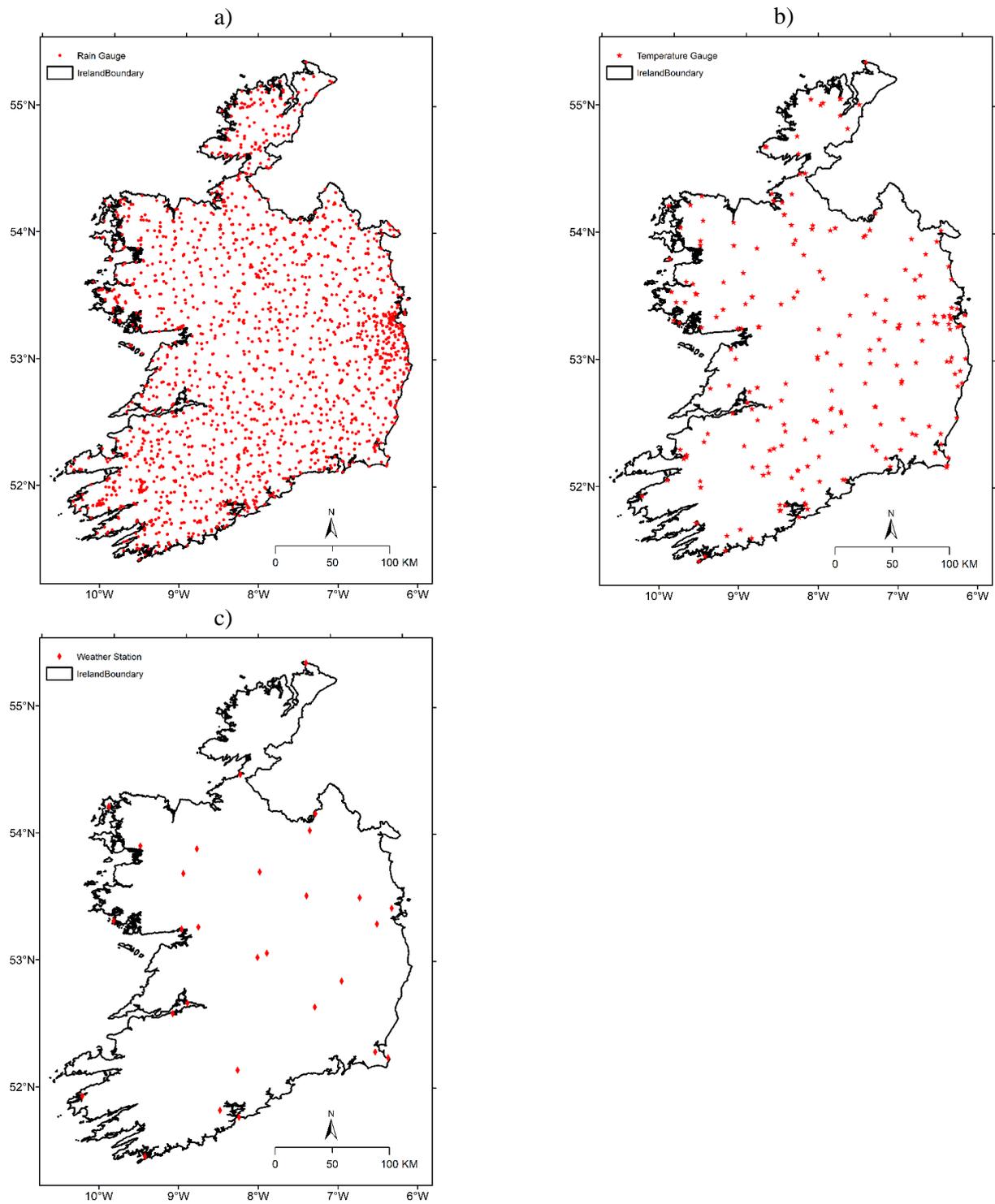



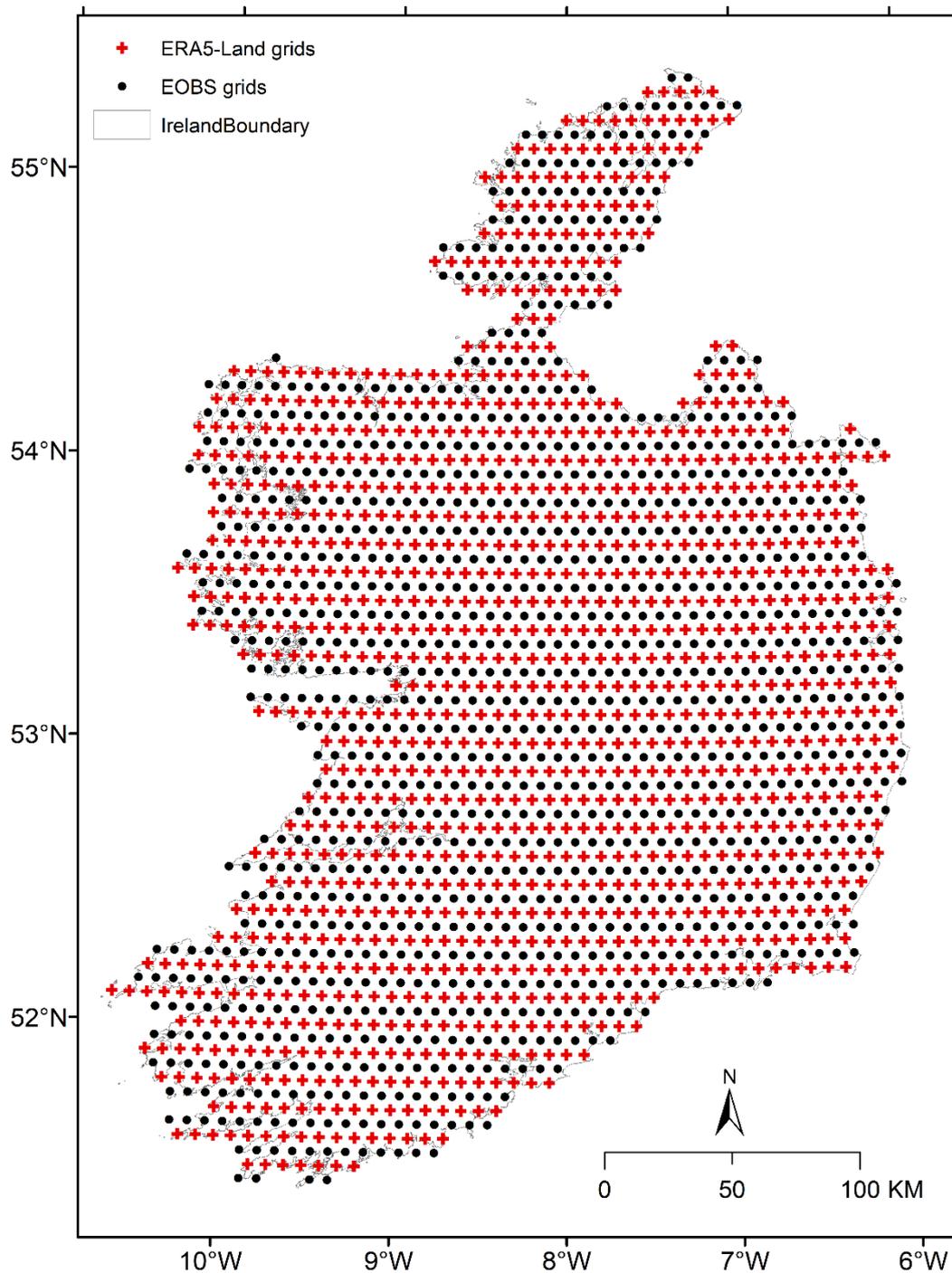
Figure 6: Locations of a) rain gauges, b) temperature gauges and the c) weather stations measuring wind speed, relative humidity and solar radiation in Ireland.

340   **Figure 7: Locations of COPERNICUS E-OBS grids and ERA5 grids covering Ireland.**

Table 1: Linkage of landcover classes available in CORINE data and SWAT model. Out of the available 44 landcover classes, 35 classes present in Ireland and shown in bold. Details of the SWAT classes are available in SWAT Model Database Appendix A
345 **(https://swat.tamu.edu/media/69419/Appendix-A.pdf).**

Sl.	Landcover CODE	Landcover description	SWAT class	Sl.	Landcover CODE	Landcover description	SWAT class
1	**111**	**Continuous urban fabric**	**URBN**	**23**	**311**	**Broad-leaved forest**	**FRSD**
2	**112**	**Discontinuous urban fabric**	**URML**	**24**	**312**	**Coniferous forest**	**FRSE**
3	**121**	**Industrial or commercial units**	**UCOM**	**25**	**313**	**Mixed forest**	**FRST**
4	**122**	**Road and rail networks and associated land**	**UTRN**	**26**	**321**	**Natural grasslands**	**RNGE**
5	**123**	**Port areas**	**UTRN**	**27**	**322**	**Moors and heathland**	**RNGB**
6	**124**	**Airports**	**UTRN**	28	323	Sclerophyllous vegetation	RNGB
7	**131**	**Mineral extraction sites**	**SWRN**	**29**	**324**	**Transitional woodland-shrub**	**RNGB**
8	**132**	**Dump sites**	**UIDU**	**30**	**331**	**Beaches, dunes, sands**	**WETN**
9	**133**	**Construction sites**	**UIDU**	**31**	**332**	**Bare rocks**	**BARR**
10	**141**	**Green urban areas**	**RNGE**	**32**	**333**	**Sparsely vegetated areas**	**BARR**
11	**142**	**Sport and leisure facilities**	**UCOM**	**33**	**334**	**Burnt areas**	**BARR**
12	**211**	**Non-irrigated arable land**	**AGRL**	34	335	Glaciers and perpetual snow	WATR
13	212	Permanently irrigated land	AGRL	**35**	**411**	**Inland marshes**	**WETN**
14	213	Rice fields	RICE	**36**	**412**	**Peat bogs**	**WETL**
15	221	Vineyards	GRAP	**37**	**421**	**Salt marshes**	**WETL**
16	**222**	**Fruit trees and berry plantations**	**AGRL**	38	422	Salines	WETL
17	223	Olive groves	OLIV	**39**	**423**	**Intertidal flats**	**WETL**
18	**231**	**Pastures**	**PAST**	**40**	**511**	**Water courses**	**WATR**
19	241	Annual crops associated with permanent crops	AGRL	**41**	**512**	**Water bodies**	**WATR**
20	**242**	**Complex cultivation patterns**	**AGRL**	**42**	**521**	**Coastal lagoons**	**WATR**
21	**243**	**Land principally occupied by agriculture, with significant areas of natural vegetation**	**AGRL**	**43**	**522**	**Estuaries**	**WATR**
22	244	Agro-forestry areas	FRST	**44**	**523**	**Sea and ocean**	**WATR**