

BONUS RETURN Reducing Emissions by Turning Nutrients and Carbon into Benefits www.bonusprojects.org/bonusprojects/the\_projects/blue\_baltic\_projects/return www.bonusreturn.eu

Deliverable No: D.4.3 – Free access to functioning SWAT application of the three river basins Ref: WP4 Task 1 Lead participant: SYKE Date: 29 Feb. 2020



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| Date              | 29/2/2020  |

| Start of the project: | 01/05/2017                            |
|-----------------------|---------------------------------------|
| End of the project:   | 01/05/2020                            |
| Project coordinator:  | Stockholm Environment Institute (SEI) |

**Dissemination level** 

| х | PU | Public.  |
|---|----|--|
|   | PP | Restricted to other project partners.              |
|   | RE | Restricted to a group specified by the consortium. |
|   | СО | Confidential, only for members of the consortium.  |



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#### **EXECUTIVE SUMMARY**

The Bonus Return project produced 3 baseline (no scenarios with e.g. mitigation measures or BMPs) SWAT applications with different parameter combinations for the project's case study catchments in Finland (Vantaanjoki), Sweden (Fyrisån) and Poland (Slupia). So, the user can not only utilize the parameterization of the case study applications in his/her similar target area, but also start making his/her own scenarios for these areas on top of the baseline applications of these Bonus Return case study areas.

As a new contribution to the SYKE's open data (<u>https://ckan.ymparisto.fi/dataset</u>), the three SWAT applications of Bonus Return project were compressed into zip-files and stored in the open data repository of the Finnish Environment Institute (SYKE), from where anyone with knowledge on SWAT can download the files and start making his/her own runs, simulations and scenarios. To find a SWAT application in the public SYKE Research Data Service, the user can either scroll or type e.g. "SWAT" into the search box, or use the direct link (<u>https://ckan.ymparisto.fi/dataset/free-access-to-functioning-swat-application-of-the-three-river-basins</u>).



#### **1 INTRODUCTION**

The degradation of the Baltic Sea is an ongoing problem, despite investments in measures to reduce external inputs of pollutants and nutrients from both diffuse and point sources. Available technological and management measures to curb eutrophication and pollution flows to the sea have not been adapted adequately to the contexts in which they are being applied. Furthermore, measures are often designed based on single objectives, thereby limiting opportunities for multiple benefits.

In addition, there is a general sense that measures to address the deterioration of the Baltic ecosystem are primarily technologically-driven and lacking broader stakeholder acceptance, and the "experts" who define these measures have little engagement with industry, investors, civil society and authorities. This problem is exacerbated by governance and management taking place in sectoral silos with poor coordination across sectors.

As a result, research shows that regional institutional diversity is presently a barrier to transboundary cooperation in the Baltic Sea Region (BSR) and that actions to achieve national environmental targets can compromise environmental goals in the BSR (Powell et al. 2013). The regional dimension of environmental degradation in the BSR has historically received weaker recognition in policy development and implementation locally. However, developments in recent years suggest a new trend with growing investments in environmental protection supporting social, economic, and territorial cohesion.

The BSR is an environmentally, politically and economically significant region and like other regions globally, its rapid growth needs to be reconciled with the challenges of sustainable development in a global setting that demands unprecedented reductions in GHG emissions. This poses a truly wicked problem exacerbated by the fact many of the challenges in BSR will also magnify in a changing climate. In order to navigate the uncertainties and controversies associated with a transformation towards a good marine environment, BONUS RETURN will enact an innovative trans-disciplinary approach for identifying and piloting systemic ecotechnologies.

Focus will be on eco-technologies that generate co-benefits within other interlinked sectors and which can be adapted according to geophysical and institutional contexts. More specifically, emphasis will be given to eco-technologies that reconcile the reduction of present and future eutrophication in marine environments with the regional challenges of policy coherence, food security, energy security, and the provision of ecosystem services.

#### **1.1 Project Objectives**

The **overall** aim of RETURN is to improve the adaptation and adoption of eco-technologies in the BSR for maximum efficiency and increased co-benefits.

The **specific objectives** of the project can be divided into 6 categories presented below. These categories are interlinked but for the purpose of providing a step-wise description, the following overview of each category proves useful. RETURN will:



## 1) Support innovation and market uptake of eco-technologies:

- Contribute to the application and adaptation of eco-technologies in the BSR through an evidence-based review (systematic map) of the developments within this field.
- Contribute to the development of emerging eco-technologies that have the capacity to turn nutrients and carbon into benefits (e.g. bio-energy, fertilizers), by providing an encompassing framework and platform for rigorous testing and analysis.
- Development of decision support systems for sustainable eco-technologies in the BSR.
- Contribute to better assessment of eco-technology efficiency via integrated and participatory modelling in three catchments areas in Finland, Sweden and Poland.
- Contribute to methodological innovation on application and adaptation of ecotechnologies
- 2) Reduce knowledge gaps on policy performance, enabling/constraining factors, and costs and benefits of eco-technologies
- Assess the broader socio-cultural drivers linked to eco-technologies from a historical perspective
- Identify the main gaps in the policy environment constraining the implementation of emerging eco-technologies in the catchments around the Baltic Sea
- Inform policy through science on what works where and under which conditions through an evidence-based review (systematic map and systematic reviews) of eco-technologies and the regional economic and institutional structures in which these technologies evolve.

# 3) Provide a framework for improved systematic stakeholder involvement:

- Develop methods for improved stakeholder engagement in water management through participatory approaches in the case study areas in Sweden, Finland and Poland.
- Enact a co-enquiry process with stakeholders into opportunities for innovations in eco-technologies capable of transforming nutrients and pollutants into benefits for multiple sectors at different scales.
- Bring stakeholder values into eco-technology choices to demonstrate needs for adaptation to local contexts and ways for eco-technologies to efficiently contribute to local and regional developments.
- Disseminate results and facilitate the exchange of learning experiences, first within the three catchment areas, and secondly across a larger network of municipalities in the BSR.
- Establish new cooperative networks at case study sites and empower existing regional networks by providing information, co-organize events and engage in dialogues.

# 4) Support commercialization of eco-technologies:

- Identify market and institutional opportunities for eco-technologies that (may) contribute to resource recovery and reuse of nutrients, micro-pollutants and micro-plastics (e.g. renewable energy).



- Identify potential constraints and opportunities for integration and implementation of eco-technologies using economical models.
- Facilitate the transfer of eco-technologies contributing to win-win solutions to multiple and interlinked challenges in the BSR.
- Link producers of eco-technologies (small and medium enterprises SMEs), to users (municipalities) by providing interactive platforms of knowledge exchange where both producers and users have access to RETURN's envisaged outputs, existing networks, and established methodologies and services.
- 5) Establish a user-driven knowledge platform and improve technology-user interface
- Develop an open-access database that maps out existing research and implementation of eco-technologies in the BSR. This database will be intuitive, also mapped out in an interactive geographical information system (GIS) platform, and easily managed so that practitioners, scientists and policy-makers can incorporate it in their practices
- Develop methodologies that enact the scaling of a systemic mix of eco-technological interventions within the highly diverse contexts that make up the BSR and allows for a deeply interactive media of knowledge.

# **1.2 Project Structure**

BONUS RETURN is structured around 6 Work Packages that will be implemented in three river basins: The Vantaanjoki river basin in Finland, the Słupia river basin in Poland, and Fyrisån river basin in Sweden. Hereafter in this report, these river basins are referred to as study catchments.

Work Package 1: Coordination, management, communication and dissemination.

Work Package 2: Integrated Evidence-based review of eco-technologies.

Work Package 3: Sustainability Analyses.

Work Package 4: Environmental Modelling.

Work Package 5: Implementation Support for Eco-technologies.

Work Package 6: Innovative Methods in Stakeholder Engagement.

# 1.3 Deliverable context and objective

The current deliverable (Del. 4.3) is part of WP4. The objectives of WP4 are to contextualize the most promising eco-technologies through three case study sites in Finland, Poland and Sweden. The objective of this deliverable is to present background and instructions of use of the openly available, free-access SWAT model applications stored in the data repository of Finnish Environment Institute (SYKE).

# 1.4 Outline of the report

This report describes the background of the free-access models and the links where they are found. There are presentation of SYKE's repository and instructions how to navigate there and how to find and download the SWAT-model applications of the three case study catchments.



2 SYKE'S DATA REPOSITORY AND INSTRUCTIONS HOW TO USE THE FREE-ACCESS MODEL

### APPLICATIONS

## 2.1 SYKE's open data

SYKE produces open data and information (<u>https://www.syke.fi/en-US/Open\_information</u>) for an ecologically, economically and socially sustainable society. SYKE's open data includes versatile information on water resources, surface and ground waters, the Baltic Sea, environmental load and distractions, the valuable natural environment, land cover and the built environment. Environmental data is accessible by utilizing web services, spatial datasets and satellite observations, as well as data stored in environmental information systems. Environmental data can also be viewed in various web map applications.

### 2.2 SWAT model

SWAT (Soil and Water Assessment Tool, <u>https://swat.tamu.edu</u>) was developed to predict the impacts of land management practices on hydrological regimes and the loading of surface waters in complex watersheds over long periods of time. Building a SWAT application is a laborious process. It is of great help to other modelers (researchers and practitioners) if ready applications, in which all the numerous parameters have already been determined for similar areas than that of the user's own target area.

Basic info about ArcSWAT can be found in the following www-pages

- ï https://swat.tamu.edu/software/arcswat
- ï https://swat.tamu.edu/software/swat-editor

The document with general descriptions of SWAT input/output files can be downloaded from here:

ï https://swat.tamu.edu/media/69296/swat-io-documentation-2012.pdf

# 2.3 Free-access SWAT applications of the Bonus Return project

The Bonus Return project produced 3 baseline (no scenarios with e.g. mitigation measures or BMPs) SWAT applications with different parameter combinations for the project's case study catchments in Finland (Vantaanjoki), Sweden (Fyrisån) and Poland (Slupia) with vigorous calibration/validation processes (see Bonus Return Deliverable D4.1). So, the user can not only utilize the parameterization of the case study applications in his/her similar target area, but also start making his/her own scenarios for these areas on top of the baseline applications of these Bonus Return case study areas. The basic input information for the model applications are listed at the end of this document.

As a new contribution to the SYKE's open research data (<u>https://ckan.ymparisto.fi/dataset</u>), the three SWAT applications of Bonus Return project were compressed into zip-files and stored in the open data repository of the Finnish Environment Institute (SYKE), from where



anyone with knowledge on SWAT can download the files and start making his/her own runs, simulations and scenarios. To find a SWAT application in the public SYKE Research Data Service, the user can either scroll or type e.g. "SWAT" into the search box, or use the direct link (https://ckan.ymparisto.fi/dataset/free-access-to-functioning-swat-application-of-thethree-river-basins). Below are images describing how the data repository pages looks like and how to navigate there.



General page of SYKE's open research data (https://ckan.ymparisto.fi/dataset):

The page where SWAT applications can be found here:

https://ckan.ymparisto.fi/dataset/free-access-to-functioning-swat-application-of-the-threeriver-basins

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The zipped files can be opened with commonly available software such as:

- i IZArc (<u>https://www.izarc.org/</u>)
- ï WinZip (<u>https://www.winzip.com/</u>)
- ï 7-Zip (<u>https://www.7-zip.org/</u>)

In the metadata there is basic information how the SWAT applications were made, what SWAT version was used in their creation etc.



In case of problems with the datasets and their deployment, the users are advised to contact:

- i Mikolaj Piniewski (M.Piniewski@levis.sggw.pl)
- ï Pawel Marcinkowski (P.Marcinkowski@levis.sggw.pl)
- i Jari Koskiaho (jari.koskiaho@ymparisto.fi)



#### **APPENDIX** Sources of basic input information for the model applications

|                         |   | Catchment   | Vantaanioki  |   |   |
|-------------------------|---|---|--|---|---|
| 1                       | ra  | Coordinator   | SYKE (Jari Koskiaho and Sirkka Tattari)  |   |   |
|                         | ene   | Modeller  | Jari Koskiaho  | 1   |   |
|                         | ő   | Catchment size [km2]  | 1688 km2   |   |   |
| -                       |   | Item  | Source   | Resolution / scale  | Description   |
|                         |   | DEM   | MML (National Land Survey of Finland)<br>SYKE (Finnish Environment Institute)  | Grid size 10m x 10m, the accuracy of the elevation 1.4 m  | Based on contour lines of MML:s terrain database.   |
|                         | u   | River network   | SYKE   | 1:250 000   | Required for "burning in" streams   |
|                         | delineatio  | Water use and transfer<br>locations   |  | 1 hydropower plant with weir<br>(Vanhankaupunginkoski) and a weir at the outlet<br>of the regulated lake Tuusulanjärvi, maybe some<br>minor fish ponds in the upper reaches   | Required in order to modify placement of inlets and outlets in watershed delineation  |
|                         | tershe  | Lake/reservoir map  | SYKE   | 1:250 000   | Required in order to modify placement of inlets and outlets in<br>watershed delineation   |
|                         | Wa  | Gauge stations locations  | SYKE/Hertta  | 9 points  | Required in order to modify placement of inlets and outlets in<br>watershed delineation   |
|                         |   | Point source locations  | SYKE/Vahti   | 21 municipal, 11 industrial   | Required in order to modify placement of inlets and outlets in<br>watershed delineation   |
| D                       | ation   | Land cover map  | CORINE Land Cover 2012   | 20m x 20m   | Principal input data for land cover map. Needs reclassification to<br>SWAT classes  |
| Ŧ                       | deline  | Soil map  | GTK (Finnish Geological Survey) and<br>SYKE  | 1:200 000   | Principal input data for soil map. Needs reclassification to SWAT<br>classes  |
|                         | efiniti   | Precipitation data  |  | 3 stations  | Recommended to interpolate precipitation from points to subbasins (stations outside are useful)   |
|                         | ٩de   | Temperature data  |  | 3 stations  |   |
|                         | lata  | Wind speed data   | FMI (Finnish Meteorological Institute)   | 1 station   |   |
|                         | er d  | wind speed data   |  | 1 Station   |   |
|                         | athe  | Relative humidity data  |  | 3 stations  |   |
|                         | Ve  | Solar radiation data  |  | 1 station   |   |
|                         | nt V  | Crop structure  | TiKe (Information Centre of the Ministry<br>of Agriculture and Forestry) and MAVI<br>(Agency for Rural Affairs)  | Field-block level data  | Data from several years needed in order to define crop rotations  |
|                         | igemei  | Mineral fertilisers   | MMM (Ministry of Agriculture &<br>Forestry)  | Nation-wide limit values of fertlization  | Required to define fertiliser rates in management schedules   |
|                         | mana  | Livestock / manure  | TiKe and MAVI  | Farm-level data   | Required to define manure rates in management schedules   |
|                         | and   | Other practices (tillage)   | TiKe and MAVI  | Field-block level data  | Required for definition of management schedules   |
|                         | 2   | BMPs  | MAVI   | Nation-wide database, from which the BMPs<br>located on the Vantaanjoki area can be extracted.  | Useful to include in the model setup, otherwise there might be<br>problems in calibration   |
|                         | ıt  | Reservoirs  | SYKE   | Data for each object  | Morphometric parameters, outflow release rules  |
|                         | ner   | Fish ponds  |  | Data for each object  | Water untake, water discharge   |
|                         |   | risii polius  |  | Data for each object  | water uptake, water uistnange   |
|                         | gei   |   | LLIKE (Natural Recourses Institute   |   |   |
|                         | anagei  | Irrigation  | LUKE (Natural Resources Institute  | ELY-centre (province) -level statistics   | Irrigated area, timing and rates  |
|                         | r managei   | Irrigation<br>Water withdrawals   | LUKE (Natural Resources Institute<br>Finland)<br>Waterworks of the municipalities using  | ELY-centre (province) -level statistics<br>Data for each object   | Irrigated area, timing and rates<br>Amount (monthly), source  |
|                         | Water manage  | Irrigation<br>Water withdrawals<br>Wastewater treatment plants  | LUKE (Natural Resources Institute<br>Finland)<br>Waterworks of the municipalities using<br>Municipalities discharging their<br>wastewaters into the river Vantaanjoki.   | ELY-centre (province) -level statistics<br>Data for each object<br>Data for each object   | Irrigated area, timing and rates<br>Amount (monthly), source<br>Effluent parameters (monthly, if not available annual)  |
| Ground                  | water manage  | Irrigation<br>Water withdrawals<br>Wastewater treatment plants<br>Hydrogeology maps   | LUKE (Natural Resources Institute<br>Finland)<br>Waterworks of the municipalities using<br>Municipalities discharging their<br>wastewaters into the river Vantaanjoki.   | ELY-centre (province) -level statistics<br>Data for each object<br>Data for each object   | Irrigated area, timing and rates<br>Amount (monthly), source<br>Effluent parameters (monthly, if not available annual)<br>Ground water elevation conturs (5 m interval) - not required but can<br>be useful   |
| Ground                  | Channel water Water manage  | Irrigation<br>Water withdrawals<br>Wastewater treatment plants<br>Hydrogeology maps<br>Channel cross-sections   | LUKE (Natural Resources Institute<br>Finland)<br>Waterworks of the municipalities using<br>Municipalities discharging their<br>wastewaters into the river Vantaanjoki.   | ELY-centre (province) -level statistics<br>Data for each object<br>Data for each object   | Irrigated area, timing and rates<br>Amount (monthly), source<br>Effluent parameters (monthly, if not available annual)<br>Ground water elevation conturs (5 m interval) - not required but can<br>be useful<br>Useful to update default SWAT channel dimensions   |
| Ground                  | rties Channel water Water manage  | Irrigation<br>Water withdrawals<br>Wastewater treatment plants<br>Hydrogeology maps<br>Channel cross-sections<br>Soil physical parameters   | LUKE (Natural Resources Institute<br>Finland)<br>Waterworks of the municipalities using<br>Municipalities discharging their<br>wastewaters into the river Vantaanjoki.   | ELY-centre (province) -level statistics<br>Data for each object<br>Data for each object<br>Data for each soil class in SWAT   | Irrigated area, timing and rates<br>Amount (monthly), source<br>Effluent parameters (monthly, if not available annual)<br>Ground water elevation conturs (5 m interval) - not required but can<br>be useful<br>Useful to update default SWAT channel dimensions<br>One of the most critical parts of the model setup  |
| Soil Ground             | properties Channel water Water manage                                     | Irrigation<br>Water withdrawals<br>Wastewater treatment plants<br>Hydrogeology maps<br>Channel cross-sections<br>Soil physical parameters<br>Soil chemical parameters   | LUKE (Natural Resources Institute<br>Finland)<br>Waterworks of the municipalities using<br>Municipalities discharging their<br>wastewaters into the river Vantaanjoki.   | ELY-centre (province) -level statistics<br>Data for each object<br>Data for each object<br>Data for each soil class in SWAT   | Irrigated area, timing and rates<br>Amount (monthly), source<br>Effluent parameters (monthly, if not available annual)<br>Ground water elevation conturs (5 m interval) - not required but can<br>be useful<br>Useful to update default SWAT channel dimensions<br>One of the most critical parts of the model setup<br>Measurements bi-annual (spring, autumn); samples from 3 depths<br>(30,60,90cm); determination NO3&NH4 in soil and ground water  |
| Atmospheric Soil Ground | deposition properties Channel water Water manage                          | Irrigation Water withdrawals Water withdrawals Wastewater treatment plants Hydrogeology maps Channel cross-sections Soil physical parameters Soil chemical parameters N and P deposition data   | LUKE (Natural Resources Institute<br>Finland)<br>Waterworks of the municipalities using<br>Municipalities discharging their<br>wastewaters into the river Vantaanjoki.<br>Literature   | ELY-centre (province) -level statistics<br>Data for each object<br>Data for each object<br>Data for each soil class in SWAT<br>2 stations inside and ? stations outside catchment   | Irrigated area, timing and rates<br>Amount (monthly), source<br>Effluent parameters (monthly, if not available annual)<br>Ground water elevation conturs (5 m interval) - not required but can<br>be useful<br>Useful to update default SWAT channel dimensions<br>One of the most critical parts of the model setup<br>Measurements bi-annual (spring, autumn); samples from 3 depths<br>(30,60,90cm); determination NO3&NH4 in soil and ground water<br>Concentrations/loads of N and P (dry and wet deposition). P data<br>cannot be used as SWAT input  |
| Atmospheric Soil Ground | deposition properties Channel water Water manage                          | Irrigation<br>Water withdrawals<br>Wastewater treatment plants<br>Hydrogeology maps<br>Channel cross-sections<br>Soil physical parameters<br>Soil chemical parameters<br>N and P deposition data<br>Discharge   | LUKE (Natural Resources Institute<br>Finland)<br>Waterworks of the municipalities using<br>Municipalities discharging their<br>wastewaters into the river Vantaanjoki.<br>Literature   | ELY-centre (province) -level statistics<br>Data for each object<br>Data for each object<br>Data for each soil class in SWAT<br>2 stations inside and ? stations outside catchment<br>9 flow gauges  | Irrigated area, timing and rates<br>Amount (monthly), source<br>Effluent parameters (monthly, if not available annual)<br>Ground water elevation conturs (5 m interval) - not required but can<br>be useful<br>Useful to update default SWAT channel dimensions<br>One of the most critical parts of the model setup<br>Measurements bi-annual (spring, autumn); samples from 3 depths<br>(30,60,90cm); determination NO3&NH4 in soil and ground water<br>Concentrations/loads of N and P (dry and wet deposition). P data<br>cannot be used as SWAT input<br>Daily data (some not in operation any more)   |
| Atmospheric Soil Ground | deposition properties Channel water Water manage                          | Irrigation Water withdrawals Water withdrawals Wastewater treatment plants Hydrogeology maps Channel cross-sections Soil physical parameters Soil chemical parameters N and P deposition data Discharge Crop yields   | LUKE (Natural Resources Institute<br>Finland)<br>Waterworks of the municipalities using<br>Municipalities discharging their<br>wastewaters into the river Vantaanjoki.<br>Literature<br>SYKE<br>SYKE   | ELY-centre (province) -level statistics<br>Data for each object<br>Data for each object<br>Data for each soil class in SWAT<br>Pata for each soil class in SWAT<br>? stations inside and ? stations outside catchment<br>9 flow gauges<br>Province-level data   | Irrigated area, timing and rates<br>Amount (monthly), source<br>Effluent parameters (monthly, if not available annual)<br>Ground water elevation conturs (5 m interval) - not required but can<br>be useful<br>Useful to update default SWAT channel dimensions<br>One of the most critical parts of the model setup<br>Measurements bi-annual (spring, autumn); samples from 3 depths<br>(30,60,90cm); determination NO3&NH4 in soil and ground water<br>Concentrations/loads of N and P (dry and wet deposition). P data<br>cannot be used as SWAT input<br>Daily data (some not in operation any more)<br>Not required, but worth ensuring that mean crop yields match with<br>observations  |
| Atmospheric Soil Ground | deposition properties Channel water Water manage                          | Irrigation Water withdrawals Water withdrawals Wastewater treatment plants Hydrogeology maps Channel cross-sections Soil physical parameters Soil chemical parameters N and P deposition data Discharge Crop yields Sediment concentrations   | LUKE (Natural Resources Institute<br>Finland)<br>Waterworks of the municipalities using<br>Municipalities discharging their<br>wastewaters into the river Vantaanjoki.<br>Literature<br>SYKE<br>SYKE<br>LUKE   | ELY-centre (province) -level statistics Data for each object Data for each object Data for each soil class in SWAT Data for each soil class in SWAT ? stations inside and ? stations outside catchment 9 flow gauges Province-level data 32 (river) water quality monitoring stations   | Irrigated area, timing and rates Amount (monthly), source Effluent parameters (monthly, if not available annual) Ground water elevation conturs (5 m interval) - not required but can be useful Useful to update default SWAT channel dimensions One of the most critical parts of the model setup Measurements bi-annual (spring, autumn); samples from 3 depths (30,60,90cm); determination NO3&NH4 in soil and ground water Concentrations/loads of N and P (dry and wet deposition). P data cannot be used as SWAT input Daily data (some not in operation any more) Not required, but worth ensuring that mean crop yields match with observations Measurements between 2000-2016 with varying frequency, on average 22 samples per year   |
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| Atmospheric Soil Ground | tion & validation deposition properties Channel water Water manage        | Irrigation Water withdrawals Water withdrawals Wastewater treatment plants Hydrogeology maps Channel cross-sections Soil physical parameters Soil chemical parameters N and P deposition data Discharge Crop yields Sediment concentrations N & P concentrations  | LUKE (Natural Resources Institute<br>Finland)<br>Waterworks of the municipalities using<br>Municipalities discharging their<br>wastewaters into the river Vantaanjoki.<br>Literature<br>SYKE<br>SYKE<br>LUKE<br>SYKE<br>SYKE<br>SYKE<br>SYKE                 | ELY-centre (province) -level statistics Data for each object Data for each object Data for each object Data for each soil class in SWAT Data for each soil class in SWAT ? stations inside and ? stations outside catchment 9 flow gauges Province-level data 32 (river) water quality monitoring stations 1 location (16 km upstream from the outlet) with 32 (river) water quality monitoring stations 1 location (16 km upstream from the outlet) with hourly intervals  | Irrigated area, timing and rates         Amount (monthly), source         Effluent parameters (monthly, if not available annual)         Ground water elevation conturs (5 m interval) - not required but can be useful         Useful to update default SWAT channel dimensions         One of the most critical parts of the model setup         Measurements bi-annual (spring, autumn); samples from 3 depths (30,60,90cm); determination NO3&NH4 in soil and ground water         Concentrations/loads of N and P (dry and wet deposition). P data cannot be used as SWAT input         Daily data (some not in operation any more)         Not required, but worth ensuring that mean crop yields match with observations         Measurements between 2000-2016 with varying frequency, on average 22 samples per year         Daily turbidity (=> sediment) data since 2011 from automatic station         Measurements between 2000-2016 with varying frequency, on average 22 samples per year         Daily turbidity (=> total P) and NO3-N data since 2011 from automatic station (still operating)  |
| Atmospheric Soil Ground | alibration & validation deposition properties Channel water Water manage  | Irrigation Water withdrawals Water withdrawals Wastewater treatment plants Hydrogeology maps Channel cross-sections Soil physical parameters Soil chemical parameters N and P deposition data Discharge Crop yields Sediment concentrations N & P concentrations TOC (Total organic carbon)                               | LUKE (Natural Resources Institute<br>Finland)<br>Waterworks of the municipalities using<br>Municipalities discharging their<br>wastewaters into the river Vantaanjoki.<br>Literature<br>SYKE<br>SYKE<br>LUKE<br>SYKE<br>SYKE<br>SYKE<br>SYKE<br>SYKE         | ELY-centre (province) -level statistics<br>Data for each object<br>Data for each object<br>Data for each object<br>Data for each soil class in SWAT<br>Data for each soil class in SWAT<br>? stations inside and ? stations outside catchment<br>9 flow gauges<br>Province-level data<br>32 (river) water quality monitoring stations<br>1 location (16 km upstream from the outlet) with<br>32 (river) water quality monitoring stations<br>1 location (16 km upstream from the outlet) with<br>hourly intervals<br>30 water quality monitoring stations;  | Irrigated area, timing and rates         Amount (monthly), source         Effluent parameters (monthly, if not available annual)         Ground water elevation conturs (5 m interval) - not required but can be useful         Useful to update default SWAT channel dimensions         One of the most critical parts of the model setup         Measurements bi-annual (spring, autumn); samples from 3 depths (30,60,90cm); determination NO3&NH4 in soil and ground water         Concentrations/loads of N and P (dry and wet deposition). P data cannot be used as SWAT input         Daily data (some not in operation any more)         Not required, but worth ensuring that mean crop yields match with observations         Measurements between 2000-2016 with varying frequency, on average 22 samples per year         Daily turbidity (=> sediment) data since 2011 from automatic station         Measurements between 2000-2016 with varying frequency, on average 22 samples per year         Daily turbidity (=> total P) and NO3-N data since 2011 from automatic station frequency (still operating)         Much more infrequent data than for TSS and nutrients: on average 2 analyses per year   |
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| Atmospheric Soil Ground | Calibration & validation deposition properties Channel water Water manage | Irrigation Water withdrawals Water withdrawals Wastewater treatment plants Hydrogeology maps Channel cross-sections Soil physical parameters Soil chemical parameters Soil chemical parameters N and P deposition data Discharge Crop yields Sediment concentrations N & P concentrations TOC (Total organic carbon) BOD5 | LUKE (Natural Resources Institute<br>Finland)<br>Waterworks of the municipalities using<br>Municipalities discharging their<br>wastewaters into the river Vantaanjoki.<br>Literature<br>SYKE<br>SYKE<br>SYKE<br>SYKE<br>SYKE<br>SYKE<br>SYKE<br>SYKE         | ELY-centre (province) -level statistics<br>Data for each object<br>Data for each object<br>Data for each object<br>Data for each soil class in SWAT<br>Data for each soil class in SWAT<br>? stations inside and ? stations outside catchment<br>9 flow gauges<br>Province-level data<br>32 (river) water quality monitoring stations<br>1 location (16 km upstream from the outlet) with<br>32 (river) water quality monitoring stations<br>1 location (16 km upstream from the outlet) with<br>hourly intervals<br>30 water quality monitoring stations;<br>1 location (16 km upstream from the outlet) with<br>hourly intervals<br>30 water quality monitoring stations;<br>19 water quality monitoring stations;<br>19 water quality monitoring stations; | Irrigated area, timing and rates         Amount (monthly), source         Effluent parameters (monthly, if not available annual)         Ground water elevation conturs (5 m interval) - not required but can be useful         Useful to update default SWAT channel dimensions         One of the most critical parts of the model setup         Measurements bi-annual (spring, autumn); samples from 3 depths (30,60,90cm); determination NO3&NH4 in soil and ground water         Concentrations/loads of N and P (dry and wet deposition). P data cannot be used as SWAT input         Daily data (some not in operation any more)         Not required, but worth ensuring that mean crop yields match with observations         Measurements between 2000-2016 with varying frequency, on average 22 samples per year         Daily turbidity (=> sediment) data since 2011 from automatic station         Measurements between 2000-2016 with varying frequency, on average 22 samples per year         Daily turbidity (=> cotal P) and NO3-N data since 2011 from automatic station (still operating)         Much more infrequent data than for TSS and nutrients: on average 2 analyses per year         Daily TOC (and DOC) data since 2011 from automatic station (still operating)         Much more infrequent data than for TSS and nutrients: on average < 1 analysis per year, for COD on average 7 analyses per year |

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# BONUS RETURN

| Image: space  | al              | Catchment   | Fyrisån                                       |  |  |
|---|-----------------|---|---|--|--|
| Note::::::::::::::::::::::::::::::::::::  | nera            | Coordinator   |   |  |  |
| Notice         Control water         Control water         Section water         Section water           Notice         Section water         Section water         Section water         Section water           Notice         Section water         Section water         Section water         Section water           Notice         Section water         Section water         Section water         Section water           Notice         Section water         Section water         Section water         Section water           Notice         Section water         Section water         Section water         Section water           Notice         Section water         Section water         Section water         Section water           Notice         Section water         Section water         Section water         Section water           Notice         Section water         Section water         Section water         Section water           Notice         Section water         Section water         Section water         Section water           Notice         Section water         Section water         Section water         Section water           Notice         Section water         Section water         Section water         Section water         Section water         Section   | Ge              | Modeller  | 2005 1  |  |  |
| Interm         Joint Process (Control Lange Control La          |                 |   | 2005 KIIIZ                                    | Posolution / scale                                       | Description  |
| Note induced.         Landmaterie Property map<br>in the induced.         Import/work landmateries. Lapitabaset. Landmateries<br>Property and the induced in the induc             |                 | DEM   | Lantmäteriet                                  | 2 m  | Lidar-based  |
| Nome         Number of the standard standard backgroup of the standard          | ation           | River network   | Lantmäteriet Property map<br>HL               |  | https://www.lantmateriet.se/globalassets/karto<br>r-och-geografisk-  |
| Image: space  | deline          | Water use and transfer locations  | SMHI?   |  | Required in order to modify placement of inlets and outlets in watershed delineation   |
| Image: statistic locations         Sulf decrepands/solf         Image: statistic locations         Sulf decrepands/solf           Image: statistic locations         MACD         MACD         Image: statistic locations         MACD         MACD         Image: statistic locations         MACD         Image: statistic locations         MACD   | shed .          | Lake/reservoir map  | Lantmäteriet Property map<br>MV               |  | https://www.lantmateriet.se/globalassets/karto<br>r-och-geografisk-  |
| Image: stand section         MoDe (Mode           | Water           | Gauge stations locations  | SLU (water quality) SMHI<br>(water discharge) |  | http://miljodata.slu.se/mvm/<br>https://www.smhi.se/klimatdata/hydrologi/vatt  |
| Not         Index         Index <th< td=""><th></th><td>Point source locations</td><td>SMED</td><td></td><td>http://tbv20.smhi.se/tbv/granska/</td></th<>   |                 | Point source locations  | SMED  |  | http://tbv20.smhi.se/tbv/granska/  |
| Note:         Index:         Index: <thindex:< th=""> <thindex:< th=""> <thindex:< th=""></thindex:<></thindex:<></thindex:<>  | -               |   | SMED  |  | http://tbv20.smhi.se/tbv/granska/  |
| Production         Product   | eatior          | Land cover map  |   |  | Potential data source for improvement of land<br>cover map in urban areas  |
| Section         Section         Section         Precination         Precination         Precination           Solit map         Optical solit map         Sol x 50 m         http://www.mini.self.matdata/meteorolog/1           Precipitation data   | elin            |   |   |  | Potential data source for improvement of land  |
| Note         Description         Description         Description         Description           Note         Solimap         Operation         Operation         Main Solimap         Main Solimap           Precipitation data         Frecipitation data         Main Solimap         Main Solimap         Main Solimap           Version         Solimap         Solimap         Main Solimap         Main Solimap         Main Solimap           Version         Solimap         Solimap         Main Solimap         Main Solimap         Main Solimap           Version         Solimap         Solimap         Solimap         Main Solimap         Main Solimap           Version         Solimap         Solimap         Solimap         Main Solimap         Main Solimap           Version         Solimap         Solimap         Solimap         Main Solimap   | IRU de          |   | Swedish Bord of                               | Block data   | Potential data source for improvement of land  |
| Precipitation data         Note: Precipitation data         Precipitation data         Precipitation data           Importance data         SMHI         Importance data         Inter.//www.smhise/bilimutidata/neteorolog/netorolog/neteorol   | т               | Soil map  | Digital soil map                              | 50 x 50 m  | http://markdata.se/  |
| Programmer of the properties of the product | u               | Precipitation data  |   |  | https://www.smhi.se/klimatdata/meteorologi/t   |
| Mund         Section         Section         Section         Section           Wind speed data         interpartmeters         interpartmeters         interpartmeters         interpartmeters           Solar radiation data         interpartmeters         interpartmeters         interpartmeters         interpartmeters           Mineal fertilisers         ScB, SMED         Production areas level, produc   | efinitio        | Temperature data  | CMUI  |  | https://www.smhi.se/klimatdata/meteorologi/n   |
| Participant         Production areas level, productin areas level, production areas level, production areas level, pro          | data d          | Wind speed data   |   |  | https://www.smhi.se/klimatdata/meteorologi/vi  |
| Solar radiation data         Solar radiation data         Reserver (kinacidata/meterolog)st<br>raining           Very Particular         Solar radiation data         Solar radiation data         Solar radiation data           Mineral fertilisers         Sci6, SMED         Production areas level, production areas<br>for Prysion         Required to define for fertiliser rates in<br>management schedules           Vestock / manure         Sci6, SMED         Production areas level, production areas<br>for Prysion         Required to define for definition of management<br>schedules           Vestock / manure         Sci6, SMED         Production areas level, production areas<br>for Prysion         Required to define for definition of management<br>schedules           Vestock / manure         Sci6, SMED         Production areas level, production areas<br>for Prysion         Required to define for definition of management<br>schedules           Vestock / manure         Sci6, SMED         Data for each object         Water uptake, water discharge           Vestor Withdrawais         ?         Data for each object         Itrigited area, titting and rates           Vestor Withdrawais         ?         Data for each object         Itrigited area, titting and rates           Vestor Withdrawais         ?         Data for each object         Itrigited area, titting and rates           Vestor Withdrawais         ?         Data for each object         Itrigited ared area witring and rates   | ather           | Relative humidity data  |   |  |  |
| Registrature         Swedish Bord of<br>Agriculture         Block data         Deck data <thdeck data<="" th="">         Deck data         Deck</thdeck>  | We              | Solar radiation data  |   |  | https://www.smhi.se/klimatdata/meteorologi/st<br>ralning   |
| Mineral fertilisers         SCB, SMED         Production areas level, production areas Required to define fertiliser rates in management schedules           ivertock / manure         SCB, SMED         Production areas level, production areas Required to define manure rates in management schedules           deprection         SCB, SMED         Production areas level, production areas Required for definition of management schedules           Mineral fertilisers         SCB, SMED         Production areas Revel, productin areas Revel, production areas Revel, production areas   | Ħ               | Crop structure  | Swedish Bord of<br>Agriculture                | Block data   | Data from several years needed in order to<br>define crop rotations  |
| Image         Image         SkB, SMED         Production areas level, production areas inclusion of for fyrisan         Required to define manuer rates in management of fyrisan           Image         SkB, SMED         Production areas level, production areas inclusion of fyrisan         Required for definition of management schedules           Image         MMR         VISS7         Data for each object         Morphometric parameters, outflow release rules           Image         SkB, SMED         Data for each object         Water uptake, water discharge           Image         SkB, SMED         Data for each object         Water uptake, water discharge           Image         SkB, SMED         Data for each object         Water uptake, water discharge           Image         SkB, SMED         Data for each object         Water uptake, water discharge           Image         SkB, SMED         Data for each object         Amount (monthly, source           Image         Plant specific data, SMED         Data for each object         Amount (monthly, source           Image         SkB, SMED         SkB, SMED         Data for each object         Amount (monthly, source           Image         SkB, SMED         SkB, SMED         Data for each object         Amount (monthly, source           Image         SkB, SMED         SkB, SMED         Data for each obje   | gemer           | Mineral fertilisers   | SCB, SMED                                     | Production areas level, production area 6<br>for Fyrisån | Required to define fertiliser rates in<br>management schedules   |
| Part of the practices (tillage)         ScB, SMED         Production areas level, production areas         Required for definition of management for prisish           MPS         MSS         MSS         Mtp://viss.lansstyrelsen.se/           May         ScB, SMED         Data for each object         Water uptake, water discharge           Fish ponds         SMED? SBoA?         Data for each object         Water uptake, water discharge           Water withdrawals         7         Data for each object         Water uptake, water discharge           Water withdrawals         7         Data for each object         Amount (monthly), source           Water withdrawals         Pant specific data, SMED         Data for each object         Amount (monthly), source           Water withdrawals         Pant specific data, SMED         Data for each object         Ground water relevation conturs (5 m interval) - notupited befault SWAT channel           Op 10         Widrogeology maps         GGU         NthP://www.sgu.se/en/groundwater/         Ground water relevation conturs (5 m interval) - notupited befault SWAT channel           Soli physical parameters         MSHI?         Data for each soli class in SWAT         One of the most critical parts of the model setup           Soli physical parameters         SMED, SLU, SBOA         SMED, SLU, SBOA         Concentrations/Dada of N and P (dry ad water           Soli phy   | mana            | Livestock / manure  | SCB, SMED                                     | Production areas level, production area 6<br>for Fyrisån | Required to define manure rates in management schedules  |
| BMS         VISSP         Inter/Visialized result           Reservoirs         SMHIP         Data for each object         Morphometric parameters, outflow release rules           Reservoirs         SMLP2 SBOAP         Data for each object         Water uptake, water discharge           Vater withdrawals         SC, SBOAP         Data for each object         Irrigated area, timing and rates           Vater withdrawals         Image of the second object         Irrigated area, timing and rates           Vater withdrawals         SGU         Data for each object         Amount (monthly), source           Vater withdrawals         SGU         Data for each object         Amount (monthly), source           Vater withdrawals         SGU         Data for each object         Ground water elevation contrus (S minterval) -<br>nanual)           Vater withdrawals         SGU         http://www.sgu.se/en/groundwater/         Ground water elevation contrus (S minterval) -<br>nanual)           Vater withdrawals         SGU         http://www.sgu.se/en/groundwater/         Ground water elevation contrus (S minterval) -<br>nanual)           Vater withdrawals         SMHIP         Data for each soil class in SWAT         One of the most critical parts of the model setup<br>water           Vater withdrawals         SMED, SLU, SBOA         SMED, SLU, SBOA         Measurements bi-annual (spring, autumn);<br>sampies from 3 depths (30,60,90cm);   | Land            | Other practices (tillage)   | SCB, SMED                                     | Production areas level, production area 6<br>for Fyrisån | Required for definition of management<br>schedules   |
| Number         Reservoirs         MHI?         Data for each object         Morphometric parameters, outflow release rules           Fish ponds         SMED? SBoA?         Data for each object         Water uptake, water discharge           Irrigation         SCB, SBoA?         Data for each object         Irrigated area, timing and rates           Water withdrawais         P         Data for each object         Amount (monthly), source           Water withdrawais         P         Data for each object         Amount (monthly), source           Water withdrawais         P         Data for each object         Amount (monthly), source           Water withdrawais         P         Data for each object         Amount (monthly), source           Water withdrawais         P         Data for each object         Amount (monthly), source           Water withdrawais         SGU         https://www.sgu.se/en/groundwater         Ground water elevation conturs (5 m interval) -<br>not required but can be useful           Water going high sicial parameters         Uterature         Data for each soil class in SWAT         One of the most critical parts of the model setup           Soil chemical parameters         SMED, SLU, SBOA         SMED, SLU, SBOA         Concentrations/loads of N and P (dry and wet<br>despristion). P data cannot be used as SWAT<br>input           for py lelds         SMHI?         Concentrat  |                 | BMPs  | VISS?   |  | http://viss.lansstyrelsen.se/  |
| Second  | nent            | Reservoirs  | SMHI?   | Data for each object                                     | Morphometric parameters, outflow release rules   |
| Image in transmission         SCB, SB0A?         Data for each object         Image intermines and rates           Vater withdrawals         ?         Data for each object         Amount (monthly), source           Vater withdrawals         ?         Data for each object         Amount (monthly), source           Vater withdrawals         ?         Data for each object         Effluent parameters (monthly, if not available annual)           Vater withdrawals         SGU         https://www.sgu.se/en/groundwater/         Ground water elevation contrus (S in interval) - on required but can be useful           Vater withdrawals         SGU         bat for each object         Ground water elevation contrus (S in interval) - on required but can be useful           Vater withdrawals         SGU         https://www.sgu.se/en/groundwater/         Ground water elevation contrus (S in interval) - on required but can be useful           Vater withdrawals         SMH1?         Data for each soil class in SWAT         One of the most critical parts of the model setup           Vater withor         SMED, SLU, SBOA         Measurements bi-annual (spring, autumn); samples from 3 depths (30,60,900cm); determination NO38NH4 in soil and ground water           Vater withor         SMED, SLU, SBOA         Measurements bi-annual (spring, autumn); samples from 3 depths (30,60,900cm); determination NO38NH4 in soil and ground water           Vater viels         SMH1?         Concrentrations/NP   | ıəge            | Fish ponds  | SMED? SBoA?                                   | Data for each object                                     | Water uptake, water discharge  |
| Mater withdrawals         ?         Data for each object         Amount (monthly), source           Water withdrawals         Plant specific data, SMED         Data for each object         Effluent parameters (monthly, if not available<br>annual)           0         IP         Hydrogeology maps         SGU         https://www.sgu.se/en/groundwater/<br>or equired but can be useful<br>dimensions           0         IP         Hydrogeology maps         SGU         https://www.sgu.se/en/groundwater/<br>or equired but can be useful<br>dimensions         Ground water elevation conturs (S m interval) -<br>nor equired but can be useful<br>dimensions           0         IP         Kater withdrawals         SGU         https://www.sgu.se/en/groundwater/<br>or equired but can be useful<br>dimensions           0         IP         Kater withdrawals         SGU         Data for each soil class in SWAT         One of the most critical parts of the model setup<br>dimensions           0         Ip         Iterature         Data for each soil class in SWAT         One of the most critical parts of the model setup<br>adput setup in the soil and ground<br>water           0         Ip         SMED, SLU, SBoA         Concentrations/loads of N and P (dry and wet<br>deposition). P data cannot be used as SWAT<br>input         Concentrations/loads of N and P (dry and wet<br>deposition). P data cannot be used as SWAT<br>input           1         Scharge         SMHI         Sult         Intep://miljodata.slu.se/mvm/   | าลทอ            | Irrigation  | SCB, SBoA?                                    | Data for each object                                     | Irrigated area, timing and rates   |
| Vestewater treatment plants         Plant specific data, SMED         Data for each object         Effluent parameters (monthly, if not available annua)           0<   | ern             | Water withdrawals   | ?   | Data for each object                                     | Amount (monthly), source   |
| go g  | Wate            | Wastewater treatment plants   | Plant specific data, SMED                     | Data for each object                                     | Effluent parameters (monthly, if not available annual)   |
| Properties         Channel cross-sections         SMHI?         Description         Description         Description         Description         Description         Description         SMED         Data for each soil class in SWAT         One of the most critical parts of the model setup           Name         Soil physical parameters         SMED, SLU, SBoA         Properties         Measurements bi-annual (spring, autumn);<br>samples from 3 depths (30,60,90cm);<br>determination NO3&NH4 in soil and ground<br>water           No         Nand P deposition data         SMHI?         Concentrations/loads of N and P (dry and wet<br>deposition). P data cannot be used as SWAT<br>input         Concentrations/loads of N and P (dry and wet<br>deposition). P data cannot be used as SWAT<br>input           No         Nand P deposition data         SMHI?         Concentrations/loads of N and P (dry and wet<br>deposition). P data cannot be used as SWAT<br>input         Concentrations/loads of N and P (dry and wet<br>deposition). P data cannot be used as SWAT<br>input           Very Fields         SCB, SMED         Concentrations         SLU         Not required, but worth ensuring that mean<br>crop yields match with observations           Sediment concentrations         SLU         http://miljodata.slu.se/mvm/         Image: Concentrations           SLU         SLU         Image: Concentrations         SLU         Image: Concentrations           BDD5         SLU         Image: Conconcentratingent carbon         Image: Concentration in  | Gro<br>und      | Hydrogeology maps   | SGU   | https://www.sgu.se/en/groundwater/                       | Ground water elevation conturs (5 m interval) -<br>not required but can be useful  |
| Boil physical parameters         Literature         Data for each soil class in SWAT         One of the most critical parts of the model setup           Soil physical parameters         SMED, SLU, SBoA         Measurements bi-annual (spring, autumn);<br>samples from 3 depths (30,60,90cm);<br>determination NO3&NH4 in soil and ground<br>water           Soil physical parameters         SMED, SLU, SBoA         Measurements bi-annual (spring, autumn);<br>samples from 3 depths (30,60,90cm);<br>determination NO3&NH4 in soil and ground<br>water           Soil physical parameters         SMED, SLU, SBoA         Concentrations NO3&NH4 in soil and ground<br>water           Soil physical parameters         SMH1?         Concentrations/loads of N and P (dry and wet<br>deposition). P data cannot be used as SWAT<br>input           Soli physical parameters         SMH1?         Integration NO3         Net required, but worth ensuring that mean<br>crop yields match with observations           Soli physical parameters         SU         Integration NO3         Net required, but worth ensuring that mean<br>crop yields match with observations           Soli physical parameters         SU         Integration Integratin Integration Integration Integration Integratin Integr   | Cha<br>nnel     | Channel cross-sections  | SMHI?   |  | Useful to update default SWAT channel<br>dimensions  |
| orginal         Selicitemical parameters         SMED, SLU, SBoA         Measurements bi-annual (spring, autumn);<br>samples from 3 depths (30,60,90cm);<br>determination NO3&NH4 in soil and ground<br>water           orginal         Nand P deposition data         SMHI?         Concentrations/loads of N and P (dry and wet<br>deposition). P data cannot be used as SWAT<br>input           pype         Discharge         SMHI?         Concentrations/loads of N and P (dry and wet<br>deposition). P data cannot be used as SWAT<br>input           pype         Discharge         SMHI?         http://willjodata.slu.se/mvm/         https://www.smhi.se/klimatdata/hydrologi/vatt<br>enforing https://vattenwebb.smhi.se/staino/           pype         Mach         SCB, SMED         Not required, but worth ensuring that mean<br>crop yields match with observations           sediment concentrations         SUU         http://miljodata.slu.se/mvm/         Suu           Ne P concentrations         SUU         Icu         Icu         Icu           SUU         Icu         Icu         Icu         Icu         Icu           Icu         Icu         Ic   | rties           | Soil physical parameters  | Literature                                    | Data for each soil class in SWAT                         | One of the most critical parts of the model setup  |
| Object         N and P deposition data         SMHI?         Concentrations/loads of N and P (dry and wet deposition). P data cannot be used as SWAT input           N and P deposition data         Discharge         SMHI         https://www.smhi.se/klimatdata/hydrologi/vatt enforing https://vattenwebb.smhi.se/station/           V provideds         SCB, SMED         Not required, but worth ensuring that mean crop yields match with observations           Sediment concentrations         SLU         http://miljodata.slu.se/mvm/           V & P concentrations         SLU         Image: Concentration Situ and the servation of the servational data (soil mosture, groundwater levels, ET measured)         SMHI?  | Soil prope      | Soil chemical parameters  | SMED, SLU, SBoA                               |  | Measurements bi-annual (spring, autumn);<br>samples from 3 depths (30,60,90cm);<br>determination NO3&NH4 in soil and ground<br>water |
| Discharge         SMHI         https://www.smhi.se/klimatdata/hydrologi/vatt<br>enforing https://vattenwebb.smhi.se/station/           Crop yields         SCB, SMED         Not required, but worth ensuring that mean<br>crop yields match with observations           Sediment concentrations         SLU         http://miljodata.slu.se/mvm/           N & P concentrations         SLU         Image: SLU           SLU         Image: SLU         Image: SLU           TOC (Total organic carbon)         SLU         Image: SLU           SLU         Image: SLU         Image: SLU           BOD5         SLU         Image: SLU           Other observational data (soil<br>moisture, groundwater levels, ET<br>measured)         SMHI?         Optional (hard to use them directly for<br>calibration in SWAT)   | Atmosp<br>heric | N and P deposition data   | SMHI?   |  | Concentrations/loads of N and P (dry and wet<br>deposition). P data cannot be used as SWAT<br>input                                  |
| Very         Crop yields         SCB, SMED         Not required, but worth ensuring that mean crop yields match with observations           Sediment concentrations         SLU         http://miljodata.slu.se/mvm/         Image: science sci   |                 | Discharge   | ѕмні  |  | https://www.smhi.se/klimatdata/hydrologi/vatt<br>enforing https://vattenwebb.smhi.se/station/  |
| Sediment concentrations         SLU         http://miljodata.slu.se/mvm/         Image: concentrations           N & P concentrations         SLU         Image: concentrations         SLU         Image: concentrations         Image: concentrations         SLU         Image: concentrations         I   |                 | Crop yields   | SCB, SMED                                     |  | Not required, but worth ensuring that mean<br>crop yields match with observations  |
| Student concentrations     SLU       N & P concentrations     SLU       TOC (Total organic carbon)     SLU       BOD5     SLU       Other observational data (soil moisture, groundwater levels, ET measured)     SMHI?   | ы               | Sediment concentrations   | SLU   | http://miljodata.slu.se/mvm/                             |  |
| SLU     SLU       TOC (Total organic carbon)     SLU       TOC (Total organic carbon)     SLU       BOD5     SLU       Other observational data (soil moisture, groundwater levels, ET measured)     SMHI?  | dati            |   | SLU   |  |  |
| SLU     SLU       TOC (Total organic carbon)     SLU       BOD5     SLU       Other observational data (soil moisture, groundwater levels, ET measured)     SMHI?   | valic           | N & P concentrations  | SLU   |  |  |
| SLU     SLU       BOD5     SLU       Other observational data (soil moisture, groundwater levels, ET measured)     SMHI?         Optional (hard to use them directly for calibration in SWAT)   | يە<br>ھ         |   | SLU   |  |  |
| End     Image: Supervisional data (soil moisture, groundwater levels, ET measured)     SMHI?     Optional (hard to use them directly for calibration in SWAT)   | tion            | IOC (Total organic carbon)  | SLU   |  |  |
| BOD5     SLU     Optional (hard to use them directly for calibration in SWAT)       Other observational data (soil moisture, groundwater levels, ET measured)     SMHI?     Optional (hard to use them directly for calibration in SWAT)  | bra             |   | S111  |  |  |
| Other observational data (soil moisture, groundwater levels, ET measured)         SMHI?         Optional (hard to use them directly for calibration in SWAT)           Optional (hard to use them directly for calibration in SWAT)         Optional (hard to use them directly for calibration in SWAT)  | Cali            | BOD5  | 310   |  |  |
| Other observational data (soil moisture, groundwater levels, ET measured) SMHI? SMHI? Calibration in SWAT) Optional (hard to use them directly for calibration in SWAT)   |                 |   |   |  | Ontional (hard to use them directly for  |
|   |                 | Other observational data (soil<br>moisture, groundwater levels, ET<br>measured) | SMHI?   |  | calibration in SWAT)<br>Optional (hard to use them directly for<br>calibration in SWAT)  |

# BONUS RETURN

| _  | cutchinent   | Siupia  |  |  |
|--|--|---|--|--|
| era  | Coordinator  | WULS (Ignazy Kardel, Mikolaj Piniewski)   |  |  |
| en   | Modeller   |   | ·  | •  |
| G  | Catchment size [km2]   | 1621 km2  |  |  |
|  | Item   | Source  | Resolution / scale   | Description  |
|  |  | CODCIV (Contro for Coodetic and Cortegraphic  |  |  |
|  | DEM  | CODGIX (Centre for Geodetic and Cartographic  | 10 m   | Lidar-based  |
| c  |  | Data)   |  |  |
| tio  | River network  | MPHP (Map of Hydrographic Division of Poland)   | 1:10 000   | Required for "burning in" streams  |
| lea  |  |   |  |  |
| elir   | Water use and transfer locations   | KZGW (Regional Water Management Authority) /  | 5 small hydropower plants, 13 weirs, 11  | Required in order to modify placement of inlets  |
| o<br>R   |  | WZIVIIO W (Land Reclammation Board)   | objects drained areas, 17 listi polius   | and outlets in watershed delineation   |
| heo  | Lake/reservoir map   | MPHP (Map of Hydrographic Division of Poland)   | 1:10 000   | and outlets in watershed delineation   |
| ers  |  | IMGW (Institute of Meteorology and Water  |  | Poquired in order to modify placement of inlets  |
| /at  | Gauge stations locations   | Management)   | 8 points   | and outlets in watershed delineation   |
| 5  |  | BZGW (Bagional Water Management Authority) /  |  | Boguired in order to medify placement of inlets  |
|  | Point source locations   | WIOŚ (Vojvodship Institute of Environmental   | 9 municipal, 6 industrial  | and outlets in watershed delineation   |
|  |  |   |  | Principal input data for land cover man Needs  |
|  |  | CORINE Land Cover 2012  | The smallest polygon ~100 ha   | reclasification to SWAT classes  |
| E  |  |   |  | Potential data source for improvement of land  |
| atic   |  | BDOT (Database of Topographic Objects)  | ?  | cover map in urban areas   |
| ne:  | Land cover map   | Copernicus Land Monitoring Service  | 20   | Potential data source for improvement of land  |
| deli   |  | (Imperviousness 2012)   | 20 m   | cover map in urban areas   |
| D.   |  | ODR (Agricultural Advisory Contros)   | Commune level statistics on crop   | Potential data source for improvement of land  |
| нн   |  | ODR (Agricultural Advisory Centres)   | structure  | cover map in agricultural areas  |
|  | Soil man   | WODGIK (Voivodship Centre for Geodetic and  | 1.2 000 -1.5 000   | Too detailed man, needs reclassification   |
|  | Son map  | Cartographic Data), Forest department   | 1.2 000 -1.5 000   | Too detailed map, needs reclassification   |
|  | Precipitation data   |   | 11 stations (+36 stations outside of   | Recommended to interpolate precipitation from  |
| n at   |  |   | catchment)   | points to subbasins (stations outside are useful)  |
| er c<br>itio   | Temperature data   | Management)   | 10 stations (some outside)   |  |
| fin.   | Wind speed data  | ivianagement)   | 2 stations   |  |
| vea<br>de  | Relative humidity data   |   | 2 stations   |  |
| S  | Solar radiation data   |   | 1 station  | To be acquired   |
|  | and a second sec |   |  | Data from several years needed in order to   |
|  | Crop structure   | ODR (Agricultural Advisory Centres)   | Commune-level data   | define crop rotations  |
| ų.   |  |   |  | Required to define fertiliser rates in   |
| len  | Mineral fertilisers  | ODR (Agricultural Advisory Centres)   | Commune-level data   | management schedules   |
| en   |  |   |  |  |
| ag   | Livestock / manure   | ODR (Agricultural Advisory Centres)   | Commune-level data   | Required to define manure rates in management  |
| nar  |  |   |  | schedules  |
| ц<br>р   | Other practices (tillage)  | ODB (Agricultural Advisory Contros)   | Communa laval data   | Required for definition of management  |
| -an  | Other practices (thiage)   | ODR (Agricultural Advisory Centres)   | commune-level data   | schedules  |
| _  |  |   |  | Useful to include in the model setup, otherwise  |
|  | BMPs   | ODR (Agricultural Advisory Centres)   | Commune-level data   | there might be problems in calibration   |
| t.   | De ser velas   |   | Data fan aank akiant   |  |
| eu   | Reservoirs   | RZGW (Regional Water Management Authority)  | Data for each object   | Morphometric parameters, outflow release rules   |
| em   | Fish ponds   | RZGW (Regional Water Management Authority)  | Data for each object   | Water uptake, water discharge  |
| Jag  | Irrigation   | WZMiUW (Land Reclammation Board)  | Data for each object   | Irrigated area, timing and rates   |
| ai   | Western with discussion  |   | Data fan aank akiant   | A manual (manufacture)   |
| 5  |  | W = 1 + 1 + 1 + 2 + 2 + 1 + 2 + 2 + 1 + 3 + 2 + 2 + 2 + 2 + 2 + 2 + 2 + 2 + 2   | Data for each object   | Amount (monthly), source   |
| erm  | water withdrawais  | K2GW (Regional Water Management Authority)  |  |  |
| Vater m  | Water withdrawais<br>Wastewater treatment plants   | WIOŚ (Voivodship Institute of Environmental   | Data for each object   | Effluent parameters (monthly, if not available   |
| Water m  | Wastewater treatment plants  | WIOŚ (Voivodship Institute of Environmental<br>Protection) + own survey   | Data for each object   | Effluent parameters (monthly, if not available annual)   |
| Gro Water m  | Water withdrawais Wastewater treatment plants Hydrogeology maps  | WIOS (Voivodship Institute of Environmental<br>Protection) + own survey<br>PIG (Polish Hydrogeological Institute)   | Data for each object<br>1:50 000   | Effluent parameters (monthly, if not available<br>annual)<br>Ground water elevation conturs (5 m interval) -<br>pot required but can be useful   |
| el Gro Water m   | Water withdrawais Wastewater treatment plants Hydrogeology maps  | WIOŚ (Voivodship Institute of Environmental<br>Protection) + own survey<br>PIG (Polish Hydrogeological Institute)   | Data for each object<br>1:50 000   | Effluent parameters (monthly, if not available<br>annual)<br>Ground water elevation conturs (5 m interval) -<br>not required but can be useful   |
| nel Gro Water m  | Water withdrawais Wastewater treatment plants Hydrogeology maps  | WIOŚ (Voivodship Institute of Environmental<br>Protection) + own survey<br>PIG (Polish Hydrogeological Institute)   | Data for each object<br>1:50 000<br>One cross-section per 500 m on main  | Effluent parameters (monthly, if not available<br>annual)<br>Ground water elevation conturs (5 m interval) -<br>not required but can be useful<br>Useful to update default SWAT channel  |
| hannel Gro Water m   | Water Withdrawais Wastewater treatment plants Hydrogeology maps Channel cross-sections   | VIOS (Voicodship Institute of Environmental<br>Protection) + own survey<br>PIG (Polish Hydrogeological Institute)<br>KZGW (National Water Management Authority)   | Data for each object<br>1:50 000<br>One cross-section per 500 m on main<br>rivers  | Effluent parameters (monthly, if not available<br>annual)<br>Ground water elevation conturs (5 m interval) -<br>not required but can be useful<br>Useful to update default SWAT channel<br>dimensions  |
| Channel Gro Water m  | Waster withdrawais Wastewater treatment plants Hydrogeology maps Channel cross-sections  | VIOS (Voivodship Institute of Environmental<br>Protection) + own survey<br>PIG (Polish Hydrogeological Institute)<br>KZGW (National Water Management Authority)   | Data for each object<br>1:50 000<br>One cross-section per 500 m on main<br>rivers  | Effluent parameters (monthly, if not available<br>annual)<br>Ground water elevation conturs (5 m interval) -<br>not required but can be useful<br>Useful to update default SWAT channel<br>dimensions  |
| s Channel Gro Water m  | Water Withdrawais Wastewater treatment plants Hydrogeology maps Channel cross-sections Soil physical parameters  | VIOS (Voivodship Institute of Environmental<br>Protection) + own survey<br>PIG (Polish Hydrogeological Institute)<br>KZGW (National Water Management Authority)   | Data for each object<br>1:50 000<br>One cross-section per 500 m on main<br>rivers<br>Data for each soil class in SWAT  | Effluent parameters (monthly, if not available<br>annual)<br>Ground water elevation conturs (5 m interval) -<br>not required but can be useful<br>Useful to update default SWAT channel<br>dimensions  |
| ties Channel Gro Water m   | Water Withdrawais Wastewater treatment plants Hydrogeology maps Channel cross-sections Soil physical parameters  | KZGW (Neglolal water Management Additionary)     WIOS (Volvaship Institute of Environmental     Protection) + own survey     PIG (Polish Hydrogeological Institute)     KZGW (National Water Management Authority)     Literature   | Data for each object<br>1:50 000<br>One cross-section per 500 m on main<br>rivers<br>Data for each soil class in SWAT  | Effluent parameters (monthly, if not available<br>annual)<br>Ground water elevation conturs (5 m interval) -<br>not required but can be useful<br>Useful to update default SWAT channel<br>dimensions<br>One of the most critical parts of the model setup   |
| perties Channel Gro Water m  | Water withdrawais Wastewater treatment plants Hydrogeology maps Channel cross-sections Soil physical parameters  | MUS (Voivodship Institute of Environmental<br>Protection) + own survey<br>PIG (Polish Hydrogeological Institute)<br>KZGW (National Water Management Authority)<br>Literature  | Data for each object<br>1:50 000<br>One cross-section per 500 m on main<br>rivers<br>Data for each soil class in SWAT  | Effluent parameters (monthly, if not available<br>annual)<br>Ground water elevation conturs (5 m interval) -<br>not required but can be useful<br>Useful to update default SWAT channel<br>dimensions<br>One of the most critical parts of the model setup<br>Measurements bi-annual (spring, autumn);   |
| oroperties Channel Gro Water m   | Water withdrawais Wastewater treatment plants Hydrogeology maps Channel cross-sections Soil physical parameters  | VIOS (Voivodship Institute of Environmental Protection) + own survey PIG (Polish Hydrogeological Institute) KZGW (National Water Management Authority) Literature   | Data for each object<br>1:50 000<br>One cross-section per 500 m on main<br>rivers<br>Data for each soil class in SWAT  | Effluent parameters (monthly, if not available<br>annual)<br>Ground water elevation conturs (5 m interval) -<br>not required but can be useful<br>Useful to update default SWAT channel<br>dimensions<br>One of the most critical parts of the model setup<br>Measurements bi-annual (spring, autumn);<br>samples from 3 depths (30.60.90cm);  |
| vil properties Channel Gro Water m   | Water Withdrawais Wastewater treatment plants Hydrogeology maps Channel cross-sections Soil physical parameters Soil chemical parameters   | VIOS (Voivodship Institute of Environmental Protection) + own survey PIG (Polish Hydrogeological Institute) KZGW (National Water Management Authority) Literature OSChR (Chemical-Agricultural Stations)  | Data for each object<br>1:50 000<br>One cross-section per 500 m on main<br>rivers<br>Data for each soil class in SWAT<br>21 locations  | Effluent parameters (monthly, if not available<br>annual)<br>Ground water elevation conturs (5 m interval) -<br>not required but can be useful<br>Useful to update default SWAT channel<br>dimensions<br>One of the most critical parts of the model setup<br>Measurements bi-annual (spring, autumn);<br>samples from 3 depths (30,60,90cm);<br>determination NO38.NH4 in soil and ground   |
| Soil properties Channel Gro Water m  | Water Withdrawais Wastewater treatment plants Hydrogeology maps Channel cross-sections Soil physical parameters Soil chemical parameters   | KUSY (Regional water Management Additional)     WIOS (Voivodship Institute of Environmental     Protection) + own survey     PIG (Polish Hydrogeological Institute)     KZGW (National Water Management Authority)     Literature     OSChR (Chemical-Agricultural Stations)  | Data for each object<br>1:50 000<br>One cross-section per 500 m on main<br>rivers<br>Data for each soil class in SWAT<br>21 locations  | Effluent parameters (monthly, if not available<br>annual)<br>Ground water elevation conturs (5 m interval) -<br>not required but can be useful<br>Useful to update default SWAT channel<br>dimensions<br>One of the most critical parts of the model setup<br>Measurements bi-annual (spring, autumn);<br>samples from 3 depths (30,60,90cm);<br>determination NO3&NH4 in soil and ground<br>water   |
| Soil properties Channel Gro Water m  | Water withdrawais Wastewater treatment plants Hydrogeology maps Channel cross-sections Soil physical parameters Soil chemical parameters   | MICS (Voivodship Institute of Environmental<br>Protection) + own survey<br>PIG (Polish Hydrogeological Institute)<br>KZGW (National Water Management Authority)<br>Literature<br>OSChR (Chemical-Agricultural Stations)   | Data for each object<br>1:50 000<br>One cross-section per 500 m on main<br>rivers<br>Data for each soil class in SWAT<br>21 locations  | Effluent parameters (monthly, if not available<br>annual)<br>Ground water elevation conturs (5 m interval) -<br>not required but can be useful<br>Useful to update default SWAT channel<br>dimensions<br>One of the most critical parts of the model setup<br>Measurements bi-annual (spring, autumn);<br>samples from 3 depths (30,60,90cm);<br>determination NO3&NH4 in soil and ground<br>water   |
| eric Soil properties Channel Gro Water m   | Water withdrawais Wastewater treatment plants Hydrogeology maps Channel cross-sections Soil physical parameters Soil chemical parameters   | VIOS (Voivodship Institute of Environmental Protection) + own survey PIG (Polish Hydrogeological Institute) KZGW (National Water Management Authority) Literature OSChR (Chemical-Agricultural Stations)  | Data for each object<br>1:50 000<br>One cross-section per 500 m on main<br>rivers<br>Data for each soil class in SWAT<br>21 locations  | Effluent parameters (monthly, if not available<br>annual)<br>Ground water elevation conturs (5 m interval) -<br>not required but can be useful<br>Useful to update default SWAT channel<br>dimensions<br>One of the most critical parts of the model setup<br>Measurements bi-annual (spring, autumn);<br>samples from 3 depths (30,60,90cm);<br>determination NO3&NH4 in soil and ground<br>water   |
| spheric Soil properties Channel Und Water m  | Water Withdrawais Wastewater treatment plants Hydrogeology maps Channel cross-sections Soil physical parameters Soil chemical parameters N and P deposition data   | KUS (Voivodship Institute of Environmental     Protection) + own survey     PIG (Polish Hydrogeological Institute)     KZGW (National Water Management Authority)     Literature     OSChR (Chemical-Agricultural Stations)     GIOŚ (Chief Inspectorate of Environemntal   | Data for each object<br>1:50 000<br>One cross-section per 500 m on main<br>rivers<br>Data for each soil class in SWAT<br>21 locations<br>3 stations outside catchment  | Effluent parameters (monthly, if not available<br>annual)<br>Ground water elevation conturs (5 m interval) -<br>not required but can be useful<br>Useful to update default SWAT channel<br>dimensions<br>One of the most critical parts of the model setup<br>Measurements bi-annual (spring, autumn);<br>samples from 3 depths (30,60,90cm);<br>determination NO3&NH4 in soil and ground<br>water<br>Concentrations/loads of N and P (dry and wet<br>deposition). P data cannot be used as SWAT   |
| ospheric Soil properties Channel Gro Water m   | Water withdrawais Wastewater treatment plants Hydrogeology maps Channel cross-sections Soil physical parameters Soil chemical parameters N and P deposition data   | KUS (Voivodship Institute of Environmental     Protection) + own survey     PIG (Polish Hydrogeological Institute)     KZGW (National Water Management Authority)     Literature     OSChR (Chemical-Agricultural Stations)     GIOŚ (Chief Inspectorate of Environemntal     Protection)   | Data for each object<br>1:50 000<br>One cross-section per 500 m on main<br>rivers<br>Data for each soil class in SWAT<br>21 locations<br>3 stations outside catchment  | Effluent parameters (monthly, if not available<br>annual)<br>Ground water elevation conturs (5 m interval) -<br>not required but can be useful<br>Useful to update default SWAT channel<br>dimensions<br>One of the most critical parts of the model setup<br>Measurements bi-annual (spring, autumn);<br>samples from 3 depths (30,60,90cm);<br>determination NO3&NH4 in soil and ground<br>water<br>Concentrations/loads of N and P (dry and wet<br>deposition). P data cannot be used as SWAT   |
| Atmospheric Soil properties Channel Gro Water m  | Water withdrawais Wastewater treatment plants Hydrogeology maps Channel cross-sections Soil physical parameters Soil chemical parameters N and P deposition data   | NLOW (Regional water Management Authority)         WIOS (Voivodship Institute of Environmental Protection) + own survey         PIG (Polish Hydrogeological Institute)         KZGW (National Water Management Authority)         Literature         OSChR (Chemical-Agricultural Stations)         GIOS (Chief Inspectorate of Environemntal Protection)   | Data for each object<br>1:50 000<br>One cross-section per 500 m on main<br>rivers<br>Data for each soil class in SWAT<br>21 locations<br>3 stations outside catchment  | Effluent parameters (monthly, if not available<br>annual)<br>Ground water elevation conturs (5 m interval) -<br>not required but can be useful<br>Useful to update default SWAT channel<br>dimensions<br>One of the most critical parts of the model setup<br>Measurements bi-annual (spring, autumn);<br>samples from 3 depths (30,60,90cm);<br>determination NO3&NH4 in soil and ground<br>water<br>Concentrations/loads of N and P (dry and wet<br>deposition). P data cannot be used as SWAT<br>input  |
| Atmospheric Soil properties Channel Und Water m  | Water Withdrawais Wastewater treatment plants Hydrogeology maps Channel cross-sections Soil physical parameters Soil chemical parameters N and P deposition data Discharge   | KUSY (Regional water Management Additional)     WIOS (Voivodship Institute of Environmental     Protection) + own survey     PIG (Polish Hydrogeological Institute)     KZGW (National Water Management Authority)     Literature     OSChR (Chemical-Agricultural Stations)     GIOS (Chief Inspectorate of Environemntal     Protection)     IMGW (Institute of Meteorology and Water   | Data for each object 1:50 000 One cross-section per 500 m on main rivers Data for each soil class in SWAT 21 locations 3 stations outside catchment 8 flow gauges  | Effluent parameters (monthly, if not available<br>annual)<br>Ground water elevation conturs (5 m interval) -<br>not required but can be useful<br>Useful to update default SWAT channel<br>dimensions<br>One of the most critical parts of the model setup<br>Measurements bi-annual (spring, autumn);<br>samples from 3 depths (30,60,90cm);<br>determination NO3&NH4 in soil and ground<br>water<br>Concentrations/loads of N and P (dry and wet<br>deposition). P data cannot be used as SWAT<br>input<br>Daily data (some not in operation any more)   |
| Atmospheric Soil properties Channel Und Water m  | Water Withdrawais Wastewater treatment plants Hydrogeology maps Channel cross-sections Soil physical parameters Soil chemical parameters N and P deposition data Discharge   | NLOW (Regional water Management Additional)         WIOS (Voivodship Institute of Environmental Protection) + own survey         PIG (Polish Hydrogeological Institute)         KZGW (National Water Management Authority)         Literature         OSChR (Chemical-Agricultural Stations)         GIOŚ (Chief Inspectorate of Environmental Protection)         IMGW (Institute of Meteorology and Water   | Data for each object 1:50 000 One cross-section per 500 m on main rivers Data for each soil class in SWAT 21 locations 3 stations outside catchment 8 flow gauges  | Effluent parameters (monthly, if not available<br>annual)<br>Ground water elevation conturs (5 m interval) -<br>not required but can be useful<br>Useful to update default SWAT channel<br>dimensions<br>One of the most critical parts of the model setup<br>Measurements bi-annual (spring, autumn);<br>samples from 3 depths (30,60,90cm);<br>determination NO3&NH4 in soil and ground<br>water<br>Concentrations/loads of N and P (dry and wet<br>deposition). P data cannot be used as SWAT<br>input<br>Daily data (some not in operation any more)   |
| Atmospheric Soil properties Channel Gro Water m<br>deposition  | Water Withdrawais Wastewater treatment plants Hydrogeology maps Channel cross-sections Soil physical parameters Soil chemical parameters N and P deposition data Discharge Crop yields   | N2DW (Regional water Management Authority)         WIOS (Voivodship Institute of Environmental Protection) + own survey         PIG (Polish Hydrogeological Institute)         KZGW (National Water Management Authority)         Literature         OSChR (Chemical-Agricultural Stations)         GIOS (Chief Inspectorate of Environemntal Protection)         IMGW (Institute of Meteorology and Water         ODR (Agricultural Advisory Centres)  | Data for each object 1:50 000 One cross-section per 500 m on main rivers Data for each soil class in SWAT 21 locations 3 stations outside catchment 8 flow gauges Commune-level data   | Effluent parameters (monthly, if not available<br>annual)<br>Ground water elevation conturs (5 m interval) -<br>not required but can be useful<br>Useful to update default SWAT channel<br>dimensions<br>One of the most critical parts of the model setup<br>Measurements bi-annual (spring, autumn);<br>samples from 3 depths (30,60,90cm);<br>determination NO3&NH4 in soil and ground<br>water<br>Concentrations/loads of N and P (dry and wet<br>deposition). P data cannot be used as SWAT<br>input<br>Daily data (some not in operation any more)<br>Not required, but worth ensuring that mean<br>cron vields match with observations  |
| Atmospheric Soil properties Channel Und Water m  | Water Withdrawais Wastewater treatment plants Hydrogeology maps Channel cross-sections Soil physical parameters Soil chemical parameters N and P deposition data Discharge Crop yields   | NLOW (Regional water Management Additionary)         WIOS (Voivadship Institute of Environmental Protection) + own survey         PIG (Polish Hydrogeological Institute)         KZGW (National Water Management Authority)         Literature         OSChR (Chemical-Agricultural Stations)         GIOS (Chief Inspectorate of Environemntal Protection)         IMGW (Institute of Meteorology and Water         ODR (Agricultural Advisory Centres)  | Data for each object          Data for each object         1:50 000         One cross-section per 500 m on main rivers         Data for each soil class in SWAT         21 locations         3 stations outside catchment         8 flow gauges         Commune-level data   | Effluent parameters (monthly, if not available<br>annual)<br>Ground water elevation conturs (5 m interval) -<br>not required but can be useful<br>Useful to update default SWAT channel<br>dimensions<br>One of the most critical parts of the model setup<br>Measurements bi-annual (spring, autumn);<br>samples from 3 depths (30,60,90cm);<br>determination NO3&NH4 in soil and ground<br>water<br>Concentrations/loads of N and P (dry and wet<br>deposition). P data cannot be used as SWAT<br>input<br>Daily data (some not in operation any more)<br>Not required, but worth ensuring that mean<br>crop yields match with observations  |
| Atmospheric Soil properties Channel Und Water m  | Water Withdrawais Wastewater treatment plants Hydrogeology maps Channel cross-sections Soil physical parameters Soil chemical parameters N and P deposition data Discharge Crop yields   | N2OW (Regional water Management Additionary)         WIOS (Voivodship Institute of Environmental Protection) + own survey         PIG (Polish Hydrogeological Institute)         KZGW (National Water Management Authority)         Literature         OSChR (Chemical-Agricultural Stations)         GIOŚ (Chief Inspectorate of Environemntal Protection)         IMGW (Institute of Meteorology and Water ODR (Agricultural Advisory Centres)         WIOŚ (Voivodship Inspectorate of Environemntal   | Data for each object          1:50 000         One cross-section per 500 m on main rivers         Data for each soil class in SWAT         21 locations         3 stations outside catchment         8 flow gauges         Commune-level data         19 water quality monitoring stations   | Effluent parameters (monthly, if not available<br>annual)<br>Ground water elevation conturs (5 m interval) -<br>not required but can be useful<br>Useful to update default SWAT channel<br>dimensions<br>One of the most critical parts of the model setup<br>Measurements bi-annual (spring, autumn);<br>samples from 3 depths (30,60,90cm);<br>determination NO3&NH4 in soil and ground<br>water<br>Concentrations/loads of N and P (dry and wet<br>deposition). P data cannot be used as SWAT<br>input<br>Daily data (some not in operation any more)<br>Not required, but worth ensuring that mean<br>crop yields match with observations<br>Monthly measurements, only 5 stations with  |
| Atmospheric Soil properties Channel Und Water m  | Water Withdrawais Wastewater treatment plants Hydrogeology maps Channel cross-sections Soil physical parameters Soil chemical parameters N and P deposition data Discharge Crop yields Soil parameters   | N2.0W (Regional water Management Authority)         WIOS (Voivodship Institute of Environmental Protection) + own survey         PIG (Polish Hydrogeological Institute)         KZGW (National Water Management Authority)         Literature         OSChR (Chemical-Agricultural Stations)         GIOŚ (Chief Inspectorate of Environemntal Protection)         IMGW (Institute of Meteorology and Water         ODR (Agricultural Advisory Centres)         WIOŚ (Voivodship Inspectorate of Environemntal Protection)  | Data for each object 1:50 000 One cross-section per 500 m on main rivers Data for each soil class in SWAT 21 locations 3 stations outside catchment 8 flow gauges Commune-level data 19 water quality monitoring stations;   | Effluent parameters (monthly, if not available<br>annual)<br>Ground water elevation conturs (5 m interval) -<br>not required but can be useful<br>Useful to update default SWAT channel<br>dimensions<br>One of the most critical parts of the model setup<br>Measurements bi-annual (spring, autumn);<br>samples from 3 depths (30,60,90cm);<br>determination NO3&NH4 in soil and ground<br>water<br>Concentrations/loads of N and P (dry and wet<br>deposition). P data cannot be used as SWAT<br>input<br>Daily data (some not in operation any more)<br>Not required, but worth ensuring that mean<br>crop yields match with observations<br>Monthly measurements, only 5 stations with<br>long term observation (>10 years)   |
| Atmospheric Soil properties Channel Und Water m  | Water Withdrawais Wastewater treatment plants Hydrogeology maps Channel cross-sections Soil physical parameters Soil chemical parameters N and P deposition data Discharge Crop yields Sediment concentrations   | NLOW (Regional water Management Additionary)         WIOS (Voivodship Institute of Environmental Protection) + own survey         PIG (Polish Hydrogeological Institute)         KZGW (National Water Management Authority)         Literature         OSChR (Chemical-Agricultural Stations)         GIOŠ (Chief Inspectorate of Environemntal Protection)         IMGW (Institute of Meteorology and Water         ODR (Agricultural Advisory Centres)         WIOŠ (Voivodship Inspectorate of Environemntal Protection)         IMGW (Institute of Meteorology and Water         ODR (Agricultural Advisory Centres)         WIOŠ (Voivodship Inspectorate of Environemntal Protection)         IMGW (Institute of Meteorology and Water  | Data for each object          Data for each object         1:50 000         One cross-section per 500 m on main rivers         Data for each soil class in SWAT         21 locations         3 stations outside catchment         8 flow gauges         Commune-level data         19 water quality monitoring stations;   | Effluent parameters (monthly, if not available<br>annual)<br>Ground water elevation conturs (5 m interval) -<br>not required but can be useful<br>Useful to update default SWAT channel<br>dimensions<br>One of the most critical parts of the model setup<br>Measurements bi-annual (spring, autumn);<br>samples from 3 depths (30,60,90cm);<br>determination NO3&NH4 in soil and ground<br>water<br>Concentrations/loads of N and P (dry and wet<br>deposition). P data cannot be used as SWAT<br>input<br>Daily data (some not in operation any more)<br>Not required, but worth ensuring that mean<br>crop yields match with observations<br>Monthly measurements, only 5 stations with<br>long term observation (>10 years)<br>Daily data since 2014 from automatic station   |
| Atmospheric Soil properties Channel Gro Water m<br>deposition  | Water Withdrawais Wastewater treatment plants Hydrogeology maps Channel cross-sections Soil physical parameters Soil chemical parameters N and P deposition data Discharge Crop yields Sediment concentrations   | N2.0W (Regional water Management Additionary)         WIOS (Voivodship Institute of Environmental Protection) + own survey         PIG (Polish Hydrogeological Institute)         KZGW (National Water Management Authority)         Literature         OSChR (Chemical-Agricultural Stations)         GIOS (Chief Inspectorate of Environemntal Protection)         IMGW (Institute of Meteorology and Water ODR (Agricultural Advisory Centres)         WIOS (Voivodship Inspectorate of Environemntal Protection)         IMGW (Institute of Meteorology and Water Management)   | Data for each object          Data for each object         1:50 000         One cross-section per 500 m on main rivers         Data for each soil class in SWAT         21 locations         3 stations outside catchment         8 flow gauges         Commune-level data         19 water quality monitoring stations;         1 location (close to outlet); daily intervals   | Effluent parameters (monthly, if not available<br>annual)<br>Ground water elevation conturs (5 m interval) -<br>not required but can be useful<br>Useful to update default SWAT channel<br>dimensions<br>One of the most critical parts of the model setup<br>Measurements bi-annual (spring, autumn);<br>samples from 3 depths (30,60,90cm);<br>determination NO3&NH4 in soil and ground<br>water<br>Concentrations/loads of N and P (dry and wet<br>deposition). P data cannot be used as SWAT<br>input<br>Daily data (some not in operation any more)<br>Not required, but worth ensuring that mean<br>crop yields match with observations<br>Monthly measurements, only 5 stations with<br>long term observation (>10 years)<br>Daily data since 2014 from automatic station   |
| Atmospheric Soil properties Channel Und Water m  | Water Withdrawais Wastewater treatment plants Hydrogeology maps Channel cross-sections Soil physical parameters Soil chemical parameters N and P deposition data Discharge Crop yields Sediment concentrations   | N2.0W (Regional water Management Authority)         WIOS (Voivodship Institute of Environmental Protection) + own survey         PIG (Polish Hydrogeological Institute)         KZGW (National Water Management Authority)         Literature         OSChR (Chemical-Agricultural Stations)         GIOŚ (Chief Inspectorate of Environemntal Protection)         IMGW (Institute of Meteorology and Water ODR (Agricultural Advisory Centres)         WIOŚ (Voivodship Inspectorate of Environemntal Protection)         IMGW (Institute of Meteorology and Water Management)         IMGW (Institute of Meteorology and Water Management)  | Data for each object          Data for each object         1:50 000         One cross-section per 500 m on main rivers         Data for each soil class in SWAT         21 locations         3 stations outside catchment         8 flow gauges         Commune-level data         19 water quality monitoring stations;         1 location (close to outlet); daily intervals   | Effluent parameters (monthly, if not available<br>annual)<br>Ground water elevation conturs (5 m interval) -<br>not required but can be useful<br>Useful to update default SWAT channel<br>dimensions<br>One of the most critical parts of the model setup<br>Measurements bi-annual (spring, autumn);<br>samples from 3 depths (30,60,90cm);<br>determination NO3&NH4 in soil and ground<br>water<br>Concentrations/loads of N and P (dry and wet<br>deposition). P data cannot be used as SWAT<br>input<br>Daily data (some not in operation any more)<br>Not required, but worth ensuring that mean<br>crop yields match with observations<br>Monthly measurements, only 5 stations with<br>long term observation (>10 years)<br>Daily data since 2014 from automatic station<br>(still operating)  |
| Atmospheric Soil properties Channel Gro Water m<br>deposition  | Water Withdrawais Wastewater treatment plants Hydrogeology maps Channel cross-sections Soil physical parameters Soil chemical parameters N and P deposition data Discharge Crop yields Sediment concentrations   | NLOW (Regional water Management Additority)         WIOS (Voivodship Institute of Environmental Protection) + own survey         PIG (Polish Hydrogeological Institute)         KZGW (National Water Management Authority)         Literature         OSChR (Chemical-Agricultural Stations)         GIOS (Chief Inspectorate of Environemntal Protection)         IMGW (Institute of Meteorology and Water         ODR (Agricultural Advisory Centres)         WIOS (Voivodship Inspectorate of Environemntal Protection)         IMGW (Institute of Meteorology and Water         ODR (Agricultural Advisory Centres)         WIOS (Voivodship Inspectorate of Environemntal Protection)         IMGW (Institute of Meteorology and Water         WIOS (Voivodship Inspectorate of Environemntal Protection)         IMGW (Institute of Meteorology and Water         Management)   | Data for each object Data for each object 1:50 000 One cross-section per 500 m on main rivers Data for each soil class in SWAT 21 locations 3 stations outside catchment 8 flow gauges Commune-level data 19 water quality monitoring stations; 1 location (close to outlet); daily intervals 19 water quality monitoring stations:  | Effluent parameters (monthly, if not available<br>annual)<br>Ground water elevation conturs (5 m interval) -<br>not required but can be useful<br>Useful to update default SWAT channel<br>dimensions<br>One of the most critical parts of the model setup<br>Measurements bi-annual (spring, autumn);<br>samples from 3 depths (30,60,90cm);<br>determination NO3&NH4 in soil and ground<br>water<br>Concentrations/loads of N and P (dry and wet<br>deposition). P data cannot be used as SWAT<br>input<br>Daily data (some not in operation any more)<br>Not required, but worth ensuring that mean<br>crop yields match with observations<br>Monthly measurements, only 5 stations with<br>long term observation (>10 years)<br>Daily data since 2014 from automatic station<br>(still operating)<br>Monthly measurements, only 5 stations with  |
| ion Atmospheric Soil properties Channel Gro Water m<br>deposition  | Water Withdrawais Wastewater treatment plants Hydrogeology maps Channel cross-sections Soil physical parameters Soil chemical parameters N and P deposition data Discharge Crop yields Sediment concentrations N & B concentrations  | N2.0W (Regional water Management Additionary)         WIOS (Voivodship Institute of Environmental Protection) + own survey         PIG (Polish Hydrogeological Institute)         KZGW (National Water Management Authority)         Literature         OSChR (Chemical-Agricultural Stations)         GIOS (Chief Inspectorate of Environemntal Protection)         IMGW (Institute of Meteorology and Water ODR (Agricultural Advisory Centres)         WIOS (Voivodship Inspectorate of Environemntal Protection)         IMGW (Institute of Meteorology and Water Management)         WIOS (Voivodship Inspectorate of Environemntal Protection)  | Data for each object          Data for each object         1:50 000         One cross-section per 500 m on main rivers         Data for each soil class in SWAT         21 locations         3 stations outside catchment         8 flow gauges         Commune-level data         19 water quality monitoring stations;         1 location (close to outlet); daily intervals         19 water quality monitoring stations;   | Effluent parameters (monthly, if not available<br>annual)<br>Ground water elevation conturs (5 m interval) -<br>not required but can be useful<br>Useful to update default SWAT channel<br>dimensions<br>One of the most critical parts of the model setup<br>Measurements bi-annual (spring, autumn);<br>samples from 3 depths (30,60,90cm);<br>determination NO3&NH4 in soil and ground<br>water<br>Concentrations/loads of N and P (dry and wet<br>deposition). P data cannot be used as SWAT<br>input<br>Daily data (some not in operation any more)<br>Not required, but worth ensuring that mean<br>crop yields match with observations<br>Monthly measurements, only 5 stations with<br>long term observation (>10 years)<br>Monthly measurements, only 5 stations with<br>long term observation (>10 years)  |
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