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# Factsheet

## SWD/2022/541

## Impact Assessment accompanying the document Proposal for a Directive of the European Parliament and of the Council concerning urban wastewater treatment (recast)

## Supporting model(s)

GREEN
SimpleTreat

# Impact assessment
# SWD/2022/541

## *Fact sheet on model contributions*

Source: Commission modelling inventory and knowledge management system (MIDAS)

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# Contents

# Overview of model contributions to the impact assessment SWD/2022/541

**Title**
Impact Assessment accompanying the document Proposal for a Directive of the European Parliament and of the Council concerning urban wastewater treatment (recast)

**Document ID**
SWD/2022/541

**Year of publication**
2022

**Led by**
ENV

**Model(s) used**
GREEN
SimpleTreat

**Additional information**
-

# GREEN

**Full title**
Geospatial Regression Equation for European Nutrient losses

**Run for this impact assessment by**
European Commission

**Contributed to**
Baseline and assessment of policy options

**Additional information**
GREEN was used to compute the discharges of N and P to the EU regional seas taking into account also other sources of nutrients (agriculture, atmospheric deposition etc.).

# SimpleTreat

**Full title**
SimpleTreat

**Run for this impact assessment by**
European Commission

**Contributed to**
Baseline and assessment of policy options

**Additional information**
SimpleTreat was used to estimate the contribution made by the existing WWTPs to the reduction of chemical pollution (not a target of the Urban wastewater treatment directive 91/271/EEC).

# Overview of models

# GREEN

## Overview

**Acronym** GREEN
**Full title** Geospatial Regression Equation for European Nutrient losses

**Main purpose**
A statistical model used to assess the impact of different nutrient sources, i.e. agriculture, wastewater and industrial discharges, atmospheric deposition, on freshwater and coastal waters.

**Summary**
GREEN is a statistical model used to assess the impact of agricultural fertilizers and other sources of nutrients on the environment. The GREEN model estimates the mass discharge of total nitrogen (N) and total phosphorus (P) through the stream network down to marine coastal areas, the concentration of N and P, and the relative contribution of diffuse and point sources to the total mass discharge/concentration.

GREEN is a simplified conceptual model, which distinguishes between two different pathways in nutrient transfer from sources to catchment outlet (Grizzetti et al., 2006, 2005a, 2005b). Diffuse sources (DS), which include applied synthetic and manure fertilisers, atmospheric deposition and emissions with wastewater from scattered dwellings (i.e. homesteads that are disconnected from sewerage systems), first undergo degradation in the soil via various processes including crop uptake, atmospheric losses and soil storage, before reaching the stream network. Point sources (PS), which include discharges from sewers, waste water treatment plants, industries and paved areas are directly emitted to the stream network. Once in the stream network, nutrients are partially retained in the streams due to algae growth, atmospheric losses etc. The calculation is performed on a catchment of interest, which is subdivided into a number of sub-basins (n) based on a topographic discretisation. A routing structure is then elaborated and serves to establish an emitting-receiving sub-basins relationship, i.e. an up-stream nutrient load is considered as an additional point source to the receiving down-stream sub-basin. With this representation, the emissions of N and P from upstream are transferred downstream taking into account the mass fraction lost in the basin and in the stream network.

**Keywords**
Environment; Agriculture; wastewater; nitrogen; phosphorus; water

**Model category (thematic)**
Miscellaneous

**Model home page**
https://cran.r-project.org/web/packages/GREENeR/

# Ownership & license

**Ownership**
EU ownership (European Commission)

**Ownership details**
-

**Licence type**
Free Software licence

# Details

**GREEN structure and approach**

-

**Input and parametrization**

Model inputs are:

- Annual climate data (precipitation)
- Annual input of fertilizer application (manure, mineral fertilizers), atmospheric nitrogen deposition and biological fixation, extent of agricultural and non-agricultural area.
- Discharges of N and P from industrial installations, untreated and treated wastewater. The latter are usually estimated from population density and connectivity to waste water collecting and treating systems, or available datasets of wastewater discharge points (Vigiak et al. 2018; 2020; 2023). Geomorphological information is needed in order to build the hydrographic model used in the calculation. The model consists of a set of interconnected sub-basins each containing a segment of the stream network.

**Main output**

Model outputs are:

- Nitrogen and phosphorus source apportionment
- Annual discharge of nitrogen and phosphorus loads, and concentration in stream water.

**Spatial - temporal extent**

*The output has the following spatial-temporal resolution and extent:*

| Parameter | Description |
|---|---|
| Spatial Extent / Country Coverage | EU Member States 27; Norway; Switzerland |
| Spatial resolution | Other<br>sub-catchment |
| Temporal extent | long-term (more than 15 years)<br>The latest model application provides annual outputs for 1990-2018. |
| Temporal resolution | Years |

# Quality & transparency

## Quality

| Question | Answer | Details |
|---|---|---|
| Models are by definition affected by uncertainties (in input data, input parameters, scenario definitions, etc.). Have the model uncertainties been quantified? Are uncertainties accounted for in your simulations? | No | The model is occasionally calibrated depending on the availability of data. Calibration provides an indication of the error associated to the model in predicting loads and concentrations. |
| Sensitivity analysis helps identifying the uncertain inputs mostly responsible for the uncertainty in the model responses. Has the model undergone sensitivity analysis? | No | The model, insofar as spatially distributed, is sensitive to the input emissions. Sensitivity analysis is only carried out for model parameters, and not on data inputs. |
| Have model results been published in peer-reviewed articles? | Yes | |
| Has the model formally undergone scientific review by a panel of external experts? (Please note that this does not refer to the cases when model results were validated by stakeholders) | No | Only in the context of the scientific peer review of journal papers. |
| Has model validation been done? Have model predictions been confronted with observed data (ex-post)? | Yes | The model has been extensively compared with measured N and P concentration data and to other model outputs, as documented in the references provided. |

## Transparency

| Question | Answer | Details |
|---|---|---|
| To what extent do input data come from publicly available sources? (Note: this may include sources accessible upon subscription and/or payment) | Entirely based on publicly available sources | |

| | | |
|---|---|---|
| Is the full model database as such available to external users? (The answer 'yes' comprises the cases when access to the database implies a specific procedure or a fee) | No | (To be made available with the latest release) |
| Have model results been presented in publicly available reports? | Yes | |
| Have output datasets been made publicly available? (Note: this could also imply a specific procedure or a fee) | Yes | JRC Data Catalogue, articles |
| Is there any user-friendly interface presenting model results – such as dashboards or interactive interfaces – that is accessible to the public? | Yes | JRC Data Catalogue. https://data.jrc.ec.europa.eu/collection/wpi |
| Is the model code open source? | Yes | An R implementation of the code (GREENeR) is publicly available. https://cran.r-project.org/web/packages/GREENeR/ |
| Can the code be accessed upon request? | Not applicable | |
| Has the model been documented in a publicly available dedicated report or a manual? (Note: this excludes IA reports) | Yes | The model does not require a user's manual. A full description of the model can be found in Grizzetti et al. (2021). The R implementation package includes a vignette that can be used for guidance. |
| Is there a dedicated public website where information about the model is provided? | No | |

# The model's policy relevance and intended role in the policy cycle

**The model is designed to contribute to the following policy areas**

- Agriculture and rural development
- Environment

**The model is designed to contribute to the following phases of the policy cycle**

- Formulation
- Evaluation

**The model's potential**

Appraisal of policy scenarios in terms of mass discharges and concentrations of N and P, by identifying areas that might be affected by nutrient pollution , evaluating the effectiveness of the legislation and policy options in reducing nutrient loads entering freshwaters.

# Previous use of the model in ex-ante impact assessments of the European Commission

Use of the model in ex-ante impact assessments since July 2017.

| In the Year | GREEN contributed to the Impact assessment called | Led by | By providing input to the | The model was run by | Details of the contribution |
|---|---|---|---|---|---|
| **2022** | Impact Assessment accompanying the document Proposal for a Directive of the European Parliament and of the Council concerning urban wastewater treatment (recast)<br><br>SWD/2022/541 | ENV | Baseline and assessment of policy options | *European Commission* | GREEN was used to compute the discharges of N and P to the EU regional seas taking into account also other sources of nutrients (agriculture, atmospheric deposition etc.). |

# Bibliographic references


- Grizzetti B, Bouraoui F, De Marsily G, Bidoglio G. A Statistical Method for Source Apportionment of Riverine Nitrogen Loads.. Journal of Hydrology 304; 2005. p. 302-315. JRC28950

- Grizzetti B, Bouraoui F, De Marsily G. Modelling Nitrogen Pressure in River Basins: A Comparison Between a Statistical Approach and the Physically-Based SWAT Model. PHYSICS AND CHEMISTRY OF THE EARTH 30; 2005. p. 508-517. JRC52755

- B. Grizzetti, O. Vigiak, A. Udias, A. Aloe, M. Zanni, F. Bouraoui, A. Pistocchi, C. Dorati, R. Friedland, A. De Roo, C. Benitez Sanz, A. Leip, M. Bielza, How EU policies could reduce nutrient pollution in European inland and coastal waters, Global Environmental Change, Volume 69, 2021, 102281, ISSN 0959-3780, https://doi.org/10.1016/j.gloenvcha.2021.102281.

- Vigiak, O. et al. 2018. Estimation of domestic and industrial waste emissions to European waters in the 2010s. Report EUR29451EN, Publications Office of the European Union, https://doi.org/10.2760/204793, https://publications.jrc.ec.europa.eu/repository/handle/JRC113729

- Vigiak, O., Grizzetti, B., Zanni, M., Aloe, A., Dorati, C., Bouraoui, F., Pistocchi, A. 2020. Domestic waste emissions to European waters in the 2010s. Scientific Data 7, 33, doi: 10.1038/s41597-020-0367-0

- Vigiak, O., Udias, A., Grizzetti, B., Zanni, M., Aloe, A., Weiss, F., Hristov, J., Bisselink, B. De Roo, A., Pistocchi, A., 2023. Recent regional changes in nutrient fluxes of European surface waters. Science of the Total Environment 858, 160063

- Friedland, R., et al. 2021. Effects of nutrient management scenarios on marine eutrophication indicators: a pan-European, multi-model assessment in support of the Marine Strategy Framework Directive. Frontiers in Marine Science 596126, doi: 10.3389/fmars.2021.296126

# SimpleTreat

## Overview

**Acronym** SimpleTreat
**Full title** SimpleTreat

**Main purpose**
From the SimpleTreat model website: *"SimpleTreat 4.1 is an exposure and emission model developed to estimate chemical emission from sewage treatment plants and exposure in surface water within the framework of risk assessment of chemicals. The current version is a revision of SimpleTreat 4.0.9, please see the release note for details. SimpleTreat 4.0 and 4.1 are both updates of SimpleTreat 3.1, which supported the chemical act 30 years ago in the Netherlands and later in the European Union (EU). The revision from v4.0 to v3.1 was necessary to account for more recent scientific insights with respect to behavior of chemicals in domestic sewage and activated sludge."*

**Summary**
SimpleTreat was developed to enable calculation of the fate of organic chemicals in a biological wastewater treatment plant (WWTP) ecosystem.

The model is a steady state, multiple box model solving the mass balance of a contaminant taking into account phase partitioning, degradation and volatilization. The model estimates concentrations of contaminants in effluents and sludge, and the corresponding discharges through air (volatilization), solid and liquid discharges from the plant.

The model is designed to appraise the environmental fate of a chemical undergoing treatment in a WWTP. It can be used in regulatory applications as well as in the assessment of policy scenarios of wastewater treatment.

**Keywords**
Wastewater; chemicals; degradation; phase partitioning; effluents; sludge

**Model category (thematic)**
Health; Environment

**Model home page**
https://www.rivm.nl/en/soil-and-water/simpletreat

# Ownership & license

**Ownership**

Third-party ownership (commercial companies, Member States, other organisations, …)

**Ownership details**

Dutch National Institute for Public Health and the Environment (RIVM)

**Licence type**

Non free Software licence

Freely available for non-commercial use

# Details

**SimpleTreat structure and approach**

The model assumes steady state and complete mixing of the contaminant in the compartments of a WWTP. It assumes partitioning to follow linear isotherms. The description has limitations on validity for ionic and polar compounds. The mass balance of a contaminant in the various phases and compartments within the WWTP is solved as a system of linear equations.

**Input and parametrization**

- Physicochemical properties of the contaminant:
  - Air-water partition coefficient
  - Degradation rate
  - Solids/water partition coefficient
- Operating conditions of the WWTP (particularly the hydraulic loading rate and sludge retention time).

**Main output**

- Concentration of the contaminant in the different compartments and phases of the WWTP, including sludge and effluents.
- Percentage of the contaminant mass in the effluents that ends up in the sludge and effluents, and degradation/volatilization removal efficiency (%).

**Spatial - temporal extent**

*The output has the following spatial-temporal resolution and extent:*

| Parameter | Description |
|---|---|
| **Spatial Extent / Country Coverage** | The model is generic and can be applied to a WWTP in any location. The model is not spatially explicit (the WWTP is represented as a set of interconnected boxes). |
| **Spatial resolution** | Not spatially explicit |
| **Temporal extent** | Steady state |
| **Temporal resolution** | Steady state models can be applied independent of time. They refer to the time for which inputs are valid. |

# Quality & transparency

## Quality

| Question | Answer | Details |
|---|---|---|
| Models are by definition affected by uncertainties (in input data, input parameters, scenario definitions, etc.). Have the model uncertainties been quantified? Are uncertainties accounted for in your simulations? | Not applicable | The model is known to be sensitive to certain parameters. No formal sensitivity/uncertainty analysis available. |
| Sensitivity analysis helps identifying the uncertain inputs mostly responsible for the uncertainty in the model responses. Has the model undergone sensitivity analysis? | Not applicable | The model is known to be sensitive to certain parameters. No formal sensitivity/uncertainty analysis available. |
| Have model results been published in peer-reviewed articles? | Yes | |
| Has the model formally undergone scientific review by a panel of external experts? (Please note that this does not refer to the cases when model results were validated by stakeholders) | No | The model is scrutinized in the community of practitioners. |
| Has model validation been done? Have model predictions been confronted with observed data (ex-post)? | Not applicable | The model has been applied mostly in a regulatory context. Comparison with observed data requires parameter calibration. |

## Transparency

| Question | Answer | Details |
|---|---|---|
| To what extent do input data come from publicly available sources? (Note: this may include sources accessible upon subscription and/or payment) | Based on both publicly available and restricted-access sources | |
| Is the full model database as such available to external users? (The answer 'yes' comprises the cases when access to the database implies a specific procedure or a fee) | No | |

| | | |
|---|---|---|
| Have model results been presented in publicly available reports? | Yes | |
| Have output datasets been made publicly available? (Note: this could also imply a specific procedure or a fee) | No | |
| Is there any user-friendly interface presenting model results – such as dashboards or interactive interfaces – that is accessible to the public? | Yes | The model comes in a format like a spreadsheet. |
| Is the model code open source? | No | |
| Can the code be accessed upon request? | Not applicable | The model equations are fully documented and can be easily replicated. |
| Has the model been documented in a publicly available dedicated report or a manual? (Note: this excludes IA reports) | Yes | |
| Is there a dedicated public website where information about the model is provided? | Yes | https://www.rivm.nl/en/soil-and-water/simpletreat |

# The model's policy relevance and intended role in the policy cycle

**The model is designed to contribute to the following policy areas**

- Environment
- Public health

**The model is designed to contribute to the following phases of the policy cycle**

-

**The model's potential**

The model can be used to appraise the fate of a chemical undergoing wastewater treatment. This may have obvious, important policy and regulatory implications.

# Previous use of the model in ex-ante impact assessments of the European Commission

Use of the model in ex-ante impact assessments since July 2017.

| In the Year | SimpleTreat contributed to the Impact assessment called | Led by | By providing input to the | The model was run by | Details of the contribution |
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# Bibliographic references


- Pistocchi A, Alygizakis NA, Brack W, Boxall A, Cousins IT, Drewes JE, Finckh S, Gallé T, Launay MA, McLachlan MS, Petrovic M, Schulze T, Slobodnik J, Ternes T, Van Wezel A, Verlicchi P, Whalley C. European scale assessment of the potential of ozonation and activated carbon treatment to reduce micropollutant emissions with wastewater. Sci Total Environ. 2022 Nov 20;848:157124. doi: 10.1016/j.scitotenv.2022.157124.

- Pistocchi, A., Dorati, C., Grizzetti, B., Udias Moinelo, A., Vigiak, O. and Zanni, M., Water quality in Europe: effects of the Urban Wastewater Treatment Directive, EUR 30003 EN, Publications Office of the European Union, Luxembourg, 2019, ISBN 978-92-76-11263-1, doi:10.2760/303163, JRC115607.

- Struijs J (2014) SimpleTreat 4.0: a model to predict fate and emission of chemicals in wastewater treatment plants: Background report describing the equations. RIVM Report 601353005. RIVM, Bilthoven The Netherlands.