Commission modelling inventory and knowledge management system (MIDAS)
Report generation date 02/10/23

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Factsheet

SWD/2023/412 final

Impact Assessment accompanying the document Proposal for a Regulation of the European Parliament and of the Council on plants obtained by certain new genomic techniques and their food and feed, and amending Regulation (EU) 2017/625

Supporting model(s)

IFM-CAP
CAPRI
SYNOPS-GIS

Impact assessment
SWD/2023/412 final

Fact sheet on model contributions

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Contents

Overview of model contributions to the impact assessment SWD/2023/412 final

Title
Impact Assessment accompanying the document Proposal for a Regulation of the European Parliament and of the Council on plants obtained by certain new genomic techniques and their food and feed, and amending Regulation (EU) 2017/625

Document ID
SWD/2023/412 final

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SANTE

Model(s) used
IFM-CAP
CAPRI
SYNOPS-GIS

IFM-CAP

Full title
Individual Farm Model for Common Agricultural Policy Analysis

Run for this impact assessment by
European Commission (JRC.D.4)

Contributed to
Baseline and assessment of policy options

Impact Areas
Cost of doing business

CAPRI

Full title
Common Agricultural Policy Regional Impact Analysis

Run for this impact assessment by
European Commission (JRC.D.4)

Contributed to
Baseline and assessment of policy options

Impact Areas
Cost of doing business
Productivity
EU exports & imports
Prices, quality, availability or choice of consumer goods and services
Emission of greenhouse gases
Sustainable production and consumption
Pollution by businesses

SYNOPS-GIS

Full title
Model for synoptic assessment of risk potential of chemical plant protection products

Run for this impact assessment by
Julius Kühn Institute

Contributed to
Baseline and assessment of policy options

Impact Areas
Availability or quality of Fresh- or ground water
Acidification, contamination or salinity of soil, and soil erosion rates
Number of species
Pollution by businesses

Overview of models

IFM-CAP

Overview

Acronym IFM-CAP
Full title Individual Farm Model for Common Agricultural Policy Analysis

Main purpose
An EU-wide farm level model used to assess the economic and environmental impacts of the Common Agricultural Policy (CAP) by providing changes in land and input use, crop and animal production, farm income and CAP expenditures.

Summary
IFM-CAP is a micro model designed for the ex-ante economic and environmental assessment of the medium-term adaptation of individual farmers to policy and market changes. IFM-CAP was developed by JRC in close cooperation with DG AGRI starting from 2013 for the purpose to improve the quality of agricultural policy assessment upon existing aggregate (regional, farm-group, …) models and to assess distributional effects of policies over the EU farm population. Rather than providing forecasts or projections, the model aims to generate policy scenarios, or 'what if' analyses. It simulates how a given scenario, for example, a change in prices, farm resources or environmental and agricultural policy, might affect a set of performance indicators important to decision makers and stakeholders.

IFM-CAP is a comparative static positive mathematical programming model applied to each individual farm from the Farm Accountancy Data Network (FADN) to guarantee the highest possible representativeness of the EU agricultural sector. Farmers are assumed maximizing their expected utility at given yields, product prices and CAP subsidies, subject to resource endowments and policy constraints. The main strengths and capabilities of the model include the possibility to conduct a flexible assessment of a wide range of farm-specific policies and to capture the full heterogeneity of EU commercial farms in terms of policy representation and impacts (e.g. small versus big farms).

IFM-CAP can be applied for ex-ante economic and environmental impact assessment of agricultural and environmental policies at micro (farm) level. For example, IFM-CAP was applied to support the DG AGRI Impact Assessment accompanying the proposal for the CAP post 2020 (SWD/2018/301).

Keywords
optimisation model; agriculture; CAP; Farm Level Model; EU; microeconomic analysis

Model category (thematic)

Agriculture

Model home page
http://dx.doi.org/10.2791/14623

Ownership & license

Ownership

EU ownership (European Commision)

Ownership details

The JRC.D4 is the developer of the IFM-CAP code. The main model data (i.e. FADN) are subject to confidentiality agreement with DG AGRI.

Licence type

Non-Free Software licence

Details

IFM-CAP structure and approach

IFM-CAP is a static positive mathematical programming model applied to each individual FADN (Farm Accountancy Data Network) farm (83 292 farms). It assumes that farmers maximise their expected utility at given yields, product prices and CAP subsidies, subject to resource endowments (arable land, grassland and feed) and policy constraints, such as CAP greening restrictions. Farmers' expected utility is defined following the mean-variance approach with a constant absolute risk aversion specification. Following this approach, expected utility is defined as expected income and the associated income variance. Effectively, it is assumed that farmers select a production plan that minimizes the variance in income caused by a set of stochastic variables for a given expected income level.

Farmer's expected income is defined as the sum of expected gross margins minus a non-linear (quadratic) activity-specific function. The gross margin is the total revenue including sales from agricultural products and direct payments (coupled and decoupled payments) minus the accounting variable costs of production activities. Total revenue is calculated using expected prices and yields assuming adaptive expectations (based on the previous three observations with declining weights). The accounting costs include the costs of seeds, fertilisers and soil improvers, crop protection, feeding and other specific costs. The quadratic activity-specific function is a behavioural function introduced to calibrate the farm model to an observed base-year situation, as usually done in positive programming models. This function intends to capture the effects of factors that are not explicitly included in the model, such as farmers' perceived costs of capital and labour, or model misspecifications.

Regarding income variance, most of the models in the literature incorporate uncertainty in the gross margin per unit of activity or in the revenues per unit of activity. The former models assume that prices, yields and costs are stochastic. The latter models either consider that costs are non-random because they are assumed to be known when decisions are made, or are less stochastic than revenues from the farmer's perspective. Thus, the variance in the gross margin can be approximated by the variance in revenues. In the IFM-CAP framework, the second approach is applied by considering uncertainty only in prices and yields (i.e. revenues) but without differentiating between sources of uncertainty.
IFM-CAP is calibrated for the base year 2012 using cross-sectional analysis (i.e. multiple observations) and Highest Posterior Density (HPD) approach with prior information on regional supply elasticities and dual values of resources (e.g. land rental prices). The calibration to the exogenous supply elasticities is performed in a non-myopic way by taking into account the effects of changing dual values on the simulation response.

The primary data source used to parameterize and calibrate IFM-CAP is individual farm-level data available from the Farm Accountancy Data Network (FADN) database complemented by other external EU-wide data sources such as Farm Structure Survey (FSS), CAPRI database and Eurostat. All farms represented in the FADN sample for the year 2012 (83 292 farms) are included in the model. However, to obtain expected income, past observations (2007–2012) on yields, prices and input costs for these farms are also used for model parameterisation and calibration.

One needs to be aware when applying IFM-CAP that the policy simulations obviously reflect the assumptions in the model. First, the current version of IFM-CAP assumes a fixed farms structure, implying that land can be reallocated only within farms in response to the simulated policy changes. A second potential caveat of the model is that market feedback effects (output price changes) are not taken into account. Third, certain crops are defined in the model as an aggregation of a set of individual crops (e.g. 'other cereals'). Fourth, FADN includes only commercial farms; small non-commercial farms are underrepresented in the database. A careful analysis of each of these limitations of the current version of IFM-CAP model is needed to be taken into account when analyzing the simulation results.

Input and parametrization

The following list includes the key data inputs used in the IFM-CAP model:

- Utilised Agricultural Area (FADN)
- Arable and grassland (FADN)
- Set of crop and livestock activities (FADN)
- Yields, Prices and Subsidies (FADN)
- Observed activity levels (hectares of crop area and number of livestock) (FADN)
- Farm level feed costs (FADN)
- Farm weighting factor (FADN)
- Land and milk quota rental prices (FADN)
- Prices and yields for fodder crops at MS level(FADN and CAPRI)
- Feed prices at MS level (CAPRI)
- Feed nutrient content (CAPRI)
- Nutrient requirement of animal activities (NRC , IPCC , LfL , CAPRI)
- Price and yield trends(CAPRI)
- Elasticities for feed demand at NUTS2 level (CAPRI)
- Supply elasticities for livestock activities (CAPRI)
- Supply elasticities for crops at NUTS2 level (Jansson and Heckelei, 2011)
- Carcass weights (Eurostat)
- Prices of live animals (Eurostat)
- Out-of quota prices for sugarbeet(Agrosynergie, 2011)
- MS sugarbeet in-quota production (DG-AGRI,2014)
- In- quota prices for sugar beet (Agrosynergie, 2011)
- Soil erosion cover-management factors (Panagos et al., 2015)

Main output

The main outputs/indicators generated by IFM-CAP for a specific policy scenario are the following:

Agronomic/structural indicators:

- Land allocation/crop area (ha)
- Herd size/animal number (heads)
- Livestock density (LU/ha)
- Share of arable land in Utilized Agricultural Area
- Share of grassland in Utilized Agricultural Area
- Land use change (ha)

- Agricultural production (Tons)
- Intermediate Input use (Tons)

Economic indicators:

- Agricultural output (€)
- CAP first pillar subsidies (€)
- CAP second pillar subsidies (€)
- Intermediate input costs (€)
- Variable costs (€)
- Total costs (€)
- Gross farm income (€)
- Net Farm Income (€)

Environmental indicators:

- Biodiversity index
- Soil erosion

Spatial - temporal extent

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

Parameter	Description
Spatial Extent / Country Coverage	EU Member states 27
Spatial resolution	National; Entity: Representative farms
Temporal extent	Medium-term (5 to 15 years)
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 calibration is estimated based on observed farm data. The scenario simulations are usually done for one data point. The duration of model computational time is long which does not allow to run complex analysis of model uncertainties.
Sensitivity analysis helps identifying the uncertain inputs mostly responsible for the uncertainty in the model responses. Has the model undergone sensitivity analysis?	Yes	Sensitivity analysis of model responses to different production shocks. The duration of model computational time is long which does not allow to run complex sensitivity analysis.
Have model results been published in peer-reviewed articles?	Yes	https://dx.doi.org/10.30430/69.2020.2.108-126 https://dx.doi.org/10.1093/aepp/ppz021 https://dx.doi.org/10.1093/erae/jbx029 https://dx.doi.org/10.1016/j.landusepol.2017.04.010 https://dx.doi.org/10.1007/978-3-319-48454-9_42
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	
Has model validation been done? Have model predictions been confronted with observed data (ex-post)?	No	The model calibration is estimated based on observed farm data. The model predictions were not confronted with observed data.

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	The main model data (i.e. FADN) are confidential and are not publicly available. They are subject to confidentiality agreement with DG AGRI. They can be accessed by requesting them from DG AGRI and signing the confidentiality agreement.

Have model results been presented in publicly available reports?	Yes	https://dx.doi.org/10.2760/248136 https://dx.doi.org/10.30430/69.2020.2.108-126 https://dx.doi.org/10.1093/aepp/ppz021 https://dx.doi.org/10.1093/erae/jbx029 https://dx.doi.org/10.1016/j.landusepol.2017.04.010
Have output datasets been made publicly available? (Note: this could also imply a specific procedure or a fee)	No	Only aggregated data respecting the conditions set in the confidentiality agreement. Individual farm data are not publically available.
Is there any user-friendly interface presenting model results – such as dashboards or interactive interfaces – that is accessible to the public?	No	
Is the model code open source?	No	
Can the code be accessed upon request?	Yes	The source code is available upon request. However, the main model data (i.e. FADN) cannot be shared. DG AGRI is the owner of FADN data and any use require approval from DG AGRI and signing confidentiality agreement.
Has the model been documented in a publicly available dedicated report or a manual? (Note: this excludes IA reports)	Yes	https://dx.doi.org/10.2760/248136 https://dx.doi.org/10.2760/218047 https://dx.doi.org/10.2791/14623
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

- Anticipation
- Formulation

The model's potential

The IFM-CAP model is designed to simulate EU-wide economic impacts of the Common Agricultural Policy and farm related policies targeted by the European Green Deal. The IFM-CAP can also be used to model environmental impacts of policies at farm level. The model provides detailed policy impacts at individual farm level on various economic and environmental indicators. More precisely, the IFM-CAP model allows a flexible assessment of a wide range of farm-specific policies; reflects the full heterogeneity of EU farms in terms of policy representation and impacts; covers all main agricultural production activities in the EU; provides a detailed analysis of different farming systems; and estimates the distributional impacts of policies across the farm population.

IFM-CAP was applied to support the following policy initiatives:

- DG AGRI assessment of CAP greening used in the Commission Staff Working Document (CSWD) 'Review of greening after one year' (see: European Commission (2016), Impact Assessment, SWD(2016) 218 final).
- Scenar 2030 - Pathways for the European agriculture and food sector beyond 2020 (see: M'barek, et al. (2017) Scenar 2030 - Pathways for the European agriculture and food sector beyond 2020, EUR 28797 EN, Publications Office of the European Union, Luxembourg, ISBN 978-92-76-16663-4, doi:10.2760/43791, JRC108449.
- Impact assessment of "CAP post 2020" (see: European Commission (2018), Impact Assessment, SWD(2018) 301 final)

CAPRI

Overview

Acronym CAPRI
Full title Common Agricultural Policy Regional Impact Analysis

Main purpose
A global agro-economic model used to assess impacts on agriculture of agricultural, trade and environmental policies. CAPRI provides results at a regional level and for economic and environmental variables.

Summary
The CAPRI modelling system is a global agro-economic model, initiated in 1999, designed for assessing economic and environmental impacts on agriculture at regional level.

CAPRI is a partial equilibrium model, which iteratively links a supply module, focusing on the EU, Norway, Turkey and Western Balkans, with a global multi-commodity market module. It consists of specific databases, a methodology, its software implementation and the researchers involved in their development, maintenance and applications. Specific modules ensure that the data used in CAPRI are mutually compatible and complete in time and space. They cover about 50 agricultural primary and processed products for the EU, from regional level to global scale including input and output coefficients.

The CAPRI model can be used for policy anticipation and formulation. It allows economic and environmental analysis of different policy scenarios regarding reforms of the Common Agricultural Policy (CAP). It is able to perform a regional level analysis of specific Common Market Organisations (e.g. sugar, dairies), trade of agricultural goods with the rest of the world (e.g. WTO proposals), environmental policies (e.g. greening, climate action and water) and different subsidy schemes in Europe (e.g. partial decoupling of agricultural subsidies). The model is frequently used in various Commission services (such as DG AGRI, DG ENV, DG CLIMA, Eurostat and the JRC) reporting on agricultural, environmental and climate policies at the regional dimension in the EU.

Keywords

partial equilibrium model; Environment; agriculture; CAP; impact analysis; climate change; greenhouse gas

Model category (thematic)
Agriculture

Model home page
http://www.capri-model.org/dokuwiki/doku.php?id=start

Ownership & license

Ownership

Co-ownership (EU & third party)

Ownership details

-

Licence type

Free Software licence

Details

CAPRI structure and approach
The economic model builds on a *philosophy of model templates* which are structurally identical so that instances for products and regions are generated by populating the template with specific parameter sets. This approach ensures comparability of results across products, activities and regions, allows for low cost system maintenance and enables its integration within large modelling networks. At the same time, the approach opens up the chance for complementary approaches at different levels, which may shed light on different aspects not covered by CAPRI or help to learn about possible aggregation errors in the model.

The CAPRI economic model, comparative-static in nature, is split into two major modules: the *supply module* and the *market module*.

The *supply module* consists of independent aggregate non-linear programming models representing activities of all farmers at regional or farm type level captured by the Economic Accounts for Agriculture (EAA). The programming models are a kind of hybrid approach, as they combine a Leontief-technology for variable costs covering a low and high yield variant for the different production activities with a non-linear cost function which captures the effects of labour and capital on farmers' decisions. The non-linear cost function allows for perfect calibration of the models and a smooth simulation response rooted in observed behaviour. The models capture in high detail the premiums paid under CAP, include NPK balances and a module with feeding activities covering nutrient requirements of animals. Main constraints outside the feed block are arable and grassland – which are treated as imperfect substitutes -, set-aside obligations and milk quotas. The complex sugar quota regime is captured by a component maximising expected utility from stochastic revenues. Prices are exogenous in the supply module and provided by the market module. Grass, silage and manure are assumed to be non-tradable and receive internal prices based on their substitution value and opportunity costs. A land supply curve let total area use shrink and expand depending on returns to land.

The *market module* consists in turn of two sub-modules. The sub-module *for marketable agricultural outputs is a spatial, non-stochastic global multi-commodity* model for about 50 primary and processed agricultural products, covering about 70 countries or country blocks in 40 trading blocks. Bilateral trade flows and attached prices are modelled based on the Armington assumptions (Armington, 1969). The behavioural functions for supply, feed, processing and human consumption apply flexible functional forms where calibration algorithms ensure full compliance with micro-economic theory including curvature. The parameters are synthetic, i.e. to a large extent taken from the literature and other modelling systems. Policy instruments cover (bi-lateral) tariffs, the Tariff Rate Quota (TRQ) mechanism and, for the EU, intervention stocks and subsidized exports. This sub-module delivers prices used in the supply module and allows for market analysis at global, EU and national scale, including a welfare analysis. A second sub-module deals with *prices for young animals*.

As the supply models are solved independently at fixed prices, *the link between the supply and market modules* is based on an iterative procedure. After each iteration, during which the supply module works with fixed prices, the constant terms of the behavioural functions for supply and feed demand are calibrated to the results of the regional aggregate programming models aggregated to Member State level. Solving the market modules then delivers new prices. A weighted average of the prices from past iterations then defines the prices used in the next iteration of the supply module. Equally, in between iterations, CAP premiums are re-calculated to ensure compliance with national ceilings.

Post-model analysis includes the calculation of different income indicators as variable costs, revenues, gross margins, etc., both for individual production activities as for regions, according to the methodology of the Economic Accounts for Agriculture (EAA). A welfare analysis at Member State level, or globally, at country or country block level, covers agricultural profits, tariff revenues, outlays for domestic supports and the money metric measure to capture welfare effects on consumers. Outlays under the first pillar of the CAP are modelled in very high detail. Environmental indicators cover NPK balances including nitrogen leaching, and carbon balances including carbon sequestration, and output of climate and air pollution relevant gases according the guidelines of the Intergovernmental Panel on Climate Change (IPCC) and the EEA/EMEP (European Monitoring and Evaluation Programme of the European Environment Agency) air pollutant emission inventory guidebook. Model results are presented as *interactive maps* and as thematic *interactive drill-down tables*. The CAPRI graphical user interface including the exploitation tools are documented in a separate user manual.

Furthermore, regional data are disaggregated to clusters of 1x1 km grid cells, covering crop shares, crop yields, animal stocking densities, and nitrogen balance term; these data are used to calculate other environmental indicators such as soil erosion.

Input and parametrization

The key inputs used for the model:

- prices
- agricultural land allocation
- supply and use balances of agro-food commodities
- productivity indicators (yields, processing ratios, slaughter weights, fat and protein content of milk)
- macroeconomic indicators (GDP, exchange rate, number of population)
- policy indicators (CAP and trade policy)

CAPRI constructs is own database (COCO – complete and consistent) at the global, national and regional level. The databases exploit wherever possible well-documented, official and harmonised data sources, especially data from EUROSTAT, EAA, FAOSTAT, OECD and extractions from the Farm Accounting Data Network (FADN). This allows for the possibility of annual updates. In case of gaps in the database, suitable algorithms were developed and applied to fill them. The database is constructed in a manner that assures consistency between the different data (i.e. closed market balances, perfect aggregations from lower to higher spatial levels, match of physical and monetary data).

Specific inputs from other sources or models are used as well (EDGAR, IMPACT, GLOBIOM, EBB, ...) to complete specific parts of the CAPRI database.

Main output

- agricultural production
- crop yields
- production areas
- agricultural commodity trade

- farmer's income
- prices and subsidies for commodities and regions
- Greenhouse gas and air pollutant emissions including carbon sequestration from land use change and land management change
- Nutrient and carbon balances including nitrogen leaching
- Water use by agricultural crop

The results generated from CAPRI are stored in a GDX format. A Java based graphical user interface allows the steering of different working steps (data base updates, baseline generation, model calibration, scenario runs).

Spatial - temporal extent

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

Parameter	Description
Spatial Extent / Country Coverage	ALL countries of the WORLD
Spatial resolution	World-regions (supranational); Sub-national (NUTS2)
Temporal extent	Short-term (from 1 to 5 years); Medium-term (5 to 15 years); Long-term (more than 15 years)
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 deterministic. Uncertainties in parameters are covered by targeted sensitivity analysis on a few key parameters. The large model size does not permit full-fledged uncertainty analyses.
Sensitivity analysis helps identifying the uncertain inputs mostly responsible for the uncertainty in the model responses. Has the model undergone sensitivity analysis?	Yes	When carrying out analysis key variables (i.e. yield trends, exchange rate, etc.) are changed to see the relative impact of assumptions on final results.
Have model results been published in peer-reviewed articles?	Yes	https://dx.doi.org/10.1016/j.jclepro.2021.128406 https://dx.doi.org/10.1016/j.agwat.2021.106872 https://dx.doi.org/10.1038/s43016-021-00385-8 https://dx.doi.org/10.1111/1477-9552.12339 https://dx.doi.org/10.1038/s41558-018-0358-8 https://dx.doi.org/10.1088/1748-9326/aabdc4 https://dx.doi.org/10.1016/j.foodpol.2018.01.011 https://dx.doi.org/10.1038/s41558-018-0230-x https://dx.doi.org/10.1007/s11027-017-9743-2
Has the model formally undergone scientific review by a panel of external experts? (Please note that <u>this does not refer</u> to the cases when model results were validated by stakeholders)	No	There has been no formal evaluation of the model by an external panel
Has model validation been done? Have model predictions been confronted with observed data (ex-post)?	No	Projections are not the main objective of the model, the model's strength lays in analysing deviations from the baseline (i.e. projections) due to external shocks (policy or other).

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)	Yes	The potential user has access to the full database (COCO) as part of the model files which are made available following the procedure described at https://www.capri-model.org/
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	Model results are available as a gdx file together with a graphic user interface available at www.capri-model.org. Some specific model runs might not be public if carried out by a partner for a specific client. Those undertaken (or funded) by the JRC can be made publicly available unless confidentiality requested by the partner DG (i.e. preliminary IA work).
Is there any user-friendly interface presenting model results – such as dashboards or interactive interfaces – that is accessible to the public?	Yes	https://www.capri-model.org/
Is the model code open source?	Yes	https://www.capri-model.org/
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	There is methodology and documentation section in the model's web site where all modules are documented. Wiki format and a collection of pdf documents are both available.
Is there a dedicated public website where information about the model is provided?	Yes	https://www.capri-model.org/

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
- Climate action
- Environment
- Regional policy

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

- Anticipation
- Formulation

The model's potential

The CAPRI model is well suited to evaluate the impact of the Common Agricultural Policy, trade and environmental policies on agricultural production, income, markets, trade and the environment, on global and regional (NUTS2) scale.

The CAPRI model is often used to evaluate changes to the CAP and the potential impact of free trade agreements on the agricultural sector. It is also used to evaluate impacts on the agricultural sector of other sectoral policies such as environment and climate change.

SYNOPS-GIS

Overview

Acronym SYNOPS-GIS
Full title Model for synoptic assessment of risk potential of chemical plant protection products

Main purpose
SYNOPS-GIS evaluates the environmental risk on regional level for terrestrial and aquatic not target organisms by calculating the risk indices on field level and aggregating these for regional extends.

Summary
SYNOPS evaluates the risk potential for terrestrial (soil and field margins) and aquatic (surface water) organisms. It combines use data of pesticides with their application conditions and their inherent properties.

SYNOPS-GIS was developed to assess the environmental risk potential of plant protection strategies on landscape level using GIS functionalities by linking it to geo-referenced databases for land use, soil conditions and climate data and to a dataset of regionalised surveys of pesticide application. The GIS databases were established by integrating all environmental information on field level, which is necessary to estimate the environmental exposure by drift, run-off erosion and drainage.

Calculation of Exposure toxicity ratios (ETR= Predicted environmental concentration/Toxicity value of a.i.)

Keywords
Environmental risk

Model category (thematic)
Agriculture; Environment

Model home page
https://synops.julius-kuehn.de/

Ownership & license

Ownership

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

Ownership details

Julius Kühn Institute, Federal Research Centre for Cultivated Plants,Erwin-Baur-Str. 27,06484 Quedlinburg, Germany

Licence type

Free Software licence

Details

SYNOPS-GIS structure and approach

The risk indicator SYNOPS models pesticide fluxes via different pathways and the resulting concentrations in soil, surface waters and field margins and therefore provides a quantitative assessment of the environmental risk due to pesticides {Strassemeyer 2017}. Risks associated with plant protection products are assessed on field level by linking geospatial data of agricultural fields in in a considered region (InVeKOS), surface waters {AdV 2015}, topography {AdV 2008}, soil characteristics {BüK 2007}, and weather data {DWD 2016}, to a of pesticide use on the specific fields. Field-specific input data for SYNOPS includes the relevant biophysical soil parameters (e.g. organic carbon content, hydrological soil class, soil texture, and field capacity), average slope, daily weather (precipitation and temperature), field margin width, and connectivity to surface waters for all the all considered agricultural fields. Information on plant protection products (active substances, concentrations, labelled mitigation measures) are derived from the German product database, and physico-chemical properties of the active substances were obtained from the Pesticides Properties Database {Lewis2016}.

A short summary of the method described in Strassemeyer et al. {Strassemeyer2017} is presented here. Risk indices are expressed as the Exposure Toxicity Ratio (ETR), calculated as the ratio of the Predicted Environmental Concentration (PEC) to the toxicity endpoints half maximum effect concentration, lethal concentration, lethal rate, lethal dose, and no-effect concentration for specific reference species. The following reference species are considered: algae, aquatic invertebrates, fish, higher aquatic plants, and sediment organisms for aquatic environments; earthworm and springtails for soil; and honeybees, Aphidius rhopalosiphi, and Typhlodromus pyri for field edge habitats. Daily loads of the active substances to the three environmental compartments and a time-dependent curve of PEC were derived. Over a 365-day period, beginning with the first day of the growing season, the 90th percentile of the time-dependent PEC curves and the 90th percentile of the seven-day time-weighted average concentration are calculated to represent the worst-case scenario of acute and chronic exposure for each active substance. The acute toxicity endpoints multiplied with a factor of 0.1 and the no-effect concentration of each active substance were used to describe acute and chronic toxicity, respectively. In order to assess the mixture toxicity of the complete crop protection strategies with multiple fungicide applications and multiple active substances, the acute and chronic risk of the active substances were aggregated according to the principle of concentration addition {Zhan2012, Verro2009}. The risk values were added on a daily basis to derive ETR sum curves and the temporal 90th percentiles to represent the overall acute or chronic risk of a complete application calendars. The risk for the each compartment is calculated as maximum risk of the considered reference organisms.

Strassemeyer J, Daehmlow D, Dominic AR, Lorenz S and Golla B, SYNOPS-WEB, an online tool for environmental risk assessment to evaluate pesticide strategies on field level. Crop Prot 97:28–44 (2017).

Strassemeyer J and Golla B, Berechnung des Umweltrisikos der Pflanzenschutzmittelanwendungen in den Vergleichsbetrieben mittels SYNOPS. Gesunde Pflanz 70:10343-018 (2018).

AdV, Dokumentation zur Modellierung der Geoinformationen des amtlichen Vermessungswesens (GeoInfoDok): Erläuterungen zum ATKIS® Basis-DLM, Version 6.0.1, Stand 25.08.2015 (2015).

AdV, Dokumentation zur Modellierung der Geoinformationen des amtlichen Versuchswesens (GeoInfoDok): ATKIS-Objektartenkatalog Basis-DLM, Version 6.0, Stand 11.04.2008 (2008).

Verro R, Finizio A, Otto S and Vighi M, Predicting pesticide environmental risk in intensive agricultural areas. II: Screening level risk assessment of complex mixtures in surface waters. Environ Sci Technol 43:530–537 (2009).

Zhan Y and Zhang M, PURE: a web-based decision support system to evaluate pesticide environmental risk for sustainable pest management practices in California. Ecotoxicol Environ Saf 82:104–113 (2012).

Input and parametrization

- geospatial data of agricultural fields in in a considered region
- surface waters
- topography
- oil characteristics
- weather data
- pesticide use data
- Information on plant protection products (active substances, concentrations, labelled mitigation measures)
- physico-chemical properties of the active substances were obtained from the Pesticides Properties Database

Main output

- Acute aquatic risk to aquatic non-target-organisms
- Acute aquatic risk to aquatic non-target-organisms
- Acute risk to non-target-organisms in the field margi
- Chronic risk to soil organisms

Spatial - temporal extent

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

Parameter	Description
Spatial Extent / Country Coverage	All risk values are calculated on field level and can be aggregate to any higher spatial extend by statistical methods.
Spatial resolution	National , Sub-national (NUTS1) , Sub-national (NUTS2) , Sub-national (NUTS3) , Sub-national (other) , Municipality , Entity , Regular Grid < 1km , Regular Grid 1km - 10km , Regular Grid 10km - 50km , Regular Grid >50km
Temporal extent	Short-term (from 1 to 5 years)
Temporal resolution	Days

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	too demanding
Sensitivity analysis helps identifying the uncertain inputs mostly responsible for the uncertainty in the model responses. Has the model undergone sensitivity analysis?	Yes	
Have model results been published in peer-reviewed articles?	Yes	https://doi.org/10.1016/j.tibtech.2023.02.005 https://doi.org/10.1016/j.scitotenv.2020.136881
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	
Has model validation been done? Have model predictions been confronted with observed data (ex-post)?	Yes	For a small catchment and a small set of active ingredients.

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	Except data on field specific pesticide use data, which must be provided by the user.
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)	Yes	Weather data (https://sf.julius-kuehn.de/openapi/weather/), phenology data (https://wsfa.julius-kuehn.de/swagger/) soil data (https://sf.julius-kuehn.de/openapi/SOIL-DE/), The product database and active ingredient data can be

		provided by public web services. All web-services are based on public available data. Additional data can be requested by e-mail: sf@julius-kuehn.de
Have model results been presented in publicly available reports?	Yes	https://data.europa.eu/doi/10.2760/715646
Have output datasets been made publicly available? (Note: this could also imply a specific procedure or a fee)	Yes	Project Data OPTAKLIM: https://sf.julius-kuehn.de/mapviewer/optaklim/optaRiskanalysis Risk analysis of pesticide use in sugar beet in Germany: https://sf.julius-kuehn.de/mapviewer/evaherb
Is there any user-friendly interface presenting model results – such as dashboards or interactive interfaces – that is accessible to the public?	Yes	Not for the regional assessment, but for field specific risk assessment https://synops.julius-kuehn.de/ is available
Is the model code open source?	No	
Can the code be accessed upon request?	Yes	Email request to: sf@julius-kuehn.de
Has the model been documented in a publicly available dedicated report or a manual? (Note: this excludes IA reports)	No	
Is there a dedicated public website where information about the model is provided?	Yes	https://synops.julius-kuehn.de/

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

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

- Evaluation

The model's potential

Not provided