FAIRWAY
Farm System Management and Governance
for Good Water Quality and Drinking Water Supplies

FAIRWAY REPORT series

Survey and Review of Decision Supports Tools

F.A. Nicholson, J.R. Williams, R. Cassidy, D. Doody, A. Ferriera, A. Jamsek, Ø. Kaste, S., Langas, R. K. Laursen, P. Schipper, N. Surdyk, L. Tendler, J. van Vliet and K. Verloop

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EXECUTIVE SUMMARY

A comprehensive overview of decision support tools (DSTs) used by farmers, farm advisors, water managers and policy makers in the EU for water, nutrient and pesticide management was undertaken encompassing paper-based guidelines, farm-level software and phone apps, and complex models intended for research studies. The overall purpose of the review was to select a subset of DSTs that could be further assessed by the Multi Actor Programme (MAP) leaders for their potential suitability in managing water quality within the case study catchments of the FAIRWAY project.

Structured searches of the scientific literature largely returned details of research-based modelling tools; therefore the unique combination of expertise and practical experience of the project participants was used to identify farm-scale tools and other locally developed DSTs that were assessed as being important in a national context. More than 150 DSTs were identified in total, of which 36 were selected for further investigation based on their national importance and relevance to the project aims. For these DSTs, a set of Information Sheets were produced to provide an easily accessible source of key information on tool capabilities, and a subset were demonstrated to a group of project partners and MAP leaders at a Workshop.

A classification scheme was devised to better understand the target users of the DSTs and the types of support they were intended to provide. The DSTs were separated into those developed to support water quality/agri-environment policy makers operating at a regional or national level, and those intended to support sustainable nutrient management at the farm level. The DSTs were further divided into groups depending on whether they provided support for i) evaluation of current practices; ii) strategic advice for farm management and implementation of measures; or iii) on-farm operational management.

Few of the selected DST were primarily aimed at improving water quality. Rather they were farm (nutrient/pesticide) management tools and their inclusion in this review was based on the assumption that the efficient use of nitrogen and pesticides indirectly improves water quality; most participants reported using this type of DST. Only 3 of the shortlisted DSTs were explicitly developed to consider the impact of mitigation methods on water quality: FARMSCOPER (UK), Environmental Yardstick for Pesticides (NL) and Catchment Lake Modelling Network (NO). However, tools that support the efficient and smart application of nutrients or pesticides (e.g. by taking into account weather forecasts), can be said to provide indicative information on management measures for reducing losses to the water environment. Economic and financial impacts of mitigation methods were infrequently represented by the shortlisted DSTs.

All the DSTs examined in this review operate within the context of the wider advisory frameworks in place in their respective countries, and this will clearly impact on the uptake of a DSTs and its usefulness/effectiveness. It may not always be straightfoward to transfer a DST from one country to another because the advisory framework are likely to be different, in addition to issues around language and requirements for country-specific data or calibration.

Selected DSTs will be evaluated in the FAIRWAY case studies for their ability to assist in implementing mitigation methods and managing water quality.

1. AIM AND OBJECTIVES

The aim of Task 5.1 was to undertake a survey and review of the existing decision support tools (DSTs) used by farmers, farm advisors, water managers and policy makers for water, nutrient and pesticide management in the project partner countries involved in this Task and elsewhere in Europe. The detailed objectives were to:

- Compile a list of DSTs used by farmers, farm advisors and water managers for water, nutrient and pesticide management in the project partner countries involved in this Task and elsewhere in Europe.
- Select a subset of DSTs to take forward for further review.
- Produce a written review of the selected DSTs in terms of their technical, governance and financial capabilities, and how they support the implementation of the measures reviewed in WP4.

The overall purpose of the task was that the outputs should provide the Multi Actor Programme (MAP) leaders with sufficient information on the selected DSTs to allow them to asses which, if any, could be useful for managing water quality within their case study catchment and/or could be taken forward for further evaluation in Task 5.2.

2. DEFINITIONS AND SCOPE

Decision support tools are designed to help end users make more effective decisions on how to act in the most appropriate way to minimize the contamination of drinking water. This can be achieved either by leading end users through clear decision stages and presenting the likelihood of various outcomes, or by optimizing (minimizing) the use of e.g. manufactured fertiliser nitrogen and pesticides with respect to a legal framework which excludes harmful substances and specifies usage limits (and eventually also by taxation). DSTs might also be designed to help end users make more cost-effective decisions, from both private/economic and a social/welfare points of view. They can be dynamic software tools, whose recommendations vary according to the user's inputs, and they may suggest an optimal decision path (Rose *et al*., 2016).

For the purposes of this review a DST was defined as any bespoke or generic software, email/text alerts, online calculator or guidance, phone app, and paper-based guidance that could contribute to an end user decision affecting surface or ground water quality. The definition does not include ‘human-based’ DSTs, such as advisors or peers. In addition, the DST must be currently in practical operation (i.e. in active use) or scheduled for release by 31st December 2017. The DSTs considered were those used by the project partners involved in this Task and elsewhere in Europe (including Norway, Switzerland and other non-EU countries with similar agro-climatic conditions e.g. New Zealand) on farms and within single catchments, groundwater abstraction areas, regions, countries or larger areas. Demo-versions of DST’s were included if they were functional, had been tested on end-users and were assessed to have a potential for practical use. End users were defined as:

- Farmers
- Agronomists and other farm advisors
- Water quality managers
- Policy makers
- Fertiliser or pesticide manufacturers or suppliers

- Researchers

Water quality was defined in terms of:

- Nitrogen (N) concentrations in the form of total N and/or nitrate (NO_3) and/or ammonium (NH_4^+) and/or nitrite (NO_2^-).
- Pesticide concentrations, where pesticides are defined as any insecticide, herbicide, fungicide, nematocide, acaricide, slimicide, molluscicide and any product related to any of these including any growth regulator, and their relevant metabolites, degradation and reaction products. Relevant was taken to mean any metabolites, degradation and reaction products that have similar pesticidal properties to their parent pesticides (DWI, 2012). The pesticides included were those in current professional use in agriculture in the different countries.

The focus of the review was on DSTs operating at farm, regional or national scale that could be of practical use in reducing nitrogen or pesticide pollution in the project MAP areas; EU level models such as MITERRA-EUROPE for nitrogen leaching (Velthof *et al*., 2008) were not considered.

3. APPROACH AND METHODOLOGY

The initial phase of the task was to compile a list of the DSTs currently in use in the participant countries. This was approached in two ways:

1. DSTs meeting the above definitions were identified by undertaking a search of the published scientific literature using the Web of Science Core Collection (1994- present). The keywords used for the search were discussed and agreed with all task participants and are listed in Table 1.

2. Each participant supplied a list of relevant DSTs used in their respective countries (DE, DK, FR, NL, NO, PT, SI, UK) informed by the appropriate national experts. In addition, information for Ireland (IE), which is not a FAIRWAY participant country, was supplied by the project partner from Northern Ireland (AFBI). The information supplied by the participants for each DST is detailed in Table 2, and was collated as a series of 'information capture proformas' in a spreadsheet-based database. Note that information about a DST did not need to have been published in the scientific literature to be included in the database. If documentation was available only in a national language (i.e. not English) then the participants supplied a written summary of the DST in the spreadsheet database.

The DSTs identified in the literature search and by the participants were combined into a 'long list'. An assessment was made of the search comprehensiveness by circulating this list to the participants who were then able to identify whether any key DSTs had been omitted and add them to the list as appropriate. The participants also confirmed whether the DSTs on the long list were in active use (see Definitions and Scope).

Table 1. Keywords used for the online literature search (Web of Science)

Search term	Keywords	
DST	Decision support tool OR	Decision support system OR
	Software tool OR	Decision management system OR
	Guidance tool OR	Decision assistance tool OR
	Guidance software OR	Calculator OR
	Decision support software OR	App*
	AND	
Pollutant/effect	Agricultur* OR	Weed manage* OR
	Farm* OR	Growth regulat* OR
	Financial cost* OR	Metaldehyde OR
	Social cost* OR	Organophosphate OR
	Cost-effective* OR	Carbamate OR
	Welfare* OR	Diazine OR
	Cost-benefit OR	Phenoxyacetic acid OR
	Policy* OR	MCPA OR
	Water quality OR	Glyphosate OR
	Water* OR	Bentazon OR
	Groundwater OR	Organochlor* OR
	Aquifer OR	Tryazine OR
	Soil* OR	Dinitroaniline OR
	Fertili* OR	Bipiridil OR
	Rush* OR	Dithiocarbamate OR
	Nitrogen OR	Triazole OR
	Nutrient* OR	Pyrethroid OR
	Nitrate* OR	Amide OR
	Nitrite* OR	Sulfonylurea OR
	Ammonium OR	Uracil OR
	Pesticide OR	Benzimidazole OR
	Herbicide OR	Nematocide OR
	Fungicide OR	Acaricide OR
	Molluscicide OR	Slimicide
	Insecticide OR	
	Weed control OR	

Once the database was complete, the DSTs were grouped according to their broad topic area (i.e nutrients or pesticides) and colour-coded to more easily identify the primary users and scale at which they operated (Tables 3 and 4). Because of the very large number of DSTs on the ‘long list’ (>150), it was not feasible (or useful in terms of acheiving the aims of this task) to undertake a literature review which examined each DST in detail. Therefore the participants were asked to identify (based on their knowledge and experience) a ‘shortlist’ of 3-5 DSTs from their country which they assessed to be the most widely used and/or of most potential relevance in the case studies. This reduced the number of DSTs for further consideration to 36.

Table 2. Details for each DST supplied by participants on the information capture proformas

Explanation of acronym
Brief description
Platform (e.g. paper-based tool, phone app, bespoke software)
Author name(s)
Author institute(s)
Date developed/released (or planned release date)
Member state(s) where developed
Member state(s) where currently used
Intended end user(s) (e.g. farmer, water quality manager, policy maker)
Temporal resolution (e.g. daily, annual, long-term)
Real-time component (e.g. incorporating live weather data, soil moisture data feeds etc.)
Geographical resolution (e.g. field, catchment, national)
Contaminant(s) covered (e.g. nitrate, metaldehyde etc.)
Number and type of mitigation measures included
Age/provenance of supporting data used to develop the DST
Details of validation and testing
Frequency of updates
Number of users or number of copies distributed/downloaded/purchased
Cost/availability
Full publication reference
Publication URL
Links to any other relevant documentation (e.g. user guides)
Demo material
Additional comments (e.g. shortcomings, obstacles)
The level of expertise or training required to use the DST*
Input data required to run the DST*
Outputs (including links to water quality and economic or financial aspects)*
Country-specific calibration or data requirements (including restrictions on use)*
The language of the DST and any supporting documentation*
Other useful information (e.g. screenshots of inputs/outputs; how the DST is used in practice)*

*Addional information supplied on Information Sheets (see Appendix)

Table 3. Summary of nutrient DSTs used in each country participating in the task (long list)

DE	DK	FR	UK	NI and IE	NL	SI	PT	NO	OTHER
Düngeplanung 1.6	CropSAT	STICS	Gatekeeper	Nitrogen Loading Calculator	ANCA	Načrtovanje gnojenja	Manual de Fertilização das Culturas	Catchment-lake modelling network	SOILNDB (SE)
ISIP	Vandregnskab Online	N-TESTER	Greenlight Grower Management	Teagasc NMP Online	Adviesbasis CBGV	Smernice za strokovno gnojenje	Gestão de resíduos orgânicos	Skifteplan	mDSS (IT)
BOWAB	GylleIT	JUBIL	MANNER-NPK	CAFRE Livestock Manure Storage Calculator	Beregeningswijzer	OECD/EUROSTAT N balance analysis		Agricat 2	FWPI (GR)
MINERVA	Farmtracking	Syst'N	The Farm Crap App	CAFRE Livestock Manure Nitrogen Loading Calculator	BedrijfsWaterWijzer (BWW)	GROWA-SI		Erosion risk map service	DAYCENT (IT)
GTS 200	Mark Online	Reglette Colza	PLANET		Bodemconditiescore	RQ-flex		Agro-Meteorological Service	LLR (FI)
SIMONTO	Dyrkningsvejledninger	FARMSTAR	Fertiliser Manual (RB209)		NDICEA	State network of groundwater monitoring points			GESCAL (ESP)
LandCaRe	CTzoom/CTtools	FERTIWeb	User Manual/User Guide		STONE	SWAT			SWAP-ANIMO (NL)
BASINFORM	BEST portal	MELODIE	Think Manures		WOG/WOD				GIBSI (Canada)
MONERIS	TargetEconN	Azofert	Think Soils		Erfemissiescan				
GREAT-R	DAISY	CASIMOD'N	Tried & Tested						
DANUBIA	PoMs assessment tool		FARMSCOPER						
SWIM			NERM						
			NIPPER						
			NEAP-N						
			MAGPIE						
			SUNDIAL						
			SAGIS						
			SEPARATE						
			NIRAMS						
			SCIMAP						

Primary users/Scale of DST

Farmers or advisors/field or farm scale

Water quality manager or policy maker/catchment scale

Modellers or researchers

DST names in black indicate DSTs identified on the proformas

DST names in red indicate DSTs identified in the literature search but not included on the proformas

Table 4. Summary of pesticide DSTs used in each country participating in the Task (long list)

DE	DK	FR	UK	NI and IE	NL	SI	PT	NO	OTHER
SEPTRI	Farmtracking	Indigo	Gatekeeper	Integrated Pest Management For Use On Irish Farms	Bodemcondities core	State network of groundwater monitoring points	Cultivar a Segurança - Manual técnico	Agro-Meteorological Service	CPOWeeds (ESP)
SIMCERC	Mark Online	OptiPhy	Greenlight Grower Management	WaterAware	Environmental yardstick for pesticides	SWAT	Aplicação de produtos fitofarmacêuticos - Manual do Formando		DET (Various EU)
Getreide-SIG	Dyrkningsvejledninger	ARTEM-WQ	p-EMA	FarmHedge	Schoonwaterwijzer	FITO - INFO	Utilização de produtos fitofarmaceuticos na agricultura		DRASTIC (US) - applied in EU
FUS-OPT	Registreringsnettet	IMAS	FOOTPRINT		GEM				EoS (Various EU)
SIMLAUS	Plant Protection Online	Ipest	SRUC Technical Notes		CASCADE				Moni-model (IT)
CERCBET3	Skulpegalmygvarsling	PHYTOPIXAL	Check it out		PEARL				PRZM (IT)
DRIPS	Kålfluevarsling	VESPP	Sentinel Online		SWASH				RICEWQ (IT)
PELMO	Ageruglevarsling	Mileos	Procheck		DROPLET				
REXTOX	Gulerodsfluevarsling	SIRIS	Liaison		TOXSCA				
	Kartoffelskimmelvarsling	GIBSI	MACRO		HAIR				
	Middeldatabasen		WaterAware		MASTEP				
	BEST portal				PERPEST				
	Pesticide vulnerable areas				GWA				
	DAISY				SPIN				

Primary users/Scale of DST

Farmers or advisors/field or farm scale

Water quality manager or policy maker/catchment scale

Modellers or researchers

DST names in black indicate DSTs identified on the proformas

DST names in red indicate DSTs identified in the literature search but not included on the proformas

The participants agreed at the project workshop in Naples (November 2017) that the review should consist of a brief summary of key aspects and capabilities of the 36 shortlisted DST, which could easily be referred to by the case study leaders to aid them to fulfill later project tasks. Key information should include:

- the number and type of users;
- their suitability for use across multiple member states;
- the level of complexity;
- the ability to meet the needs of actors in the MAP (Task 5.2).

Therefore a series of 3-page 'information sheets' was produced summarising relevant technical and practical aspects of the shortlisted DSTs which the participants had previously agreed should be captured (Table 2). The information sheets for the 36 DSTs were made available on the project website for Case Study leaders and other project participants to access, and are reproduced in Appendix 1 of this report. A summary of the rest of the DSTs on the long list is provided in Appendix 2 and 3.

4. RESULTS AND DISCUSSION

4.1 GENERAL REMARKS

The term 'decision support tool' (and its synonyms;Table 1) when entered into a search engine returns a very large number of 'hits'. This is because it can be applied to a wide range of tools encompassing paper-based guidelines, bespoke software and phone apps used by farmers, as well as complex sets of mathematical models intended for modelling and research purposes. All can justifiably claim to aid decision making, albeit for different sets of end users.

We found that the scientific literature searches returned significantly different numbers of 'hits' depending on the intended primary users: papers on DSTs developed for modelling and research purposes have been actively published, whilst only a limited number of papers on tools used by farmers and advisors were found in peer-reviewed journals. By their very nature these tend to be more practical tools intended for routine farm use. They may be based on sound scientific principles, but scientific publications may not necessarily be their main focus. Information on this type of DST is more likely to be made available by the developers or funders (e.g. national government, extension service; fertliser/pesticide manufacturers) in the form of user guides or other web-based information, and is often only available in the local language. Hence it was extremely valuable to have access to the information supplied by the project participants about the DSTs most widely used in their countries, as these included farm-based tools not captured by the literature searches.

Table 5 shows the shortlist of DSTs selected by the project participants for further consideration and potential practical evaluation in the Case Studies. The list includes DSTs focussing on:

- single or multiple nutrients
- pesticides
- both nutrients and pesticides

Note that no DSTs were selected from Portugal as all were paper-based systems available only in Portuguese.

Table 5. Shortlist of DSTs for further consideration.

No.	Country	DST name	Nutrient tool	Pesticide tool	WQ indic.*	WQ**	Mitiga-ion***
1	DE	Düngeplanung 1.6	Y		Y		
2	DE	ISIP	Y			Y	
3	DK	Mark Online	Y	Y	Y		
4	DK	Dyrkningsvejledninger	Y	Y			
5	DK	Plant Protection Online		Y			
6	DK	CTzoom/CTtools	Y			Y	
7	DK	BEST Kemi	Y			Y	
8	DK	TargetEconN	Y		Y		
9	FR	PHYTOPIXAL		Y	Y		
10	FR	SIRIS		Y			
11	IE	Teagasc NMP online	Y				
12	IE	FarmHedge		Y			
13	NL	ANCA	Y		Y		
14	NL	Adviesbasis CBGV	Y				
15	NL	Beregeningswijzer	Y				
16	NL	BedrijfsWaterWijzer (BWW)	Y			Y	
17	NL	Bodemconditiescore	Y	Y			
18	NL	NDICEA	Y				
19	NL	Environmental Yardstick		Y		Y	Y
20	NL	STONE	Y				
21	NO	Catchment-lake modelling network	Y			Y	Y
22	NO	Skifteplan	Y		Y		
23	NO	Agro-meteorological service	-	-			
24	SI	Načrtovanje gnojenja	Y				
25	SI	Smernice za strokovno gnojenje	Y				
26	SI	OECD/EUROSTAT N balance	Y		Y		
27	SI	GROWA-SI	Y			Y	
28	SI	State network of groundwater monitoring points	Y	Y		Y	
29	SI	FITO-INFO		Y			
30	UK	PLANET	Y		Y		
31	UK	FARMSCOPER	Y			Y	Y
32	UK	Check it out		Y			
33	UK	Sentinel Online		Y			
34	UK	Procheck		Y			
35	UK	SCIMAP	Y			Y	
36	UK	WaterAware		Y			

*Represents indicators of water quality such as inputs (use of fertiliser/pesticides), nutrient balance/surplus/efficiency.
**Water quality is explicity represented (e.g. amount or risk of nitrate/pesticide leaching)
***Mitigation methods are specifically represented

Primary users/scale of DST

Farmers or advisors/field or farm scale (mostly farm nutrient/pesticide management tools)

Water quality manager or policy maker/catchment scale

Modellers or researchers

The complexity and competetiveness of the pesticide market can mean that chemical companies will develop product-specific DSTs and will only make these available to users of their product(s); these DSTs are unlikely to appear in the scientific literature and there is limited publically available information about them. More generally available pesticide management tools are fewer in number and have usually been developed by academics (e.g. Environmental Yardstick for Pesticides, NL; FarmHedge, IR) and they tend to cover a wider range of plant protection products. For example, the Environmental Yardstick for Pesticides offers comparison of 3 crop protection products for free and comparison of an 'unlimited' number on purchase of a subscription.

A number of the nutrient management DSTs identified in this report was also commerical software which is available only at a charge to the end user (e.g. Mark Online, Plant Protection Online, DK). In some cases, these DSTs have been developed by or in conjunction with academic institutions (e.g. NDICEA, NL); in others, the details of DST development, validation and testing are commercially sensitive and are not publically available. In the UK, the computer code for nutrient management DSTs such as PLANET (Gibbons *et al*., 2005) and MANNER (Nicholson *et al*., 2013), which were developed using public funding from Defra, has now been made freely available and is incorporated with widely-used commerical software tools for farmers such as Gatekeeper and Greenlight Grower Management; these DSTs also use information published in a paper form as The Fertiliser Manual (RB209) (Defra, 2010).

There are a few DSTs available which cover both nutrients and pesticides (Mark Online and Dyrkningsvejledninger, DK; Bodemconditiescore, NL and Gatekeeper and Greenlight Grower in UK). Mark Online is the most widely used farm information management system in Denmark and covers all aspects of crop management including soil tillage and crop protection (Bligaard, 2014), whilst Dyrkningsvejledninger consists of manuals for growing different crops which provide information on Good Agricultural Practice and crop protection. In the UK, widely used farm advice tools such as Gatekeeper and Greenlight Grower Management also include modules for nutrient and pesticide planning and management, so that farmers only need to purchase a single software package to cover all their requirements.

Some of the DSTs were either meteorological information services (Agro-meteorological service, NO) providing information and advice on when weather conditions are likely to be suitable for pesticide application (and other agricultural operations), or the DST included access to meteorological information (e.g. Plant Protection Online, DK), often via a phone app interface (e.g. FarmHedge, IE) making them suitable for farmers to use in the field.

4.2 TYPES OF DSTS

A classification scheme was devised to better understand the target users of the DSTs and the types of support they were intended to provide. Table 6 and 8 shows the outline schemes for nutrient and pesticide DSTs, respectively, whereby the DSTs were separated into those developed to support water quality/agri-environment policy makers operating at a regional or national level, and those intended to support sustainable nutrient management at the farm level. The DSTs were further divided into groups depending on whether they provided support for :

- evaluation of current practices;
- strategic advice for farm management and implementation of measures;
- on-farm operational management

Tables 6 and 8 include examples of how DSTs falling into each category might be used, to help the participants complete the schemes. The completed schemes are shown in Tables 7 and 9.

Table 6. DST scheme for nutrients with examples of how DSTs in each category could be used

	Support for:		
Target	**Evaluation of current practices**	**Strategic advice on farm management and implementation of measures**	**Operational management (climate smart, innovations for equipment, IT-apps, instructions / rules for sustainable application)**
Targeted to support regional (water quality, agri-environment) policy makers	• Current nutrient loads to waterbodies (catchments) • Quantification of the drivers, sources and pathways • Regional in- en output of fertilizers • (on-line) surveys	• Where and how to focus support? Where most needed with regard to diffuse pollution • What measures are possible and effective in the catchment / drinking water protection zone? (e.g. Suitability or effectivity mapping, quantification effects measures on nitrate leaching, N and P loads to surface water bodies) • How to stimulate wider implementation (communication to increase awareness/ understanding) • How to monitor implementation and effects? (e.g. via participative monitoring)	• Where and how to focus support? Where most needed with regard to diffuse pollution • What farm practices are most critical for diffuse pollution?
Targeted to support sustainable farm (nutrient) management	• Nutrient efficiency • Current losses to soil and water • Risks for surface runoff at the farmyard and in the field	• Nutrient (mineral) efficiency, identification of measures for improvement • Sustainable soil management: identification of measures for improvement • Quantification of load reduction measures • Costs-effectiveness estimates of measures	• Right time, place, amount application, based on weather forecast, soil quality, soil moisture, growing stage crop etc. • Best management practices for the farmyard (prevent surface runoff of minerals, organic matter etc.)

Table 7. Completed scheme for nutrient DSTs

	Support for:		
Target	**Evaluation current practices**	**Strategic advice, farm management and implementation of measures**	**Operational management (climate smart, innovations for equipment, IT-apps, instructions/rules for sustainable application)**
Targeted to support regional (water quality, agri-environment) policy makers	[6] CTtools [7] BEST kemi [20] STONE [21] Catchment-lake modelling network [26] OENBA [27] GROWA [28] SNGMP [30] FARMSCOPER [34] SCIMAP	[8] TargetEconN [20] STONE [21] Catchment-lake modelling network [26] OENBA [30] FARMSCOPER	
Targeted to support sustainable farm (nutrient) management	[1] Düngeplanung [2] ISIP [3] Mark Online [13] ANCA [16] BWW [17] Bodemconditiescore [25] SSG/GPBF	[1] Düngeplanung [2] ISIP [3] Mark Online [4] Dyrkningsvejledninger [11] Teagasc NMP Online [13] ANCA [16] BWW [24] NG/FP [25] SSG/GPBF [29] PLANET	[12] Farmhedge [14] CBGV [15] BeregeningsWijzer [18] NDICEA [22] Skifteplan [29] PLANET

[1] Düngeplanung. A farm-holistic DST which helps to identify the total amount of fertilizer to be purchased and its field-specific distribution. It combines measured on-farm data (soil nutrient contents, farm manure analysis, etc.), information on crop cultivation (crop rotation, yield level, etc.) with economic implications (e.g. fertilizer prices).

[2] ISIP. A process-oriented model which simulates N-mineralisation in the soil and adjusts real-time recommendation for N-fertilizers in winter wheat accordingly. Input variables are soil texture, crop rotation, yields quality expectations, prices of N-fertilizers and the wheat product, irrigation and depth of groundwater table. The required N-fertilizer is calculated by the sum of N-withdrawal + N in the soil which is not crop available - Nmin - N-mineralisation.

[3] Mark Online. Applied by farmers and advisors for fertiliser planning, optimization and documentation in Danish crop production. It covers all aspects of crop management including soil tillage and crop protection. Mitigation is included by economic optimisation with respect to national rules and regulations. Mark Online ensures that pesticides and nutrients are used according to legislation and key data obtained via field trials.

[4] Dyrkningsvejledninger. Manuals for growing the different agricultural crops based on results from the most recent field trials. The manuals are updated yearly (or whenever needed) to give farmers and advisors information on all aspects of Good Agricultural Practise in crop production (recommendations on how to grow individual crops).

[6] CTtools. The CTtool provides estimates for nitrate leaching based on nitrogen surplus calculations for individual fields. The results are used to define current practices.

[7] BEST kemi. A groundwater chemical management and forecasting DST intended to assist the municipality and water works by providing an overview (screening) of the concentrations of nitrate and pesticides in the groundwater. Additionally, it can be used to monitor/follow the state and trends in the groundwater quality.

[8] TargetEconN. An integrated economic and biophysical social planner model which minimizes the costs of meeting a nutrient load reduction target in a specific water body. The model is calibrated for the watershed to the Danish Fjord Limfjorden. It is currently being set up for the whole country of Denmark, and is being used for advise of the Ministry of Environment and Food for planning related to the Water Framework Directive.

[11] Teagasc Nutrient Management Planner Online. A system for developing farm-scale nutrient management plans for environmental and regulatory purposes. In addition to guidance on storage for on-farm slurry/manure and concentrate needs the application provides field maps showing nutrient and liming requirements based on soil testing. Quite technical so likely to be used by agricultural consultants on behalf of most farmers.

[12] FarmHedge. A commercial phone app, allowing farmers in the same geographic areas to obtain volume-based discounts on purchases of feed stuffs or fertiliser and to sell farm produce easily and securely. The secondary component of the app uses farm location to create a set of weather alerts relating to Grass Growth, Environment & Safety, Harvesting, Fertilising & Seeding and Animal Health.

[13] ANCA (Annual Nutrient Cycle Assessment). ANCA gives a farm specific view of nutrient inputs and outputs and the emissions to the environment; N and P surpluses to the soil (surpluses resulting from fertilizer use and plant uptake), NO_3 leaching to upper groundwater

and NH_3 emissions to the air. ANCA does not include measures, but farm advisors use the results to discuss possible improvements (and thus possible measures) for nutrient efficiency with the farmer. When measures are implemented, ANCA can be used as a monitoring tool to evaluate the effects on the emissions and nutrient use efficiency. Although ANCA was developed to support at farm level, results on a regional scale are used by regional policy makers to estimate possible and feasible reductions of N and P surpluses in catchments.

[14] Adviesbasis CBGV. The recommendations for fertilization of grassland and maize are published by the Commission on Fertilization of Grassland and Fodder crops. The recommendations refer to, amongst others, N rates and are specified for different growing conditions, such as soil type, N release in soil by mineralisation and hydrology (water availability).

[15] BeregeningWijzer. Online meteorological data on precipitation and field data are processed to give irrigation requirements for individual fields. Recommendations on optimal rates prevent excess irrigation which could enhance leaching and facilitates preservation of the optimal level of water content in soil, resulting in higher N uptake and better utilization of fertilizer N.

[16] BWW (Farm Water Management Guide). BWW indicates risks on 7 main water management aspects for specific dairy farms and suggests measures for improvement. The aspects are 1) runoff form the farmyard, 2) water retention in the soil (draught prevention), 3) wetness (damage crops), 4) NO_3 leaching to groundwater, 5) runoff and drainage of N & P to local surface waters, 6) drinking water for cattle and 7) management of local surface waters (ditches) and recycling of grass clippings and dredging. The indicated risks are scored in a qualitative way (Good, Moderate, Insufficient, bad). BWW can support farmers to evaluate the effect of measures and, although not directly, indicates measures to improve the water related risks.

[17] Bodemconditiescore. A consistent and comprehensive evaluation method of visual observations on sod density (sprouts per cm^2), botanical composition of grass sod, soil density, biological activity, abundance of macro fauna, rooting depth. Optionally also chemical quality of the grass and maize silage. This supports farmers to indicate soil problems.

[18] NDICEA (Nitrogen Dynamics in Crop rotations in Ecological Agriculture). The NDICEA nitrogen planner presents an integrated assessment of nitrogen availability for crops. This is more than simple nitrogen budgeting for each crop - crop demand is on one side, and expected availability of artificial fertilizers and manures, crop residues, green manures and soil is on the other side, also taking into account leaching and denitrification losses.

[20] STONE. This integrated modeling system calculates nutrient emissions to water from agriculture and nature land areas in the Netherlands. It is designed and used for evluation at national and regional level of the effects of fertilizer policy measures for runoff and leaching of N and P to ground water and surface waters. The coupled model SWAP-Animo in STONE can distinguish the processes and sources that determine runoff and leaching to water (fertiizer use, atmospheric deposition, seepage, mineralization). This output is used by regional and national policy makers to initiate effective measures, allocate source reduction targets and underpin (semi) natural background levels in catchments of surface water bodies.

[21] Ctachment Lake Modelling Network. A network of process-based, mass-balance models linking climate, hydrology, catchment-scale nutrient dynamics and lake processes. The model network allows disentangling of the effects of climate change from those of land-use change on lake water quality and phytoplankton growth. The model network can thus support decision-making to achieve good water quality and ecological status.

[22} Skifteplan. The most commonly used farm level DST for fertiliser application (N and P) on agricultural fields in Norway. Calculates optimal fertilization rates, to avoid excess N and P in soils and runoff. Also used to keep track of what is grown on the fields year by year and what other treatments/measures implemented; plant protection, soil cultivation, etc. Used by farmers and agricultural advisers.

[24] NG/FP (Načrtovanje gnojenja /fertilisation planning). Assists agricultural advisers and farmers to optimise fertilizer use in all agricultural sectors, most notably in horticulture and field crop agriculture. Allows the user to quickly calculate recommended quantities of N, P and K fertilizers, both as organic and easily soluble mineral fertilizers, as well as the need for lime. Annual or multi-year fertilizwe plans can be produced, together with the correct crop rotation taking into account the amount of organic fertilisers produced on the farm.

[25] SSG/GPBF (Smernice za strokovno gnojenje / Guidelines for professional based fertilisation). A collection of fertiliser use instructions based on experience, plant development observations, and chemical analyses of soil and plant parts. The guidelines are in line with the regulations and requirements for the quality of crops and the preservation of a clean environment. Intented to set a broader framework that is not based solely on political decisions or fashion trends, but on rational expert findings.

[26] OENBA (OECD/EUROSTAT N balance analysis). Joint Eurostat/OECD meetings identify and agree on the most robust and feasible methodology for the calculation of N and P balances. This handbook sets out the main principles of the methodology across OECD and EU Member countries. The aim is to be able to consistently produce an indicator based on a single methodology and harmonised definitions for all countries. In Slovenia, results are prepared by the Agricultural Institute for the Ministry of Environment and Spatial Planning. This paper based tool serves as basis for reporting to the EU about Nitrate Directive implantation and as a basis for preparation of legislation and measures for drinking water protection areas.

[27] GROWA (GROWA-SI - Water quality model). The regional water balance model GROWA-SI is the official state model for reporting of Nitrate Directive implementation at a country wide level. It was developed by the JULICH Institute from Germany for the Slovenian Environmental Agency (SEA). It can calculate groundwater recharge rates for Slovenia. It also has the capability to account for N balances.

[28] SNGMP (State network of groundwater monitoring points). Policy makers and water managers (Ministry, Environmental Agency) make decisions based on the state approved water quality monitoring network. Measured values and their trends over the years serve as one of the base indicators for introducing new measures or of the success of previously introduced measures. The temporal scale of state monitoring is once or twice per year. Monthly, daily or weekly monitoring (depending on conditions) is performed by drinking water suppliers (water companies).

[29] PLANET. A nutrient management decision support tool for use by farmers and advisers in England/Wales and Scotland for field level nutrient planning and for assessing and demonstrating compliance with the Nitrate Vulnerable Zone (NVZ) rules.

[30] FARMSCOPER. FARMSCOPER (FARM Scale Optimisation of Pollutant Emission Reduction) can be used to assess diffuse agricultural pollutant loads on a farm and quantify the impacts of farm mitigation methods on these pollutants. The farm systems within the tool can be customised to reflect management and environmental conditions representative of farming across England and Wales. Contains over 100 mitigation methods, including many of those in the latest Defra Mitigation Method User Guide.

[34} SCIMAP. A tool to help decision-makers, including governments, non-governmental organisations, land owners etc. to work out where to prioritise activities that protect the water environment, and so make our water clean again. SCIMAP is an approach to the generation of risk maps for diffuse pollution within catchments. SCIMAP aims to determine where within a catchment is the most probable source of diffuse pollution and is based on a probabilistic/relative approach.

Table 8. DST scheme for pesticides with examples of how DSTs in each category could be used

	Support for (functions):		
Target	**Evaluation of current practices**	**Strategic advice on farm management and implementation of measures**	**Operational management (climate smart, innovations for equipment, IT-apps, instructions / rules for sustainable application)**
Targeted to support regional (water quality, agri-env) policy makers	• Current pesticide emission to waterbodies (catchments)/ concentrations compared to environmental levels • Quantification of the sources (crops, application types) and pathways • Regional use and expected emission of pesticides • on-line) surveys on adoption of best practices in IPM	• Where and how to focus support? Where most needed with regard to diffuse pollution • What measures are possible and effective in the catchment / drinking water protection zone? (e.g. Suitability or effectivity mapping, quantifying effects of measures on leaching to ground water, direct spray drift, run off etc to surface water bodies) • How to stimulate wide implementation (communication to more awareness, understanding, targeted subsidies) • How to monitor implementation and effects?	• Decide where and how to focus support • Draw up implementation instructions and/or rules
Targeted to support sustainable farm crop protection (Integrated Pest Management)	• Efficient and effective use of pesticides • Current losses to soil and water • Risks for surface runoff at the farmyard and in the field	• Spraying efficiency, identification of measures for improvement • Identification of alternatives to pesticide spraying through prevention, non-chemical control • Quantification of reduction measures (in kg active ingredient or environmental impact) • Costs-effectiveness estimates of measures	• Choice of best practices crop protection methods (preferably non-chemical). • If chemical - choose pesticide with lowest environmental impact • Right time and dosage for application, based on weather forecast, soil and crop moisture, infection chances of certain pests • Identification of risks for runoff / leaching from farmyard and best practices to remediate these risk

Table 7. Completed scheme for pesticide DSTs

	Support for:		
Target	**Evaluation of current practices**	**Strategic advice on farm management and implementation of measures**	**Operational management (climate smart, innovations for equipment, IT-apps, instructions/rules for sustainable application)**
Targeted to support regional (water quality, agri-environment) policy makers	[7] BEST kemi [9] Phytopixal [10] SIRIS [19] Yardstick [28] SNGMP	[9] Phytopixal [10] SIRIS [29] FITO-INFO	
Targeted to support sustainable farm crop protection (Integrated Pest Management)	[3] Mark Online [9] Phytopixal [10] SIRIS [19] Yardstick [29] FITO-INFO	[3] Mark Online [4] Dyrkningsvejledninger [5] Plant Protection Online [19] Yardstick	[5] Plant Protection Online [12] FarmHedge [32] Check it Out [34] Procheck. [35] Sentinel Online [36] Water Aware

[3] Mark Online. Applied by farmers and advisors for planning, optimization and documentation in Danish crop production. It covers all aspects of crop management including soil tillage and crop protection. Mitigation is included by economic optimisation with respect to national rules and regulations. Mark Online makes sure that pesticides and nutrients are used according to legislation and key figures obtained via field trials.

[4] Dyrkningsvejledninger. Manuals for growing the different agricultural crops based on results from the most recent field trials. The manuals are updated yearly (or whenever needed) to give farmers and advisors information on all aspects of Good Agricultural Practise in crop production (recommendations on how to grow the individual crops).

[5] Plant Protection Online. Applied by farmers and advisors for reduction of use of pesticides and ensuring that only legal pesticides are used. The tool gives recommendations on whether or not to spray, dosage and spraying time.

[7] BEST kemi. A groundwater chemical management and forecasting DST intended to assist the municipality and water works by providing an overview (screening) of the concentrations of nitrate and pesticides in the groundwater. Additionally, it can be used to monitor/follow the state and trends in the groundwater quality.

[9] SIRIS. Allows pesticides to be classified according to their potential to reach surface water and groundwater. SIRIS allows classification of pesticides into the 'ideal' and the 'worst' for use on the farm/field. It can help a farmer to select the best one according environment parameters. Additionally, SIRIS-Pesticides can help to organize the monitoring of pesticides in waters at the regional or local scale (as set by the user). The results of SIRIS are rankings that represent risks.

[10] Phytopixal. Based on a combination of indicators relating to the environmental vulnerability of the surface water environment and the agricultural pressure. The combination of these indicators for each pixel provides the contamination risk. PHYTOPIXAL is a GIS model. Using this tool saves time in the detection of action zones allowing for a better implementation of the recommendations aimed at reducing contamination. The method can be an accessible common baseline (reference tool).

[12] FarmHedge. The FarmHedge app is primarily commercial, allowing farmers in the same geographic areas to obtain volume-based discounts on purchases of feed stuffs, pesticides or fertiliser and to sell farm produce easily and securely. The secondary component of the app uses farm location to create a set of weather alerts relating to Grass Growth, Environment & Safety, Harvesting, Fertilising & Seeding and Animal Health.

[19] Environmental Yardstick for Pesticides. The online version of the yardstick and the information sheets per crop, are used mainly to support IPM operational management at farmscale. The excel and GRIP-based offline application are used to evaluate current practices and the effect of measures that are being taken: Spraying schemes are evaluated in terms of environmental impact. This is done in hindsight or ex-ante, for one crop or all, for one farm or for groups on a regional level. When done on a regional level during several years this provides water authorities with a proxy – instead of real measurements in groundwater as travel times of pollution takes so long - on the effectiveness of programs aimed at reducing impact on groundwater.

[28] SNGMP (State network of groundwater monitoring points). Policy makers and water managers (Ministry, Environmental Agency) accept their decisions based on the state approved water quality monitoring network. Measured values and their trends over the years serve as one of the base indicators for actions in introducing new measures or of success of in the past introduced measures. Temporal scale of state monitoring one to twice per year. Monthly, daily or weekly monitoring scale (depends on conditions) is performed by drinking water suppliers (water companies).

[29] FITO-INFO (Slovene information system for plant protection). State information system for public use presenting information for producers. Registered plant protection products, plant protection related legislation, organism names, descriptions, pictures, forecast information, important information for plant producers, news, other information regarding plant protection.

[32] Check it Out. The Check it Out Tool was designed to help farmers and sprayer operators review and improve spraying practices and so reduce the risk of pesticides reaching water. The tool has 22 multi-choice questions covering Planning and Management, Filling and

Handling, Soil Management and Field Practice. After completing the questions, users are given a score for each aspect of their spraying operation, and an overall score.

[34] Procheck. An electronic database which contains details of product label and off-label information including MRL's, environmental and operator restrictions, ProCheck provides a highly comprehensive pesticide data source. Maintained daily by Muddy Boots, ProCheck is updated using the latest web technology. Being an off-line application ensures users can access the data at any time without the need to 'log-on', and even use the system in the field on a laptop. Its powerful search engine enables product choice by a large number of criteria delivering true decision support capability.

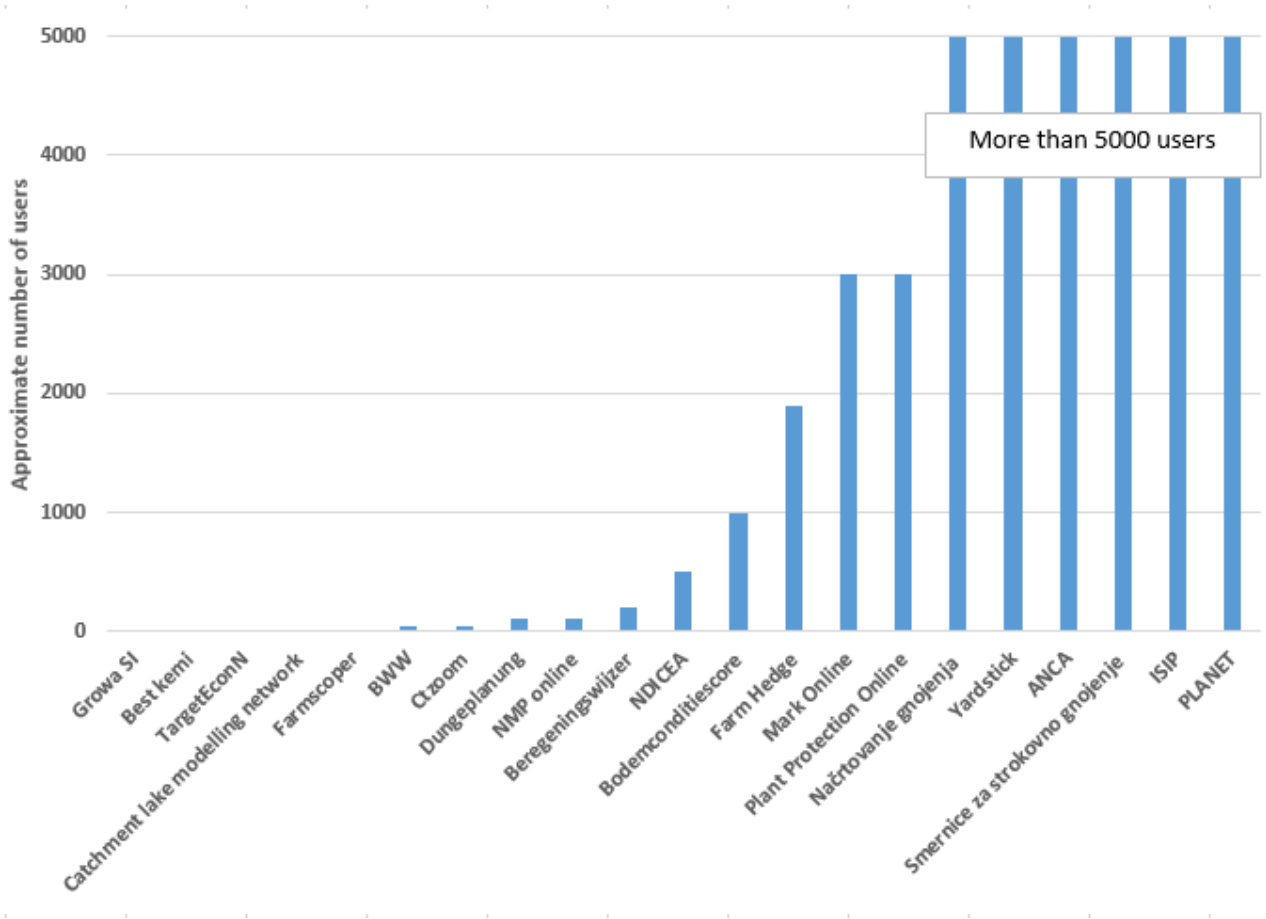
[35] Sentinel Online. Allows anyone with an interest in crop production to quickly find the information required to make key decisions in crop management. Features include: The Pesticide Database; Library; Decision support including crop nutrition, NVZ rules and recommendations; Technical updates; Weeds, pests and disease identification information; Diary Dates i.e. cross compliance dates and deadlines.

[36] Water Aware. A phone app which forecasts risk of movement of selected pesticides from soils based on soil type and soil moisture deficit, along with forecasted weather conditions. Uses a traffic light system to advise farmers and sprayer operators when it is safe/unsafe to apply chemicals or slug pellets. The latest version incorporates #SlugAware which provides an estimated risk of slug and snail activity on a field-by-field basis for the day and 72 hours in advance (particularly focussed on metaldehyde).

4.3 NUMBERS AND TYPES OF USERS

For many of the shortlisted DSTs, no details were provided on numbers of users, because the participants did not have access to the information. However, Figure 1 shows the numbers of users of the DSTs for which data was available.

Figure 1. Numbers of users of the shortlisted DSTs (where data is available)



In some countries farmers are obliged under regulations or commercial pressures to use DSTs, and this will clearly affect take-up and user numbers. For example, dairy farmers in the Netherlands who provide milk to Friesland Campina have to use ANCA (Annual Nutrient Cycling Assessment) to analyse nutrient flows and emissions from dairy farms hence indirectly improving water quality; there are currently *c.*16,000 users. In the UK, farmers in Nitrate Vulnerable Zones

(NVZs) can use a DST such as PLANET (Gibbons *et al*., 2005) to demonstrate compliance with NVZ rules and it is widely used for this purpose. The Düngeplanung DST developed in Lower Saxony (DE) is becoming more widely used (currently 50-100 users) following recent changes to regulations which require farmers to produce a fertiliser plan and nutrient balances.

In constrast, the number of users is often small for specialised DSTs such as the Norwegian 'Catchment Lake Modelling Network', which comprises a series of process-based, mass-balance models for phosphorus and is designed primarily as a catchment management tool rather than for general use (Couture *et al*., 2014).

4.4 NATIONAL AND INTERNATIONAL REPRESENTATION

There is a wide variation in the number and sophistication of the DSTs available in the different participant countries, reflecting the degree of investment and funding provided. In some countries such as Denmark, a number of different computer-based and online DSTs have been developed aimed at both farmers/advisors (e.g. Mark Online, Plant Protection Online, Dyrkningsvejledninger) and water quality managers (e.g. CTzoom/CTtools, BEST portal,TargetEconN). In contrast, the only DSTs available in Portugal are paper-based manuals and guidelines such as the 'Manual de Fertilização das Culturas' and 'Utilização de produtos fitofarmaceuticos na agricultura' (although some of these are also available online).

The DSTs aimed at farmers and advisors are rarely used in more than one country because often such a DST and supporting information are only available in the local language. The reason for this limitation is that many DSTs have been developed to meet the specific needs and requirements of a particular country or part of a country, and also they may be tailored to fit the local legislature or agro-climatic conditions. For instance, the German Düngeplanung bespoke software tool was developed in Lower Saxony to help farmers and advisors identify the amount of fertiliser which should be applied based on the local legal framework and economic circumstances; it is only available in German. An exception to this is the Dutch Environmental Yardstick for Pesticides (Reus & Leendertse, 2000), which is used in both the Netherlands and Belgium, and is currently being tested with data from US farms; the tool and supporting documentation is available in English. In addition, Plant Protection Online which was developed in Denmark is being used in the Baltics and Poland, with user information available in Danish, English and German.

In the absence of other tools capable of modelling agri-environmental measures, Slovenia employs the OECD/Eurostat methodology to calculate nitrogen (and phophate) balances. Joint Eurostat/OECD meetings identify and agree on the most robust and feasible methodology for the balance calculations. A handbook sets out the main principles of the methodology across OECD and EU Member countries in order to consistently produce an indicator based on a single methodology and harmonised definitions. In line with other EU member states, this paper-based tool serves as basis for reporting Nitrate Directive implementation to the EU, and for the preparation of national policy/legislation and recommendations for farmers on measures for drinking water protection. Slovenia also use the regional water balance model GROWA-SI for reporting Nitrate Directive implementation at a country wide level. This model was developed in Germany for the Slovenian Environmental Agency, and can calculate groundwater recharge rates and account for N balances (Andelov *et al*., 2014; Tetzlaff *et al.*, 2015).

Some of the more scientifically focussed DSTs are also used internationally, with the results published in the scientific literature. For example, the SCIMAP model developed in the UK has been used in Indonesia to target reforestation to reduce diffuse pollution risks (Curry, 2016). On a worldwide scale, the Soil and Water Assessment Tool (SWAT) which was initially developed in the US has been widely used to model the impacts of agricultural management on water quality (e.g. Azzellini *et al*., 2015; Cau & Paniconi, 2007; Taylor *et al*., 2016; Pisinarus *et al*., 2010). Indeed,

there is a SWAT literature database containing thousands of papers and a number of review articles relating to the SWAT model (https://swat.tamu.edu/).

4.5 REPRESENTATION OF WATER QUALITY

Very few of the selected DST were aimed explicitly at improving water quality or represented water quality directly (e.g. by the calculation of N or pesticide concentrations); Table 5. Many are agronomic tools for farmers and advisors which aim to optimise the use of N and/or pesticides to obtain maximum crop yields. They are effectively farm management tools and their inclusion in this report is based on the assumption that the efficient use of N and pesticides will improve water quality. Using a fertiliser recommendation system or a manure management tool will facilitate the application of the correct amount of fertiliser/manure to meet crop needs at the appropriate time, thus minimize nutrient losses to water bodies. Most participants reported using this type of DST; examples delivered via a range of platforms include PLANET, MANNER and The Fertiliser Manual (RB209) (UK), Načrtovanje gnojenja (SI), Düngeplanung (DE), Načrtovanje gnojenja (SI), Skifteplan (NO) and Teagasc NMP online (IE).

Indeed Düngeplanung which is used in Lower Saxony (DE) was specifically developed to help farmers in water sensitive areas (e.g. for drinking water abstraction) with fertiliser planning and regulatory compliance. Supported by water suppliers, it brought together several parallel software tools that existed previously. It indirectly affects water quality by:

- combining all the available information for a farm (soil analyses, crop rotation, fertiliser history, specific restrictions in water protected area)
- optimising yields and thus the amount of N exported from the field
- improving N-efficiency (e.g. well-balanced soil P, K, Mg, S levels help to make more efficient use of the N available)
- providing practical information on amounts and timing of fertiliser applications

Farmers using Düngeplanung have reported reductions in fertiliser use of roughly 5-10% (L. Tendler, *pers. comm*.).

Whilst again not specifically designed to represent water quality, the French SIRIS decision support tool allows pesticides to be classified according to their potential to reach surface and ground water, and helps to organize monitoring of pesticides in waters at the regional or local scale (Le Gall *et al*., 2007).

4.6 REPRESENTION OF MITIGATION METHODS

The ability of the DSTs to represent mitigation measures for diffuse nitrate and pesticide pollution, and the number of different measures represented by the DSTs, was assessed. However, only three of the shortlisted DSTs (Table 5) were explicitly developed to consider the impact of mitigation methods on water quality: FARMSCOPER (UK), Environmental Yardstick for Pesticides (NL) and Catchment Lake Modelling Network (NO).

FARMSCOPER (Gooday *et al*., 2014), first developed in 2010, is a DST that can be used to assess diffuse agricultural pollutant loads (nitrate, phosphorus and sediment) on a farm and quantify the impacts of farm mitigation methods on these pollutants. Inputs are at the farm scale, however the outputs can be scaled up to catchment, regional and national levels. It currently contains over 100 mitigation methods adapted from the User Guide for England and Wales (Newell-Price *et al*., 2011) and they can be tested either individually or in combination for 3 broad soil types defined according to the probability of having artificial under-drainage for conventional

agriculture: i) not requiring under-drainage; ii) requiring under-drainage for arable use; and iii) requiring under-drainage for both arable and grassland. The testable mitigation methods include:

- establish cover crops in the autumn;
- establish riparian buffer strips;
- integrate manure and fertiliser use;
- increase use of clover;
- extend/reduce grazing season
- cultivate land for crops in spring not autumn
- use correctly inflated low ground pressure tyres
- cultivate and drill across the slope
- install beetle banks
- re-site gatewyas from high risk areas
- cultivate compacted tillage soils
- use a fertiliser recommendation system
- etc.

FARMSCOPER is a tool mainly used by policy makers and catchment managers, with the potential to be used by advisors on farms. To date it has been used to study the impacts of various mitigation methods in the Wensum and Avon Demonstration Test Catchments (DTCs) in England.

The Environmental Yardstick for Pestcides (Reus & Leendertse, 2000) is a DST designed to quantify the environmental impact of the use of pesticides in outdoor and greenhouse crops. The mitigation methods represented are:

- choice of pesticide;
- dose rate;
- application technique (drift);
- width of untreated buffer zone.

For each pesticide the yardstick assigns environmental impact points for the risk to aquatic organisms, the risk of leaching to groundwater and the risk to soil organisms (depending on the user-specified soil organic matter content and season of application). The yardstick also shows the risk to pollinators, beneficials and applicators. It is used in the Netherlands (and Belgium) as a management tool for farmers and technical consultants, a tool for monitoring the environmental performance of farmers, a tool for setting standards for ecolabels, a tool for the supply chain to be able to purchase sustainable agricultural products, and as a policy evaluation tool.

The Catchment-Lake Modelling Network, designed specifically for the Lake Vansjø catchment in Southern Norway, consists of a network of process-based, mass-balance models linking climate, hydrology, catchment-scale nutrient (phosphorus) dynamics and lake processes (Couture *et al.,* 2014). The model network allows the effects of climate change to be disentangled from those of land-use change on lake water quality and phytoplankton growth, and includes the following mitigation methods:

- land use change;
- cultivation change;
- crop rotation;
- erosion risk reduction measures;
- change in fertilizer application.

The model network can thus support decision-making to achieve good water quality and ecological status within the Lake Vansjø catchment. It was developed to model phosphorus and suspended sediment loadings, although it is also possible to include nitrate. The model network is transferable

to other catchments; however, it is quite time-consuming to set up and calibrate for a new catchment.

Whilst not directly evaluating the effects of mitigation methods, the UK SCIMAP model (Perks *et al*., 2017) provides a framework for generating catchment risk maps for sediment losses, so that the areas within a catchment where mitigation methods are most urgently required can be identified. SCIMAP is being used in the River Eden Demonstration Test Catchment project which is investigating the dynamics of water quality from agricultural land, and by Durham Wildlife Trust to identify areas with high fine sediment pollution risk within the River Wear catchment. In addition, Bedrijfswaterwijzer (NL) was developed to provide starting points for indicatively evaluating measures to reduce emissions to water, whilst STONE (NL) is a modelling tool wherin various policy measures to reduce nutrient emissions to ground water and surface waters may be specified.

Other DSTs identified during the literature search (but not shortlisted or assessed in detail) which may have the ability to represent mitigation methods include (see Appendix 3 and 4 for more information):

- **Agricat 2 (NO)**. An empirical, 'management oriented' GIS based model. Designed to assess the effectiveness of mitigation measures to reduce phosphorus losses from agricultural land.
- **DET (various countries).** A practical, interactive tool to evaluate the risk of spray drift for specific weather and field situations, and propose effective measures to mitigate this risk.
- **EOS (various countries)**. EOS (Environmentally Optimised Sprayer) is an application evaluating the risk mitigation potential of sprayers based on their technological features.
- **IMAS (FR)**. The model of agricultural scenarios defines a "reference scenario" representing actual soil use and pesticide-spraying practices, and compares this with alternative scenarios defined by stakeholders targeting mitigation measures.

4.7 REPRESENTATION OF ECONOMIC AND FINANCIAL ASPECTS

The economic and financial implications of implementing mitigation methods were infrequently represented in the shortlisted DSTs. However, FARMSCOPER (UK; Gooday *et al*., 2013) estimates the cost effectiveness of mitigation methods as a cost-efficiency (C/E) ratio in terms of money (£) saved per % reduction in nitrate, phosphorus or sediment loss. The TargetEconN model (DK) is an integrated economic and biophysical social planner model which minimizes the costs of meeting a nutrient load reduction target in a specific water body. Some other DSTs do have the capability to represent economic aspects e.g. Düngeplanung (DE) allows cost-benefit comparison of different fertiliser use scenarios.

A recent research project investigated the economic benefits of diffuse pollution mitigation targeting using SCIMAP within a number of UK Demonstration Test Catchments to identify the optimal locations to install diffuse pollution measures. The economic benefit of the interventions was assessed using crop growth and yield models in terms of production profit, although the results have not yet been published.

4.8 BARRIERS TO UPTAKE.

Although some DSTs are available for farmers that cover both nutrients and pesticides (and other aspects of farm management), some may opt to use more than one DST (or none) depending on their particular needs and requirements, and the legislative and economic environment in which they are operating. DSTs often deal with complex issues, so it is not always easy for farmers to

understand and use them – using multiple tools in different types does not always lead to a better decision, as it can be difficult to decide which tools to use under which circumstances.

A recent project undertaken in the UK (Defra, 2015) looked in detail at farmers' usage of the fertiliser recommendations for grassland published in one of the key UK paper-based decision support tools (The Fertiliser Manual (RB209); Defra, 2010). The majority of respondents did not use the The Fertiliser Manual (RB209), although they described it as 'adequate' as a reference guide. Drawing on information from in-depth interviews and focus groups, the study found that users:

- needed to supplement the information provided with their own information and experience;
- wanted the tool to be more user friendly and flexible; it should be written in 'farmers language';
- thought that potential economic gain should be explicitly demonstrated.

Similarly in Denmark (Axelsen *et al*., 2012), users and non-users of the pesticide DST Plant Protection Online identified several barriers to uptake including:

- time consuming
- too complicated
- lack of user knowledge (on how to identify weeds and diseases)
- competition from human consultants
- lack of confidence
- only chemical solutions recommended

Another UK study reviewed tools for decision making in agriculture and found that despite their availability in a wide range of formats, uptake in the UK and many other countries has been low (Rose *et al*., 2016). Using a combination of qualitative interviews and quantitative surveys, the authors identified fifteen factors that are influential in convincing farmers and advisers to use DSTs, including:

- usability
- cost-effectiveness
- performance
- relevance to user
- compatibility with compliance demands.

The authors concluded that a better understanding of these factors should lead to more effective DST design and delivery in the future. These authors followed up this work with a study on how stakeholders could be more effectively involved to improve DST design (Rose *et al*., 2018). DST use was explored in a series of 78 interviews and 5 focus groups. Their main suggestion was to assess the 'decision support context' before building a product. Other requirements were better knowledge of user-centred desgin practices, a clear understanding of advice systems and greater collaboration with humam-computer interaction researchers.

DSTs aimed at policy makers, water quality managers or catchment managers tend to be more complex and require more data. However, the drivers for using such tools are often legislative or policy focussed; thus, potential users of a particular DST should be provided with an appropriate level of training and have access to the relevant datasets in order to do so.

5. CONCLUDING COMMENTS

The term 'decision support tool' encompasses a wide range of tools including paper-based guidelines, farm level software and phone apps, and complex models intended for modelling and

research purposes. Scientific literature searches largely returned details of papers on modelling tools because DSTs used by farmers and advisors are not usually published in the scientific literature. We therefore relied on the project participants to identify and supply information on national farm scale tools and other locally developed DSTs. More than 150 DSTs were identified through the literature search and the project participant reports. Of these, 36 were selected for further investigation based on their national importance and relevance to the project aims. Assessment of the shortlisted DSTs found that:

- The pesticide management tools available for general use were usually developed by academic institutes and cover a wide range of plant protection products. A number of the nutrient management DSTs identified were commerically available software tools, although some had been developed by or in conjunction with academic institutions. A few DSTs cover both nutrients and pesticides, which could be an advantage for farmers who would only need to purchase a single software package to cover all their requirements. Take-up and user numbers will depend to a large extent on whether farmers are obliged under regulations to use DSTs.
- The number and sophistication of the DSTs available in the different participant countries vary widely depending on the level of investment and funding availabillity. Very few of the DSTs aimed at farmers and advisors are used in more than one country, and often the DST and the supporting information are available only in the local language. Some countries who do not have access to their own DSTs (e.g. Slovenia) will employ standard EU methodologies or adapt tools developed elsewhere as a basis for reporting Nitrate Directive compliance. Modelling tools are more likely to be used internationally as a basis for undertaking research projects.
- Not many of the selected DST were primarily aimed at improving water quality. Rather they were farm (nutrient/pesticide) management tools and their inclusion in this report was based on the assumption that the efficient use of N and pesticides will indirectly improve water quality. Most participants reported using this type of DST. The only shortlisted DSTs that were explicitly developed to consider the impact of mitigation methods on water quality were FARMSCOPER (UK), Environmental Yardstick for Pesticides (NL) and Catchment Lake Modelling Network (NO). The number of different mitigation methods represented ranged from 5-6 (Environmental Yardstick for Pesticides and Catchment Lake Modelling Network) to more then 100 (FARMSCOPER). However, tools that support efficient and smart application of minerals or pesticides (i.e. by taking into account weather forecasts, soil moisture content etc.), can be said to provide indicative information on management measures for reducing losses to the environment/water.
- Economic and financial aspects were infrequently represented by the shortlisted DSTs, with only FARMSCOPER (UK) and TargetEconN (DK) offering cost effectiveness assessments for different mitigation options.
- The number and type of DSTs employed will depend on the particular needs and requirements of the end user, and the legislative and economic environment in which they operate. Recent research has investigated why many farmers are still reluctant to use DSTs, and has offered suggestions for more effective DST design and delivery in the future.

All the DSTs examined in this report operate within the context of the wider advisory frameworks in place in their respective countries, and this will clearly impact on the uptake of a DSTs and its usefulness/effectiveness. It may not always be straightfoward to transfer a DST from one country to another because the advisory framework will probably be very different (in addition to language and country-specific calibration issues). We therefore recommend that later project tasks explore the wider water quality advice frameworks which operate in the participant countries, and assess whether elements of these could be transferred or tested in the Case Studies.

This report and the associated Information Sheets will be used, in conjunction with presentations of some of the DSTs at a Workshop, to provide the Case Study leaders with sufficient information on the selected DSTs to allow them to asses which could be useful for managing water quality within their case study catchments and which could be taken forward for further evaluation in Task 5.2. The information will also be used to assess how DSTs can support the implementation of the measures reviewed in WP4.

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APPENDIX 1: DST INFORMATION SHEETS

1. DÜNGEPLANUNG 1.6 FAIRWAY partner: Linda Tendler (Landwirtschaftskammer Niedersachsen, DE)	
Brief description	
A farm-holistic DST which helps to identify the total amount of fertilizer to be purchased and its field-specific distribution. It combines measured on-farm data (soil nutrient contents, farm manure analysis, etc.), information on crop cultivation (crop rotation, yield level, etc.) with economic implications (e.g. fertilizer prices).	
Contaminants covered (e.g. nitrate, pesticides etc.)	Nitrate (and phosphate) but only indirectly links to water quality.
Intended end users (e.g. farmer, water quality manager, policy maker)	Farmers and advisors
Level of expertise and/or training required	Some basic training and agronomic expertise required. However, the application is mostly “learning by doing”
Geographical resolution (e.g. field, catchment, national)	Field and farm scale. Suitable for all farms growing crops.
Temporal resolution (e.g. daily, annual, long-term).	Annual and multi-annual
Real-time component (e.g. live weather data, soil moisture data feeds etc.)	None
Number and type of mitigation measures included	Comparison of different fertilizing scenarios is possible. Crop rotation measures (e. g. fallow, malting barley, winter rye, cover crops.) can be tested in reference to the potential reduction of nutrient balances. (Cost-benefit comparisons of scenarios is possible)
Platform (e.g. paper-based tool, phone app, bespoke software).	Bespoke software Up to now only available in German language
Frequency of updates	Infrequently, depending on feedback and legislative changes
Cost/availability	Free for advisors of LWK Available for everybody for a fee of 77 EUR (one time charge) + 10 EUR/year and farm for maintenance.
Number of users or number of copies distributed/ downloaded/purchased	About 50 – number will probably increase (LWK is currently advertising the application)
Links to demo material and other relevant information (e.g. user guides).	None available
Additional comments	Not available in English

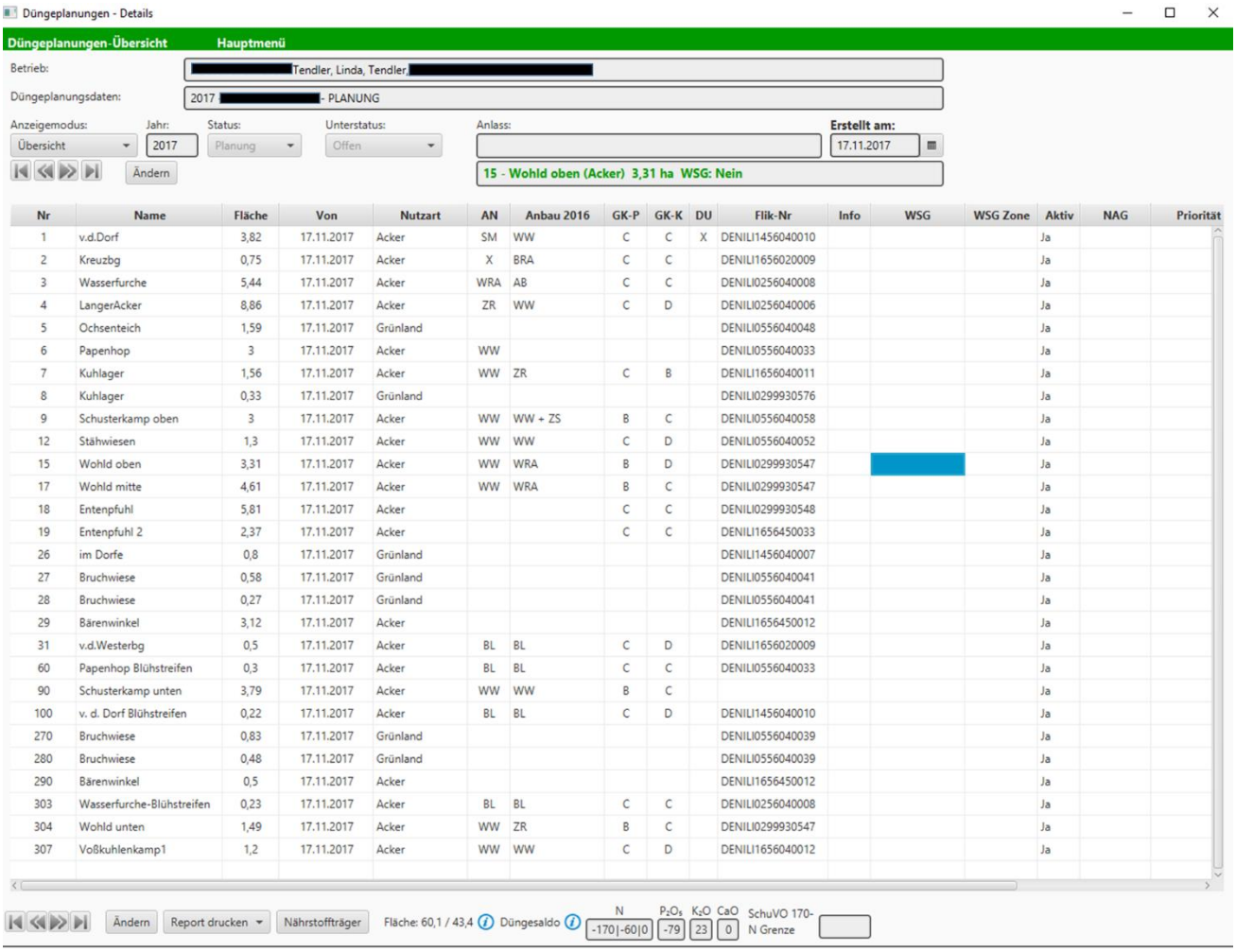
Düngeplanung 1.6 **FAIRWAY partner: Linda Tendler (Landwirtschaftskammer Niedersachsen, DE)**	
Input data required to run the DST	- **list of fields and their respective size*** - information whether some fields are located in water protected areas - **soil analysis (contents of humus, P, K, Mg, (CaO), ..)*** - **information about recent/long-term soil mineral nitrogen (Nmin)*** - **information about current crop rotation (and crop rotation in previous year)*** - **information on yield levels (crop-specific)*** - latest analysis of farm manure to be applied - (if cost-benefit comparison is requested: list of fertilizer price) - Type of fertilizer preferred by the farmer *mandatory
Outputs (including links to water quality and economic or financial aspects)	- Fertilizer plan (which crop, which fertilizer, which amount, which timing) - Overview of fertilizer to be purchased - Anticipated nutrient balance (N, P, K) of different fertilizing scenarios (given the yield level is met) Only indirectly links to water quality. The tool helps to plan type, amount and timing of fertilization according to the national law and (as appropriate) further restrictions demanded by water protected areas. However, since the tool was developed in the framework of water protected areas, it includes some benchmarks which are stricter than the overall national regulation (e. g. concerning the deduction of nutrients contained in organic fertilizers). Generally the tool aims at both reducing total amount of nitrogen and/or phosphorus to be applied and increasing nutrient efficiency. It has a high practical relevance since it produces practically feasible fertilization plans for the farmer.
Age/provenance of supporting data used to develop the DST	- Based on official recommendations of LWK (data of several decades) - values set by the national fertilizer ordinance
Country-specific calibration or data requirements (including restrictions on use)	National regulation (i.e. fertilizer ordinance) are considered - E.g. maximum N-requirements for crops according to legislation - Specific regulations in water protected areas
Details of validation and testing	Software tested by selected end users and validated by officials of authority of fertilization of Lower Saxony
Date developed/released (or planned release date)	First developed in 2014, testing and upgrade since 2015
Author/developer names and affiliations	Düngebehörde of LWK (Authority of fertilization of LWK); programming executed by GID Landwirtschaftskammer Niedersachsen (LWK Niedersachsen) (Agricultural chamber of Lower Saxony) GeoInformationsDienst GmbH, Rosdorf
Member state(s) where developed	DE
Member state(s) where currently used	DE (developed in 2014 and recently becoming more popular in the province of Lower Saxony
Key publication references	https://www.lwk-niedersachsen.de/index.cfm/portal/96/nav/2208/article/31583.html https://www.lwk-niedersachsen.de/index.cfm/portal/polaris-niedersachsen/nav/2179.html

Düngeplanung 1.6

FAIRWAY partner: Linda Tendler (Landwirtschaftskammer Niedersachsen, DE)

Any other useful information (e.g. screenshots of DST input/outputs)

Screenshot of program interface: List of fields with information on crop rotation.



Use in practice

The farm advisor and the farmer use the DST to plan fertilization field-specifically. The tool covers nutrient mineralization of the soil, crop residues and farm manure. It provides an overview about fertilizers needed and predicted nutrient balances.It is possible to also compare different economic scenarios with each other.

2. ISIP

FAIRWAY partner: Linda Tendler (Landwirtschaftskammer Niedersachsen, DE)

Brief description	
Informationssystem Integrierte Pflanzenproduktion (ISIP - Information system of integrated plant production) is a process-oriented model which simulates N-mineralisation in the soil and adjusts real-time recommendation for N-fertilization in winter wheat accordingly. Input variables are soil texture, crop rotation, yields quality expectations, prices of N-fertilizers and the wheat product, irrigation and depth of groundwater table. The required N-fertilization is calculated by the sum of N-withdrawal + N in the soil which is not crop available - Nmin - N-mineralisation.	
Contaminants covered (e.g. nitrate, pesticides etc.)	Nitrate
Intended end users (e.g. farmer, water quality manager, policy maker)	Farmers and advisors.
Level of expertise and/or training required	Moderate
Geographical resolution (e.g. field, catchment, national)	Field scale
Temporal resolution (e.g. daily, annual, long-term).	Daily
Real-time component (e.g. live weather data, soil moisture data feeds etc.)	Precipitation, temperature, radiation, evaporation
Number and type of mitigation measures included	Optimized fertilization planning resulting in reduced amounts of N applied
Platform (e.g. paper-based tool, phone app, bespoke software).	Bespoke software Available in German only
Frequency of updates	Frequent updates during the development phase of the model; currently no updates planned.
Cost/availability	Available to farmers and agricultural advisors in several German states for a small fee.
Number of users or number of copies distributed/ downloaded/purchased	From January - August 2017 *c.*18.000 hits on online-platform
Links to demo material and other relevant information (e.g. user guides).	https://www.isip.de/isip/servlet/isip-de Available in German only
Additional comments	Practical implementation; N-fertilization recommendation by ISIP is integrated into field experiments of different authorities for agriculture.

ISIP **FAIRWAY partner: Linda Tendler (Landwirtschaftskammer Niedersachsen, DE)**	
Input data required to run the DST	• Site conditions (Field location, soil mineral nitrogen in spring, soil type and soil textures) • Agricultural management (crop rotation, sowing date, sowing density, irrigation, expected yield, …)
Outputs (including links to water quality and economic or financial aspects)	Model results and reference measurements of: • current crop development (+N-uptake + leaf area index) • soil water content and drought stress • amount of nitrate leached during winter • recommendation for amount and timing of N-fertilization • climate and weather data
Age/provenance of supporting data used to develop the DST	Data derived from experimental stations of Lower Saxony (ca. 2006-2011)
Country-specific calibration or data requirements (including restrictions on use)	Link to weather data is country specific.
Details of validation and testing	Interaction between soil water and plant productivity validated with long term data of reference years. N-withdrawal validated with long term data of field trials of 12 different sites within Lower Saxony.
Date developed/released (or planned release date)	2011
Author/developer names and affiliations	Dr A. Ratjen (CAU) Dr E. Reinsdorf (LWK)
Member state(s) where developed	DE
Member State(s) where currently used	DE
Key publication references (including url)	https://www.isip.de/isip/servlet/isip-de

ISIP

FAIRWAY partner: Linda Tendler (Landwirtschaftskammer Niedersachsen, DE)

Any other useful information (e.g. screenshots of DST input/outputs)

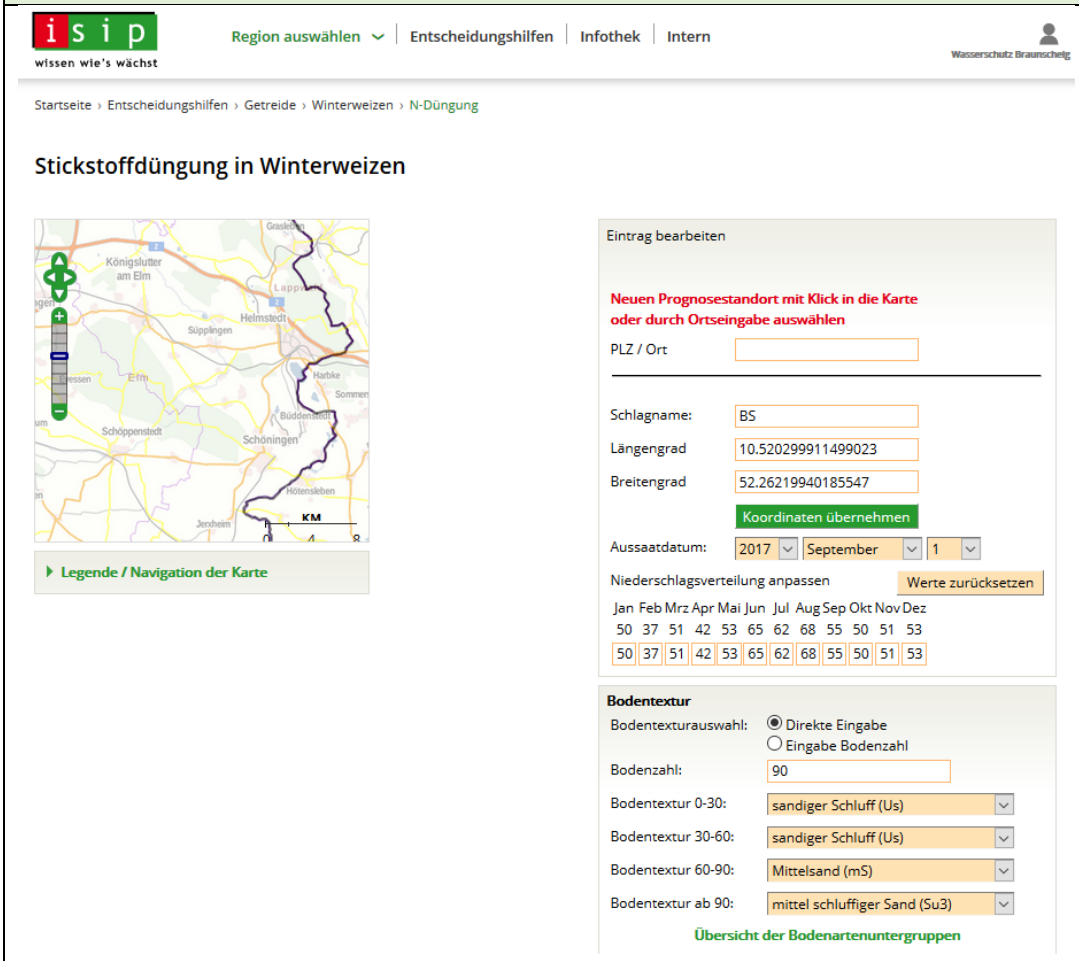


Figure 1: Part of the ISIP input screen

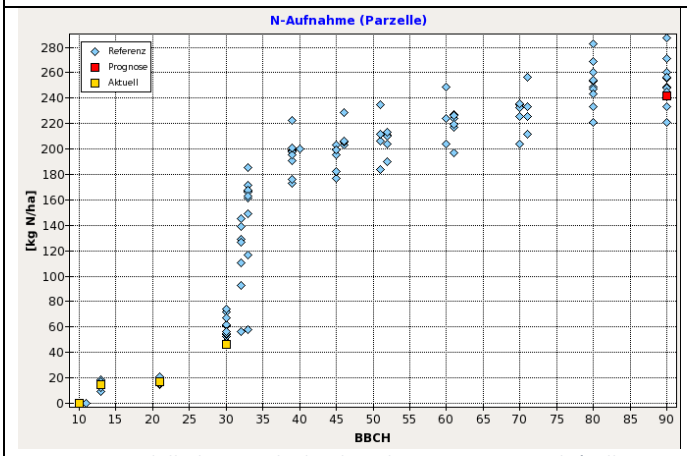


Figure 2: Modelled N-uptake by the wheat crop in March (yellow squares) in comparison to the reference values (blue diamonds) and the final prognosis (red square)

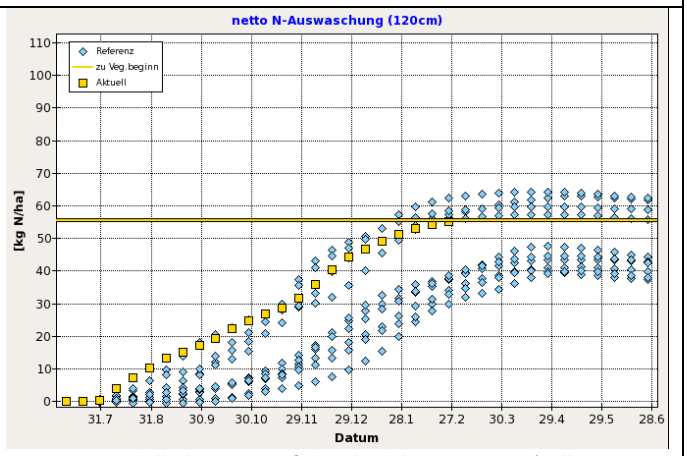


Figure 3: Modelled amount of leached during winter (yellow squares) in comparison to the reference values (blue diamonds)

3. MARK ONLINE FAIRWAY partner: Rikke Krogshave Laursen (SEGES, DK)	
Brief description	
Mark Online is the most widely used DST/ Farm Management Information System for fertilizer planning, optimization and documentation in Danish crop production. It covers all aspects of crop management including soil tillage and crop protection.	
Contaminants covered (e.g. nitrate, pesticides etc.)	N, P, K, Pesticides (active ingredients)
Intended end users (e.g. farmer, water quality manager, policy maker)	Farmers and advisors.
Level of expertise and/or training required	Trained farmers and advisers
Geographical resolution (e.g. field, catchment, national)	Field scale. Output scales to farm level.
Temporal resolution (e.g. daily, annual, long-term).	Daily and annual
Real-time component (e.g. live weather data, soil moisture data feeds etc.)	None
Number and type of mitigation measures included	Mitigation according to economical optimisation with respect to national rules and regulations
Platform (e.g. paper-based tool, phone app, bespoke software).	Bespoke software Danish
Frequency of updates	Updated whenever needed (weekly)
Cost/availability	From 180 Euro per Year Commercialised software, https://www.seges.dk/da-dk/software/plante
Number of users or number of copies distributed/ downloaded/purchased	Actively used on 2.2 mio ha = 85 % of all land in DK (25,000 farms) by app 350 advisers and 2,500 farmers
Links to demo material and other relevant information (e.g. user guides).	https://www.seges.dk/da-dk/software/plante In Danish
Additional comments	

Mark Online **FAIRWAY partner: Rikke Krogshave Laursen (SEGES, DK)**	
Input data required to run the DST	Field data – livestock data – fertilizer – pesticides - precipitation - prices
Outputs (including links to water quality and economic or financial aspects)	Use of nutrients and pesticides according to legislation and key figures. Indirectly good water quality
Age/provenance of supporting data used to develop the DST	SEGES R/D for 30+ years, Landsforsøgene ®
Country-specific calibration or data requirements (including restrictions on use)	Legal pesticides and quotas for nitrogen application. Minimum utilization of nitrogen in animal manure
Details of validation and testing	Tested in real life on 80 percent of the farms and 100 per cent reporting to the authorities.
Date developed/released (or planned release date)	First version developed approx. 1991. Current version released January 2017
Author/developer names and affiliations	SEGES, Digital. SEGES, Landbrug & Fødevarer F.m.b.A., Agro Food Park 15, 8200 Aarhus N, Denmark, www.seges.dk
Member state(s) where developed	DK
Member State(s) where currently used	DK
Key publication references (including url)	Jens Bligaard, 2014. Mark Online, a Full Scale GIS-based Danish Farm Management Information System, Int. J. Food System Dynamics 5 (4), 2014, 190-195. www.fooddynamics.org

Mark Online

FAIRWAY partner: Rikke Krogshave Laursen (SEGES, DK)

Any other useful information (e.g. screenshots of DST input/outputs)

The N-quota is reported.

Kontroller				**N-regnskab**		
Harmonikravet er overholdt				Overskridelse af N-kvoten	-1,633 kg	-44.6 kg/ha
N-kvote overholdt				Overdraget forbrug af N	kg	
Lagerreglen er overholdt				Forbrug af N i handelsgødning	3,369 kg	92.0 kg/ha
Interne overførsler stemmer				Max forbrug af N i handelsgødning	5,003 kg	136.5 kg/ha
Harmoni				Forbrug af N (udnyttet) org. gødn.	2,045 kg	55.8 kg/ha
Harmoniareal:	36.64 ha			**P-regnskab**		
Dyreenheder og harmoni				Pt for alle harmoniarealer:		Nej
Forbrug af DE:	32.77 DE	52.73	Max	**N-kvote**		
Lageropbygning	1.21 DE			N-prognose:	-71 kg	
Forbrug af DE pr. ha:	0.89 DE/ha	1.44	Max	Anvendt forhøjet udbytte	0.0 kg	Nej
Forbrug af total N i org. gødning	86.3 kg/ha		Max	N-kvote efter korrektioner	7,048 kg	192.3 kg/ha
				Max N i handelsg. + N i org.gødn.	6,394 kg	174.5 kg/ha
				Planlagt N-behov	7,750 kg	211.5 kg/ha

4. DYRKNINGSVEJLEDNINGER

FAIRWAY partner: Rikke Krogshave Laursen (SEGES, DK)

Brief description	
Manuals for growing the different agricultural crops based on results from the most recent field trials. Updated yearly.	
Contaminants covered (e.g. nitrate, pesticides etc.)	N, P, K, Pesticides
Intended end users (e.g. farmer, water quality manager, policy maker)	Farmers and advisors.
Level of expertise and/or training required	Trained farmers
Geographical resolution (e.g. field, catchment, national)	N/A
Temporal resolution (e.g. daily, annual, long-term).	Daily and annual
Real-time component (e.g. live weather data, soil moisture data feeds etc.)	None
Number and type of mitigation measures included	Information on all aspects of Good Agricultural Practise (GAP) in crop production
Platform (e.g. paper-based tool, phone app, bespoke software).	Paper-based In Danish
Frequency of updates	Updated whenever needed (yearly)
Cost/availability	Free. www.landbrugsinfo.dk
Number of users or number of copies distributed/ downloaded/purchased	Not known
Links to demo material and other relevant information (e.g. user guides).	https://dyrk-plant.dlbr.dk/Web/(S(iyzgfk42poveddd1r3hflnrh))/forms/Afgroeder.aspx?kategori=1 Danish
Additional comments	Also used for education of students and farmers

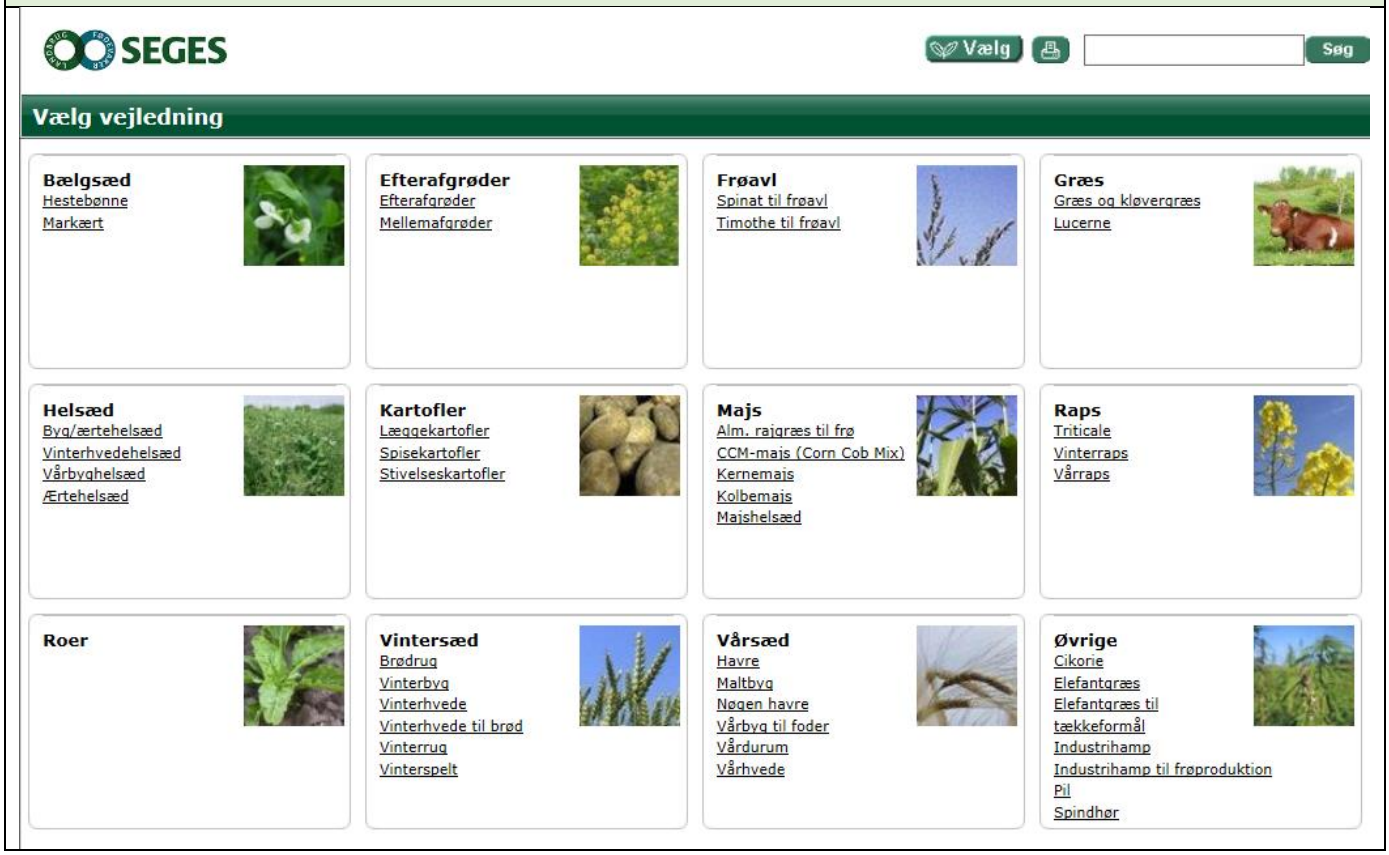
Dyrkningsvejledninger **FAIRWAY partner: Rikke Krogshave Laursen (SEGES, DK)**	
Input data required to run the DST	No
Outputs (including links to water quality and economic or financial aspects)	Written recommendations on how to grow the individual crops. Indirectly secures good water quality
Age/provenance of supporting data used to develop the DST	SEGES R/D for 30+ years, Landsforsøgene ®
Country-specific calibration or data requirements (including restrictions on use)	The crop specialists at SEGES update yearly according to nationwide results of the field trials and marketed varieties fertilizers and pesticides
Details of validation and testing	Validated by the users who will inform the authors when needed
Date developed/released (or planned release date)	Mid 1990s with yearly updates
Author/developer names and affiliations	SEGES, Digital. SEGES, Landbrug & Fødevarer F.m.b.A., Agro Food Park 15, 8200 Aarhus N, Denmark, www.seges.dk
Member state(s) where developed	DK
Member State(s) where currently used	DK
Key publication references (including url)	https://dyrk-plant.dlbr.dk/Web/(S(iyzqfk42poveddd1r3hflnrh))/forms/Afgroeder.aspx?kategori=1

Dyrkningsvejledninger

FAIRWAY partner: Rikke Krogshave Laursen (SEGES, DK)

Landbrugsafgrøder - konventionel

Any other useful information (e.g. screenshots of DST input/outputs)



5. PLANT PROTECTION ONLINE

FAIRWAY partner: Rikke Krogshave Laursen (SEGES, DK)

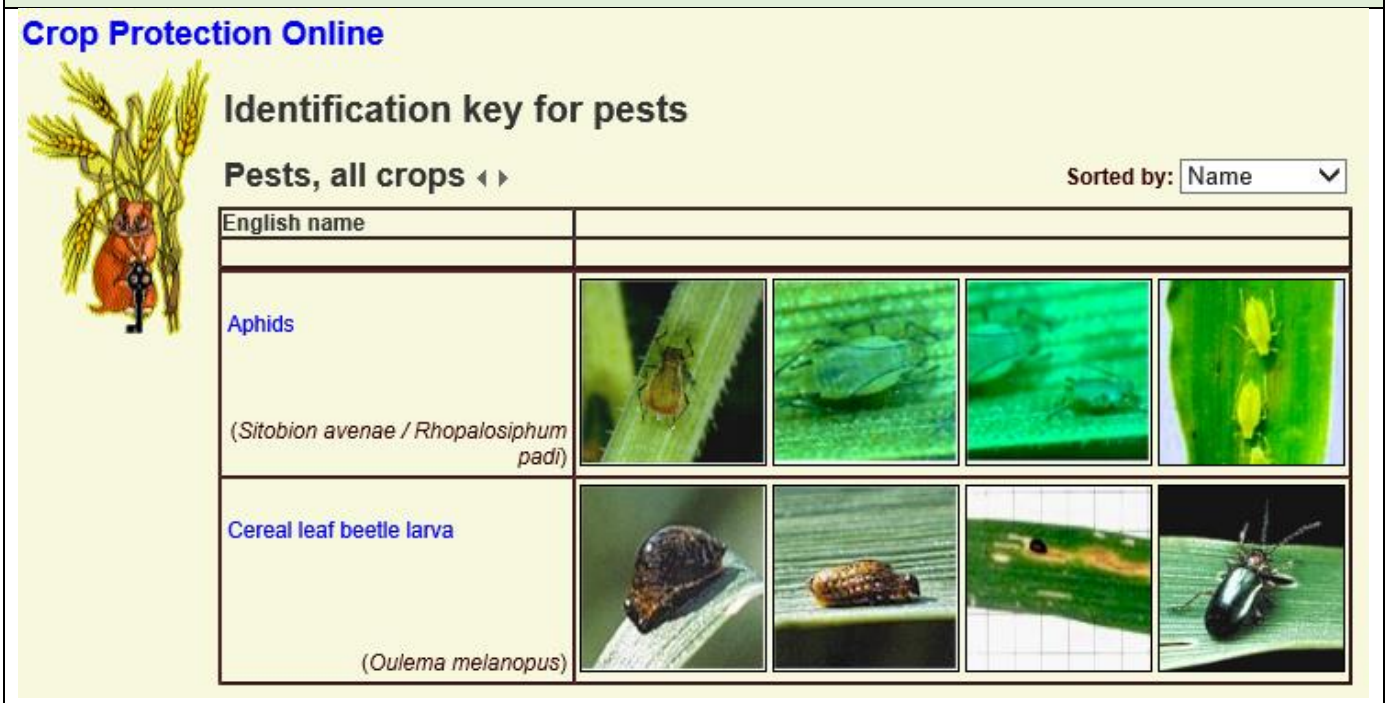
Brief description	
An online system to decide the need for plant protection in individual fields based on the result of field trials, individual field data and features of the active ingredients (insecticides, herbicides and fungicides).	
Contaminants covered (e.g. nitrate, pesticides etc.)	Pesticides
Intended end users (e.g. farmer, water quality manager, policy maker)	Farmers and advisers
Level of expertise and/or training required	Skilled farmer and adviser
Geographical resolution (e.g. field, catchment, national)	Field
Temporal resolution (e.g. daily, annual, long-term).	Daily
Real-time component (e.g. live weather data, soil moisture data feeds etc.)	Weather data and field observations
Number and type of mitigation measures included	Reduction of use and ensuring that only legal pesticides are used
Platform (e.g. paper-based tool, phone app, bespoke software).	Bespoke software, Danish, English and German
Frequency of updates	Yearly
Cost/availability	From 180 Euro per ha.
Number of users or number of copies distributed/ downloaded/purchased	3000
Links to demo material and other relevant information (e.g. user guides).	https://plantevaernonline.dlbr.dk/cp/documents/InfoFactSheet2.pdf In Danish, English and German
Additional comments	

Plant Protection Online **FAIRWAY partner: Rikke Krogshave Laursen (SEGES, DK)**	
Input data required to run the DST	Crop, variety, meteorological data, field observations
Outputs (including links to water quality and economic or financial aspects)	Recommendation on whether or not to spray, dosage and spraying time
Age/provenance of supporting data used to develop the DST	Yearly
Country-specific calibration or data requirements (including restrictions on use)	Results from annually field trials on ordinary farms. https://www.landbrugsinfo.dk/Planteavl/Landsforsoeg-og-resultater/Oversigten-og-tabelbilaget/Sider/Oversigten_2017_web.pdf
Details of validation and testing	In practice via observations done by farmers and advisers
Date developed/released (or planned release date)	1991 as PC-Plant Protection 2006 as Plant Protection Online
Author/developer names and affiliations	University og Aarhus And SEGES, Digital. SEGES, Landbrug & Fødevarer F.m.b.A., Agro Food Park 15, 8200 Aarhus N, Denmark, www.seges.dk
Member state(s) where developed	Denmark
Member State(s) where currently used	Denmark, Baltics and Poland
Key publication references (including url)	https://www.landbrugsinfo.dk/planteavl/plantevaern/plantevaern-online/sider/startside.aspx In Danish

Plant Protection Online

FAIRWAY partner: Rikke Krogshave Laursen (SEGES, DK)

Any other useful information (e.g. screenshots of DST input/outputs)



6. CTZOOM/CTTOOLS

FAIRWAY partner: Rikke Krogshave Laursen (SEGES, DK)

Brief description	
Calculation of nitrate leaching based on nitrogen surplus calculation for individual fields	
Contaminants covered (e.g. nitrate, pesticides etc.)	Nitrate
Intended end users (e.g. farmer, water quality manager, policy maker)	Municipality
Level of expertise and/or training required	administrator
Geographical resolution (e.g. field, catchment, national)	Field and catchment
Temporal resolution (e.g. daily, annual, long-term).	annual
Real-time component (e.g. live weather data, soil moisture data feeds etc.)	Data input to the model comes from governmental registers (Gødningsregnskaberne og Det Generelle LandbrugsRegister, GLR) on agricultural nitrogen input and output.
Number and type of mitigation measures included	2 Crop rotation and N-application
Platform (e.g. paper-based tool, phone app, bespoke software).	Model Danish
Frequency of updates	Monthly/yearly
Cost/availability	Affordable for the municipality
Number of users or number of copies distributed/ downloaded/purchased	Approx. 50
Links to demo material and other relevant information (e.g. user guides).	http://www.conterra.dk/index.php?action=text_pages_show&id=158&menu=36 Danish
Additional comments	Can be used for worst case screening

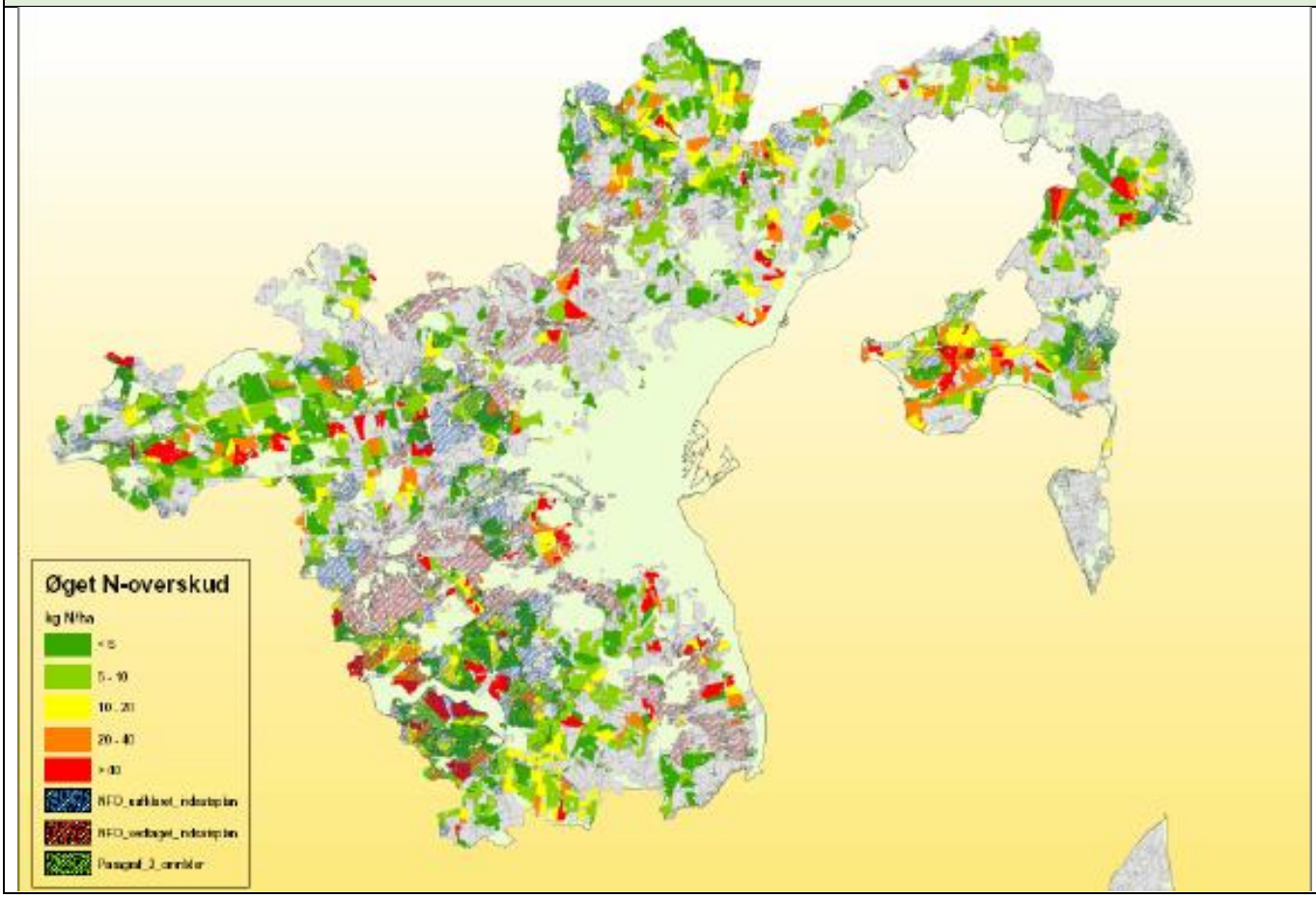
CTzoom/CTtools **FAIRWAY partner: Rikke Krogshave Laursen (SEGES, DK)**	
Input data required to run the DST	Public databases for nitrogen use and crop distribution
Outputs (including links to water quality and economic or financial aspects)	A calculated nitrate concentration in the root zone
Age/provenance of supporting data used to develop the DST	Annual
Country-specific calibration or data requirements (including restrictions on use)	Only done by the company itself In Danish
Details of validation and testing	No impartial validation
Date developed/released (or planned release date)	2014
Author/developer names and affiliations	ConTerra
Member state(s) where developed	DK
Member State(s) where currently used	DK
Key publication references (including url)	http://www.conterra.dk/ In Danish

CTzoom/CTtools

FAIRWAY partner: Rikke Krogshave Laursen (SEGES, DK)

ConTerra
Arealanalyse og Kortlægning

Any other useful information (e.g. screenshots of DST input/outputs)



7. BEST KEMI FAIRWAY partner: Rikke Krogshave Laursen (SEGES, DK)	
Brief description	
BEST Kemi is a groundwater chemical management and forecasting DST providing an overview (screening) of the concentrations of nitrate and pesticides in the groundwater. Additionally, it can be used to monitor/follow the state and trends in the groundwater quality. BEST Kemi is a part of the BEST Portal which includes several DSTs e.g. a DST to check the groundwater utilisation ratio on a municipal level.	
Contaminants covered (e.g. nitrate, pesticides etc.)	Nitrate, pesticides
Intended end users (e.g. farmer, water quality manager, policy maker)	Municipality, water works
Level of expertise and/or training required	Trained personnel
Geographical resolution (e.g. field, catchment, national)	Municipality level
Temporal resolution (e.g. daily, annual, long-term).	Varies depending on the available data (water analyses) from the monitoring program established for the water well.
Real-time component (e.g. live weather data, soil moisture data feeds etc.)	Data input to BEST Kemi comes from the national GEUS Jupiter database, which register all well information including water quality data.
Number and type of mitigation measures included	Controls that the concentration of pesticides and nitrate is below the drinking water quality threshold values (50 mg/l for nitrate and 0 µg/l for pesticides).
Platform (e.g. paper-based tool, phone app, bespoke software).	IT solution in Danish. A municipality has its own bespoke software.
Frequency of updates	Daily
Cost/availability	Commercialised software
Number of users or number of copies distributed/ downloaded/purchased	The BEST portal is applied by 34 municipalities in Denmark (98 municipalities exists). Only 3 municipalities have BEST Kemi (it is still a relatively new DST)
Links to demo material and other relevant information (e.g. user guides).	Information regarding the BEST portal and BEST Kemi is written in Danish and is not public available.
Additional comments	

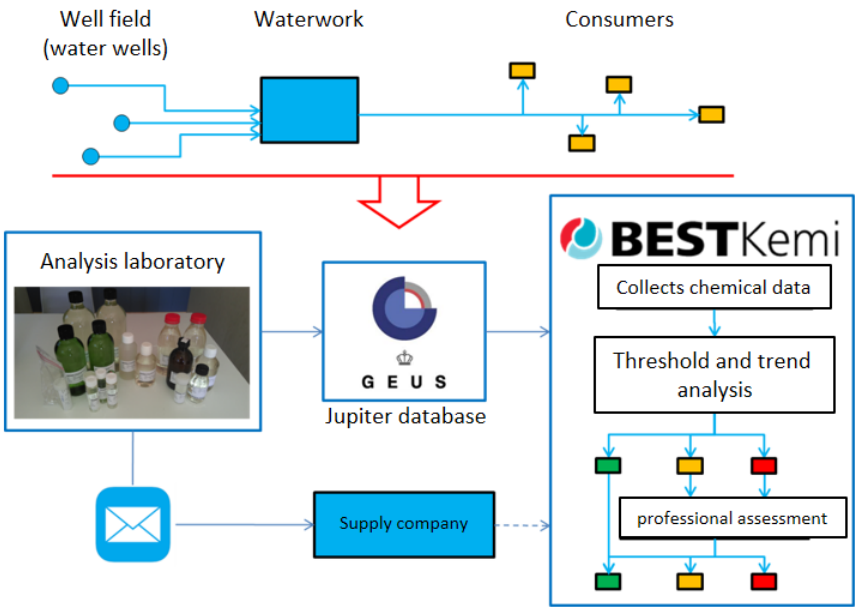
BEST kemi **FAIRWAY partner: Rikke Krogshave Laursen (SEGES, DK)**	
Input data required to run the DST	Required data input comes from the national GEUS Jupiter database, which register all well information including water quality data.
Outputs (including links to water quality and economic or financial aspects)	Concentrations of, among others, nitrate and pesticides (state). Trend analysis.
Age/provenance of supporting data used to develop the DST	Varies depending on the available data (water analyses) from the monitoring program established for the water well.
Country-specific calibration or data requirements (including restrictions on use)	Yes. BEST Kemi is specifically set up for a municipality. A database like the national GEUS Jupiter database must be available.
Details of validation and testing	The applied water quality data is based on water analyses. If a water analysis contains nitrate and/or pesticides above the drinking water quality threshold values another water sample is analysed. There is no validation or testing within the DST.
Date developed/released (or planned release date)	The first DSTs in the BEST Portal were released in 2011. BEST Kemi was released in 2017.
Author/developer names and affiliations	NIRAS
Member state(s) where developed	DK
Member State(s) where currently used	DK
Key publication references (including url)	None

BEST Kemi

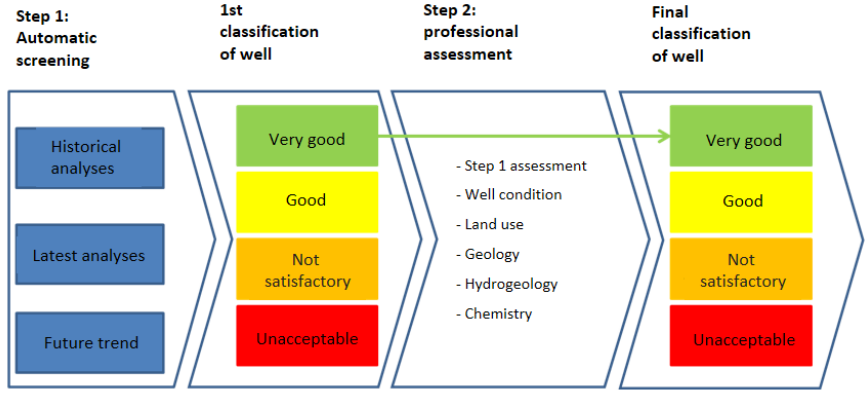
FAIRWAY partner: Rikke Krogshave Laursen (SEGES, DK)

Any other useful information (e.g. screenshots of DST input/outputs)

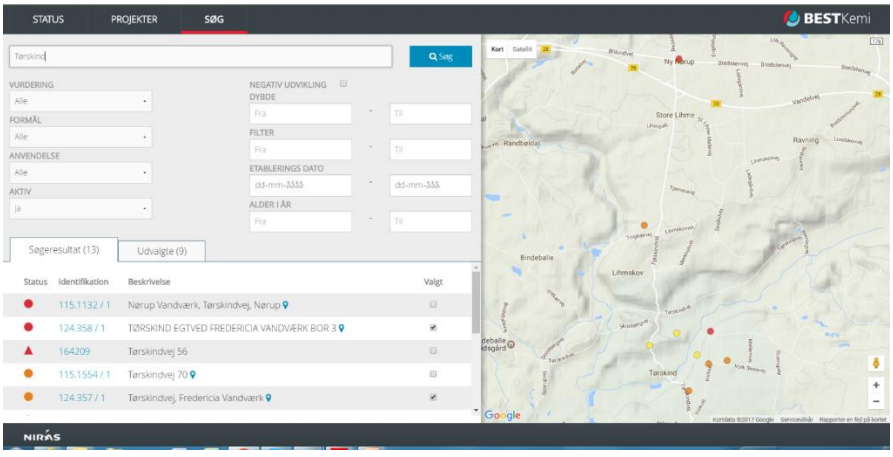
Illustration of BEST Kemi's functionality:



Based on the groundwater chemical state of all water wells they are classified as: Red (Unacceptable), Orange (Not satisfactory), Yellow (Good) and Green (Very Good). The classification is conducted in two steps.



The user interface:

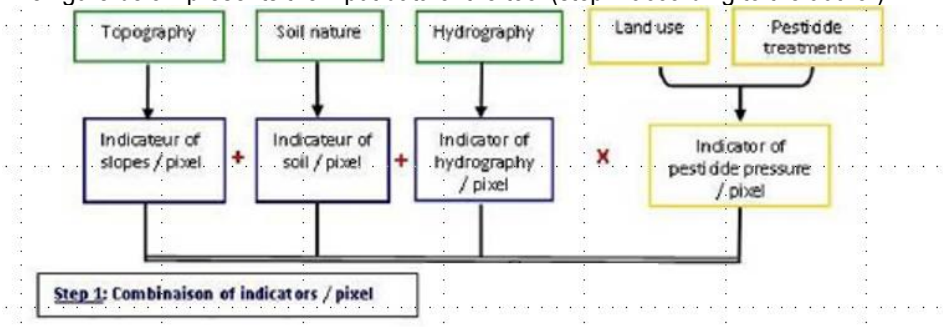


8. TargetEconN **FAIRWAY partner: Berit Hasler (AU, DK)**	
Brief description	
The TargetEconN model is an integrated economic and biophysical social planner model which minimizes the costs of meeting a nutrient load reduction target in a specific water body. The model is calibrated for the watershed of the Danish Fjord Limfjorden. It is currently being set up for the whole country of Denmark, and is being used to advise the Ministry of Environment and Food on planning related to the Water Framework Directive.	
Contaminants covered (e.g. nitrate, pesticides etc.)	Nitrogen. The model will be set up for phosphorus when data are available, and a model version is set up to cover effects on pesticide use from the implementation of nitrogen abatement measures.
Intended end users (e.g. farmer, water quality manager, policy maker)	Intended use of results: Policy makers
Level of expertise and/or training required	Experience with linear programming model or the like is beneficial for running the model
Geographical resolution (e.g. field, catchment, national)	The model is set up for one main catchment in Denmark and will be set up for all 23 main catchments. The spatial resolution for the data inputs is field level, and the optimisation takes place at sub-catchment level – e.g. Limfjorden is subdivided into 3 sub-catchments.
Temporal resolution (e.g. daily, annual, long-term).	Annual
Real-time component (e.g. live weather data, soil moisture data feeds etc.)	Soil quality data (clay, sand), retention data, crops at field level, fertiliser application at field level
Number and type of mitigation measures included	24
Platform (e.g. paper-based tool, phone app, bespoke software).	The model is set up in GAMS which is software for optimisation (in English).
Frequency of updates	It is currently updated upon demand from the Ministry, but updates are not done regularly
Cost/availability	Use of the model requires expert consultation
Number of users or number of copies distributed/ downloaded/purchased	The main users are researchers at AU (only 3 users), but the results are used by the Ministry
Links to demo material and other relevant information (e.g. user guides).	http://dnmark.org/wp-content/uploads/2017/03/Fact-sheet-TargetEconN-modelling-framework_Final.pdf
Additional comments	

TargetEconN **FAIRWAY partner: Berit Hasler (AU, DK)**	
Input data required to run the DST	None
Outputs (including links to water quality and economic or financial aspects)	Abatement costs for nutrient reductions in a catchment
Age/provenance of supporting data used to develop the DST	
Country-specific calibration or data requirements (including restrictions on use)	To calibrate the model to other countries detailed catchment data are needed on crops, fertiliser application, and retention in the catchment.
Details of validation and testing	
Date developed/released (or planned release date)	
Author/developer names and affiliations	Berit Hasler, Aarhus University
Member state(s) where developed	Denmark
Member State(s) where currently used	Denmark
Key publication references (including url)	http://dnmark.org/wp-content/uploads/2017/03/Fact-sheet-TargetEconN-modelling-framework_Final.pdf

TargetEconN **FAIRWAY partner: Berit Hasler (AU, DK)**	
Any other useful information (e.g. screenshots of DST input/outputs)	

9. PHYTOPIXAL FAIRWAY partner: Nicolas Surdyk (BRGM, FR)	
Brief description	
PHYTOPIXAL is based on a combination of indicators relating to the environmental vulnerability of the surface water environment (slope, soil type and distance to the stream) and the agricultural pressure (land use and practices of the farmers). The combination of these indicators for each pixel provides the contamination risk. The scoring of variables was implemented according knowledge in literature and of experts. To use PHYTOPIXAL a model is built with a GIS at pixel level of remote sensing.	
Contaminants covered (e.g. nitrate, pesticides etc.)	Pesticides
Intended end users (e.g. farmer, water quality manager, policy maker)	Farmers, Farm advisers, public stakeholder
Level of expertise and/or training required	Required skill in GIS. Need for a good understanding of multi-criteria modelling (Electre model) and multi-criteria analysis
Geographical resolution (e.g. field, catchment, national)	Catchment scale (watershed)
Temporal resolution (e.g. daily, annual, long-term).	Annual
Real-time component (e.g. live weather data, soil moisture data feeds etc.)	None
Number and type of mitigation measures included	No mitigation measures are included but thanks to the GIS-model association, different land use and practices of the farmers can be tested
Platform (e.g. paper-based tool, phone app, bespoke software).	GIS French (But many article available in English).
Frequency of updates	
Cost/availability	A request must be made to the research team
Number of users or number of copies distributed/ downloaded/purchased	Not known
Links to demo material and other relevant information (e.g. user guides).	No demo material on-line See publication
Additional comments	tbc

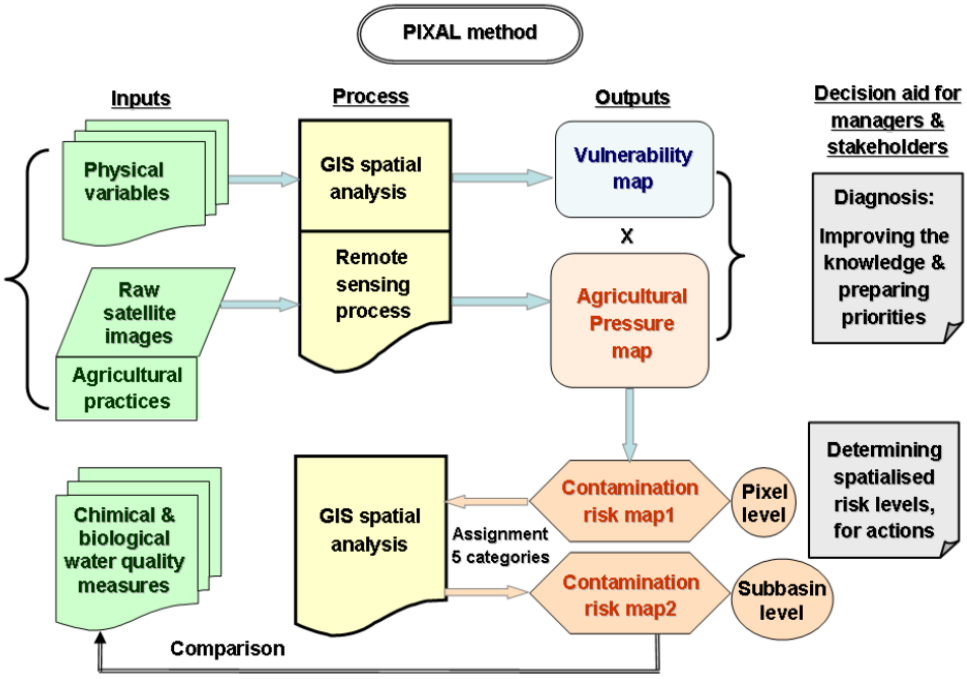
Phytopixal **FAIRWAY partner: Nicolas Surdyk (BRGM, FR)**	
Input data required to run the DST	The figure below presents the input data of the tool (step 1 according to the author) 
Outputs (including links to water quality and economic or financial aspects)	This method is used to target specific agricultural input transfer risks. There is no direct link to water quality (only potential). There no link to economic aspects.
Age/provenance of supporting data used to develop the DST	Based on field experiments
Country-specific calibration or data requirements (including restrictions on use)	This tool is site specific. A calibration on site and site data are needed.
Details of validation and testing	Tested at a site in the south of France
Date developed/released (or planned release date)	Last updated in 2014
Author/developer names and affiliations	Macary et al. IRSTEA, university of Toulouse
Member state(s) where developed	FR
Member State(s) where currently used	FR
Key publication references (including url)	Macary, Francis and Morin, Soizic and Probst, Jean-Luc and Saudubray, Frédéric A multi-scale method to assess pesticide contamination risks in agricultural watersheds. (2014). Ecological Indicators, 36 . pp. 624-639. ISSN 1470-160X, http://www.sciencedirect.com/science/article/pii/S1470160X13003336 In this document the AZOPIXAL (for nitrogen) is also described: https://pdfs.semanticscholar.org/7bce/851275c7f2b56d3ed15df9f35b2fa4d0b58a.pdf

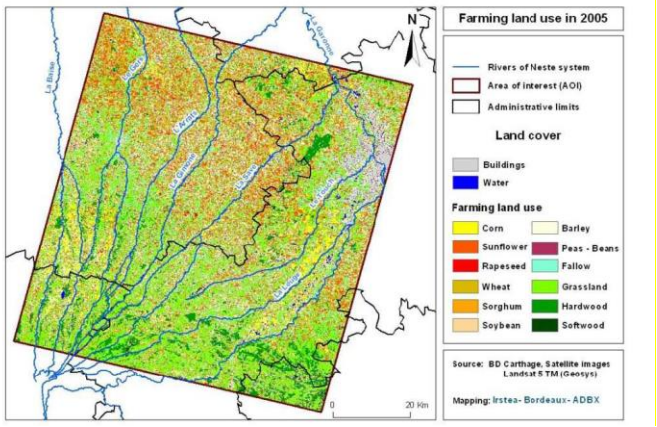
Phytopixal

FAIRWAY partner: Nicolas Surdyk (BRGM, FR)

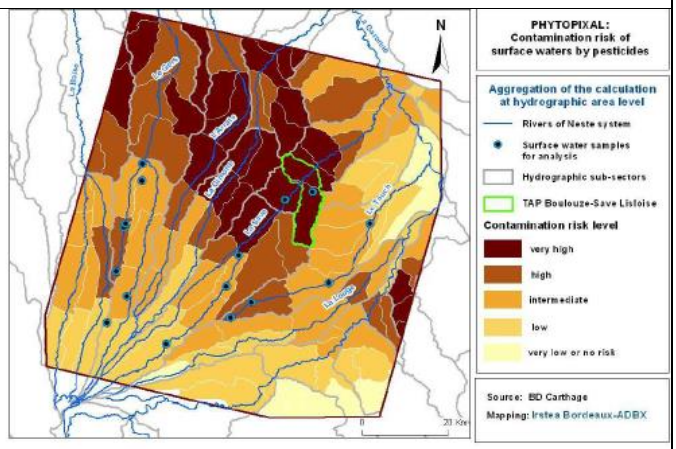
Any other useful information (e.g. screenshots of DST input/outputs)

Conceptual model of the generic PIXAL method





Example of input data : the land use of the study area

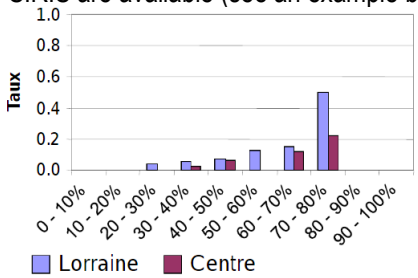


Example of output data : the estimated risk at the scale of the watershed

10.SIRIS

FAIRWAY partner: Nicolas Surdyk (BRGM, FR)

Brief description	
SIRIS-Pesticides is a decision support tool that allows classifying pesticides according to their potential to reach surface water and groundwater. SIRIS-Pesticides help to organize the monitoring of pesticides in waters at the regional or local scale. It is a software tool developed around a simple interface.	
Contaminants covered (e.g. nitrate, pesticides etc.)	Pesticides
Intended end users (e.g. farmer, water quality manager, policy maker)	Farmers and advisors; catchment managers
Level of expertise and/or training required	Knowledge of pesticides transfer is required.
Geographical resolution (e.g. field, catchment, national)	Field scale, catchment scale
Temporal resolution (e.g. daily, annual, long-term).	Annual
Real-time component (e.g. live weather data, soil moisture data feeds etc.)	None
Number and type of mitigation measures included	None
Platform (e.g. paper-based tool, phone app, bespoke software).	Online application **In French**
Frequency of updates	
Cost/availability	Free (after registration)
Number of users or number of copies distributed/ downloaded/purchased	Online application / Not Known
Links to demo material and other relevant information (e.g. user guides).	Manual (on line) in French : https://siris-pesticides.ineris.fr/guide_utilisation Other information in French at https://siris-pesticides.ineris.fr/
Additional comments	

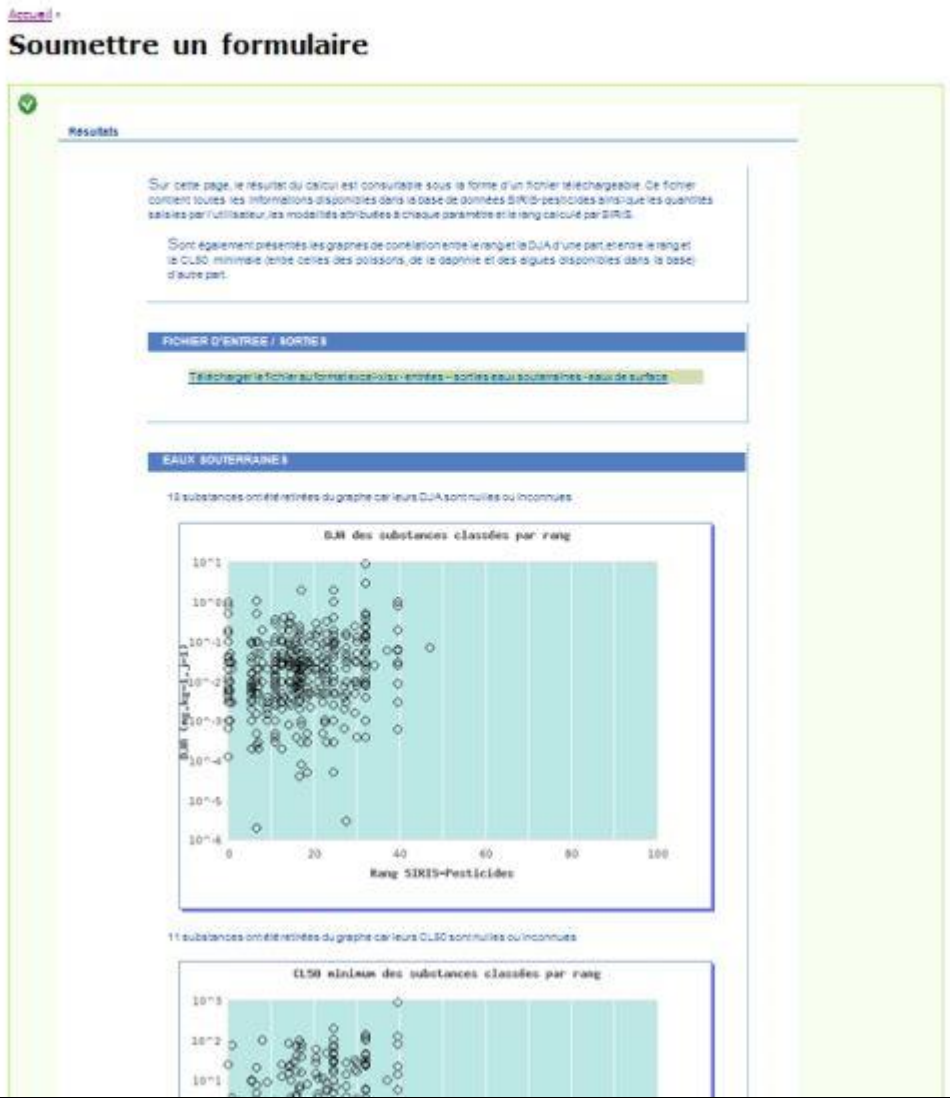
SIRIS **FAIRWAY partner: Nicolas Surdyk (BRGM, FR)**	
Input data required to run the DST	A database with the main properties of the pesticides is provided Doses uses on the catchment have to be provided
Outputs (including links to water quality and economic or financial aspects)	No direct links to water quality (only potential) No link economic or financial aspects
Age/provenance of supporting data used to develop the DST	Last update in 2012 ; The data come from French data bases or specific reports from INERIS (see https://siris-pesticides.ineris.fr/bibliographie)
Country-specific calibration or data requirements (including restrictions on use)	The properties of pesticides are theoretically the same in Europe. For these parameters, no calibration is necessary. The users provide the data that are catchment/country specific (doses).
Details of validation and testing	Some comparisons on rate of substance measured in the water (detected or above 0,1 µg) versus the substances classified by SIRIS are available (see an example below for two French regions)  A poster about the validation can be found here (in English): https://www.researchgate.net/publication/281626217_SIRIS-Pesticides_update_and_validation_of_a_decision_support_system_for_pesticides_monitoring_in_freshwater
Date developed/released (or planned release date)	First developed in 2006
Author/developer names and affiliations	Ineris
Member state(s) where developed	FR
Member State(s) where currently used	FR
Key publication references (including url)	Le Gall, A-G, Jouglet, P., Morot, A., Guerbet; M., (2007) SIRIS-Pesticides: update and validation of a decision support system for pesticides monitoring in freshwater. Conference: 17. SETAC Europe Annual Meeting, At Porto, Portugal. https://www.researchgate.net/publication/281626217_SIRIS-Pesticides_update_and_validation_of_a_decision_support_system_for_pesticides_monitoring_in_freshwater

SIRIS

FAIRWAY partner: Nicolas Surdyk (BRGM, FR)

Any other useful information (e.g. screenshots of DST input/outputs)

Here is the online presentation of the results. These graphs show the ranks SIRIS vs parameters of toxicity and ecotoxicity. These charts are used to evaluate quickly and on the first approach if substances have a high rank SIRIS and if tox or ecotoxicology criteria are of concern.



11. NMP ONLINE FAIRWAY partner: Donnacha Doody (AFBI, IE)	
Brief description	
The Teagasc NMP online (Nutrient Management Plan) is an online system for developing nutrient management plans for environment and regulatory purposes. It is available to all Agricultural professionals.	
Contaminants covered (e.g. nitrate, pesticides etc.)	Nutrients - N and P
Intended end users (e.g. farmer, water quality manager, policy maker)	Farm Advisors: Access is for Teagasc farm advisors or registered external agricultural consultants only
Level of expertise and/or training required	Designed for Agricultural professional with the user guide outlining step by step instruction for use. In additional a helpdesk email and phone are available to provide extra support where necessary
Geographical resolution (e.g. field, catchment, national)	Farm scale - maps of individual fields showing nutrient levels from soil tests and recommendations for chemical fertiliser, slurry and lime.
Temporal resolution (e.g. daily, annual, long-term).	Annual nutrient account
Real-time component (e.g. live weather data, soil moisture data feeds etc.)	None
Number and type of mitigation measures included	Nitrogen (and other nutrients). Indicates appropriate nutrient loads for individual fields; indicates storage issues on-farm for nutrients; guidance on soil test results.
Platform (e.g. paper-based tool, phone app, bespoke software).	Online - Need to log in through Teagasc
Frequency of updates	At least annually
Cost/availability	Only for select users - fees payable for affiliation with Teagasc advisory based on client numbers: 0 - 50 clients €350 51 - 100 clients €550 101 - 150 clients €750 Additional 50 clients €150
Number of users or number of copies distributed/ downloaded/purchased	Figures not available. All farm advisors registered with Teagasc in RoI will have access to this tool.
Links to demo material and other relevant information (e.g. user guides).	Presentation describing the development of the system at: https://www.teagasc.ie/media/website/publications/2015/NMP-Online-Launch-Teagasc-Soil-Fertility-Conference-Presentation-2015.pdf (In English)
Additional comments	

NMP Online **FAIRWAY partner: Donnacha Doody (AFBI, IE)**	
Input data required to run the DST	Soil phosphorus and potassium concentrations Farm location and land parcels numbers Livestock type and numbers Organic fertiliser imports Concentrate Feed Inputs Winter Housing- Animal numbers and type Slurry storage facilities Dirty Water storage facilities Farmyard Manure production –Bale Type Farmyard Manure storage Crop, Year, Total Weight (t) for harvested crop and Moisture Content (%). Farm Map (if available)
Outputs (including links to water quality and economic or financial aspects)	Phosphorus and Nitrogen nutrient management plan on a field by field basis. There is no direct link with water quality other than the nutrient advice provided adheres to current Best Management Practices No Economic outputs provided
Age/provenance of supporting data used to develop the DST	Will be up to date and based on Teagasc research.
Country-specific calibration or data requirements (including restrictions on use)	Used is restricted, access can only be obtained using a farm id number. The tool has been design and evaluated for use on Irish farms only
Details of validation and testing	Not known
Date developed/released (or planned release date)	2015
Author/developer names and affiliations	Teagasc, Johnstown Castle, Co Wexford, Republic of Ireland
Member state(s) where developed	IE
Member State(s) where currently used	IE
Key publication references (including url)	Online User Manual: https://www.teagasc.ie/media/website/environment/soil/NMP_User_Manual_2016__D5.pdf

NMP Online **FAIRWAY partner: Donnacha Doody (AFBI, IE)**	
Any other useful information (e.g. screenshots of DST input/outputs)	
Can not access the tool itself as a farm ide number is required. Information is based sololy on the user manual .	

12. FARMHEDGE FAIRWAY partner: Donnacha Doody (AFBI, IE)	
Brief description	
FarmHedge has two components: (1) use of current and forecasted weather for the farm location to provide messages that guide farm activities (e.g. Increased runoff risk on fertilised slopes). (2) The second commercial component allows farmers to book delivery of feed/fertiliser/animal health products online and secure a discount on delivery based on other farmers also ordering.	
Contaminants covered (e.g. nitrate, pesticides etc.)	Advice relates to pesticides (windy days - avoid spraying), slurry/fertiliser (runoff risk from sloping fields), animal health (wet ground - foot problems).
Intended end users (e.g. farmer, water quality manager, policy maker)	Farmers
Level of expertise and/or training required	No specialised training required
Geographical resolution (e.g. field, catchment, national)	General - uses geo-location (network-based approximate location and GPS precise location) . Uses the European Centre for Medium-Range Weather Forecasts (ECMWF) model, which they claim is most accurate available. Live weather data are converted into a set of alerts.
Temporal resolution (e.g. daily, annual, long-term).	Hourly to 10 days in advance
Real-time component (e.g. live weather data, soil moisture data feeds etc.)	Weather data is obtained using the ECMWF Model https://www.ecmwf.int/en/forecasts
Number and type of mitigation measures included	General advice e.g.: "Flooding risk on low-lying ground will increase"; "Increasing runoff risk on fertilised slopes"
Platform (e.g. paper-based tool, phone app, bespoke software).	Phone app (in English). Available for both Android and iOS platforms
Frequency of updates	Less than annual
Cost/availability	Free
Number of users or number of copies distributed/ downloaded/purchased	>1900
Links to demo material and other relevant information (e.g. user guides).	http://farmhedge.io/ (In English) http://www.ul.ie/news-centre/news/farmhedge-app (In English) http://www.agriland.ie/farming-news/will-this-smartphone-app-make-farmers-lives-easier/ (In English)
Additional comments	

FarmHedge **FAIRWAY partner: Donnacha Doody (AFBI, IE)**	
Input data required to run the DST	Not available
Outputs (including links to water quality and economic or financial aspects)	Not available
Age/provenance of supporting data used to develop the DST	Not provided
Country-specific calibration or data requirements (including restrictions on use)	The App is free to download and was developed for Ireland but is now being rolled out in Germany and Austria
Details of validation and testing	Not known – developed by a commercial company
Date developed/released (or planned release date)	Version 1.0.4 released 18th April 2016
Author/developer names and affiliations	Dr John Garvey, Senior Lecturer in Risk Management and Insurance at University of Limerick (http://www.ul.ie/news-centre/news/farmhedge-app). University of Limerick spin out company; FarmHedge Ltd contact via: farmhedgeio2016@gmail.com
Member state(s) where developed	IE
Member State(s) where currently used	IE (listed and rated on www.agriapps.ie)
Key publication references (including url)	http://farmhedge.io/

FarmHedge **FAIRWAY partner: Donnacha Doody (AFBI, IE)**	
Any other useful information (e.g. screenshots of DST input/outputs)	

13. ANCA

FAIRWAY partner: Koos Verloop (Wageningen University and Research, NL)

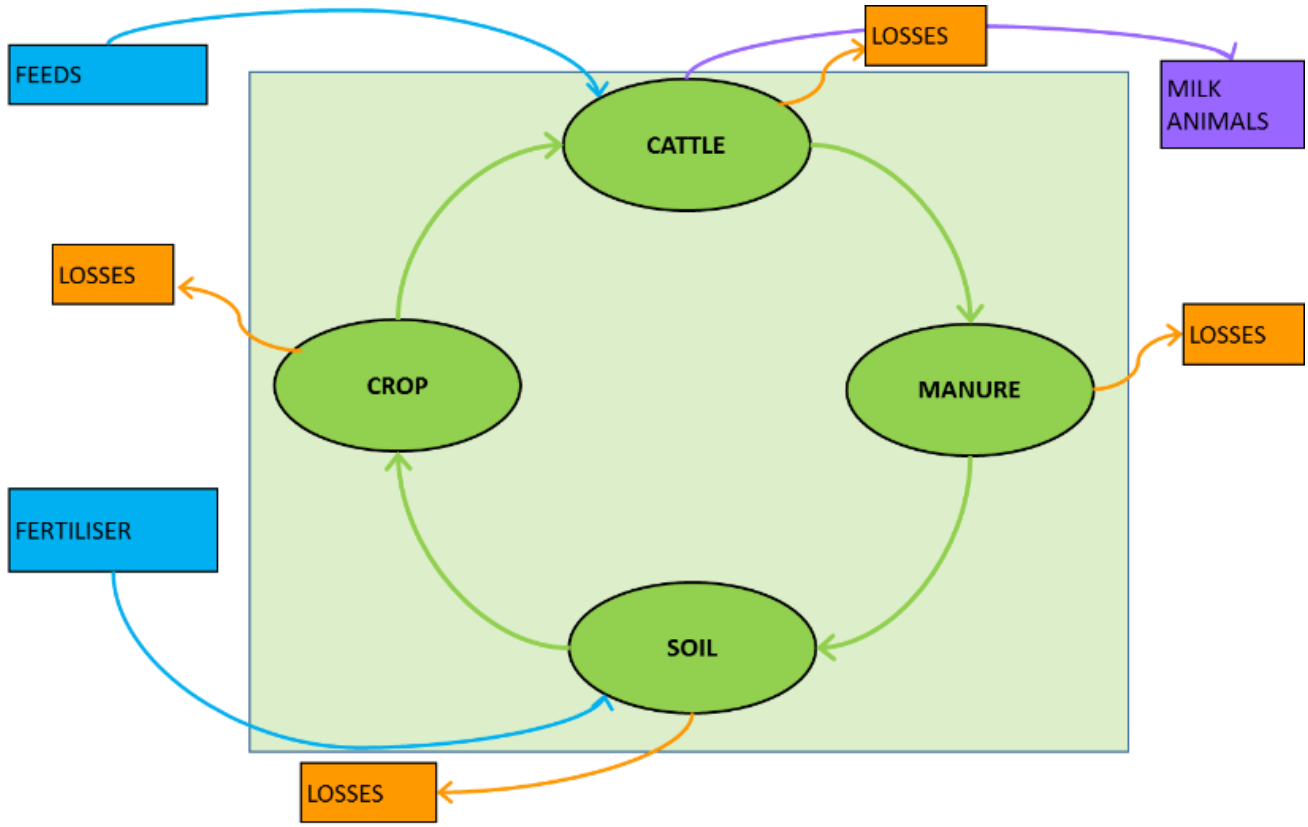
Brief description	
Annual Nutrient Cycling Assessment. The ANCA (Dutch: KringloopWijzer) is a farm specific tool to analyse nutrient flows within dairy farms (cycling from feeds, to herd, to storage, to soil, to crops and back to herd) and emissions by losses from this imperfect cycle. It covers nitrogen, phosphorus and carbon.	
Contaminants covered (e.g. nitrate, pesticides etc.)	N, P, C
Intended end users (e.g. farmer, water quality manager, policy maker)	Farmer, farm advisor, policy maker, milk industry
Level of expertise and/or training required	User must have some technical understanding of dairy farming. One day training required
Geographical resolution (e.g. field, catchment, national)	Farm scale to aggregated crop.
Temporal resolution (e.g. daily, annual, long-term).	Annual
Real-time component (e.g. live weather data, soil moisture data feeds etc.)	None
Number and type of mitigation measures included	No explicit measures included. However, it shows the performance and is a starting point to decide on changes in farm management that may result in lower surpluses.
Platform (e.g. paper-based tool, phone app, bespoke software).	Bespoke software/internet tool Dutch and English
Frequency of updates	Once a year
Cost/availability	Freely available for registered dairy farmers
Number of users or number of copies distributed/ downloaded/purchased	Dairy farmers (16,000) are obliged to use this tool.
Links to demo material and other relevant information (e.g. user guides).	https://www.mijnkringloopwijzer.nl/ In Dutch
Additional comments	Developed for the dairy sector, project Cows and Opportunities

ANCA **FAIRWAY partner: Koos Verloop (Wageningen University and Research, NL)**	
Input data required to run the DST	Year, personalia, farm fFeeds purchased(input/output/change of stocks), farm organic/artificial manure (i/o), type of housing, farm agricultural area, land use (ha grassland, maize, arable land), soiltype, number and breed of cows and young stock <1 yr, > yr, milk production farm (delivered), cows exported from farm, artificial fertilizer applied, volume of manure storage, method off application of manure and artificial fertilizer, volume of maize silage stored, change of stocksing rates silage, contents of grass and maize silage, number of days that cows are allowed to graze/hours per day, legumes, P status soil.
Outputs (including links to water quality and economic or financial aspects)	It assesses soil surplus of N and P. N surplus on the soil balance can be used as indicator for both losses to surface water and groundwater. The model outcomes help dairy farmers to demonstrate towards authorities and the dairy industry that they have produced their milk in accordance with sustainability standards.
Age/provenance of supporting data used to develop the DST	Experimental farm de Marke (1993) and Cows & Opportunities (16 farms, 1998)
Country-specific calibration or data requirements (including restrictions on use)	Yes, in particular concerning conversion of energy into gain of bodymass, reprodcution and milk of cattle.
Details of validation and testing	Validated with records of Cows & Opportunities
Date developed/released (or planned release date)	First version 2008. Current version released 2017
Author/developer names and affiliations	Oenema, Schröder, Sebek, De Haan and Aarts. WUR, Animal Science Group & Wageningen Plant Research.
Member state(s) where developed	NL
Member State(s) where currently used	NL, Flanders
Key publication references	Aarts, H.F.M.; Haan, M.H.A. de; Schroder, J.J.; Holster, H.C.; Boer, J.A. de; Reijs, Joan; Oenema, J.; Hilhorst, G.J.; Sebek, L.B.; Verhoeven, F.P.M.; Meerkerk, B. (2015). Quantifying the environmental performance of individual dairy farms - the Annual Nutrient Cycling Assessment (ANCA). In: Grassland and forages in high output dairy farming systems. - Wageningen : Wageningen Academic Publishers (Grassland Science in Europe) - ISBN 9789090289618 - p. 377 - 380. http://library.wur.nl/WebQuery/wurpubs/514477 Report available at http://edepot.wur.nl/370323 (In Dutch)

ANCA

FAIRWAY partner: Koos Verloop (Wageningen University and Research, NL)

Any other useful information (e.g. screenshots of DST input/outputs)



Use in practice

ANCA is meant as an advisory tool but from this year (2017) dairy farmers are obliged to report their farm performance using ANCA. Many projects on improved farm management totally rely on ANCA. Farmers involved in these projects amount to about 300-400

14. ADVIESBASIS CBGV

FAIRWAY partner: Koos Verloop (Wageningen University and Research, NL)

Brief description	
Advice on fertilization N, P and other elements for grass and fodder crops (maize). Fertilizer and manure N, P rates and rates of other elements are recommended. The recommendations are widely used by farm advisers. Generally the recommendations are tuned to optimal rates from an economical point of view. That is the higher N, P rates the lower the recovery and thus high rates are not cost effective anymore. The optimum is the rate that is just below the point where recovery drops. This is also the point whererate above which risks for leaching increase.	
Contaminants covered (e.g. nitrate, pesticides etc.)	N, P, K
Intended end users (e.g. farmer, water quality manager, policy maker)	Farmers and advisors
Level of expertise and/or training required	No particular training required for a professional agronomist
Geographical resolution (e.g. field, catchment, national)	National scale; differentiated for soil type and geohydrological situations.
Temporal resolution (e.g. daily, annual, long-term).	Annual
Real-time component (e.g. live weather data, soil moisture data feeds etc.)	None
Number and type of mitigation measures included	Not specified.
Platform (e.g. paper-based tool, phone app, bespoke software).	Paper-based, also available by internet Dutch
Frequency of updates	Updated whenever needed
Cost/availability	Free
Number of users or number of copies distributed/ downloaded/purchased	Not specified
Links to demo material and other relevant information (e.g. user guides).	Not available
Additional comments	This is not farm specific but commonly used. This tool is not explicitely related to nitrate, but it is generally accepted that many problems concerning nitrate leaching could be avoided provided that fertilizer recommendations would be followed (more) closely by farmers. That is why it was considered relevant in the frame of DSTs.

Adviesbasis CBGV **FAIRWAY partner: Koos Verloop (Wageningen University and Research, NL)**	BEMESTINGSADVIES Commissie Bemesting Grasland en Voedergewassen
Input data required to run the DST	None
Outputs (including links to water quality and economic or financial aspects)	Fertilizer recommendations (rates N, P, K etcetera) for grassland and maize. Recommendations are soil specific and are differentiated for hydrological conditions
Age/provenance of supporting data used to develop the DST	Not specified (many field trials)
Country-specific calibration or data requirements (including restrictions on use)	Fertilizer recommendations (rates N, P, K etcetera) for grassland and maize. Recommendations are soil specific and are differentiated for hydrological conditions
Details of validation and testing	Field trials are the basis for recommendations
Date developed/released (or planned release date)	Not given, updates are provided annually
Author/developer names and affiliations	CBGV, secr. Van Middelkoop. CBGV suppported by LTO, Zuivel NL
Member state(s) where developed	NL
Member State(s) where currently used	NL
Key publication references	https://www.bemestingsadvies.nl/nl/bemestingsadvies.htm

Adviesbasis CBGV **FAIRWAY partner: Koos Verloop (Wageningen University and Research, NL)**	BEMESTINGSADVIES Commissie Bemesting Grasland en Voedergewassen
Any other useful information (e.g. screenshots of DST input/outputs)	

15. BEREGENINGSWIJZER

FAIRWAY partner: Koos Verloop (Wageningen University and Research, NL)

Brief description	
Irrigation management. Online meteorological data on precipitation and field data are processed to give the need for irrigation on the individual fields. Recommendations on the optimal rate prevents excess irrigation which could enhance leaching and facilitates preservation of the optimal level of water content in soil, resulting in higher N uptake and better utilization of fertilizer N.	
Contaminants covered (e.g. nitrate, pesticides etc.)	Leaching of N
Intended end users (e.g. farmer, water quality manager, policy maker)	Farmers and advisors
Level of expertise and/or training required	Low
Geographical resolution (e.g. field, catchment, national)	Field scale
Temporal resolution (e.g. daily, annual, long-term).	Daily
Real-time component (e.g. live weather data, soil moisture data feeds etc.)	Live weather data
Number and type of mitigation measures included	Water use and irrigation based on live weather data
Platform (e.g. paper-based tool, phone app, bespoke software).	Bespoke software (in Dutch)
Frequency of updates	Updated whenever needed (annually)
Cost/availability	Commercial software
Number of users or number of copies distributed/ downloaded/purchased	Approx. 200 farmers
Links to demo material and other relevant information (e.g. user guides).	Not available
Additional comments	

Beregeningswijzer **FAIRWAY partner: Koos Verloop (Wageningen University and Research, NL)**	
Input data required to run the DST	- Meteorological: precipitation, potential evapotranspiration (both historically and predicted) - Groundwater level - Crop - Rootdepth - Price of forage and foraging stock in case of grassland
Outputs (including links to water quality and economic or financial aspects)	- Moisture content of the rootzone - Irrigation advice with grassland renewal as a risk factor in the consideration of whether or not to irrigate - irrigation gift
Age/provenance of supporting data used to develop the DST	Not reported
Country-specific calibration or data requirements (including restrictions on use)	Soil characterisation
Details of validation and testing	Not reported
Date developed/released (or planned release date)	First developed c.1991. Current version released January 2017.
Author/developer names and affiliations	Hoving (ASG, WUR)
Member state(s) where developed	NL
Member State(s) where currently used	NL
Key publication references	http://edepot.wur.nl/24356

Beregeningswijzer **FAIRWAY partner: Koos Verloop (Wageningen University and Research, NL)**	
Any other useful information (e.g. screenshots of DST input/outputs)	

16. BEDRIJFSWATERWIJZER (BWW)

FAIRWAY partner: Koos Verloop (Wageningen University and Research, NL)

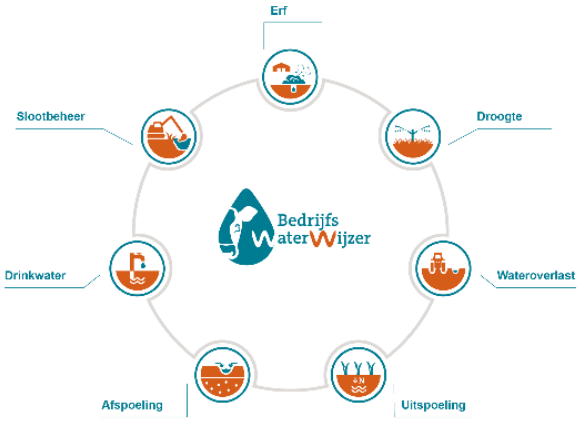
Brief description	
Guide for Farm Water management. Farm specific indication of risks related to dairy farm management. The tool addresses: pollution from farm yard (storages), drought, water excess, leaching to groundwater, run off to surface water, quality of drinking water for cattle and ecological quality of surface water. The tool facilitates cooperation between dairy farmers and water boards that are responsible for realization of KRW targets in their region.	
Contaminants covered (e.g. nitrate, pesticides etc.)	N, P, Biological degradable material
Intended end users (e.g. farmer, water quality manager, policy maker)	Farmers and advisers
Level of expertise and/or training required	Specialised farm advisors is required
Geographical resolution (e.g. field, catchment, national)	Farm>Parcel>Spot (10m2)
Temporal resolution (e.g. daily, annual, long-term).	Actual situation (moment of supplying input)
Real-time component (e.g. live weather data, soil moisture data feeds etc.)	None
Number and type of mitigation measures included	No explicit measures included. Only diagnostic. From 2018 measures will be added, mainly related to management.
Platform (e.g. paper-based tool, phone app, bespoke software).	Bespoke software/Internet tool (in Dutch)
Frequency of updates	Updated continuously until official release in 2018
Cost/availability	Free access of online tool
Number of users or number of copies distributed/ downloaded/purchased	At present some 50 dairy farmers involved in testing
Links to demo material and other relevant information (e.g. user guides).	Not published yet
Additional comments	Input of data is time consuming, working on automatized data supply from other spatial data systems. Development for common use is strongly supported by the dairy sector.

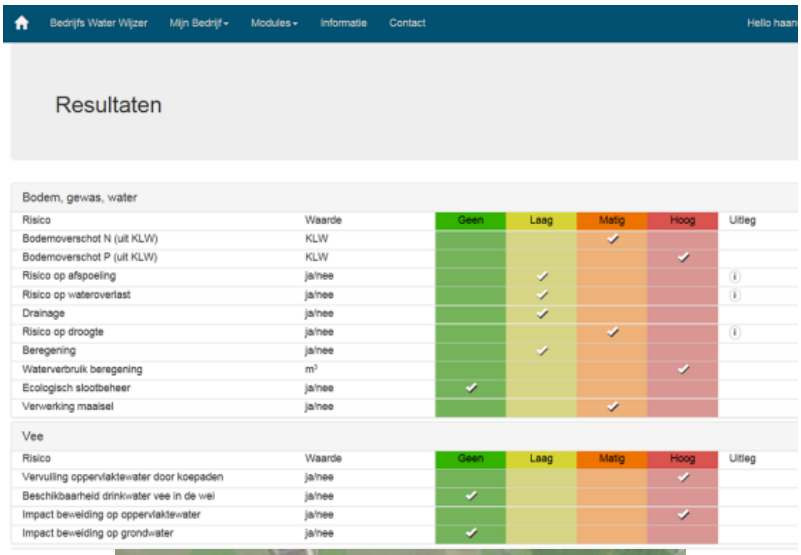
BedrijfsWaterWijzer (BWW) **FAIRWAY partner: Koos Verloop (Wageningen University and Research, NL)**	
Input data required to run the DST	Facilities to store silage, manure and/or byproducts on the farm, for alle parcels on the farm: hydrological conditions, soil type, soil characteristics, depth of root zone, organic matter content, P status, irrigation management, timing/rates of fertilization, crop plan, quality of surface water, quality of drinking water for cattle, crop yields, grazing intensity of cattle.
Outputs (including links to water quality and economic or financial aspects)	Risks concerning run off polluted water from the farm yard, drought stress in crops, leachng of nutrients to ground water, leaching and run off to surface water, quality of drinking water for cows and ecology of water systems
Age/provenance of supporting data used to develop the DST	Integration of recent and older information and data
Country-specific calibration or data requirements (including restrictions on use)	Spatial data on farm area
Details of validation and testing	None
Date developed/released (or planned release date)	Current version only limited access. From January 2018 general access.
Author/developer names and affiliations	Verloop, Noij, Hoving, De Haan (WUR, Animal Science Group & Wageningen Plant Research)
Member state(s) where developed	NL
Member State(s) where currently used	NL
Key publication references	Not published yet

BedrijfsWaterWijzer (BWW)

FAIRWAY partner: Koos Verloop (Wageningen University and Research, NL)

Any other useful information (e.g. screenshots of DST input/outputs)





17. BODEMCONDITIESCORE

FAIRWAY partner: Koos Verloop (Wageningen University and Research, NL)

Brief description	
Visual soil examination and evaluation. A semi-quantitative method that provides rapid information on soil quality, referring to soil texture, structure and biological activity.	
Contaminants covered (e.g. nitrate, pesticides etc.)	N, P, Pesticides
Intended end users (e.g. farmer, water quality manager, policy maker)	Farmers and advisers
Level of expertise and/or training required	Field training
Geographical resolution (e.g. field, catchment, national)	Field scale
Temporal resolution (e.g. daily, annual, long-term).	Annual
Real-time component (e.g. live weather data, soil moisture data feeds etc.)	Live weather data
Number and type of mitigation measures included	Regional advise on pest population dynamics based on weekly field scouting
Platform (e.g. paper-based tool, phone app, bespoke software).	On line tool supported by downloads (in Dutch but based on the Visual Soil Assessment of Shepherd see also http://www.fao.org/tempref/docrep/fao/010/i0007e/i0007e06.pdf
Frequency of updates	Updated weekly during the growth season
Cost/availability	No costs, freely available
Number of users or number of copies distributed/ downloaded/purchased	500-1000.
Links to demo material and other relevant information (e.g. user guides).	http://www.mijnbodemconditie.nl/over-mijnbodemconditie
Additional comments	This is commonly used on project meetings with dairy farmers

Bodemconditiescore **FAIRWAY partner: Koos Verloop (Wageningen University and Research, NL)**	
Input data required to run the DST	Visual observations on sod density (sprouts per cm2), botanical composition of grass sod, soil density, biological activity, abundance of macro fauna, rooting depth. Optionally also chemical quality of the grass and maize silage
Outputs (including links to water quality and economic or financial aspects)	Judgement of soil quality in terms of structure, texture, soil life
Age/provenance of supporting data used to develop the DST	Several databases are used for the several prototypes
Country-specific calibration or data requirements (including restrictions on use)	Visual soil quality assessment should be adjusted for each region to optimally cover regional soil charactersistics and its agronomic judgment
Details of validation and testing	None supplied
Date developed/released (or planned release date)	2014
Author/developer names and affiliations	Shepherd, adjusted by Sonneveld (WUR), applied by Van Eekeren (Louis Bolk).
Member state(s) where developed	NL
Member State(s) where currently used	NL
Key publication references	Sonneveld, M. P. W., Heuvelink, G. B. M. & Moolenaar S.W. (2014). Application of a visual soil examination and evaluation technique at site and farm level. Soil Use and Management, 30, 263–271. http://mijnbodemconditie.nl/images/pdf/sum12117.pdf Maricke M.W.J. van Leeuwen, Gerard B.M. Heuvelink, Jacob Wallinga, Imke J.M. de Boer, Jos C. van Dam, Everhard A. van Essen, Simon W. Moolenaar, Frank P.M. Verhoeven, Jetse J. Stoorvogel, Cathelijne R. Stoof. 2018. Visual soil evaluation: reproducibility and correlation with standard measurements. Soil& Tillage Research 178, 167-178.

Bodemconditiescore

FAIRWAY partner: Koos Verloop (Wageningen University and Research, NL)

Any other useful information (e.g. screenshots of DST input/outputs)

mijn bodem conditie.nl

MijnBodemconditie: **Bedrijfsmeting**

De BodemConditieScore online uitrekenen? Ga dan naar www.mijnbodemconditie.nl

1 Gegevens bedrijf

Naam bedrijf ..... Plaats .....

Datum ..... Naam uitvoerder .....

	1	2	3	4	5	6
Perceel/volgnummer [1]						
Oppervlakte (ha) [1]						
Positie bodemkuilen /GPS coörd. W /GPS coörd. N						
Bodemtype [2]						
Gewascode [3]						

[1] Zie gecombineerde opgave gewassen Ministerie EZ [2] 1 = zware klei 2 = lichte klei 3 = zwak lemig zand 4 = sterk lemig zand 5 = veen

[3] 259 = mais rotatie, 259c = mais continue, 266 = tijdelijk gras (<6 jaar), 265 = permanent gras

2 Bodemanalyse

	1	2	3	4	5	6
Zuurgraad (pH-$CaCl_2$) [4]						
Organische Stof (%) [4]						

[4] Zie bodemanalyse perceel, indien aanwezig, anders inschatten

3 BodemConditieScore (BCS)

Score x Wegingsfactor (0 = onvoldoende, 1 = matig, 2 = goed)

	Wegingsfactor	1	2	3	4	5	6
1 Gewasbedekking	2						
2 Bewortteling	3						
3 Verdichting ondergrond 20- 40 cm	3						
4 Regenwormen	3						
5 Bodemstructuur	3						
6 Zuurgraad (pH)	3						
7 Organische stof (kleur)	3						
8 Aantal gekleurde vlekken	1						

4 Aanvullende waarnemingen

Is seizoensafhankelijk en worden negatief beoordeeld

Score x Wegingsfactor (0 = geen, 1 = matig, 2 = veel)

		1	2	3	4	5	6
9 Plasvorming	-2						
10 Scheuren	-1						
11 Spoorvorming / vertrapping	-1						
Totaal BodemConditieScore							

5 Resultaten

BodemConditieScore:

Verdeel de scores over de maatlat

0	10	20	30	40
Slecht	Onvoldoende	Matig	Goed	Zeer Goed

6 Opmerkingen

LOUIS BOLK INSTITUUT

WAGENINGEN UR

AEQUATOR groen & ruimte

18. NDICEA

FAIRWAY partner: Koos Verloop (Wageningen University and Research, NL)

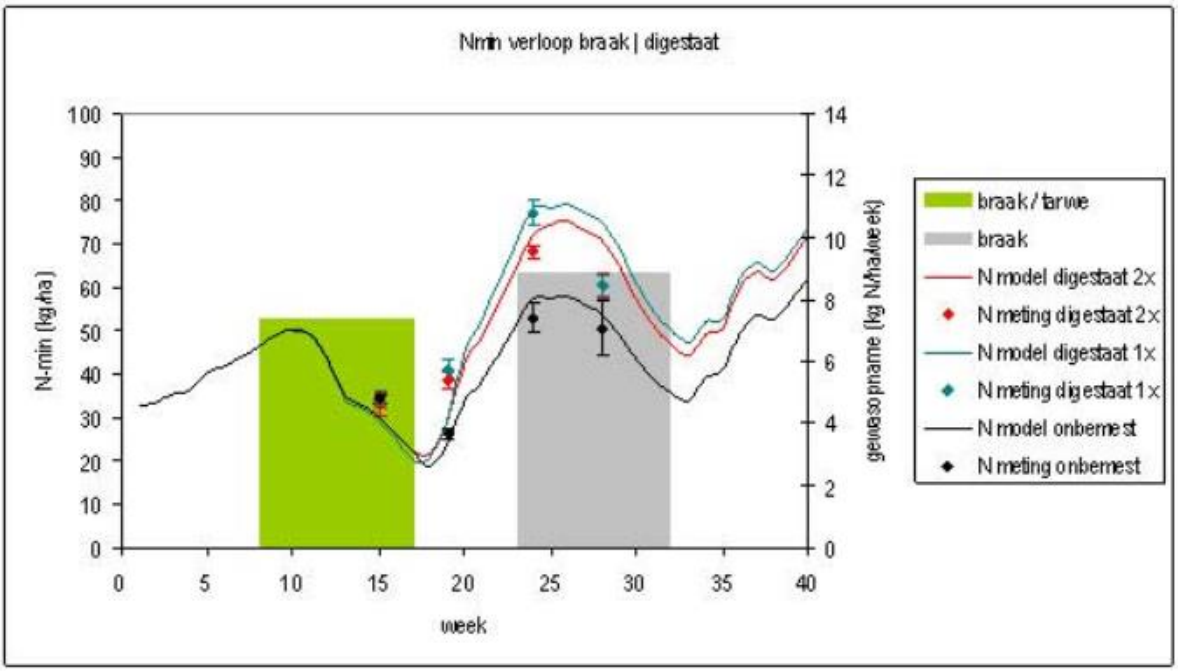
Brief description	
Nitrogen Dynamics In Crop rotations in Ecological Agriculture. The program NDICEA nitrogen planner presents an integrated assessment on the question of nitrogen availability for your crops. This is more than a simple nitrogen budgeting for each crop: crop demand on one side, and expected availability out of artificial fertilizers and manures, crop residues, green manures and soil on the other side.	
Contaminants covered (e.g. nitrate, pesticides etc.)	Nitrogen
Intended end users (e.g. farmer, water quality manager, policy maker)	Farmers and advisors
Level of expertise and/or training required	Low level of expertise or training required
Geographical resolution (e.g. field, catchment, national)	Field scale
Temporal resolution (e.g. daily, annual, long-term).	Daily
Real-time component (e.g. live weather data, soil moisture data feeds etc.)	Weather data: temperature, rainfall, evapotranspiration
Number and type of mitigation measures included	Nitrogen for arable farming and horticulture; soil organic matter
Platform (e.g. paper-based tool, phone app, bespoke software).	Bespoke software (in Dutch, English, Danish, Spanish, German)
Frequency of updates	Not reported
Cost/availability	Commercial software
Number of users or number of copies distributed/ downloaded/purchased	> 1000 downloads
Links to demo material and other relevant information (e.g. user guides).	www.ndicea.nl (In Dutch, English, Spanish)
Additional comments	In conversion towards a web-based version instead of PC-based version

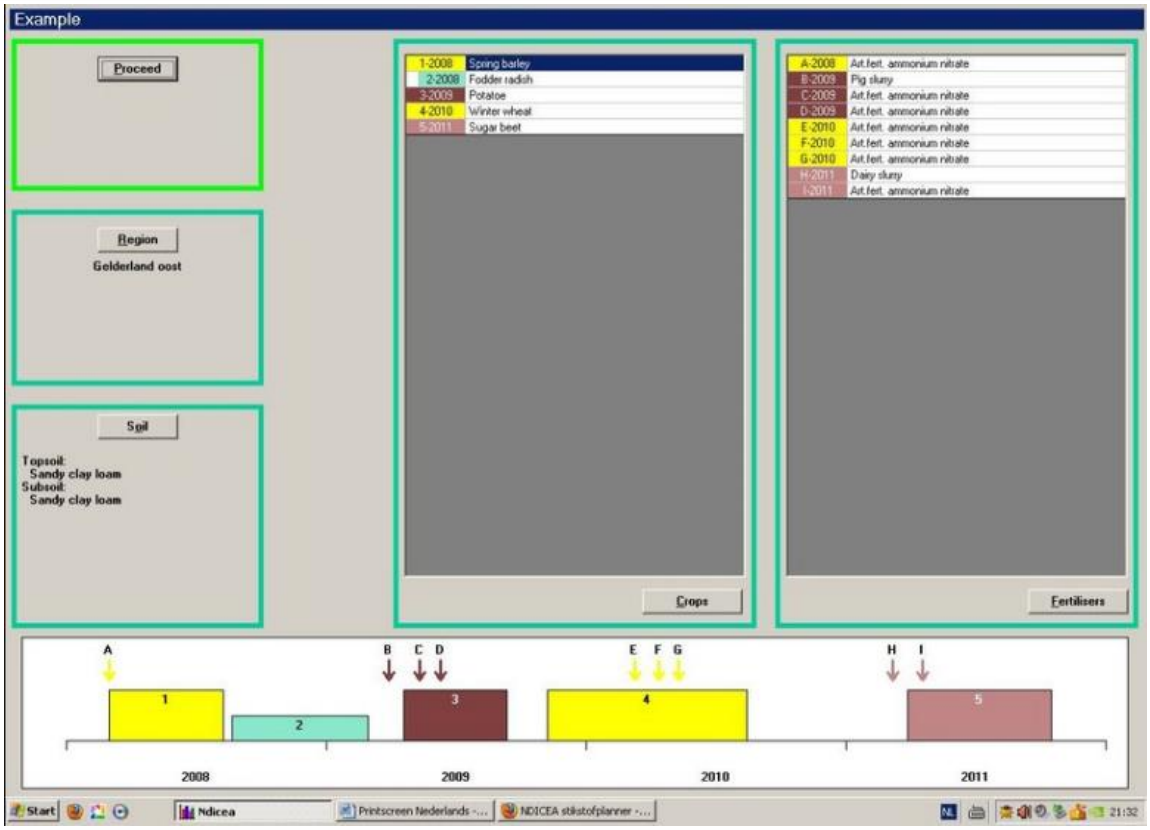
NDICEA FAIRWAY partner: Koos Verloop (Wageningen University and Research, NL)	
Input data required to run the DST	Country; region within the country (So far: NL 6 regions, ES 2 regions, UK 4 regions, DK 5 regions, D 8 regions (in Nordrhein-Westfalen) Field data: soil type topsoil and subsoil, organic matter content topsoil, pH topsoil, groundwater table Environmental data, daily-based: average temperature, rainfall, irrigation, evapotranspiration Historical (at least two years) and actual (this year) data on: Crops: sowing date, harvest date, yield. If available: N-P-K content, d.m. content Green manures / catch crops: sowing date, havest date, estimated d.m. production Artificial N fertilizers: type, quantity, date of application Organic fertilizers: type, quantity, date of application. If available: N-P-K, DM and OM content
Outputs (including links to water quality and economic or financial aspects)	Graph crop nitrogen uptake versus nitrogen availability Graph course soil inorganic nitrogen level (topsoil, subsoil) Graph cumulative nitrogen leaching for each crop / catchcrop Graph cumulative nitrogen denitrification from topsoil Graph course of topsoil pH Graph course of topsoil organic matter quantity Table mineral balance, average per year of the scenario in question.
Age/provenance of supporting data used to develop the DST	First model design 1987 Adaptations in both calculation methodology (for example root growth, temperature-driven start of crop-growth) and crop/manure input data 2000 - 2014 Last upgrade 2014, including introduction of N losses due to volatilization from artificial fertilizers
Country-specific calibration or data requirements (including restrictions on use)	The model has been validated for northwest-European climatic and soil conditions. Calibration, validation or model adaptation required for: - conditions with substantial snowfall / soil frost - conditions with a substantial shortage in the rainfall - evapotranspiration balance - soil conditions substantially different from northwest-European soils. At each site: calibration by means of a check between measured and simulated level of soil inorganic N could improve model performance. A calibration procedure is included in the model.
Details of validation and testing	None supplied
Date developed/released (or planned release date)	Early 2000
Author/developer names and affiliations	Van der Burgt (WUR/Louis Bolk)
Member state(s) where developed	NL
Member State(s) where currently used	NL
Key publication references	Burgt G.J.H.M. van der, Oomen G.J.M., Habets A.S.J. & Rossing W.A.H. (2006) : The NDICEA model, a tool to improve nitrogen use efficiency in cropping systems. Nutrient Cycling in Agroecosystems 74: 275-294. Burgt G.J.H.M. van der, Oomen G.J.M. & Rossing W.A.H. (2006): The NDICEA model as a learning tool: field experiences 2005. In Proceedings European Joint Organic Congress, 30-31 May 2006, Odense, Denmark, 236-237.

NDICEA

FAIRWAY partner: Koos Verloop (Wageningen University and Research, NL)

Any other useful information (e.g. screenshots of DST input/outputs)





Environmental yardstick for pesticides FAIRWAY partner: Koos Verloop (Wageningen University and Research, NL)	
Brief description	
A DST to quantify the environmental impact of the use of pesticides in outdoor and greenhouse crops. For each pesticide the yardstick assigns environmental impact points for the risk to water organisms, the risk of leaching to groundwater and the risk to soil organisms. The yardstick shows the risk to pollinators, beneficials and applicators. It is used in the Netherlands as a management tool for farmers and technical consultants, as a tool for monitoring the environmental performance of farmers, as a tool for setting standards for ecolabels and as a tool for the supply chain to be able to purchase sustainable agricultural products, and as a policy evaluation tool.	
Contaminants covered (e.g. nitrate, pesticides etc.)	Pesticides
Intended end users (e.g. farmer, water quality manager, policy maker)	Farmers and advisors, ecolabel managers, supply chain managers sustainability, policy makers
Level of expertise and/or training required	
Geographical resolution (e.g. field, catchment, national)	Field scale. Output can be scaled up to regional or national level. Suitable for all farms growing crops (arable, greenhouse, horticulture)
Temporal resolution (e.g. daily, annual, long-term).	Environmental impact specified for wet (autumn-winter) and drier season (spring-summer)
Real-time component (e.g. live weather data, soil moisture data feeds etc.)	None
Number and type of mitigation measures included	Choice of pesticide, dose rate, organic matter content of soil, season, application technique (drift) and width of untreated buffer zone
Platform (e.g. paper-based tool, phone app, bespoke software).	Bespoke software with an excel database, internet application
Frequency of updates	Every 6 months new pesticides are added and new environmental data are added if available
Cost/availability	Free for comparison of 3 pesticides. Free environmental impact sheets for different crops. Subscription for unlimited comparison of pesticides and the possibility of exporting the results to an Excel sheet. For a free download or a subscription visit the following website: http://www.milieumeetlat.nl/en/home.html
Number of users or number of copies distributed/ downloaded/purchased	More than 15.000 users in arable farming, ornamentals and fruit. 6400 website visitors in 2016
Links to demo material and other relevant information (e.g. user guides).	Animation on http://www.milieumeetlat.nl/nl/home.html (in Dutch), environmental impact sheets including instructions
Additional comments	

19. ENVIRONMENTAL YARDSTICK FOR PESTICIDES FAIRWAY partner: Koos Verloop (Wageningen University and Research, NL)	
Input data required to run the DST	
Outputs (including links to water quality and economic or financial aspects)	Outputs can impact on both surface water quality (ecological quality: risk for water organisms) and groundwater quality (risk of leaching in comparison to the drinking water norm). The tool is used to inform policy makers on the effect of collective changes in farmers' pesticide use over the years, before these changes can be seen in ground water monitoring due to time lagging effects.
Age/provenance of supporting data used to develop the DST	Risks to water organisms and soil organisms are computed on data supplied by the Ctgb (Board for authorisation of plant protection products). Risk to groundwater are based on leaching model PEARL. These risk calculations comply with the authorisation procedures and data in Europe. Risks to pollinators and natural enemies are based on the side effects database of Koppert Biological Systems, supplemented with data from the PDDB database. Risk to the applicator is based on data supplied by the Ctgb.
Country-specific calibration or data requirements (including restrictions on use)	
Details of validation and testing	The yardstick is regularly validated against filed data of pesticides in ground and surface water. Furthermore the yardstick was tested in a European study on comparing pesticide tools (Reus *et al.* 2001). Finally the practical applicability was tested in several groups of farmers during its development.
Date developed/released (or planned release date)	First developed between 1991 - 1994 ; effects on pollinators added in 2005, current version released in 2017
Author/developer names and affiliations	J.A.W.A. Reus, G.A. Pak, G.M. Bouwman, P.C. Leendertse CLM Research and Advise
Member state(s) where developed	NL
Member State(s) where currently used	NL, BE and outside the EU. The yardstick is currently being used for calculations on USA farm data and is available in English
Key publication references	Bouwman, G.M. & J.A.W.A. Reus (1994). Milieumeetlat voor bestrijdingsmiddelen: Pilotstudie en plan voor verdere introductie en beheer. Centre for Agriculture and Environment, Utrecht. Leendertse, P.C., Reus, J., 1997. Een milieumeetlat voor bestrijdingsmiddelen in de glastuinbouw (An environmental yardstick for the use of pesticides in greenhouse horticulture). Milieu 2: 87-94. Reus, J.A.W.A., Leendertse P.C. (2000). The environmental yardstick for pesticides: a practical indicator used in the Netherlands. Crop Protection, 19, 637-641 https://www.researchgate.net/publication/228551191_The_environmental_yardstick_for_pesticides_A_practical_indicator_used_in_the_Netherlands Reus, J.A.W.A. (1991). Milieumeetlat voor bestrijdingsmiddelen: ontwikkeling en plan voor toetsing (Environmental yardstick for pesticides: development and test plan). Centre for Agriculture and Environment, Utrecht. Reus, J.A.W.A. (1992). Milieumeetlat voor bestrijdingsmiddelen: toetsing en bijstelling (Environmental yardstick for pesticides: testing and adaption). Centre for Agriculture and Environment, Utrecht. Reus, J.A.W.A. & G.A. Pak (1993). An environmental yardstick for pesticides. Med. Fac. Landbouww.Univ. Gent 58: 249-255.

Environmental yardstick for pesticides

FAIRWAY partner: Koos Verloop (Wageningen University and Research, NL)

clm yardstick environment

Any other useful information (e.g. screenshots of DST input/outputs)

Example of data input and outputs for the online yardstick for field crops

1: Choose soil type and season

Soil type	1,5 - 3 % organic matter
Season	Spring (March - August)

2: Choose one or more pesticides

Pesticides	Dose (kg/ha or l/ha)	Drift (%) ?
ACROBAT DF	1.00	1.00
MALVIN WG	1.00	1.00
TALENT	1.00	1.00

☐ I agree to the terms of use [download]

See effects

Result

		Environmental effects			Associated risks		
Pesticides	Active substance (kg/ha)	Aquatic organisms	Soil organisms	Groundwater	Pollinators	Natural Enemies	Applicator
ACROBAT DF	0.742	30	48	2	B	B	S
MALVIN WG	0.800	54	10	26	A	A	S
TALENT	0.930	9	300	0	?	?	I

Aquatic and soil organisms and groundwater	
	0-100 EIP
	100-1000 EIP
	>1000 EIP

Risk applier	
I	Irritant
S	Harmful
G	Toxic
ZG	Very toxic
B	Corrosive

Use in integrated pest management	
A	Suitable
B	Moderately suitable
C	Not suitable
?	Unkown

Use in practice

Farmers or their advisers use the tool to choose pesticides with less environmental impact or choose a non-chemical control option or reduced-emission application techniques if they see that a pesticide has a high impact on groundwater quality or soil and water biota. Currently retailers and the certification body of Planet Proof use the data from the tool in prioritizing which pesticides should be restricted in use.

20.STONE FAIRWAY partner: Koos Verloop (Wageningen University and Research, NL)	
Brief description	
A nutrient emission modelling system (STONE) designed for evaluation at the national and regional scale of the effects of changes in the agricultural sector (e.g. changes in fertilizer recommendations and cropping patterns) and in policy measures (e.g. EU nitrate directive for ground water) for the leaching of nitrogen (N) and phosphorus (P) from agricultural land areas to ground water and surface waters.	
Contaminants covered (e.g. nitrate, pesticides etc.)	N, P
Intended end users (e.g. farmer, water quality manager, policy maker)	Used by researchers to advise policy makers
Level of expertise and/or training required	Expert users only
Geographical resolution (e.g. field, catchment, national)	National and regional scale
Temporal resolution (e.g. daily, annual, long-term).	Long-term
Real-time component (e.g. live weather data, soil moisture data feeds etc.)	None
Number and type of mitigation measures included	Various policy measures to reduce nutrient emissions to ground water and surface waters (e.g. MINAS system), may be specified, which can be translated into data on the number of various farm animals and their manure excretion.
Platform (e.g. paper-based tool, phone app, bespoke software).	Software tool used by researchers
Frequency of updates	
Cost/availability	
Number of users or number of copies distributed/ downloaded/purchased	
Links to demo material and other relevant information (e.g. user guides).	
Additional comments	

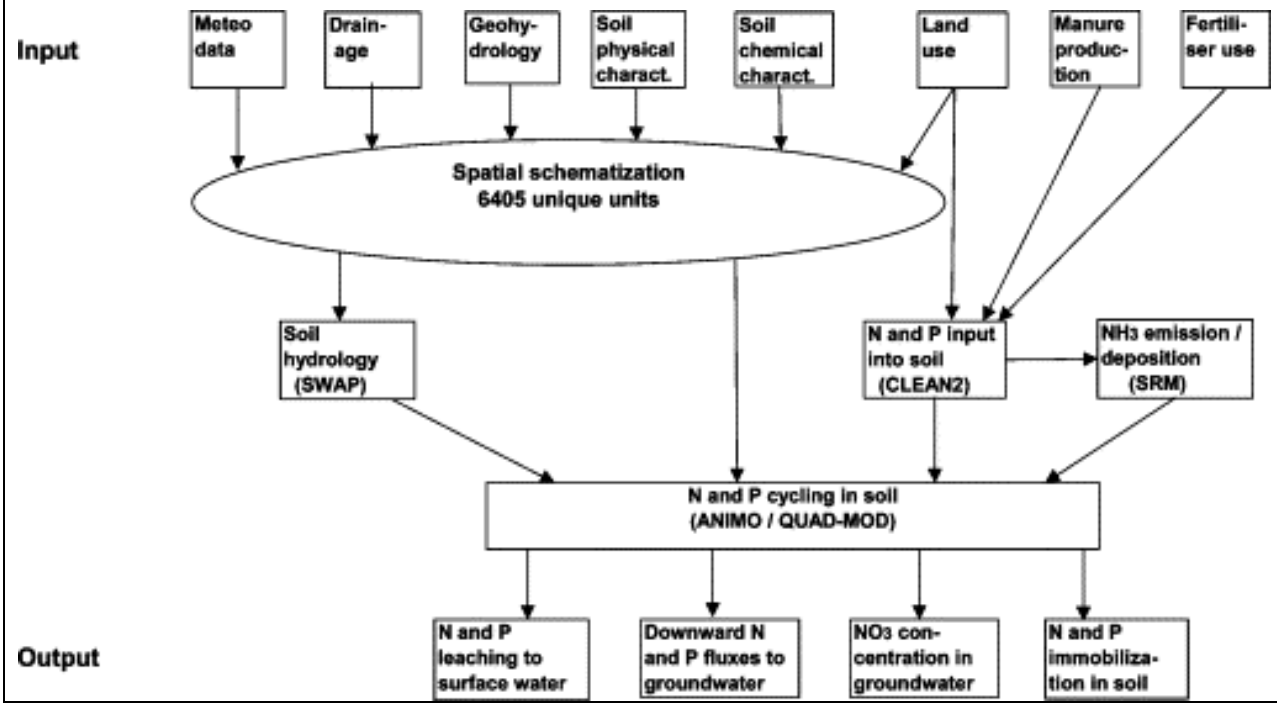
STONE **FAIRWAY partner: Koos Verloop (Wageningen University and Research, NL)**	
Input data required to run the DST	Extensive input information is required by each model component (see Wolf *et a*l, 2003)
Outputs (including links to water quality and economic or financial aspects)	The main outputs are: (1) main soil N and soil P processes; (2) immobilization of N and P in soils; (3) lateral fluxes of water, N and P to drainage systems and surface waters; (4) vertical fluxes of water, N and P to deeper soil layers and ground water; (5) N and P concentrations in shallow ground water. The output is given as a yearly average and its change over the 15-year period, and is specified for the 6405 STONE plots and for the 31 regions, covering the Netherlands as a whole.
Age/provenance of supporting data used to develop the DST	Details given in Wolf *et al* (2003)
Country-specific calibration or data requirements (including restrictions on use)	Nationally differentiated for soil type and geohydrology
Details of validation and testing	Details given in Wolf *et al* (2003)
Date developed/released (or planned release date)	1998
Author/developer names and affiliations	J. Wolf, A.H.W. Beusen, P. Groenendijk, T. Kroon, R. Rötter, H. van Zeijts (ALTERRA and RIVM)
Member state(s) where developed	NL
Member State(s) where currently used	NL
Key publication references	Beusen, A.H.W., Boogaard, H.L., Finke, P.A., Gehrels, B., Groenendijk, P., Van Jaarsveld, J.A., Knol, O.M., 1998. User's guide STONE 1.0 (in Dutch). RIVM report. RIVM, Bilthoven, the Netherlands. Wolf *et al*. (2003). The integrated modeling system STONE for calculating nutrient emissions from agriculture in the Netherlands. *Environmental Modelling & Software*, 18, 597-617 https://www.sciencedirect.com/science/article/pii/S1364815203000367?via%3Dihub

STONE

FAIRWAY partner: Koos Verloop (Wageningen University and Research, NL)

Any other useful information (e.g. screenshots of DST input/outputs)

Overview of input data, modeled processes in different components, and output of the STONE modeling system.



21. CATCHMENT LAKE MODELLING NETWORK

FAIRWAY partner: Oyvind Kaste (NIVA, NO)

Brief description	
A network of process-based, mass-balance models linking climate, hydrology, catchment-scale nutrient dynamics and lake processes. The model network allows disentangling of the effects of climate change from those of land-use change on lake water quality and phytoplankton growth. The model network can thus support decision-making to achieve good water quality and ecological status.	
Contaminants covered (e.g. nitrate, pesticides etc.)	Phosphorus, suspended sediment, possible to include nitrate
Intended end users (e.g. farmer, water quality manager, policy maker)	Policy makers; advisors; catchment managers
Level of expertise and/or training required	Scientific personnel
Geographical resolution (e.g. field, catchment, national)	Catchment/lake scale
Temporal resolution (e.g. daily, annual, long-term).	Daily
Real-time component (e.g. live weather data, soil moisture data feeds etc.)	Under development
Number and type of mitigation measures included	Land use change, cultivation change, crop rotation, erosion risk reduction measures, change in fertilizer application
Platform (e.g. paper-based tool, phone app, bespoke software).	The model network consists of four separate models: Three GCM climate models, a hydrological model (PERSIST), a catchment model (INCA-P), and a lake model (MyLake).
Frequency of updates	Last update: 2014
Cost/availability	Free. Individual models can be downloaded
Number of users or number of copies distributed/ downloaded/purchased	Primarily a scientific tool, not distributed as a model package for end users.
Links to demo material and other relevant information (e.g. user guides).	Not available
Additional comments	

Catchment Lake Modelling Network FAIRWAY partner: Oyvind Kaste (NIVA, NO)	
Input data required to run the DST	Land use data, time series on meteorology, hydrology, water quality, management practises, and implemented measures to reduce pollution risk.
Outputs (including links to water quality and economic or financial aspects)	Nitrate and phosphate concentrations in rivers and lakes. Algal biomass in lakes.
Age/provenance of supporting data used to develop the DST	Calibration period: 1996-2000
Country-specific calibration or data requirements (including restrictions on use)	No specific requirements
Details of validation and testing	To capture the envelope of acceptable parameter sets systematically throughout the parameter combination space, a probabilistic calibration was performed using a Bayesian inference scheme, where each parameter was given a prior distribution and a posterior distribution using a recent MCMC approach, within the framework of a self-adaptive differential evolution learning scheme (DREAM) implemented in MATLAB
Date developed/released (or planned release date)	Developed in 2013
Author/developer names and affiliations	Couture RM, Tominaga K, Starrfelt J, Moe J, Kaste Ø, Wright RF (NIVA)
Member state(s) where developed	NO
Member State(s) where currently used	NO
Key publication references (including url)	Couture RM, Tominaga K, Starrfelt J, Moe J, Kaste O, Wright RF. 2014. Modelling phosphorus loading and algal blooms in a Nordic agricultural catchment-lake system under changing land-use and climate. Environmental Science: Processes & Impacts, DOI: 10.1039/c3em00630a http://pubs.rsc.org/-/content/articlehtml/2014/em/c3em00630a

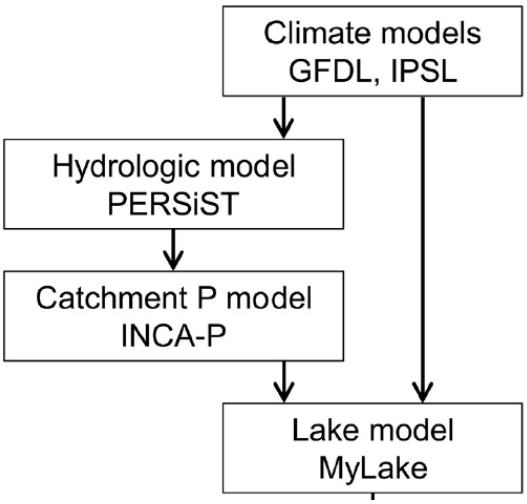
Catchment Lake Modelling Network

FAIRWAY partner: Oyvind Kaste (NIVA, NO)

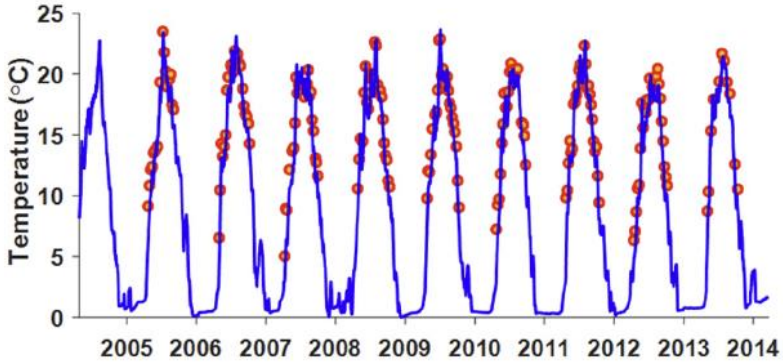
Norwegian Institute for Water Research

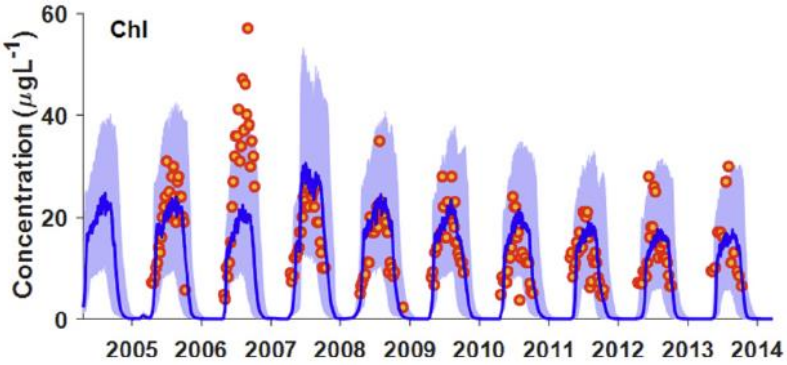
Any other useful information (e.g. screenshots of DST input/outputs)

Components of the model chain



Example of model output:





22. SKIFTEPLAN

FAIRWAY partner: Oyvind Kaste (NIVA, NO)

Brief description	
Skifteplan is the most commonly used farm level DST for fertiliser application (N and P) on agricultural fields in Norway. The program calculates optimal fertilization rates, to avoid excess N and P in soils and runoff. Also used to keep track of what is grown on the fields year by year and what other treatments / measures implemented; plant protection, soil cultivation, etc. Used by farmer and agricultural advisers.	
Contaminants covered (e.g. nitrate, pesticides etc.)	N, P, Ca, water (irrigation)
Intended end users (e.g. farmer, water quality manager, policy maker)	Farmers, agricultural advisers
Level of expertise and/or training required	Farmers and agricultural advisers
Geographical resolution (e.g. field, catchment, national)	Field
Temporal resolution (e.g. daily, annual, long-term).	Annual
Real-time component (e.g. live weather data, soil moisture data feeds etc.)	No, but includes a water balance componenet
Number and type of mitigation measures included	N and P balance
Platform (e.g. paper-based tool, phone app, bespoke software).	Software (licenced product) can be downloaded from Agromatic's webpage: http://www.agromatic.no/skifteplan.html
Frequency of updates	Last update: 2016
Cost/availability	Licenced, cost not known
Number of users or number of copies distributed/ downloaded/purchased	Information not available
Links to demo material and other relevant information (e.g. user guides).	http://www.agromatic.no/skifteplan.html
Additional comments	

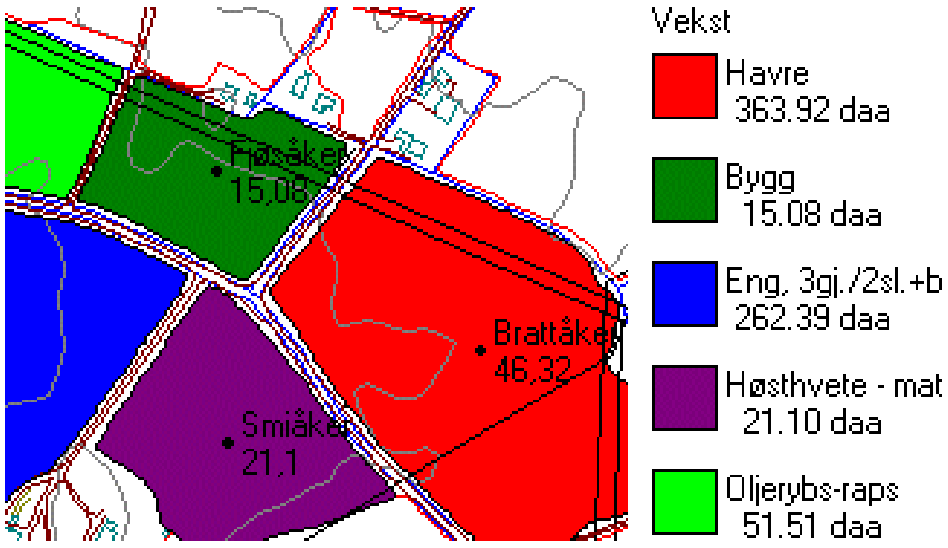
Skifteplan **FAIRWAY partner: Oyvind Kaste (NIVA, NO)**	
Input data required to run the DST	Field and crop information, soil type, N and P content, fertilizer information
Outputs (including links to water quality and economic or financial aspects)	Optimal fertilization rates
Age/provenance of supporting data used to develop the DST	First DOS-version developed in 1988
Country-specific calibration or data requirements (including restrictions on use)	Adapted for Norwegian conditions
Details of validation and testing	Information not available
Date developed/released (or planned release date)	1996 / most recent version from 2016
Author/developer names and affiliations	Not known
Member state(s) where developed	NO (Norway)
Member state(s) where currently used	NO (Norway)
Key publication references	http://www.agromatic.no/skifteplan.html

Skifteplan

FAIRWAY partner: Oyvind Kaste (NIVA, NO)

Any other useful information (e.g. screenshots of DST input/outputs)

http://www.agromatic.no/skifteplan.html



23. AGRO-METEOROLOGICAL SERVICE FAIRWAY partner: Oyvind Kaste (NIVA, NO)	
Brief description	
The Agro-Meteorological Service portal is run by NIBIO in collaboration with the Norwegian met office, and the main task is to provide meteorological data for better management of climate risks in important agricultural and horticultural districts.	
Contaminants covered (e.g. nitrate, pesticides etc.)	N/A
Intended end users (e.g. farmer, water quality manager, policy maker)	Farmers, agricultural advisers
Level of expertise and/or training required	No training required
Geographical resolution (e.g. field, catchment, national)	National
Temporal resolution (e.g. daily, annual, long-term).	Hourly
Real-time component (e.g. live weather data, soil moisture data feeds etc.)	Yes
Number and type of mitigation measures included	DST to optimise the timing (or to avoid unfavorable conditions) for tilling, fertiliser application, pesticide application, etc.
Platform (e.g. paper-based tool, phone app, bespoke software).	Map service In Norwegian
Frequency of updates	Not known
Cost/availability	Public access (no cost)
Number of users or number of copies distributed/ downloaded/purchased	Web portal (number of users not known)
Links to demo material and other relevant information (e.g. user guides).	http://lmt.nibio.no/
Additional comments	

Agro-meteorological service **FAIRWAY partner: Oyvind Kaste (NIVA, NO)**	
Input data required to run the DST	No requirements
Outputs (including links to water quality and economic or financial aspects)	Climate risks for selected agricultural and horticultural districts.
Age/provenance of supporting data used to develop the DST	N/A
Country-specific calibration or data requirements (including restrictions on use)	For Norway
Details of validation and testing	Not known
Date developed/released (or planned release date)	Not known
Author/developer names and affiliations	Not known
Member state(s) where developed	NO (Norway)
Member state(s) where currently used	NO (Norway)
Key publication references	http://lmt.nibio.no/

Agro-meteorological service

FAIRWAY partner: Oyvind Kaste (NIVA, NO)

Any other useful information (e.g. screenshots of DST input/outputs)

Målestasjoner

Søk på navn

Timeverdier

	Måletid	Lufttemp °C	Vind m/s	Nedbør mm	Last ned	Se i kart
Alvdal	19:00	-4.1	1.4	0.0		
Apelsvoll	19:00	-3.8	0.9	0.0		
Balestrand	19:00	2.3	-	0.0		
Bjørkelangen	19:00	0.4	0.7	0.2		
Brunlanes	19:00	-0.6	0.1	0.0		
Bø	19:00	-1.6	0.1	0.0		
Dærbu	20.10.17	4.2	-	0.0		
Djønno	19:00	1.3	-	0.0		
Etne	19:00	1.6	1.6	0.0		
Flesberg	19:00	-2.9	0.5	0.0		

Forrige 1 2 3 4 5 6 7 8 9 Neste

Siste driftsmeldinger

Se flere

2018-03-21 - Usikkerhet ved måling av relativ luftfuktighet (RH)

24. NAČRTOVANJE GNOJENJA FAIRWAY partner: Matjaž Glavan (UL, SI), Case study leader Katarina Kresnik, Andrej Jamšek (KGZ Maribor, SI)	Kmetijsko gozdarska zbornica Slovenije
Brief description	
Načrtovanje gnojenja (Fertiliser Planning) is intended to assist agricultural advisers and farmers to optimize fertilizer use in all agricultural sectors, most notably in horticulture and field crop agriculture. With its help, we can quickly calculate the recommended quantities for phosphorus, potassium and nitrogen fertilizers, both with organic as well as with easily soluble mineral fertilizers, as well as the need for land lime. We can make annual or multi-year fertilization plans, while at the same time we can plan the correct crop rotation and take into account the amount of organic fertilizers on the farm.	
Contaminants covered (e.g. nitrate, pesticides etc.)	N, P_2O_5, K_20, pH (acidity of a soil)
Intended end users (e.g. farmer, water quality manager, policy maker)	Advisors, Farmers
Level of expertise and/or training required	Moderate level of expertise and training required to use the software.
Geographical resolution (e.g. field, catchment, national)	Field scale.
Temporal resolution (e.g. daily, annual, long-term).	Annual
Real-time component (e.g. live weather data, soil moisture data feeds etc.)	None
Number and type of mitigation measures included	Organic and mineral fertiliser types and application method and timing (5 year crop rotation).
Platform (e.g. paper-based tool, phone app, bespoke software).	Bespoke software working via web. http://jsks.kgzs.si/ng/
Frequency of updates	Every few years.
Cost/availability	Not free. Available only to public agricultural advisors service under Chamber of agriculture and forestry of Slovenia. Farmers receive fertilisation plan only.
Number of users or number of copies distributed/ downloaded/purchased	Used exclusively by public agricultural advisors service only under Chamber of agriculture and forestry of Slovenia. In use for between 8.000 and 8.500 farms.
Links to demo material and other relevant information (e.g. user guides).	Not available. Users' guide is not public.
Additional comments	-

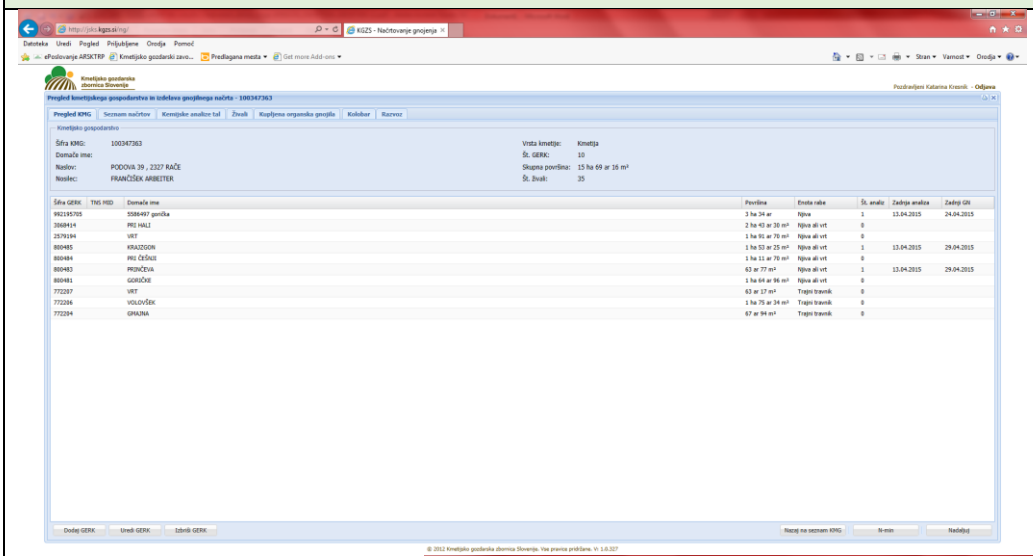
Načrtovanje gnojenja **FAIRWAY partner: Matjaž Glavan (UL, SI), Case study leader Katarina Kresnik, Andrej Jamšek (KGZ Maribor, SI)**	Kmetijsko gozdarska zbornica Slovenije
Input data required to run the DST	Information needed: - soil analysis (organic matter (C), P_2O_5, K_2O, CaO (pH)) - soil type - information about land parcel (crop, area) - manure type at farm and application method - future crops (5 years)
Outputs (including links to water quality and economic or financial aspects)	Fertiliser plan (amount of selected fertilisers per field per individual year (5)) to reach medium/good stocked soil.
Age/provenance of supporting data used to develop the DST	Based on Guidelines for professionally based fertilizer use https://www.program-podezelja.si/sl/knjiznica/26-smernice-za-strokovno-utemeljeno-gnojenje/file
Country-specific calibration or data requirements (including restrictions on use)	No.
Details of validation and testing	No special details. Model results are validated each time new soil analysis is done for the same parcel (5-years cycle))
Date developed/released (or planned release date)	First developed in 2003; current version released 2013. Updates are planned.
Author/developer names and affiliations	Anton JAGODIC Chamber of Agriculture and Forestry of Slovenia
Member state(s) where developed	SI
Member State(s) where currently used	SI
Key publication references (including url)	http://jsks.kgzs.si/ng/ (only for users)

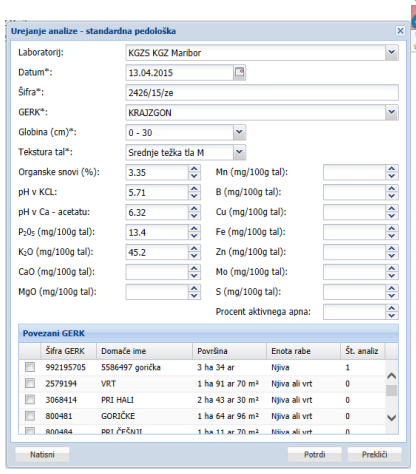
Načrtovanje gnojenja

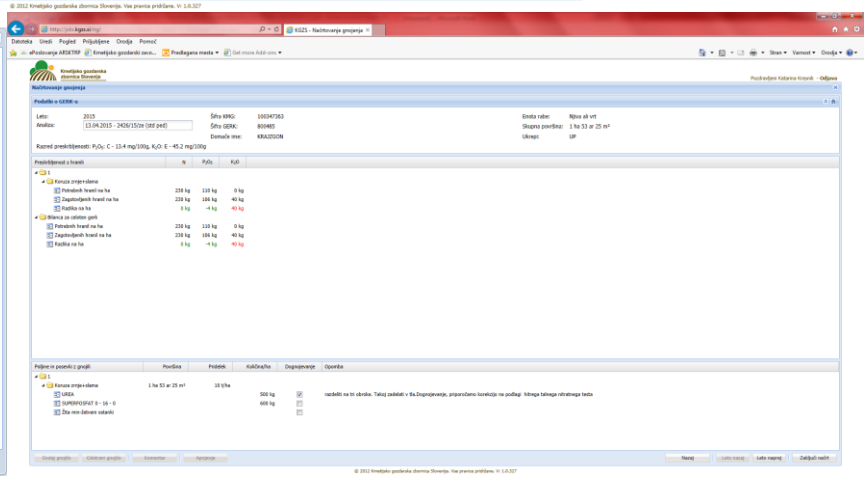
FAIRWAY partner: Matjaž Glavan (UL, SI), Case study leader Katarina Kresnik, Andrej Jamšek (KGZ Maribor, SI)

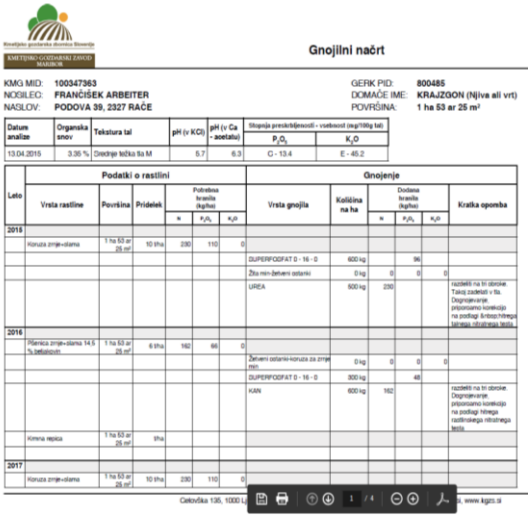
Kmetijsko gozdarska zbornica Slovenije

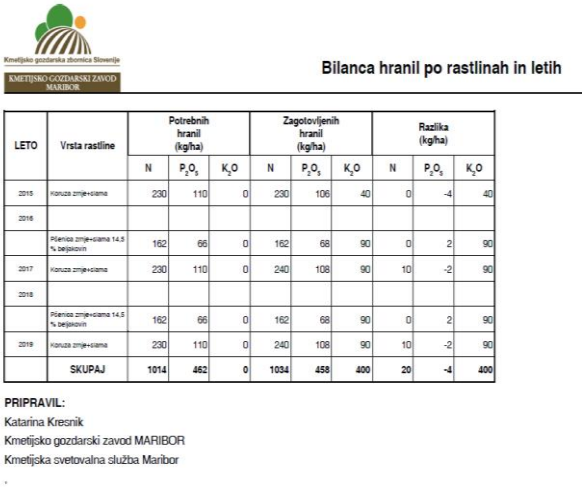
Any other useful information (e.g. screenshots of DST input/outputs)











25. SMERNICE ZA STROKOVNO GNOJENJE FAIRWAY partner: Matjaž Glavan (UL, SI), Case study leader Katarina Kresnik, Andrej Jamšek (KGZ Maribor, SI)	REPUBLIC OF SLOVENIA MINISTRY OF AGRICULTURE, FORESTRY AND FOOD
Brief description	
Smernice za strokovno gnojenje (Guidelines for professional based fertiliser use) is a collection of the main fertilizer application instructions based on experience, plant development observations, and chemical analyses of soil and plant parts. The guidelines are in line with the regulations and requirements for the quality of crops and the preservation of a clean environment, and aim to set a broader framework that is not based solely on political decisions or fashion trends, but on rational expert findings.	
Contaminants covered (e.g. nitrate, pesticides etc.)	N, P_2O_5, K_20, pH (acidity of a soil), macro- and micro-elements (B, Cu, Mg)
Intended end users (e.g. farmer, water quality manager, policy maker)	Advisors, Farmers, Research, General public
Level of expertise and/or training required	Moderate level of expertise and training required to understand and use the guidelines.
Geographical resolution (e.g. field, catchment, national)	Field scale.
Temporal resolution (e.g. daily, annual, long-term).	Annual
Real-time component (e.g. live weather data, soil moisture data feeds etc.)	None
Number and type of mitigation measures included	Organic and mineral fertiliser types and application method and timing.
Platform (e.g. paper-based tool, phone app, bespoke software).	Paper-based tool – open source available via web. https://repozitorij.uni-lj.si/IzpisGradiva.php?id=69494&lang=eng https://www.program-podezelja.si/sl/knjiznica/26-smernice-za-strokovno-utemeljeno-gnojenje/file
Frequency of updates	Not available.
Cost/availability	Free.
Number of users or number of copies distributed/ downloaded/purchased	Not available. Potential users are farmers in Slovenia (ca. 70.000).
Links to demo material and other relevant information (e.g. user guides).	Open source – Web available. https://repozitorij.uni-lj.si/IzpisGradiva.php?id=69494&lang=eng https://www.program-podezelja.si/sl/knjiznica/26-smernice-za-strokovno-utemeljeno-gnojenje/file
Additional comments	

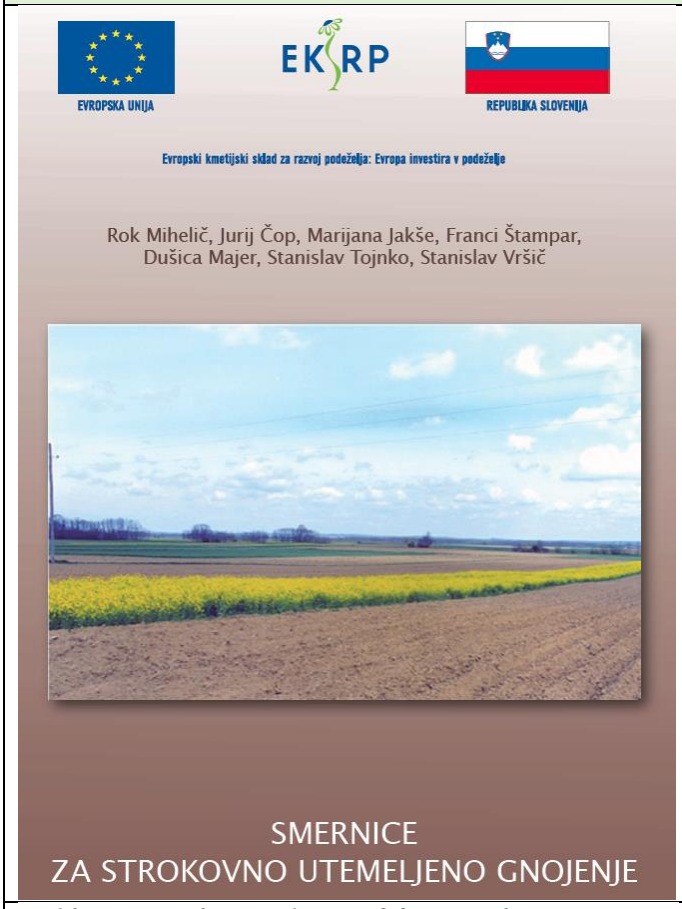
Smernice za strokovno gnojenje **FAIRWAY partner: Matjaž Glavan (UL, SI), Case study leader Katarina Kresnik, Andrej Jamšek (KGZ Maribor, SI)**	REPUBLIC OF SLOVENIA MINISTRY OF AGRICULTURE, FORESTRY AND FOOD
Input data required to run the DST	Information needed: - soil analysis (organic matter (C), P_2O_5, K_2O, CaO (pH)) - soil type - information about land parcel (crop, area) - manure type at farm and application method - future crops (5 years)
Outputs (including links to water quality and economic or financial aspects)	Fertiliser plan (amount of selected fertilisers per field per individual year) to reach medium stocked soil
Age/provenance of supporting data used to develop the DST	Professional research and scientific knowledge was used to develop this paper tool – manual. https://www.program-podezelja.si/sl/knjiznica/26-smernice-za-strokovno-utemeljeno-gnojenje/file
Country-specific calibration or data requirements (including restrictions on use)	No.
Details of validation and testing	No special details. Model results are validated each time new soil analysis is done for the same parcel (5-years cycle))
Date developed/released (or planned release date)	Developed in 2010.
Author/developer names and affiliations	Rok Mihelič Biotechnical Faculty of University of Ljubljana
Member state(s) where developed	SI
Member State(s) where currently used	SI
Key publication references (including url)	https://www.program-podezelja.si/sl/knjiznica/26-smernice-za-strokovno-utemeljeno-gnojenje/file (for free - open source)

Smernice za strokovno gnojenje

FAIRWAY partner: Matjaž Glavan (UL, SI), Case study leader Katarina Kresnik, Andrej Jamšek (KGZ Maribor, SI)

REPUBLIC OF SLOVENIA
MINISTRY OF AGRICULTURE, FORESTRY AND FOOD

Any other useful information (e.g. screenshots of DST input/outputs)



Preglednica 13: Mejne vrednosti in gnojilne norme za kalij po AL-metodi v intenzivnem poljedelstvu v plasti tal do globine oranja

Stopnja preskrbljenosti tal z AL-K_2O				Gnojilna norma (primer za povprečni odvzem 200 kg K_2O/ha)	
oznaka	mg K_2O/100g tal (glede na teksturo tal)		stanje preskrbljenosti tal	kg K_2O/ha	
	lahka do srednja	težka tla			
A	< 10	< 12	siromašno	240 do 260	(200 + 40 do 60)
B	10 – 19	12 – 22	srednje preskrbljeno	220 do 230	(200 + 20 do 30)
C	20 – 30	23 – 33	dobro (cilj dosežen)	200	(200 + 0)
D	31 – 40	34 – 45	čezmerno	100	(1/2 odvzema)
E	> 40	> 45	ekstremno	0	(do naslednje analize tal)

V preglednicah 14 in 15 smo poleg mejnih vrednosti, ki so enake kot za njive, navedli tudi gnojilne norme za 2-kosno, 3 do 4 -kosno in pašno-kosno rabo.

Preglednica 14: Mejne vrednosti za fosfor po AL-metodi v plasti tal od 0 do 6 cm na travinju in ustrezni odmerki P_2O_5

Mejna vrednost		Odmerek P_2O_5 v kg/ha		
Stopnja	mg P_2O_5/100 g tal	2 košnji	3 košnje***	intenzivna pašno-kosna raba**(2,5 GVŽ/ha/leto)
A	< 6	70 – 80*	80 – 90	50
B	6 – 12	60 – 70	70 – 80	40
C	13 – 25	50 – 60	60 – 70	30
D	26 – 40	30	40	15
E	> 40	0	0	0

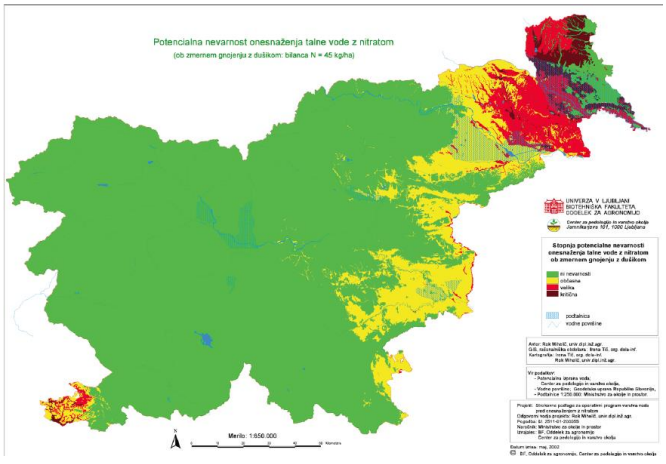
Preglednica 15: Mejne vrednosti za kalij po AL-metodi v plasti tal od 0 do 6 cm na travinju in ustrezni odmerki K_2O

Mejna vrednost			Odmerek K_2O v kg/ha		
Stopnja	mg K_2O/100 g tal lažja do srednja	težka tla	2 košnji	3 košnje***	intenzivna pašno-kosna raba** (2,5 GVŽ/ha/leto)
A	< 10	< 12	120 – 160*	160 – 200	70
B	10 – 19	12 – 22	100 – 140	140 – 180	55
C	20 – 30	23 – 33	80 – 120	100 – 140	40
D	31 – 40	34 – 45	50	60	20
E	> 40	> 45	0	0	0

* V okviru razpona več za večji pridelek, manj za manjšega; številke pomenijo količine hranil iz organskih in rudninskih gnojil skupaj.
** Navedene količine P_2O_5 in K_2O je treba pri pašno-kosni rabi dati v obliki mineralnih gnojil poleg vseh živalskih iztrebkov (hlevskega gnoja, gnojice, gnojevke).
*** Pri 4 kosni rabi se odmerki povečajo za 15 kg P_2O_5 oziroma za 30 kg K_2O, če dosegamo (ob ustrezno večji uporabi N) vsaj za 10 dt/ha več sušine mrve kot pri 3-kosni rabi.

Preglednica 12: Mejne vrednosti in gnojilne norme za fosfor po AL-metodi v intenzivnem poljedelstvu v plasti tal do globine oranja

Stopnja preskrbljenosti tal z AL-P_2O_5			Gnojilna norma (primer za povprečni odvzem 70 kg P_2O_5/ha)	
oznaka	mg P_2O_5/100g tal	stanje preskrbljenosti tal	kg P_2O_5/ha	
A	< 6	siromašno	100 do 120	(70 + 30 do 50)
B	6 – 12	srednje preskrbljeno	90 do 100	(70 + 20 do 30)
C	13 – 25	dobro (cilj dosežen)	70	(70 + 0)
D	26 – 40	čezmerno	40	(1/2 odvzema)
E	> 40	ekstremno	0	(do naslednje analize tal)



Preglednica 10: Izračun doprinosa organskih gnojil k vsebnosti humusa

Vrsta organskega gnojila	Vsebnost suhe snovi (s.s; %)	Vsebnost organske snovi (% v s.s.)	Hum. količnik	Tvorba humusa (kg/t)	Tvorba humus-C (kg/t)
hlevski gnoj (svež)	25	80	0,25	50	29
hlevski gnoj (zrel)	25	75	0,35	66	38
gnojevka s 5% s.s.	5	75	0,19	7	4
gnojevka s 7,5% s.s.	7,5	75	0,19	11	6
gnojevka z 10% s.s.	10	75	0,19	14	8
slama	86	92	0,17	135	78
listje slad. pese z glavami	16	92	0,10	15	9
kompost iz organskega dela odpadkov	60	30	0,31	61	35
kompost. hlevski gnoj	60	33	0,38	75	44
blato komunalne čistilne naprave	5	50	0,17	4	2

Leskošek in Mihelič, 1998

Preglednica 11: Primer izračuna humusne bilance na praktičnem primeru večletnega kolobarja iz prakse na poljih osrednje Slovenije

Leto	Posevek	Gnojenje z organskimi gnojili		Tvorba humus-C iz org. gnojil	Razgradnja humus-C	Letna bilanca humusnega C
			t/ha	(kg/ha)	(kg/ha)	(kg/ha)
2006	Silažna koruza	Hlevski gnoj	30	870	700	170
2007	Ozimna pšenica				300	-300
	Krmni ohrovt			200		200
2008	Krompir	Hlevski gnoj	30	870	800	70
2009	Silažna koruza	Hlevski gnoj	30	870	700	170
2010	Ozimna pšenica				300	-300
Skupaj				2810	2800	10
Povprečna bilanca humusnega C na leto (kg/ha)				562	560	2

26.OECD/EUROSTAT N BALANCE ANALYSIS FAIRWAY partner: Matjaž Glavan (UL, SI), Case study leader Katarina Kresnik, Andrej Jamšek (KGZ Maribor, SI)	Kmetijski inštitut Slovenije REPUBLIC OF SLOVENIA MINISTRY OF THE ENVIRONMENT AND SPATIAL PLANN
Brief description	
Joint Eurostat/OECD meetings identify and agree on the most robust and feasible methodology for the calculation of a nitrogen (and also for phosphate) balance. This handbook sets out the main principles of the methodology across OECD and EU Member countries. The aim is to be able to consistently produce an indicator based on a single methodology and harmonised definitions for all countries. In Slovenia results are prepared by Agricultural Institute for Ministry of environment and spatial planning. This paper based tool serves as basis for reporting to EU about Nitrate directive implementation and as basis for preparation of legislation and measures for drinking water protection.	
Contaminants covered (e.g. nitrate, pesticides etc.)	N, P
Intended end users (e.g. farmer, water quality manager, policy maker)	Policy makers
Level of expertise and/or training required	High level of expertise and training required to understand and use the guidelines.
Geographical resolution (e.g. field, catchment, national)	National, Regional, Local, Field scale.
Temporal resolution (e.g. daily, annual, long-term).	Annual
Real-time component (e.g. live weather data, soil moisture data feeds etc.)	None
Number and type of mitigation measures included	None
Platform (e.g. paper-based tool, phone app, bespoke software).	Paper-based tool – open source available via web. http://ec.europa.eu/eurostat/cache/metadata/Annexes/aei_pr_gnb_esms_an1.pdf
Frequency of updates	Every few years with new development of knowledge
Cost/availability	Free.
Number of users or number of copies distributed/ downloaded/purchased	Member states of OECD and EU as well as other interested.
Links to demo material and other relevant information (e.g. user guides).	Open source – Web available. http://ec.europa.eu/eurostat/cache/metadata/Annexes/aei_pr_gnb_esms_an1.pdf http://www.oecd.org/tad/sustainable-agriculture/agri-environmentalindicators.htm http://kazalci.arso.gov.si/?data=indicator&ind_id=818&lang_id=94 http://kazalci.arso.gov.si/?data=indicator&ind_id=818 http://kazalci.arso.gov.si/?data=indicator&ind_id=465&lang_id=94 http://kazalci.arso.gov.si/?data=indicator&ind_id=465
Additional comments	- pesticides part is in the process of establishing In lack of other tools, capable of modelling agri-environmental measures, this is still preferred way of making conclusions and new decisions. Eurostat/OECD results are most often coupled with state monitoring results to accept new decisions.

OECD/EUROSTAT N balance analysis based **FAIRWAY partner: Matjaž Glavan (UL, SI), Case study leader Katarina Kresnik, Andrej Jamšek (KGZ Maribor, SI)**	Kmetijski inštitut Slovenije REPUBLIC OF SLOVENIA MINISTRY OF THE ENVIRONMENT AND SPATIAL PLANNING
Input data required to run the DST	Information needed for getting the tool properly used are: - Mineral fertilizers input - Manure production - Net manure import/export, withdrawals, stocks - Other organic fertilizers input - Biological N fixation - Atmospheric N deposition - Seed and planting materials - Crop production - Fodder production - Residues removed /burnt
Outputs (including links to water quality and economic or financial aspects)	- Gross nitrogen surplus in agriculture - Gross phosphorus surplus in agriculture
Age/provenance of supporting data used to develop the DST	- Professional research and scientific knowledge was used to develop this paper tool – handbook. http://ec.europa.eu/eurostat/cache/metadata/Annexes/aei_pr_gnb_esms_an1.pdf http://www.oecd.org/tad/sustainable-agriculture/agri-environmentalindicators.htm
Country-specific calibration or data requirements (including restrictions on use)	No.
Details of validation and testing	No special details. Model results can be validated with other tools/models.
Date developed/released (or planned release date)	Developed in 2007 and updated in 2013 as last version.
Author/developer names and affiliations	European Commission/Eurostat
Member state(s) where developed	EU
Member State(s) where currently used	EU
Key publication references (including url)	http://ec.europa.eu/eurostat/cache/metadata/Annexes/aei_pr_gnb_esms_an1.pdf

OECD/EUROSTAT N balance analysis

FAIRWAY partner: Matjaž Glavan (UL, SI), Case study leader Katarina Kresnik, Andrej Jamšek (KGZ Maribor, SI)

Kmetijski inštitut Slovenije

REPUBLIC OF SLOVENIA
MINISTRY OF THE ENVIRONMENT AND SPATIAL PLANNING

Any other useful information (e.g. screenshots of DST input/outputs)

EUROPEAN COMMISSION
EUROSTAT

Directorate E: Sectoral and regional statistics
Unit E-1: Agriculture and fisheries

Methodology and Handbook Eurostat/OECD

Nutrient Budgets

EU-27, Norway, Switzerland

Date: 17/05/2013
Version: 1.02
Authors: Anne Miek Kremer
Revised by:
Approved by:
Public:
Reference Number:

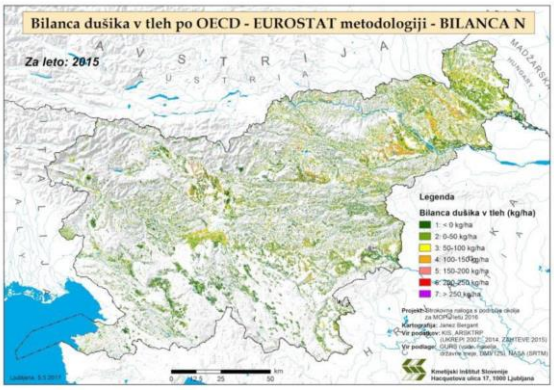
Commission européenne, 2920 Luxembourg, LUXEMBOURG - Tel. +352 43011
Office: BECH - Tel. direct line +352 4301-38298

http://epp.eurostat.ec.europa.eu
Annemiek.KREMER@ec.europa.eu

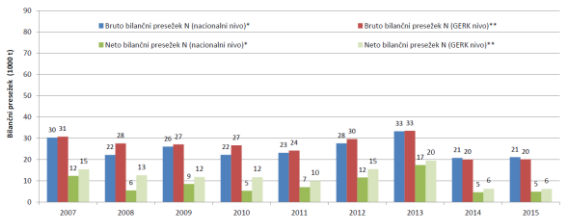
Table 2. Current, ideal and proposed improved Gross Nitrogen Budgets

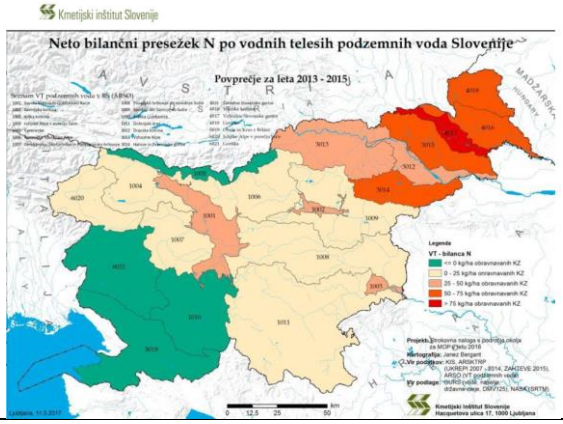
Current GNB	Ideal GNB	Practical GNB
INPUTS		
N1) Mineral fertilizers	N1) Mineral fertilizers	N1) Mineral fertilizers
N2) Manure production	N2) Manure production	N2) Manure production
N3) Net manure import/export, withdrawals, stocks	N3) Net manure import/export, withdrawals, stocks	N3) Net manure import/export, withdrawals
N4) Other organic fertilizers	N4) Other organic fertilizers	N4) Other organic fertilizers
N5) Biological N fixation	N5) Biological N fixation	N5) Biological N fixation
N6) Atmospheric N deposition	N6) Atmospheric N deposition	N6) Atmospheric N deposition
N7) Seed and planting materials	N7) Seed and planting materials	N7) Seed and planting materials
	N8) Crop residues inputs	
N9) **Total inputs** = sum (N1,N2,N3,N4,N5,N6,N7)	N10) **Total inputs** = sum (N1,N2,N3,N4,N5,N6,N7,N8)	N11) **Total inputs** = sum (N1,N2,N3,N4,N5,N6,N7)
OUTPUTS		
N12) Crop production	N12) Crop production	N12) Crop production
N13) Fodder production	N13) Fodder production	N13) Fodder production
N14) Crop residues outputs	N14) Crop residues outputs	N16) Residues removed /burnt
	N15) Stock changes of N in soil	
N17) **Total outputs** = sum (N12, N13, N14)	N18) **Total outputs** = sum (N12, N13, N14, N15)	N19) **Total outputs** = sum (N12, N13, N16)
SURPLUS		
N20) **GNS** = N9 – N17	N21) **GNS** = N10 - N18	N24) **GNS** = N11 - N19
	N22) **aGNS** = N gas emissions	N22) **aGNS** = N gas emissions
	N23) **hGNS** = N21 – N22	N25) **hGNS** = N24 - N22

Results for Slovenia preperad by Agricultural Institute of Slovenia for the Ministry of environmnet and spatial planning



Primerjava bilančnega presežka N po metodi "nacionalna raven" in "raven KZ"





27. GROWA-SI

FAIRWAY partner: Matjaž Glavan (UL, SI), Case study leader Katarina Kresnik, Andrej Jamšek (KGZ Maribor, SI)

REPUBLIC OF SLOVENIA
MINISTRY OF THE ENVIRONMENT AND SPATIAL PLANNING
SLOVENIAN ENVIRONMENT AGENCY

Brief description

The regional water balance model GROWA-SI (Water Quality model) is the official state model for reporting of Nitrate directive implementation on country wide level. It was developed by JULICH Institute form Germany for Slovenian Environmental Agency (SEA). It can calculate groundwater recharge rates for Slovenia. It has the capability to account also N balances.

Contaminants covered (e.g. nitrate, pesticides etc.)	N
Intended end users (e.g. farmer, water quality manager, policy maker)	Policy makers, water managers
Level of expertise and/or training required	High level of expertise and training required to understand and use the model.
Geographical resolution (e.g. field, catchment, national)	National, Regional, Catchment scale
Temporal resolution (e.g. daily, annual, long-term).	Annual, Monthly
Real-time component (e.g. live weather data, soil moisture data feeds etc.)	No
Number and type of mitigation measures included	No
Platform (e.g. paper-based tool, phone app, bespoke software).	Bespoke software. Only for SEA use. http://www.arso.gov.si/novice/datoteke/036813-Energie_Umwelt_339.pdf https://link.springer.com/article/10.1007/s12665-015-4639-5 https://www.sciencedirect.com/science/article/pii/S1001074214000734 http://mvd20.com/LETO2013/R17.pdf http://meteo.arso.gov.si/met/sl/watercycle/growa-si/ http://www.fz-juelich.de/ibg/ibg-3/EN/Research/Modelling_and_management_of_catchments/Water_Balance_And_Climate_Change/_node.html
Frequency of updates	Every few years with new development of knowledge
Cost/availability	Not publicly available.
Number of users or number of copies distributed/ downloaded/purchased	In use only at Slovenian Environmental Agency by one user. It is also available at JULICH institute.
Links to demo material and other relevant information (e.g. user guides).	http://www.arso.gov.si/novice/datoteke/036813-Energie_Umwelt_339.pdf https://link.springer.com/article/10.1007/s12665-015-4639-5
Additional comments	The model system GROWA – DENUZ / WEKU has just been introduced in Slovenia for the determination of the diffuse nitrogen inputs into groundwater and surface water. For this purpose the agricultural nitrogen balance (Eurostat/OECD) surpluses derived by the Agricultural Institute of Slovenia were coupled with the model system GROWA – DENUZ / WEKU.

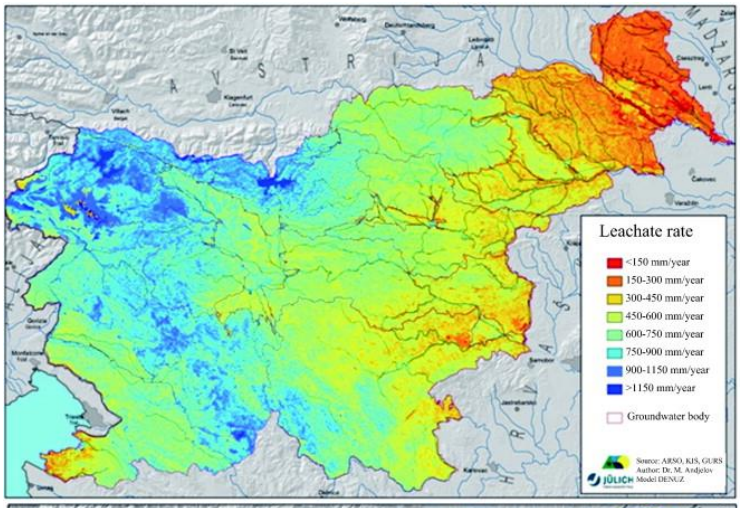
GROWA-SI **FAIRWAY partner: Matjaž Glavan (UL, SI), Case study leader Katarina Kresnik, Andrej Jamšek (KGZ Maribor, SI)**	
Input data required to run the DST	Information needed for getting the tool properly used are: - Agrarian statistical data on N fertilizer input, manure per animal, crop withdrawal etc., - Atmospheric deposition of oxidized and reduced nitrogen, - Precipitation data summer/winter (1971–2000), annual potential evapotranspiration (1971–2000), - Land cover, Soil types, soil texture, effective field capacities for arable land, - Effective field capacities, influence of perching water, rooting depth, - Depth to groundwater, Artificially drained areas, - Digital elevation model (DMR 100) - Geological and hydrogeological map, River network, political boundaries, cities etc., - Catchments areas, daily runoff data (1971–2000)
Outputs (including links to water quality and economic or financial aspects)	- water balance, total runoff, direct runoff and groundwater runoff (groundwater recharge), - nitrate in leachate (percolation water)
Age/provenance of supporting data used to develop the DST	- Professional research and scientific knowledge was used to develop this model http://www.arso.gov.si/novice/datoteke/036813-Energie_Umwelt_339.pdf https://link.springer.com/article/10.1007/s12665-015-4639-5 https://www.sciencedirect.com/science/article/pii/S1001074214000734
Country-specific calibration or data requirements (including restrictions on use)	Yes. Model specially developed for Slovenian conditions.
Details of validation and testing	Model was calibrated and validated by monitoring data from surface and groundwater bodies.
Date developed/released (or planned release date)	Developed in 2013 and constantly updated.
Author/developer names and affiliations	Slovenian Environmental Agency Forschungszentrum Jülich GmbH, Institute of Bio- and Geosciences Agrosphere
Member state(s) where developed	SI
Member State(s) where currently used	SI
Key publication references (including url)	http://www.arso.gov.si/novice/datoteke/036813-Energie_Umwelt_339.pdf https://link.springer.com/article/10.1007/s12665-015-4639-5 https://www.sciencedirect.com/science/article/pii/S1001074214000734

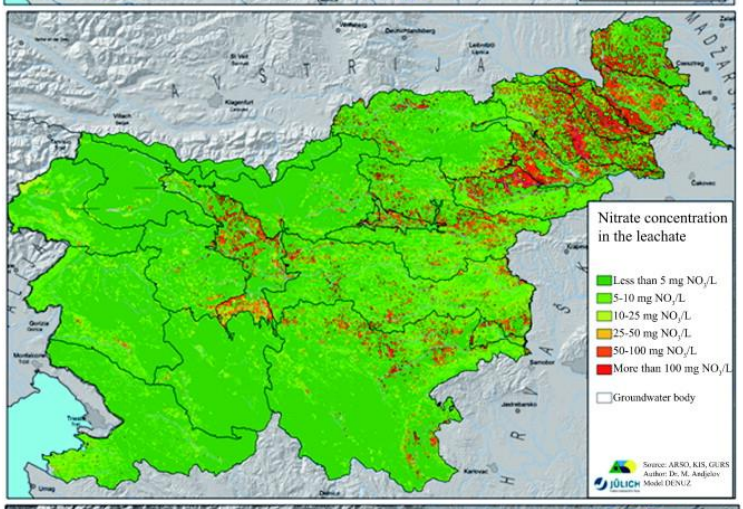
GROWA-SI

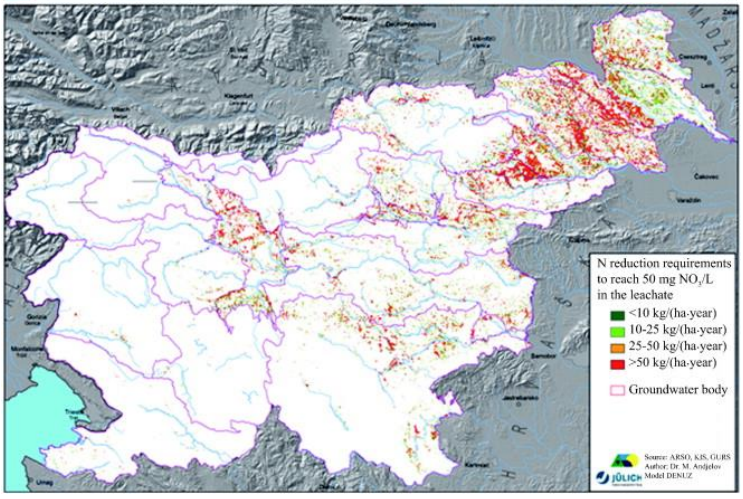
FAIRWAY partner: Matjaž Glavan (UL, SI), Case study leader Katarina Kresnik, Andrej Jamšek (KGZ Maribor, SI)

REPUBLIC OF SLOVENIA
MINISTRY OF THE ENVIRONMENT AND SPATIAL PLANNING
SLOVENIAN ENVIRONMENT AGENCY

Any other useful information (e.g. screenshots of DST input/outputs)







28. STATE NETWORK OF GROUNDWATER MONITORING POINTS **FAIRWAY partner: Matjaž Glavan (UL, SI), Case study leader Katarina Kresnik, Andrej Jamšek (KGZ Maribor, SI)**	REPUBLIC OF SLOVENIA MINISTRY OF THE ENVIRONMENT AND SPATIAL PLANNING SLOVENIAN ENVIRONMENT AGENCY
Brief description	
Policy makers and water managers (Ministry, Environmental Agency) accept their decisions based on the state approved water quality monitoring network. Measured values and their trends over the years serve as one of the base indicators for actions in introducing new measures or of success of in the past introduced measures. Temporal scale of state monitoring one to twice per year. Monthly, daily or weekly monitoring scale (depends on conditions) is performed by drinking water suppliers (water companies).	
Contaminants covered (e.g. nitrate, pesticides etc.)	N, P, pesticides
Intended end users (e.g. farmer, water quality manager, policy maker)	Policy makers, water managers
Level of expertise and/or training required	Moderate training and expertise to understand monitoring results. However to be able to decide on measures to be implemented high level expertise and deep understanding of the local water system and agricultural practices is required.
Geographical resolution (e.g. field, catchment, national)	Water body/ catchment scale.
Temporal resolution (e.g. daily, annual, long-term).	Annually (State) Monthly, weekly, daily (Water company)
Real-time component (e.g. live weather data, soil moisture data feeds etc.)	Some stations are automatic with daily or hourly data.
Number and type of mitigation measures included	None
Platform (e.g. paper-based tool, phone app, bespoke software).	Paper-based tool. http://www.arso.gov.si/en/water/reports%20and%20publications/ http://www.arso.gov.si/vode/podatki/
Frequency of updates	State monitoring network is stable however it has to be confirmed by Ministry every year, depending on financial resources. Water companies have to follow water quality in active wells on regular basis.
Cost/availability	Free.
Number of users or number of copies distributed/ downloaded/purchased	Not known.
Links to demo material and other relevant information (e.g. user guides).	Open source – Web available. Paper-based tool. http://www.arso.gov.si/en/water/reports%20and%20publications/ http://www.arso.gov.si/vode/podatki/
Additional comments	In lack of other tools, capable of modelling agri-environmental measures, this is still preferred way of making conclusions and new decisions. Monitoring results are most often coupled with Eurostat/OECD results to accept new decisions.

State network of groundwater monitoring points **FAIRWAY partner: Matjaž Glavan (UL, SI), Case study leader Katarina Kresnik, Andrej Jamšek (KGZ Maribor, SI)**	REPUBLIC OF SLOVENIA MINISTRY OF THE ENVIRONMENT AND SPATIAL PLANNING SLOVENIAN ENVIRONMENT AGENCY
Input data required to run the DST	Location of monitoring points from certain surface water of groundwater body.
Outputs (including links to water quality and economic or financial aspects)	Concentration of nitrate and phosphorus. Concentration of pesticides. Concentration of heavy metals, volatile compounds, drug residues
Age/provenance of supporting data used to develop the DST	- Professional research and scientific knowledge was used to develop this paper tool. http://www.arso.gov.si/en/water/reports%20and%20publications/ http://www.arso.gov.si/vode/podatki/
Country-specific calibration or data requirements (including restrictions on use)	No.
Details of validation and testing	No special details. Results are validated with repeated sampling.
Date developed/released (or planned release date)	Not available
Author/developer names and affiliations	Slovenian Environmental Agency
Member state(s) where developed	Slovenia
Member State(s) where currently used	Slovenia
Key publication references (including url)	http://www.arso.gov.si/en/water/reports%20and%20publications/ http://www.arso.gov.si/vode/podatki/

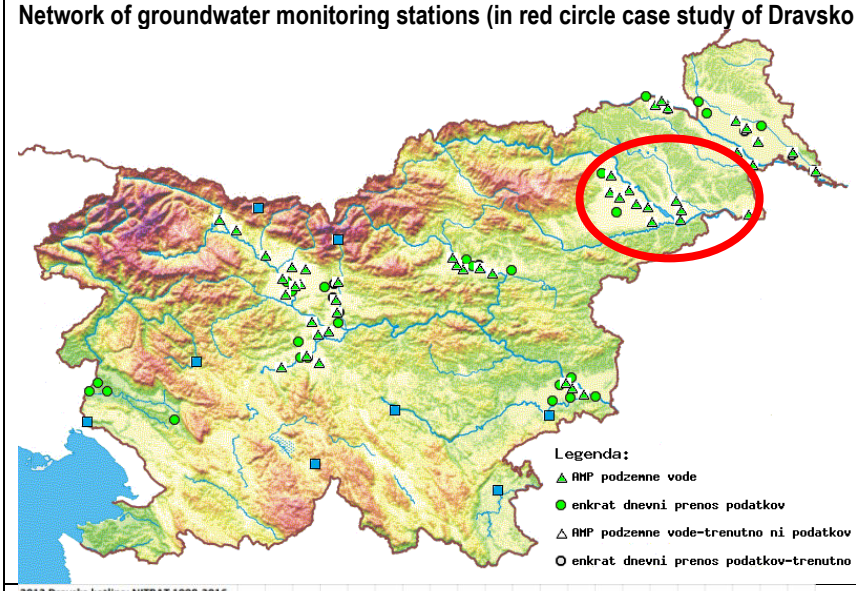
State network of groundwater monitoring points

FAIRWAY partner: Matjaž Glavan (UL, SI), Case study leader Katarina Kresnik, Andrej Jamšek (KGZ Maribor, SI)

REPUBLIC OF SLOVENIA
MINISTRY OF THE ENVIRONMENT AND SPATIAL PLANNING
SLOVENIAN ENVIRONMENT AGENCY

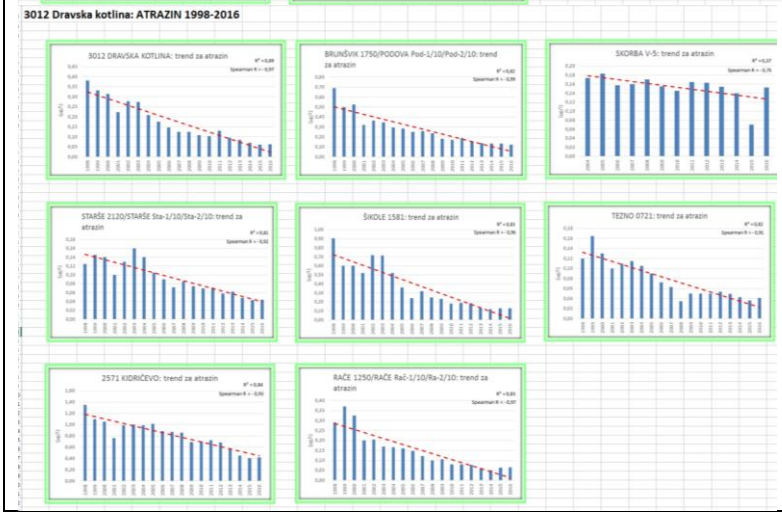
Any other useful information (e.g. screenshots of DST input/outputs

Network of groundwater monitoring stations (in red circle case study of Dravsko polje)



3012 Dravska kotlina: NITRAT 1998-2016

3012 Dravska kotlina: ATRAZIN 1998-2016



29. FITO-INFO **FAIRWAY partner:** **Matjaž GLAVAN (UL, SI), Case study leader** **Katarina KRESNIK, Andrej JAMŠEK (KGZ Maribor, SI)**	
Brief description	
Slovene information system for plant protection. Information systems for public use: – Plant protection products – Plant protection related legislation – Organisms names, descriptions, pictures, ... – Forecast information's – Important information for plant producers – news – All other information regarded to plant protection...	
Contaminants covered (e.g. nitrate, pesticides etc.)	Pesticides
Intended end users (e.g. farmer, water quality manager, policy maker)	Farmers, advisors, research, policy makers
Level of expertise and/or training required	Low
Geographical resolution (e.g. field, catchment, national)	National
Temporal resolution (e.g. daily, annual, long-term).	Annual
Real-time component (e.g. live weather data, soil moisture data feeds etc.)	
Number and type of mitigation measures included	None
Platform (e.g. paper-based tool, phone app, bespoke software).	Website (in Slovenian)
Frequency of updates	Updated whenever needed (weekly)
Cost/availability	Free
Number of users or number of copies distributed/ downloaded/purchased	
Links to demo material and other relevant information (e.g. user guides).	http://www.fito-info.si/E_index.asp
Additional comments	

FITO-INFO **FAIRWAY partner:** **Matjaž GLAVAN (UL, SI), Case study leader** **Katarina KRESNIK, Andrej JAMŠEK (KGZ Maribor, SI)**	
Input data required to run the DST	
Outputs (including links to water quality and economic or financial aspects)	
Age/provenance of supporting data used to develop the DST	Based on: - meteorological, phenological data, forecasting model, insects or diseases development observation, years of experience.
Country-specific calibration or data requirements (including restrictions on use)	Information specific to Slovenia
Details of validation and testing	
Date developed/released (or planned release date)	Developed 1997
Author/developer names and affiliations	Administration of the Republic of Slovenia for Food Safety, Veterinary Sector and Plant Protection
Member state(s) where developed	Slovenia
Member State(s) where currently used	Slovenia
Key publication references (including url)	http://www.fito-info.si/E_index.asp

FITO-INFO

FAIRWAY partner:
Matjaž GLAVAN (UL, SI), Case study leader
Katarina KRESNIK, Andrej JAMŠEK (KGZ Maribor, SI)

Any other useful information (e.g. screenshots of DST input/outputs

Home page

30. PLANET

FAIRWAY partner: Fiona Nicholson (ADAS, UK)

Brief description	
PLANET (Planning Land Applications of Nutrients for Efficiency and the environment) is a nutrient management decision support tool for use by farmers and advisers in England/Wales and Scotland for field level nutrient planning and for assessing and demonstrating compliance with the Nitrate Vulnerable Zone (NVZ) rules.	
Contaminants covered (e.g. nitrate, pesticides etc.)	Nitrate (nutrients)
Intended end users (e.g. farmer, water quality manager, policy maker)	Farmers and advisors
Level of expertise and/or training required	Some experience needed to use the software but extensive help and information is available (see below)
Geographical resolution (e.g. field, catchment, national)	Field and farm scale.
Temporal resolution (e.g. daily, annual, long-term).	Annual
Real-time component (e.g. live weather data, soil moisture data feeds etc.)	None
Number and type of mitigation measures included	None
Platform (e.g. paper-based tool, phone app, bespoke software).	Bespoke software (in English only) can be downloaded from the following website: http://www.planet4farmers.co.uk
Frequency of updates	Most recent version v3.3 (August 2014). Regularly updated to reflect changes in the NVZ Action Plan - last update November 2016.
Cost/availability	Free to download or on DVD
Number of users or number of copies distributed/ downloaded/purchased	Over 18,000 users
Links to demo material and other relevant information (e.g. user guides).	Tutorials and help (in English) available at http://www.planet4farmers.co.uk/Content.aspx?name=Tutorials A dedicated Helpdesk for users is provided.
Additional comments	PLANET incorporates the ADAS MANNER software. The PLANET code is publically available and has been incorporated into commercial software packages such as Gatekeeper and Greenlight.

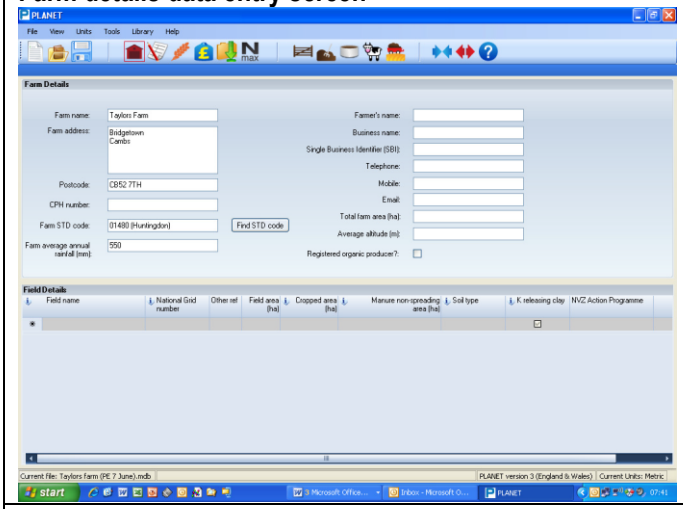
PLANET **FAIRWAY partner: Fiona Nicholson (ADAS, UK)**	
Input data required to run the DST	Data inputs depend on the module being used and include farm details, livestock type and numbers, cropping, soil analysis, fertiliser and manure applications, capacity and surface area of manure stores, rainwater collection area, volume of wash water, area of low runoff risk land,
Outputs (including links to water quality and economic or financial aspects)	At the end of the season, details of actual cropping, soil analysis, organic manure and nutrient/lime applications to each crop are recorded and can be used to generate next year's RB209 recommendations which can be used as the basis for developing a nutrient application plan for each field. Estimates are produced of manure quantities from different sources and their financial value, and an estimate of the NVZ minimum storage capacity requirement. Outputs do not directly link to water quality. All PLANET reports can be viewed and printed.
Age/provenance of supporting data used to develop the DST	Based on the Defra Fertiliser Manual (RB209) and the ADAS MANNER software.
Country-specific calibration or data requirements (including restrictions on use)	Based on the UK RB209 fertiliser recommendations and UK NVZ regulations. Not possible to modify without extensive work.
Details of validation and testing	No information
Date developed/released (or planned release date)	Version 3.3 released in 2014.
Author/developer names and affiliations	ADAS and SRUC
Member state(s) where developed	UK
Member State(s) where currently used	UK (England, Wales and Scotland)
Key publication references (including url)	http://www.informatique-agricole.org/download/efita-conference/Congres_EFITA_2005/PA190%20-%20Gibbons.pdf

PLANET

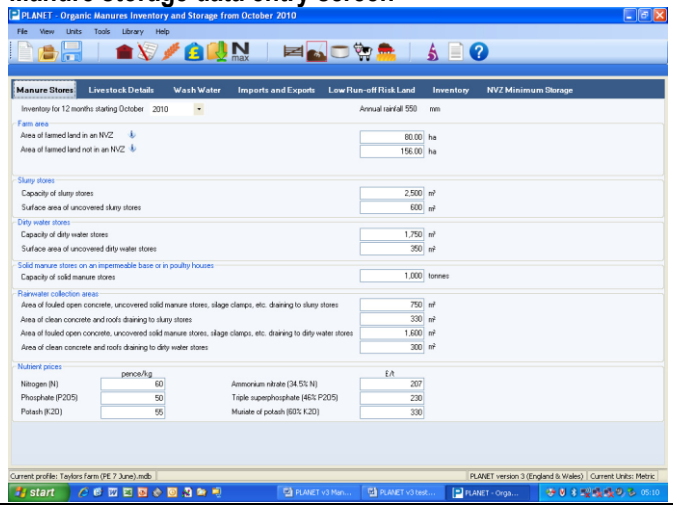
FAIRWAY partner: Fiona Nicholson (ADAS, UK)

Any other useful information (e.g. screenshots of DST input/outputs)

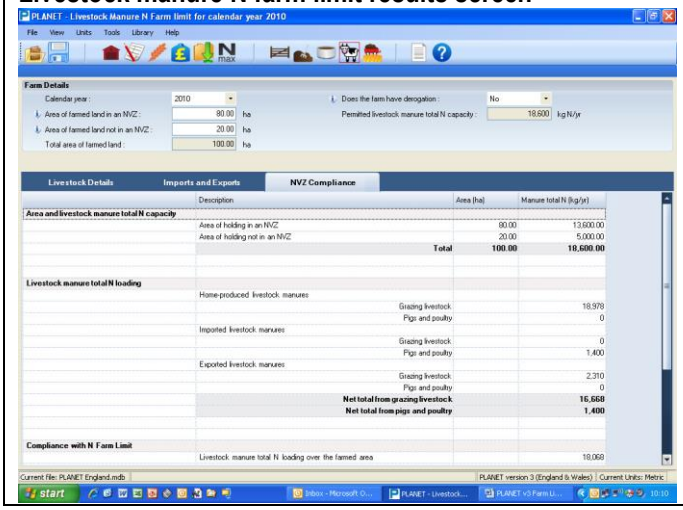
Farm details data entry screen



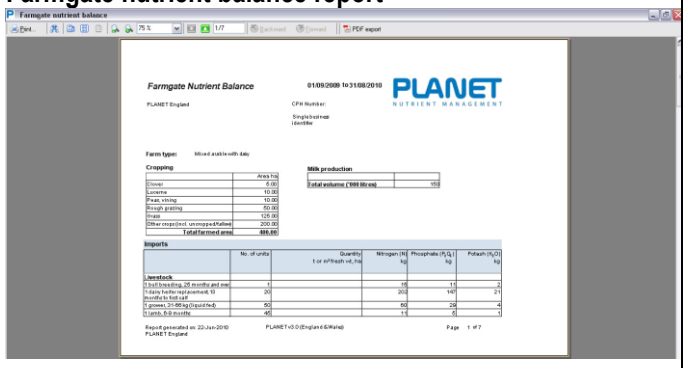
Manure storage data entry screen



Livestock manure N farm limit results screen



Farmgate nutrient balance report



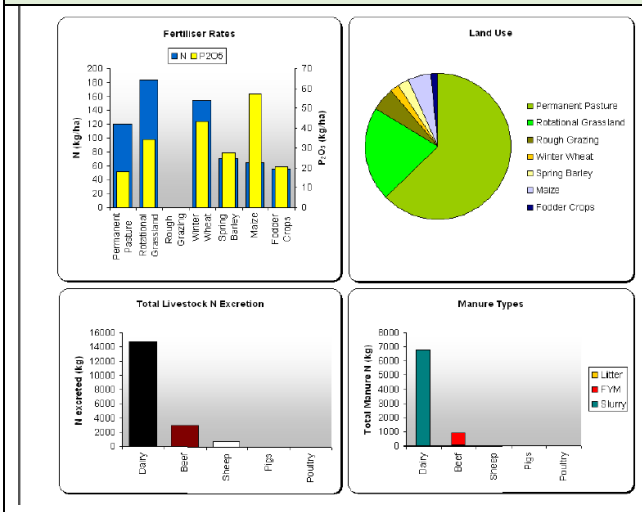
31. FARMSCOPER FAIRWAY partner: Fiona Nicholson (ADAS, UK)	
Brief description	
FARMSCOPER (FARM Scale Optimisation of Pollutant Emission Reduction) can be used to assess diffuse agricultural pollutant loads on a farm and quantify the impacts of farm mitigation methods on these pollutants. The farm systems within the tool can be customised to reflect management and environmental conditions representative of farming across England and Wales. The tool contains over 100 mitigation methods, including many of those in the latest Defra Mitigation Method User Guide.	
Contaminants covered (e.g. nitrate, pesticides etc.)	Nitrate, phosphorus, sediment, FIOs, pesticides
Intended end users (e.g. farmer, water quality manager, policy maker)	Advisors; catchment managers, policy makers.
Level of expertise and/or training required	Good understanding of farm systems and mitigation methods needed. Moderate level of training required to use the software.
Geographical resolution (e.g. field, catchment, national)	Farm scale. Outputs can be scaled up to catchment, regional or national level.
Temporal resolution (e.g. daily, annual, long-term).	Annual
Real-time component (e.g. live weather data, soil moisture data feeds etc.)	None
Number and type of mitigation measures included	Contains over 100 mitigation methods which can be applied to different farming systems and environments
Platform (e.g. paper-based tool, phone app, bespoke software).	Bespoke software with an interface consisting of 5 Excel workbooks linked to an Access database (mdb). Software (in English only) can be downloaded from the following website: http://www.adas.uk/Service/farmscoper
Frequency of updates	Catchment scale data updated in 2015. Most recent version released July 2017 (FARMSCOPER v4)
Cost/availability	Free to download
Number of users or number of copies distributed/ downloaded/purchased	Used by policy makers in Defra, Environment Agency and Natural England
Links to demo material and other relevant information (e.g. user guides).	Information (in English) about FARMSCOPER use in the Wensum in Demonstration Test Catchment is available here: http://www.wensumalliance.org.uk/factsheets.html Information (in English) about FARMSCOPER use in the Avon in Demonstration Test Catchment is available here: http://www.avondtc.org.uk/Mitigation.aspx
Additional comments	The mitigation methods detailed in the Defra Mitigation Methods User Guide are included within FARMSCOPER

FARMSCOPER **FAIRWAY partner: Fiona Nicholson (ADAS, UK)**	
Input data required to run the DST	Information needed to build a 'model farm' includes rainfall zone, soil type, drainage status, farm type, livestock numbers, cropping, manure management, details of field operations. User selects from a list of pollutants of interest and mitigation methods to be tested.
Outputs (including links to water quality and economic or financial aspects)	Graphs and reports produced which specify the relative importance of each pollutants and reductions achieved for each mitigation method. Pollutant losses shown as kg or t lost from the whole farm or apportioned by land use. A Cost workbook determines the cost effectiveness of the different methods and the total costs of method implementation.
Age/provenance of supporting data used to develop the DST	P and nitrate losses based on existing models (PSYCHIC for P and NEAP-N for nitrate)
Country-specific calibration or data requirements (including restrictions on use)	Contains default data on climate, farm type, crop and livestock types etc. that are applicable/relevant to England and Wales. Could be modified for other countries or regions. Baseline levels of pollutant losses can be replaced with measured data. The default library of mitigation methods can be edited and expanded. Economic information is reported in pounds sterling (£).
Details of validation and testing	FARMSCOPER has been used in two Demonstration Test Catchments and has been demonstrated and used by farm advisors in workshop settings.
Date developed/released (or planned release date)	FARMSCOPER was originally developed under Defra project WQ0106 (2006-10). It was expanded under Defra Project SCF0104 to include additional pollutants and two new workbooks – one providing greater detail on the costs of mitigation method implementation, the other allowing the tool to be applied at catchment to national scale. Under Environment Agency funding, the catchment scale data has been updated to 2015, with data now included for a range of smaller spatial scales. New documentation on applying FARMSCOPER at smaller spatial scales is included in the installation package.
Author/developer names and affiliations	R. Gooday, S. Anthony, P. Newell-Price, D. Harris, D. Duethmann. (ADAS, UK); R. Fish, M. Winter (University of Exeter, UK) A. Collins, (University of Southampton, UK) D. Chadwick (Bangor University, UK)
Member state(s) where developed	UK
Member State(s) where currently used	UK
Key publication references (including url)	R. Gooday, S. Anthony, D. Chadwick, P. Newell-Price, D. Harris, D. Duethmann, R. Fish, A. Collins & M. Winter (2014). Modelling the cost-effectiveness of mitigation methods for multiple pollutants at farm scale. Science of the Total Environment, 468-469, 1198-1209. http://www.sciencedirect.com/science/article/pii/S0048969713005123 Y. Zhang, A.L. Collins, R.D. & Gooday (2012). Application of the FARMSCOPER tool for assessing agricultural diffuse pollution mitigation methods across the Hampshire Avon Demonstration Test Catchment, UK. Environmental Science & Policy, 24, 120-131. https://www.sciencedirect.com/science/article/pii/S1462901112001360 R. Gooday, S. Anthony, C. Durrant, D. Harris, D. Lee, P. Metcalfe, P. Newell-Price & A. Turner (2015). Developing the Farmscoper Decision support tool. Final Report for Defra Project SCF0104. http://randd.defra.gov.uk/Default.aspx?Module=More&Location=None&ProjectID=18702

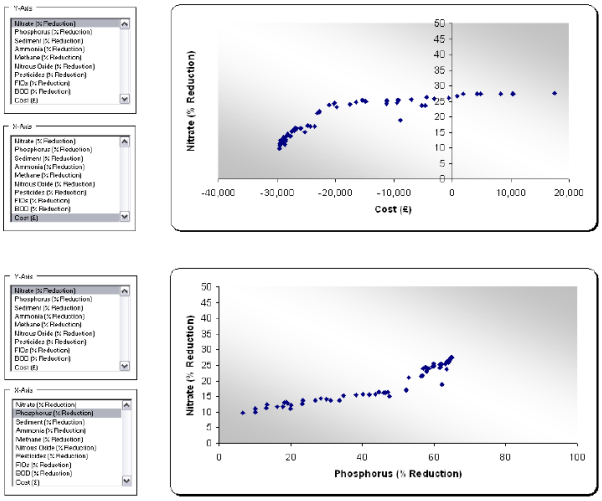
FARMSCOPER

FAIRWAY partner: Fiona Nicholson (ADAS, UK)

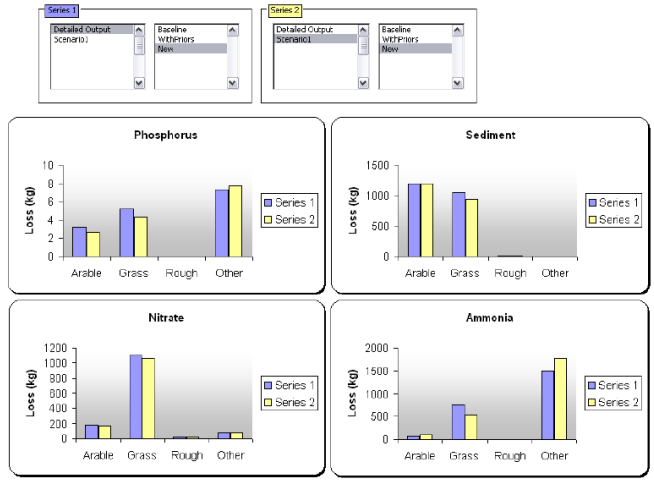
Any other useful information (e.g. screenshots of DST input/outputs)



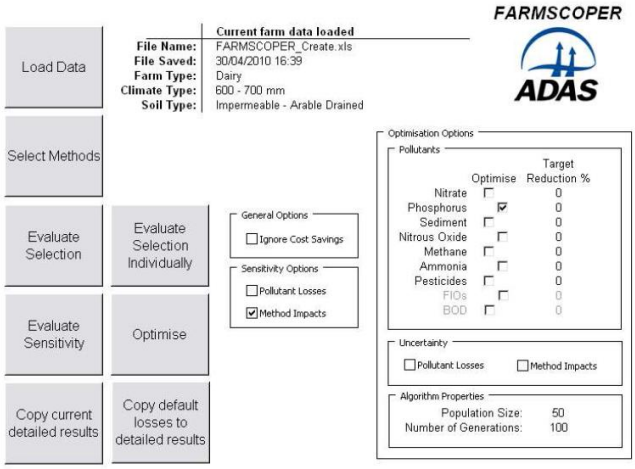
Graphs of farm data from the Farm Design Workbook



Optimisation results for cost-effective mitigation for multiple pollutants



Comparison of the results of different suites of mitigation methods from multiple pollutants from different source areas



User interface from Farm Solver Workbook

32. CHECK IT OUT

FAIRWAY partner: Fiona Nicholson (ADAS, UK)

Brief description	
The Check it Out Tool has been designed to help farmers and sprayer operators review and improve spraying practices and so reduce the risk of pesticides reaching water. The new tool was developed by the Crop Protection Association with support from Catchment Sensitive Farming and has 22 multi-choice questions covering Planning and Management, Filling and Handling, Soil Management and Field Practice. After completing the questions, users are given a score for each aspect of their spraying operation, and an overall score.	
Contaminants covered (e.g. nitrate, pesticides etc.)	Pesticides
Intended end users (e.g. farmer, water quality manager, policy maker)	Farmers and sprayer operators
Level of expertise and/or training required	No specialist training required
Geographical resolution (e.g. field, catchment, national)	Field and farm
Temporal resolution (e.g. daily, annual, long-term).	As required
Real-time component (e.g. live weather data, soil moisture data feeds etc.)	None
Number and type of mitigation measures included	None
Platform (e.g. paper-based tool, phone app, bespoke software).	Online questionnaire (in English)
Frequency of updates	Not known
Cost/availability	Free to use online: http://checkitout.voluntaryinitiative.org.uk/tool/
Number of users or number of copies distributed/ downloaded/purchased	Not known
Links to demo material and other relevant information (e.g. user guides).	
Additional comments	

Check It Out **FAIRWAY partner: Fiona Nicholson (ADAS, UK)**	The Voluntary Initiative
Input data required to run the DST	Details of farm and spraying operation
Outputs (including links to water quality and economic or financial aspects)	A detailed report with recommendations on how farmers can improve their practices is provided as a download.
Age/provenance of supporting data used to develop the DST	Not known
Country-specific calibration or data requirements (including restrictions on use)	None
Details of validation and testing	Not known
Date developed/released (or planned release date)	2017
Author/developer names and affiliations	The Crop Protection Association supported by Catchment Sensitive Farming
Member state(s) where developed	UK
Member State(s) where currently used	UK
Key publication references (including url)	None

Check It Out

FAIRWAY partner: Fiona Nicholson (ADAS, UK)

Any other useful information (e.g. screenshots of DST input/outputs)

Check it Out Tool

Getting Started

Help

Welcome to the Check it Out Tool. It has been designed to help farmers and sprayer operators review and improve spraying practices and so reduce the risk of pesticides reaching water. There are 22 questions across four sections, and it should take no more than 20 minutes to complete.

Make sure you put your correct email address in the form below if you want the report emailed to you at the end of the exercise.

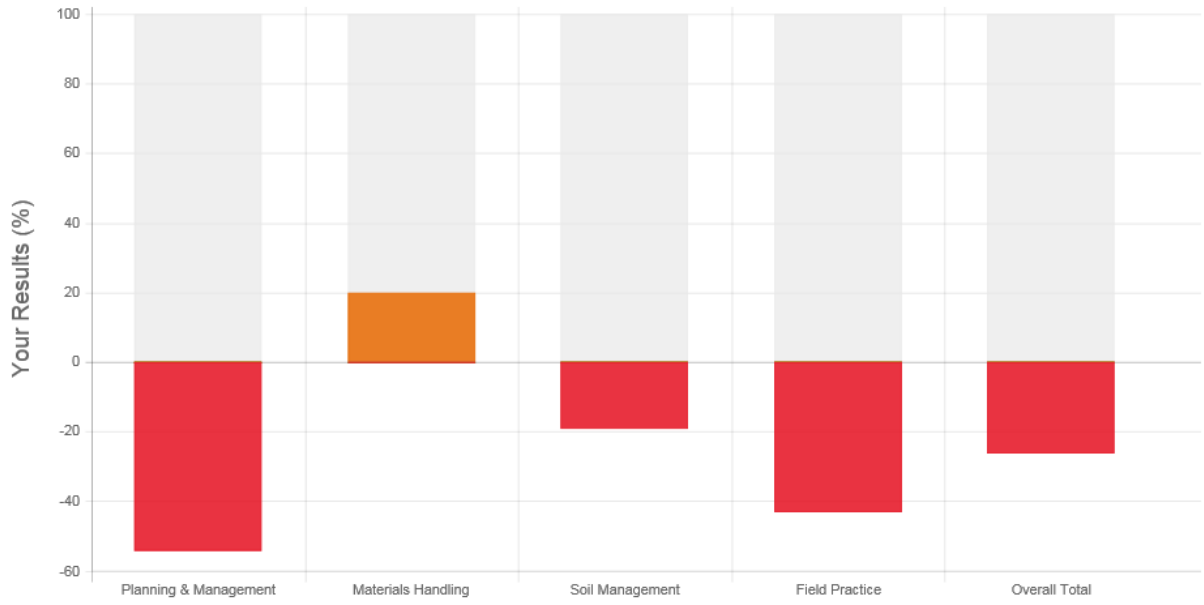
My Details | Planning & Management | Materials Handling | Soil Management | Field Practice | Results

Your details

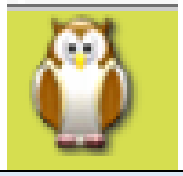
If you would like to keep a personalised copy of your report please record your personal details below. Your email address will be needed if you want the report emailed to you at the end of the exercise. Some personal information - your name, email address, birth date and registration number will be needed if you wish to collect NRoSO or BASIS CPD points. These details will be passed to City and Guilds or BASIS to confirm your CPD **points**. All other information and answers you supply will be confidential to the VI. It will be anonymised and used to build up and track a national picture of best practice.

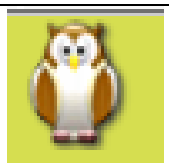
Summary Results

Your summary scores are shown below. To view your full results download your full report below.

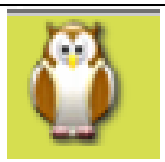


	Planning & Management	Materials Handling	Soil Management	Field Practice	Overall Total
Your Total	-65	20	-20	-45	-110
Total Possible	120	100	105	105	430
National Averages	... Coming soon ...				

33. SENTINEL ONLINE FAIRWAY partner: Fiona Nicholson (ADAS, UK)	
Brief description	
Sentinel Online allows anyone with an interest in crop production to quickly find the information required to make key decisions in crop management. Features include: The Pesticide Database; Library; Decision support including crop nutrition, NVZ rules and recommendations; Technical updates; Weeds, pests and disease identification information; Diary Dates i.e. cross compliance dates and deadlines.	
Contaminants covered (e.g. nitrate, pesticides etc.)	Pesticides
Intended end users (e.g. farmer, water quality manager, policy maker)	Farmers and advisers
Level of expertise and/or training required	No specialised training required
Geographical resolution (e.g. field, catchment, national)	Field
Temporal resolution (e.g. daily, annual, long-term).	As required
Real-time component (e.g. live weather data, soil moisture data feeds etc.)	None
Number and type of mitigation measures included	None
Platform (e.g. paper-based tool, phone app, bespoke software).	Online information
Frequency of updates	Daily
Cost/availability	Free to use online: https://secure.gk-cloud.com/sentinel/viewer.html#topic-home
Number of users or number of copies distributed/ downloaded/purchased	Not known
Links to demo material and other relevant information (e.g. user guides).	https://secure.gk-cloud.com/sentinel/viewer.html#topic-home
Additional comments	Sentinel is the information base for the Gatekeeper module Sentinel Active, a decision support tool providing detailed crop approval information and real-time/instant verification for all UK pesticides.

Sentinel Online **FAIRWAY partner: Fiona Nicholson (ADAS, UK)**	
Input data required to run the DST	None
Outputs (including links to water quality and economic or financial aspects)	Information on pesticide approvals and use.
Age/provenance of supporting data used to develop the DST	Regular updates
Country-specific calibration or data requirements (including restrictions on use)	Information is specific to the UK
Details of validation and testing	Not known
Date developed/released (or planned release date)	Not known
Author/developer names and affiliations	Various. Technical updates from companies including Bayer Crop Science, John Deere and Nufarm UK
Member state(s) where developed	UK
Member State(s) where currently used	UK
Key publication references (including url)	None

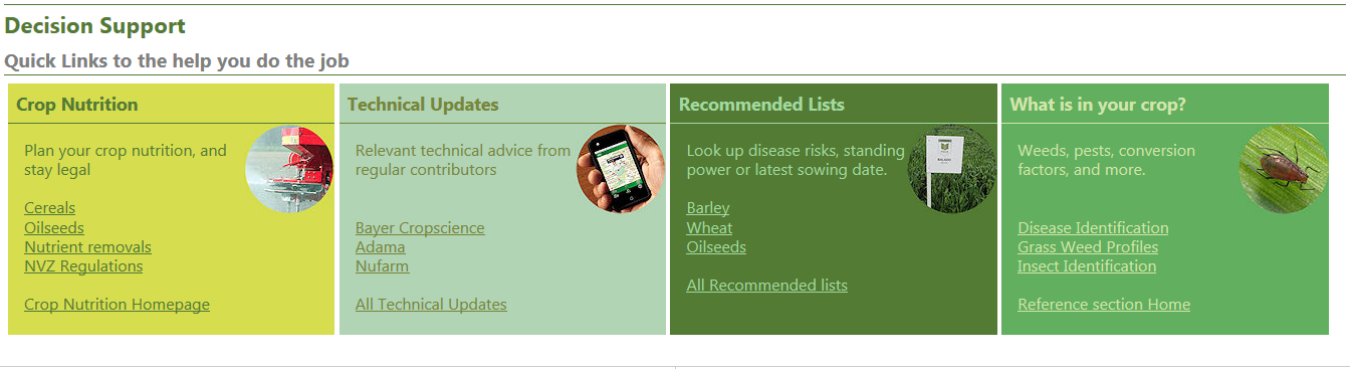
Sentinel Online



FAIRWAY partner: Fiona Nicholson (ADAS, UK)

Any other useful information (e.g. screenshots of DST input/outputs)

Decision support available online



34. PROCHECK

FAIRWAY partner: Fiona Nicholson (ADAS, UK)

Brief description	
An interactive decision support system for pesticide use. ProCheck is an electronic database which contains details of product label and off-label information including MRL's, environmental and operator restrictions, ProCheck provides a highly comprehensive pesticide data source. Maintained daily by Muddy Boots, ProCheck is updated using the latest web technology. Being an off-line application ensures users can access the data at any time without the need to 'log-on', and even use the system in the field on a laptop Its powerful search engine enables product choice by a large number of criteria delivering true decision support capability.	
Contaminants covered (e.g. nitrate, pesticides etc.)	Pesticides.
Intended end users (e.g. farmer, water quality manager, policy maker)	Farmers and advisors
Level of expertise and/or training required	No specialised training required
Geographical resolution (e.g. field, catchment, national)	Field
Temporal resolution (e.g. daily, annual, long-term).	As required
Real-time component (e.g. live weather data, soil moisture data feeds etc.)	None
Number and type of mitigation measures included	None
Platform (e.g. paper-based tool, phone app, bespoke software).	Downloadable software. Also available as Pocket ProCheck on a Pocket PC handheld computer.
Frequency of updates	Updated daily
Cost/availability	Chargeable
Number of users or number of copies distributed/ downloaded/purchased	Not known
Links to demo material and other relevant information (e.g. user guides).	
Additional comments	Links to the FERA Liaison pesticide database. Links to CropWalker, Muddy Boots' crop management system.

ProCheck **FAIRWAY partner: Fiona Nicholson (ADAS, UK)**	
Input data required to run the DST	
Outputs (including links to water quality and economic or financial aspects)	Details of pesticide properties and use
Age/provenance of supporting data used to develop the DST	Updated daily
Country-specific calibration or data requirements (including restrictions on use)	
Details of validation and testing	
Date developed/released (or planned release date)	2012
Author/developer names and affiliations	Developed by Muddy Boots software
Member state(s) where developed	UK
Member State(s) where currently used	UK
Key publication references (including url)	

ProCheck **FAIRWAY partner: Fiona Nicholson (ADAS, UK)**	
Any other useful information (e.g. screenshots of DST input/outputs)	

35. WATERAWARE FAIRWAY partner: Fiona Nicholson (ADAS, UK)	
Brief description	
WaterAware is a phone app which forecasts risk of movement of selected pesticides from soils based on soil type and soil moisture deficit information along with forecasted weather conditions. It uses a traffic light system to advise farmers and sprayer operators when it is safe or unsafe to apply chemicals or slug pellets. The latest version incorporates #SlugAware which provides user an estimated risk of slug and snail activity on a field-by-field basis for the day and 72 hours in advance (particularly focussed on metaldehyde).	
Contaminants covered (e.g. nitrate, pesticides etc.)	Pesticides - crop protection solutions supplied by ADAMA including herbicides, fungicides, insecticides and growth regulators.
Intended end users (e.g. farmer, water quality manager, policy maker)	Farmers
Level of expertise and/or training required	No specialised training required
Geographical resolution (e.g. field, catchment, national)	Uses real-time location at field scale.
Temporal resolution (e.g. daily, annual, long-term).	Daily and up to 72 hours in advance
Real-time component (e.g. live weather data, soil moisture data feeds etc.)	WIMBY map read in (i.e. information from the Environment Agency – What's In My Back Yard). Water Aware uses current and predicted weather conditions,
Number and type of mitigation measures included	Not applicable
Platform (e.g. paper-based tool, phone app, bespoke software).	Phone app (in English). The app is designed to work on Android devices with an operating system of 4.0 (API level 14) or higher and on iOS devices capable of supporting iOS 8 (e.g. iPhone 4).
Frequency of updates	At least annual
Cost/availability	Free to download from http://www.adama.com/uk/en/wateraware/
Number of users or number of copies distributed/ downloaded/purchased	100-500 downloads on Google Play Store (16/08/17)
Links to demo material and other relevant information (e.g. user guides).	http://www.adama.com/documents/268722/268805/app-instructions_tcm105-70418.pdf You Tube videos and Infographic (In English). Instruction for use are also available as a downloadable pdf file (in English).
Additional comments	

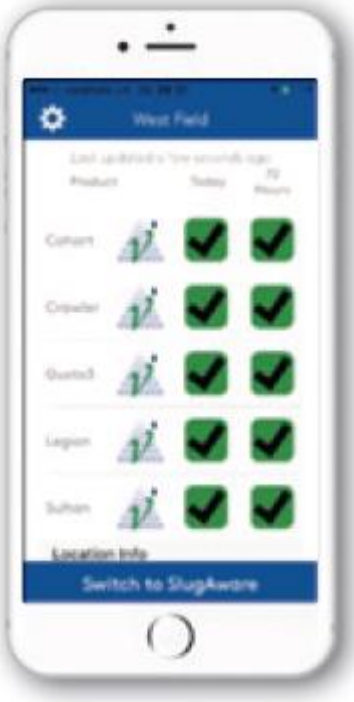
Water Aware App **FAIRWAY partner: Fiona Nicholson (ADAS, UK)**	
Input data required to run the DST	Location, products used, soil type, current and previous crop.
Outputs (including links to water quality and economic or financial aspects)	Risk assessment for each product selected and advisory information. Informs farmers whether it is safe to apply a product in terms of movement of the pesticide into watercourses.
Age/provenance of supporting data used to develop the DST	Not known – developed by a commercial company
Country-specific calibration or data requirements (including restrictions on use)	Uses UK soil type and weather data.
Details of validation and testing	Not known – developed by a commercial company
Date developed/released (or planned release date)	Version 2.4 released 24th July 2017
Author/developer names and affiliations	Adama Agricultural Solutions UK Ltd. Unit 15, Thatcham Business Village, Colthrop Way, Thatcham, Berkshire RG19 4LW Also address listed as ADAMA Agriculture BV, Amsterdam (NL) Schaffhausen Branchm Spitalstrasse 5, Schaffhausen, Switzerland.
Member state(s) where developed	UK
Member State(s) where currently used	UK, IE
Key publication references (including url)	None

Water Aware App

FAIRWAY partner: Fiona Nicholson (ADAS, UK)

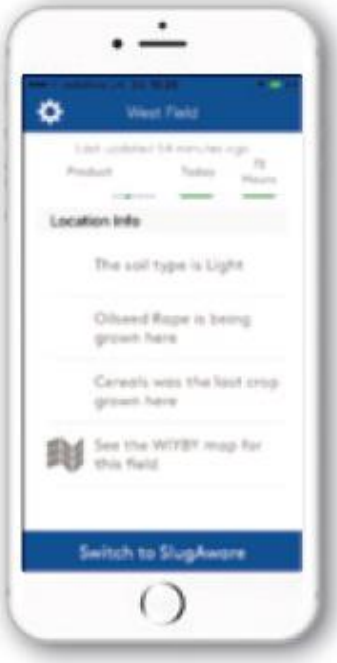
Any other useful information (e.g. screenshots of DST input/outputs)

Example of risk assessment screen for pesticides



Example of risk assessment screen for slug pellets

Location information



36. SCIMAP

FAIRWAY partner: Fiona Nicholson (ADAS, UK)

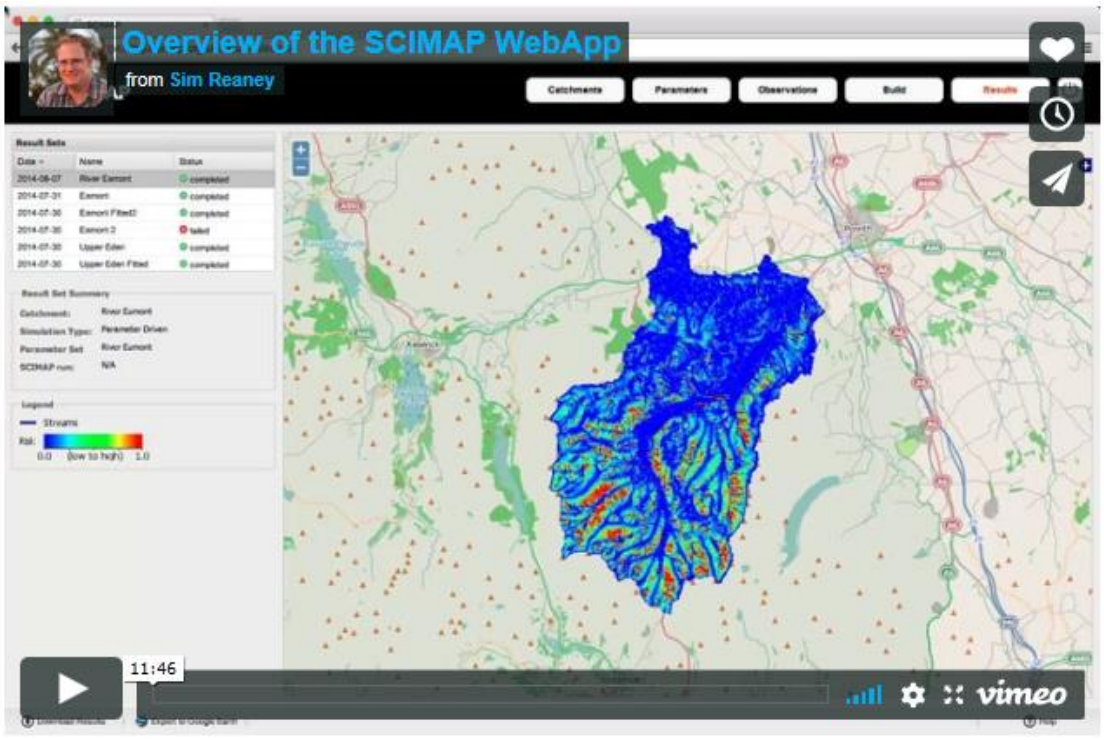
Brief description	
SCIMAP - Diffuse Pollution Risk Mapping. SCIMAP is a tool to help decision-makers, including governments, non-governmental organisations, land owners etc. to work out where to prioritise activities that protect the water environment, and so make our water clean again. SCIMAP is an approach to the generation of risk maps for diffuse pollution within catchments. SCIMAP aims to determine where within a catchment is the most probable source of diffuse pollution and is based on a probabilistic / relative approach.	
Contaminants covered (e.g. nitrate, pesticides etc.)	Sediment and FIOs (E.coli)
Intended end users (e.g. farmer, water quality manager, policy maker)	Policy makers, water quality managers
Level of expertise and/or training required	Knowledge of GIS is required. Training is required to run the model and export data to various GIS platforms. Training video available. http://www.scimap.org.uk/category/training/
Geographical resolution (e.g. field, catchment, national)	Catchment scale model
Temporal resolution (e.g. daily, annual, long-term).	Long term
Real-time component (e.g. live weather data, soil moisture data feeds etc.)	None
Number and type of mitigation measures included	Not explicitly modelled
Platform (e.g. paper-based tool, phone app, bespoke software).	Windows software can be downloaded from: http://www.scimap.org.uk/category/software/ Also a web-based version is under development: https://my.scimap.org.uk/app/auth.php (users need to register) In English
Frequency of updates	Ongoing
Cost/availability	Free to download or access online
Number of users or number of copies distributed/ downloaded/purchased	Not known
Links to demo material and other relevant information (e.g. user guides).	Comprehensive information available on the project website http://www.scimap.org.uk/
Additional comments	SCIMAP is being used in the River Eden Demonstration Test Catchment (EdenDTC) project. The results will be used to design mitigation measures to reduce the impact of agricultural activity on in-stream water quality and ecology whilst maintaining agricultural production. Also Durham Wildlife Trust is using SCIMAP to identify areas with high fine sediment pollution risk within the River Wear catchment

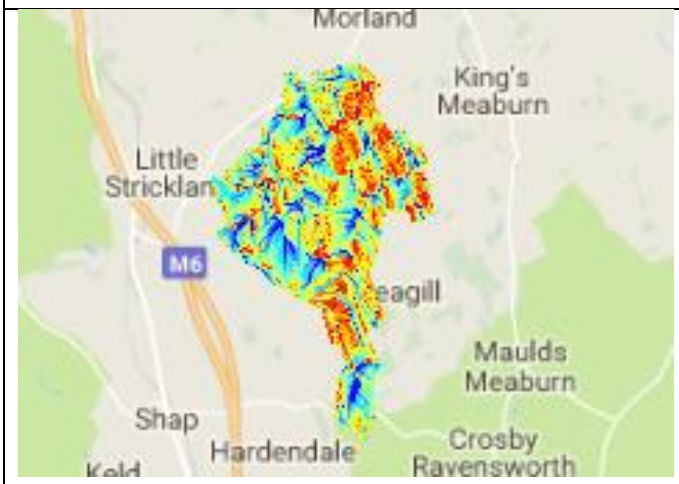
SCIMAP **FAIRWAY partner: Fiona Nicholson (ADAS, UK)**	
Input data required to run the DST	See publications. The web based version simplifies the process of developing SCIMAP risk maps by using the datasets stored on website, removing the need to install and used desktop GIS packages and allows simple export of the results to either GIS or GoogleEarth.
Outputs (including links to water quality and economic or financial aspects)	Maps of areas at risk of generating diffuse pollution.
Age/provenance of supporting data used to develop the DST	See publications
Country-specific calibration or data requirements (including restrictions on use)	See publications
Details of validation and testing	See publications
Date developed/released (or planned release date)	Original model developed in 2009
Author/developer names and affiliations	Originally jointly developed between Durham and Lancaster Universities. SCIMAP is supported by the U.K.'s Natural Environment Research Council, the Eden Rivers Trust, the Department of the Environment, Food and Rural Affairs and the Environment Agency.
Member state(s) where developed	UK
Member State(s) where currently used	UK (has also been used in Indonesia).
Key publication references (including url)	Perks, M.T., Warburton J., Bracken, L.J., Reaney, S.M., Emery, S.B. & Hirst S. 2017. Use of spatially distributed time-integrated sediment sampling networks and distributed fine sediment modelling to inform catchment management. Journal of Environmental Management 202, Part 1, 249-478. https://www.sciencedirect.com/science/article/pii/S0301479717300609 Porter K. D.H., Reaney S. M., Quilliam R. S., Burgess C. and Oliver D. M. 2017: Predicting diffuse microbial pollution risk across catchments: The performance of SCIMAP and recommendations for future development; Science of The Total Environment 609, 456-465. https://www.sciencedirect.com/science/article/pii/S0048969717318909 Milledge D. G., Lane S. N., Heathwaite A. L. and Reaney S. M. 2012: A Monte Carlo approach to the inverse problem of diffuse pollution risk in agricultural catchments; Science of the Total Environment 433, 434–449. http://dx.doi.org/10.1016/j.scitotenv.2012.06.047 Reaney S. M., Lane S. N., Heathwaite A. L. and Dugdale L. J.2011: Risk-based modelling of diffuse land use impacts from rural landscapes upon salmonid fry abundance; Ecological Modelling 222, 1016-1029 https://www.sciencedirect.com/science/article/pii/S0304380010004175?via%3Dihub

SCIMAP

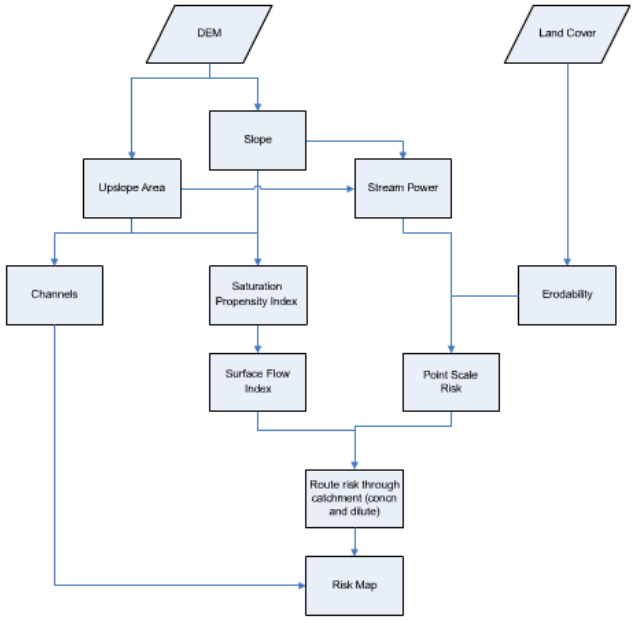
FAIRWAY partner: Fiona Nicholson (ADAS, UK)

Any other useful information (e.g. screenshots of DST input/outputs)





Map showing relative risks of sediment pollution generation in a catchment



Information flows withing the model

APPENDIX 2: SUMMARY INFORMATION ON OTHER (LONGLISTED) NUTRIENT DSTS

Agricat 2 (NO)

Empirical, «management oriented» model in GIS environment. Designed to assess the effectiveness of mitigation measures to reduce phosphorus (P) losses from agricultural land. Output: soil and P loss under actual or scenario management. Input: readily, publicly available data and maps for relevant factors (environmental and anthropogenic) Developed by Bioforsk in 2014, based on previous model «Agricat».

http://hdl.handle.net/11250/2444546

AZOFERT (FR)

Tool for diagnosis of nitrogen loss in cropping systems to improve nitrogen management. Works at the field scale. Usable in French crop systems. The tool consists of two parts: - a nitrogen flow model that estimates the loss of nitrogen - a database of simulations already completed and measures available that can be consulted by users.

http://inra-dam-front-resources-cdn.brainsonic.com/ressources/afile/246552-f4cd8-resource-azoferto-a-new-decision-support-tool-for-fertiliser-n-advice-based-on-a-dynamic-version-of-the-predictive-balance-sheet-method.htm

BASINFORM (DE)

Abstract. One major scientific challenge posed by the EU Water Framework Directive (WFD) is the design of a decision support process that meets the Directive's requirement to achieve "good status" for all water bodies using a cost-effective combination of measures. This paper presents BASINFORM, a new decision methodology for selecting cost-effective management measures, developed in close co-operation with the water authorities and tested in the 5,154 km² mesoscale river Weisse Elster in central Germany. BASINFORM comprises (i) a procedure for framing the specific problems in the water bodies, including quantification of the need for action, (ii) modelling tools for quantifying the impacts of management measures, and (iii) a method for selecting cost-effective combinations of measures. One innovative feature of BASINFORM is that it structures the complex decision problems appropriately for practical use and provides an easy-to-use framework for integrating scientific and practical knowledge. A trial run applying BASINFORM to the Weisse Elster catchment revealed that good surface water status with respect to nutrient levels cannot be achieved if only the "standard" actions of current water management are taken to reduce point sources (sewage treatment) and diffuse agricultural sources. It also became clear that the nutrient-reduction measures available will generate considerable costs. The application of BASINFORM in this case study demonstrated its practical applicability in the WFD implementation process. Beyond the case study described here BASINFORM is currently being used for practical implementation of the WFD in the German Federal State of Thuringia.

https://link.springer.com/article/10.1007/s11269-011-9944-5

BOWAB (DE)

BOWAB is a process-oriented soil water model which calculates with multiple soil layers. It containes crop-specific information on water requirement of crops, at different development stages, rooting depth and provides re commendation for optimized irrigation management.

ENGEL, N., MÜLLER, U. & SCHÄFER, W. (2012): BOWAB – Ein Mehrschicht-Bodenwasserhaushaltsmodell. – Geoberichte 20: 85–98, 4 Abb., 4 Tab.; Hannover (LBEG)

CAFRE Livestock Manure Nitrogen Loading Calculator (NI)

Calculates the N loading for your farm. Checks if you are below the 170kg N/ha/year limit or if operating under a derogation the 250kg N/ha/year limit.

https://eservices.ruralni.gov.uk/onlineservices/FarmNutrient/index.asp

CAFRE Livestock Manure Storage Calculator (NI)

Calculates the weekly slurry, dirty water, manure production and current storage capacity for the farm. Checks if there is the required 22 or 26 weeks storage or how much additional storage is needed.

https://eservices.ruralni.gov.uk/onlineservices/FarmNutrient/index.asp

CASIMOD'N (FR)

CASIMOD'N integrates farming systems at the farm level and N transfers and transformations at the field, farm and catchment levels. It was built by combining two models: a catchment-scale model and a farm models (MELODIE). CASIMOD'N was developed by adapting and combining decisional models with a biophysical model at the catchment scale. It considering farming systems and their expression through management practices.

http://www.sciencedirect.com/science/article/pii/S0308521X13000243%20-%20!

CropSAT (DK)

Calculation of graduated need for nitrogen fertilizer, growth regulator and fungicides based on satelite photos.

DAISY (DK)

Abstract. Daisy is a well tested dynamic model for simulation of water and nitrogen dynamics and crop growth in agro-ecosystems. The model aims at simulating water balance, nitrogen balance and losses, development in soil organic matter and crop growth and production in crop rotations under alternate management strategies. The software, which recently was rewritten, has been carefully designed to facilitate interaction with other models, either by replacing individual Daisy processes or by using Daisy as a part of a larger system, thus making Daisy an open software system.

https://www.sciencedirect.com/science/article/pii/S1364815200000037

DANUBIA (DE)

Abstract. Within the GLOWA-Danube project, the integrated decision support system DANUBIA was developed to address effects of global change on water resources of the Upper Danube watershed (~80,000 km2). Key components of DANUBIA in respect to water quality and plant growth modelling are nitrogen turnover, nitrogen fluxes and storages. This paper discusses an approach to model soil nitrogen dynamics in a mesoscale watershed. Within the model, the soil column is represented by three soil layers. The model components for water fluxes, nitrogen uptake and nitrogen transformation are process-based. To validate the model, field data from four locations were used. Nitrogen modelling results are in good agreement with measured data. Statistical analysis for soil nitrogen and water content resulted in satisfactory indices of agreement. The study demonstrated that the coupled soil moisture and soil nitrogen transformation model is suitable to simulate the fate of mineral nitrogen within the soil profile on the field scale. Sensitivity studies indicate that the model quality for large scale modelling depends particularly upon the appropriate representation of sandy soils, the accurate parameterization of the saturated hydraulic conductivity and the precise initialization of soil mineral nitrogen content.

https://www.sciencedirect.com/science/article/pii/S0304380008003037

DAYCENT (US)

Abstract. Many efforts have been made in Europe to improve the environmental quality of agro-ecosystems. Since the 2000s, agri-environmental measures (AEMs) have been financed and implemented in EU countries, although their beneficial effects are still questioned due to poorly targeted environmental issues and a lack of site-specific payments. Indeed, estimates of AEM outcomes at the territorial level require considerable efforts to consider simultaneously multiple environmental objectives with multiple targets. As a result, a DAYCENT model-GIS platform was developed that integrates multiple types of pedo-climatic and land management information. The aim was to provide a decision support system for spatially evaluating and selecting the best AEMs in terms of soil, water and air quality, when compared with a standard scenario without any adopted measure. Our modelled results showed that in the Veneto Region, north-eastern Italy, the AEMs applied from 2007 to 2013 improved the environmental value of the agro-ecosystems, especially in terms of soil and water quality. Continuous soil cover, reduction of soil disturbance through grasslands, conservation agriculture and cover crops were the best simulated strategies to increase soil organic matter content (+25%) and reduce nitrogen leaching -90%). These strategies were also able to sharply reduce soil water erosion (-86%) and as a consequence P loss, in particular in the steep hilly and mountain areas, although their application to arable lands in those landscapes is still rare. In contrast, care should be taken in the long-term regarding an increase in P leaching, since predictions up to +0.15 kg/ha/y are reached compared to the standard scenario. Finally, greenhouse gas (GHG) emissions (N2O and CH4) were reduced mainly due to increased fertilisation efficiency. The proposed method can be a flexible decision support tool for a result-oriented and scientifically-based evaluation of AEMs that may help policy makers to evaluate the most effective measures for increasing the environmental value of agro-ecosystems.

http://www.sciencedirect.com/science/article/pii/S016788091630398X

Erfemissiescan (NL)

Growers can identify risks for runoff/leaching from their farmyard and are given information on best practices to remediate these risks.

https://www.erfemissiescan.nl/

Erosion risk map service (NO)

The maps indicate erosion risk and thus also the risk of soil and P loss, divided in 4 classes. There are restrictions on land management in the most vulnerable classes. The maps can also be uploaded in the DST tool “Skifteplan”.

https://kilden.nibio.no

FARMSTAR (FR)

Farmstar is based on satellite images and agronomic models. Advisers with agronomic models that also include weather conditions and cultural characteristics of the plots interpret information on the crop status, from satellite images. The results are translated into agricultural advice and provided throughout the cultural campaign easy to use maps.

http://www.farmstar-conseil.fr/

Farmtracking (DK)

Field record keeping, registration of hotspots with eg. week, navigation and alerts

https://www.seges.dk/da-dk/software/plante

Fertiliser Manual (RB209) (UK)

Guidance to help farmers and land managers assess the fertiliser required for the range of crops they plan to grow.

https://www.gov.uk/government/publications/fertiliser-manual-rb209--2

FERTIWeb (FR)

FERTIWeb® is an "on line" application to achieve agronomic and regulatory manure application prevision. A module helps to import very easily, plot plan, analyses of soil, nitrogen and livestock manure. FERTIWeb® allows planning of fertilizer use on most cultivated species.

https://www.arvalis-infos.fr/file/galleryelement/pj/b3/56/bf/f3/16px30-fertiweb4902842735930498029.pdf

FOOTPRINT (UK)

FOOTPRINT was a research project in the 6th Framework Programme which developed a suite of three pesticide risk prediction and management tools, for use by three different end-user communities: 1. farmers and extension advisors at the farm scale;2. water managers at the catchment scale; and 3. policy makers/registration authorities at the national/EU scale.

http://sitem.herts.ac.uk/aeru/projects/footprint/index.htm

FWPI (GR)

Abstract. Fertilizers have undoubtedly contributed to the significant increase in yields worldwide and therefore to the considerable improvement of quality of life of man and animals. Today, attention is focussed on the risks imposed by agricultural fertilizers. These effects include the dissolution and transport of excess quantities of fertilizer major- and trace-elements to the groundwater that deteriorate the quality of drinking and irrigation water. In this study, a map for the Fertilizer Water Pollution Index (FWPI) was generated for assessing the impact of agricultural fertilizers on drinking and irrigation water quality. The proposed methodology was applied to one of the most intensively cultivated with tree crops area in Crete (Greece) where potential pollutant loads are derived exclusively from agricultural activities and groundwater is the main water source. In this region of 215 km2, groundwater sampling data from 235 wells were collected over a 15-year time period and analyzed for the presence of anionic (NO−3, PO−34) and cationic (K+1, Fe+2, Mn+2, Zn+2, Cu+2, B+3) fertilizer trace elements. These chemicals are the components of the primary fertilizers used in local tree crop production. Eight factors/maps were considered in order to estimate the spatial distribution of groundwater contamination for each fertilizer element. The eight factors combined were used to generate the Fertilizer Water Pollution Index (FWPI) map indicating the areas with drinking/irrigation water pollution due to the high groundwater contamination caused by excessive fertilizer use. Moreover, by taking into consideration the groundwater flow direction and seepage velocity, the pathway through which groundwater supply become polluted can be predicted. The groundwater quality results show that a small part of the study area, about 8 km2 (3.72%), is polluted or moderately polluted by the excessive use of fertilizers. Considering that in this area drinking water sources (wells) are located, this study highlights an analytic method for delineation wellhead protection zones. All these approaches were incorporated in a useful GIS decision support system that aids decision makers in the difficult task of protection groundwater resources.

http://www.sciencedirect.com/science/article/pii/S0301479716310179

Gatekeeper (UK)

A commercial crop recording system aiming to help the farmer keep demonstrate compliance, keep track of costs and reduce paperwork. Includes a nutrient management tool based on PLANET/RB209. Allows farm maps and precision farming data to be incorporated into crop management records. Sentinel acitive (pesticide DST) can also be added.

GESCAL (ES)

Abstract. The Manzanares River, located in Madrid (Spain), is the main water supplier of a highly populated region, and it also receives wastewater from the same area. The effluents of eight Waste Water Treatment Plants (WWTPs) downstream of the river, which represent 90% of the flow in the middle and lower parts of the river, are the primary sources of water pollution. Although the situation has improved slightly in the last two years, the water in the river is highly polluted, making it uninhabitable for aquatic life. Water quality modelling is typically used to assess the effect of treatment improvements in water bodies. In this work, the GESCAL module of the Aquatool Decision Support System Shell was used to simulate water quality in the Manzanares River. GESCAL is appropriate for modelling in an integrated way water quality for whole water resources systems, including reservoirs and rivers. A model was built that simulates conductivity, phosphorous, carbonaceous organic matter, dissolved oxygen, organic nitrogen, ammonia, and nitrates. The period from October 2006 to September 2008 was selected for calibration due to the many treatment modifications that occurred during this time. An earlier and longer period, from October 2000 to September 2006, was used for validation. In addition, a daily model was used to analyse the robustness of the GESCAL model. Once the GESCAL model was validated, different

scenarios were considered and simulated. First, different combinations of nutrient elimination among the different WWTPs were simulated, leading to the conclusion that investments have to focus on three of the proposed WWTPs. Moreover, these treatments will not be sufficient to maintain fish habitat conditions at all times. Additional measures, such as the increment of the flow in the river or oxygen injection, were simulated. Incrementing the flow of the Manzanares River has been shown to be an efficient means of increasing water quality, but this implies an increment in the risk of water scarcity situations in the Madrid water supply system.

http://www.sciencedirect.com/science/article/pii/S0048969710001816

Gestão de resíduos orgânicos (PT).

Includes a description of the characteristics and processes of soil organic matter. A characterization of organic wastes with interest for agriculture (specially from animal husbandry, from crops, from urban, sewage from wastewater treatment plants and from the food industry origin. It addresses the pollutant potential of organic waste (N, P, Pathogens, Heavy metals,organic micropollutants). Principles for a safe and efficient use of organic waste. Use of organic fertilizers in agriculture (does not provide informations for individual crops).

Gonçalves M.S. (2005) Gestão de resíduos orgânicos. Coleção Agricultura e Ambiente, SPI – Sociedade Portuguesa de Inovação, PRINCIPIA.

GIBSI (CANADA)

Abstract. Hydrological and pollutant fate models have long been developed for research purposes. Today, they find an application in integrated watershed management, as decision support systems (DSS). GIBSI is such a DSS designed to assist stakeholders in watershed management. It includes a watershed database coupled to a GIS and accessible through a user-friendly interface, as well as modelling tools that simulate, on a daily time step, hydrological processes such as evapotranspiration, runoff, soil erosion, agricultural pollutant transport and surface water quality. Therefore, GIBSI can be used to assess a priori the effect of management scenarios (reservoirs, land use, waste water effluents, diffuse sources of pollution that is agricultural pollution) on surface hydrology and water quality. For illustration purposes, this paper presents several management-oriented applications using GIBSI on the 6680 km2 Chaudi`ere River watershed, located near Quebec City (Canada). They include impact assessments of: (i) municipal clean water program; (ii) agricultural nutrient management scenarios; (iii) past and future land use changes, as well as (iv) determination of achievable performance standards of pesticides management practices. Current and future developments of GIBSI are also presented as these will extend current uses of this tool and make it useable and applicable by stakeholders on other watersheds. Finally, the conclusion emphasizes some of the challenges that remain for a better use of DSS in integrated watershed management.

https://www.hydrol-earth-syst-sci.net/11/1785/2007/hess-11-1785-2007.pdf

Greenlight Grower Management (UK)

A cloud based program that enable farmers and agronomists to access, update and share field and crop records in real time. Allows the user to create agrochemical and fertilser plans. Includes a nutrient management tool based on PLANET/RB209. (Used to be called CropWalker).

GTS200 (DE)

Since timing of fertilization in spring is essential to for nutrient losses through leaching, this model aims at predicting the best timing for fertilization which is no ealier than at the start of vegetative growth. The model sums up the average daily temperature starting from 1th January and weighs it by month-specific factors. When 200 degrees are reached, vegetative growth is likely to have started and fertilization measures can be carried out.

GylleIT (DK)

Calculation of the effect of nitrogen in slurry depending on weather data and application technique.

JUBIL (FR)

The JUBIL® method is based on a estimated nitrogen balance, supplemented by a dosage of nitrates in the juice from the base of stem to estimate the actual consummation of the plant. It allows to adapt the doses of nitrogen to the real needs of the culture. The farmers make the dosage of the nitrates in the field with a specific kit (containing a reflectometer to measure concentration). A document helps the farmers for interpretation.

Landcare (DE)

Abstract. Decision support to develop viable climate change adaptation strategies for agriculture and regional land use management encompasses a wide range of options and issues. Up to now, only a few suitable tools and methods have existed for farmers and regional stakeholders that support the process of decision-making in this field. The interactive model-based spatial information and decision support system LandCaRe DSS attempts to close the existing methodical gap. This system supports interactive spatial scenario simulations, multi-ensemble and multi-model simulations at the regional scale, as well as the complex impact assessment of potential land use adaptation strategies at the local scale. The system is connected to a local geo-database and via the internet to a climate data server. LandCaRe DSS uses a multitude of scale-specific ecological impact models, which are linked in various ways. At the local scale (farm scale), biophysical models are directly coupled with a farm economy calculator. New or alternative simulation models can easily be added, thanks to the innovative architecture and design of the DSS. Scenario simulations can be conducted with a reasonable amount of effort. The interactive LandCaRe DSS prototype also offers a variety of data analysis and visualisation tools, a help system for users and a farmer information system for climate adaptation in agriculture. This paper presents the theoretical background, the conceptual framework, and the structure and methodology behind LandCaRe DSS. Scenario studies at the regional and local scale for the two Eastern German regions of Uckermark (dry lowlands, 2600 km(2)) and Weißeritz (humid mountain area, 400 km(2)) were conducted in close cooperation with stakeholders to test the functionality of the DSS prototype. The system is gradually being transformed into a web version (http://www.landcare-dss.de) to ensure the broadest possible distribution of LandCaRe DSS to the public. The system will be continuously developed, updated and used in different research projects and as a learning and knowledge-sharing tool for students. The main objective of LandCaRe DSS is to provide information on the complex long-term impacts of climate change and on potential management options for adaptation by answering "what-if" type questions.

https://www.researchgate.net/publication/236199089_LandCaRe_DSS_-_An_interactive_decision_support_system_for_climate_change_impact_assessment_and_the_analysis_of_potential_agricultural_land_use_adaptation_strategies

LLR (FI)

Abstract. Implementation of the EU Water Framework Directive (WFD) has set a great challenge on river basin management planning. Assessing the water quality of lakes and coastal waters as well as setting the accepted nutrient loading levels requires appropriate decision supporting tools and models. Uncertainty that is inevitably related to the assessment results and rises from several sources calls for more precise quantification and consideration. In this study, we present a modeling tool, called lake load response (LLR), which can be used for statistical dimensioning of the nutrient loading reduction. LLR calculates the reduction that is needed to achieve good ecological status in a lake in terms of total nutrients and chlorophyll a (chl-a) concentration. We show that by combining an empirical nutrient retention model with a hierarchical chl-a model, the national lake monitoring data can be used more efficiently for predictions to a single lake. To estimate the uncertainties, we separate the residual variability and the parameter uncertainty of the modeling results with the probabilistic Bayesian modeling framework. LLR has been developed to answer the urgent need for fast and simple assessment methods, especially when implementing WFD at such an extensive scale as in Finland. With a case study for an eutrophic Finnish lake, we demonstrate how the model can be utilized to set the target loadings and to see how the uncertainties are quantified and how they are accumulating within the modeling chain.

https://link.springer.com/article/10.1007/s00267-015-0514-0

MAGPIE (UK)

A national agri-environmental database and nitrate modelling system has been developed to support the UK government's nitrate policy development. The framework, ‘MAGPIE’, consists of a database and models linked within a Geographical Information System and provides a user interface which allows detailed spatial and statistical investigation of the current state (data and model output) and the impact of changes in conditions or agricultural practice. Data on crops and livestock numbers taken from the annual agricultural census were modified in relation to land cover data derived from remote sensing, and other sources. These data and data on climate, soils and altitude were interpolated to a 1 km grid. The models of nitrate loss were adapted to work with this data set while retaining as far as possible the salient features of the more detailed models and data from which they were derived. The resulting Policy Decision Support System was found to give estimates of mean annual flow and nitrate load for agricultural catchments which matched measured data closely. The system has contributed to work on a number of policy issues both within the UK and in the UK's contribution to international policy development on pollution derived from agriculture.

http://onlinelibrary.wiley.com/doi/10.1111/j.1475-2743.2000.tb00222.x/abstract

MANNER-NPK (UK)

A DST for quantifying manure (and other organic material) crop available nutrient supply. Comprises N transformation/loss modules (covering ammonia volatilisation, nitrate leaching and nitrous oxide/di-nitrogen emissions, and organic N mineralisation), and estimates of manure P, K,

S and Mg supply. Also provides N availability estimates for following crops through the mineralisation of organic N.

http://onlinelibrary.wiley.com/doi/10.1111/sum.12078/abstract

Manual de Fertilização das Culturas (PT)

Soil fertility manual, including a theoretical introduction to key aspects of fertilization followed by specific advises on how to perform the fertilization (different techniques) and how to perform it to the various crops.

INIAP (2006) Manual de Fertilização das Culturas. INIAP - Laboratório Químico Agrícola Rebelo da Silva.

mDSS (IT)

Abstract. This paper presents the methodology applied and results obtained from testing the Decision Support System 'mDSS' developed by the MULINO Project (Multi-sectoral, integrated and operational decision support system for the sustainable use of water resources at the catchment scale), for assessing alternative measures for the reduction of nitrogen pressure from agriculture on water resources at European level. The European policy background is set by the EU Nitrates Directive (91/676/EEC) and the Water Framework Directive (2000/60/EC). The nature of the research is exploratory. It is aimed in particular at testing the usefulness of available official statistics for ex ante evaluations of alternative policy measures at the European scale, and the feasibility of such operations within the newly released mDSS software.

https://www.researchgate.net/publication/223534619_A_decision_support_tool_for_simulating_the_effects_of_alternative_policies_affecting_water_resources_An_application_at_the_European_scale

MELODIE (FR)

Abstract. In regions of intensive pig and dairy farming, nutrient losses to the environment at farm level are a source of concern for water and air quality. Dynamic models are useful tools to evaluate the effects of production strategies on nutrient flows and losses to the environment. This paper presents the development of a new whole-farm model upscaling dynamic models developed at the field or animal scale. The model, called MELODIE, is based on an original structure with interacting biotechnical and decisional modules. Indeed, it is supported by an ontology of production systems and the associated programming platform DIESE. The biotechnical module simulates the nutrient flows in the different animal, soil and crops and manure sub-models. The decision module relies on an annual optimization of cropping and spreading allocation plans, and on the flexible execution of activity plans for each simulated year. These plans are examined every day by an operational management sub-model and their application is context dependent. As a result, MELODIE dynamically simulates the flows of carbon, nitrogen, phosphorus, copper, zinc and water within the whole farm over the short and long-term considering both the farming system and its adaptation to climatic conditions. Therefore, it is possible to study both the spatial and temporal heterogeneity of the environmental risks, and to test changes of practices and innovative scenarios. This is illustrated with one example of simulation plan on dairy farms to interpret the Nitrogen farm-gate budget indicator. It shows that this indicator is able to reflect small differences in Nitrogen losses between different systems, but it can only be interpreted using a mobile average, not on a yearly basis. This example illustrates how MELODIE could be used to study the dynamic behaviour of the system and the dynamic of nutrient flows. Finally, MELODIE can also be used for comprehensive

multi-criterion assessments, and it also constitutes a generic and evolving framework for virtual experimentation on animal farming systems.

https://www.researchgate.net/publication/227708373_MELODIE_A_whole-farm_model_to_study_the_dynamics_of_nutrients_in_dairy_and_pig_farms_with_crops?

MINERVA (DE)

MINERVA is a deterministic model which simulates the N-dynamic in agricultural soils. It is composed of models for water and plant growth.

BEBLIK, A.J. (1992): MINERVA - Das N-Haushaltsmodell aus dem Institut für Boden- und Gewässerschutz (iBUG). Programmbedienung und Befehlsreferenz. Braunschweig (iBUG) [5. Au,age 1997, 201 p].

BEBLIK, A.J. (1996): Beschreibung des Modells MINERVA zur Simulation des N-Haushalts. In: RICHTER, G.M. & BEBLIK, A.J. (1996): Nitrataustrag aus Ackerböden ins Grundwasser unterschiedlich belasteter Trinkwassereinzugsgebiete Niedersachsens. Abschlussbericht - Ergebnisteil. Braunschweig (Inst. f. Geographie und Geoökologie), p5 - 32.

KERSEBAUM , K.C. (1989): Die Simulation der Stickstoff-Dynamik von Ackerböden. Dissertation,Universität Hannover. [180 p].

VAN KEULEN, H.; PENNING DE VRIES, F.W.T.; DREES, E.M. (1982): A summary model for crop growth. In: PENNING DE VRIES AND VAN LAAR (eds.). Simulation of plant growth and crop production. Wageningen (Pudoc). p 87-97.

MONERIS and GREAT-ER (DE)

Abstract. The Elbe-DSS is a computer based system for integrated river basin management of the German part of River Elbe basin. Simulation models are used to assess the efficiency of measures such as reforestation, changes of agricultural practices or the efficiency of wastewater treatment plants for achieving management targets. MONERIS and GREAT-ER are integrated into the Elbe-DSS to assess nutrient and pollutant loads. MONERIS calculates nutrient inputs from diffuse and point sources on a sub-catchment scale of about 1000 km2. GREAT-ER is a tool for exposure assessment of point source emissions and considers fate in sewage treatment plants as well as degradation and transport in rivers. Both models make long-term predictions, but their spatial scales of operations differ. GREAT-ER divides the whole river network into small segments that are linked through a routing algorithm. The segments are coupled to MONERIS using accumulated flow length distribution. Linking the two models allows to distribute diffuse nutrient emissions calculated from MONERIS and point source emissions from GREAT-ER to the river network, where further elimination and transport processes are calculated. We exemplify the DSS in a study assessing the effects of different reforestation and erosion control measures on phosphate loads and concentrations in the river network.

https://www.sciencedirect.com/science/article/pii/S1364815205001830

NEAP-N (UK).

The NEAP-N model (was developed under Defra Water Quality funding as a policy tool to allow estimation of nitrate loss from agricultural land, applicable to any catchment in England and Wales.

https://link.springer.com/article/10.1023%2FA%3A1012695413780

NERM (UK)

The Nutrient Export Risk Matrix (NERM) is a decision support tool to allow farmers and land use planners to assess the risk of nutrient loss from their land and to explore options to reduce nutrient loss whilst maintaining farmer income. (See also FARM and PERM tools based on the same DSM approach). Still under development.

http://ac.els-cdn.com/S0378377416300841/1-s2.0-S0378377416300841-main.pdf?_tid=a24ff260-9ea6-11e7-b70b-00000aacb362&acdnat=1505982598_79355f24a97cec03f516a882d6510243

NIPPER (UK)

Nipper simulates the leaching of nitrate from a soil profile to ground and surface waters. This is achieved by modelling sources and sinks of soil mineral nitrogen (SMN), the effects of land management on SMN and the transport of N in soil water and runoff. The model is largely modular in structure, with various sub-models predicting changes in SMN arising from a group of associated processes (such as crop growth and the associated uptake of nitrogen), and the transport of N through the soil profile. The model predicts crop growth solely in order to estimate the associated uptake of nitrogen; it is not designed to provide accurate predictions of yield required for cost-benefit analyses.

Nitrogen Loading Calculator (NI)

Developed by the Department of Agriculture and Rural Development of Northern Ireland, the calculator is designed to help manage the nitrogen loading limit of the Nitrates regulations. The nitrogen loading limit for most farms is 170 kg N/ha and this is in effect a stocking rate limit. By entering the numbers of livestock and the land area that is farmed the calculator will check if the farm is below the 170kg N/ha/year limit or if operating under derogation below the 250kg N/ha/year limit.

https://www.daera-ni.gov.uk/publications/nitrogen-loading-calculator-app-instruction-manual

NIRAMS (UK)

The Nitrogen Risk Assessment Model for Scotland (NIRAMS) has been developed as a screening tool for prediction of streamwater N concentrations draining from agricultural land in Scotland. The objective of the model is to be able to predict N concentrations for ungauged catchments, to fill gaps in monitoring data and provide guidance in relation to policy development. The model uses national land use, soils and meteorology data sets and has been developed within an ArcView GIS user interface. The model includes modules to calculate N inputs to the land, residual N remaining at the end of the growing season, weekly time-series of leached N and transport of N at the catchment scale. The N leaching and transport are W controlled by hydrological modules, including a national water balance model and a catchment scale transport model. Preliminary testing of NIRAMS has been carried out on eight Scottish catchments, diverse in terms of geographic location as well as land use. The model is capable of predicting the correct mean level of stream N concentrations, as well as the basic characteristics of seasonal variation. As such the model can be of value for providing estimates of N concentrations in ungauged areas.

https://www.researchgate.net/publication/29626835_Nitrogen_Risk_Assessment_Model_for_Scotland_I_Nitrogen_leaching

N-TESTER (FR)

Yara N - tester® is an electronic manual tool that allows quick and easy diagnosis of nitrogen nutrition on a growing culture. N - tester® allows to adjust the doses of nitrogen especially end-of-cycle.

pEMA (UK)

A computer-based decision support tool (p-EMA) has been developed to support UK Government policy of optimising agricultural pesticide use. The system estimates risks to a wide range of taxonomic groups and environmental compartments using methods consistent with current regulatory assessments, but also allows adjustments to reflect formulation, the local conditions and the environmental costs and benefits of varying management practices. Simple models of the dispersion pathways of the pesticide in the local environment are used to estimate predicted environmental concentrations in the field and margin soil, the toxicological properties of the pesticide in the form of toxicity:exposure ratios. Concentrations in groundwater are calculated on the basissurface water and groundwater. Exposure estimates are then combined withof a meta-version of the MACRO model linked to environmental and pesticide databases. Surface water concentrations are taken as themaximum of those arising from inputs via spray drift and drainflow. *No longer available*.

http://sitem.herts.ac.uk/aeru/projects/pestrisk/p-emaleaflet.pdf

PoMs assessment tool (DK)

Abstract. For the 2nd and 3rd river basin management cycles (2015–2027) of the Water Framework Directive (WFD), EU Member States are required to fully integrate climate change into the process of river basin management planning (RBMP). Complying with the main WFD objective of achieving ‘good ecological status’ in all water bodies in Denmark requires Programmes of Measures (PoMs) to reduce nitrogen (N) pollution from point and diffuse sources. Denmark is among the world's most intensively farmed countries and in spite of thirty years of significant policy actions to reduce diffuse nutrient emissions, there is still a need for further reductions. In addition, the impacts of climate change are projected to lead to a situation where nutrient loads will have to be reduced still further in comparison to current climate conditions. There is an urgent need to address this challenge in WFD action programmes in order to develop robust and cost-effective adaptation strategies for the next WFD RBMP cycles. The aim of this paper is to demonstrate and discuss how a map-based PoMs assessment tool can support the development of adaptive and cost-effective strategies to reduce N losses in the Isefjord and Roskilde Fjord River Basin in the north east of Denmark. The tool facilitates assessments of the application of agri-environmental measures that are targeted towards low retention agricultural areas, where limited or no surface and subsurface N reduction takes place. Effects of climate change on nitrate leaching were evaluated using the dynamic agro-ecosystem model ‘Daisy’. Results show that nitrate leaching rates increase by approx. 25% under current management practices. This impact outweighs the expected total N reduction effect of Baseline 2015 and the first RBMP in the case study river basin. The particular PoMs investigated in our study show that WFD N reduction targets can be achieved by targeted land use changes on approx. 4% of the agricultural area under current climate conditions and approx. 9% of the agricultural area, when projected climate change impacts on nitrate leaching rates are included in the assessment. The study highlights the potential of the PoMs assessment tool to assist in evaluation of alternative WFD RBMP scenarios to achieve

spatially targeted and cost-effective reductions of N loads at catchment scale in the context of a changing climate.

http://www.sciencedirect.com/science/article/pii/S0301479716302146

Reglette Colza (FR)

The tool calculates the fertilization by hectare for rapeseed, and suggest additional advice for implementation. A detailed report is made (the report can be send by email). The dose depends on a dozen data to enter: Department, type of soil, yield objective, weight of the colza, organic products fertilization on the plot. Pea seeding effect before rapeseed is integrated.

Lieven, J., Raimbault, J., Charbonnaud, J., Palleau, J., (2014) Nouvelle Réglette azote Colza du Cetiom-Formalimes et Paramètres pour la zone Ouest. Oleotech. 12p.

RQ-flex (SI)

RQ-flex is an electronic manual tool that allows quick and easy diagnosis of nitrogen nutrition (NO3-) on a growing culture and soil.

SAGIS (UK)

Estimates of in-river concentrations (mg/l) and loads (kg/day) of nutrients to rivers in England and Wales from multiple sector sources, modelled with SAGIS (Source Apportionment GIS). The nutrients include nitrate (mg/l N) and ortho-phosphate (mg/l P); the estimate loads are expressed as kilograms per day (kg/day) and the in-river concentrations as milligrams per litre (mg/l). Sources are both diffuse and point. Diffuse sources include livestock farming, arable farming, highways, urban runoff, background (from soils), onsite wastewater treatment systems and atmospheric deposition. Point sources include treated wastewater effluent, combined sewer overflows and storm tanks, industrial discharges and mine water discharges. Concentrations and loads are modelled using the Environment Agency's catchment river model, SIMCAT, at the locations of model features or every 1 km along each river, taking into account all upstream sources and user defined river losses.

https://www.researchgate.net/publication/255691868_Development_of_a_Chemical_Source_Apportionment_Decision_Support_Framework_for_Catchment_Management

SEPARATE (UK)

SEPARATE (SEctor Pollutant AppoRtionment for the AquaTic Environment) includes emissions to the aquatic environment from both diffuse (agriculture, urban, river channel banks, atmospheric) and point (sewage treatment works (STWs), septic tanks, combined sewer overflows (CSOs), storm tanks) sources and summarises the source apportionment on the basis of Water Framework Directive cycle 2 waterbodies.

http://www.sciencedirect.com/science/article/pii/S1462901114000823#!

SIMONTO (DE)

A simulation model which calculates the ontogenetic development of winter wheat based on measured temperature and day length. With that more precise recommendation for timing of fertilization and plant protection measures can be given.

ROßBERG D., JÖRG E. und FALKE K. (2005): "SIMONTO - ein neues Ontogenesemodell für Wintergetreide und Winterraps"; Nachrichtenblatt des Deutschen Pflanzenschutzdienstes (57): 74-80.

SOILNDB/SOILN (SE)

Abstract. The purpose of this study was to develop a method for assessing generalised N leaching estimates from large areas of agricultural land. The system developed was based on calculating a number of N leaching estimates for different typical cropping situations. The estimates were normalised with respect to varying weather conditions and crop production. The different cropping situations were described by setting up a matrix consisting of crucial factors influencing leaching such as soils, crops and climate. Nitrogen leaching was then estimated for a number of combinations of these factors. Calculations were made for three different regions where all the major crops were cultivated on soils with seven different textures and four different organic-N classes and two fertilisation regimes. The three regions are representative of climates and agricultural practices in some of the major agricultural areas in Sweden. The model used was the SOILN model. Leaching of nitrogen from the root zone showed large variations. The range was from 1 to 50 kg ha−1 for different soils and crops when only fertiliser N was applied. Leaching varied both due to different climates and differences in cultivation practices between the regions. Leaching decreased in a south-north gradient. Leaching increased as a result of greater mineralisation when the organic matter content in the soils was increased, leaching was less from soils with a high clay content and was very small for the heavy clay soil.

https://www.researchgate.net/publication/226250415_A_method_for_assessing_generalised_nitrogen_leaching_estimates_for_agricultural_land

SRUC Technical Notes (UK)

Guidance to help farmers and land managers assess the persticides and fertilisers required for the range of crops they plan to grow.

https://www.sruc.ac.uk/downloads/120202/technical_notes

STICS (FR)

Abstract. STICS (Simulateur mulTIdiscplinaire pour les Cultures Standard) is a crop model constructed as a simulation tool capable of working under agricultural conditions. Outputs comprise the production (amount and quality) and the environment. Inputs take into account the climate, the soil and the cropping system. STICS is presented as a model exhibiting the following qualities: robustness, an easy access to inputs and an uncomplicated future evolution thanks to a modular (easy adaptation to various types of plant) nature and generic. However, STICS is not an entirely new model since most parts use classic formalisms or stem from existing models. The main simulated processes are the growth, the development of the crop and the water and nitrogenous balance of the soil-crop system. The seven modules of STICS- development, shoot growth, yield components, root growth, water balance, thermal environment and nitrogen balance- are presented in turn with a discussion about the theoretical choices in comparison to other models. These choices should render the model capable of exhibiting the announced qualities in

classic environmental contexts. However, because some processes (e.g. ammoniac volatilization, drought resistance, etc.) are not taken into account, the use of STICS is presently limited to several cropping systems.

https://www.agronomy-journal.org/articles/agro/abs/1998/05/Agronomie_0249-5627_1998_18_5-6_ART0001/Agronomie_0249-5627_1998_18_5-6_ART0001.html

STONE (NL)

A nutrient emission modeling system, called STONE that was designed for evaluation at the national and regional scale of the effects of changes in the agricultural sector (e.g. changes in fertilizer recommendations and cropping patterns) and in policy measures (e.g. EU nitrate directive for ground water) for the leaching of nitrogen (N) and phosphorus (P) from agricultural land areas to ground water and surface waters.

https://www.sciencedirect.com/science/article/pii/S1364815203000367?via%3Dihub

SUNDIAL (UK)

The model simulates the decomposition of soil organic matter but has been used to model strategies to decrease nitrate losses at the farm level.

https://dl.sciencesocieties.org/publications/aj/abstracts/88/1/AJ0880010038

SWAP/ANIMO (NL)

SWAP-ANIMO consists of the soil physical sub-model SWAP for simulating transport and storage of water and heat, and the nutrient sub-model ANIMO for simulation of soluble C-, N- and P-compounds on the basis of water balance terms and soil temperatures provided by SWAP. It forms the core of the STONE model which was developed for evaluating changes in the agricultural sector (e.g. changes in fertiliser recommendations and cropping patterns) and in policy measures that restrict fertilization levels on the leaching of nitrogen (N) and phosphorus (P) to ground and surface waters on the national scale in the Netherlands.

SWAT (US)

The Soil Water Assessment tool (SWAT) developed in the US has been widely used in the EU and worldwide. See the dedicated SWAT website for details.

https://swat.tamu.edu/

SWIM (DE)

Abstract. This study deals with fuzzy rule based modelling of nitrogen (N)-leaching from arable land. Main purpose is the elaboration of a method, which allows dynamical regionalisation of results from process-based models for large regions and can be efficiently included in metamodels or decision support systems for rapid integrated assessment of water resources. The paper is the second part of a two-part paper. In the first paper the distributed ecohydrological model SWIM had been applied to calculate and analyse nitrogen dynamics in arable soils for a set of representative natural and management conditions in the Saale River basin (Ecol. Model. (in press)). Here, in the

second paper the results from those simulation experiments are used to define, train and validate fuzzy rule systems for the estimation of N-leaching. Nine fuzzy rule systems, specific for nine soil classes, were created from the simulation experiments, representing the conditions for the whole Saale River basin. The fuzzy rule systems operate on monthly time steps and consist of 15 rules and seven input variables each, which are compiled from time series of precipitation, percolation and evapotranspiration as well as from information about fertilizer and crop specific nitrogen uptake. Simulated annealing as a non-linear discrete optimisation method is used for automatic rule assessment. Validation of the fuzzy rule systems, carried out by split sampling of 30-year simulation period, shows satisfactory performance on an annual basis and good performance on the long-term basis with average correlation between SWIM-simulated and fuzzy rule-estimated N-leaching values of 0.78 and 0.94, respectively

https://www.sciencedirect.com/science/article/pii/S0304380001005269

Syst'N (FR)

Software tool for reasoning the nitrogen fertilization, based on a nitrogen balance model for a large number of crops covering field different situations. It simulates the supply of nitrogen through the soil and the organic sources over time.

https://www.sciencedirect.com/science/article/pii/S1364815215000894

The Farm Crap App (UK)

The app can help you get the most from your manure utilising the nutrients efficiently and gaining environmental and economic benefits. You can use it to visually assess application rates and calculate what is being provided in terms of the available nutrients. You can also obtain estimates of potential savings you may make in artificial fertilisers. It allows you to select different seasons, crops and manure type and access information on what the manure will provide in terms of fertiliser value.

https://www.agricology.co.uk/resources/natural-resources-waste-organic-matter-crop-nutrition-fertility-building/farm-crap-app

Think Manures (UK)

Practical guide to manure management

http://www.nutrientmanagement.org/assets/12029

Think Soils (UK)

Practical guide to reducing runoff and erosion.

http://adlib.everysite.co.uk/adlib/defra/content.aspx?doc=263232&id=263233

Tried & Tested (UK)

Website for farmers to improved nutrient management planning. Library of tools and guidance for farmers. As well as introducing the concept of nutrient planning and helping farmers meet

regulatory requirements, good nutrient management will help to reduce diffuse water pollution in order to meet the objectives of the Water Framework Directive.

http://www.nutrientmanagement.org/home/

User Manual/User Guide (UK)

The objective of the ‘User Manual’ was to provide policy makers and those implementing policies with information about the cost, effectiveness and applicability of potential methods in a form that would be readily understood by non-specialists. The ‘User Manual’ was based on earlier reports synthesizing available research data and, where data were unavailable, used expert elicitation. The outcome generated 44 potential methods (under the broad categories of land use, soil management, livestock management, fertilizer management, manure management and farm infrastructure) and described the simultaneous impact of applying each method on losses of nitrate, phosphorus and faecal indicator organisms relative to baseline losses. Estimates of cost and effectiveness were presented at the whole-farm level for seven model farm types. Methods differed widely in their cost-effectiveness and applicability to the different model farms. Advantages and limitations of the approach are discussed and subsequent developments of the original ‘User Manual’ are described, together with the opinions of catchment officers who have used the ‘User Manual’ to implement mitigation methods on farms.

Cuttle, S. P. and Newell-Price, J. P. and Harris, D. and Chadwick, D. R. and Shepherd, M. A. and Anthony, S. G. A. and Macleod, C. J. A. and Haygarth, Philip Matthew and Chambers, B. J. (2016) A method-centric 'User Manual' for the mitigation of diffuse water pollution from agriculture. Soil Use and Management, 32 (Suppl). pp. 162-171. ISSN 0266-0032

Vandregnskab Online (DK)

Online meteorological data own measurement of precipitation and field data are processed to give the need for irrigation on the individual fields.

https://www.seges.dk/da-dk/software/plante

WOG/WOD (NL)

A model that links fertilizer rates, farm management with emissions (leaching of nitrate) using the surplus of N (and P) as key parameters. This model has been used to derive N application standards in the Netherlands.

http://edepot.wur.nl/5350

APPENDIX 3: SUMMARY INFORMATION ON OTHER (LONGLISTED) PESTICIDE DSTS

Ageruglevarsling (DK)

Warning system for when to protect against Agrotis segetum.

Aplicação de produtos fitofarmacêuticos - Manual do Formando (PT)

Technical manual for the use of phytopharmaceutical products. Includes biological fight and biotechnic fight , the characterization phytopharmaceutical products, the regulations, how to apply the substances, security procedures, risk minimization, best phytosanitary practices, application techniques and materials, accidents with phytopharmaceutical products.

Carvalho A.J., Mendes C.C., Rodrigues J.G., Ramalho M. (2010) Aplicação de Produtos Fitofarmaceuticos. Manual do Formando. CONFAGRI

ARTEM-WQ (FR)

ARTEM-WQ main purpose is to provide water stakeholders with a holistic tool for identifying and assessing the risks posed by the complex range of pressures (agricultural, industrial, climatic, etc.) on water resources. The general architecture takes the following sequential approach. Water resources risk analysis based on a score determined from data on catchment land-use and land management.

https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4113881/

CASCADE (NL)

CASCADE is a tool for assessing exposure concentrations of plant protection products in systems of small water courses based on good agricultural practice of these products. The scale of the area of interest is typically of the order of 10 km². The CASCADE software tool has the following components

- CASCADE_Drift to calculate the deposition on water courses due to good agricultural application practices
- CASCADE_TOXSWA to calculate exposure concentrations in water resulting from deposition as calculated by the CASCADE drift component.

http://www.cascade.pesticidemodels.eu/

CERCBET3 (DE)

Delivers a prognosis of the infection rate of sugar beets with Cercospora beticola. It requires a onetime input of infection rate in previous year. It helps to optimize timing of fungicide applications.

JÖRG E., RACCA P. und KLEINHENZ B. (2001): "The CERCBET - Models: Decision Support Systems for Cercospora Leaf Spot Control in Sugar Beet in Germany"; EFITA 2001, Third

European Conference of the European Federation for Information Technology in Agriculture Food and the Environment, pp. 13-18.

CPOWeeds (ESP)

Abstract. The Danish decision support system Crop Protection Online (CPO) optimises herbicide weed control. CPO recommends specific herbicide solutions to achieve a required level of control. The aim is to apply herbicides as little as possible but as much as necessary. CPOWeeds is a version of CPO adjusted to conditions in North-eastern Spain. The predicted efficacies and the yield obtained with CPOWeeds were validated in winter cereal field trials from 2010 to 2013. All CPOWeeds treatments were related to the efficacies obtained with standard herbicide treatments decided upon by local advisors. The predictions from CPOWeeds were compared to the actually achieved efficacies in the field trials for the nine weed species at different developmental stages and for 84.2% of the comparisons the obtained efficacies were equal to or higher than predicted. The average difference between predicted and observed efficacies was 2.35 percentage points. Yield was measured in three trials and the recommendations from CPOWeeds were maintaining yield. There were two situations where CPOWeeds were performing suboptimal. One is in the early weed growth stages, as the model is not yet prepared to account for water stress on root action herbicides applied at 10-11 BBCH. The second situation was in fields with a prior unidentified population of resistant Alopecurus myosuroides. For key species in winter cereals in Spain, such as Avena sterilis, Lolium rigidum and Papaver rhoeas, CPOWeeds achieved a satisfactory control level. It was concluded that the use of CPOWeeds allowed optimisation of the herbicide application with a very high robustness. The recommendations were satisfactorily for the conditions of the Northeast of Spain and have the potential to decrease the amount of applied herbicides by at least 30%. Therefore, it can be an important tool in Integrated Weed Management.

http://www.sciencedirect.com/science/article/pii/S0261219414001975

Cultivar a Segurança - Manual técnico (PT)

Technical manual for the use of phytopharmaceutical products, including an introdution, the transport of small amounts of phytopharmaceutical products, storage, syrup preparation, phytopharmaceutical application, post application, Preventive mesures in the use of phytopharmaceutical products, security for consumers.

http://anipla.com/cultivaraseguranca.php?id=1001

DET (various)

Abstract. In order to protect water and other sensitive areas from spray drift, and make the best use of mitigation measures, an evaluation of drift risk should be made prior to a spray application. The objective of this work was to develop a practical, interactive tool to evaluate the risk of spray drift for specific weather and field situation, and propose effective measures to mitigate this risk. This should help the pesticide user to make better decisions in order to reduce potential spray drift contamination. The Drift Evaluation Tool (DET) is intended to be used by the pesticide users and advisors, and hence raise their awareness on the effect of factors influencing spray drift and on mitigation measures to reduce drift risk. The aim was to offer a simple and practical application software that would be user-friendly and educative to encourage its wide use. The operator communicates with the software via its simple and intuitive visual interface. He is guided through three pages and asked to select in the proposed lists of options the parameters that best reflect his

actual situation. On the first page the user determines the application site: within or beyond the zone of awareness (buffer zone plus boom width), i.e. whether or not risk of drift need to be considered. On the next page he determines actual weather and field conditions: wind direction and velocity, air temperature and humidity, crop height and adjacent structures. Once the items are selected the Drift Risk Value SITUATION (%) (DRVS) is calculated and expressed both in figure and graphically. Thus, the user can see directly how variations in weather and field conditions may affect the spray drift risk. Depending on the risk level appropriate practical recommendation appears on the screen. On the last page the user simulates mitigation measures by selecting different application techniques and application parameters. He may select spray drift reduction class of the simulated technique, boom height and driving velocity. For each selection a Drift Risk Value – APPLICATION (%) (DRVA) is calculated to show the effect of the selected risk mitigation measures. The final recommendation is given to the user based on the determined risk level. The algorithm of calculation of drift risk values for the selected items is based on available results of drift studies, and where information was missing, especially on interactions between factors, an expert judgment was used in the algorithm.

http://www.sciencedirect.com/science/article/pii/S0168169913001361#!

DRASTIC (GR)

Abstract. The evaluation of groundwater vulnerability is a very important task, especially in sensitive areas such as islands where groundwater resources are scarce and often of poor quality. In the present study a geographic information systems based methodological approach is followed, considering three different models, namely the Generic DRASTIC, the Pesticide DRASTIC and the Susceptibility index (SI) in order to evaluate groundwater vulnerability in the island of Aegina, Greece. Seven parameters—depth to water, net recharge, aquifer media, soil media, topography, impact of vadose zone media and hydraulic conductivity of the aquifer (DRASTIC) along with land use changes—have been considered as weighted layers to enable an accurate mapping of groundwater contamination risk. The results indicate “high” to “very high” vulnerability to groundwater contamination along the north and the northwestern parts of Aegina island for both DRASTIC and SI models. These sensitive regions exhibit characteristics such as shallow depth to groundwater, extensive marine and alluvial deposits, highly permeable limestones, flat topography and intensive agricultural activities. The distribution of nitrate concentrations in groundwater in the study area indicated that both DRASTIC models are characterized by quite good to very good accuracy, while moderate correlation was noted for the SI model. Sensitivity analysis was also performed to assess the impact of DRASTIC and SI parameters and thus identify the most critical ones that require further future investigation. Aquifer media is the parameter that exhibited the highest impact on groundwater vulnerability indices followed by the impact of the topography and soil media. The methodology adopted in the present study can be used as a decision support tool to indicate which preventive or remedial measures need to be taken by local and regional authorities as well as by policy makers, in order to minimize the cost of groundwater monitoring and consequently improve groundwater quality and agricultural sustainability.

https://www.researchgate.net/publication/316136528_Evaluation_of_groundwater_vulnerability_in_a_Greek_Island_using_GIS-based_models

DRIPS (DE)

Abstract. The GIS-based decision support system (DSS)—drainage runoff input of pesticides in surface water, DRIPS—has been developed on behalf of the German EPA (UBA) for exposure assessment of agriculturally used pesticides in surface waters. The tool estimates the quantity of

pesticide input from non-point sources via surface runoff, tile drainage and spraydrift. Furthermore, the resulting predicted environmental concentration of pesticides in surface waters (PECsw) can be calculated considering the mean daily inputs of substances into river basins, characterized by their daily discharge. A graphical user interface (GUI) was created to provide users of the DSS with easy access to the model algorithms. Model parameters such as sorption (Koc), half-life (DT50), dose rate and application date of pesticides can be modified by the user in order to generate customized scenarios predicting PECsw for a choice of field crops, orchards or vineyards. Results are available as grid cell maps for the territory of Germany, featuring monthly catchment specific PECsw values

http://www.sciencedirect.com/science/article/pii/S1364815203002573#!

DROPLET (NL)

DROPLET is the acronym for "DRinkwater uit OPpervlaktewater Landbouwkundig gebruik Evaluatie Tool". For the nine Dutch surface water abstraction points for drinking water production it calculates the expected pesticide concentration after Good Agricultural Practice. DROPLET uses the edge-of-field concentration in the FOCUS D3 ditch as a starting point for its calculation (with spray drift deposition according to the Dutch Drift Table and not the FOCUS Drift Calculator). Next, pesticides flow from the edge-of-field ditch to the abstraction points situated in larger water bodies downstream. On their way towards the abstraction points, the concentration is reduced by pesticide dissipation processes and inflow from water not containing pesticides. The concentration reduction is calculated with the aid of intake area and pesticide specific factors:

- the ratio of the relevant crop area and the entire intake area
- the market share of the pesticide
- the difference in timing of applications
- degradation and volatilization and in some cases
- additional dilution by a lake or incoming river

http://www.droplet.pesticidemodels.eu/

EOS (various EU)

Abstract. Despite technological progress in pesticide application equipment, chemical crop protection continues to contribute to environmental pollution. Water is at risk of contamination with pesticides from point and diffuse sources and could be reduced to a great extent with a better sprayer design. The sprayer manufacturers and pesticide applicators need to take more responsibility for the prevention of water pollution and therefore they have to make environmentally responsible decisions at different stages, from designing to servicing sprayers. The objective of the presented work was to develop an interactive application that would support decisions made by sprayer manufacturers during the production process, and by pesticide applicators when selecting and operating the sprayers. The EOS (Environmentally Optimised Sprayer) is an application evaluating the risk mitigation potential of sprayers based on their technological features, within five risk areas, representing sources of pollution: (i) Inside Contamination; (ii) Outside Contamination; (iii) Filling; (iv) Spray Loss & Drift; (v) Remnants. The evaluator completes the EOS questionnaire by checking for the technical solutions identified in the evaluated sprayer and the result reflects the sprayer quality in terms of potential environmental risk mitigation. The EOS tool also proved its awareness raising facility and educative value when used during training activities and university courses.

http://www.sciencedirect.com/science/article/pii/S0048969714003027

FITO – INFO (SI)

Information system for public use:

– Plant protection products

– Plant protection related legislation

– Organisms names, descriptions, pictures, ...

– Forecast information

– Important information for plant producers – news

– All other information regarded to plant protection.

http://www.fito-info.si/E_index.asp

FUS-OPT (DE)

Simulation of infection risk of winter wheat by Fusarium graminearum. Combination of climatic data, data on agricultural management (precrop) and site condition (soil quality, etc.); data on plant development is genererated by model SIMONTO.

Jörg, E & Racca, Paolo & Weinert, J & Tiedemann, Andreas & Kleinhenz, Benno. (2008). FUS-OPT A decision support system for fungicide scheduling against fusarium headblight. 507.

GEM (NL)

The Greenhouse Emission Model (GEM) instrument incorporates the new greenhouse horticulture exposure scenarios as developed by two Dutch working groups on demand of the Dutch ministries of Economic Affairs and Infrastructure & the Environment. It has been developed to be used in the Dutch registration process. As far as we know, this is the first instrument that is specifically dedicated to greenhouse horticulture to be used in the environmental risk assessment as part of the PPP registration process. In the coming years the developments in this important Dutch economic sector will continue. This instrument intends to keep pace with these new (scientific) insights. The instrument enables the calculation of the Predicted Environmental Concentration for the protection goals: ‘Aquatic ecosystem’ and ‘Groundwater as source for drinking water’, while using the scenarios as described in Van der Linden et al. (2015) and Wipfler et al. (2015).

http://www.pesticidemodels.eu/gem/home

Getreide-SIG (DE)

Simulation of infection potential of cereals with 23 diseases (winter wheat, winter barley, winter rye, winter triticale, summer barley)

FALKE K. und RACCA P. (2010): "Darstellung der Schaderreger-Infektions-Gefahr (SIG) im Getreide in Form von Risikokarten"; In: PFLANZENSCHUTZTAGUNG D. und KüHN-INSTITUT J. (eds.) 57. Deutsche Pflanzenschutztagung. 6. - 9.September 2010 Humboldt-Universität zu Berlin; Gesunde Pflanze, gesunder Mensch, p. 136. Berlin: Julius Kühn-Inst., Bundesforschungsinst. für Kulturpflanzen.

Guidance Notes on Integrated Pest Management For Use On Irish Farms (IE)

A paper-based advisory sheet which presents farmers with options for pest management and highlights alternatives that they may not have considered. They are designed to help end users of PPPs to reduce reliance on PPP use and to reduce the risks associated with such use. All pesticide users in a professional capacity (including farmers) must must operate to the principles of IPM from January 2014.

http://www.iasis.ie/Documents/Guidance%20Notes%20on%20Integrated%20Pest%20Management%20(IPM).pdf

Gulerodsfluevarsling (DK)

Warning system for when to protect against Psiale rosae

GWA (NL)

The Groundwater Atlas (GWA) contains monitoring data on the presence of active substances and related metabolites of plant protection products and biocides. These data were collected by the regional government authorities (Provinces of the Netherlands) and by the Dutch drinking water companies that are monitoring the quality of the groundwater regularly.

The aim of the Groundwater Atlas is to make relevant monitoring data accessible for use in the registration procedure for plant protection products and biocides. Version 1.1 contains part of the existing, relevant monitoring data in The Netherlands. The user may explore the data interactively, i.e. by selecting the compound of interest, the period in time, the sampling depth, and the monitoring networks. General statistics on the data are available, as well as several spatial and temporal presentations of the data, and some basic report functions.

http://www.pesticidemodels.eu/groundwateratlas/home

HAIR (NL)

The HAIR instrument can calculate risk indicators related to the agricultural use of pesticides in European countries. The intended use of HAIR is to calculate trends in aggregated risk, for evaluating the objectives on the sustainable use of pesticides mentioned e.g. in a National Action Plan (Sustainable Use Directive EU 2009/128).

http://www.pesticidemodels.eu/hair/home

IMAS (FR)

The model of agricultural scenario (IMAS) draws on a range of data and expert knowledge. A so-called “reference scenario” represents the actual soil occupation and pesticide-spraying practices. A number of alternative scenarios are then defined in cooperation with stakeholders targeting mitigation measures. The assessment of these scenarios is based on the calculation of spatialized environmental indicators and on integrated bio-economic modeling.

https://link.springer.com/article/10.1007%2Fs11356-016-7657-2

INDIGO (FR)

After several version, "Ipest" become "Iphy". A new method was set called "Indigo" to use this indicator. Indigo is a tool for agronomists to enable them to assess the impact on the environment (water, soil, air, non-renewable resources, etc.) of systems existing or being designed so. Indigo could 1) identify weak and strong systems 2) identify improvements tracks 3) Select the most effective cropping systems

https://www6.inra.fr/ciag/content/download/5189/40623/file/Vol31-5-Lebellec.pdf

IPEST (FR)

Ipest is an indicator calculated by a fuzzy expert system. IPEST reflects an expert perception of the potential environmental impact of the application of a pesticide in a field crop. Four modules are defined : one reflecting the presence of the pesticide, the other three reflecting the risk for three major environmental compartments (groundwater, surface water, air).

http://www.sciencedirect.com/science/article/pii/S0045653597101941?via%3Dihub

Kålfluevarsling (DK)

Warning system for when to spray against Delia radicum.

www.landbrugsinfo.dk

Kartoffelskimmelvarsling (DK)

Internet based programme that calculates how often and which amount of fungicide is needed to prevent Phytopthera infestas in the individual field based on meteorotogical data and site specific precipitation

www.landbrugsinfo.dk

Liaison (UK)

LIAISON provides instant online access to a wealth of information on all UK pesticide approvals, label information and Maximum Residue Levels (MRLs) – helping everyone in the food supply chain to make well-informed decisions about pesticide management, responsible sourcing, crop-treatment practices and other factors affecting the safety and quality of food. By providing all of this disparate and sometimes difficult-to-find data in one place, LIAISON helps to save you time and resources when you need information on any UK-registered crop-protection product. LIAISON is updated daily using pesticide authorisations, manufacturers' labels and the latest Extensions of Authorisation for Minor Use (EAMUs). Tailored information can also come direct to your inbox when you subscribe to the information bulletin service for weekly updates. Everything you need to make confident decisions about pesticide management is available on your laptop, smartphone, or tablet in the office or in the field. All this ensures LIAISON is an indispensable decision-support tool for growers, food processors, agronomists, retailers, wholesalers and testing laboratories

https://www.fera.co.uk/liaison#detail

MACRO (UK/SE)

MACRO-DB: a decision-support tool for assessing pesticide fate and mobility in soils.

http://www.sciencedirect.com/science/article/pii/S1364815297001473#!

MASTEP (NL)

The MASTEP (Metapopulation model for Assessing Spatial and Temporal Effects of Pesticides) model is a metapopulation model describing the effects and recovery of invertebrates after exposure to pesticides as a result of spray drift. The model is currently parameterised for the waterlouse Asellus aquaticus but more species with different life-cycle characteristics will be added in 2006. It is able to evaluate the effects on and recovery of the species using the pond, ditch and stream FOCUS scenario. The model can use the FOCUS exposure modelling using the use patterns, the FOCUS spray drift data and the fate model TOXSWA as input for exposure data. The modelled landscape is represented as a lattice of connected cells, which have a dimension of 1 by 1 meter. The structure of the landscapes is defined according to the FOCUS scenarios for pond, ditch and stream.

http://www.mastep.wur.nl/

Middeldatabasen (DK)

A web based database on all Danish pesticides used for crop protection - containing full information on active ingredients, trade names, approvals, effect, vendor etc.

www.landbrugsinfo.dk

MILEOS (FR)

Mileos® lets the user know at any time the 'risk of mildew' in the field depending on the weather, the variety, the dates of planting, the health status around the field and the interventions (treatments and irrigations). Mileos® is a decision support tool at the plot scale to position the pesticide treatment against mildew on potatoes.

https://www.perspectives-agricoles.com/file/galleryelement/pj/f8/21/37/ce/305_7656659985044721166.pdf

Moni-model (IT)

Abstract. Historically, the approach used to manage risk of chemical contamination of water bodies is based on the use of monitoring programmes, which provide a snapshot of the presence/absence of chemicals in water bodies. Monitoring is required in the current EU regulations, such as the Water Framework Directive (WFD), as a tool to record temporal variation in the chemical status of water bodies. More recently, a number of models have been developed and used to forecast chemical contamination of water bodies. These models combine information of chemical properties, their use, and environmental scenarios. Both approaches are useful for risk assessors in decision processes. However, in our opinion, both show flaws and strengths when taken alone. This paper proposes an integrated approach (moni-modelling approach) where monitoring data and modelling simulations work together in order to provide a common decision framework for the risk assessor. This approach would be very useful, particularly for the risk

management of pesticides at a territorial level. It fulfils the requirement of the recent Sustainable Use of Pesticides Directive. In fact, the moni-modelling approach could be used to identify sensible areas where implement mitigation measures or limitation of use of pesticides, but even to effectively re-design future monitoring networks or to better calibrate the pedo-climatic input data for the environmental fate models. A case study is presented, where the moni-modelling approach is applied in Lombardy region (North of Italy) to identify groundwater vulnerable areas to pesticides. The approach has been applied to six active substances with different leaching behaviour, in order to highlight the advantages in using the proposed methodology.

http://www.sciencedirect.com/science/article/pii/S0048969715312146

OPTIPHY (FR)

OptiPhy is a tool of optimization of pesticide practices based on risk indicators.Two indicators have been developed. The IRSA is an indicator, which evaluates the acute toxicities and chronic pesticide. The IRTE indicator assesses the eco-toxicological impacts on non-targets organisms as well as the physicochemical transfert of the molecules in the environment.

https://link.springer.com/article/10.1007/s11356-016-6775-1

PEARL (NL)

PEARL and GeoPEARL are used to evaluate the leaching of pesticides to the groundwater, drainage of pesticides to surface waters and persistence of pesticides in topsoils. Primary aim is to support European and Dutch pesticide registration procedures. Metamodels of PEARL are used to evaluate policies, such as the EU Thematic Strategy on the Sustainable Use of Plant Protection Products.

http://www.pearl.pesticidemodels.eu/

PELMO (DE)

Abstract. The PELMO model was used independently by five modellers to reproduce the results of a lysimeter study performed at Tor Mancina in Italy and a field study performed at Vredepeel in the Netherlands. For the comparisons of the Tor Mancina data set the main features of the measured fluxes of water and bromide were well reproduced by the simulations. The deviations between simulated and experimental cumulative amounts of water leached were generally less than 50%. The measured leaching of metolachlor was small (typical concentrations considerably below 0.1 µg/l). These trace amounts were not reproduced by any of the simulations, not even by those calibrated for bromide leaching in the re-packed lysimeters. For Vredepeel, the agreement between the measured and simulated water tables were generally poor, even on a qualitative level. This was mainly due to PELMOs inability to deal with shallow, fluctuating groundwater tables. Concentrations of both the tracer and the pesticides were generally satisfactorily reproduced in the initial phases of the experiment but not at later stages. In most cases, the penetration depth of the centre of mass was over-estimated by the model and the dispersion of the pesticide under-estimated. The correct determination of the parameters to simulate the degradation (and adsorption) of pesticide in the field seemed to be of much greater importance for accurately modelling the transport of such chemicals in soils than improvements in the water balance. The degradation data from long-term laboratory studies clearly did not reflect field conditions. Additional sampling dates to determine more concentration profiles and to measure DT50 values from the field would have helped reducing the differences in picking different input data by the modellers

and would have improved the accuracy of the model predictions. Validation tests, user guidance and good modelling practice are recommended as essential tools to improve the confidence of the scientific community in modelling results.

http://www.sciencedirect.com/science/article/pii/S0378377499000955#!

PERPEST (NL)

PERPEST is a model that Predicts the Ecological Risks of PESTicides in freshwater ecosystems. This system predicts the effects of a particular concentration of a pesticide on various (community) endpoints, based on empirical data extracted from the literature, see figure below. The method that it uses is called Case-Based Reasoning (CBR), a technique that solves new problems (e.g., what is the effect of pesticide A?) by using past experience (e.g., published microcosm experiments). The database containing the “past experience” has been constructed by performing a review of freshwater model ecosystem studies evaluating the effects of pesticides. This review assessed the effects on various endpoints (e.g. community metabolism, phytoplankton, macro-invertebrates) and classified them according to their magnitude and duration. The PERPEST model searches for situations in the database which resemble the question case, based on relevant (toxicity) characteristics of the compound. This allows the model to predict effects of pesticides for which no evaluation on a semi-field scale have been published. PERPEST results in a prediction showing the probability of classes of effects (no, slight or clear effects, plus an optional indication of recovery) on the various grouped endpoints. The model is described in the scientific paper written by Van den Brink et al. (2002).

http://www.perpest.alterra.nl/

PRIZM (IT)

Abstract. The need to quantitatively predict pesticide runoff and erosion under cropping system management has gained increasing importance. In Europe, predictive models have not yet been fully validated because of the lack of field data sets. The objective of this study was to validate the capability of PRZM (Pesticide Root Zone Model) 3.12 to predict water runoff, sediment erosion, and associated transport of atrazine (6-chloro-N(2)-ethyl-N(4)-isopropyl-1,3,5-triazine-2,4-diamine), terbuthylazine (N(2)-tert-butyl-6-chloro-N(4)-ethyl-1,3,5-triazine-2,4-diamine), and metolachlor [2-chloro-6'-ethyl-N-(2-methoxy-l-methylethyl)acet-o-toluidide] under common tillage management practices found in northern Italy. A 2-yr field data set was used to evaluate the model. Results showed that the model could qualitatively simulate significant differences of water runoff, soil erosion, and associated herbicide losses between conventional tillage (CT) and minimum tillage (MT) for a winter barley (Hordeum vulgare L.) cover crop. For MT, water runoff, soil erosion, herbicide losses in water runoff and eroded sediment, and the proportion of herbicide loss via sediment erosion were significantly lower than for CT. The model failed to correctly simulate event-based herbicide concentration, water runoff, and soil erosion. The model usually underestimated pesticide runoff events with high rainfall intensity and low daily precipitation volume, and overestimated runoff events with low intensity and high volume. The main reason was that the description of runoff and erosion processes is rather empirical in the model and not physically based. Moreover, model calculations do not adequately reflect the relationships between soil erosion intensity and chemical concentration in sediment losses, leading to discrepancies between predictions and field observations.

https://www.researchgate.net/publication/8358274_Modeling_the_Effects_of_Tillage_Management_Practices_on_Herbicide_Runoff_in_Northern_Italy

Registreringsnettet (DK)

Nation wide monitoring system for different crop diseases communicated via the internet and agricultural magazines.

www.landbrugsinfo.dk

REXTOX (DE)

Abstract. The prediction of runoff-related pesticide entry into surface waters on a landscape level usually requires considerable efforts with regard to input data, time, and personnel. Therefore, the need for an easy to use simulation tool with easily accessible input data, for example from already existing public sources, is obvious. In this paper, we present a simulation tool for the simulation of pesticide entry from arable land into adjacent streams. Our aim was to develop a tool applicable on the landscape level using “real world data” from numerous sites and for the simulation of parameter case studies concerning particular parameters at single sites. We used the ratio of exposure to toxicity (REXTOX) model proposed by the OECD, which had been successfully validated in the study area as part of a previous study and which was extended to calculate pesticide concentrations in adjacent streams. We simulated the pesticide entry on the landscape level at 737 sites in small streams situated in the central lowland of Germany with winter wheat, barley, and sugar beat as the main agricultural crops. A sensitivity analysis indicated that the most significant model parameters were the width of the no-application zone and the degree of plant interception. The simulation was carried out for the 15 most frequently detected substances found in the study area using eight different environmental scenarios, covering variation of the width of the no-application zone, climate, and seasonal scenarios. The highest in-stream concentrations were predicted for a scenario using no (0 m) buffer zone in conjunction with increased precipitation. According to the predicted concentrations, the risk for the aquatic communities was estimated based on standard toxicity tests and the application of a safety factor. The simulation results are presented both by means of risk maps for the study area showing the simulated pesticide concentration and the resulting ecological risk for numerous sites under varying scenarios and by case study diagrams with focus on the model behavior under the influence of single parameters. Risk maps confirmed the importance of no-application (buffer) zones for the levels of pesticide input. They also indicated the importance of the existing no-application zones for certain compounds and in some cases the need for a further evaluation of these regulations. The simulation tool was implemented as a standard PC software combining the REXTOX model with a geographical information system and can be used on any current personal computer. All input data was taken from public sources of German authorities. With little effort the tool should be applicable for other areas with similar data quality

http://www.sciencedirect.com/science/article/pii/S0147651305001028

RICEWQ (IT)

Abstract. Model predictions are often seriously affected by uncertainties arising from many sources. Ignoring the uncertainty associated with model predictions may result in misleading interpretations when the model is used by a decision-maker for risk assessment. In this paper, an analysis of uncertainty was performed to estimate the uncertainty of model predictions and to screen out crucial variables using a Monte Carlo stochastic approach and a number of statistical methods, including ANOVA and stepwise multiple regression. The model studied was RICEWQ (Version 1.6.1), which was used to forecast pesticide fate in paddy fields. The results

demonstrated that the paddy runoff concentration predicted by RICEWQ was in agreement with field measurements and the model can be applied to simulate pesticide fate at field scale. Model uncertainty was acceptable, runoff predictions conformed to a log-normal distribution with a short right tail, and predictions were reliable at field scale due to the narrow spread of uncertainty distribution. The main contribution of input variables to model uncertainty resulted from spatial (sediment-water partition coefficient and mixing depth to allow direct partitioning to bed) and management (time and rate of application) parameters, and weather conditions. Therefore, these crucial parameters should be carefully parameterized or precisely determined in each site-specific paddy field before the application of the model, since small errors of these parameters may induce large uncertainty of model outputs.

https://www.researchgate.net/publication/51369157_Uncertainty_assessment_of_the_model_RICEWQ_in_northern_Italy

Schoonwaterwijzer (NL)

Growers can design their own yearly plan for Integrated Pest Management. Farmer fill out which crops they grow and are given recommendations to implement the several steps of IPM (prevention, monitoring, non-chemical and chemical control).

http://schoonwaterwijzer.nl/

SEPTRI (DE)

Simulation of infection risk of winter wheat by Mycosphaerella graminicola - Combination of climatic data, and site condition (soil quality, etc.); data on plant development is genererated by model SIMONTO.

FALKE K., ERVEN, T. (2011): "SEPTRI-Prognosemodelle - Sortenanfälligkeit bei der Bekämpfungsstrategie gegen Septoria tritici beachten"; Getreidemagazin (2).

SIMCERC (DE)

Simulation of infection risk with Pseudocercosporella herpotrichoides between plant development stages BBCH 23 and BBCH 32; it integrates real-time climatic data, seeding time, crop varieties and crop rotation. Data on plant development is genererated by model SIMONTO.

WEINERT J., KLEINHENZ B., JÖRG E. und RACCA P. (2004): "SIMCERC 3 - ein optimiertes Modell zur Prognose von Pseudocercosporella herpotrichioides an Winterweizen und Triticale" 54. Deutsche Pflanzenschutztagung, p. 164. Hamburg: Biologische Bundesanstalt für Land- und Forstwirtschaft, Berlin und Braunschweig.

SIMLAUS (DE)

Population development of Rhopalosiphum maidis is calculated based on a start population and recent climatic data in autumn. It helps to determine optimized timing of insecticide measures.

Skulpegalmygvarsling (DK)

Warning system for when to spray against Daseneura brassicae.

www.landbrugsinfo.dk

SPIN (NL)

In the EU and Dutch registration procedure, exposure assessment models such as PEARL, TOXSWA, SWASH and GEM, are used to evaluate the environmental risk of agricultural use of plant protection products. For each of these models substance specific parameters are required as input to calculate the relevant environmental exposure concentrations. Because a number of substance properties are the same for all of these models, SPIN has been developed to edit and store substance properties.

SPIN is a database that stores substance properties relevant to the supported exposure assessment tools. The (graphical) user-interface facilitates access to the database and the interaction with the user. Each substance has a unique code, a name and a short description. New substances can be added easily to the database by creating a new substance or by copying, renaming and editing an existing substance. Substance properties are organized according to the process they address, i.e. 'sorption', 'transformation' and 'crop processes'. To facilitate easy creation of new substances, example substances are provided for each host application, which can be copied and modified. The database can be copied and exchanged between users, whereas substances with their properties can also be exported and imported using a pre-described procedure. SPIN automatically creates a new database when it does not detect an existing database e.g. when the old database has been removed or when no prior installation of a SPIN version has been done. SPIN version 2.2 is linked to exposure assessment tools, which are referred to as host-applications (currently FOCUS_SWASH 5.3, FOCUS_TOXSWA 4.4.3, GEM 1.1.1). FOCUSSPIN version 2.2 (equivalent with SPIN 2.2.) can only be downloaded from the FOCUS website http://focus.jrc.ec.europa.eu/sw/index.html. SPIN can be run in two different modes; in the standalone mode all substance properties are accessible and can be filled in, when started by a host application only the host-specific properties are accessible and can be filled in. It has been developed such that all new releases can communicate with earlier released host-applications. An import-export option enables easy exchange of data.

http://www.pesticidemodels.eu/spin/home

SWASH (NL)

SWASH is an acronym for Surface WAter Scenarios Help and is an overall user-friendly shell, managing the communication and data transfer between three models involved in Step 3 calculations for the FOCUS Surface Water Scenarios. These scenarios have been developed as part of the EU evaluation process under 91/414/EEC (See FOCUS Website). Spray drift, drainage and run-off are the routes of pesticide entry into surface waters. Using spray-drift deposition tables and the MACRO, PRZM and TOXSWA models the exposure concentrations in surface waters can be assessed. To carry out the FOCUS Surface Water Scenarios, a drift assessment tool and two pesticide fate models have to be run in the correct sequence.

http://www.pesticidemodels.eu/swash/home

TOXSWA (NL)

TOXSWA is a pseudo-dimensional model, describing pesticide behaviour in a water layer and its underlying sediment at the edge-of-field scale. TOXSWA is the acronym for TOXic substances in Surface WAters. TOXSWA calculates Predicted Environmental Concentrations in surface water to

support the pesticide registration procedures in the Netherlands with TOXSWA v1.2 since 1999, and in Europe with FOCUS_TOXSWA since 2003.

http://www.pesticidemodels.eu/toxswa/home

Utilização de produtos fitofarmaceuticos na agricultura (PT)

Technical manual for the use of phytopharmaceutical products. Includes biological fight and biotechnic fight , the characterization phytopharmaceutical products, the regulations, how to apply the substances, security procedures, risk minimization, best phytosanitary practices, application techniques and materials, accidents with phytopharmaceutical products.

Simões J.S. (2005) Utilização de produtos fitofarmaceuticos na agricultura. Coleção Agricultura e Ambiente, SPI – Sociedade Portuguesa de Inovação, PRINCIPIA.

VESPP (FR)

VESPP is an environmental indicator of surface water vulnerability to phytosanitary products. VESPP is intended to be considered in different parts of a watershed. The following characteristics are taken into account:-the properties of the product used; -the duration and the intensity of the rains in the reporting period; -geometric and hydrological parameters.

https://www.shf-lhb.org/articles/lhb/abs/2006/02/2006_2_106/2006_2_106.html