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Pesticides in European rivers, lakes and groundwaters – Data assessment

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1 Executive summary

In Europe, a stable and reliable food supply has become normal over recent decades. This has been achieved in many cases by the use of pesticides to control pests, weeds, and diseases, plus fertilisers to supply additional nutrients. Pesticides play an important role in the food production process, maintaining or enhancing crop yields and protecting quality in both conventional and organic arable farming. However, they can also lead to harmful effects in the environment, including aquatic ecosystems and risks to human health. There is now widespread concern about the addition of a substance to the environment, designed to be toxic to part of the ecosystem.

European policies aimed at reducing the potential risk from pesticides are supported by the Plants Protection Products Regulation (EU, 2009), the Sustainable Use of Pesticides Directive (EU, 2009) and the Biocidal Products Regulation (EU, 2012). The Water Framework Directive (WFD) (EU, 2000) and its daughter directives help to protect water quality from pesticide pollution. There is, however, little evidence to show whether this legislation has been effective, mainly because of limited data on the actual risk from pesticides in surface waters and groundwater at the European level (EEA, 2018a). Addressing this gap is of high interest for policy, practitioners, and the public because of the risks pesticides present to both the environment and human health. Most recently, the Green Deal and its associated strategies and actions include the Biodiversity and Farm to Fork Strategies, which aim to reduce by 50 % the use and risk of pesticides by 2030 (EC, 2019b; EC, 2020a, 2020b).

This technical report provides an overview of the available information on pesticides in surface waters and groundwater in EEA countries. Its main output is a comprehensive summary of the data on pesticides in surface waters and groundwater reported through WISE-SoE reporting to EEA[1], over the period 2007 to 2017.

The EEA's Waterbase – Water Quality database contains the most comparable data available from across Europe. For the assessment, 180 pesticide substances were selected and characterised according to their usage, their Mode of Action (MoA), their chemical grouping, and their environmental quality standards (EQS) considering the reported analytical limits of quantification (LoQ). The methods for the quality assurance of data, selection criteria and extraction, as well as the assignment of thresholds and calculation of exceedance rates result in a unique database. This can be seen as a starting point for assessing pesticide risk in surface waters and groundwater in Europe (see Annexes and files). EQS correspond to European standards where available, otherwise to national EQS set under the WFD, using the lowest value as a precautionary approach.

The reported data for European surface water monitoring stations suggest that in the time period 2007 to 2017, 5–15 % showed exceedances by herbicides and 3–8 % by insecticides. For groundwater, the percentages were about 7 % for herbicides and below 1 % for insecticides. Exceedances of fungicides seemed to be less prevalent for both surface waters and groundwater.

Status assessments for water bodies in the 2nd River Basin Management Plans submitted in 2016 under the WFD showed 0.4 % of all surface water bodies failing good chemical status because of the pesticides in the priority substances list, and 6.5 % of the area of groundwater bodies failing good chemical status because of pesticides. As set out in the EEA's report 'Chemicals in European Waters', the WFD reporting for surface waters does not adequately reflect the range of pesticides currently in use, nor their suspected impact (EEA 2018a).

This report also lists a number of other data sources for pesticides, especially scientific research and emissions data, as well as national pesticide inventories and specific monitoring programmes. They are diverse and often have limited spatial coverage, which makes them less useful for a European assessment of the risk of pesticides in surface waters and groundwater.

The aim of this work is to provide a baseline for what we know about pesticides in water at the European level. The objective of further work is to develop an indicator on the basis of the measured concentrations.

[1] Data source: https://www.eea.europa.eu/data-and-maps/data/waterbase-water-quality-2

2 Introduction

2.1 Context

Pesticides are a topic of considerable policy interest across environmental, agricultural and human health legislation. There is widespread interest in pesticides from regulators, farmers and the public owing to their role in crop protection and in the risks they can present for both the environment and human health. Under the Water Framework Directive (WFD), pesticides are second only to nitrates in causing failure of good chemical status in groundwater (EEA, 2018b).

For a topic of such interest, at European level we know surprisingly little about the actual levels of pesticides, and their relevant metabolites and transformation products, in surface and ground waters. Even less is known about the effects of these substances and mixtures thereof on the environment and organisms. In particular those pesticides with no or unknown toxicological relevance might be underestimated in their impact to the environment and to human health. Monitoring data are scarce and heterogeneous. Reasons for this include:

- Countries monitor a number of different pesticides, but the reported data on pesticide concentrations in waters are very different in quality and quantity and therefore difficult to bring together to establish a European overview.
- Pesticide use in crop production depends on the crop type, season, weather and equipment availability. Some estimates of pesticides in the environment are based on sales data, but this gives very little indication of actual use or the concentrations of pesticides in water.
- Monitoring and assessment of pesticides in surface waters is mostly done routinely, but pesticide peaks in surface waters can only be identified by event-based monitoring, such as following pesticide spraying or heavy rainfall or in the spraying/application season.
- Agricultural pesticide input is mainly caused by diffuse sources, which makes it hard to quantify emissions. This is also valid for other pesticide sources, like aquaculture or forestry. Pesticide pollution from point sources could have different sources, in particular pesticide substances used in biocidal products (e.g. household products, facade paint, gardening, greenhouses), which enter the water cycle mainly through discharges from urban waste water treatment plants (UWWTP), storm overflows or urban run-off. There is limited understanding of the significance of such contributions relative to those from agriculture.
- There is limited availability on the sale and use of plant protection products (PPP) and biocidal products in Europe, which could help to identify areas of intensive use, and the relative importance of agricultural and non-agricultural use.

Alongside these specific issues, there is also concern about the role pesticides may play in mixture toxicity. Existing environmental quality standards (EQS) apply to single substances or small groups of related substances, but in the environment, organisms are exposed to mixtures. We know little about their combined effects, but there is a risk that even if the concentrations of individual chemicals are below individual EQS, they could combine to reach harmful levels (EFSA, 2019; EEA, 2018a; Busch, 2016; Kortenkamp et al., 2009).

2.2 Aim and scope of the report

The aim of this technical report is to provide an overview of information available on pesticides and their metabolites in surface waters and groundwater (see Box 1 for definition), based on reported information. This report includes descriptions and assessments of available data from different data and information sources, with a focus on the European level.

It needs to be mentioned that once a substance has reached the environment, it is not usually possible to ascertain the original source or use of it. Organisms experiencing the resultant mixture do not discriminate by source, though such information is helpful for the identification of appropriate prevention measures. Based on this, the given results within the report cannot be attributed to particular sources (agricultural use, pesticide substances used in biocides, aquaculture, forestry etc.). Furthermore, other chemicals except pesticides which may be present in the water are out of the scope of this technical report. This technical report provides information which may in future be used to consider mixture toxicity, going beyond the single-substance approach commonly used.

2.3 Definition and classification of pesticides

According to the FAO (2002), pesticides are defined as follows:

"Any substance or mixture of substances intended for preventing, destroying, or controlling any pest, including vectors of human or animal disease, unwanted species of plants or animals, causing harm during or otherwise interfering with the production, processing, storage, transport, or marketing of food, agricultural commodities, wood and wood products or animal feedstuffs, or substances that may be administered to animals for the control of insects, arachnids, or other pests in or on their bodies. The term includes substances intended for use as a plant growth regulator, defoliant, desiccant, or agent for thinning fruit or preventing the premature fall of fruit. Also used as substances applied to crops either before or after harvest to protect the commodity from deterioration during storage and transport" (FAO, 2002).

EU legislation divides pesticides into plant protection products and biocides. The term *'pesticide'* is often used interchangeably with *'plant protection product (PPP)'*, however, pesticide is a broader term that also covers non-plant / crop uses, for example biocides[2]. These PPPs are products including 'pesticide substances' that protect crops, or desirable and useful plants. They are primarily used in the agricultural sector but also in forestry, horticulture, amenity areas and in gardens. The products contain at least one active substance and have one of the following functions:

- protect plants or plant products against pests/diseases, before or after harvest,
- influence the life processes of plants,
- preserve plant products,
- destroy or prevent growth of undesired plants or parts of plants.

Active substances used in plant protection products and/or biocides are approved at EU level. EU countries authorise the placing on the market of plant protection products containing those active substances on their territory and ensure compliance with EU rules.

Box 1 Definition of pesticide substances considered in the report

Active substance means the pesticide(s) only defined as any chemical, plant extract, pheromone or micro-organism (including viruses) that has action against 'pests' on plants, parts of plants or plant products[3].

Metabolites (also degradation product, breakdown or reaction products) from an active substance of pesticides are seen as products of biological, physical, or chemical degradation processes or other chemical reactions, which then can be found as contaminants associated with the parent compounds. The toxicity of the metabolite may have a similar, stronger or lesser effect to organisms and humans than the pesticide.

[2] Data source: https://www.eea.europa.eu/data-and-maps/data/waterbase-water-quality-2

[3] Source: https://ec.europa.eu/food/plant/pesticides_en

Overall, pesticides are grouped in different ways depending on the defined interest group, usage or other factors. Main classifications are usually based on biological, chemical or technical features. The biological classification distinguishes between, among others, the pests to be controlled and the Mode of Action (MoA). Another grouping is based on chemical structure (e.g. organophosphate insecticides, neonicotinoids, pyrethroides). The boundaries between these groups are rather fluid, which may add to confusion.

Based on the given definitions and to limit potential confusion, the grouping of pesticides within this report was based on their usage and their mode of action (MoA), i.e. the way in which the pesticide acts on an organism. This grouping is in a way comparable to the EFSA (European Food Safety Authority) based 'Cumulative Assessment Group or CAG'[4].

According to their usage, the report focusses on the three groups (i) herbicides, (ii) insecticides and (iii) fungicides. Herbicides are used to control unwanted plants, insecticides to prevent unwanted insect infestation, and fungicides to kill parasitic fungi or their spores.

The classification according to the MoA of pesticides is oriented towards their effects in non-human organisms. Table 1.1 lists the different MoA, which were assigned to the pesticides available under Waterbase – Water Quality in the time period 2007 to 2017 (see Annex 5).

Table 1.1 Groups of pesticides according to mode of action (MoA) and their effects on organisms

MoA – group	MoA – effects
Photosynthesis Inhibition[1]	The production of energy in the chlorophyll of plants is inhibited by these substances. As a result, the chemically bound energy of the plant is consumed and the plant dies.
Plant Growth Regulator[1]	Plant growth is regulated through the phytohormones that make individual plant parts grow stronger. Some substances inhibit the plant's longitudinal growth and promote fruit growth. Other substances promote the growth of the green parts of the plant, while at the same time root growth stagnates. As a result, the plant dies due to the lack of nutrients in the plant.
Cell membrane disruption[1,3]	The selectivity of the cell membrane is disturbed so that it becomes more or less permeable.
Mitosis, Cell Cycle[1,2]	Inhibition of growth by preventing cell division.
Respiratory action[1,2]	Various processes prevent the exchange of oxygen in membranes or the chemical binding of oxygen.
Neurotoxic[2]	Prevents the transmission of stimuli or the reaction in nerves.
Lipid metabolism[1,2,3]	Inhibition of the enzyme 'acetyl-CoA-carboxylase', which is responsible for controlling fatty acid metabolism and degradation. By inhibiting lipid biosynthesis, the development of the immature stages (larvae and nymphs) of certain insects and mites will be stopped, thus reducing fertility.
Multi site activity[1,2,3]	Inhibition can be caused by membrane damage to specific modulation of receptors, or inhibition of enzymes, or a mixture of several effects.
Signal transduction[2,3]	Inhibition of transmission of molecular signals from a cell's exterior to its interior in fungi and plants.
Fungal spore inhibitor[3]	The reproduction of fungi is disturbed.
Sterol biosynthesis inhibition[3]	Inhibition of the important cell membrane component of the sterol type (= typical MoA for fungicides).
Protein denaturation[3]	Essential proteins are destroyed in fungi so that the metabolism is disturbed.

[1] MoA to plants; [2] MoA to insects; [3] MoA to fungi

Note: Based on the used methods, data availability and data selection, only photosynthesis inhibition and neurotoxic MoA were assessed (see Section 4.1.1.1).

[4] Source: http://www.efsa.europa.eu/en/consultations/call/180508-0

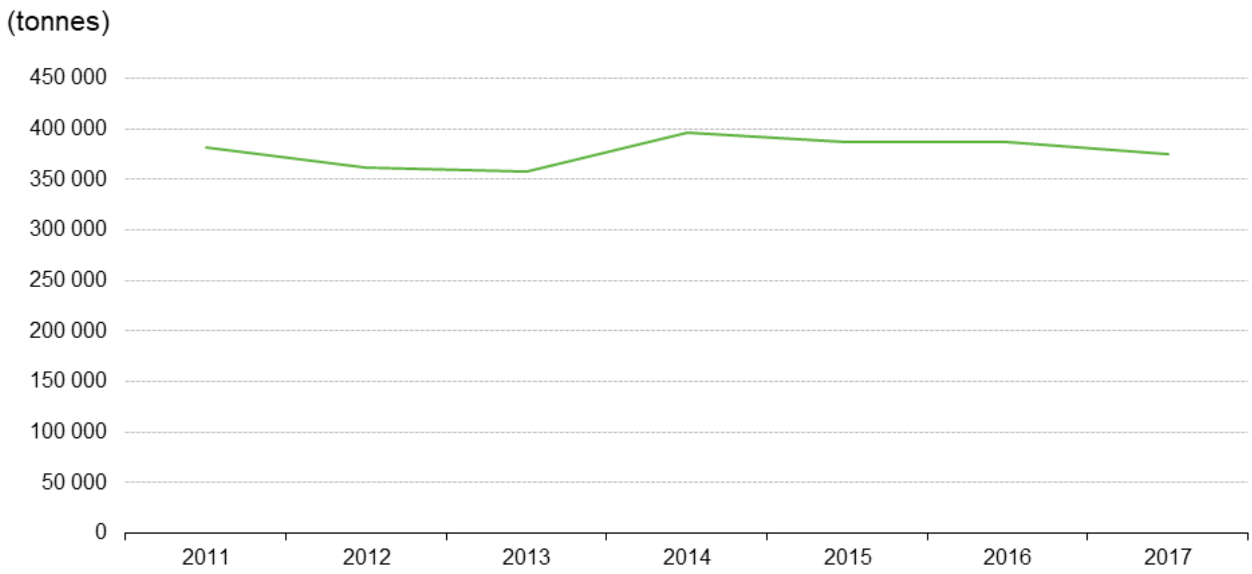
2.4 Sources, uses and sales of pesticides

Pesticides differ from many other pollutants as they are designed to act against organisms (plants, insects) and thus inevitably have an effect on the environment. They should selectively act against specific pest organisms, but it is difficult to achieve absolute selectivity (i.e. where effects are limited to only the target species). Furthermore, when concentrations of pesticides are above critical thresholds, individually or as mixtures, they can be harmful to humans and/or the environment by contaminating soil, surface waters and groundwater. Pesticide contamination of both surface waters and groundwater can affect aquatic fauna and flora, as well as human health when, for example, pesticide-polluted water or fish are used for public consumption. Aquatic organisms are directly exposed to pesticides used in agricultural production or indirectly through trophic chains (Maksymiv, 2015).

The pesticide pollution of surface waters or groundwater may have different sources: (i) Diffuse sources, e.g. spray drift due to pesticide application, surface run-off from farmyards during cleaning of application techniques, leaching to field drains or shallow groundwater, or (ii) point sources from waste water treatment plants (e.g. run-off from farmyards connected to sewer systems) (Sandin, 2017; Aktar et al., 2009). In addition to agricultural activities, other relevant sources for pesticides include forestry, municipal use (e.g. on roadsides), grasslands (e.g. golf courses) and domestic gardens.

Population growth, increase in food production and consumption, and export of agricultural products (crops as well as meat) has led to intensification of agricultural practices, relying on fertilizers and chemical plant protection (FAO & IWMI, 2017). The currently available European statistics indicate that the total volume of pesticide sales has remained about constant since 2011 (Figure 2.1). France, Italy, Spain and Germany sold together over 65 % of the total volumes reported in the EU-28 (Agri-environmental indicator – consumption of pesticides – Statistics Explained 2019). However, this statistic does not allow any conclusion about spatial hotspots and impact on the environment.

Figure 2.1: Sales of pesticides, EU-28, 2011–2017



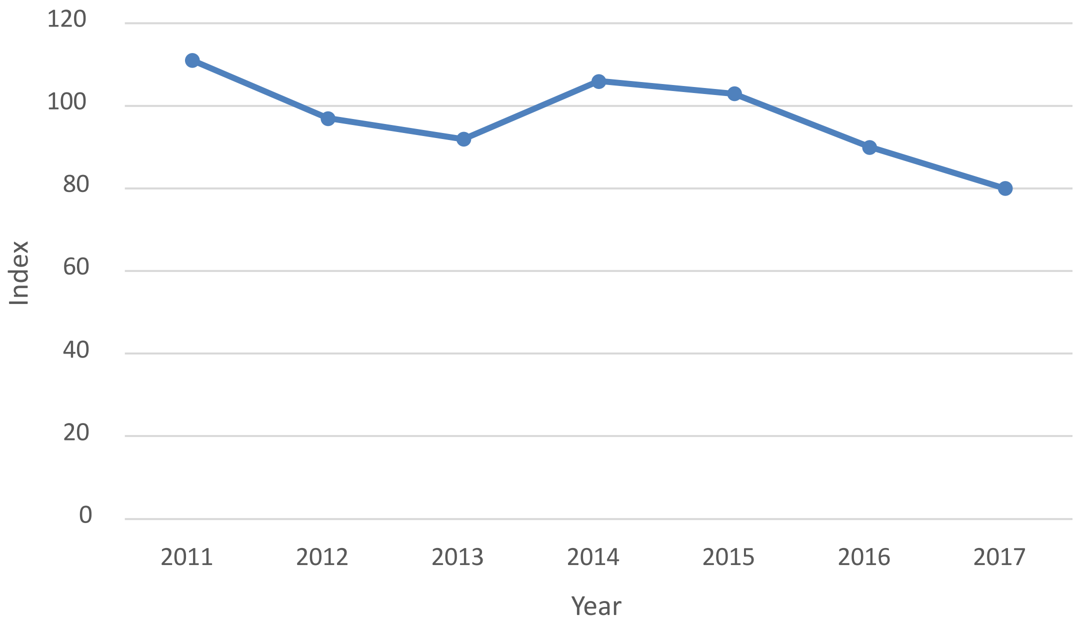
Note: This figure does not take into account confidential values. They represent < 3 % of the total of sales over the entire time series.

Source: Eurostat (online data code : aei_fm_salpest09).
https://ec.europa.eu/eurostat/statistics-explained/images/1/18/Sales_of_pesticides%2C_EU-28%2C_2011-2017_%28tonnes%29.png

Based on sales data, EEA developed the 'Total sales of pesticides' indicator under the 7th Environment Action Programme within priority objective 3, to safeguard the Union's citizens from environment-related pressures and risks to health and well-being (EEA, 2018c). It shows fairly stable trends in pesticide sales grouped by their usage from 2011 to 2016. It is also stated, that: *"This indicator does not allow, at present, for a full evaluation of progress towards the 2020 objective as pesticide sales are not synonymous with the risk of harmful effects on humans and the environment"*[5].

The European Commission developed the Harmonised Risk Indicator (HRI) to support the goals of the Sustainable Use of Pesticides Directive (EU, 2009b). HRI 1 is based on the quantities of active substances placed on the market in plant protection products, with a weighting applied to reflect the hazardous properties of the active substances. HRI 1 shows a 20 % decrease in the risks associated with plant protection products in the 2011–2017 period (Figure 2.2).

Figure 2.2: Harmonised Risk Indicator 1, 2011–2017



Note: A baseline of the average of three years 2011–2013 is used as the starting point against which subsequent values are compared (Index 2011–2013 = 100).

Source: https://appsso.eurostat.ec.europa.eu/nui/show.do?dataset=aei_hri&lang=en

There is a need to develop a management tool such as an indicator, which would combine the information on concentrations in water with the eco-toxicological knowledge of the specific pesticide product. In this way regulators and decision-makers would be able to search for, detect and identify the most important (i.e. most toxic and in highest concentrations) pesticides in their region of interest and prioritise management actions.

2.5 Legislation and broader regulation on pesticides

The European Union has tackled water pollution since the 1970s, e.g. Dangerous Substances Directive (EU, 1976), the Urban Waste Water Treatment Directive – UWWTD (EU, 1991a), the Drinking Water Directive – DWD (EU, 1998) and the Nitrates Directive (EU, 1991b). In 2000, the Water Framework Directive became the central instrument for water management and the protection of EU waters (EU, 2000). For substances (including pesticides), two daughter directives added quality standards to be achieved.

[5] Source: https://www.eea.europa.eu/data-and-maps/daviz/pesticide-sales-in-eu28-1#tab-chart_2

Most recently, the Green Deal (EC, 2019b) has set out a number of strategies and action plans aimed at reducing the risk from pesticides. The Biodiversity (EC, 2020a) and Farm to Fork Strategies (EC, 2020b) have targets to reduce the use and risk of pesticides by 50 %, by 2030. The forthcoming Chemicals Strategy (expected autumn 2020) and Zero Pollution Action Plan (expected 2021), which aims to prevent and reduce pollution to waters and oceans, should also have a focus on lowering concentrations of harmful substances in water.

The following list of Directives and Regulations distinguishes between water policy and source control legislation, which addresses pesticide substances or goals to reduce pesticide pollution:

Water policy:

- The Water Framework Directive (WFD) (EU, 2000) establishes a scheme for water management at river basin level. With regular six yearly planning, and programmes of measures, a good status of surface waters and groundwater is to be achieved.
- The WFD daughter directives on Environmental Quality Standards (EQSD) in water policy (EU, 2008), as amended in 2013 (EU, 2013b), and on Groundwater (EU, 2006a) set quality standards and objectives for pesticides in surface waters and groundwater.
- The Drinking Water Directive (EU, 1998) sets quality objectives for pesticides at the tap. A revised Directive has been politically agreed and is to be adopted and published by the end of 2020 with the introduction of a 'risk-based approach', provisions to protect raw water, and the consideration of pesticide metabolites.

Source control legislation according to pesticide substances:

- The Plant Protection Products Regulation (EU, 2009) set out rules for the authorisation of plant protection products and their marketing, use and control. Based on this Regulation, the Seventh Environment Action Programme (EU, 2013a) set the objective that, by 2020, the use of plant protection products should not have any harmful effects on human health or unacceptable influence on the environment, and that such products should be used sustainably.
- The Biocidal Products Regulation (EU, 2012) focusses on the marketing and use of biocidal products.
- The Regulation on the European Pollutant Release and Transfer Register (E-PRTR) (EU, 2006b), is the Europe-wide register providing accessible key environmental data from industrial facilities in European countries including substances used as pesticides or biocides.
- The REACH Regulation (EU, 2006c) – Registration, Evaluation, Authorisation and Restriction – aims to improve the protection of human health and the environment from chemical substances including pesticide substances, and to register the information in a central database.
- The Directive on the Sustainable Use of Pesticides (EU, 2009b) aims at reducing the risks and impacts of pesticide use on human health and the environment, and promoting the use of integrated pest management and alternatives such as non-chemical approaches.
- The Directive on Industrial Emissions (EU, 2010), which obliges that the permits must take account of a plant's complete environmental performance to avoid pollution of air, water and land. Priority should be given to preventing pollution by intervening at source and ensuring prudent use and management of natural resources.
- The Regulation 396/2005 on maximum residue levels of pesticides in or on food and feed (EU, 2005). The traces that pesticides leave in treated products are called 'residues'. A maximum residue level (MRL) is the highest level of a pesticide residue that is legally tolerated in or on food or feed when pesticides are applied correctly (Good Agricultural Practice).
- The UN Stockholm Convention recommends the ban of specific substances, *inter alia* pesticides, to protect human health and the environment from persistent organic pollutants (UNEP, 2018)[6] including the Persistent Organic Pollutants (PoPs) Regulation 2019/102/EU.

[6] List of persistent organic pollutants: http://chm.pops.int/TheConvention/ThePOPs/AllPOPs/tabid/2509/Default.aspx

Financing:

- According to financial instruments, the Common Agricultural Policy (CAP) aims *inter alia,* to support the implementation of agri-environmental measures to reduce pesticide pollution from agriculture, towards sustainable management of natural resources. In relation to the Rural Development Regulation 1305/2013/EU, Member States allocated more than 50 % of the overall budget for restoring, preserving and enhancing ecosystems related to agriculture and forestry in the CAP time period 2013 to 2020 (Devot et al., 2020). Much of this regulation is aimed at preventing pesticides from causing pollution, while the knowledge base of application, fate and impact is imprecise and incomplete. More representative, updated and comparable environmental monitoring information at European level is needed to confirm the effectiveness of policy interventions (EEA, 2018b).

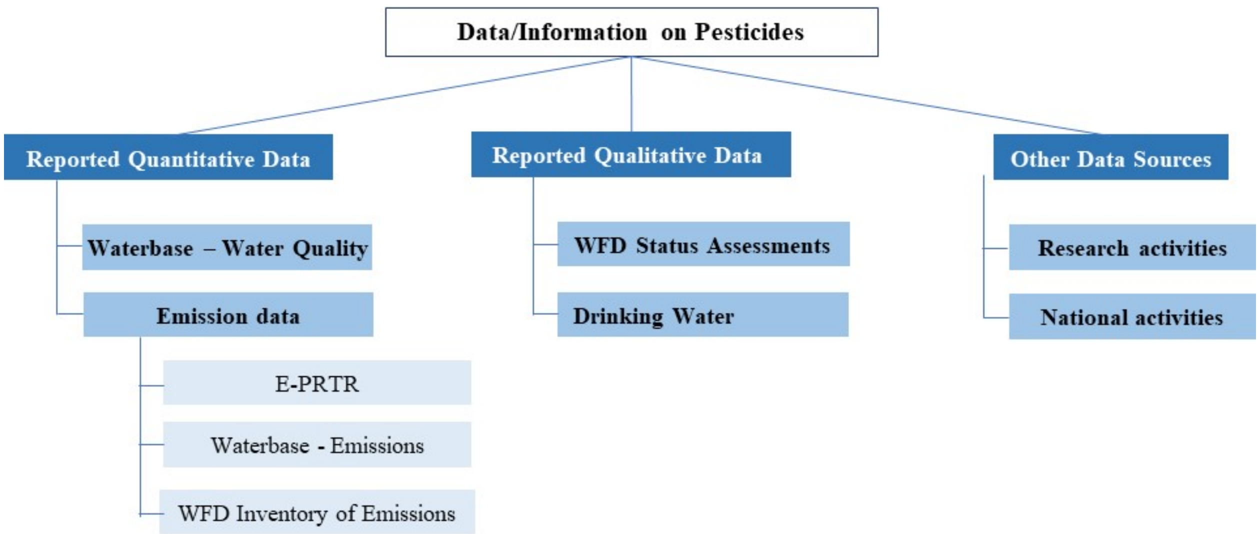
This report aims to address and synthesise our current knowledge about pesticides in the aquatic environment and their impact. This is also in-line with new strategies at European level. Those integrated strategies may help to improve knowledge, monitoring, and data availability on pesticides.

3 Data and information sources

This section gives an overview of quantitative and qualitative data sources as well as other data overviews addressing the topic of pesticides, which were assessed for their usefulness for this report (Figure 3.1). These data and information sources were analysed in accordance to the availability of sufficient information on pesticides. Quantitative data sources are those providing figures, e.g. of concentrations in waters or emission loads to surface waters. Qualitative data sources give assessments (e.g. names of substances exceeding quality standards). Other data sources are listed at the end of this section, e.g. substance authorisation and description databases, literature databases as well as national databases for the implementation of the Directive on the Sustainable Use of Pesticides (EU, 2009).

As shown in Figure 3.1, the project originally considered a wider range of sources than Waterbase – Water Quality, but through the work, it was concluded that comparability was best served by using this dataset. The data assessments are presented in Section 4 – status of information on pesticides.

Figure 3.1: Data and information sources on pesticides, analysed regarding their usefulness for this report



Note: Other water-related legislation was also checked with regard to the pesticide information provided.

3.1 Quantitative data sources

3.1.1 Waterbase – Water Quality

Waterbase – Water Quality[7] is a database containing water quality data in rivers, lakes and groundwater reported by up to 39 European countries under the WISE SoE reporting stream. All Waterbase collected data, like water quality and emission data are compiled in the 'Waterbase' of the EEA.

Over time, disaggregated water quality data on the observed values have increasingly been reported, representing one sampling at a specific monitoring site and day for a specific parameter. Before 2015, more data were reported as aggregated records – i.e. annual statistics for each monitoring site and substance. Since 2015, most data on hazardous substances have been reported as disaggregated data. The updated versions of the database are published annually, with the version 2019 used in this report covering the data up to 2017.

The monitoring sites that provide data to Waterbase – Water Quality are located in European water bodies and reported – along with their descriptive attributes – to the 'WISE WFD Reference Spatial Dataset'[8] and 'WISE EIONET Spatial Dataset'[9]. For the reference dataset used in this report, monitoring sites on rivers, lakes, and groundwater were used.

The pesticide data of Waterbase – Water Quality have been reported by 34 countries of Europe, representing the Eionet monitoring network of Member States of the EU and EEA member and cooperating countries.

The data on hazardous substances in water (including pesticides) from the Waterbase – Water Quality database were systematically assessed in the ETC/ICM technical report on Hazardous Substances in European Waters from (ETC/ICM, 2015), covering the data for the period 2002–2011. This report summarised the state and availability of the data and provided a useful display of the large dataset, but it cannot be regarded as an assessment of the situation across the reporting countries. It was concluded that despite the quality check procedures undertaken, some data were still questionable owing mainly to issues such as unclear reporting of the limit of detection (LoD) or the limit of quantification (LoQ).

The report at hand gives an updated assessment of the Waterbase – Water Quality data, also using a new approach in data selection and processing, explained in the following subsection.

3.1.1.1 Selection of reference pesticides

The report focuses on currently, and also formerly, used pesticides or their active ingredients, that contribute to current water pollution, e.g. by spraydrift, washing of equipment at the farmyard during usage or run-off filtration through the soil etc. after usage. The selection of pesticides for evaluation was limited to substances that were reported in the period under review (2007 to 2017). Data in WISE become increasingly available from 1990 and, in terms of available records per year, data more notably increase after 2006, with the largest number of records available for 2013 and 2014. Furthermore, the following criteria were used for the selection of substances: (i) approved and approval expired during the investigation period; 2007 to 2017 (ii) listed as priority substance in Annex X under the WFD; (iii) regulated nationally under the WFD in three or more Member States; (iv) mainly used in agriculture (pesticides), not as biocides.

[7] The version of 2019, published in April 2019 and used for this report, is available at: https://www.eea.europa.eu/data-and-maps/data/waterbase-water-quality-2.

[8] Available at: https://www.eea.europa.eu/data-and-maps/data/wise-wfd-spatial-2.

[9] Available at: https://www.eea.europa.eu/data-and-maps/data/wise-eionet-spatial-1.

For building up the basis for an assessment, the list of substances was analysed in respect of different parameters. For this, each pesticide was checked in the Pesticides Properties Database (PPDB[10]) (Lewis et al., 2016). The outcome was a list with 180 pesticides including columns for chemical identifiers, usage, information about whether the parent substance or a transformation product, MoA (see Annex 5 and Annex 6). Based on this list, different assessments were made, which are further detailed in the paragraphs below.

Only three main usage groups could be identified: herbicides (78 distinct pesticides), insecticides (72 distinct pesticides) and fungicides (23 distinct pesticides). The remainder were either transformation products/metabolites (three substances), could not be assigned to a specific usage, or were multi-use pesticides.

In the PPDB most of the pesticides are clearly assigned to a specific MoA. As the number of different MoA is very diverse, it was decided to further simplify the grouping for easier analysis in this technical report. Thus, all substances which, for example, in one way or another modified nerve signalling or muscle activity (e.g. GABA receptors, AChE inhibitors) were allocated to the group of ‘neurotoxic compounds’. Similarly, all herbicides which inhibited photosynthesis – even if the exact position of the inhibition might be PS II or protoporphyrinogen oxidase inhibition or another mechanism – were assigned to the group of ‘photo-synthesis inhibition’.

Based on these selection criteria, Table 3.1 shows an overview of the available data in the time period 2007 to 2017, which were used for the specific assessments. Note that usually many fewer substances are reported by a single country.

Table 3.1 Overview of selected substances and groups of available data reported under Waterbase – Water Quality on pesticides, in time period 2007 to 2017

	Surface waters (rivers and lakes)	**Groundwater**
Total number of selected substances	180	159
Usage		
Number of herbicides	78	75
Number of insecticides	69	61
Number of fungicides	19	11
Number of ‘others’	14	12
Mode of Action		
Number of neurotoxic	49	44
Number of photosynthesis inhibition	30	29
Number of ‘others’	101	86

Note: Pesticide selection criteria set out in the text.

[10]https://sitem.herts.ac.uk/aeru/ppdb/

3.1.1.2 *Threshold setting*

To determine the threshold of each substance, environmental quality standards, groundwater quality standards and comparable assessment values were checked. For this, the following sources were considered:

Surface waters

- EQS of the pesticides listed under the priority substances of the WFD; AA-EQS (annual average EQS), which are protective against chronic toxicity, and MAC-EQS (maximum allowable concentration EQS), which should protect against acute toxicity. This gives thresholds for 13 pesticides regulated with 2008/108/EC (EU, 2008) and nine more, following the amendment of this Directive in 2013 (Annex 6).
- The maximum acceptable detection limit, according to the Watch List under Commission Implementing Decision (EU) 2015/495 and Commission Implementing Decision (EU) 2018/840. The Watch List for surface waters lists substances including several pesticides that must be monitored to confirm whether they pose a risk at European level. It does not set EQS, but the detection limit is an indicator of the likely order of magnitude. This provides thresholds for 7 pesticides (Annex 6).
- EQS for 86 pesticides listed by EU Member States as River Basin Specific Pollutants (RBSPs), if available: AA-EQS (annual average EQS) and MAC-EQS (maximum allowable concentration EQS). The EQS value for RBSPs can vary between Member States. For the assessments based on Waterbase – Water Quality data (see Section 4.1.1.1), the lowest reported EQS for a substance was used. This was decided according to the precautionary principle for this first assessment and is discussed further in Section 3.4.
  When three or more countries nationally regulated a substance as River Basin Specific Substance (RBSP), it was considered 'relevant' to be used further in the analysis. This approach led to the inclusion of 32 pesticides in the surface water assessment.
- If no EQS is available, a regulatory acceptable concentration (RAC) under the Regulation concerning the placing of plant protection products on the market (EU, 2009c) can be used as an alternative. In this case, it must be checked whether risk mitigation measures have been factored into the derivation of the RAC, which reduce the level of protection. The risk mitigation measures are applied if, for example, the input into water bodies can be reduced by minimum distances or special application techniques. The environmental assessment of plant protection products without these reduction measures is comparable to the EQS derivation.

Groundwater

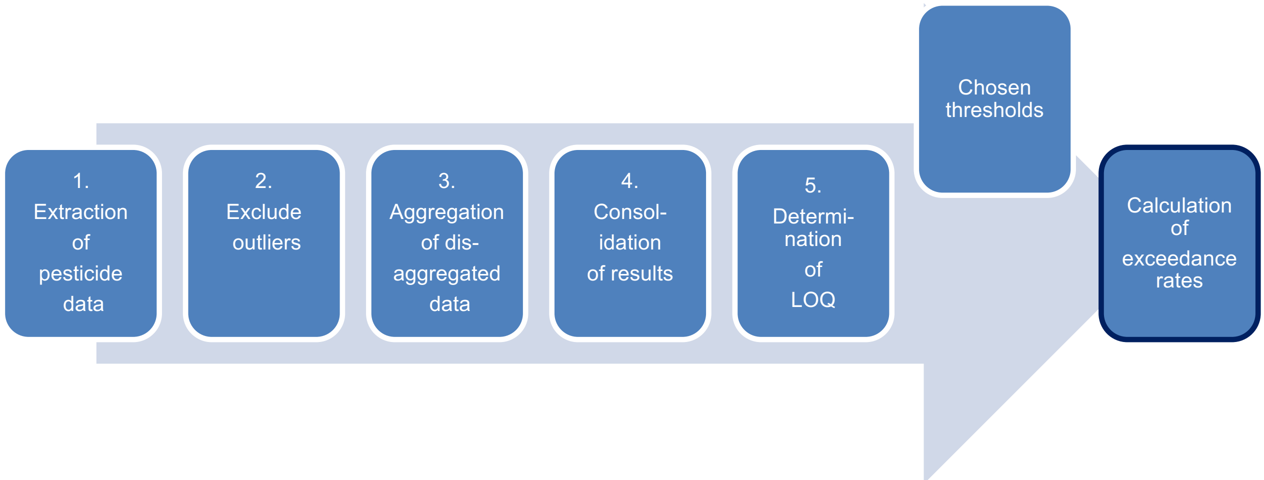
- The Groundwater Quality Standard of 0.1 µg/l in accordance with the Directive 2006/118/EC for each active substance in pesticides, including their relevant metabolites, degradation and reaction products. The quality standard of 0.5 µg/l for the total sum of pesticides was not considered. For this study, single values for the substances are needed, which were not available from some EU countries.

In Annex 6, more detail is provided on the AA-EQS and MAC-EQS values used for surface waters.

3.1.1.3 *Extraction of the reference dataset on pesticides*

The dataset used in this report was extracted from Waterbase – Water Quality database based on the following procedure (Figure 3.2).

Figure 3.2: Procedure to extract the reference dataset on pesticides



1. Extraction of disaggregated[11] and aggregated[12] data records on pesticides defined in Section 3.1.1.1 (above) for the period 2007 to 2017, excluding records flagged for low reliability[13] but including any records flagged in the Waterbase – Water Quality database as potential outliers.
2. For both aggregated and disaggregated data, the 95th percentile of values by monitoring site and substance was calculated. Any records that were more than 1000-fold above the calculated 95th percentile of the corresponding monitoring site and substance were excluded. This should exclude errors arising from incorrect units.
3. Determination of LoQ for each annual record (see Box 2 for further explanation of LoQ and their use in the assessment).
   - *known LoQ:* in Waterbase – Water Quality, the LoQ of the analytical method used is requested to be reported with each single or annual record (for the latter, the highest LoQ in a series of measurements within a year should be reported, although typically the same analytical method is used at the site throughout the year);
   - *unknown LoQ but flagged as 'below LoQ':* some records in the database are only flagged as 'below LoQ', where the actual LoQ is uncertain.
   - *no data or flags regarding the LoQ* are available for a record at all.
4. Determination of threshold value exceedance for each annual record, so that the share of exceedances out of all records of a substance can be determined:
   - *for records with no data or flags regarding the LoQ*, no EQS or threshold value exceedance could be determined; this yielded 24 682 surface water annual records (0.68 % of all surface water records in the reference dataset) for which an EQS exceedance cannot be determined, and 68 764 groundwater annual records (1.89 % of all groundwater records in the reference dataset) for which a threshold value exceedance cannot be determined;

[11] http://dd.eionet.europa.eu/tables/9153.

[12] http://dd.eionet.europa.eu/tables/9323.

[13] Records assigned as being of low quality, for the user to be aware. For example, the combination of data in the record (such as non-default unit of measurement) raises ambiguity which could not be clarified with the reporting country at the time, indicating low confidence in the reported value.

- *exceedances in surface waters:*
  - if the calculated annual mean value is above the LoQ and higher than the AA-EQS, it exceeds the threshold.
  - if the calculated annual maximum is above the LoQ and higher than the MAC-EQS, it exceeds the threshold.
- *exceedances in groundwater:* if the mean calculated value is above the LoQ and greater than the groundwater quality standard of 0.1 µg/l.

The data on 180 distinct pesticides were extracted using this process, covering a total of 16 886 groundwater monitoring sites in 26 countries, and 9 495 surface water[14] monitoring sites in 34 countries (accounting for 3.63 million annual records altogether). The list of pesticides by water category, the number of records and the number of monitoring sites at which the substance was monitored, as well as the time period, is available in Annex 1 for surface waters and in Annex 2 for groundwater. Figure 3.3 illustrates the number of pesticide monitoring sites per year.

Box 2 Definition of the Limit of Quantification (LoQ) and their use in the assessment

The Limit of Quantification (LoQ) as well as the Limit of Detection (LoD) are terms used to describe the smallest concentration of a substance that can be reliably measured by an analytical procedure (Armbruster and Pry, 2008).

Based on the definitions given in 2009/90/EC (EU, 2009a)

- 'limit of detection' means the output signal or concentration value above which it can be affirmed, with a stated level of confidence that a sample is different from a blank sample containing no determinand of interest.
- 'limit of quantification' means a stated multiple of the limit of detection at a concentration of the determinand that can reasonably be determined with an acceptable level of accuracy and precision. The limit of quantification can be calculated using an appropriate standard or sample and may be obtained from the lowest calibration point on the calibration curve, excluding the blank.

According to the principles of Directive 2009/90/EC on technical specifications for chemical analysis and monitoring of water status (EC, 2009a), the LoQ of the method needs to be equal to or lower than one third of the defined EQS and the precision the Directive requires for an uncertainty of measurement of 50 % or below (k = 2), estimated at this concentration.

Within Waterbase – Water Quality, countries have been recommended to report LoQ for each substance since 2010 and have been required to do so for data reported since 2015. For the reporting of aggregated data, specific rules are defined especially for the calculation of annual mean substance concentration, where concentration values below LoQ must be replaced with half of the LoQ value[15].

If LoQ were reported as values, an additional check of data has been carried out. This was done to identify uncertainties in the reporting, which could have effects on the assessment and the interpretation of the results with the following rules:

- for data reported as annual records, values of minimum, maximum and mean substance concentration match with the reported LoQ (this indicates that all single values were below LoQ);
- for data reported as single measurement or annual records, LoQ > EQS (which indicates, that e.g. the use of analytical methods is not sensitive enough).

In all cases, we decided to use those data below LoQ as 'not exceeded' in the assessment.

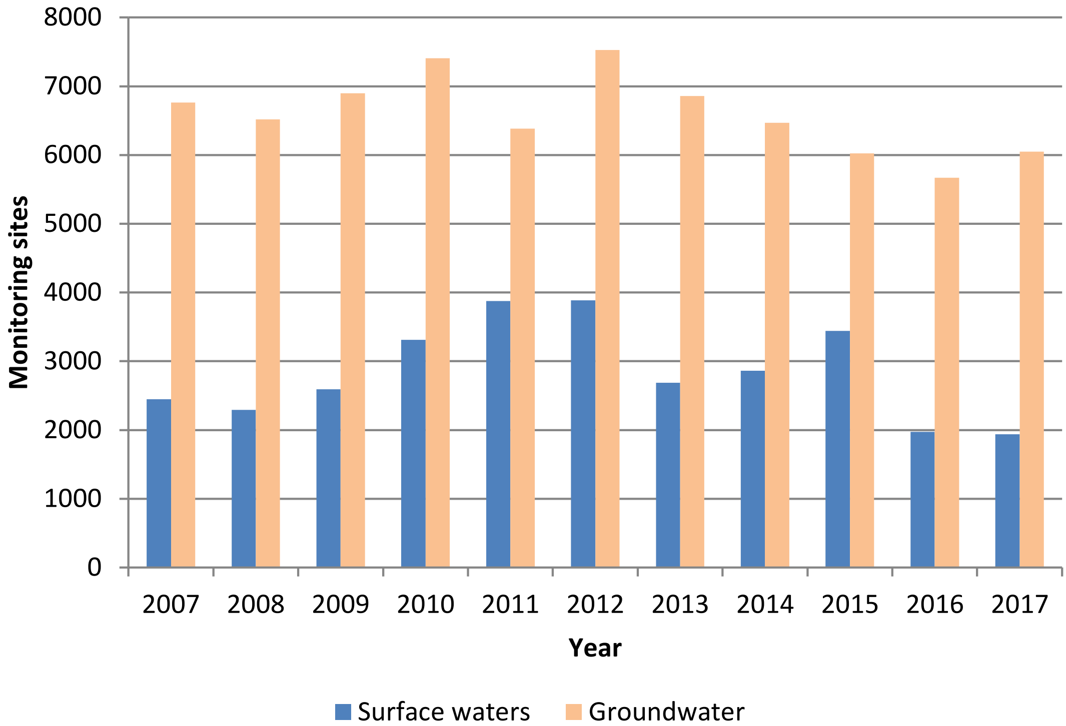
[14] Water categories of 'groundwater' and 'surface water' (the latter including both river and lake monitoring sites) are defined for the purpose of this report.

[15] Source: http://dd.eionet.europa.eu/tables/9323

3.1.1.4 Temporal coverage of data

The following figure shows the temporal coverage of the monitoring sites with pesticide data in Waterbase – Water Quality.

Figure 3.3: Number of pesticide monitoring sites by year for surface water and groundwater, used in the reference dataset of pesticides extracted from Waterbase – Water Quality



Source: Waterbase – Water Quality database, version April 2019

3.1.1.5 Spatial coverage of data

Figure 3.4 illustrates the spatial coverage of available data on pesticide monitoring reported under Waterbase – Water Quality in the time period 2007 to 2017 for each country, in relation to the arable land ratio. Arable land ratio was used here as an indicator of potential intensity of pesticide usage in the agriculture of the countries. The arable land ratio was calculated based on the country area and the arable land area in this country.

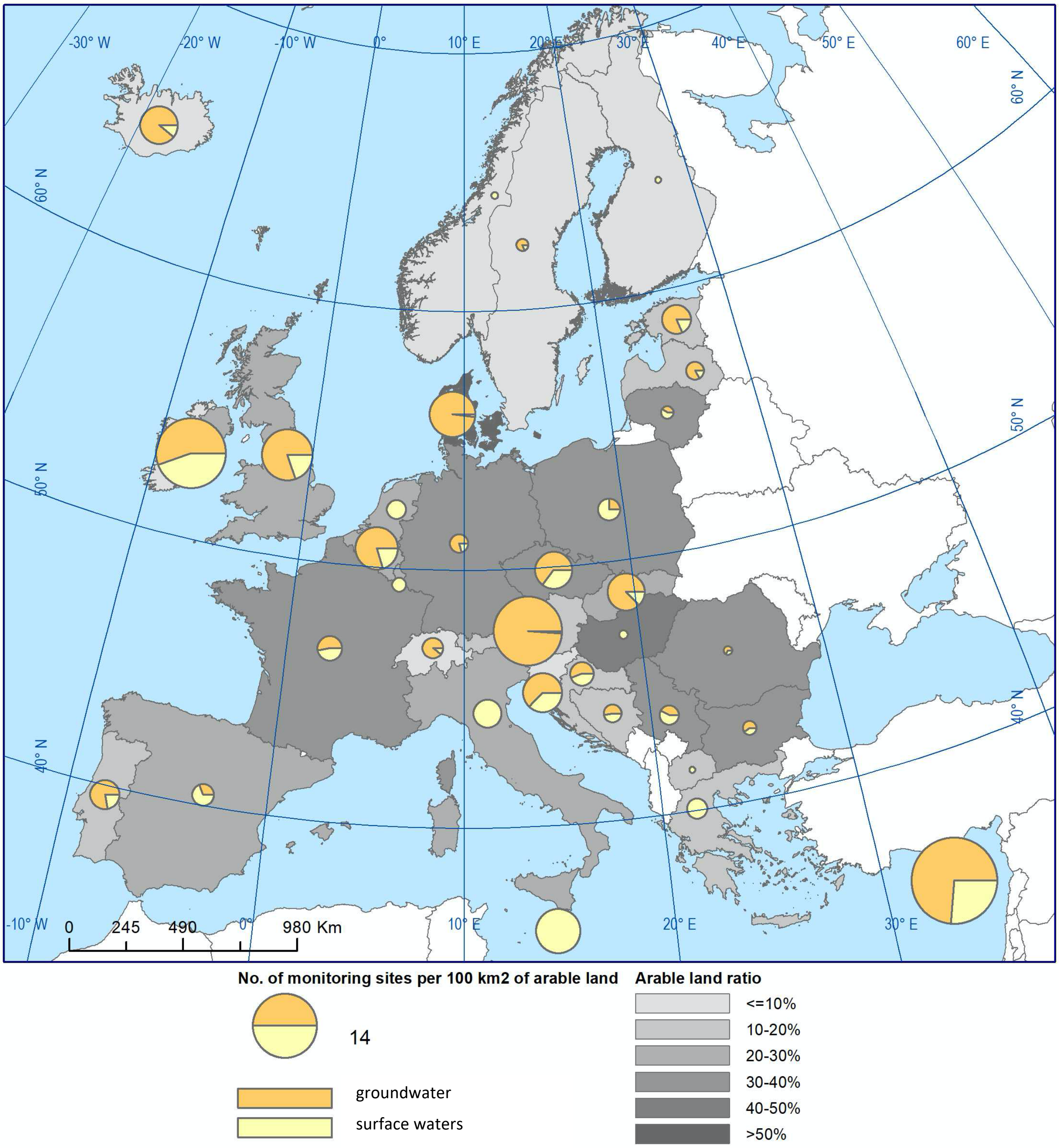
The data source was CORINE Land Cover. Corine land cover defines arable land as intensively used (usually ploughed) land, non-irrigated and permanently irrigated arable land and rice fields[16]. Among the land use classes of CORINE Land Cover also permanent crops, e.g. vineyards or orchards might be areas of intensive plant protection. Permanent crops have a lower share of area and were not included here. Within the other CORINE classes of agriculture (pastures and heterogeneous areas) intensity of pesticide usage is usually lower.

According to the arable land ratio, over 50 % of land area is arable in Denmark and Hungary. Between 30–45 % land is arable in Poland, Germany, Czechia, Slovakia, Hungary, Romania, Serbia, Bulgaria and Lithuania (listed here in decreasing order).

[16] CORINE land cover land use definitions: https://land.copernicus.eu/eagle/files/eagle-related-projects/pt_clc-conversion-to-fao-lccs3_dec2010

The reported number of monitoring sites differs between countries. Whereas Austria (16), Cyprus (10), Iceland (47), Ireland (16) and Malta (89) reported more than 10 monitoring sites per 100 km² arable land in the time period 2007 to 2017, the mean of the reported monitoring sites for all other countries is 2.2. A list of available data on the arable land use ratio, monitoring sites as well as number of reported pesticides is given in Annex 3.

Figure 3.4: Number of reported monitoring sites on pesticides per 100 km² arable land in European countries, in the time period 2007 to 2017

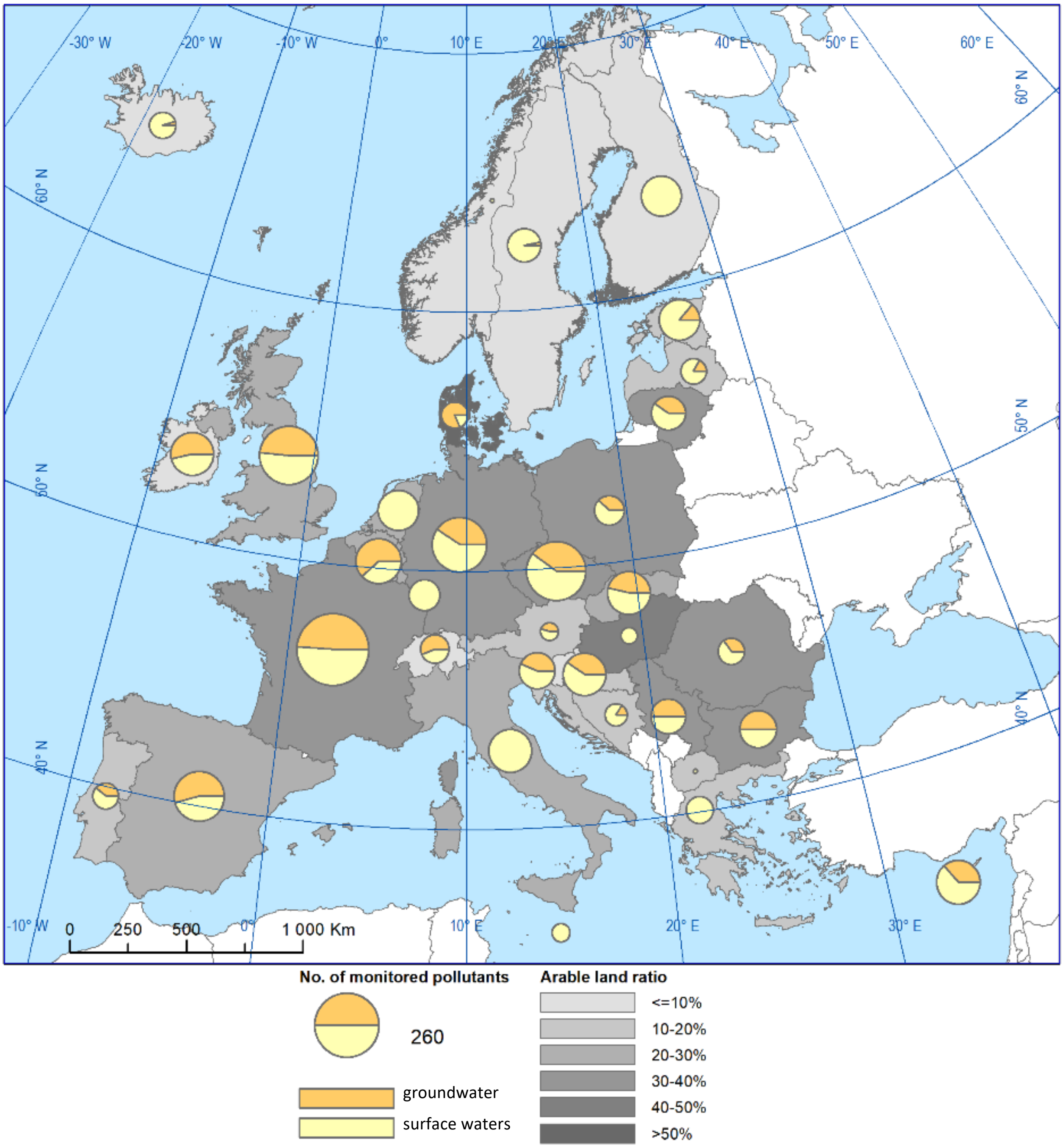


Notes: The map includes two types of information: the arable land ratio and the number of monitoring stations. Arable land ratio represents the amount of arable land in each country. The size of the piechart represents 14 monitoring sites per 100 km² of arable land.

Source: Waterbase – Water Quality database, version April 2019; Eurostat and Corine Land Cover data on arable land ratio.

Figure 3.5 shows the number of reported monitored pesticides for each country in the time period 2007 to 2017. The number of reported pesticide substances varies between 1 (North Macedonia and Norway) and 319 (France). Overall, there is neither correlation between the reported monitoring sites under consideration of the amount of arable land, nor the number of reported monitoring sites and reported monitored pesticide substances.

Figure 3.5: Number of reported monitored pesticides in European countries, in the time period 2007 to 2017

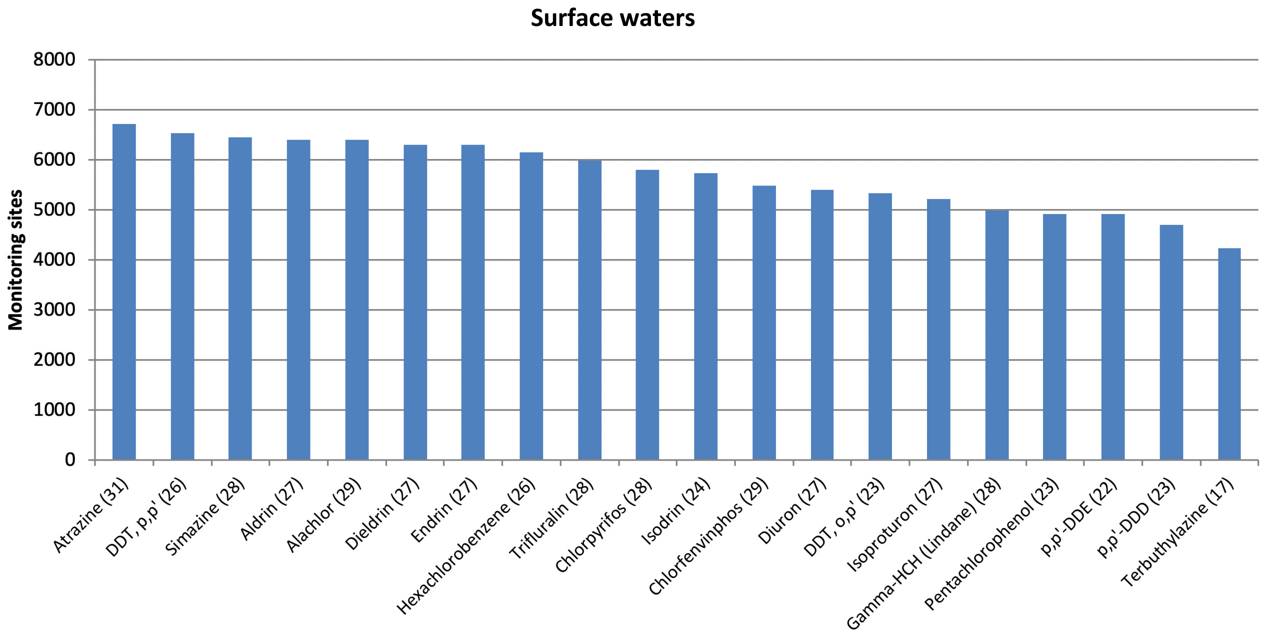


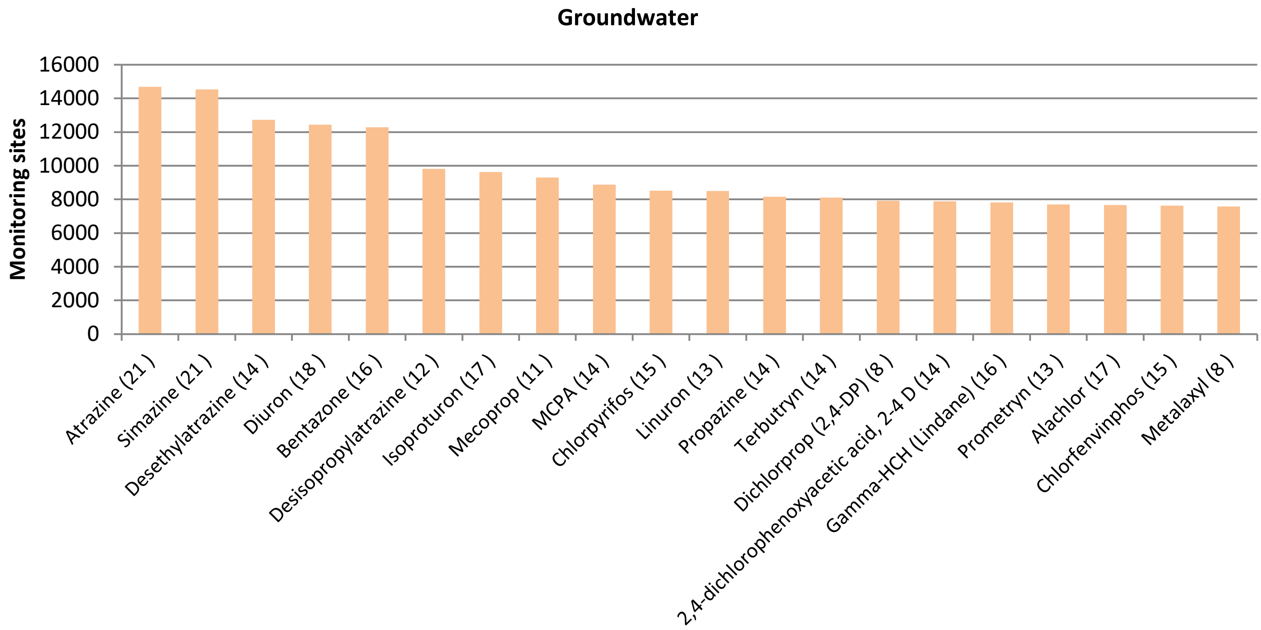
Notes: The map includes two types of information: the arable land ratio and the number of monitored pollutants. Arable land ratio represents the amount of arable land in each country. The size of the piechart represents 260 monitored pollutants in a country.

Source: Waterbase – Water Quality database, version April 2019; Eurostat and Corine land cover data on arable land ratio.

Figure 3.6 illustrates 20 pesticides with the largest number of monitoring sites for surface water and groundwater, respectively. In surface waters, 11 substances were reported as monitored at more than 6 000 monitoring sites. For groundwater, atrazine, simazine, desethylatrazine, diuron, and bentazone are the five most frequently reported pesticides in the dataset.

Figure 3.6: Number of monitoring sites for the pesticides with the most frequently reported number of monitoring sites in surface waters and groundwater





Note: The charts show the number of monitoring sites for those 20 pesticides, which are monitored at most of the sites, ordered by the number of monitoring sites.

Source: Waterbase – Water Quality database, version April 2019.

3.1.2 Emission data

Table 3.2 shows an overview of the emission data with European coverage on pesticide loads considered in this report. The data comprises of three different reporting streams and include a range of approaches for assessing sources of emissions to waters. These three reporting streams are further described in the following sub-sections. A small note on sites with soil contamination completes the section.

On emissions, this report extends the discussion of the usefulness and representativity of emission data for hazardous substance assessments, carried out in the earlier report 'Chemicals in European Waters – knowledge developments' (EEA, 2018a).

Table 3.2 Overview of emission data considered

Data source	Sources of emissions to waters				No. of countries reporting
	Legal obligation	Industry	UWWTP*	Diffuse sources	
E-PRTR	x	x	x		33 (EU-MS+ UK + EFTA[17]+Serbia)
Waterbase – Emissions		x	x	x	38 (EEA 2020)[18] + UK
WFD Inventory of emissions	x	x	x	x	EU-MS (2016) + EFTA

*Urban waste water treatment plants

3.1.2.1 *E-PRTR – European pollutant transfer and release register*

E-PRTR collects emission data to air, water and land. Countries report facilities with economic activity listed in Annex I, and substance loads from point sources above threshold values given in Annex II of the Directive. All facilities under activity *4.d Chemical installations for the production on an industrial scale of basic plant health products and of biocides* should be included, other facilities should report discharging into water if it exceeds the given thresholds (1 kg per year for most of the pesticides). Among the 91 substances listed in Annex II, emissions to water are to be reported for 71, including several pesticides. E-PRTR includes limited information on some diffuse sources, but no information on pesticides from diffuse, agricultural sources is available. The database contains annual releases (kg per year) per facility.

E-PRTR reporting shows that the main pesticide discharges to water come not from installations manufacturing pesticides, but from urban waste water treatment plants (which receive inputs from a range of sources) (see Section 2.4). A number of issues with E-PRTR emission thresholds to water have been identified (Van den Roovaart et al., 2017; ICF Consulting Limited, 2020) which can result in a) under-estimation of the pesticide load into the environment, as emissions from smaller UWWTPs are not reported, and b) discontinuous emission data over time (as in some years emissions may be above the threshold, while in others they are below and so not reported).

Table 3.3 shows the list of pesticide emissions to water as reported under the E-PRTR. The number of records represents the emission load from one facility within one year for a given pollutant – e.g. if the emission load from two facilities is reported every year for ten years, it will result in twenty records. It also shows the number of countries reporting releases, information on the monitoring time period, if the specific substance is still approved (**Y**es or **N**o), and the number of monitored facilities listed.

[17] EFTA: Norway, Iceland, Switzerland, Liechtenstein

[18] EEA member countries: EU + EFTA + Turkey; six cooperating countries: Albania, Bosnia and Herzegovina, Montenegro, North Macedonia; Serbia and Kosovo under the UN Security Council Resolution 1244/99.

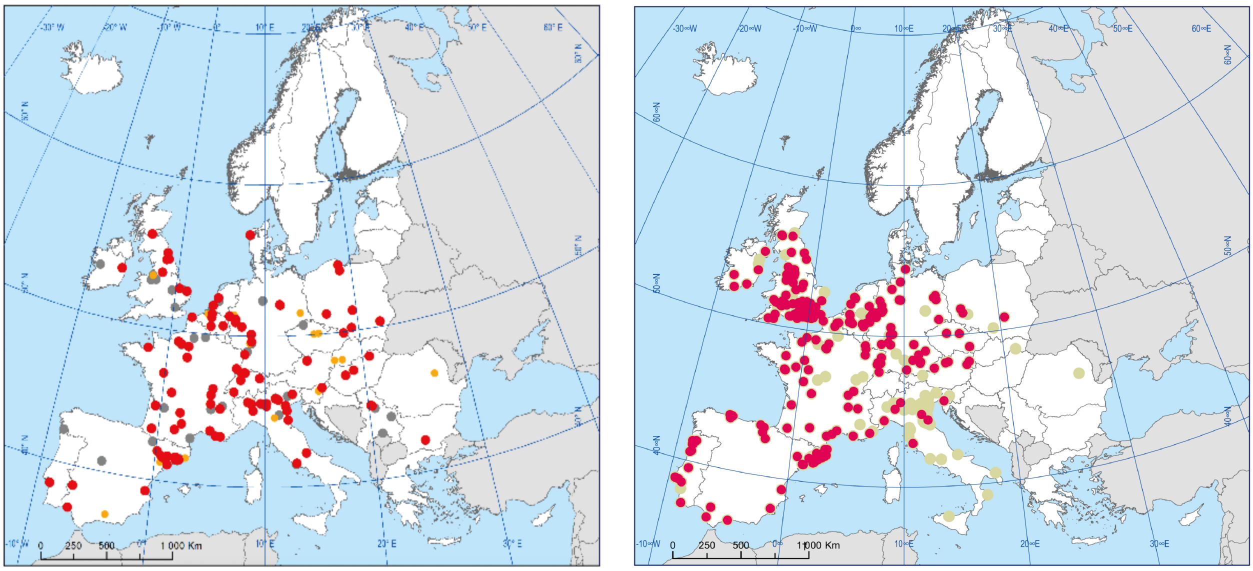
Table 3.3 Pesticide emissions to water reported under E-PRTR

Pesticide	No. of records	No. of countries	No. of years monitored	Start	End	Approved	No. of facilities 2017
Alachlor	26	7	10	2007	2017	N	3
Aldrin	103	4	11	2007	2017	N	11
Atrazine	77	13	11	2007	2017	N	6
Chlordecone	12	3	6	2008	2014	N	?
Chlorfenvinphos	8	4	4	2007	2011	N	?
Chlordane	5	1	4	2008	2017	N	1
Chlorpyrifos	24	5	8	2007	2017	Y	5
DDT	24	5	11	2007	2017	N	3
Dieldrin	117	5	11	2007	2017	N	12
Diuron	1 136	12	11	2007	2017	Y	122
Endosulfan	19	5	8	2007	2017	N	3
Endrin	82	5	11	2007	2017	N	8
Ethylene oxide	7	4	6	2009	2017	N	2
Heptachlor	15	2	10	2007	2017	N	3
1,2,3,4,5,6-hexachlo-rocyclohexane (HCH)	80	8	13	2001	2017	N	7
Isodrin	98	6	11	2007	2017	N	9
Isoproturon	336	11	11	2007	2017	N	20
Mirex	2	2	2	2008	2011		
Simazine	82	9	11	2007	2017	N	6
Trifluralin	15	3	10	2007	2017	N	2

Source: https://prtr.eea.europa.eu/#/home (EEA 2019)

Figure 3.7 shows the facilities with pesticide production and the facilities with pesticide discharge in the time period 2007 to 2017.

Figure 3.7: Facilities producing pesticides (E-PRTR activity 4.d) as their main or other activity (left) and facilities discharging pesticides into water (right), in the time period 2007 to 2017



facilities manufacturing pesticides as main activity in 2007
facilities manufacturing pesticides as other activity in 2017
facilities manufacturing pesticides as main activity since 2017
E-PRTR countries
other countries

discharge into water (approved pesticides)
discharge into water (not approved pesticides)
E-PRTR countries
other countries

Note: E-PRTR countries = countries reported data under E-PRTR. The points only show facilities where discharge of pesticides was reported, and not the amount of discharge from these facilities; 4.(d) means facilities including chemical installations for the production on an industrial scale of basic plant health products and of biocides; *Water* includes marine waters as well as freshwater (surface waters and groundwater).

Source: https://prtr.eea.europa.eu/ (EEA, 2019)

Table 3.4 shows the number of facilities which reported pesticide discharges in 2017. In contrast to 38 other facilities, 185 waste water treatment plants are listed with discharge of pesticides into waters.

Table 3.4 Number and type of facilities reported under E-PRTR discharging pesticides into water, in 2017

Activity Code	Activity name	Count of facilities
1.(a)	Mineral oil and gas refineries	2
4.(a)	Chemical installations for the production on an industrial scale of basic organic chemicals	4
4.(e)	Installations using a chemical or biological process for the production on an industrial scale of basic pharmaceutical products	2
5.(a)	Installations for the recovery or disposal of hazardous waste	13
5.(c)	Installations for the disposal of non-hazardous waste	14
5.(f)	Urban waste water treatment plants	185 (10 countries)
6.(b)	Industrial plants for the production of paper and board and other primary wood products	3

Source: https://prtr.eea.europa.eu/ (EEA, 2019)

3.1.2.2 *Waterbase – Emissions*

Under the reporting obligation of Waterbase – Emissions, EEA countries report the loads per year for specific substances at country-, river basin-, or subunit-level. For the reporting, the emission load can be assigned to different types of sources. The countries can report emissions from point sources and diffuse sources. Pesticide loads were mainly reported from point sources (industry and urban waste water treatment plants) with rather few from diffuse sources (Table 3.5).

Table 3.5 Pesticide emissions reported under Waterbase – Emissions, in the time period 2008 to 2017

Emission source	Number of countries
I – Point sources – Industrial waste water	15
I3 – Point – Industrial waste water – treated	14
I4 – Point – Industrial waste water – untreated	5
NP – Diffuse	1
NP1 – Diffuse -–Agricultural emissions	3
NP2 – Diffuse – Atmospheric deposition	2
NP3 – Diffuse – Un-connected dwellings emissions	2
NP5 – Diffuse – Storm overflow emissions	2
NP7 – Diffuse – Other diffuse emissions	2
NP72 – Diffuse – Transport emissions	2
O – Point – Other point emissions	7
O2 – Point – Waste disposal sites	7
O3 – Point – Mine waters	3
O4 – Point – Aquaculture	2
PT – Point sources	5
U – Point – Urban waste water	9
U1 – Point – Urban waste water – untreated	3
U11 – Point – Urban waste water – untreated – less than 2,000 p.e.	1
U12 – Point – Urban waste water – untreated – between 2,000 and 10,000 p.e.	1
U13 – Point – Urban waste water – untreated – between 10,000 and 100,000 p.e.	1
U14 – Point – Urban waste water – untreated – more than 100,000 p.e.	1
U2 – Point – Urban waste water – treated	9
U21 – Point – Urban waste water – treated – less than 2,000 p.e.	3
U22 – Point – Urban waste water – treated – between 2,000 and 10,000 p.e.	7
U23 – Point – Urban waste water – treated – between 10,000 and 100,000 p.e.	8
U24 – Point – Urban waste water – treated – more than 100,000 p.e.	10

Note: p.e. = population equivalent

Source: https://www.eea.europa.eu/data-and-maps/data/waterbase-emissions-7

3.1.2.3 WFD Inventory of emissions, discharges and losses

Limited information on pesticides was reported by the first inventory of emissions, discharges and losses of priority substances (EU, 2008), which was reported in the 2nd River Basin Management Plans under the WFD, and only a small number of Member States reported pollutant release from agriculture or riverine load (Table 3.6). Note that some countries reported releases from agriculture for substances that have been banned already.

Table 3.6 Overview of pesticides of the WFD Inventory of emissions according to the WFD 2016 reporting

Chemical substance	No. countries with emission values above 0	No. countries reporting pollutant releases from agriculture	No. countries reporting riverine load
Endosulfan	6	2	2
Hexachlorobenzene	8	2	3
Simazine	6	1	2
Trifluralin	6	1	2
Alachlor	4	1	1
Atrazine	6	1	2
Chlorpyrifos	6	1	3
Aldrin	2	0	0
Diuron	8	1	2
Isoproturon	7	2	2
Isodrin	2	0	0
Chlorfenvinphos	3	1	2
DDT,p,p'	4	1	1
Dieldrin	2	0	0
Hexachlorocyclohexane	6	2	3
Endrin	2	0	0
Total cyclodiene pesticides (aldrin + dieldrin + endrin + isodrin)	2	1	0
Total DDT (DDT, p,p' + DDT, o,p' + DDE, p,p' + DDD, p,p')	2	1	0

Source: ETC, 2018[19]

[19] WFD-dataset review, background document, Prepared by ETC/ICM-Deltares in 2018

3.1.2.4 Pressures from sites with soil contamination

In Europe, a large number of contaminated sites exist where former polluting activities occurred and where contamination of soils is suspected, but the extent of risk to the environment has not been investigated. The number of such sites for the EU-28 is estimated at 2.8 million (Payá Pérez and Rodríguez Eugenio, 2018). This includes orphan sites (polluter not identified) and brownfields (formerly used sites with suspected or real contamination). Contaminated sites pose a significant pressure on surface and groundwaters. However, the status of most sites is not investigated, and many national registries are still incomplete. Among the polluting activities are chemical production and leakage from pesticide storage. Box 3 shows an example of pesticide concentration in agricultural topsoils.

Box 3 A European wide study on pesticide concentration in agricultural topsoils

Pesticide contamination in agricultural soils can indicate the potential risk to water pollution by erosion, runoff or leaching, entering the aquatic ecosystems. A European-wide study on pesticide concentration in agricultural topsoils in 2015 shows high concentration in soils and also variation under consideration of different crop types (Silva et al., 2019).

In this study, the distribution of 76 pesticide residues was evaluated in 317 agricultural topsoil samples from across the European Union. The soils were collected in 2015 and originated from 11 EU Member States and 6 main cropping systems. Over 80 % of the tested soils contained pesticide residues (25 % of samples had 1 residue, 58 % of samples had mixtures of two or more residues), in a total of 166 different pesticide combinations. glyphosate and its metabolite AMPA, DDTs and the broad-spectrum fungicides were the compounds most frequently found in soil samples and the compounds found at the highest concentrations.

It needs to be noted that the results of this study cannot be directly read across to pesticide pollution in aquatic ecosystems, because direct links e.g., pathways, adsorption processes, or geomorphological circumstances, lead to different contamination potential.

3.2 Qualitative data sources

3.2.1 Water Framework Directive

Pesticides in waters are covered by several parts of the reporting:

- Surface water body: Priority Substances (PS) for the assessment of chemical status, and River Basin Specific Pollutants (RBSP) for the assessment of ecological status.
- Groundwater body: Groundwater pollutants for the assessment of chemical status.
- WFD Inventory of emissions: Emissions to water under consideration of different sources (see Section 3.1.1).

3.2.2 Drinking Water Directive

The Drinking Water Directive (DWD; EU, 1998) sets a concentration limit of 0.1 µg/l for individual pesticides, and of 0.5 µg/l for the total sum of pesticides. Because the presence of pesticides in drinking water at the tap is normally at low concentrations, exposure to these chemicals would generally be chronic (EEA, 2016).

Under the 1998 Drinking Water Directive, countries report every three years on the quality of drinking water. The monitoring data originate from 'Water Supply Zones', which are the places where the water is used, with no information on where it comes from. Exceedances of selected pollutants from drinking water standards are reported. The last reporting period in 2018 covered the years 2014 to 2016, the next is due to be in 2021. Results from the years 2010 to 2013 were described in the Commission report (EC, 2016b). Note, that this Directive has just been updated and new provisions will come into force in the forthcoming years (see Section 5.2).

For reporting purposes, Member States reported on the following pesticides:

- Atrazine
- Atrazine-Desethyl
- Bentazone
- Bromacil
- Diuron
- Isoproturon
- MCPA
- Mecoprop
- Pesticides total (this parameter includes also other national monitored pesticides beside the short list)
- Simazine
- S-Metolachlor
- Terbutylatrazine.

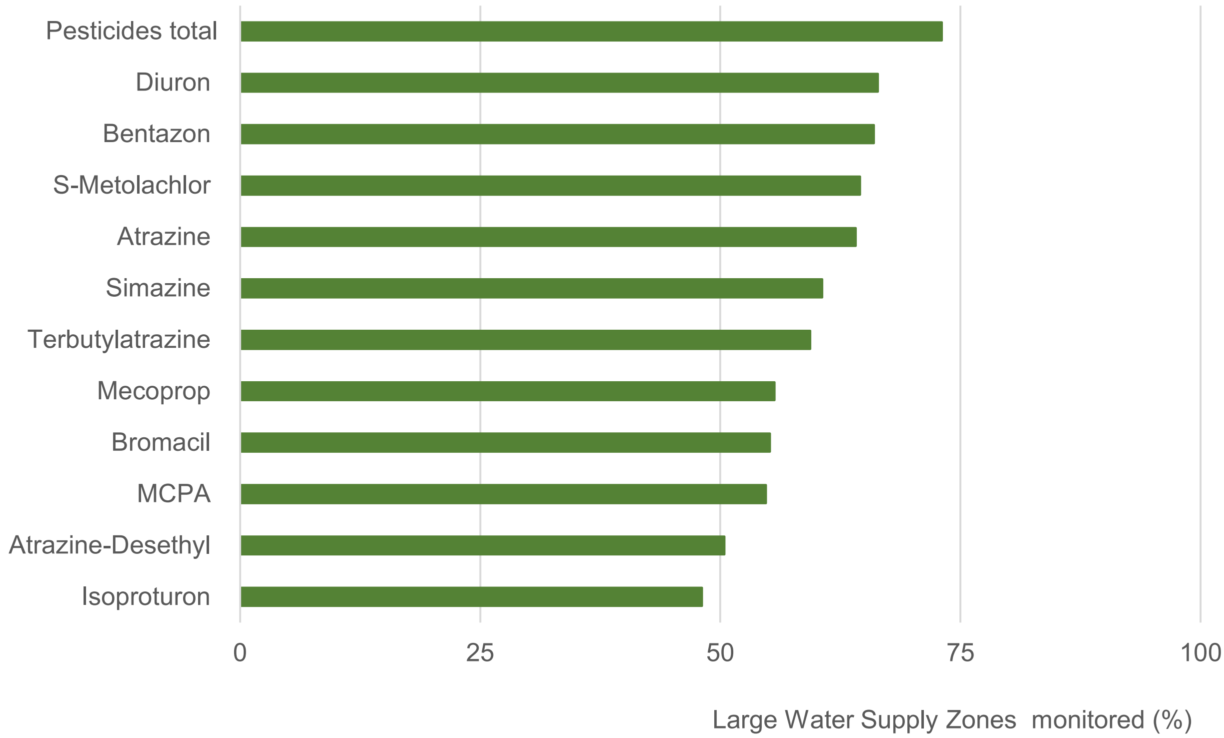
The short list is a harmonised approach and makes reporting comparable but does not show the full picture of all pesticides and all relevant metabolites in a country. In 2016, the EU Drinking Water Expert Group compiled an informal draft list of pesticides and metabolites of concern for consideration in national monitoring programmes[20].

Member States monitor a considerable number of pesticides and metabolites (degradation and reaction products) in drinking water, which are chosen at national level and are thus specific for each Member State. However, only those pesticides that are likely to be present in a given supply need to be monitored. For the presented short list of pesticides, the number of records with exceedances for each water supply zone and the compliance rate is available.

Based on available data of the DWD reporting in the time period 2014 to 2016, the short list of pesticides was monitored in about 60 % out of 9 500 large Water Supply Zones in Europe (Figure 3.8). This is an increase in comparison to the period 2011 to 2013, when pesticides were monitored in below 30 % of Water Supply Zones (EEA, 2016). The compliance rate of pesticides is shown in Section 4.2.2. Based on the amount of monitored Water Supply Zones, no information on pesticide risk to drinking water can currently be derived at the European level.

[20] Informal List of Pesticides and Metabolites of concern: https://circabc.europa.eu/ui/group/65764c73-4a57-45dc-8199-473014cf65bf/library/309b29d1-b8f8-4809-a044-6a9cca1cbabf/details

Figure 3.8: Share of Water Supply Zones, in which pesticides were monitored according to the Drinking Water Directive in reporting period 2014 to 2016



Source: DWD reporting 2014-2016, https://rod.eionet.europa.eu/obligations/171

3.2.3 Other water-related Directives

The data flows for other water-related Directives do not include pesticide data:

- Urban Waste Water Treatment Directive (91/271/EEC)
- Bathing Water Directive (2006/7/EC)
- Nitrates Directive (91/676/EEC)
- Floods Directive (2007/60/EC).

3.3 Other data sources

There are many studies that have investigated pesticide pollution. Other data, of European or worldwide coverage, focussing on the collection and assessment of pesticide contaminations were considered for the literature analysis (Table 3.7). Furthermore, pesticides data sources of European countries are available, which focus on the registration of plant production products (see Annex 4) or on the implementation of the National Action Plans under the Directive on Sustainable Use of Pesticides (EU, 2009). Within these data sources many national examples may also be found. Box 4 shows an example of a specific monitoring programme for pesticides in Germany.

Overall, data availability from scientific projects are diverse and their quality may vary in a way which makes comparison between and across studies difficult. Furthermore, sampling sites or research activities were mainly focussed on specific areas or model regions, which is also challenging for inter-comparison with routinely-monitored sites. The findings of such research projects can help to fill knowledge gaps but are less useful to address data gaps in studies of temporal and spatial pesticide contamination.

Table 3.7 Overview of additional data sources attributed to pesticide registration, research and national activities

Data source	Link to database	Contents
Food and Agriculture (FAO)	http://www.fao.org/faostat/en/#data/RP	The Pesticides Use database includes data on the use of major pesticide groups (Insecticides, Herbicides, Fungicides, Plant growth regulators and Rodenticides) and of relevant chemical families
EU	https://ec.europa.eu/food/plant/pesticides/eu-pesticides-database/public/?event=homepage&language=EN	EU-wide pesticides database on active substances, products and residues to fulfil the regulation on maximum residue levels of pesticides in or on food and feed of plant and animal origin (EU, 2005)
Pesticides Properties Database (PPDB)	https://sitem.herts.ac.uk/aeru/ppdb/en/search.htm	The PPDB is a comprehensive, relational database of pesticide chemical identity, physicochemical, human health and ecotoxicological data. It has been developed by the Agriculture & Environment Research Unit (AERU) at the University of Hertfordshire (UK) for a variety of end users to support risk assessments and risk management.
EU Member States	https://ec.europa.eu/food/plant/pesticides/sustainable_use_pesticides/nap_en	National Action Plans on the Sustainable Use of Plant Protection Products under the Directive on Sustainable Use of Pesticides (EU, 2009)
European and Mediterranean Plant Protection Organization (EPPO)	https://www.eppo.int/ACTIVITIES/plant_protection_products/registered_products	List of databases on registered plant protection products in the EPPO region
West Palaearctic Region Section (WPRS)	https://ec.europa.eu/food/plant/pesticides/eu-pesticides-database/public/?event=homepage&language=EN	Pesticide side effect database of the West Palaearctic Region Section (WPRS) (including all of Europe) with information on effects of plant production products.
Norman	https://www.norman-network.net/	The NORMAN scientists' network organises the development and maintenance of various web-based databases for the collection & evaluation of data/ information on emerging substances in the environment
EuroMix 2015–2019	http://www.euromixproject.eu/	European data and research results on chemical mixtures. Results will possibly be relevant for national food safety authorities, public health institutes, the European Food Safety Authority (EFSA), the European Chemical Agency (ECHA), industry, regulatory bodies and other stakeholders.
AQUAREHAB 2009–2013	https://www.wur.nl/en/show/aquarehab-1.htm	The project developed innovative rehabilitation technologies for soil, groundwater and surface water to cope with a number of different priority contaminants incl. pesticides in the Netherlands.
SOLUTIONS 2013–2018	https://www.solutions-project.eu/	EU FP7 project SOLUTIONS Assessment of toxicity effects of chemical mixtures in waters. e.g. • effect-based techniques as tools suitable for the different purposes of water quality monitoring the use of non-target methods.

Table 3.7 cont.

Data source	Country	Contents
National research or programme on specific pesticide monitoring	Norway	Summary of 10 years pesticide monitoring in groundwater (2007) https://www.researchgate.net/publication/227635339_Ten_Years_of_Pesticide_Monitoring_in_Norwegian_Ground_Water
	Norway	OECD Survey of National Pesticide Risk Indicators, 1999–2000 – human health and environmental risk indicators for Norway http://www.oecd.org/chemicalsafety/pesticides-biocides/1934217.pdf
	Sweden	Long-term Data from the Swedish National Environmental Monitoring Programme of Pesticides in Surface Waters (2019) https://dl.sciencesocieties.org/publications/jeq/articles/48/4/1109
	Finland	Pesticides in Groundwater (2016) https://www.slu.se/globalassets/ew/org/centrb/ckb/publikationer/dokumentation/p17-juvonen.pdf
	Denmark	Groundwater monitoring https://www.geus.dk/media/20715/grundvand_1989-2017.pdf
	Denmark	Pesticide risk indicator (2018) https://www.researchgate.net/publication/322179304_Pesticide_Load-A_new_Danish_pesticide_risk_indicator_with_multiple_applications
	France	Pesticides: evolution of sales, usage and presence in rivers since 2009 https://www.statistiques.developpement-durable.gouv.fr/pesticides-evolution-des-ventes-des-usages-et-de-la-presence-dans-les-cours-deau-depuis-2009
	The Netherlands	Surface water taxation due to the use of some plant protection products in agriculture, 2005–2017 https://www.clo.nl/indicatoren/nl0518-belasting-van-het-oppervlaktewater-door-het-gebruik-van-gewasbeschermingsmiddelen-in-de-landbouw?ond=20900
	Switzerland	National specific monitoring on surface water quality https://www.newsd.admin.ch/newsd/message/attachments/56290.pdf

Box 4 Example of a pesticide research project: Nationwide monitoring of small streams in Germany

Streams may be sampled for routine chemical analysis once a month, with pesticides seldom being found, even during the application period. However, when samples are taken under an event-controlled regime, with a rise of the water level of 5 cm and after pesticide application ('event-driven'), pesticides are found much more often. Until now, such sampling was made in scientific studies only (e.g. Liess et al., 1999; Moschet et al., 2014; Gustavsson et al., 2017).

One objective of the German National Action Plan (NAP) on Sustainable Use of Pesticides (to implement Directive 2009/128/EC) is, that by the year 2023, 99 % of the event-driven monitoring samples of one year should comply with the regulatory acceptable concentration (RAC) regulated within the authorisation of pesticides. For monitoring this, 120 catchments with an area of less than 30 km², an agricultural proportion over 40 %, and a distance of at least 3 km to waste water treatment plants upstream of the sampling sites were selected (Szöcs et al., 2017). Each site was sampled once between spring to early summer 2018 and 2019 and, automatically, event-driven after the occurrence of rain events. A uniform substance list of over 90 active substances and 40 metabolites was analysed.

The first results of the 2018 sampling campaign at 60 monitoring sites indicate that measured pollution exceeds RACs for one or several substances in more than 50 % of the event-driven samples. These exceedances occurred at more than 80 % of the monitoring sites. At about 40 % of the sites, five or more RAC exceedances occurred. Rain events triggering the sampling devices occurred at 90 % of the sites from spring to early summer, even in the very dry year of 2018. At two sites, 9 consecutive events occurred.

11 of the monitored pesticides are regulated under the WFD with maximum EQS. With event-driven sampling, 17 exceedances of these EQS at 6 % of the sites were found. With regular monthly grab sampling, only 8 exceedances at 3 % of the sites were found.

3.4 Data availability, gaps and uncertainties

As discussed above, there are many data sources for pesticides, but the availability of comparable data across Europe is rather limited. The types of Europe-wide data available, their representativity in relation to substances, time and space, and comments on the different datasets are summarised in Table 3.8 and discussed in the following.

Table 3.8 Overview of available data for pesticides in water at European level

Dataset	Content	Coverage			Comments
		Substances	Time period	Spatial	
Waterbase – Water Quality	Surface water and groundwater concen-trations	ca. 180	Annual from 1990s	EEA member and cooperating countries. Surface Waters: up to 6,500 sites; Groundwater: up to 14 000 sites	Often (especially before 2012) LoQ not reported or higher than effect threshold; low number of sites before 2007; small rivers and lakes under-represented.
Waterbase – Emissions	Emissions to water	231	Annual from 2004	River basins in EEA member and cooperating countries	231 substances or groups of substances were reported. 19 countries reported at least one pesticide, and only two countries report emissions from diffuse sources including agriculture.

Table 3.8 cont.

Dataset	Content	Coverage			Comments
		Substances	Time period	Spatial	
E-PRTR	Emissions from industrial facilities	20	Annual from 2007	Installations in EU and EFTA countries	High-size thresholds for some facilities e.g. UWWTPs; UWWTPs are most frequently reported facilities with emissions to water; no reporting of diffuse emissions.
WFD (Status)	Substances failing EQS: Surface waters Groundwater	13 out of 33 PS 86 RBSP Substance groups only	Second RBMP in 2016 (1st RBMP 2010: only group 'pesticides')	Water bodies in 28 EU Member States plus Norway	Status reported in relation to quality standards: not concentration data. Substance usually only reported when failing good status.
WFD (Pressures)	Inventory of emissions of priority substances	13 out of 33 PS	First reported in RBMP 2016	River basins in 28 EU Member States	Data related to 2010 period. Should include point and diffuse emissions. Poor comparability of data between countries. Some information on diffuse emissions.
Drinking Water Directive	Non-compliance rate in drinking water	9 (as reported); many more were monitored	Every three years, first reported in period 2011 to 2013	Compliance rate at the tap	Monitoring obligation to large Water Supply Zones. Compliance rate after treatment. No data on raw water officially available.

Abbreviations: LOQ – Limit of Quantification, UWWTP – Urban Waste water Treatment Plant, RBSP – River Basin Specific Pollutants, RBMP – River Basin Management Plan, PS – Priority Substances.

The Waterbase – Water Quality database includes a large volume of concentration measurement data reported by countries to the European Environment Agency, covering about 180 different pesticides. Data include observations on sampling dates (so called 'disaggregated') data and aggregated data (including yearly mean, minimum, maximum and Limit of Quantification (LoQ) of pesticide concentrations).

The most prominent uncertainty in the Waterbase – Water Quality dataset is the inconsistent reporting of the Limit of Quantification (LoQ) values (Section 3.1.1.3 and Box 2). This increases uncertainty in determining measurements that are below LoQ, needed for analyses such as EQS exceedance. Also, where LoQ values are reported for a substance, these values vary between and within a country, between and within any particular year, as well as over time. Another inconsistency lies in the reporting of data from the same monitoring sites through time, which would lead to a consistent time series of comparable data. Instead, the data for many monitoring sites were not reported for more than a few years, which disperses spatial and temporal coverage of the dataset and makes trend analysis less credible.

There is also a correlation between the type and size of a waterbody. Concentrations of pesticides in surface water bodies can vary widely over the course of a year, reflecting, for instance, the seasonal use of these substances and runoff events, especially in small water bodies. No further analysis of variability according to waterbody type and size was made in this step.

In cases where there was not a European quality standard, this report selected the reported minimum value of EQS for a substance as a threshold value, where at least 3 countries had a quality standard for the substance. Given the high variation in reported EQS for RBSP and other substances, this proposal is based on the precautionary principle, but this does have a significant effect on the results of the assessment (see Section 4.1.1.). Other attempts could be to distinguish between EQS derived for ecotoxicological assessments, and those used for the assessment of raw water for drinking water supply (usually 0.1 µg/l). Qualitative data on pesticides, according to the chemical and ecological status assessment under the Water Framework Directive, are limited at European level to the six yearly WFD reporting cycle. Only the latest 2016 reporting included substances causing failure of chemical status of surface water bodies. These reports are comparable for priority substances and groundwater (with similar standards across the EU), but not for river basin specific pollutants. RBSP EQS are regulated on a national basis and can differ between Member States.

Emission data (E-PRTR, Waterbase – Emissions, Inventory of emissions) offer limited information on pesticides. The substance lists are restricted and do not include many pesticides. E-PRTR thresholds, which set volume limits below which it is not necessary to report, mean that only the largest sources are reported. Diffuse sources – which are likely to be very important for pesticides – are not included or only roughly estimated in these inventories. For most substances, the inventories include only a very low share of all emissions of the addressed substances.

Qualitative data reported under the 1998 Drinking Water Directive (DWD) focus on a short list of pesticides and their compliance with the DWD, even though EU Member States monitored a broad range of pesticides in their countries. The compliance rate for each substance is attributed solely to large Water Supply Zones, and the reporting of compliance for decentralised small wells is not required under the Directive (and is not monitored regularly). Furthermore, the point of compliance (and monitoring) was not the raw water from the drinking water source, but rather at the tap (i.e. after treatment). While the amount of compliance will give a hint to main pesticide problems within EU Member States, data are poorly comparable with other databases.

Data from literature exist in overwhelming amounts but could not be harmonized here to be comparable over Europe and thus give a representative picture.

From this review of the available data, we conclude that the Waterbase – Water Quality database is the most comparable source to give a European-wide overview of pesticide concentrations in surface waters and groundwater.

4 Status of information on pesticides

This section provides data assessments, ordered into quantitative assessments from data sources giving figures, e.g. of concentrations in waters (e.g. in µg/l) or emission loads to surface waters (e.g. in kg/year) and qualitative assessments (e.g. names of substances exceeding quality standards given in WFD reporting).

4.1 Assessments and results from quantitative data sources

4.1.1 Waterbase – Water Quality

4.1.1.1 Pesticides in surface waters

Data of 180 pesticide substances are found in Waterbase – Water Quality (see Section 3.1.1.1). 63 of them are considered relevant for Europe (due to EU-wide regulation), included in the Watch List or regulated nationally in three or more Member States (see Section 3.1.1.2). Data were included from 2007 to 2017. Before 2007, the number of sites seems to be too small for an analysis to be comparable with those from 2007 onwards. Data were available for the period up to 2017. The assessment is split into usage groups (herbicides, insecticides, fungicides), since these have different effects in the ecosystems (e.g. herbicides inhibit photosynthesis and insecticides have neurotoxic action).

Exceedance rates

Based on the methods explained in Section 3.1.1.3, Table 4.1 shows the specific substances reported under Waterbase – Water Quality, with the highest rate of exceedances ordered in usage groups. The thresholds for each substance used for the calculation of the exceedance rate are listed in Annex 6.

The total number of records within the group of herbicides in the time period 2007 to 2017 is 157 341, and the substance with the highest exceedance rate is glyphosate (15.6 %) even though the number of records is relatively low (n = 6,257). With some 20,000 records, trifluralin and diuron, which are listed as priority substances under WFD, show lower exceedance rates, at 2.2 % and 1.0 % respectively. Four substances show exceedance rates greater than 5 % (Table 4.1).

Insecticides include a total of 69 different substances. The number of records of the 17 insecticides listed in Table 4.1 is 116 358 in the time period 2007 to 2017 (23.3 % out of some 500 000 records). Heptachlor and alpha-endosulfan have the highest number of records. Nine substances show exceedance rates over 10 %: malathion, heptachlor, dichlorvos, heptachlor epoxide, imidacloprid, cypermethrin, fenitrothion, parathion, dicofol. Seven substances show an exceedance rate between 5 and 10 %.

Only 19 substances are listed under the usage group of fungicides, with the total number of records between 2007 to 2017 of 59 295. The mean exceedance rate of all 19 fungicides is low with 0.2 % and only the substances hexachlorobenzene and metalaxyl have exceedance rates of more than 1 %.

Table 4.1 Number of reported substances with the most reported rate of exceedances in surface waters, grouped by usage, in the time period 2007 to 2017

Group	Substance	Number of records per substance, year and monitoring sites	Rate of exceedance (%)	Threshold used for calculation (µg/l)	Listed in
Herbicides	Glyphosate	6 257	15.6	0.1	RBSP
	Diflufenican	719	6.7	0.009	RBSP
	Bifenox	5 499	6.6	0.012	RBSP*
	Metolachlor[21]	12 062	6.2	0.3	RBSP
	Desethylterbuthylazine	8 515	4.3	0.1	RBSP
	Terbuthylazine	12 984	2.7	0.2	RBSP
	Desethylatrazine	9 464	2.4	0.1	RBSP
	Ethofumesate	7 751	2.2	0.1	RBSP
	Trifluralin	20 218	2.2	0.03	PS
	Oxadiazon	2 350	1.6	0.088	RBSP
	MCPA	13 870	1.6	0.1	RBSP
	Linuron	16 058	1.3	0.1	RBSP
	2,4-dichloropheno-xyacetic acid, 2-4 D	9 330	1.1	0.1	RBSP
	Bentazone	9 130	1.0	0.1	RBSP
	Diuron	19 583	1.0	0.2	PS
Insecticides	Malathion	7 479	29.2	0.0008	RBSP
	Heptachlor	11 847	20.7	0.0000007	RBSP*
	Dichlorvos	9 773	16.4	0.0006	RBSP*
	Heptachlor epoxide	8 479	15.9	0.0002	RBSP*
	Imidacloprid	2 394	15.5	0.0083	WL-1,2
	Cypermethrin	5 326	15.4	0.00008	RBSP*
	Fenitrothion	9 317	14.8	0.0009	RBSP
	Parathion	8 777	13.7	0.0002	RBSP
	Dicofol	7 600	13.3	0.0013	RBSP*
	Endosulfan	7 084	8.7	0.005	PS
	Hexachlorocyclohexane	4 583	8.3	0.02	PS
	Omethoate	5 803	7.8	0.0008	RBSP
	Parathion-methyl	8 446	7.0	0.005	RBSP
	Permethrin-cis+trans	2 426	6.8	0.001	RBSP
	Alpha-Endosulfan	15 083	6.7	0.005	RBSP
	Methiocarb	1 272	5.0	0.002	WL[1,2]
	Thiacloprid	669	4.8	0.0083	WL[1,2]
Fungicides	Hexachlorobenzene	19 771	2.0	0.05 (MAC EQS)	PS
	Metalaxyl	7 304	1.5	0.1	RBSP
	Carbendazim	4 769	1.0	0.15	RBSP
	Fenpropimorph	6 181	0.5	0.02	RBSP
	Epoxiconazole	5 069	0.2	0.1	RBSP
	Propiconazole	6 226	0.1	0.1	RBSP

Notes: The number of records for one substance is an aggregate of samples taken at one site, in one year.
MAC = Maximum Acceptable Concentration.
Threshold for inclusion of the substance is the exceedance rate: herbicides > 1 %, insecticides > ~5 %, fungicides > 0,1 %.
PS = Priority Substances; RBSP = River Basin Specific Pollutant (nationally regulated); RBSP* = RBSP became PS in 2013; WL = Watch List ([1]according to Commission Implementing Decision (EU) 2015/495; [2]according to Commission Implementing Decision (EU) 2018/840).

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[21] Metolachlor consists of two isomers: S-metolachlor and R-metolachlor. The mixture of both as metolachlor was approved until 31.12.2003. S-metolachlor was approved until 31.07.2020. In Waterbase – Water Quality, the results of metolachlor and S-metolachlor are combined.

Trends

Figure 4.1 shows the rate of exceedance over the time period from 2007 to 2017 of the three groups: insecticides, herbicides and fungicides. This assessment is based on the number of monitoring sites, because the effects of these three groups impact on three different aquatic organism groups. For this reason, the exceedance per year and sampling site is crucial for the assessment.

Insecticides show the highest rate of exceedances in the time period 2007 to 2012, with a range between 22 % in 2007 and 48 % in 2012. After 2012, the rate of exceedance of insecticides decreased significantly, to less than 10 % in 2017. One reason for this might be problems in data. Before 2012, LoQs were not reported from many countries. Furthermore, the data selection and calculation method, made according to the precautionary principle, lead to high exceedance rates (Section 3.1.1.3 and Box 2). After 2012, most of the EU countries implemented EQSD, which led to the development of improved analytical methods with lower LoQ. More data on values and LoQ were reported, and we assume that these data might be more reliable as they would be less affected by data selection and calculation methodology.

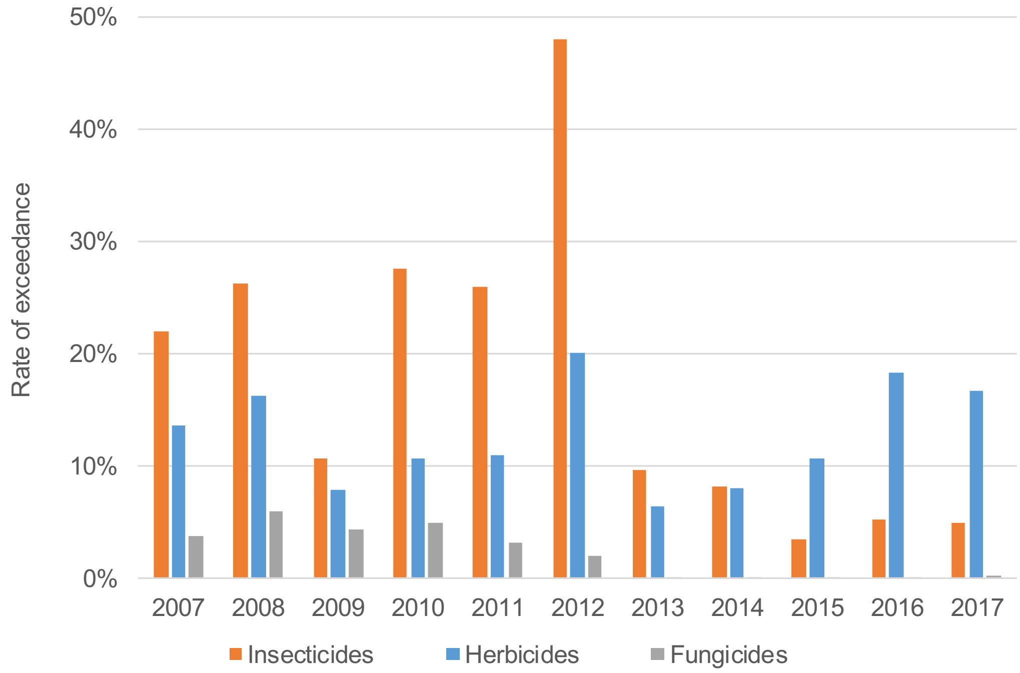
The same effect might be true for fungicides. They show the lowest exceedance rates over the whole time period and since 2013, the rate of exceedance decreased to less than 1 % per year. Fungicides are seldom seen as a water quality problem.

Exceedance rates of substances used as herbicides also varied over the years, but a break or linear increasing or decreasing trend is not visible. Because most herbicides have usually higher EQS in the range of the drinking water standard, and have a much longer analysis history, the exceedance effect regarding LoQs is unusual for herbicides. Since 2014 herbicides have shown more exceedances at monitoring stations than insecticides.

The issue of analytical results being below LoQ, LoQ being above EQS and missing reports of LoQ needs more investigation.

It should be noted that the exceedance rates of the three usage groups of pesticides are caused by a relatively limited number of substances.

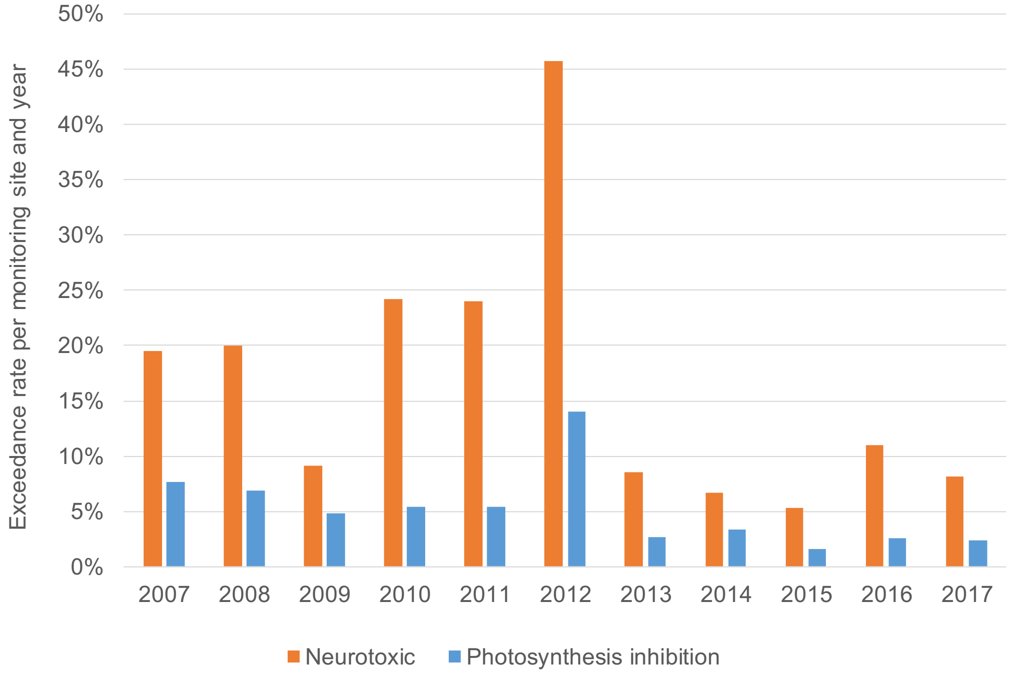
Figure 4.1: Rate of exceedances of the three usage groups of pesticides in surface waters in the time period 2007 to 2017



Note: For determining exceedance, see Section 3.1.1.

Figure 4.2 shows the result based on the grouping according to Mode of Actions (MoA). Based on the available data and the methods for the pesticide selection, only two groups of substances showed many EQS exceedances: neurotoxic and photosynthesis inhibitors. Because neurotoxic substances are used as insecticides, and photosynthesis inhibiting pesticides are herbicides, results of MoA grouping of pesticides show nearly the same amounts of exceedances as presented on pesticide usages. Additionally, the problems discussed above are valid for values lower than the LoQ as the reason for uncertainty in exceedances before 2012 for neurotoxic insecticides.

Figure 4.2: Rate of exceedances per monitoring site; MoA grouping of pesticides in surface waters in the time period 2007 to 2017



Note: Based on the used methods, data availability and data selection, only photosynthesis inhibition and neurotoxic MoA are available.

4.1.1.2 Pesticides in groundwater

By analogy with the results of pesticide substances in surface waters (Section 4.1.1.1), Table 4.2 shows the number of substances and their exceedance rate for groundwater. Data on 159 pesticide substances are found in Waterbase – Water Quality (see Section 3.1.1.1). A discussion on substance relevance in groundwater is not needed – the EU-wide EQS (= threshold) for all substances is 0.1 µg/l. This is higher than thresholds for many insecticides and fungicides in surface waters.

The total number of records within the group of herbicides in the time period 2007 to 2017 is some 1 400 000, and the substances with most exceedance rates are deisopropyldeethylatrazine (4.9 %), desethylatrazine (3.5 %) and 2,6-dichlorobenzamide (3.1 %). Only five substances show exceedance rates over 1 % (out of 75).

Reported insecticides include a total of 61 different substances. The total number of records of the 61 substances in the time period 2007 to 2017 is 850 327, and some 219 000 records of the 11 insecticides listed in Table 4.2. Here, only one substance – demethon-S-methyl – has exceedance rates over 2 %. The exceedance rate of all other substances is less than 1 %.

None of the selected substances assigned to the group of fungicides shows exceedance rates over 1 %. In the time period 2007 to 2017, 113 688 records were reported from the 11 selected fungicides.

Table 4.2 Number of reported substances with the most frequently reported rate of exceedances in groundwater, grouped by usage, in the time period 2007 to 2017

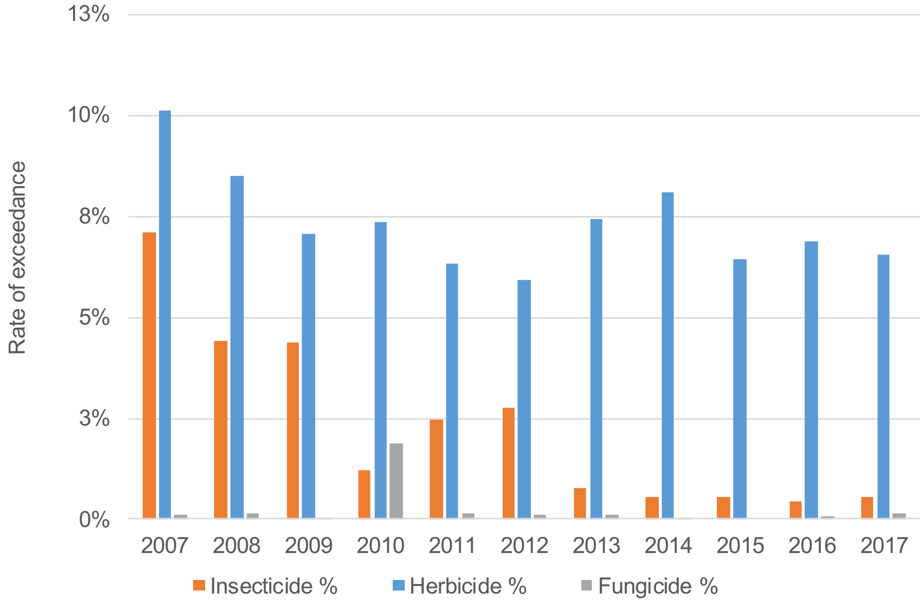
Group	Substance	Number of records per substance, year and monitoring sites	Rate of exceedance (%)
Herbicides	Deisopropyldeethylatrazine	13 436	4.90
	Desethylatrazine	59 184	3.49
	2,6-dichlorobenzamide	17 054	3.10
	Bentazone	45 363	1.42
	Atrazine	63 941	1.26
	Dichlobenil	22 136	0.83
	Glyphosate	14 954	0.78
	Aminomethylphosphonic acid (AMPA)	14 177	0.71
	Desisopropylatrazine	43 349	0.57
	Metolachlor	19 130	0.51
	Hydroxyatrazine	11 697	0.49
Insecticides	Demeton-S-methyl	4 972	2.92
	Isodrin	23 227	0.78
	Pirimicarb	22 054	0.75
	Endrin	27 154	0.69
	Dimethoate	25 504	0.59
	1,2-dibromoethane	2 561	0.55
	Chlordecone (Kepone)	3 031	0.46
	Heptachlor epoxide	13 765	0.31
	Beta-HCH	19 879	0.30
Fungicides	Epoxiconazole	9 199	0.30
	Hexachlorobenzene	24 891	0.18
	Metalaxyl	23 873	0.08
	Propiconazole	11 593	0.06
	Fenpropimorph	19 000	0.02

Notes: The number of records is an aggregate of samples taken at one site, for one substance, in one year; typically composed of (more) disaggregated, but also aggregated reported records.
The groundwater quality standard applied to all substances was 0.1 µg/l (see Section 3.1.1.2).

Figure 4.3 shows the rate of exceedance over the time period from 2007 to 2017 of the three groups insecticides, herbicides and fungicides in groundwater monitoring stations. The results show by far the highest rates of exceedances of herbicides, with a possible slightly decreasing trend from 8–10 % in 2007 to 2009 to 7–8 % in 2015 to 2017. The exceedance rates at monitoring stations occurs also for insecticides. The rate starts with 2–7.5 % until 2012 and decreases to 0.5 % after 2012. Fungicides show (like the results in surface waters) the lowest exceedance rates over the whole time period with a small peak in 2010 (which cannot be interpreted in detail). Overall, the exceedance rates at groundwater monitoring stations are much lower than exceedance rates in surface waters.

In groundwater, the assesment according to MoA grouping is not relevant, because groundwater assessment is not based on the effects to aquatic organisms. The threshold value is derived from the objective to protect drinking water from all pesticides.

Figure 4.3: Rate of exceedances of the three usage groups of pesticides in groundwater in the time period 2007 to 2017



4.1.2 E-PRTR

Table 4.3 shows the number of records since 2007 and the total load in 2017 reported under the E-PRTR for pesticides. Diuron is the pesticide reported under E-PRTR with the most emissions, followed by lindane, dieldrin, aldrin and atrazine.

Table 4.3 Total pesticide load to water reported under E-PRTR in 2017

Pollutant Name	No. of records (2007–2017)	No. of MS (2007–2017)	Total 2017 (kg)	No. of facilities 2017
Alachlor	26	7	19.4	3
Aldrin	103	4	61.9	11
Atrazine	77	13	61.1	6
Chlordecone	12	3	0	0
Chlorfenvinphos	8	4	0	0
Chlordane	5	1	1.3	1
Chlorpyrifos	24	5	27.6	5
DDT	24	5	25.4	3
Dieldrin	117	5	67.9	12
Diuron	1 136	12	389.9	122
Endosulfan	19	5	25.4	3
Endrin	82	5	52.0	8
Heptachlor	15	2	25.4	3
1,2,3,4,5,6-hexachlorocyclo hexane (HCH, Lindane)	80	8	71.6	7
Isodrin	98	6	54.4	9
Isoproturon	336	11	47.1	20
Mirex	2	2	0	0
Simazine	82	9	39.9	6
Trifluralin	15	3	20.1	2

Note: Reporting threshold in E-PRTR is for all mentioned substances 1 kg/year; except Mirex, which does not have a threshold.
Source: E-PRTR .16, published in 2019 including 2017 data.

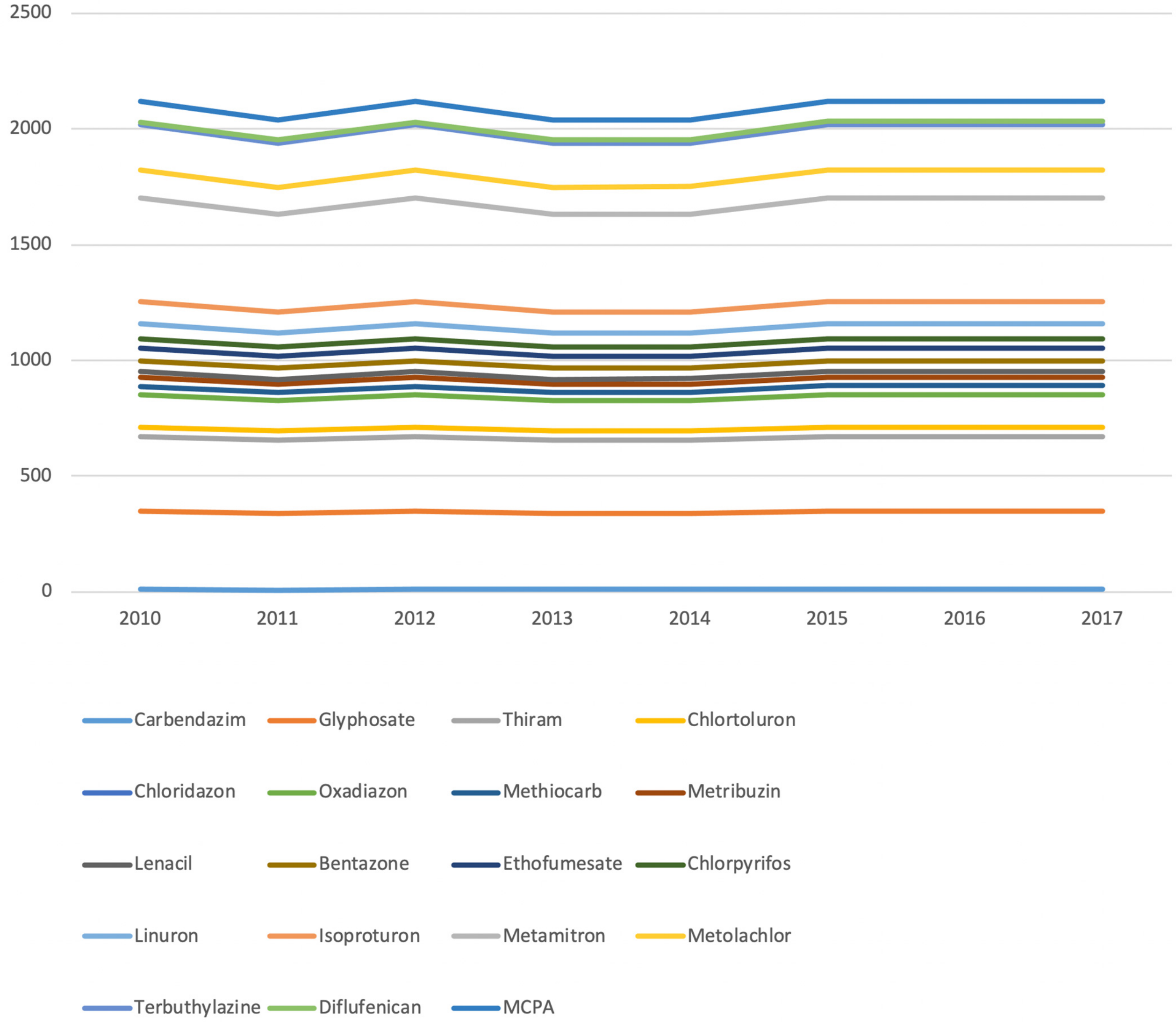
Most of the pesticides reported under E-PRTR are no longer authorised for use: simazine, DDT, lindane, mirex, aldrin, dieldrin, endrin and isodrin are banned under the Stockholm POP convention, isoproturon was banned in 2016, respectively. Chlordane is not approved. Diuron is still in use, but also restricted. Additionally, a substance banned as a pesticide might be still used as a biocide.

4.1.3 Waterbase – Emissions

As already described in Section 3.1.2.2, only few Member States reported pesticide emissions under the Waterbase – Emissions database.

Figure 4.4 shows an example of the Waterbase – Emissions data for pesticide releases from agriculture based on modeled data (NMI3 for the Netherlands and the WEISS model developed and used in Belgium). According to this database, the amount of pesticides released has not changed over the last 10 years.

Figure 4.4: Trend of pesticide releases from agriculture (kg/year) in RBD Maas and Schelde (Belgium) reported under Waterbase – Emissions



Source: https://www.eea.europa.eu/data-and-maps/data/waterbase-emissions-7.

4.2 Assessments and results of qualitative data sources

4.2.1 Water Framework Directive

Surface waters

Since the publication of EEA assessments on the River Basin Management Plans and Chemicals in European waters (EEA, 2018b, 2018a), the data for four more countries (Greece, Ireland, Lithuania and Norway) have been reported. Furthermore, WFD reporting has been updated where substances had not been correctly coded. The analysis in this report reflects this updated reporting.

According to the implementation of the WFD, 533 surface water bodies (0.4 %) are still failing to achieve good chemical status in the 2nd RBMP due to pesticides among the Priority Substances (PS). Most of these water bodies are affected by the herbicide isoproturon (200 in nine Member States) and/or the insecticide hexachlorocyclohexane (lindane, 118 in 11 Member States) (Table 4.4). 437 water bodies improved from failing to achieve good chemical status in the 1st RBMP as a result of these substances meeting the relevant standards, among them diuron (169) and isoproturon (116)[22]. For comparison: the priority substance tributyltin, a biocide mainly used to combat marine biofouling but also used as a biocide in imported clothing, caused failure of good chemical status in 775 WB and in 14 Member States.

Additionally, several pesticides regulated nationally as river basin specific pollutants (RBSP) exceeded their nationally-set standards. Priority Substances are regulated EU-wide with the same EQS, while EQS can differ for RBSP (see Annex 6), which makes exceedance only for PS really comparable between Member States. Prominent examples of RBSP are the herbicides MCPA (exceeding in 160 water bodies in six Member States) and metolachlor (140 WB in six Member States) or the insecticide malathion (21 WB in five Member States) (Table 4.4). AMPA, glyphosate (highly ranked in the Waterbase – Water Quality assessment, see Table 4.1) exceeded in 125 WB of two Member States (of which 124 were from Italy).

[22] Source: https://www.eea.europa.eu/themes/water/european-waters/water-quality-and-water-assessment/water-assessments/chemical-status-of-surface-water-bodies (accessed 29.05.2020)

Table 4.4 List of pesticides most frequently exceeding EQS in surface water bodies in 2nd RBMPs, EU 28 +NO (out of 148 803 water bodies)

Pollutant	Type / Use of chemical	No. of Member States with EQS exceedance	No. of water bodies ex-ceeding EQS	Priority substance (PS / RBSP)
Endosulfan	Insecticide	12	75	PS
Hexachlorocyclohexane	Insecticide	11	118	PS
Isoproturon	Herbicide, biocide	9	200	PS
Diuron	Herbicide	9	69	PS
DDT	Insecticide	9	46	PS
Chlorpyrifos	Insecticide	8	70	PS
MCPA	Herbicide	6	160	RBSP
Metolachlor	Herbicide	6	140	RBSP
Terbuthylazine	Herbicide	6	52	RBSP
Trifluralin	Herbicide	6	12	PS
Malathion	Insecticide	5	21	RBSP
Chlorfenvinphos	Insecticide	5	11	PS
2-4 D (2,4-Dichlorophenoxyacetic acid)	Herbicide	4	18	RBSP
Parathion-methyl	Insecticide	4	21	RBSP
Atrazine	Herbicide	4	9	PS
Parathion	Insecticide	4	7	RBSP
Bentazone	Herbicide	3	82	RBSP
Linuron	Herbicide	3	46	RBSP
Chloridazon	Herbicide	3	27	RBSP
Diazinon	Insecticide	3	26	RBSP
Metazachlor	Herbicide	3	26	RBSP
Dichlorvos	Insecticide	3	25	RBSP
Metribuzin	Herbicide	3	13	RBSP
Alachlor	Herbicide	3	5	PS
Azinphos-ethyl	Insecticide	3	4	RBSP
Fenitrothion	Insecticide	3	4	RBSP

Note: Substances with exceedance in three or more MS, listed in order of the numbers of Member State exceedance

Source: Priority Substances (PS): https://www.eea.europa.eu/themes/water/european-waters/water-quality-and-water-assessment/water-assessments/chemical-status-of-surface-water-bodies
River Basin Specific Pollutants (RBSP):
https://tableau.discomap.eea.europa.eu/t/Wateronline/views/WISE_SOW_FailingRBSP/SWB_FailingRBSP?:embed=y&:showAppBanner=false&:showShareOptions=true&:display_count=no&:showVizHome=no

Groundwater

Based on the published data of the WFD, nitrate was the most frequently reported substance causing a failure to achieve good chemical status in groundwater, followed by pesticides (EEA, 2018a). Table 4.5 shows the share of groundwater area failing to achieve good chemical status due to pesticides within the 2nd RBMP 2016. For this, pesticide substances causing failure to achieve good chemical status for groundwater were selected and merged to the six groups listed in Table 4.5 (grouping and usage of substances, see Annex 5). Based on the 2016 WFD reporting, nearly 80 % of groundwater area in Luxembourg are significantly affected by herbicides, and some 50 % in Czech Republic; some 24 % of all groundwater area in Belgium and 17 % in France are affected by pesticides. These shares are far higher than in all other Member States.

Table 4.5 Share of groundwater area failing to achieve good chemical status due to pesticides and biocides (%)

Member State	Pesticides and biocides	Herbicides	Insecticides	Fungicides	Metabolites	Pesticides
Austria	0.2	0.0	0.0	0.0	0.2	0.0
Belgium	27.1	3.5	0.0	0.0	3.7	23.6
Czechia	48.4	48.4	0.2	0.0	17.1	0.0
Denmark	3.2	0.0	0.0	0.0	0.0	3.2
Estonia	1.7	0.0	0.0	0.0	0.0	1.7
Finland	2.3	2.0	0.2	0.1	1.7	0.8
France	17.1	0.0	0.0	0.0	0.0	17.1
Germany	8.0	3.3	0.0	0.0	3.4	4.0
Hungary	0.4	0.4	0.0	0.0	0.0	0.0
Italy	16.0	10.7	4.3	0.3	11.3	0.0
Luxembourg	78.9	78.9	0.0	0.0	0.0	0.0
Netherlands	0.5	0.0	0.0	0.0	0.0	0.5
Slovakia	1.2	1.2	0.0	0.0	0.0	0.0
Slovenia	2.1	2.1	0.0	0.0	0.0	0.0
Spain	2.2	0.6	0.1	0.0	0.0	1.6
Sweden	2.4	0.0	0.0	0.0	0.0	2.4
United Kingdom	4.6	3.6	0.7	0.0	0.0	0.5

Note: 'Pesticides' (last column of the table) is not the sum of the specific substance groups. Here, 'pesticides' are substances reported under code EEA_34-01-5 = active substances in pesticides, including their relevant metabolites, degradation and reaction products.

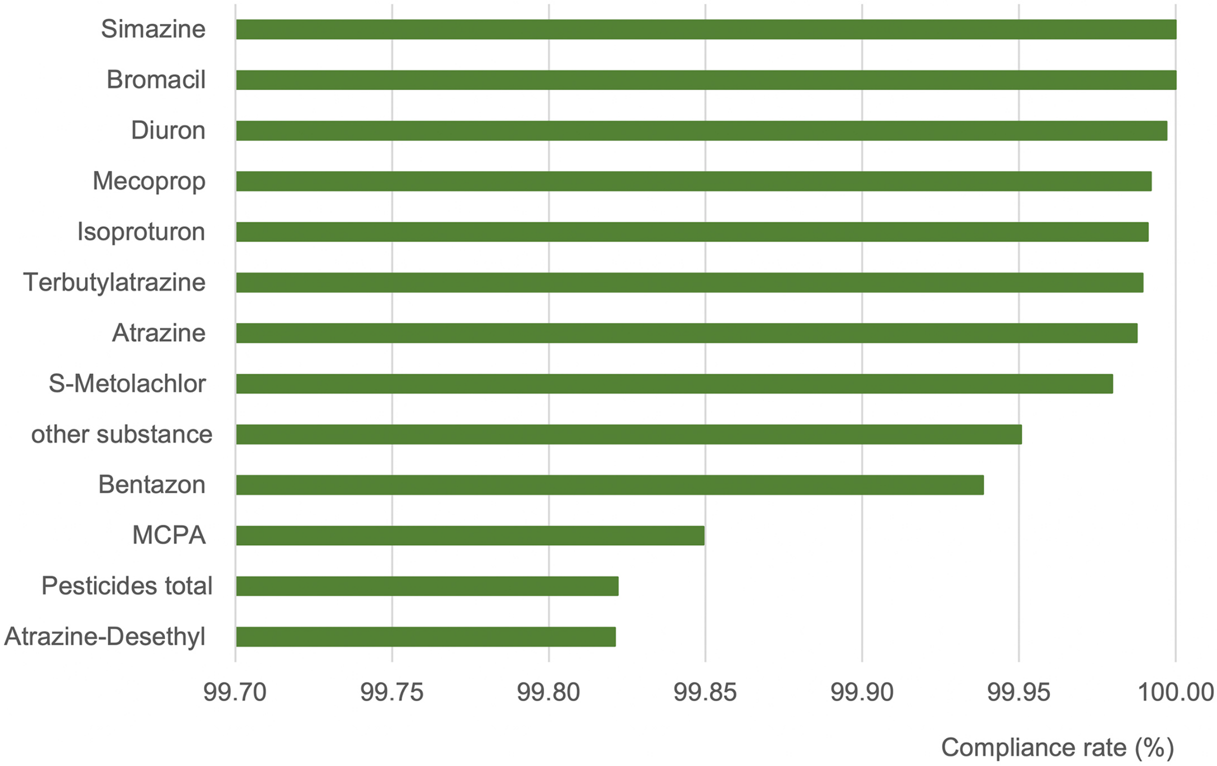
Source:
https://tableau.discomap.eea.europa.eu/t/Wateronline/views/WISE_SOW_gwPollutant/GWB_gwPollutant_Europe?:embed=y&:showAppBanner=false&:showShareOptions=true&:display_count=no&:showVizHome=no

4.2.2 Drinking Water Directive

Based on data of the last reporting period under the Drinking Water Directive, Figure 4.5 shows the compliance rate of pesticide monitoring. The compliance rate was calculated based on the number of samples between 2014 and 2016 in all Water Supply Zones, and the number of samples with non-compliance (exceedance of threshold).

Based on this, the compliance rate with the list of pesticides is high and varies between 99.8–100 % (see Section 3.2.2), however this does not necessarily represent the pesticides actually present. Several derogations from the parametric values granted by Member States show that exceedances, mainly for metabolites, occur and that contamination of drinking water by pesticides can be an issue.

Figure 4.5: Compliance rate of pesticides in the EU reported under the Drinking Water Directive in the period 2014 to 2016



Source: DWD reporting 2014 to 2016; https://rod.eionet.europa.eu/obligations/171/deliveries

4.3 Summary on status information

The EEA's Waterbase – Water Quality database suggests that for the period 2007 to 2017, 5–15 % of surface water monitoring stations were affected by herbicides and 3–8 % by insecticides. For groundwater the shares were about 7 % for herbicides and 1 % for insecticides. Fungicides seem to be of lower significance. WFD status reporting in 2016 (covering 2010 to 2015) shows only 0.4 % of water bodies affected by pesticides, but 15 % of the groundwater body area.

For surface waters, both databases (EEA's Waterbase – Water Quality and WFD status reporting) show, that insecticides most often exceed EQS, followed by herbicides. But the two databases highlight different substances. This ranking resulted from analysing Waterbase using the time series 2007 to 2017. It was found that these data include high exceedance rates of insecticides between 2007 and 2012, which could not be confirmed. It may be that the data are biased by values lower than LoQ.

For groundwater, Waterbase – Water Quality shows herbicides and herbicide metabolites most often exceeding the threshold.

Emissions data add some (fragmented) information, mainly on point sources. Emissions data could not be combined with the assessments of environmental data. Emissions reporting is not comprehensive and little information is available on diffuse emissions. For surface waters, no loads could be calculated from the concentrations.

5 Measures

If pesticide pollution reaches surface waters and groundwater, measures need to be taken to improve water quality and reduce the risks to human health and the environment. The planning of measures to reduce pesticide pollution is done within the programmes of measures under the WFD, as well as part of the National Action Plans for the implementation of the Sustainable Use of Pesticides Directive. Furthermore, mitigation measures for the protection of water used for drinking water are part of the Drinking Water Directive obligations. The following sections describe types of measures under the different directives, and present examples on the successful implementation to reduce pesticide pollution in waters and soil.

5.1 Measures under the Water Framework Directive

The planning of measures to improve water body status is part of the River Basin Management planning process under the WFD. Measures are specified by the Member States in the programme of measures (PoM) in their River Basin Management Plans (RBMPs), for implementation during each management cycle. The WFD distinguishes between basic measures, which comprise the minimum requirements to be complied with, including those already defined in existing legislation, and supplementary measures. Supplementary measures are those measures designed and implemented in addition to the basic measures, where they are necessary to achieve environmental objectives. WFD Annex VI Part B includes a non-exclusive list of such measures.

For the reporting of measures in the PoM, 25 Key Types of Measures (KTM) were defined (EC, 2016a). The KTM are the types of measure expected to bring the most substantial improvements in water bodies to reach the WFD objectives. Each KTM can include one or more specific measures.

In the PoMs reported in the 2nd RBMPs under the WFD, the KTMs addressed directly or indirectly to pesticide reduction in surface waters and groundwater are:

KTM 3: Reduce pesticide pollution from agriculture

KTM 12: Advisory service for agriculture

KTM 13: Drinking water protection measures (e.g. establishment of safeguard- or buffer zones)

KTM 15: Measures for the phasing-out of emissions, discharges and losses of Priority Hazardous Substances or for the reduction of emissions, discharges and losses of Priority Substances.

Based on the European Commission’s implementation report (EC, 2019c), 24 out of 25 Member States reported a total of 1 250 measures according to the four mentioned KTM (Table 5.1).

Table 5.1 Overview of reported basic and supplementary measures for four key type measures assigned to reduce pesticide pollution in groundwater and surface water, 2nd RBMPs

	Basic measures		**Supplementary measures**	
	Number of Member States with reported measures	Number of reported measures	Number of Member States with reported measures	Number of reported measures
KTM 3: Reduce pesticides pollution from agriculture	21	213	16	102
KTM 12: Advisory service for agriculture	6	25	15	181
KTM 13: Drinking water protection measures	19	243	16	71
KTM 15: Measures for the phasing-out of emissions, dis-charges and losses of Priority Hazardous Substances or for the reduction of emissions, dis-charges and losses of Priority Substances	20	280	17	51

Source: EC, 2019

5.2 Measures under the Drinking Water Directive

In accordance with the 1998 Drinking Water Directive, Member States are obliged to implement mitigation measures in case of exceedances of the DWD-listed substances. These can include monitoring programmes, including measurements in the catchment; risk assessments (e.g. drinking water safety plan); and treatment that needs to be done. The target value of the pesticides within the DWD is 0.1 µg/l for any single pesticide substance, or 0.5 µg/l for the sum of all pesticides. In case of exceedances, the authorities are responsible to do research: identify the source of contamination, how to regulate it and stop the emission or discharge. In most cases, exceedances will be reduced by blending water sources or selecting other abstractions.

Protecting raw water is particularly important. Critical groundwater bodies need special attention and measures to protect drinking water resources. That cannot be the task of the competent authority or water suppliers alone. Rather, they need to cooperate with various stakeholders, work closely to a plan and implement measures in the catchment area. To protect drinking water against pollution from the catchment area, there must be well-integrated links between the DWD, the implementation of the water safety plan approach and the WFD (EEA, 2016).

Additionally, the new Drinking Water Directive 2020 (see Section 2.5 on legislation above) introduces the so-called 'risk-based approach' and includes provisions to protect raw water. Through the new Article 8, it requires a risk assessment and risk management of the catchment area(s) for the abstraction point(s) of drinking water. It entails an assessment of possible risks that might cause deterioration of the water quality to the extent that it may constitute a risk for human health. Recital 15 explicitly mentions pesticides amongst possible pollution sources to be identified and monitored, for example because of information from the water suppliers. Furthermore, the Article requires better communication, and finally to take prevention and mitigation measures.

The new Directive has also modified the notes to the pesticides' entry in Annex I. It clarifies that pesticides in the sense of the Drinking Water Directive include their metabolites, as defined in Article 3(32) of Regulation (EC) No 1107/2009 (EU, 2009c), that are considered relevant for water intended for human consumption. It adds further a new definition: *"A pesticide metabolite is deemed relevant for water intended for human consumption, if there is reason to consider that it has intrinsic properties comparable to those of the parent substance in terms of its pesticide target activity, or that it generates (itself or its transformation products) a health risk to the consumer".*

The EU project FAIRWAY under the HORIZON 2020 programme addresses the challenge of pesticide pollution. The goals of the project are to review approaches for the protection of drinking water resources against pollution by pesticides and nitrate, and to identify and further develop innovative measures and governance approaches for more effective drinking water protection. It runs from 2017 to 2021 and has a budget of about 5 Million Euros. The project partners are researchers, farm advisers and consultancies, building on 13 case studies in 11 different EU countries of the FAIRWAY project (2019)[23].

Three case studies in Ireland, the United Kingdom and the Netherlands focus on pesticide contamination in drinking water resources.

In the Derg catchment in **Ireland**, MCPA arising from spray drift on agricultural land threatens drinking water resources. Within this catchment, a farm incentive scheme was developed as a voluntary initiative, which goes beyond the requirements that already apply to farms in the context of pesticide legislation, the Water Framework Directive, the Drinking Water Directive and other Regulations. In this scheme, several mitigation measures were included, like technical advice/ education, the development of a farm water safety plan, the implementation of riparian buffer strips, herbicide substitutions or stock fencing. Furthermore, monitoring of water and soil is carried out. As the project is still ongoing, results of the effectiveness of the implemented measures are not yet available.

In the Anglian region of the **UK**, there was serious contamination in surface waters with metaldehyde, a molluscicide used against slugs in crops such as potatoes, oilseed rape and cereals. It is difficult to remove metaldehyde in water treatment, leading to challenges in the supply of drinking water. This case study focusses on the social science to reduce on-farm pesticide use, collecting comparable data in areas with metaldehyde challenges, and testing a new network engagement[24] between the stakeholders included in the FAIRWAY project.

In the Noord-Brabant case study of the **Netherlands**, 11 of the 39 abstraction sites for drinking water are impacted by pesticides. Here, a contract between farmers and the province has been put in place, including an agreement on the reduced use of pesticides. The farmers implement measures and they choose pesticides with a low environmental impact using the 'Environmental Yardstick for Pesticides'[25], and register their pesticide use. The municipalities have reduced their pesticide use to zero on hard surfaces and they aim for zero use in parks, sport pitches and golf areas.

The development of the 'Environmental Yardstick for Pesticides' provides an overview of the environmental pressures generated by all crop protection agents permitted on the Dutch market. It enables the user to compare these agents and chooses the least harmful crop protection strategy. The Yardstick is also explained in a short and simple video on how to use and where to find the relevant information[26]. It can be downloaded as an App on smartphones and tablets. In the programme, the user can include the specific pesticide resulting in a classification of risk for soil and water (Figure 5.1).

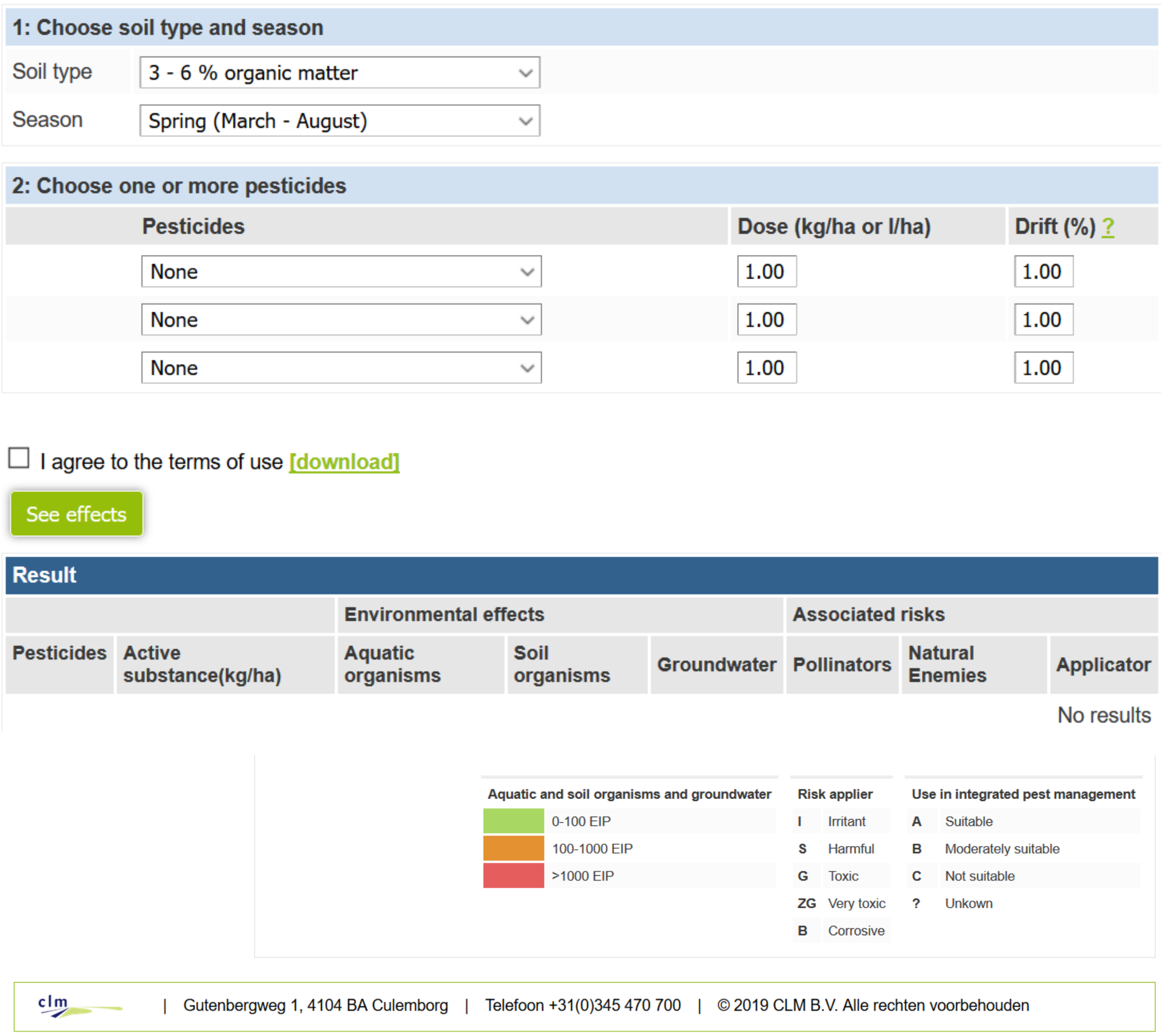
[23] Project homepage: https://www.fairway-project.eu/

[24] Detailed information under: https://www.anglianwater.co.uk/business/help-and-advice/working-with-farmers/slug-it-out/

[25] Project homepage: https://www.pesticideyardstick.eu/

[26] Video: www.youtube.com/watch?v=RCYYWumSQh4

Figure 5.1: Example of a Yardstick for the use of pesticides in farmlands and municipalities



Note: EIP = **Environmental Impact Points. Depends on the toxicity** of a pesticide for aquatic organisms, and s**pray drift** to watercourses depending on the application technique. Furthermore, factors like wind speed, wind direction, crop size, distance to the watercourse, temperature and atmospheric humidity play a part in the amount of drift.

Source: https://www.pesticideyardstick.eu/en/bereken-open-teelt.html

5.3 Measures under the Directive for the Sustainable Use of Pesticides

According to the Directive 128/2009/EC for the Sustainable Use of Pesticides, European Member States established National Action Plans (NAP) to reduce pesticide losses to the environment. The Directive itself also builds on other legislation, like the requirements of the Water Framework Directive, to protect surface waters and groundwater as well as protected areas for the use of drinking water.

The Directive includes specific chapters and articles which are the basis for the development of the NAP, including the conceptual framing of measures. This includes, for example, training for professional users, special requirements for sales of pesticides, information and awareness raising. The last two activities in particular are of high priority to inform the general public on the risks according to acute or chronic effects of pesticides (EU, 2009b). In addition to these aspects, inspection of equipment in use as well as specific practices and uses are mentioned. According to this, Article 11 of the Directive leads to *Specific measures* *to protect the aquatic environment and drinking water*. These measures shall support and be compatible with the Water Framework Directive, such as giving preference to pesticides that are not classified as dangerous for the aquatic environment, minimising the risk of off-site pollution caused by spray drift, drain-flow and run-off, or reducing or eliminating applications on or along roads, railway lines, very permeable surfaces, or other infrastructure close to a surface water or groundwater.

- A screening of the implemented NAPs of Member States shows a number of specific measures. Examples of these are the establishment of untreated buffer zones to protect surface waters, increased monitoring by water authorities and inspections, or prohibition or restriction in use of pesticides or stricter policy for the presence of pesticides in surface waters[27].

Based on the EU overview report on the implementation of Member States measures to achieve the sustainable use of pesticides (EC and Directorate-General for Health and Food Safety, 2017), 500 000 samples of surface waters, groundwater and drinking water were analysed annually in the 28 EU Member States (in comparison to 80 000 food samples, which were tested for pesticide residues).

Within the report, examples of best practices were highlighted in six out of 28 Member States:

- Target setting: Denmark to reduce their pesticide load by 40 % by the end of 2015 compared with 2011. This target was met according to the Pesticides Load Indicator (PLI), which is based on sales data (Ministry of Environment and Food of Denmark 2017). Germany plans a 20 % reduction in the environmental risks associated with pesticide use by 2018, and a 30 % reduction in risk by 2023.
- Restrictions and permissions: The Netherlands have pioneered the implementation of Emission Reduction Plans (ERPs). Where pesticides are detected in surface waters, the product authorization holders are obliged to draft and implement these plans to improve the situation. Sweden has a system of permits for pesticide use along roads, very permeable surfaces and sealed surfaces; an approach also implemented in Germany.
- Buffer zones: Sweden requires a minimum buffer zone of 12 metres around wells used to abstract drinking water. In addition, sprayers cannot be filled or cleaned within 30 meters of watercourses or wells. Denmark and Germany also delineate buffer zones.
- Information: The Netherlands developed a set of 17 factsheets outlining practical measures for reducing the emissions of pesticides to surface water, which are publicly available online.

More examples are given in Belgium and England (Thorén, 2017). Belgium sets out several different measures with focus on restrictions in buffer zones, which are set at 2 to 30 meters depending on the size of the water as well as the land use in the area. England implements a *Catchment sensitive farming programme,* investigates impacts of agricultural practices and successes of measures as well as encourages good practice. This programme also links to grants for measures[28].

[27] All available NAPs were screened, and relevant measures for water protection listed.
Source: https://ec.europa.eu/food/plant/pesticides/sustainable_use_pesticides/nap_en

[28] Source: https://www.gov.uk/guidance/catchment-sensitive-farming-reduce-agricultural-water-pollution

6 Conclusions and future perspectives

This report is based on the data available for pesticides in waters at European level. We found that there are relatively few datasets that are comparable across Europe, so the report focussed on the data reported under Waterbase – Water Quality as the most representative dataset available.

The Green Deal (EC, 2019b) has a number of strategies and action plans aimed at reducing the risk from pesticides, including the Biodiversity Strategy (EC, 2020a) and Farm to Fork Strategy (EC, 2020b) which have targets to reduce the use and risk of pesticides by 50 %. Delivering on these objectives, and on the forthcoming Zero Pollution Action Plan, needs data to be able to inform on progress.

Pesticide monitoring in surface waters and groundwater in Europe and reporting to the EEA is largely driven by the monitoring obligations under the WFD, or national requirements in countries not reporting under the WFD. Additional monitoring effort is made to tackle regional or more local issues. Such monitoring is often designed by environmental, drinking water and agricultural regulators and stakeholders working together. The monitored pesticide concentrations, together with, for instance, information on agricultural activities (including pesticide usage) can inform the regional management about the environmental contamination of pesticides.

The Waterbase – Water Quality database reveals large differences between different European countries in terms of the number of substances reported to the EEA and the number of monitored stations. Different LoQs also point to the use of different chemical analytical techniques. Improved harmonisation with regard to monitored substances, density of monitoring stations and methodology would improve comparability. Likewise, more streamlining of approaches towards data collection and monitoring, such as the application of common analytical quality rules (e.g. those under the WFD; EC, 2009), would improve comparability.

The data were analysed to identify pesticide groups (herbicides, insecticides and fungicides) and substances (including metabolites) responsible for causing failure of the available thresholds. Additionally, the limits of quantification were of interest. Our statistical checks to unravel concentration values lower than the limits of quantification (LoQ) are an example of the need to improve harmonisation of the reporting.

The reported information on pesticides in Europe's waters is currently insufficient to support a thorough assessment of the risks posed. This situation represents a significant cause for concern in our attempts to protect and improve water quality. Enlarging the information base will take time, but by identifying specific needs, we aim to facilitate the necessary improvements.

Focusing effort on the substances actually used and monitoring at relevant times and intervals (e.g. monitoring around the pesticide application season) is also necessary. Such effect-based monitoring could facilitate the use of scarce resources, thus ensuring the collection of high-quality monitoring data necessary to effectively support the assessment of environmental and health risks. Reporting of all monitored pesticides would improve the knowledge base for Europe, and allow for a better oversight of the real situation.

Enhanced data collection would be beneficial for more specific management. In combination with data on agricultural area and pesticide sales, enhanced monitoring data collection would inform us about the relative contribution and thus toxic pressure from different pesticide usages (e.g. corn herbicides, wheat insecticides) for a specific region. Additional analysis of spatial and temporal distribution would increase our understanding of the risks and management options.

Data availability from scientific projects seems to be very diverse and their quality may also differ. However, even though not using harmonised procedures and probably not painting a picture which is representative for the overall situation, such projects may provide important input with regard to relevant substances and novel assessment techniques.

One aim of our wider project was to investigate the available data for its potential to contribute to the development of an indicator of pesticides in water. Different approaches can be used to assess the risks from pollutants, depending on the goal of the work. The current approach, used in surface waters and groundwater quality, is based on the assessment of risks from single substances (or, in a few cases, small groups of related substances), i.e. whether a single quality standard for a substance or group is exceeded.

However, it is clear that the environment contains a mixture of chemicals and that some of them can have combined effects (EFSA, 2019). It has been recognised that these effects should be considered when assessing the risks from pollutants in water (EEA, 2018a). In human pharmacology and toxicology, for example, mixture toxicity considers the effects of many different substances. In the context of pesticides in water, the Toxic Unit (TU) system could be used to support the assessment of combined risk based on 'concentration addition'. Such a combined-risk indicator could help authorities to better identify the water bodies and regions at greatest overall risk, and thus to better target management measures.

The need to address mixture toxicity in water was also identified in the Commission's Fitness Check of the European water legislation published in 2019 (EC, 2019a). Furthermore, the Chemicals Strategy for Sustainability[29] under the European Commission's Green Deal is expected to include actions to improve the way in which the risk from mixtures of chemicals is assessed and addressed, while the Zero Pollution Action Plan is expected to include actions aimed at improving pollutant monitoring and reducing emissions.

[29] Source: https://ec.europa.eu/info/law/better-regulation/have-your-say/initiatives/12264-Chemicals-strategy-for-sustainability

7 Abbreviations

2,4,5-T	2,4,5-Trichlorophenoxyacetic acid
2,4-DB	2,4-(dichlorophenoxy)butyric acid
AA-EQS	Annual average Environmental Quality Standard
AMPA	α-amino-3-hydroxy-5-methyl-4-isoxazolepropionic acid (breakdown product of glyphosate)
Beta-HCH	Beta hexachlorocyclohexane
DDD	Dichlorodiphenyldichloroethane
DDE	Dichlorodiphenyl-2,2-dichoroethane
DDT	Dichlorodiphenyltrichloroethane
DEHP	Bis(2-ethylhexyl)phthalate
DWD	Drinking Water Directive
EC	European Commission
EEA	European Environment Agency
EIONET	European Environment Information and Observation Network
EMEP	Co-operative programme for monitoring and evaluation of the long-range transmissions of air pollutants in Europe
EPER	European Pollutant Emission Register
E-PRTR	European Pollutant Release and Transfer Register
EQS	Environmental quality standard
EQSD	Environmental quality standards Directive
ERP	Emissions Reduction Plan
ETC-ICM	European Topic Centre – Inland, coastal and marine waters
EU	European Union
EU-28	The 28 EU Member States as of 1 July 2013
FAO	Food and Agriculture Organisation
HRI	Harmonised Risk Indicator
KTM	Key Type Measure
LoD	Limit of Detection
LoQ	Limit of Quantification
MAC EQS	Maximum Acceptable Concentration EQS
MCPA	2-methyl-4-chlorophenoxyacetic acid
MCPB	4-(4-chloro-o-tolyloxy)butyric acid
MoA	Mode of Action
NAP	National Action PlanPLan
PHS	Priority Hazardous Substance
PoM	Programme of Measures
PPDB	Pesticide Properties DataBase
PPP	Plant Protection Product
PS	Priority Substance
PSII	Photosystem II
RAC	Regulatory Acceptable Concentration
RBMP	River Basin Management Plan
RBSP	River Basin Specific Pollutant
REACH	Registration, Evaluation, Authorisation and Restriction of Chemicals (EU Regulation)
SoE	State of Environment
TU	Toxic Unit
UWWTD	Urban Wastewater Treatment Directive (91/271/EEC)
WFD	Water Framework Directive (2000/60/ECC)
WISE	Water Information System for Europe

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Annex 1 Pesticide reference dataset on surface waters 2007 to 2017 in Waterbase – Water Quality

Parameter	CAS	Distinct records	Distinct monitoring sites	Distinct countries	Distinct years
Atrazine	CAS_1912-24-9	23 027	6 721	31	11
Simazine	CAS_122-34-9	22 510	6 456	28	11
Alachlor	CAS_15972-60-8	21 792	6 397	29	11
Aldrin	CAS_309-00-2	21 432	6 411	27	11
Dieldrin	CAS_60-57-1	20 999	6 309	27	11
Endrin	CAS_72-20-8	20 983	6 300	27	11
DDT, p,p'	CAS_50-29-3	20 626	6 534	26	11
Chlorpyrifos	CAS_2921-88-2	20 299	5 801	28	11
Trifluralin	CAS_1582-09-8	20 218	5 995	28	11
Hexachlorobenzene	CAS_118-74-1	19 771	6 161	26	11
Trichloromethane	CAS_67-66-3	19 762	6 405	23	11
Gamma-HCH (Lindane)	CAS_58-89-9	19 620	4 987	28	11
Diuron	CAS_330-54-1	19 583	5 398	27	11
Isodrin	CAS_465-73-6	19 302	5 739	24	11
Isoproturon	CAS_34123-59-6	19 171	5 224	27	11
Chlorfenvinphos	CAS_470-90-6	18 982	5 485	29	11
p,p'-DDE	CAS_72-55-9	18 257	4 920	22	11
DDT, o,p'	CAS_789-02-6	17 716	5 333	23	11
p,p'-DDD	CAS_72-54-8	17 068	4 709	23	11
Pentachlorophenol	CAS_87-86-5	17 021	4 923	23	11
Linuron	CAS_330-55-2	16 058	3 941	19	11
Alpha-Endosulfan	CAS_959-98-8	15 083	3 879	25	11
MCPA	CAS_94-74-6	13 870	3 421	20	11
Terbuthylazine	CAS_5915-41-3	12 984	4 238	17	11
Alpha-HCH	CAS_319-84-6	12 700	4 053	23	11
Metolachlor	CAS_51218-45-2	12 062	3 965	14	11
Beta-HCH	CAS_319-85-7	12 036	3 768	20	11
Heptachlor	CAS_76-44-8	11 847	3 743	21	11
Beta-Endosulfan	CAS_33213-65-9	11 215	3 683	21	11
Mecoprop	CAS_7085-19-0	10 658	2 950	15	11
Terbutryn	CAS_886-50-0	10 566	3 279	21	11
Dichlorvos	CAS_62-73-7	9 773	2 924	18	11
Desethylatrazine	CAS_6190-65-4	9 464	2 706	13	11
Delta-HCH	CAS_319-86-8	9 387	2 935	17	11
Dimethoate	CAS_60-51-5	9 344	2 982	17	11
2,4-dichlorophenoxyacetic acid, 2-4 D	CAS_94-75-7	9 330	2 924	13	11
Fenitrothion	CAS_122-14-5	9 317	3 371	15	11
Pendimethalin	CAS_40487-42-1	9 138	2 833	9	11
Bentazone	CAS_25057-89-0	9 130	2 786	15	11

Parameter	CAS	Distinct records	Distinct monitoring sites	Distinct countries	Distinct years
Metazachlor	CAS_67129-08-2	8 823	2 358	13	11
Parathion	CAS_56-38-2	8 777	3 331	10	11
Desethylterbuthylazine	CAS_30125-63-4	8 515	2 662	9	11
Heptachlor epoxide	CAS_1024-57-3	8 479	2 717	14	11
Parathion-methyl	CAS_298-00-0	8 446	3 112	11	11
Desisopropylatrazine	CAS_1007-28-9	7 828	2 257	11	11
Metribuzin	CAS_21087-64-9	7 810	2 515	11	11
Ethofumesate	CAS_26225-79-6	7 751	2 351	9	11
Prometryn	CAS_7287-19-6	7 669	2 379	12	11
Aclonifen	CAS_74070-46-5	7 630	2 437	12	8
Dicofol	CAS_115-32-2	7 600	2 300	11	10
Acetochlor	CAS_34256-82-1	7 549	2 047	4	11
Malathion	CAS_121-75-5	7 479	3 387	12	11
Propazine	CAS_139-40-2	7 400	2 703	13	11
Hexazinone	CAS_51235-04-2	7 366	2 086	6	11
Metalaxyl	CAS_57837-19-1	7 304	2 260	9	11
Chloridazon	CAS_1698-60-8	7 215	2 393	10	11
Metamitron	CAS_41394-05-2	7 214	2 154	11	11
Endosulfan	CAS_115-29-7	7 084	3 195	18	11
Dichlorprop (2,4-DP)	CAS_120-36-5	7 083	2 045	9	11
Bromacil	CAS_314-40-9	6 986	1 966	6	11
Cyanazine	CAS_21725-46-2	6 889	2 008	11	11
Quinoxyfen	CAS_124495-18-7	6 782	2 317	14	8
Chlortoluron	CAS_15545-48-9	6 567	2 417	11	10
Dichlobenil	CAS_1194-65-6	6 512	2 157	10	11
Carbofuran	CAS_1563-66-2	6 448	2 095	8	11
Methoxychlor	CAS_72-43-5	6 419	1 910	11	11
2,4,5-T	CAS_93-76-5	6 404	2 111	7	11
Chlorpyrifos-methyl	CAS_5598-13-0	6 389	2 157	11	11
Bromoxynil	CAS_1689-84-5	6 327	1 866	5	11
Ametryn	CAS_834-12-8	6 297	1 988	9	11
Dicamba	CAS_1918-00-9	6 275	1 940	10	11
Glyphosate	CAS_1071-83-6	6 257	2 224	14	11
Chlorobenzene	CAS_108-90-7	6 253	3 314	12	11
Propiconazole	CAS_60207-90-1	6 226	2 118	11	11
Fenpropimorph	CAS_67564-91-4	6 181	1 711	8	11
Pirimicarb	CAS_23103-98-2	5 953	2 180	10	11
Lenacil	CAS_2164-08-1	5 873	1 749	4	11
Omethoate	CAS_1113-02-6	5 803	1 935	9	11
Bifenox	CAS_42576-02-3	5 499	2 044	10	7
Cypermethrin	CAS_52315-07-8	5 326	1 868	11	11
Hydroxyatrazine	CAS_2163-68-0	5 256	1 595	2	11
Phosalone	CAS_2310-17-0	5 199	1 763	4	11

Parameter	CAS	Distinct records	Distinct monitoring sites	Distinct countries	Distinct years
Ioxynil	CAS_1689-83-4	5 122	1 570	3	11
Terbumeton	CAS_33693-04-8	5 114	1 493	2	10
Epoxiconazole	CAS_133855-98-8	5 069	1 961	9	8
2,6-dichlorobenzamide	CAS_52315-07-8	5 056	1 835	7	11
MCPB	CAS_94-81-5	4 861	1 472	9	11
Carbendazim	CAS_10605-21-7	4 769	1 813	7	8
Secbumeton	CAS_26259-45-0	4 748	1 305	4	11
Diazinon	CAS_333-41-5	4 714	2 328	13	11
Chlorsulfuron	CAS_64902-72-3	4 635	1 363	3	11
Hydroxyterbuthylazine	CAS_66753-07-9	4 617	1 544	2	9
Hexachlorocyclohexane	CAS_608-73-1	4 583	2 767	15	11
Demeton-S-methyl	CAS_919-86-8	4 487	1 450	6	11
1,4-dichlorobenzene	CAS_106-46-7	4 478	2 465	13	10
Clopyralid	CAS_1702-17-6	4 425	1 634	9	11
Pyridate	CAS_55512-33-9	4 379	1 614	3	11
Demeton-S-methylsulfon	CAS_17040-19-6	4 368	1 358	4	11
Dimethachlor	CAS_50563-36-5	4 296	1 460	5	8
Sebuthylazine	CAS_7286-69-3	4 132	1 303	5	11
Epsilon-HCH	CAS_6108-10-7	4 039	1 531	7	9
Prometon	CAS_1610-18-0	3 985	1 354	5	11
Propyzamide	CAS_23950-58-5	3 884	2 011	9	11
2,4-DB	CAS_94-82-6	3 875	1 390	5	11
Deisopropyldeethylatrazine	CAS_3397-62-4	3 811	1 473	5	11
o,p'-DDE	CAS_3424-82-6	3 751	1 844	14	11
Metsulfuronmethyl	CAS_74223-64-6	3 669	1 285	8	8
Aminomethylphosphonic acid (AMPA)	CAS_1066-51-9	3 551	1 792	9	11
Dinoseb	CAS_88-85-7	3 507	1 273	5	11
Carbetamide	CAS_16118-49-3	3 424	1 430	3	5
1,2-dibromoethane	CAS_106-93-4	3 276	1 713	8	11
Hydroxysimazine	CAS_2599-11-3	3 257	1 402	2	7
Desmetryn	CAS_1014-69-3	3 017	1 190	5	11
Captan	CAS_133-06-2	2 927	1 538	5	10
Desmedipham	CAS_13684-56-5	2 808	1 269	3	11
Chlordane	CAS_57-74-9	2 760	1 243	7	11
Propetamphos	CAS_31218-83-4	2 745	1 149	2	5
Methamidophos	CAS_10265-92-6	2 605	1 630	5	11
Terbufos	CAS_13071-79-9	2 456	1 300	2	9
Benfluralin	CAS_1861-40-1	2 441	1 273	2	7
Permethrin-cis+trans	CAS_52645-53-1	2 426	1 347	7	10
Imidacloprid	CAS_138261-41-3	2 394	1 465	24	8
Oxadiazon	CAS_19666-30-9	2 350	1 511	25	8
3-hydroxycarbofuran	CAS_16655-82-6	2 245	892	2	7

Parameter	CAS	Distinct records	Distinct monitoring sites	Distinct countries	Distinct years
Trietazine	CAS_1912-26-1	2 130	1 011	3	5
Tebufenozide	CAS_112410-23-8	2 051	1 095	1	5
Quintozene	CAS_82-68-8	2 037	1 128	4	11
Methomyl	CAS_16752-77-5	1 974	1 233	3	6
Dinitro-o-cresol (DNOC)	CAS_534-52-1	1 919	1 066	4	11
Chlordecone (Kepone)	CAS_143-50-0	1 903	1 060	2	11
Iodofenphos	CAS_18181-70-9	1 891	946	2	10
Fluquinconazole	CAS_136426-54-5	1 843	1 140	3	7
Ethanimidamide	CAS_135410-20-7	1 709	1 178	25	7
Fenazaquin	CAS_120928-09-8	1 461	861	1	5
Thiamethoxam	CAS_153719-23-4	1 449	908	26	7
Chlorthiamid	CAS_1918-13-4	1 428	864	1	5
Dichlorprop-P	CAS_15165-67-0	1 390	865	5	11
Tri-allate	CAS_2303-17-5	1 372	956	24	7
Bromoxynil octanoate	CAS_1689-99-2	1 327	859	1	5
Methiocarb	CAS_2032-65-7	1 272	894	26	8
Fenoprop	CAS_93-72-1	1 220	786	4	11
Formaldehyde	CAS_50-00-0	1 081	901	4	10
Mirex	CAS_2385-85-5	1 073	619	6	9
Dalapon	CAS_75-99-0	914	670	2	11
Thiram	CAS_137-26-8	863	535	2	9
Mecoprop-P (MCPP-P)	CAS_16484-77-8	854	570	5	9
2-chloroethylphosphonic acid	CAS_16672-87-0	814	623	2	6
Fenbutatin oxide	CAS_13356-08-6	770	384	1	4
Maleinhydrazid	CAS_123-33-1	731	363	1	4
Diflufenican	CAS_83164-33-4	719	283	6	7
Thiacloprid	CAS_111988-49-9	669	466	26	7
Nitrophen	CAS_1836-75-5	661	235	1	4
Metalaxyl-M	CAS_70630-17-0	548	411	2	7
Clothianidin	CAS_210880-92-5	536	401	25	6
Bromomethane	CAS_74-83-9	491	280	4	8
Ziram	CAS_137-30-4	269	201	1	4
Toxaphene	CAS_8001-35-2	254	132	2	3
Isobenzane	CAS_297-78-9	148	127	4	8
trans-Nonachlor	CAS_39765-80-5	75	35	2	11
Sulfosulfuron	CAS_141776-32-1	24	8	1	4
Trichloroacetic acid	CAS_76-03-9	21	21	1	1
Flucythrinate	CAS_70124-77-5	15	15	1	1
Bronopol	CAS_52-51-7	14	11	1	2
Tetrasul	CAS_2227-13-6	12	12	1	1
Azinphos-ethyl	CAS_2642-71-9	4	2	1	2
Chlorothalonil	CAS_1897-45-6	4	2	1	2
Deltamethrin	CAS_52918-63-5	4	2	1	2

Parameter	CAS	Distinct records	Distinct monitoring sites	Distinct countries	Distinct years
Fenthion	CAS_55-38-9	4	2	1	2
Folpet	CAS_133-07-3	4	2	1	2
Formothion	CAS_2540-82-1	4	2	1	2
Iprodione	CAS_36734-19-7	4	2	1	2
Kresoxim-methyl	CAS_143390-89-0	4	2	1	2
Penconazole	CAS_1836-75-5	4	2	1	2
Acrylonitrile	CAS_107-13-1	3	1	1	3
Hydrogen cyanide	CAS_74-90-8	2	2	1	1
Cyprodinil	CAS_121552-61-2	1	1	1	1
Dimethomorph	CAS_110488-70-5	1	1	1	1
Pyrimethanil	CAS_53112-28-0	1	1	1	1

Annex 2 Pesticide reference dataset on groundwater 2007 to 2017 in Waterbase – Water Quality

Parameter	CAS	Distinct records	Distinct monitoring sites	Distinct countries	Distinct years
Atrazine	CAS_1912-24-9	63 941	14 690	21	11
Simazine	CAS_122-34-9	63 276	14 542	21	11
Desethylatrazine	CAS_6190-65-4	59 184	12 722	14	11
Diuron	CAS_330-54-1	46 083	12 430	18	11
Bentazone	CAS_25057-89-0	45 363	12 288	16	11
Desisopropylatrazine	CAS_13684-56-5	43 349	9 809	12	11
Alachlor	CAS_15972-60-8	42 301	7 660	17	11
Isoproturon	CAS_34123-59-6	42 038	9 630	17	11
Linuron	CAS_330-55-2	36 833	8 505	13	11
Mecoprop	CAS_7085-19-0	35 365	9 294	11	11
Trichloromethane	CAS_67-66-3	35 080	10 951	17	11
Chlorpyrifos	CAS_2921-88-2	34 378	8 524	15	11
Prometryn	CAS_7287-19-6	33 441	7 699	13	11
MCPA	CAS_94-74-6	32 931	8 871	14	11
Propazine	CAS_139-40-2	32 495	8 157	14	11
Terbuthylazine	CAS_5915-41-3	31 053	6 266	14	11
Gamma-HCH (Lindane)	CAS_58-89-9	30 884	7 815	16	11
Terbutryn	CAS_886-50-0	30 774	8 110	14	11
2,4-dichlorophenoxyacetic acid, 2-4 D	CAS_16672-87-0	30 500	7 883	14	11
Chlorfenvinphos	CAS_470-90-6	29 774	7 636	15	11
Trifluralin	CAS_1582-09-8	29 540	7 563	15	11
Aldrin	CAS_309-00-2	28 331	7 392	18	11
Dieldrin	CAS_60-57-1	27 282	7 498	18	11
Endrin	CAS_72-20-8	27 154	7 310	18	11
Metazachlor	CAS_67129-08-2	26 718	7 367	11	11
Dichlorprop (2,4-DP)	CAS_120-36-5	26 136	7 914	8	11
Cyanazine	CAS_21725-46-2	26 031	6 970	9	11
Ethofumesate	CAS_26225-79-6	25 846	7 440	8	11
Dimethoate	CAS_60-51-5	25 504	7 347	12	11
Hexachlorobenzene	CAS_118-74-1	24 891	6 189	14	11
DDT, p,p'	CAS_50-29-3	24 481	6 927	16	11
p,p'-DDE	CAS_72-55-9	23 885	6 083	12	11
Metalaxyl	CAS_57837-19-1	23 873	7 579	8	11
Chloridazon	CAS_1698-60-8	23 819	6 793	11	11
Alpha-Endosulfan	CAS_959-98-8	23 657	6 323	14	11
Alpha-HCH	CAS_319-84-6	23 487	6 015	12	11
Isodrin	CAS_465-73-6	23 227	6 248	14	11
DDT, o,p'	CAS_789-02-6	22 682	5 197	9	11
Dichlobenil	CAS_1194-65-6	22 136	6 746	9	11

Parameter	CAS	Distinct records	Distinct monitoring sites	Distinct countries	Distinct years
Pirimicarb	CAS_23103-98-2	22 054	6 639	7	11
Pentachlorophenol	CAS_87-86-5	21 677	5 983	11	11
Dicamba	CAS_1918-00-9	21 362	6 523	9	11
Parathion-methyl	CAS_298-00-0	21 334	6 328	9	11
Fenitrothion	CAS_122-14-5	21 257	6 737	9	11
Parathion	CAS_56-38-2	20 649	6 174	7	11
Chlorpyrifos-methyl	CAS_5598-13-0	20 495	6 603	7	11
p,p'-DDD	CAS_72-54-8	20 302	5 327	12	11
Bromoxynil	CAS_1689-84-5	20 072	5 766	5	11
Dichlorvos	CAS_62-73-7	19 944	6 362	8	11
Beta-HCH	CAS_319-85-7	19 879	5 623	13	11
MCPB	CAS_94-81-5	19 650	6 216	7	11
Metolachlor	CAS_51218-45-2	19 130	5 374	9	11
Metribuzin	CAS_21087-64-9	19 110	5 654	10	11
Fenpropimorph	CAS_67564-91-4	19 000	5 639	5	11
Heptachlor	CAS_76-44-8	18 720	6 664	16	11
Metsulfuronmethyl	CAS_74223-64-6	18 679	5 424	5	11
Clopyralid	CAS_1702-17-6	18 483	6 078	7	11
Carbofuran	CAS_1563-66-2	18 206	6 024	6	11
Hexazinone	CAS_51235-04-2	18 152	5 188	5	11
Ioxynil	CAS_1689-83-4	17 316	5 334	5	11
2,6-dichlorobenzamide	CAS_2008-58-4	17 054	5 086	8	11
Pendimethalin	CAS_40487-42-1	16 645	5 499	11	11
o,p'-DDE	CAS_3424-82-6	16 346	4 945	8	11
2,4-DB	CAS_94-82-6	16 315	4 886	4	11
Beta-Endosulfan	CAS_33213-65-9	16 312	5 443	10	11
Bromacil	CAS_314-40-9	15 129	3 994	9	11
Glyphosate	CAS_1071-83-6	14 954	4 289	8	11
2,4,5-T	CAS_93-76-5	14 800	5 224	7	11
Desethylterbuthylazine	CAS_30125-63-4	14 660	4 536	9	11
Methoxychlor	CAS_72-43-5	14 508	5 323	12	11
Aminomethylphosphonic acid (AMPA)	CAS_1066-51-9	14 177	3 834	7	11
Metamitron	CAS_41394-05-2	13 895	3 663	11	11
Heptachlor epoxide	CAS_1024-57-3	13 765	5 012	13	11
Diazinon	CAS_333-41-5	13 731	4 813	12	11
Acetochlor	CAS_34256-82-1	13 443	3 370	9	11
Deisopropyldeethylatrazine	CAS_3397-62-4	13 436	4 082	3	11
Chlortoluron	CAS_15545-48-9	12 687	3 579	10	11
Hydroxyatrazine	CAS_2163-68-0	11 697	3 321	4	7
Propiconazole	CAS_60207-90-1	11 593	3 586	9	11
Propyzamide	CAS_23950-58-5	11 517	3 831	6	5
Fenoprop	CAS_93-72-1	11 329	3 983	3	11

Parameter	CAS	Distinct records	Distinct monitoring sites	Distinct countries	Distinct years
Lenacil	CAS_2164-08-1	11 077	2 780	5	11
Hydroxyterbuthylazine	CAS_66753-07-9	10 742	2 996	4	9
Desmetryn	CAS_1014-69-3	10 212	3 262	3	5
Ametryn	CAS_834-12-8	10 044	2 421	7	11
Chlordane	CAS_57-74-9	9 981	3 879	6	11
Phosalone	CAS_2310-17-0	9 748	2 769	5	10
Malathion	CAS_121-75-5	9 686	3 599	7	5
Delta-HCH	CAS_319-86-8	9 445	3 184	9	11
Epoxiconazole	CAS_133855-98-8	9 199	3 055	5	6
Dimethachlor	CAS_50563-36-5	9 182	2 461	3	5
Chlorsulfuron	CAS_64902-72-3	8 983	2 208	2	6
Chlorobenzene	CAS_143-50-0	8 830	4 249	9	11
Imidacloprid	CAS_138261-41-3	8 687	2 483	4	5
Carbendazim	CAS_10605-21-7	8 432	2 374	4	5
Hydroxysimazine	CAS_2599-11-3	8 412	3 065	3	8
Tri-allate	CAS_2303-17-5	7 886	2 233	3	5
Methomyl	CAS_16752-77-5	7 805	2 530	3	5
Carbetamide	CAS_16118-49-3	7 735	2 599	3	5
Methiocarb	CAS_2032-65-7	7 499	2 408	2	5
Sulfosulfuron	CAS_141776-32-1	7 458	2 155	2	5
Epsilon-HCH	CAS_6108-10-7	7 344	1 733	4	11
Terbumeton	CAS_33693-04-8	7 254	2 058	3	8
Secbumeton	CAS_26259-45-0	7 150	1 653	2	11
Diflufenican	CAS_83164-33-4	7 002	1 886	3	5
Oxadiazon	CAS_19666-30-9	6 761	1 757	2	5
Methamidophos	CAS_10265-92-6	6 694	2 128	2	5
Aclonifen	CAS_74070-46-5	6 621	1 915	3	5
3-hydroxycarbofuran	CAS_16655-82-6	6 556	2 035	2	6
Cypermethrin	CAS_52315-07-8	6 494	2 353	5	5
Quinoxyfen	CAS_124495-18-7	6 440	1 860	3	5
Iodofenphos	CAS_18181-70-9	6 439	2 491	2	5
Prometon	CAS_1610-18-0	6 333	1 841	5	10
Dinoseb	CAS_88-85-7	6 157	1 521	3	11
Captan	CAS_133-06-2	5 932	1 776	2	5
Benfluralin	CAS_1861-40-1	5 867	1 571	1	5
Bifenox	CAS_42576-02-3	5 864	1 629	1	5
Permethrin-cis+trans	CAS_52645-53-1	5 836	1 571	2	5
Propetamphos	CAS_31218-83-4	5 669	1 907	3	5
Sebuthylazine	CAS_7286-69-3	5 604	1 684	2	9
Thiamethoxam	CAS_153719-23-4	5 586	1 942	3	5
Fluquinconazole	CAS_136426-54-5	5 480	1 580	2	5
Dicofol	CAS_115-32-2	5 476	2 054	4	5
Endosulfan	CAS_115-29-7	5 445	2 443	12	11

Parameter	CAS	Distinct records	Distinct monitoring sites	Distinct countries	Distinct years
Desmedipham	CAS_13684-56-5	5 224	1 571	2	11
Demeton-S-methyl	CAS_919-86-8	4 972	1 562	2	9
Fenazaquin	CAS_120928-09-8	4 934	1 376	1	5
Hexachlorocyclohexane	CAS_608-73-1	4 902	2 524	4	8
Quintozene	CAS_82-68-8	4 793	1 473	1	5
Pyridate	CAS_55512-33-9	4 657	1 626	2	10
Terbufos	CAS_13071-79-9	4 469	1 544	2	5
Omethoate	CAS_1113-02-6	4 354	1 509	5	7
Dichlorprop-P	CAS_15165-67-0	3 982	1 461	1	5
Tebufenozide	CAS_112410-23-8	3 903	1 255	1	5
Demeton-S-methylsulfon	CAS_17040-19-6	3 761	1 626	2	5
Mecoprop-P (MCPP-P)	CAS_16484-77-8	3 632	1 131	1	5
Trietazine	CAS_1912-26-1	3 529	1 407	4	5
Ethanimidamide	CAS_135410-20-7	3 417	1 188	2	5
Thiacloprid	CAS_111988-49-9	3 235	1 178	2	5
Trichloroacetic acid	CAS_76-03-9	3 227	984	3	7
Chlordecone (Kepone)	CAS_143-50-0	3 031	1 309	1	5
Chlorthiamid	CAS_1918-13-4	3 017	1 140	1	5
1,4-dichlorobenzene	CAS_106-46-7	2 752	1 333	5	5
1,2-dibromoethane	CAS_106-93-4	2 561	1 490	6	11
Thiram	CAS_137-26-8	2 410	820	1	5
Clothianidin	CAS_210880-92-5	2 363	905	2	4
Metalaxyl-M	CAS_70630-17-0	2 172	739	2	5
Mirex	CAS_2385-85-5	1 931	1 030	5	10
Maleinhydrazid	CAS_123-33-1	1 915	1 039	1	5
Tetrasul	CAS_2227-13-6	1 406	459	1	4
Dalapon	CAS_75-99-0	1 017	566	2	7
Toxaphene	CAS_8001-35-2	697	434	1	4
Dinitro-o-cresol (DNOC)	CAS_534-52-1	651	651	2	2
Formaldehyde	CAS_50-00-0	135	70	2	4
Ziram	CAS_137-30-4	77	54	1	5
Bromomethane	CAS_74-83-9	73	73	2	2

Annex 3 Availability of pesticides data based on Waterbase – Water Quality in the time period 2007 to 2017

Country	Area	Area Arable Land	Data source	Ratio Arable Land	No. of Sites		Monitoring Density		No. of Pollutants	
					SW	GW	SW	GW	SW	GW
	(ha)	(km²)		(%)			Per 100 km² arable land			
AT	83 858	13 123	corine	15.6	19	2 040	0.1	15.5	11	9
BA	51 209	5 940	eurostat	11.6	29	33	0.5	0.6	25	5
BE	32 545	6 672	corine	20.5	104	404	1.6	6.1	48	78
BG	110 912	38 222	corine	34.5	86	128	0.2	0.3	42	42
CH	41 284	4 002	eurostat	9.7	6	50	0.1	1.2	22	28
CY	9 251	2 272	corine	24.6	60	176	2.7	7.5	75	43
CZ	78 866	28 709	corine	36.4	404	736	1.4	2.6	129	86
DE	357 022	135 835	corine	38.0	267	776	0.2	0.8	109	75
DK	43 094	26 852	corine	62.3	32	1 610	0.1	6.0	8	35
EE	45 100	6 882	corine	15.3	38	152	0.5	2.2	87	14
GR	131 957	18 978	eurostat	14.4	0	0	1.4	0.0	45	0
ES	505 992	98 140	corine	19.4	1 329	594	1.4	0.6	71	84
FI	338 145	16 768	corine	5.0	25	0	0.2	0.0	99	0
FR	551 500	153 839	corine	27.9	1 763	1 974	1.1	1.3	163	156
HR	56 538	6 104	corine	10.8	65	82	1.1	1.3	67	45
HU	93 032	47 092	corine	50.6	105	0	0.2	0.0	17	0
IE	70 273	4 603	eurostat	6.6	332	414	7.2	9.0	53	61
IS	103 000	19	eurostat	0.0	1	8	5.2	41.9	41	2
IT	301 318	79 515	corine	26.4	1 710	1 764	2.2	0.0	114	0
LT	65 300	21 015	eurostat	32.2	60	44	0.3	0.2	43	29
LU	2 586	443	corine	17.1	4	0	0.9	0.0	58	0
LV	64 600	12 054	corine	18.7	23	116	0.2	1.0	34	7
MK	25 713	4 167	eurostat	16.2	5	0	0.1	0.0	1	0
MT	316	7	corine	2.1	6	0	89.1	0.0	20	0
NL	41 528	7 327	corine	17.6	125	0	1.7	0.0	101	0
NO	385 155	8 072	eurostat	2.1	12	0	0.1	0.0	1	0
PL	312 685	133 403	corine	42.7	1 230	449	1.0	0.3	34	21
PT	91 982	6 849	corine	7.4	53	206	0.9	3.0	25	16
RO	238 391	86 008	corine	36.1	73	148	0.1	0.2	28	15
RS	77 474	25 950	eurostat	33.5	189	138	0.7	0.5	37	37
SE	449 964	30 040	corine	6.7	24	101	0.1	0.3	66	2
SI	20 256	1 744	eurostat	8.6	33	55	1.9	3.2	45	35
SK	49 033	15 861	corine	32.3	79	530	0.5	3.4	61	53
UK	242 900	60 890	eurostat	25.1	992	4 158	1.7	6.8	109	102

Data source: Corine land cover: https://land.copernicus.eu/eagle/files/eagle-related-projects/pt_clc-conversion-to-fao-lccs3_dec2010); Eurostat: https://ec.europa.eu/eurostat/web/products-datasets/-/tag00025

Note: SW = surface waters; GW = groundwater

Annex 4 Overview of EU-country databases on pesticides (European)

Country	Link to database
Austria	https://psmregister.baes.gv.at/psmregister/faces/main?_afrLoop=695602457331339&_afrWindowMode=0&_adf.ctrl-state=rqaph0bok_14
Croatia	https://fis.mps.hr/TrazilicaSZB/Default.aspx?lan=en-Us
Denmark	https://middeldatabasen.dk/positiveList.asp
Estonia	https://portaal.agri.ee/avalik/#/taimekaitse/taimekaitsevahendid-otsing/en
France	https://ephy.anses.fr/resultats_recherche/substance
France	http://www.agritox.anses.fr/php/donnees-essentielles.php
Georgia	List of pesticides registered in Georgia
Germany	https://apps2.bvl.bund.de/psm/jsp/index.jsp?modul=form
Greece	http://wwww.minagric.gr/syspest/syspest_bycat_byActive_eng.aspx
Hungary	https://novenyvedoszer.nebih.gov.hu/Engedelykereso/kereso
Ireland	http://www.pcs.agriculture.gov.ie/products/
Italy	http://www.fitosanitari.salute.gov.it/fitosanitariwsWeb_new/FitosanitariServlet
Lithuania	http://195.182.68.150:8080/vaat/aap/aap/aap_list.jsf
Luxembourg	https://saturn.etat.lu/tapes/tapes_de_mnu_pdt.htm
Moldova	http://www.pesticide.md/registrul-de-stat/
Netherlands	https://pesticidesdatabase.ctgb.nl/nl/authorisations
Norway	https://www.mattilsynet.no/plantevernmidler/godk.asp?sortering=preparat&preparat=Alle&sprak=In+English
Poland	https://www.gov.pl/attachment/e79ce4f1-af75-495b-bad8-3834b0bcb25f
Slovakia	http://pripravky.uksup.sk/pripravok/search
Slovenia	http://spletni2.furs.gov.si/FFS/REGSR/EN/index.htm
Sweden	http://webapps.kemi.se/BkmRegistret/Kemi.Spider.Web.External/Produkt#8bcf2b59-bd6f-4128-a945-b69e22cd7b04
Switzerland	https://www.psm.admin.ch/fr/produkte/bs/A
Turkey	https://bku.tarim.gov.tr/Kullanim/TavsiyeArama
Ukraine	https://agroscience.com.ua/views/perelik-pest-all
United Kingdom	https://secure.pesticides.gov.uk/pestreg/ProdSearch.asp

Source: https://www.eppo.int/ACTIVITIES/plant_protection_products/registered_products

Annex 5 Overview of pesticides available under Waterbase – Water Quality, characteristics and grouping

Label	CAS	Usage	Chemical group	Parent (P) or Transformation Product (TP)	Mode of Action (MoA)	Mode of Action – specific	PPP-approval; Yes; No
1,2-dibromoethane	106-93-4	Insecticide	Unclassified	P	Neurotoxic	CNS toxicity	N
1,3-dichloropropene	542-75-6	Pesticide	Halogenated hydrocarbon	P	Unknown		N
1,4-dichlorobenzene	106-46-7	Pesticide / Desinfectant		P	not found in database		N
2,4,5-T (2,4,5-Trichlorophenoxyacetic acid)	93-76-5	Herbicide		P	Plant Growth Regulator	Ethylene generator	Y
2,4-DB	94-82-6	Herbicide	Aryloxyalkanoic acid	P	Synthetic Auxin (Plant growth regulator)		Y
2,4-dichlorophenoxyacetic acid, 2-4 D	94-75-7	Herbicide		P	Synthetic Auxin (Plant growth regulator)		Y
2,6-dichlorobenzamide	2008-58-4	Herbicide	Chlorophenoxy acid	P	Synthetic Auxin (Plant growth regulator)		N
2-chloroethylphosphonic acid (Ethephon)	16672-87-0	Herbicide	Substituted benzene	TP	Unknown	Not applicable	
3-hydroxycarbofuran	16655-82-6	Metabolite	Unclassified	TP	Unknown		
Acetochlor	34256-82-1	Herbicide	Chloroacetamide	P	Mitosis, Cell cycle, cell wall synthesis	Inhibition of VLCFA (inhibition of cell division)	N
Aclonifen	74070-46-5	Herbicide	Diphenyl ether	P	Carotenoid biosynthesis inhibition		Y
Acrylonitrile	107-13-1	Insecticide	Unclassified	P	Respiratory action		N
Alachlor	15972-60-8	Herbicide	Chloroacetamide	P	Mitosis, Cell cycle, cell wall synthesis	Inhibition of VLCFA (inhibition of cell division)	N
Aldrin	309-00-2	Insecticide	Organochlorine	P	Neurotoxic	GABA antagonist	N
Alpha-Endosulfan	959-98-8	Insecticide	Organochlorine	P	Neurotoxic	GABA antagonist	
Alpha-HCH	319-84-6	Insecticide	Organochlorine	P	not applicable	Not applicable	
Ametryn	834-12-8	Herbicide	Triazine	P	Photosynthesis inhibition	Photosystem II	N
Aminomethylphosphonic acid (AMPA)	1066-51-9	Metabolite		TP	unknown		

Label	CAS	Usage	Chemical group	Parent (P) or Transformation Product (TP)	Mode of Action (MoA)	Mode of Action – specific	PPP-approval; Yes; No
Atrazine	1912-24-9	Herbicide	Triazine	P	Photosynthesis inhibition	Photosystem II	N
Azinphos-ethyl	2642-71-9	Insecticide	organophosphate	P	Neurotoxic	AChE inhibition	N
Benfluralin	1861-40-1	Herbicide	Dinitroaniline	P	Mitosis, Cell cycle, cell wall synthesis	Microtubule assembly inhibition	Y
Bentazone	25057-89-0	Herbicide	Benzothiazinone	P	Photosynthesis inhibition	Photosystem II	Y
Beta-Endosulfan	33213-65-9	Insecticide	Organochlorine	P	Neurotoxic	GABA antagonist	
Beta-HCH	319-85-7	Insecticide		P	Neurotoxic		
Bifenox	42576-02-3	Herbicide	Diphenyl ether	P	Photosynthesis inhibition	Protoporphyrinogen oxidase (PPO) inhibition	Y
Bromacil	314-40-9	Herbicide	Uracil	P	Photosynthesis inhibition	Photosystem II	N
Bromomethane	74-83-9	Insecticide	Inorganic compound	P	Respiratory action	Respiratory action	N
Bromoxynil	1689-84-5	Herbicide	Hydroxybenzonitrile	P & TP	Photosynthesis inhibition	Photosystem II	Y
Bromoxynil octanoate	1689-99-2	Herbicide	Hydroxybenzonitrile	P	Photosynthesis inhibition		Y
Bronopol	52-51-7	Fungicide		P	Cell membrane disruption	Inhibition of dehydro-genase activity causes membrane damage	N
Captan	133-06-2	Fungicide	Thiophthalimide	P	Multi-site activity	Non-systemic with pro-tective and curative action. Multi-site activity	Y
Carbendazim	10605-21-7	Fungicide / Metabolite	Benzimidazoles	P & TP	Mitosis, Cell cycle, cell wall synthesis	Beta-tubulin assembly inhibition	N
Carbetamide	16118-49-3	Herbicide	Amide	P	Neurotoxic	AChE inhibition	Y
Carbofuran	1563-66-2	Insecticide	N-Methyl Carbamate	P	Neurotoxic	AChE inhibition	N
Carbon tetrachloride	56-23-5	Insecticide	Organochlorine	P	Neurotoxic		N
Chlordane	57-74-9	Insecticide	Organochlorine	P	Neurotoxic	GABA antagonist	N
Chlordecone (Kepone)	143-50-0	Insecticide	Organochlorine	P	Neurotoxic	GABA antagonist	N
Chlorfenvinphos	470-90-6	Insecticide	organophosphate	P	Neurotoxic	AChE inhibition	N
Chloridazon	1698-60-8	Herbicide	Pyridazinone	P	Photosynthesis inhibition	Photosystem II	N

Label	CAS	Usage	Chemical group	Parent (P) or Transformation Product (TP)	Mode of Action (MoA)	Mode of Action – specific	PPP-approval; Yes; No
Chlorobenzene	108-90-7	Industrial chemical / Synthese product	Organochlorine	not applicable	unknown		N
Chlorothalonil	1897-45-6	Fungicide	Chloronitrile	P	Multi-site activity	Spore germination, zoospore motility	Y
Chlorpyrifos	2921-88-2	Insecticide	Organophosphate	P	Neurotoxic	AChE inhibition	Y
Chlorpyrifos-methyl	5598-13-0	Insecticide	Organophosphate	TP	Neurotoxic	AChE inhibition	Y
Chlorsulfuron	64902-72-3	Herbicide	Sulfonylurea	P	Mitosis, Cell cycle, cell wall synthesis		Y
Chlorthiamid	1918-13-4	Herbicide	Benzonitrile	P	Mitosis, Cell cycle, cell wall synthesis		N
Chlortoluron	15545-48-9	Herbicide	Phenylurea	P	Photosynthesis inhibition	Photosystem II	Y
Clopyralid	1702-17-6	Herbicide	Pyridinecarboxylic acid	P	Synthetic Auxin (Plant growth regulator)		Y
Clothianidin	210880-92-5	Insecticide	Neonicotinoid	P & TP	Neurotoxic	nAChR receptor agonist	N
Cyanazine	21725-46-2	Herbicide	Triazine	P	Photosynthesis inhibition	Photosystem II	N
Cypermethrin	52315-07-8	Insecticide	Pyrethroid	P	Ion channel blocker / modulator	Sodium channel modulation	Y
Cyprodinil	121552-61-2	Fungicide	Pyrimidine	P	Protein biosynthesis inhibition	methionine biosynthesis (proposed)	Y
Dalapon	75-99-0	Herbicide	Organochlorine	P	Plant Growth Regulator		
DDT, o,p'	789-02-6	Insecticide	Organochlorine	P	Neurotoxic	GABA antagonist	
DDT, p,p'	50-29-3	Insecticide	Organochlorine	P	Neurotoxic	GABA antagonist	N
Deisopropyldeethylatrazine	3397-62-4	Herbicide		TP			
Delta-HCH	319-86-8	Insecticide	Organochlorine	TP/ isomer			
Deltamethrin	52918-63-5	Insecticide	Pyrethroid	P & TP	Neurotoxic	Sodium channel modulation	Y
Demeton-S-methyl	919-86-8	Insecticide	Organophosphate	P	Neurotoxic	AChE inhibition	N
Demeton-S-methylsulfon	17040-19-6	Insecticide	Organophosphate	P & TP	Neurotoxic	AChE inhibition	N
Desethylatrazine	6190-65-4	Metabolite (Herbicide)	Triazine	TP			

Label	CAS	Usage	Chemical group	Parent (P) or Transformation Product (TP)	Mode of Action (MoA)	Mode of Action – specific	PPP-approval; Yes; No
Desethylterbuthylazine	30125-63-4	Metabolite (Herbicide)	Triazine	TP			
Desisopropylatrazine	1007-28-9	Herbicide	Triazine	TP			
Desmedipham	13684-56-5	Herbicide	Carbamate	P	Photosynthesis inhibition		Y
Desmetryn	1014-69-3	Herbicide	Triazine	P	Photosynthesis inhibition		N
Diazinon	333-41-5	Insecticide	Organophosphate	P	Neurotoxic	AChE inhibition	N
Dicamba	1918-00-9	Herbicide	Benzoic acid	P	Synthetic Auxin (Plant growth regulator)		Y
Dichlobenil	1194-65-6	Herbicide	Benzonitrile	P	Mitosis, Cell cycle, cell wall synthesis	Cell wall biosynthesis	N
Dichlorprop (2,4-DP)	120-36-5	Herbicide	Chlorophenoxy Acid or Ester	P	Synthetic Auxin (Plant growth regulator)		N
Dichlorprop-P	15165-67-0	Herbicide	Aryloxyalkanoic acid	P	Synthetic Auxin (Plant growth regulator)		Y
Dichlorvos	62-73-7	Insecticide	Organophosphate	P	Neurotoxic	AChE inhibition	N
Dicofol	115-32-2	Insecticide	Organochlorine	P	Neurotoxic		N
Dieldrin	60-57-1	Insecticide	Organochlorine	P & TP	Neurotoxic	GABA antagonist	N
Diflufenican	83164-33-4	Herbicide	Carboxamide	P	Carotenoid biosynthesis inhibition		Y
Dimethachlor	50563-36-5	Herbicide	Chloroacetamide	P	Mitosis, Cell cycle, cell wall synthesis		Y
Dimethoate	60-51-5	Insecticide	Organophosphate	P	Neurotoxic	AChE inhibition	Y
Dimethomorph	110488-70-5	Fungicide	Morpholine	P	Lipid metabolism	Fatty acid biosynthesis inhibition	Y
Dinitro-o-cresol (DNOC)	534-52-1	Insecticide		P			N
Dinoseb	88-85-7	Herbicide	Dinitrophenol derivative	P	Respiratory action	Membrane disruption	N
Diuron	330-54-1	Herbicide	Phenylurea	P	Photosynthesis inhibition	Photosystem II	Y
Endosulfan	115-29-7	Insecticide	Organochlorine	P			N
Endrin	72-20-8	Insecticide	Organochlorine	P	Neurotoxic	Chloride channel blocking	N
Epoxiconazole	133855-98-8	Fungicide	Triazole		Sterol biosynthesis inhibition		Y

Label	CAS	Usage	Chemical group	Parent (P) or Transformation Product (TP)	Mode of Action (MoA)	Mode of Action – specific	PPP-approval; Yes; No
Epsilon-HCH	6108-10-7	Insecticide		TP/ isomer			
Ethanimidamide (Acetamipride)	135410-20-7	Insecticide	Neonicotinoid		Neurotoxic	Acetylcholine receptor (nAChR) agonist	Y
Ethion	563-12-2	Insecticide	Organophosphate	P	Neurotoxic	AChE inhibition	N
Ethofumesate	26225-79-6	Herbicide	Benzofuran	P	Lipid metabolism	Fatty acid biosynthesis inhibition	Y
Fenazaquin	120928-09-8	Insecticide	Quinazoline	P	Respiratory action		Y
Fenbutatin oxide	13356-08-6	Insecticide	Organometal		Respiratory action		N
Fenitrothion	122-14-5	Insecticide	organophosphate	P	Neurotoxic	AChE inhibition	N
Fenoprop	93-72-1	Herbicide		P	Synthetic Auxin (Plant growth regulator)	Synthetic auxin affecting nucleic acid biosynthesis and cell elongation	N
Fenpropimorph	67564-91-4	Fungicide	Morpholine		Cell membrane disruption		Y
Fenthion	55-38-9	Insecticide	Organophosphate	P	Neurotoxic	AChE inhibition	N
Flucythrinate	70124-77-5	Insecticide	Pyrethroid	P	Neurotoxic	Ion channel blocker/modulator	N
Fluquinconazole	136426-54-5	Fungicide	Triazole	P	Sterol biosynthesis inhibition		Y
Folpet	133-07-3	Fungicide	Phthalimide	P	Mitosis, Cell cycle, cell wall synthesis		Y
Formaldehyde	50-00-0	Pesticide	Unclassified	P & TP	Protein denaturation		N
Formothion	2540-82-1	Insecticide	Organophosphate	P	Neurotoxic	AChE inhibition	N
Gamma-HCH (Lindane)	58-89-9	Insecticide	Organochlorine	P	Ion channel blocker / modulator	GABA antagonist	N
Glyphosate	1071-83-6	Herbicide	Phosphonoglycine	P	Protein biosynthesis inhibitor	EPSP synthase inhibition	Y
Heptachlor	76-44-8	Insecticide	Organochlorine	P	Ion channel blocker / modulator		N
Heptachlor epoxide	1024-57-3	Metabolite (Insecticide)	Organochlorine	TP			
Hexachlorobenzene	118-74-1	Fungicide		P & TP	Fungal spore inhibitor		N
Hexachlorocyclohexane	608-73-1	Insecticide	Organochlorine	P	Ion channel blocker / modulator	GABA antagonist	N

Label	CAS	Usage	Chemical group	Parent (P) or Transformation Product (TP)	Mode of Action (MoA)	Mode of Action – specific	PPP-approval; Yes; No
Hexazinone	51235-04-2	Herbicide	Triazinone	P	Photosynthesis inhibition	Photosystem II	N
Hydrogen cyanide	74-90-8	Pesticide	Unclassified	P			N
Hydroxyatrazine	2163-68-0	Herbicide		TP			
Hydroxysimazine	2599-11-3	Herbicide		TP			
Hydroxyterbuthylazine	66753-07-9	Herbicide		TP (from terbuthylazine)			
Imidacloprid	138261-41-3	Insecticide	Neonicotinoid	P	Neurotoxic	nAChR receptor agonist	Y
Iodofenphos	18181-70-9	Insecticide	organophosphate	P			N
Ioxynil	1689-83-4	Herbicide	Hydroxybenzonitrile	P & TP	Photosynthesis inhibition	Photosystem II	N
Iprodione	36734-19-7	Fungicide	Dicarboximide	P	Signal transduction	Signal transduction inhibitor	N
Isobenzane	297-78-9	Insecticide	Organochlorine	P	Ion channel blocker/modulator	GABA antagonist	N
Isodrin	465-73-6	Insecticide	Organochlorine	P			N
Isoproturon	34123-59-6	Herbicide		P	Photosynthesis inhibition	Photosystem II	N
Kresoxim-methyl	143390-89-0	Fungicide	Strobilurin / Strobin	P	Respiratory action	QoL fungicide	Y
Lenacil	2164-08-1	Herbicide	Uracil	P	Photosynthesis inhibition	Photosystem II	Y
Linuron	330-55-2	Herbicide	Urea	P	Photosynthesis inhibition	Photosystem II	N
Malathion	121-75-5	Insecticide	organophosphate	P	Neurotoxic	AChE inhibition	Y
Maleinhydrazid	123-33-1	Herbicide	Pyridazine	P			Y
MCPA	94-74-6	Herbicide		P			Y
MCPB	94-81-5	Herbicide		P			Y
Mecoprop	7085-19-0	Herbicide	Aryloxyalkanoic acid	P			N
Mecoprop-P (MCPP-P)	16484-77-8	Herbicide	Aryloxyalkanoic acid	P	Synthetic Auxin (Plant growth regulator)		Y
Metalaxyl	57837-19-1	Fungicide	Phenylamide	P	Synthetic Auxin (Plant growth regulator)		Y
Metalaxyl-M	70630-17-0	Fungicide	Phenylamide	P	Synthetic Auxin (Plant growth regulator)		Y
Metamitron	41394-05-2	Herbicide	Triazinone	P	Photosynthesis inhibition	Photosystem II	Y

Label	CAS	Usage	Chemical group	Parent (P) or Transformation Product (TP)	Mode of Action (MoA)	Mode of Action – specific	PPP-approval; Yes; No
Metazachlor	67129-08-2	Herbicide	Chloroacetamide	P	Mitosis, Cell cycle, cell wall synthesis	Ergosterol inhibitor	Y
Methamidophos	10265-92-6	Insecticide	organophosphate	P & TP	Neurotoxic	AChE inhibition	N
Methidathion	950-37-8	Insecticide	organophosphate	P	Neurotoxic	AChE inhibition	N
Methiocarb	2032-65-7	Insecticide	Carbamate	P	Neurotoxic	AChE inhibition	Y
Methomyl	16752-77-5	Insecticide	Carbamate	P	Neurotoxic	AChE inhibition	Y
Methoxychlor	72-43-5	Insecticide	Organochlorine	P	Neurotoxic	AChE inhibition	N
Metolachlor	51218-45-2	Herbicide	Chloroacetamide	P	Neurotoxic	AChE inhibition	N
Metribuzin	21087-64-9	Herbicide	Triazinone	P	Photosynthesis inhibition	Photosystem II	Y
Metsulfuronmethyl	74223-64-6	Herbicide	Triazinone	P	Mitosis, Cell cycle	Gibberellin pathway	Y
Mirex	2385-85-5	Insecticide	Organochlorine	P	Photosynthesis inhibition	Photosystem II	
Molinate	2212-67-1	Herbicide	ThioCarbamate	P	Mitosis, Cell Cycle		N
Nitrophen	1836-75-5	Herbicide	Diphenyl ether	P			N
o,p'-DDE	3424-82-6	Pesticide	Organochlorine	P & TP	Lipid metabolism		
Omethoate	1113-02-6	Insecticide	organophosphate	P	Neurotoxic	AChE inhibition	N
Oxadiazon	19666-30-9	Herbicide	Oxidiazole	P			N
p,p'-DDD	72-54-8	Insecticide	Organochlorine	P & TP	Neurotoxic	AChE inhibition	N
p,p'-DDE	72-55-9	Insecticide	Organochlorine	P & TP			
Parathion	56-38-2	Insecticide	Organophosphate	P			N
Parathion-methyl	298-00-0	Insecticide	Organophosphate	TP			N
Penconazole	66246-88-6	Fungicide	Triazole	P		Ergosterol inhibitor	Y
Pendimethalin	40487-42-1	Herbicide	Dinitroaniline	P	Mitosis, Cell cycle, cell wall synthesis	Inhibition of mitosis and cell division Microtubule assembly inhibition	Y
Pentachlorophenol	87-86-5	Pesticide	Organochlorine	P	Sterol biosynthesis inhibition		N
Permethrin-cis+trans	52645-53-1	Insecticide	Pyrethroid	P	Mitosis, Cell cycle	Microtubule assembly inhibition	N
Phosalone	2310-17-0	Insecticide	Organophosphate	P	Neurotoxic	AChE inhibition	N

Label	CAS	Usage	Chemical group	Parent (P) or Transformation Product (TP)	Mode of Action (MoA)	Mode of Action – specific	PPP-approval; Yes; No
Pirimicarb	23103-98-2	Insecticide	Carbamate	P	Neurotoxic	AChE inhibition	Y
Procymidone	32809-16-8	Fungicide	Dicarboximide	P		Signal transduction inhibitor / modulator	N
Prometon	1610-18-0	Herbicide	Methoxytriazine	P	Photosynthesis inhibition	Photosystem II	
Prometryn	7287-19-6	Herbicide	Triazine	P			N
Propazine	139-40-2	Herbicide	Triazine	P			N
Propetamphos	31218-83-4	Insecticide	organophosphate	P	Photosynthesis inhibition	Photosystem II	N
Propiconazole	60207-90-1	Fungicide	triazole	P	Sterol biosynthesis inhibition	Ergosterol inhibitor	N
Propyzamide	23950-58-5	Herbicide	Benzamide	P	Mitosis, Cell cycle, cell wall synthesis		Y
Pyridate	55512-33-9	Herbicide	Phenylpyridazine	P	Photosynthesis inhibition	Photosystem II	Y
Pyrimethanil	53112-28-0	Fungicide	Anilinopyrimidine	P	Mitosis, Cell cycle, cell wall synthesis	Microtubule assembly inhibition	Y
Quinoxyfen	124495-18-7	Fungicide	Quinoline	P	Photosynthesis inhibition	Photosystem II	N
Quintozene	82-68-8	Fungicide	Chlorophenyl	P	Lipid metabolism	Lipid peroxidation inhibitor	N
Sebuthylazine	7286-69-3	Herbicide	Triazine	P	Signal transduction	G-Proteins	N
Secbumeton	26259-45-0	Herbicide	Methoxytriazine	P			N
Simazine	122-34-9	Herbicide	Triazine	P			N
Sulfosulfuron	141776-32-1	Herbicide	Sulfonylurea	P			Y
Tebuconazole	107534-96-3	Fungicide	Triazole	P	Sterol biosynthesis inhibition		Y
Tebufenozide	112410-23-8	Insecticide	Diacylhydrazine	P	Protein biosynthesis inhibition	Acetolactate synthase (ALS) inhibition	Y
Terbufos	13071-79-9	Insecticide	organophosphate	P	Neurotoxic	AChE inhibition	N
Terbumeton	33693-04-8	Herbicide	Triazine	P	Photosynthesis inhibition	Photosystem II	N
Terbuthylazine	5915-41-3	Herbicide	Triazine	P	Photosynthesis inhibition	Photosystem II	Y
Terbutryn	886-50-0	Herbicide	Triazine	P	Photosynthesis inhibition	Photosystem II	N
Tetrasul	2227-13-6	Insecticide	bridged diphenyl	P	Photosynthesis inhibition	Photosystem II	N
Thiacloprid	111988-49-9	Insecticide	Neonicotinoid	P	Neurotoxic	nAChR receptor agonist	Y

Label	CAS	Usage	Chemical group	Parent (P) or Transformation Product (TP)	Mode of Action (MoA)	Mode of Action – specific	PPP-approval; Yes; No
Thiamethoxam	153719-23-4	Insecticide	Neonicotinoid	P	Neurotoxic	nAChR receptor agonist	Y
Thiram	137-26-8	Fungicide	Carbamate	P & TP			Y
Toxaphene	8001-35-2	Insecticide	Chlorinated hydrocarbon	P	Neurotoxic		N
trans-Nonachlor	39765-80-5	Insecticide	Organochlorine	P			
Tri-allate	2303-17-5	Herbicide	ThioCarbamate	P			Y
Trichloroacetic acid	76-03-9	Metabolite	Haloacetic acid	TP			N
Trietazine	1912-26-1	Herbicide	Triazine	P	Photosynthesis inhibition	Photosystem II	N
Trifluralin	1582-09-8	Herbicide	Dinitroaniline	P	Mitosis, Cell cycle, cell wall synthesis	Microtubule assembly inhibition	N
Ziram	137-30-4	Fungicide	Carbamate	P	Multi-site activity		Y

Annex 6 Overview of pesticides available under Waterbase – Water Quality, thresholds

Label	CAS	Approved until	AA-EQS [µg/l]	MAC-EQS [µg/l]	List (PS, WL)	AA-EQS regulated in MS (No.)	Lowest AA-EQS regulated in MS [µg/l]	MS with lowest AA-EQS	MAC-EQS regulated in MS (No.)	Lowest MAC-EQS regulated in MS [µg/l]	MS with lowest MAC-EQS
1,2-dibromoethane	106-93-4		2.0	500		1	2	DE	1	500	BE
1,3-dichloropropene	542-75-6		2.0			2	2	BE			
1,4-dichlorobenzene	106-46-7	31.12.2004	1.0	70		7	1	BE	1	70	BE
2,4,5-T (2,4,5- Trichloro-phenoxyacetic acid)	93-76-5	31.12.2003				3	0.1	DE	1	20	BE
2,4-DB	94-82-6	31.10.2032									
2,4-dichlorophenoxyacetic acid, 2-4 D	94-75-7	31.12.2030	0.1			8	0.1	CZ, DE	2	1	DE
2,6-dichlorobenzamide	2008-58-4		0.1			2	0.1	IT			
2-chloroethylphosphonic acid (Ethephon)	16672-87-0	31.07.2020									
3-hydroxycarbofuran	16655-82-6										
Acetochlor	34256-82-1					1	0.1	IT			
Aclonifen	74070-46-5	31.07.2022	0.12	0.12	PS2						
Acrylonitrile	107-13-1										
Alachlor	15972-60-8	18.06.2007	0.3	0.7	PS1						
Aldrin	309-00-2	29.04.2004	0.1		PS1						
Alpha-Endosulfan	959-98-8		0.005	0.005		2	0.005	ES	1	0.005	ES
Alpha-HCH	319-84-6		0.1			1	0.1	IT			
Ametryn	834-12-8	31.12.2003	0.1			3	0.1	BG, IT			
Aminomethylphosphonic acid (AMPA)	1066-51-9		0.1			2	0.1	IT			
Atrazine	1912-24-9	31.12.2007	0.6	2	PS1						
Azinphos-ethyl	2642-71-9					1	0.01	DE			
Benfluralin	1861-40-1	29.02.2020	0.1			1	0.1	IT			
Bentazone	25057-89-0	31.05.2025	0.1	100		10	0.1	DE, LU	4	100	PT
Beta-Endosulfan	33213-65-9										

Label	CAS	Approved until	AA-EQS [µg/l]	MAC-EQS [µg/l]	List (PS, WL)	AA-EQS regulated in MS (No.)	Lowest AA-EQS regulated in MS [µg/l]	MS with lowest AA-EQS	MAC-EQS regulated in MS (No.)	Lowest MAC-EQS regulated in MS [µg/l]	MS with lowest MAC-EQS
Beta-HCH	319-85-7										
Bifenox	42576-02-3	31.12.2019	0.012	0.04	PS2						
Bromacil	314-40-9					1	0.6	DE			
Bromomethane	74-83-9										
Bromoxynil	1689-84-5	31.07.2020	0.5			1	0.5	DE			
Bromoxynil octanoate	1689-99-2	31.07.2020									
Bronopol	52-51-7		0.7			2	0.7	SE			
Captan	133-06-2	31.07.2020	0.1	0.34		2	0.1	IT	1	0.34	NL
Carbendazim	10605-21-7	30.11.2014	0.15	0.6		3	0.15	UK	2	0.6	NL
Carbetamide	16118-49-3	31.05.2021									
Carbofuran	1563-66-2		0.1			1	0.1	IT			
Chlordane	57-74-9	29.04.2004	0.002		POP	4	0.002	AT, BE, LU			
Chlordecone (Kepone)	143-50-0		0.1			1	0.1	FR			
Chlorfenvinphos	470-90-6	31.12.2003	0.1	0.3	PS1						
Chloridazon	1698-60-8	31.12.2018	0.1	20		5	0.1	DE, IT	2	20	BE
Chlorothalonil	1897-45-6	20.05.2019									
Chlorpyrifos	2921-88-2	31.01.2020	0.03	0.1	PS1						
Chlorpyrifos-methyl	5598-13-0	31.01.2020	0.03			2	0.03	ES			
Chlorsulfuron	64902-72-3	31.12.2019									
Chlorthiamid	1918-13-4										
Chlortoluron	15545-48-9	31.10.2019	0.4	0.8		7	0.4	NL	2	0.8	SI
Clopyralid	1702-17-6	30.04.2020	70	300		1	70	SK	1	300	SK
Clothianidin	210880-92-5	31.01.2019	0.0083		WL[1,2]						
Cyanazine	21725-46-2		0.1			1	0.1	IT			
Cypermethrin	52315-07-8	31.10.2019	0.00008	0.0006	PS2						
Cyprodinil	121552-61-2	30.04.2020									

Label	CAS	Approved until	AA-EQS [µg/l]	MAC-EQS [µg/l]	List (PS, WL)	AA-EQS regulated in MS (No.)	Lowest AA-EQS regulated in MS [µg/l]	MS with lowest AA-EQS	MAC-EQS regulated in MS (No.)	Lowest MAC-EQS regulated in MS [µg/l]	MS with lowest MAC-EQS
Dalapon	75-99-0										
DDT, o,p'	789-02-6	29.04.2004	0.025		PS1						
DDT, p,p'	50-29-3	29.04.2004	0.01		PS1						
Deisopropyldeethylatrazine	3397-62-4										
Delta-HCH	319-86-8										
Deltamethrin	52918-63-5	31.10.2019									
Demeton-S-methyl	919-86-8		0.1			1	0.1	DE			
Demeton-S-methylsulfon	17040-19-6		0.1			1	0.1	DE			
Desethylatrazine	6190-65-4		0.1			4	0.1	IT			
Desethylterbuthylazine	30125-63-4		0.1	0.1		3	0.1	IT. PT	1	0,1	PT
Desisopropylatrazine	1007-28-9										
Desmedipham	13684-56-5	31.07.2020	1	15		1	1	SK	1	15	SK
Desmetryn	1014-69-3										
Diazinon	333-41-5		0.1			1	0.1	IT			
Dicamba	1918-00-9	31.12.2019	0.1				0.1	IT			
Dichlobenil	1194-65-6										
Dichlorprop (2,4-DP)	120-36-5	31.12.2003	0.1	200		3	0.1	CZ, DE	1	200	BE
Dichlorprop-P	15165-67-0	30.04.2020	1.0	7.6		2	1	NL	1	7.6	NL
Dichlorvos	62-73-7	06.12.2008	0.0006	0.0007	PS2						
Dicofol	115-32-2	30.03.2010	0.0013		PS2						
Dieldrin	60-57-1	29.04.2004	0.1		PS1						
Diflufenican	83164-33-4	31.12.2019	0.009			2	0.009	DE			
Dimethachlor	50563-36-5	31.12.2021	0.09			1	0.09	CZ			
Dimethoate	60-51-5	31.07.2020	0.02	0.2		7	0.02	BE	3	0.2	BE
Dimethomorph	110488-70-5	31.07.2020									
Dinitro-o-cresol (DNOC)	534-52-1										
Dinoseb	88-85-7										

Label	CAS	Approved until	AA-EQS [µg/l]	MAC-EQS [µg/l]	List (PS, WL)	AA-EQS regulated in MS (No.)	Lowest AA-EQS regulated in MS [µg/l]	MS with lowest AA-EQS	MAC-EQS regulated in MS (No.)	Lowest MAC-EQS regulated in MS [µg/l]	MS with lowest MAC-EQS
Diuron	330-54-1	30.09.2020	0.2	1.8	PS1						
Endosulfan	115-29-7	02.06.2007	0.005	0.01	PS1						
Endrin	72-20-8	29.04.2004	0.1		PS1						
Epoxiconazole	133855-98-8	30.04.2020	0.1			2	0.1	IT			
Epsilon-HCH	6108-10-7										
Ethanimidamide (Acetamipride)	135410-20-7	28.02.2033	0.1			1	0.1	IT			
Ethion	563-12-2										
Ethofumesate	26225-79-6	31.10.2031	0.1	50		2	0.1	IT	1	50	SK
Fenazaquin	120928-09-8	31.05.2023									
Fenbutatin oxide	13356-08-6										
Fenitrothion	122-14-5	25.11.2008	0.0009	0.002		6	0.0009	BE	1	0.002	BE
Fenoprop	93-72-1										
Fenpropimorph	67564-91-4	30.04.2019	0.02	20		1	0.02	DE	1	20	DE
Fenthion	55-38-9		0.004			1	0.004				
Flucythrinate	70124-77-5										
Fluquinconazole	136426-54-5	31.12.2021									
Folpet	133-07-3	31.07.2020									
Formaldehyde	50-00-0	31.12.2003	5.0	50		3	5	SK	2	50	SK
Formothion	2540-82-1										
Gamma-HCH (Lindane)	58-89-9	20.12.2002	0.01		PS1	2	0.01	CZ			
Glyphosate	1071-83-6	15.12.2022	0.1	197		6	0.1	IT	1	197	SI
Heptachlor	76-44-8	29.04.2004	0.0000007	0.0003	PS2						
Heptachlor epoxide	1024-57-3	29.04.2004	0.0002	0.3	PS2	3	0.0002	ES	1	0.3	ES
Hexachlorobenzene	118-74-1	29.04.2004		0.05	PS12						
Hexachlorocyclohexane	608-73-1	29.04.2004	0.02	0.04	PS1						
Hexazinone	51235-04-2		0.048			2	0.048	CZ			

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Hydrogen cyanide	74-90-8					2	1	BG			
Hydroxyatrazine	2163-68-0										
Hydroxysimazine	2599-11-3										
Hydroxyterbuthylazine	66753-07-9										
Imidacloprid	138261-41-3	31.07.2022	0.0083	0.1	WL[1,2]						
Iodofenphos	18181-70-9										
Ioxynil	1689-83-4										
Iprodione	36734-19-7	04.12.2017									
Isobenzane	297-78-9										
Isodrin	465-73-6		0.1		PS1						
Isoproturon	34123-59-6	30.09.2017	0.3	1	PS1						
Kresoxim-methyl	143390-89-0	31.12.2024									
Lenacil	2164-08-1	31.12.2019	0.1			1	0.1	IT			
Linuron	330-55-2	03.03.2017	0.1	0.29		8	0.1	DE	2	0.29	NL
Malathion	121-75-5	30.04.2022	0.0008	0.003		5	0.0008	BE	1	0.003	BE
Maleinhydrazid	123-33-1	31.10.2032									
MCPA	94-74-6	31.10.2019	0.1	13		9	0.1	CZ, DE, FR	3	13	BE
MCPB	94-81-5	31.10.2019	0.1			1	0.1	CZ			
Mecoprop	7085-19-0	31.01.2017	0.1	40		6	0.1	CZ, DE, IT	2	40	BE
Mecoprop-P (MCPP-P)	16484-77-8	31.01.2020	0.1			2	0.1	CZ			
Metalaxyl	57837-19-1	30.06.2023	0.1			1	0.1	IT			
Metalaxyl-M	70630-17-0	30.06.2020	0.1			1	0.1	IT			
Metamitron	41394-05-2	31.08.2022	0.1			2	0.1	IT			
Metazachlor	67129-08-2	31.07.2021	0.08	0.48		5	0.08	NL	1	0.48	NL
Methamidophos	10265-92-6	30.06.2008	0.1			2	0.1	DE			
Methidathion	950-37-8										

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Methiocarb	2032-65-7	31.07.2020	0.002		WL[1,2]						
Methomyl	16752-77-5	31.08.2019									
Methoxychlor	72-43-5		0.005			1	0.005	BG			
Metolachlor[30]	51218-45-2	31.07.2020	0.1	0.3		6	0.1	IT, LU	3	0.3	SI
Metribuzin	21087-64-9	31.07.2020	0.08			3	0.08	SE			
Metsulfuronmethyl	74223-64-6	31.03.2023	0.01	0.03		2	0.01	NL	1	0.03	NL
Mirex	2385-85-5				POP						
Molinate	2212-67-1										
Nitrophen	1836-75-5										
o,p'-DDE	3424-82-6										
Omethoate	1113-02-6	31.12.2003	0.0008	0.22		9	0.0008	BE	3	0.22	BE
Oxadiazon	19666-30-9	31.12.2018	0.088		WL[1]						
p,p'-DDD	72-54-8		0.00625			1	0.00625	ES			
p,p'-DDE	72-55-9		0.00625			1	0.00625	ES			
Parathion	56-38-2	09.07.2003	0.0002	0.004		7	0.0002	BE, LU	1	0.004	BE
Parathion-methyl	298-00-0	10.03.2005	0.005			6	0.005	CZ			
Penconazole	66246-88-6	31.12.2021									
Pendimethalin	40487-42-1	31.08.2024	0.1	0.3		5	0.1	IT	2	0.3	SI
Pentachlorophenol	87-86-5	20.11.2002	0.4	1	PS1						
Permethrin-cis+trans	52645-53-1		0.001			1	0.001	UK			
Phosalone	2310-17-0		0.1			2	0.1	AT, IT			
Pirimicarb	23103-98-2	30.04.2020	0.09	1.8		4	0.09	NL, SE, DE	1	1.8	NL
Procymidone	32809-16-8	30.06.2008									
Prometon	1610-18-0					1	1	BG			

30 Metolachlor consists of two isomeres: S-Metolachlor and R-Metolachlor. The mixture of both as Metolachlor was approved until 31.12.2003. S-Metolachlor was approved until 31.07.2020. In Waterbase – Water Quality, the differences between Metolachlor and S-Metolachlor was not considered.

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Prometryn	7287-19-6	31.12.2003	0.1			3	0.1	IT			
Propazine	139-40-2		0.1			2	0.1	IT			
Propetamphos	31218-83-4										
Propiconazole	60207-90-1	31.01.2019	0.1			6	0.1	IT			
Propyzamide	23950-58-5	30.06.2025	0.1			1	0.1	IT			
Pyridate	55512-33-9	31.12.2030									
Pyrimethanil	53112-28-0	30.04.2020									
Quinoxyfen	124495-18-7	30.04.2019	0.15	2.7	PS2						
Quintozene	82-68-8		0.1			2	0.1	IT			
Sebuthylazine	7286-69-3		0.01			1	0.01	AT			
Secbumeton	26259-45-0										
Simazine	122-34-9	10.09.2005	1.0	4	PS1						
Sulfosulfuron	141776-32-1	31.12.2030	0.05			1	0.05	SE			
Tebuconazole	107534-96-3	31.08.2020									
Tebufenozide	112410-23-8	31.05.2024	0.1			1	0.1	IT			
Terbufos	13071-79-9										
Terbumeton	33693-04-8		0.1			1	0.1	IT			
Terbuthylazine	5915-41-3	31.12.2024	0.2	0.5		6	0.2	NL	4	0.5	SI
Terbutryn	886-50-0	20.11.2002	0.065	0.34	PS2						
Tetrasul	2227-13-6										
Thiacloprid	111988-49-9	30.04.2020	0.0083		WL[1,2]						
Thiamethoxam	153719-23-4	30.04.2019	0.0083		WL[1,2]						
Thiram	137-26-8	30.04.2019									
Toxaphene	8001-35-2										
trans-Nonachlor	39765-80-5										
Tri-allate	2303-17-5	31.12.2021	0.67		WL[1]						
Trichloroacetic acid	76-03-9										

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Trietazine	1912-26-1										
Trifluralin	1582-09-8	25.06.2010	0.03		PS1						
Ziram	137-30-4	30.04.2020									

Notes: Lists: PS = Priority Substances, PS1 = regulated 2008, PS2 = regulated 2013, PS12 = regulated 2008, UQN changed 2013; a blank in column 'approved until': obviously no information about approval found, no information about approval after 2006 in particular.

WL = Watch List ([1]according to Commission Implementing Decision (EU) 2015/495; [2]according to Commission Implementing Decision (EU) 2018/840)

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The European Topic Centre on Inland, Coastal and Marine waters (ETC/ICM) is a consortium of European institutes under contract of the European Environment Agency.