

European waters and its pollution:

a political, scientific and technical introduction

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Acknowledgement

- The author thanks the following institutions providing data and information on the environment
 - Without such a relevant information this conference would not exist
 - [EEA : European environmental agency](#)
 - [JRC : Joint research centre \(Ispra\)](#)
 - [USGS : United states geological survey](#)
 - [Onema : Office national de l'eau et des milieux aquatiques \(French Institute for Water and Aquatic Media\)](#)

On this slide can be found the different sources of information that have been used for this presentation. Since the subject is very large a choice have been made, interested readers are encouraged to visit those sources to find more information on waters.

Waters, what are we dealing with?

- A resource for life
 - Among which freshwater is scarce and vulnerable to pollutions
 - Complex relationships between surface and ground water
- A vector of many risks
 - Flooding, landslides, avalanches, drought, sea level rise, icebergs...
 - Subject to the consequences of climate change
- Several very different ecosystems with a huge biodiversity
 - Oceans, Seas, Lakes, Rivers, Wetlands...
- A strong water policy in Europe
 - Water framework directive
 - Marine strategy framework directive
 - Regulations and directives to limit anthropic pressures
 - (Nitrates, pesticides, REACH...)

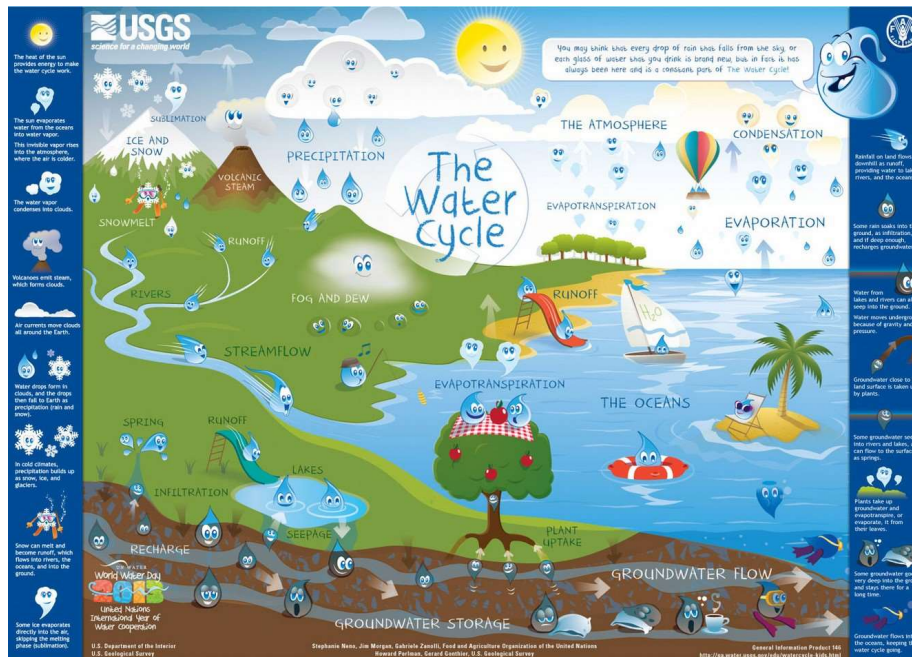
The fact that water is a resource for life is well known. Our own body contains more than 90% of water.

Water is a source of risks like flooding, avalanche, drought or sea level rise. These risks are modified by climate change.

Life began in waters. Water bodies are a habitat for life. AN ecosystem is made from an habitat and a set of populations of living organisms. These two entities are strongly interdependent. So waters have to be considered as an habitat for many aquatic living organisms.

Water is also a policy shared by the EU member states with several directives. It is comparable with the air quality policy. Unfortunately there is no EU soil quality, despite an attempt by the commission that did not succeed to reach consensus among members states.

The water cycle



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This is the water cycle. Let's start by the ocean where 95% of water on earth is located. Water evaporates and goes in the atmosphere, then it can condense in clouds and goes back to the sea or on land and then flow in the rivers down to the sea or infiltrate to ground waters. Water also evaporates from living organisms. Water in solid phase lies in snow and ice caps and is stored this way. Climate change might decrease the amount of water in the ice caps and glaciers and increase sea level. All these movements of water create what is called a cycle, the large water cycle.

A small water cycle can also be considered, it is the cycle of human usages of waters. Extraction from surface or ground, distribution, consumption and the sewage and water treatment. The interaction of the small cycle with the large cycle is a concern as far as waters as ecosystems are concerned.

Water quantity on earth

- A renewable resource for life on earth

Water source	Water volume, in cubic kilometers	Percent of freshwater	Percent total water
Oceans, Seas, & Bays	1,338,000,000 --		96.5400
Ice caps, Glaciers, & Permanent Snow	24,064,000	68.700	1.7400
Fresh groundwater	10,530,000	30.100	0.7600
Saline groundwater	12,870,000 --		0.9300
Soil Moisture	17	0.050	0.0010
Ground Ice & Permafrost	300	0.860	0.0220
Freshwater lakes	91	0.260	0.0070
Saline lakes	85 --		0.0060
Atmosphere	13	0.040	0.0010
Swamp Water (wetlands)	11	0.030	0.0008
Rivers	2	0.006	0.0002
Biological Water	1	0.003	0.0001

Source USGS



This table shows the amount of waters in different compartments of the large cycle.

Why protecting waters?

- Quality of drinking water is key to protecting human health from diseases
- Water is necessary for agriculture and livestock
- Polluted or modified water bodies degrade biodiversity
- Recreation uses can be threatened
- Water is a vector of risks (flooding, sea submersion)
- Waters shelter resources that can be (sustainably)harvested

As an egoist human species we first think of drinking water quality. In many countries people are lacking good quality of water. Even in countries like France where there is no drinking water scarcity there are quality problems. The cost of avoidance of using tap water because of its pollution have been calculated by economists to be as large as one billion euros in France. This is just an example of the cost of a pollution.

Agriculture needs water. For instance exporting agricultural products is a way to export water.

Biodiversity is a very important environmental issue which is clearly linked with water habitats. These habitats need to be protected if one to protect biodiversity.

Other uses of water like recreation, or fishing are important. Overfishing is also a large environmental problem and also a social problem when it is not sustainable, which is the case in many water bodies. It is also important to remember that water is an important vector of risks.

Regulations are very important to solve those environmental issues

Threats to water and aquatic ecosystems

- Water pollution
- Change of water bodies characteristics
- Excess of water withdrawal
- Ecological continuity (specially for migratory fish)
- Warming of waters
- Risks linked with changes in hydrological regime

This is the list of threats to waters that will be explained in the following slides. We will start by examining the anthropic pressures on waters and then look at the environmental situation that is linked with the pressures.

Pollutions

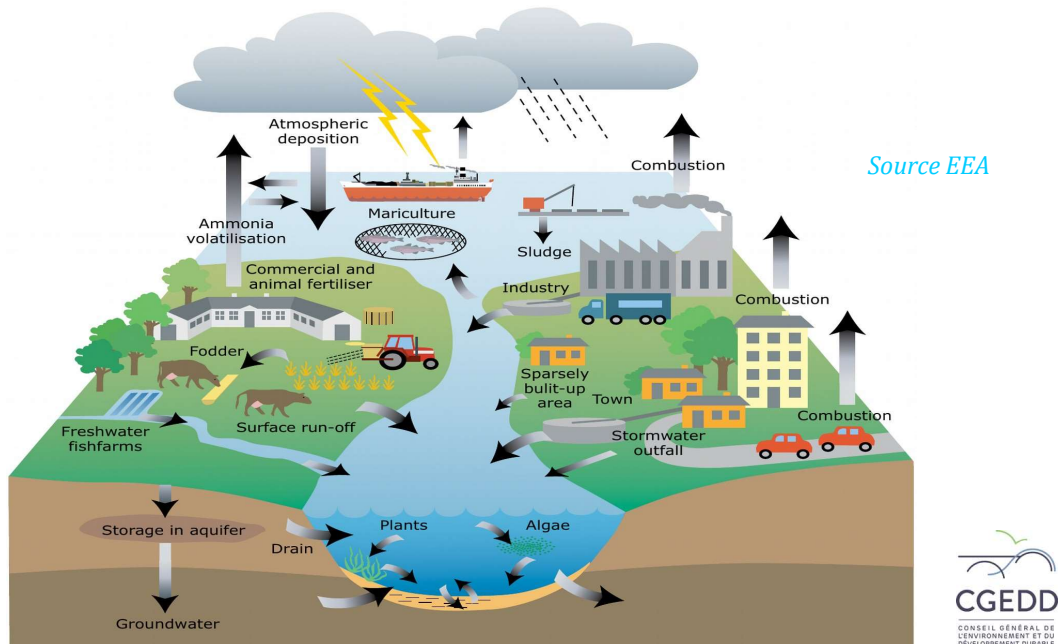
- Agriculture is a major source of pollution
 - *Agricultural production is becoming increasingly intensive, with high input of fertilisers and pesticides, in turn resulting in significant loads of pollutants to the water environment through diffuse pollution.*
- Pollution by industrial chemicals comes through domestic use
 - *Sources for hazardous substances are pesticides and veterinary medicines from farmland, discharge of heavy metals and some industrial chemicals, and wastewater from consumer products such as body care products, pharmaceuticals and cleaning agents.*
- Historic sources of pollutions are still a threat
 - *Landfill sites and contaminated land from historical industrial and military activities can be a source of pollution to the aquatic environment*

It is important to know that the major source of water pollution is now agriculture. It is linked to excess of nitrates and phosphates, livestock and pesticides. This pollution is diffuse and this makes it very difficult to handle it since there is no point where one could measure pollution sources and act on them.

Industry is still thought as a very important source of pollution, it was true in the past but it is no longer true. Industrial pollution has decreased. It is punctual, so very easy to manage. It is also quite easy to discuss pollution issues with industry and convince that since it makes profits from using waters it needs to avoid pollutions and can afford it. However, industry produce and distributes many chemicals that are used by people. These pollutants are very often rejected in waters and it creates a diffuse pollution problem. An important emerging issue is pollution by medicinal drugs that are very useful for health but might be over-consumed and finally end up in waters as toxic pollutants.

Historical sources of pollution still exist, it is often stored in soils and then released in rivers or ground waters.

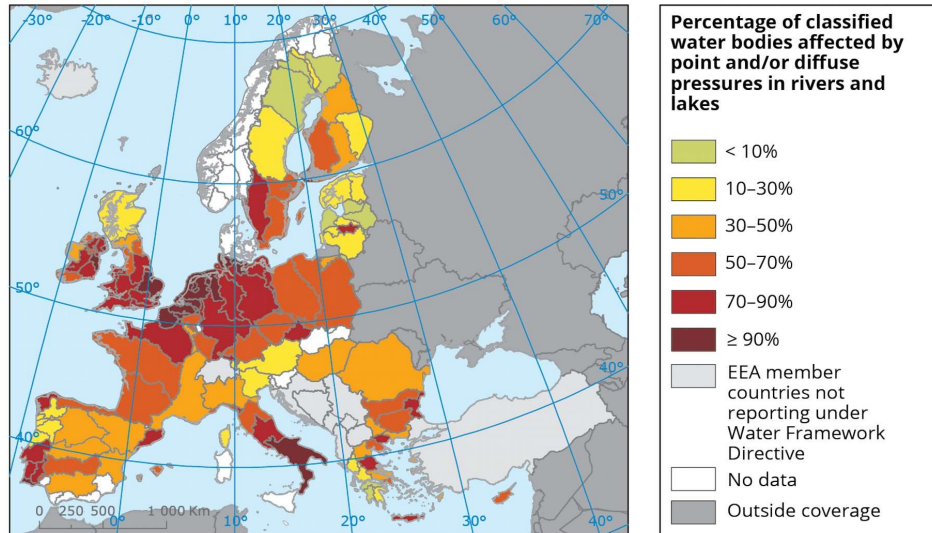
Waters are most often the ultimate receptor of pollutions



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This image shows the different sources of pollutants and how they end up in waters due to many pathways. It is in a way an interference between man and the natural water cycle. It shows that pollutants seen in waters may come from very remote sources. It makes it difficult to find out where the responsibilities of pollution are.

Pollution in European freshwaters



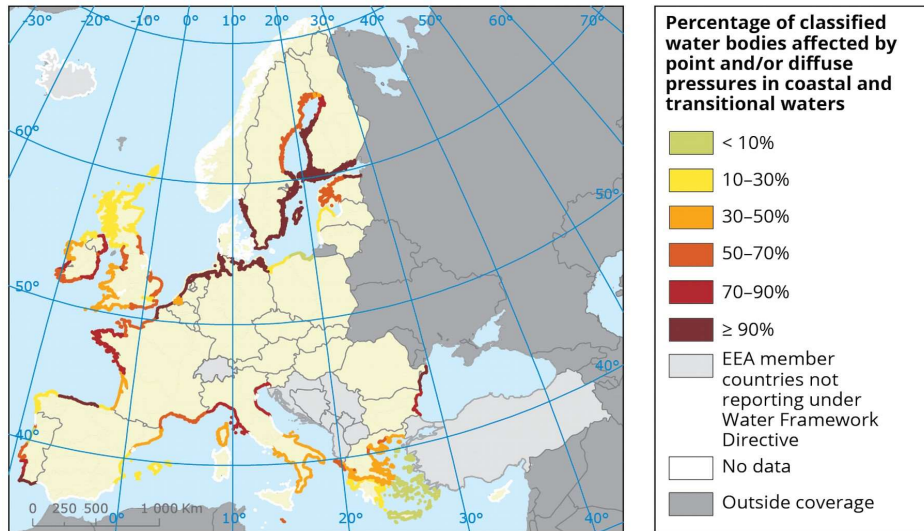
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Source EEA



Here the colour codes show the proportion of fresh waters that are affected by pollutions. It clearly shows that the situation is not satisfactory and that most of the industrialized and densely populated countries are highly polluted.

Pollution in European coastal waters

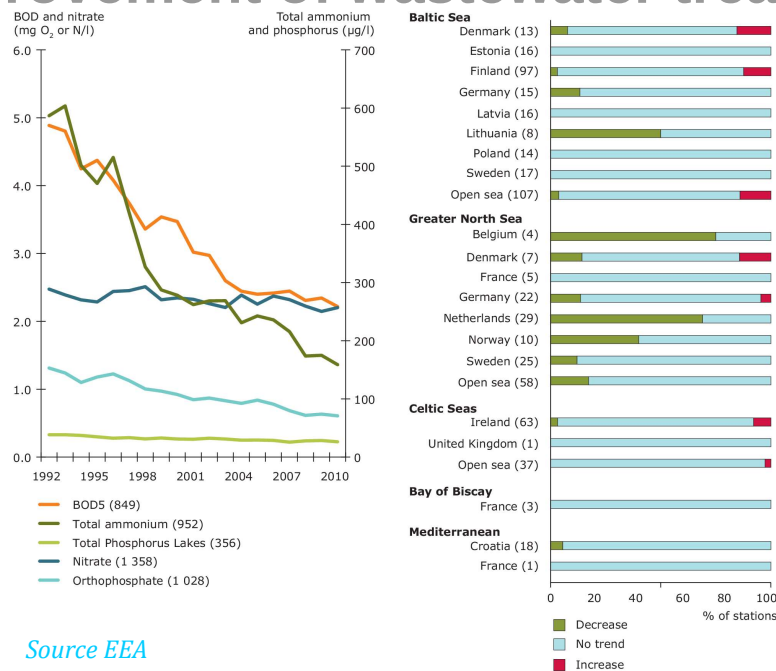


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Source EEA

The pollution of coastal zones shows a similar pattern compared to freshwater pollution.

Improvement of organic pollution : improvement of wastewater treatment

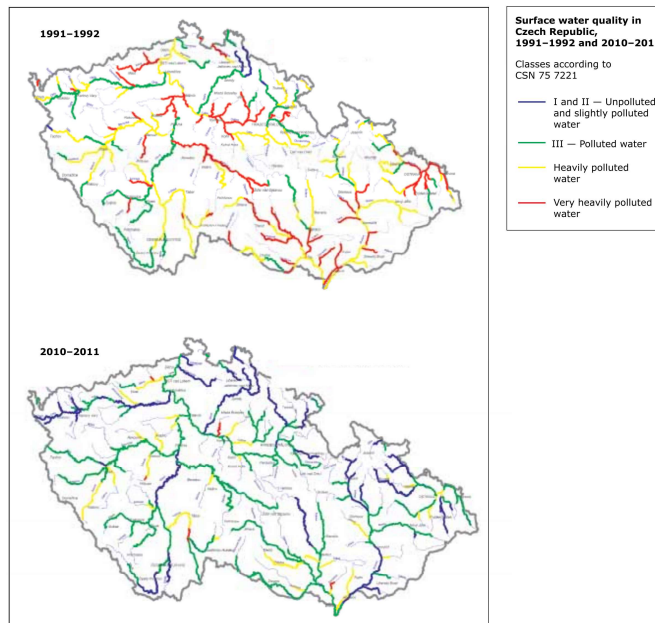


Source EEA

However there are improvements in water pollution. Pollution by ammonia for instance is decreasing. Water from sewage systems is polluted by substances that are subject to biochemical processes of oxidation, so they consume oxygen which can be measured. This measure called biological oxygen demand (BOD) is a good proxy for organic pollution. It has been decreasing in the last decades

Nitrates are still a big problem in Europe. It creates eutrophication. Eutrophication is linked with algal development in waters. In some coastal areas it has also created health problems, even mortality due to hydrogen sulfide. Pollution by nitrates is clearly linked with agriculture. The nitrates directive helps to decrease the release of nitrates in waters. However it will not be always sufficient to cope with the good ecological status required by the water framework directive. This example shows that the two directives complement each other.

EU integration can trigger improvements on aquatic environment



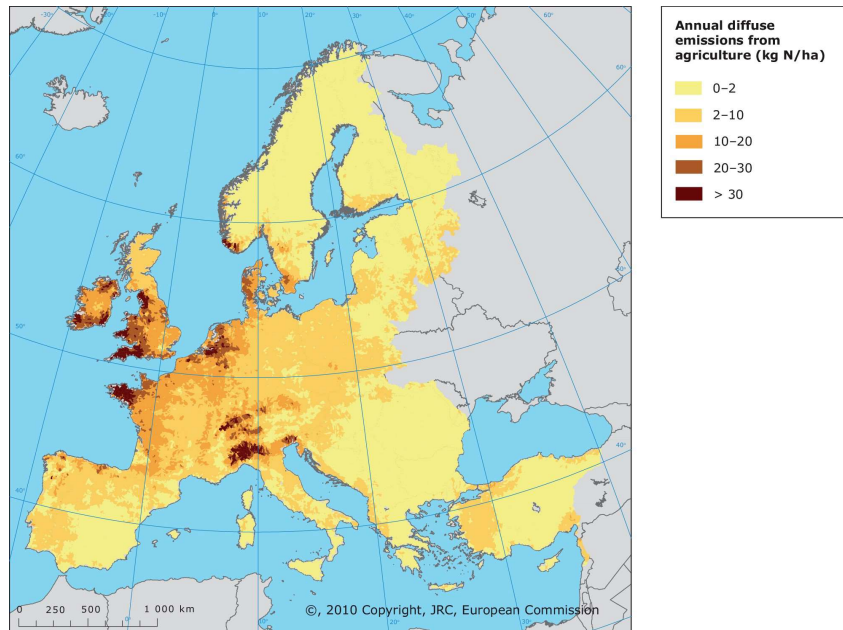
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Source EEA



This figure shows that European integration might trigger a virtuous cycle in water protection. In the Czech Republic, for example, water quality has improved significantly in the last decades.

Emissions of nitrogen by agriculture

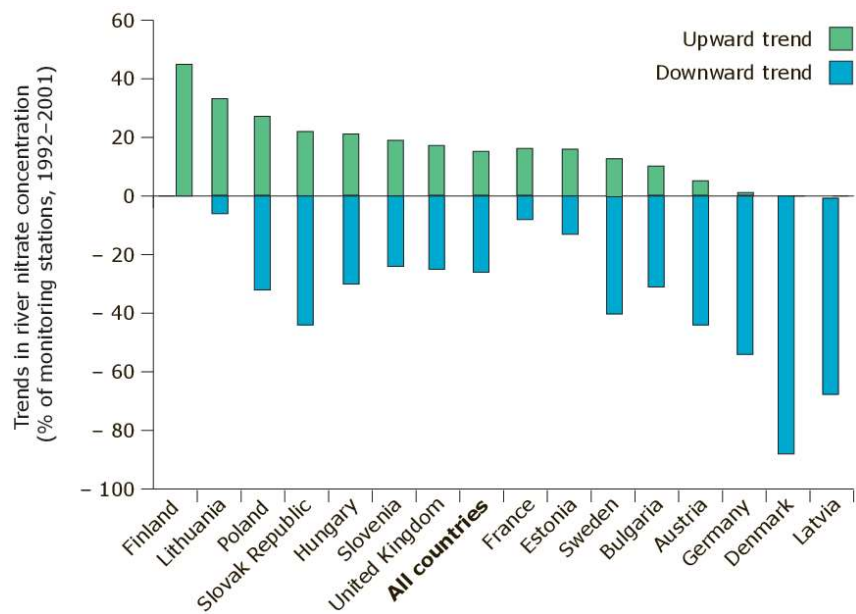


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Source EEA

This map shows where the pollution by nitrates (the major source of nitrogen) occurs.

Nitrates : one directive, different trends

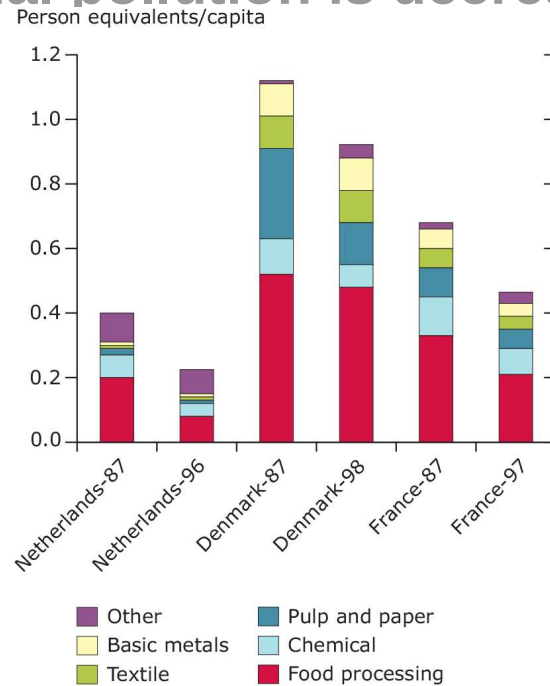


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Source EEA

Comparison of several European countries shows the improvements and might help a sort of competition for water quality.

Industrial pollution is decreasing



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Source EEA

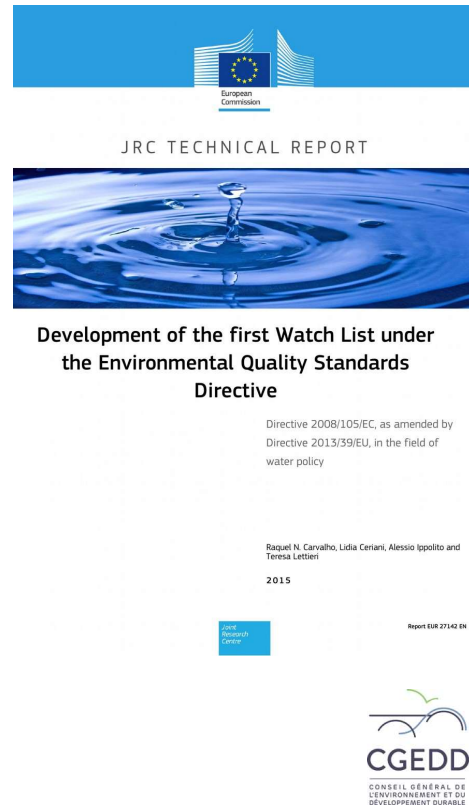


This graph shows the decrease of industrial pollution, especially for food processing and paper mills. The cause of this improvement is linked to depuration systems but also in investments in new cleaner and more productive processes.

Such a process where pollution decrease is linked to improvements of the production processes is still lacking in agriculture. The future of agriculture might be to produce better food with less pollution. Consumers seem to request products from organic agriculture, this might trigger a future improvement.

Emerging pollutants

- Among them
 - Pesticides (neonicotinoids...)
 - Endocrine disrupters
 - Medicines
 - Antibiotics
- Environmental quality standards
 - Threshold values for chemical quality of waters
 - Are based on ecotoxicity tests
- EQS directive
 - List of substances to be monitored
 - Can be updated if RQ > 1

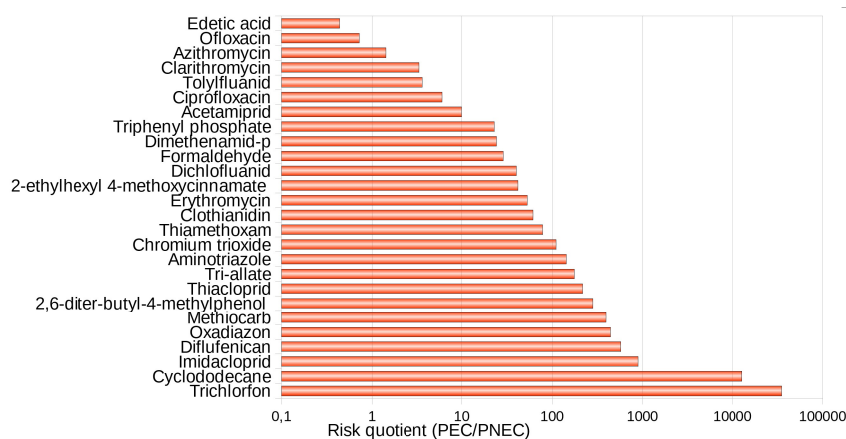


What is called emerging pollutants is not always new pollutants but newly detected pollution problems with substances that were not easy to measure in waters in the past

These “emerging” pollutants are now new families of pesticides (like neonicotinoids) and medicines or antibiotics..

Emerging pollutants

- List of pollutants of concern
 - PNEC = predicted non effect concentration
 - PEC = predicted environmental concentration



This graph shows the pollutants that are of concern ranked by the ratio of their predicted environmental concentration (PEC) versus their predicted no effect concentration (PNEC). These values (PEC and PNEC) are representative of respectively their fate in the environment calculated using their persistence and usage volume and their toxicity. The more high the PEC/PNEC ratio the more likely it is that the pollutant threatens the environment.

Alterations of hydro-morphology

- A water body is an habitat for many species
 - Water bed shape, rocks granulometry, water speed and height, water temperature govern communities ability to populate waters
 - *For decades – sometimes centuries – humans have altered European surface waters (straightening and canalisation, disconnection of flood plains, land reclamations, dams, weirs, bank reinforcement, etc.) to enable agriculture and urbanisation, produce energy and protect against flooding¹*
 - *Hydromorphological alterations very often explain a major part of the observed poor biological water quality of rivers. Consequently, mitigation of main known chemical pollutions is generally not sufficient to recover the good ecological status requested by the WFD².*

Sources

1: EEA

2: Onema: French Institute for Water and Aquatic Media

Examples of hydromorphologic alterations: River doorsteps

- Algal proliferation can be easily seen upstream



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Source Onema



A doorstep creates a quiet area in a normally running river. Fish that need fast flowing waters do not appreciate living in such quiet areas. The slow speed also decreases the exchange with air and thus the oxygen content of water. Algae can also proliferate in such places, especially if excess of nitrates and phosphates occur in the same time.

Examples of hydromorphologic alterations: Rectified water bed

- The flow is made homogenous => decrease of biodiversity



Corinne Forst - Onema

Source Onema



In such a river there is no place for fish to nest and reproduce even if chemical water quality is good.

Examples of hydromorphologic alterations: Stabilized banks

- Habitats for fish, invertebrates or aquatic plants disappear



Source Onema



When a bank is stabilized this way all the interactions between the river and the terrestrial ecosystem is lost.

Important hydromorphologic elements : Riparian corridors

- This example from Meuse shows riparian corridors
 - Banks stabilization
 - Capture of excess
 - Production of nutritive
 - Displacement of fa
 - Protection from par
 - Capture of nitrates pesticides



Pierre Mangot - Onema

Source Onema

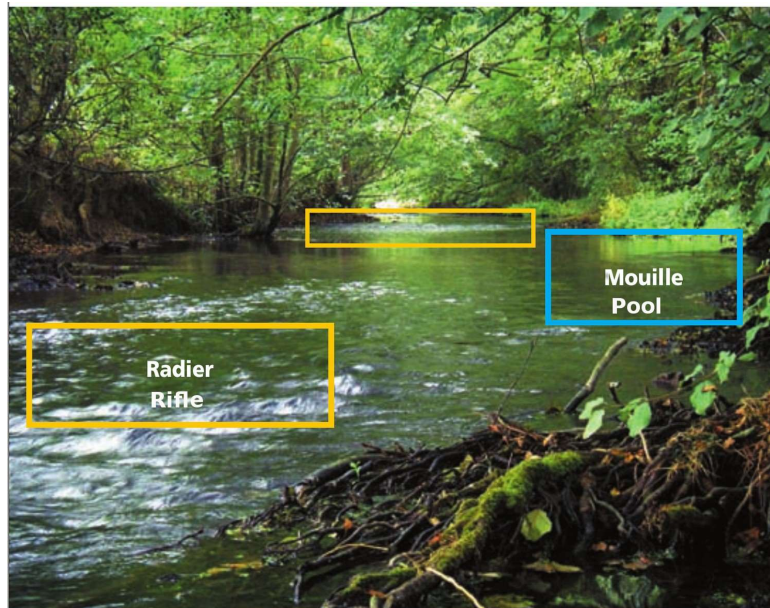


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On this slide riparian corridors with trees can be seen. Riparian trees have several important roles :

- they provide shadow to the river in summer, avoiding overheating and overproduction of unicellular algae which need light to develop;
- Falling leaves feed the aquatic ecosystem with carbon as a source for trophic chains;
- They shelter many terrestrial species that depend on water proximity like amphibians;
- They are also circulation zones for many animals.

Diversity of water speed : Rifles and pools



A natural river, in upstream zones, shows alternating riffles and pools where different species or different life stages of fish or invertebrates live.

This alternation is important for biodiversity

Laetitia Boutet-Berry - Onema

Source Onema



The alternance of riffles (where water speed is high) and pools (where water speed is slower) is useful for fish that need both to feed and reproduce or for different stages of their life cycle.

Width of rivers: habitat for species and flood plains

Allowing a river to divagate within a large minor bed provide natural habitats and also storage zone to retain floods upstream

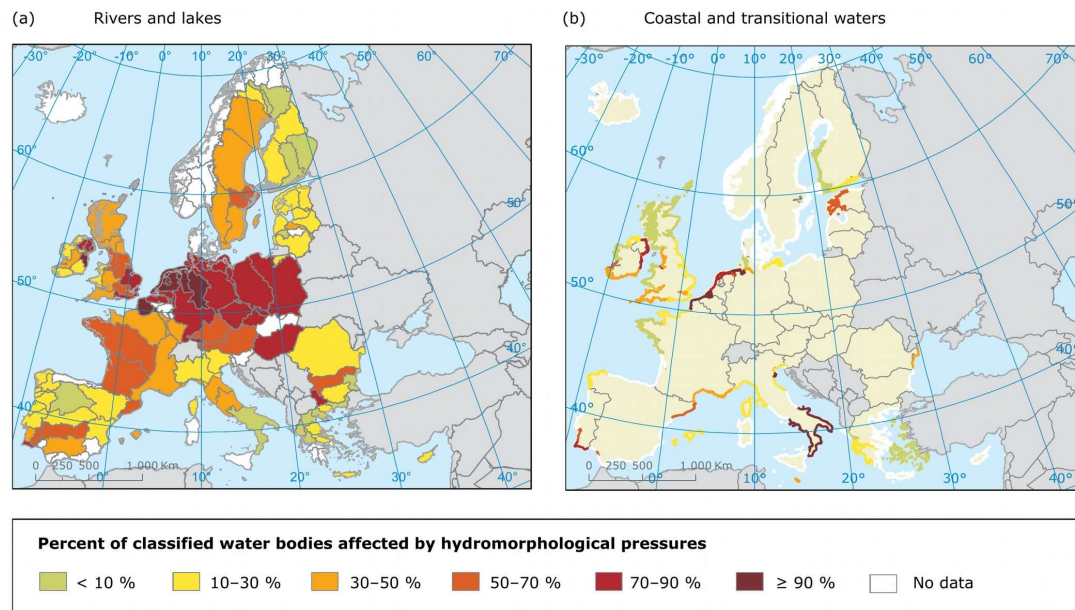


Christian Peugot - Onema

A large water bed has two functions :

- It is an habitat for many species and can shelter eggs and juvenaile fish away from predators;
- They are invade by water during flooding, preventing water to accumulate downstream.

Hydromorphological pressure on fresh and coastal waters in Europe



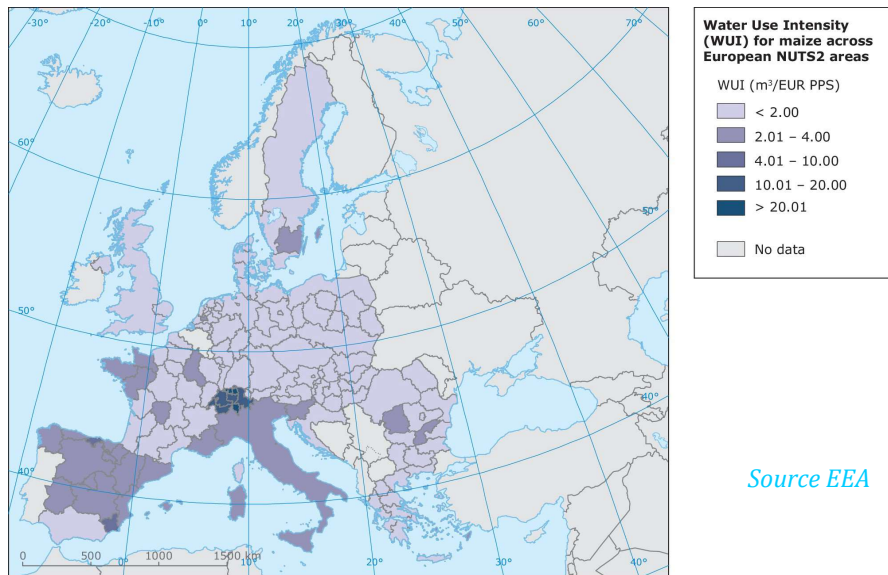
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Source EEA

CONSEIL GÉNÉRAL DE
L'ENVIRONNEMENT ET DU
DÉVELOPPEMENT DURABLE

This graph shows that the pressure on hydromorphology is high in most European areas on rivers and lakes as well as coastal zones.

Water use by agriculture high in southern countries

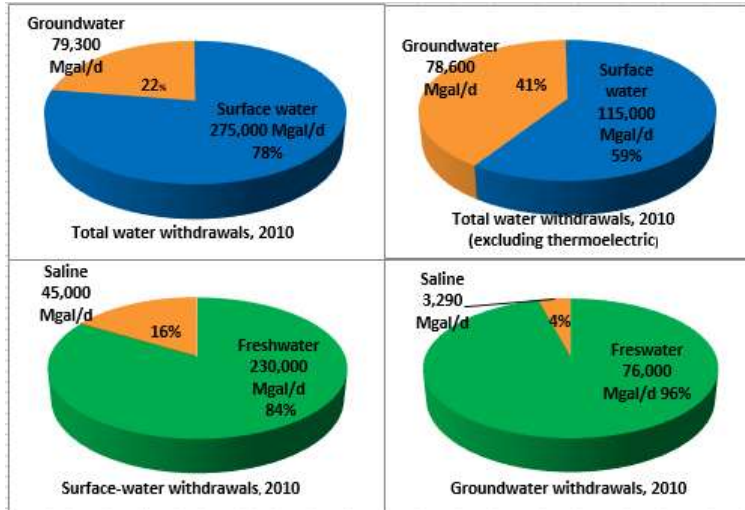


Source EEA

The use of water by agriculture is especially high in southern countries. It leads to a strong decrease of water volume within the rivers and thus to poor habitat for fish and invertebrates.

The use of water by humans

- Water withdrawal at the global scale

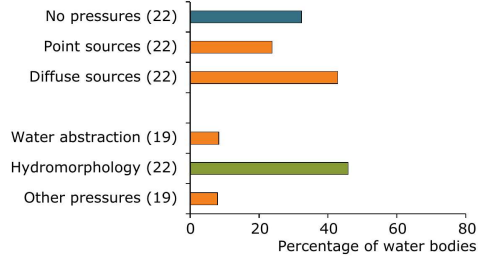


Source USGS

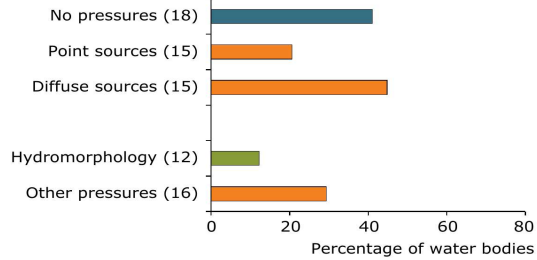
This slide shows the amount of water that is used by humanity with and without water used for cooling thermal powerplants

Synthesis of water pressures in Europe

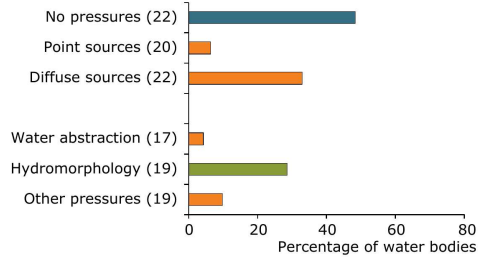
Rivers pressures



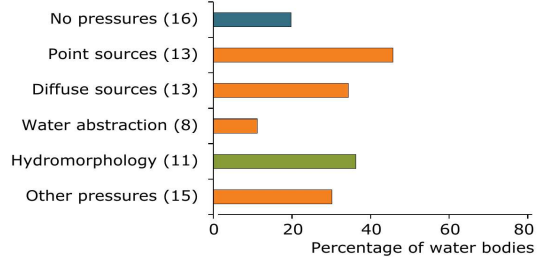
Coastal pressures



Lakes pressures



Transitional pressures



Source EEA

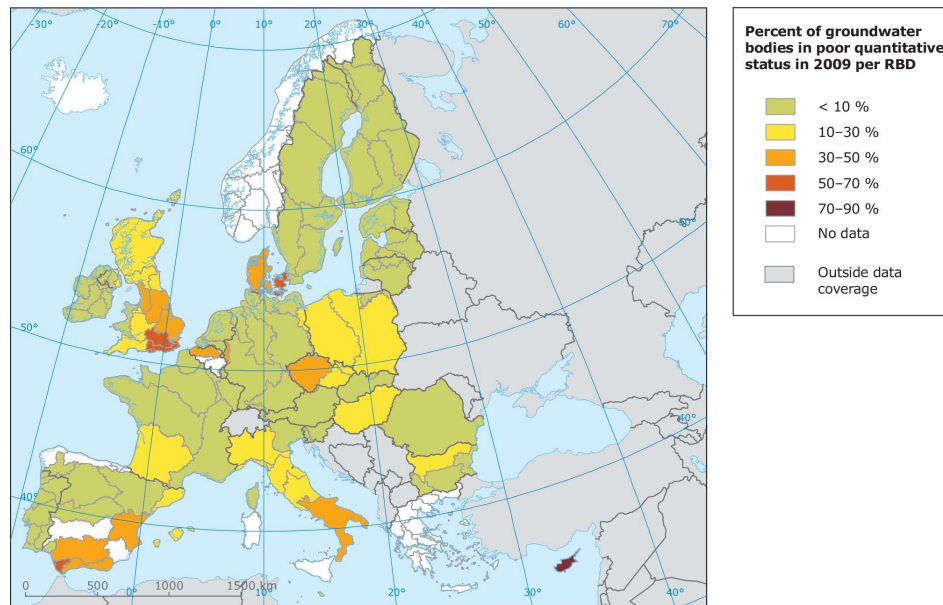
Self explaining slide summarizing the pressures on waters, the next part of the presentation will examine the effects observed linked to these pressures

Are European waters in good health?

- The answer is clearly no!
 - *More than half of the surface water bodies in Europe are reported to be in less than good ecological status or potential.*
 - *Diffuse pollution from agriculture is a significant pressure in more than 40 % of Europe's water bodies in rivers and coastal waters.*
 - *Poor chemical status for groundwater, by area, is about 25 % across Europe. [...] this figure exceeds 50 % in four Member States.*
- However there are some good trends
 - *During the last 25 years, significant progress has been made in numerous European waters in reducing the pollution.*
- Reporting problems:
 - *EEA 2012 : "Improved knowledge, but ambiguous results due to data gaps and methodology issues"*

Source: EEA Report No 8/2012 European waters — assessment of status and pressures

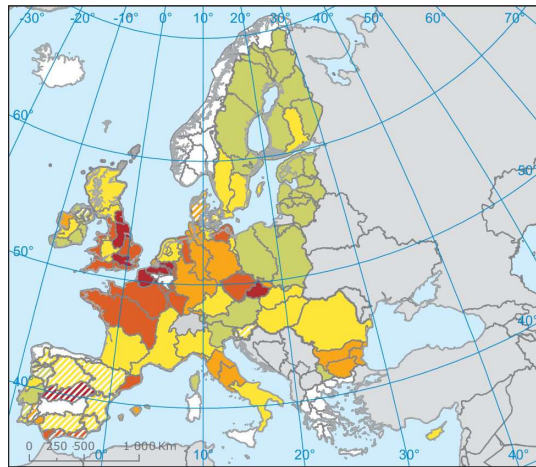
Groundwater scarcity



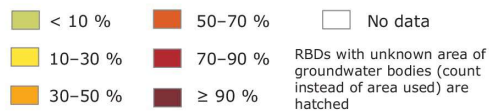
Source EEA

This map shows that some european areas suffer from water scarcity. This is not only true for southern countries.

Poor quality of groundwaters



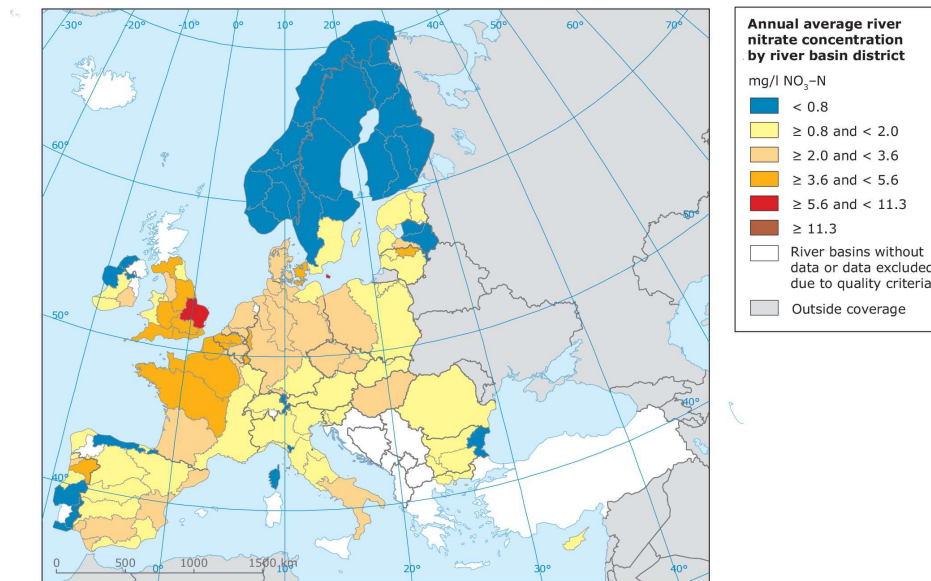
Percent of classified groundwater bodies with poor chemical status



Source EEA

Groundwater quality is poor, mainly in all the historically industrialized parts of Europe

Nitrates in European waters

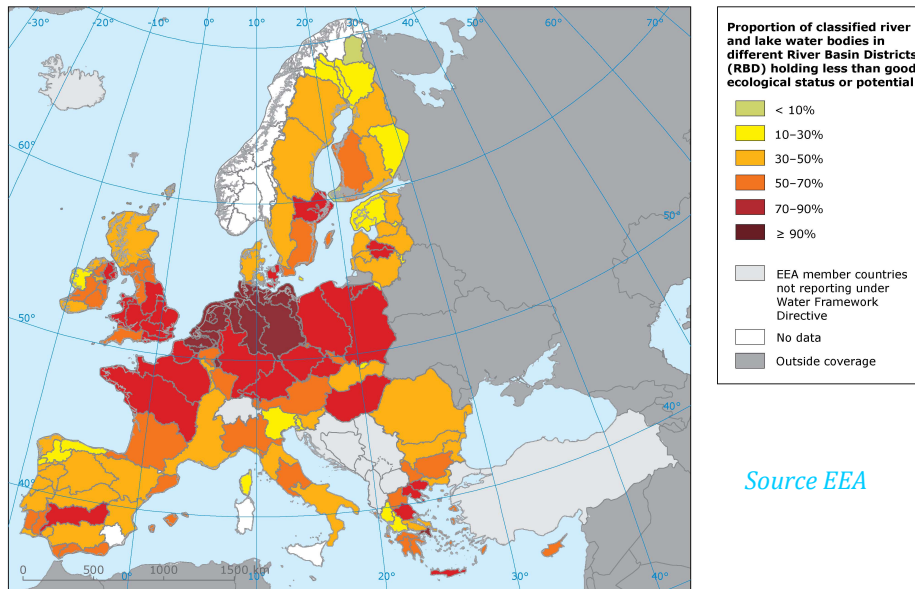


Source EEA

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Nitrates are in excess almost everywhere in Europe with the exception of Scandinavia.

Freshwaters good ecological status objective far from being reached

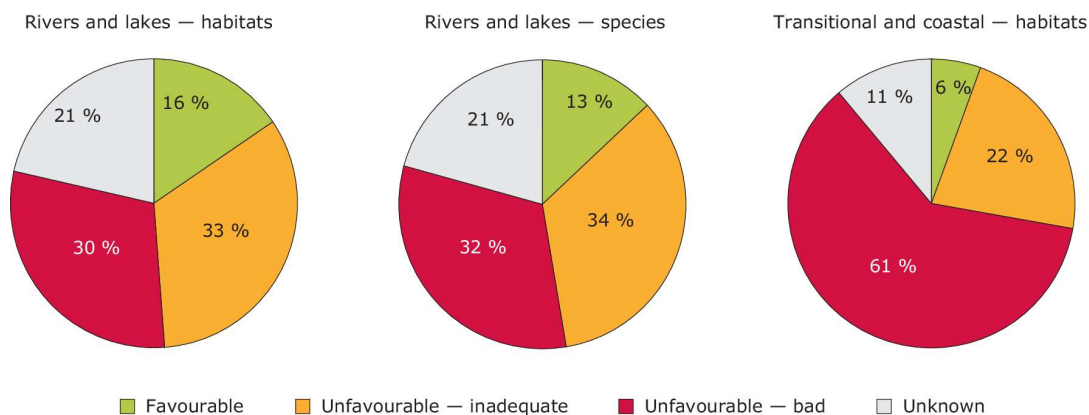


Source EEA



The good ecological status, which was a target for all European countries for 2015 according to the water framework directive is very far from being reached.

Habitat and species are rarely in favourable situation

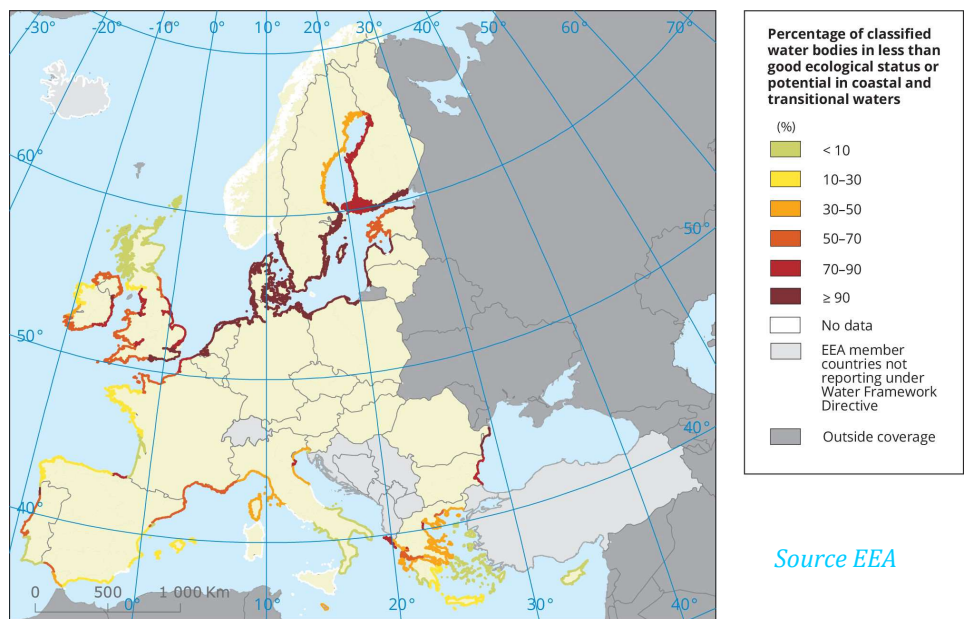


Source EEA



All water bodies suffer from habitat and species unfavourable situations

Coastal and transitional waters also far from the 2015 objective

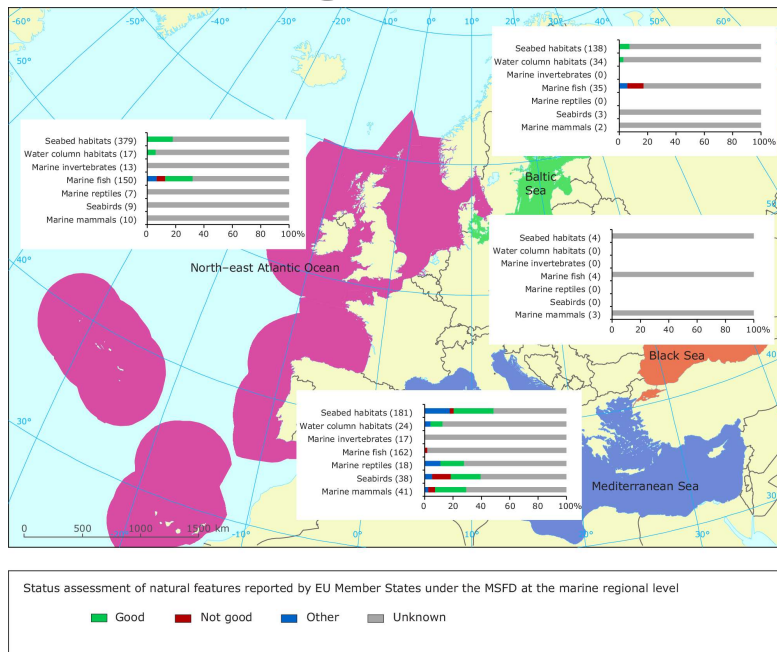


Source EEA



The same situation can be seen when dealing with coastal and transitional waters

Marine waters : few reports and bad status with regard to the MSFD

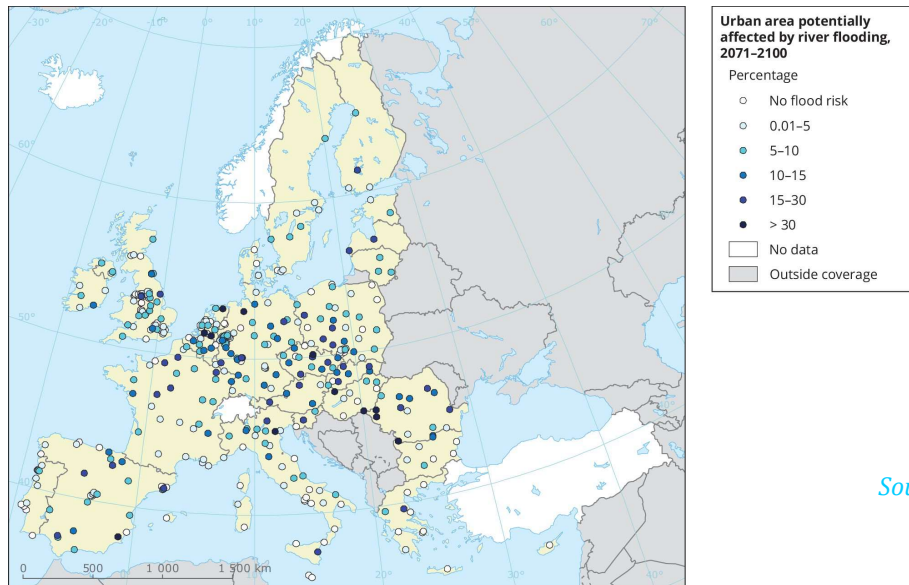


Source EEA



It is too soon to make a precise idea of the situation of European marine waters with regard to the marine strategy framework directive which expect all marine water to reach good ecological status by 2021.

River flooding risk in urban areas by the end of XXIst century



Source EEA



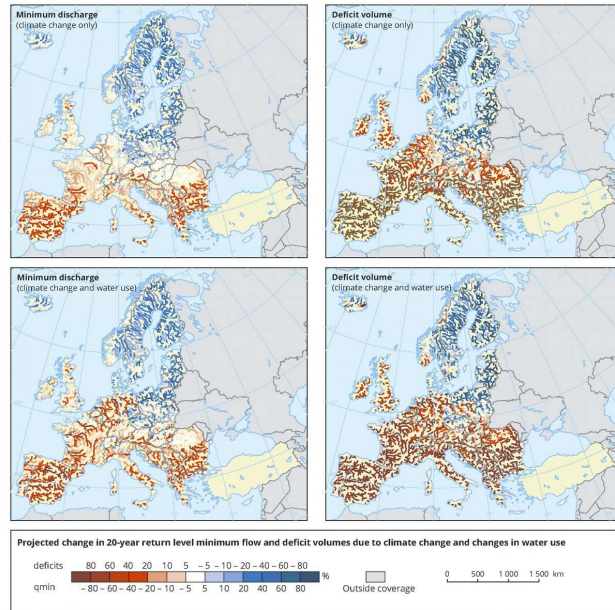
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Projections of the effects of climate change on flooding risk shows that there is some concern in most European cities. It is therefore very important to promote a better management of river habitat to promote storage of waters upstream together with better hydromorphology as it was presented on [slide 25](#).

Drought in the future

- Anticipated increase of drought linked to climate change and increase of water use

Source EEA



Another anticipated effect of climate change is drought. The graphs show the anticipated change at the end of our century showing that water use combined with climate change is deleterious everywhere except Scandinavia.

Ways to protects waters

- Limitation or avoidance of the threats
 - Regulation of human practices (REACH, Pesticides, Nitrates, WW treatment...)
 - Impact assessment and the (Avoid, reduce, compensate) set of measures
 - Eco-taxation
- Water quality objectives
 - Based on quantitative measurable parameters
 - Based on ecology of aquatic ecosystems
- Approach at the socio-ecosystem level
 - Management at the catchment level
 - Involvement of communities in the protection of waters that matter for them
 - Awareness of threats, ecological status and development of local solutions

Waters belong to a global set of interactions

- The water cycle is closely linked to climate and climate change
- Waters interact with soils
 - Soils preservation is the weak point of European environmental policy
 - Soil degradation is a very slow pernicious process
- Waters interact with land use
 - Channelization reduce the carrying capacity for live
 - Littoral protection policies versus coastal urbanisation is a major issue
- Waters interact with energy production
 - Cooling of thermal production
 - Hydroelectricity
 - Marine energies

General conclusion

- Water policy is a very large subject that should be considered in a wide set of environmental interactions
- WFD is quite a revolution since it is based on ecological status
- Despite significant decrease of the pressures there is still a concern about European waters (quantity, quality, hydromorphology)
- Problems occur in continental, coastal and marine waters
- A strong cooperation between science, making and justice is needed