

Orientation for the week

**”Water and Environmental
Quality”**

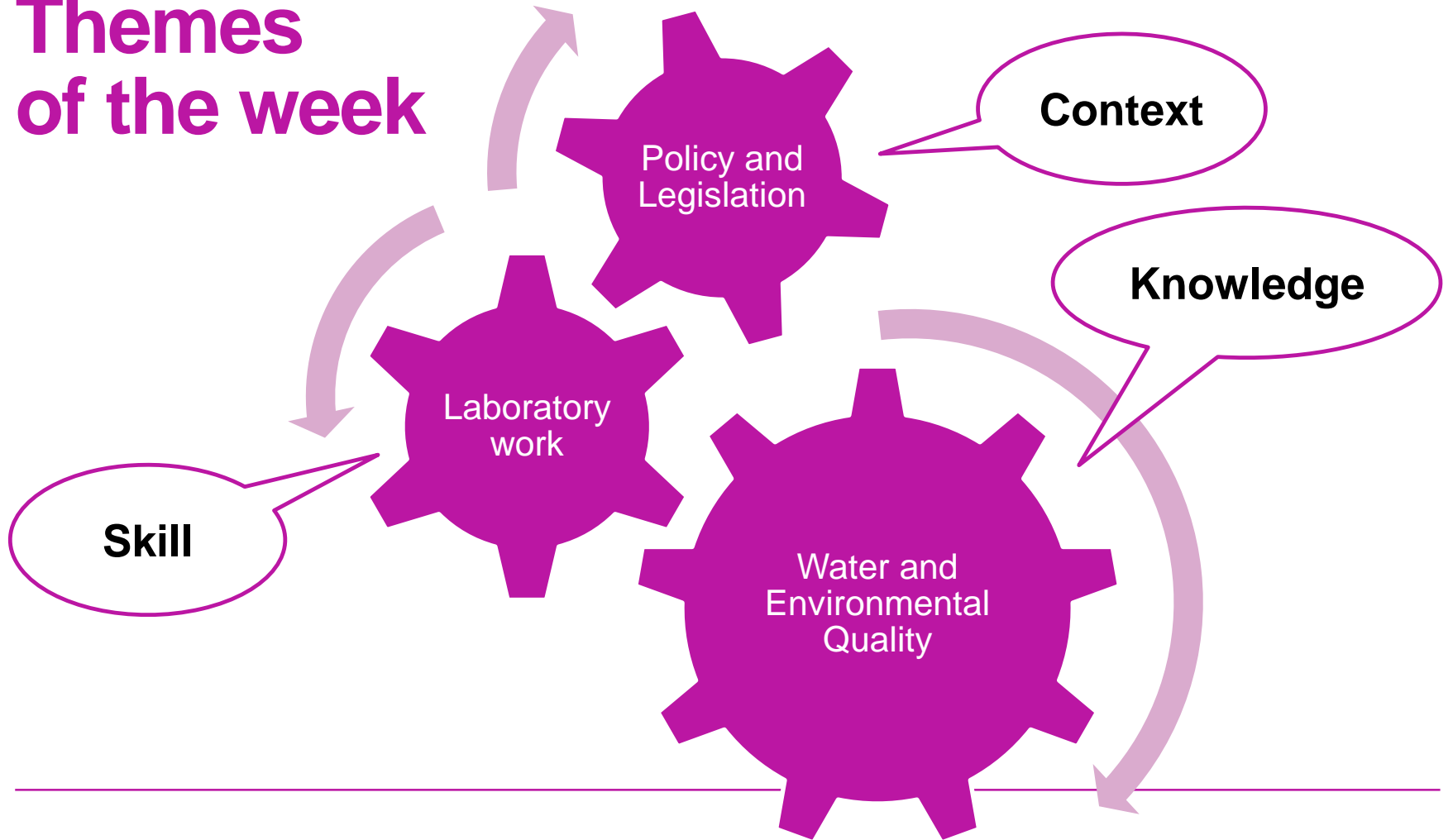
Prof. Riku Vahala

Learning objectives of the week

After the completion of the week the student

- Is able to identify the broader societal context relevant to water and environmental engineering, including key institutional, **legal** and economic aspects [*knowledge*]
- Understands the **key principles of good environmental and water quality**, including the relevant chemical, biological and limnological processes **and their measurement** [*knowledge*]
- Can apply basic water and environmental measurement methods and related **basic analyses in the laboratory** [*skill*]

Themes of the week



Knowledge

Water and Environmental Quality

Material to be used in the essay

Lectures & lecture material

Reading material in My Courses (you need to be in Aalto's network in order to access the e-books):

- Day, J. & Dallas, H.: Understanding the basics of water quality. In Grafton, R.Q. & Hussey, K.: Water resources planning and management, Cambridge University Press 2011 (Chapter 4, pp. 68-89).
- Sullivan, C.A. & O'Keeffe, J.: Water, biodiversity and ecosystems: reducing our impact. In Grafton, R.Q. & Hussey, K.: Water resources planning and management, Cambridge University Press 2011 (Chapter 6, pp. 117-130).
- Almasri, M.N. & Kaluarachchi, J.J.: Groundwater quality: Fate and transport of contaminants (NOTE: read only pages 36-44). In Aral, M.M & Taylor, S.W.: Groundwater quality and quantity management, American Society of Civil Engineers 2011 (Chapter 3, pp. 36-44).

(You can refer to lab exercises on Tue-Thu if you wish, but this is not obligatory)

→ Essay assignment supports you to gather the essential knowledge and to reflect on that with your future profession as an engineer → achieving the week's learning outcomes

Essay = Home exam (DL 21.10 @ 23.00)

Write an essay on the following subject:

Contributing to a good environmental and water quality as a WAT engineer

- **The essay should be based on the lectures and lecture material on Monday, and on the given three book chapters (remember to refer to your sources adequately!).**
- **The essay ought to be max four pages (excluding list of references) with 25mm marginal, 12pt font and a line spacing of 1.5.**
- **Submit the essay (as .doc or .pdf) through Turnitin-submission box in MyCourses.**

Your essay could answer e.g. to the following questions:

- How to define a good environmental and water quality?
- What affects good environmental and water quality?
- What kind of consequences contamination may cause?
- What are the key institutional, legal and economic aspects that relate to managing environmental and water quality?
- Identification of different disciplines that are connected to managing good environmental and water quality;
- Reflection to own professional performance and future requirements that relate to contributing to environmental and water quality management.

Grading of the Essay is based on the following rubrics :

1. = Able to identify and list a very limited number of points. No evidence of using these points to provide reasoning to why and how they are interrelated. Very limited use of given reference material. The essay as a whole reflects a very limited level of understanding of the learning outcomes for the week.
 2. = Able to identify and briefly write about limited points. Very little evidence of using these points to provide reasoning to why and how they are interrelated. Very little or no evidence on causalities or consequences. Very limited use of given reference material. The essay as a whole reflects a limited level of understanding of the learning outcomes for the week.
 3. = Able to identify a number of relevant points with some details. Using these points to provide a fair reasoning or causality. No evidence of a comprehensive overview of reasoning, interrelations, causalities or consequences. Limited use of given reference material. The essay as a whole reflects a good level of understanding of the learning outcomes for the week.
 4. = Able to identify a full range of relevant points with details, supported by good use of given reference material. Points are organized to provide a comprehensive and cohesive reasoning or causality. Able to give an example of an own professional requirement related to current reasoning. The essay as a whole reflects a good level of mastering the learning outcomes for the week.
 5. = Able to identify a full range of relevant points with details, supported by good use of given reference material. Points are organized to provide a comprehensive and cohesive reasoning or evidence on causalities and consequences. Able to link current reasoning to own professional performance and future requirements. The essay as a whole reflects an excellent level of mastering the learning outcomes for the week.
-

Skill

Laboratory Work

Laboratory report (DL 21.10 @ midnight)

Each group has been signed with one mystery water sample. Through a series of different quality analyses, each group is supposed to discover which sample they are working with. The analyses conducted are presented in the Laboratory Analyses –printout (see MyCourses). Please familiarize yourselves with the analysis prior to the session, this will significantly facilitate and speed up the session for everyone. If you come unprepared, it is very easy to forget everything you have done quickly.

All groups are to return the laboratory report by 21.10 @ midnight. More information on the laboratory report, the content and instructions will be given during the laboratory exercise.

Laboratory safety exam

NOTE! In order to be able to participate in the laboratory analysis, you have to have passed the Laboratory Safety Exam.

All the groups should inform Gaurav, who will attend the laboratory exercises in person and who will attend in Zoom.

Any feedback about the exam?

Context

Policy and Legislation

Context

In your laboratory report, try to assess, whether your water is suitable for bathing according to the European Bathing Water Directive? Is it safe to drink according to Drinking Water Directive? Is the water body achieving “good status” according to the Water Framework Directive? If not, why?

Timetable

Monday

09.00: Orientation for Water & Environmental Week, Riku Vahala

10.00: Two examples of environmental pollution:

- Emerging micropollutants in wastewater treatment, Dr. Antonina Kruglova
- Pollution in the Baltic Sea, Aino Ahvo, Finnish Environment Institute

Afternoon individual reading for the home exam.

Tuesday

09:00-10:00 Introduction of the laboratory work (Group 6 in water building)

10:00 - 12:30 Group 6

13:30 - 16:00 Group 5

Wednesday

09:00 - 11:30 Group 4

12:30 - 15:00 Group 3

Thursday

09:00 - 11:30 Group 2

12:30 - 15:00 Group 1

Friday

13.00-16.00 Wrap-up session (Presentation of each group's mystery water. Present the results and the basis for your conclusions. 10 minutes each group.)

What kind of waters can you identify?

For example: Drinking water

What characteristics do you consider important in them?

One does not get sick and,...

Which quality parameters describe the important characteristics in water

For example:

Indicators such as E.coli and enterococci are used to assess the absence of pathogens in drinking water.

How would you control that the quality is maintained over the time?

For example:

- In EU, directive for water intended for human consumption sets the sampling frequency of tap water for E.coli and enterococci
- Water supplier manages the risks continuously by WHO's Water Safety Plan approach, which is externally audited

...

Example: Parameters in drinking water directive

Microbiological parameters

- Enterococci and E.coli

Chemical parameters

- Acrylamid, antimony, arsenic,..

Indicator parameters

- Aluminium, ammonium, chloride,...

Radioactivity

=> Totally 48 parameters

(COUNCIL DIRECTIVE
98/83/EC of 3 November 1998
on the quality of water intended
for human consumption)

Some relevant European directives

Bathing Water Directive:

- Directive 2006/7/EC of the European Parliament and of the Council of 15 February 2006 concerning the management of bathing water quality and repealing Directive 76/160/EEC

Drinking Water Directive:

- Council Directive 98/83/EC of 3 November 1998 on the quality of water intended for human consumption

Water Framework Directive:

- Directive 2000/60/EC of the European Parliament and of the Council of 23 October 2000 establishing a framework for Community action in the field of water policy

Bathing Water Directive

CHAPTER I GENERAL PROVISIONS

Article 1

Purpose and scope

1. This Directive lays down provisions for:
 - (a) the monitoring and classification of bathing water quality;
 - (b) the management of bathing water quality; and
 - (c) the provision of information to the public on bathing water quality.
2. The purpose of this Directive is to preserve, protect and improve the quality of the environment and to protect human health by complementing Directive 2000/60/EC.

Bathing Water Directive

CHAPTER II QUALITY AND MANAGEMENT OF BATHING WATER

Article 3

Monitoring

1. Member States shall annually identify all bathing waters and define the length of the bathing season. They shall do so for the first time before the start of the first bathing season after 24 March 2008.
2. Member States shall ensure that monitoring of the parameters set out in Annex I, column A, takes place in accordance with Annex IV.
3. The monitoring point shall be the location within the bathing water where:
 - (a) most bathers are expected; or
 - (b) the greatest risk of pollution is expected, according to the bathing water profile.

ANNEX I

For inland waters

	A	B	C	D	E
	Parameter	Excellent quality	Good quality	Sufficient	Reference methods of analysis
1	Intestinal enterococci (cfu/100 ml)	200 (↻)	400 (↻)	330 (↻)	ISO 7899-1 or ISO 7899-2
2	Escherichia coli (cfu/100 ml)	500 (↻)	1 000 (↻)	900 (↻)	ISO 9308-3 or ISO 9308-1

For coastal waters and transitional waters

	A	B	C	D	E
	Parameter	Excellent quality	Good quality	Sufficient	Reference methods of analysis
1	Intestinal enterococci (cfu/100 ml)	100 (↻)	200 (↻)	185 (↻)	ISO 7899-1 or ISO 7899-2
2	Escherichia coli (cfu/100 ml)	250 (↻)	500 (↻)	500 (↻)	ISO 9308-3 or ISO 9308-1

Bathing water <https://www.eea.europa.eu>

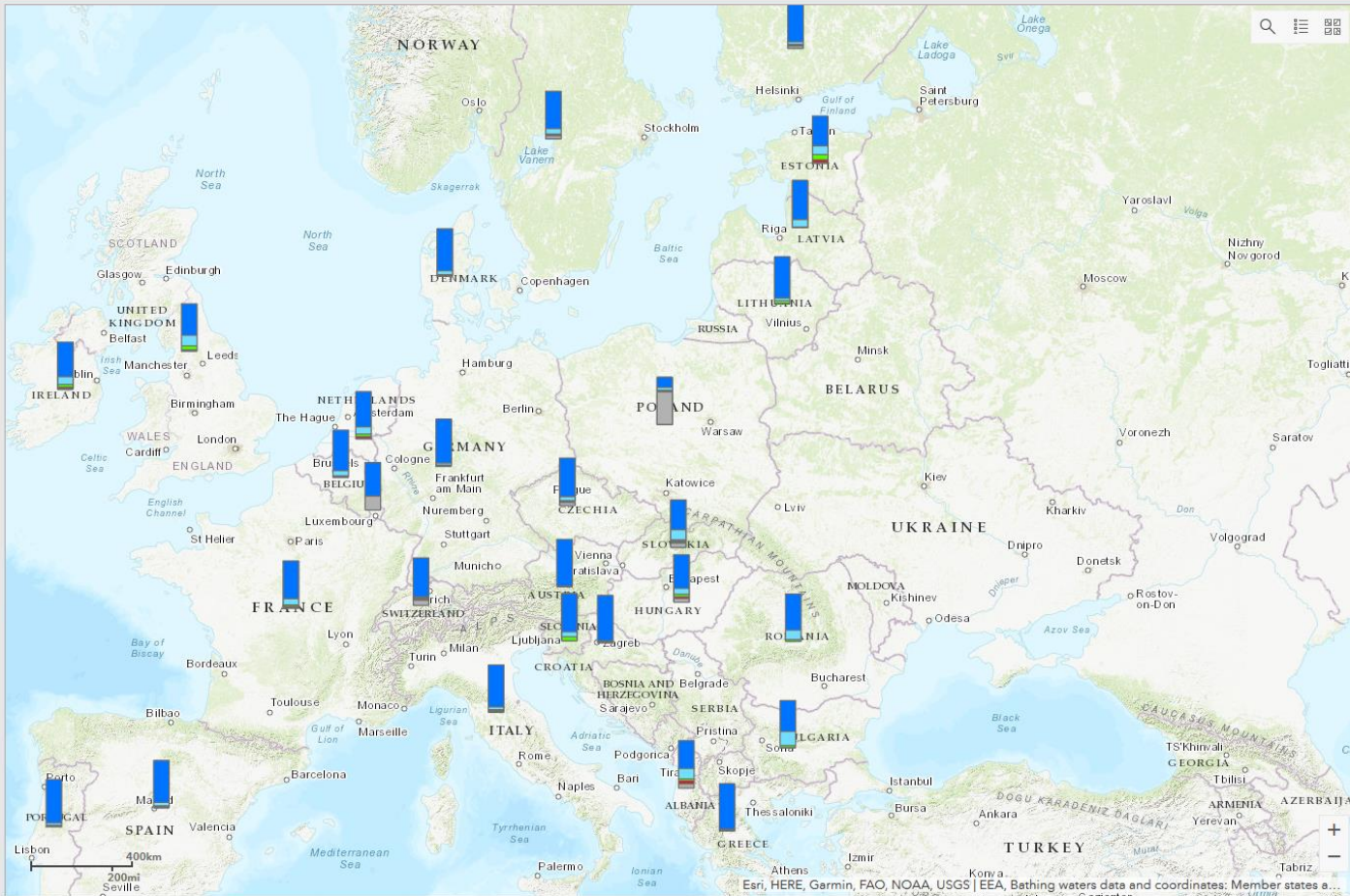


European Environment Agency

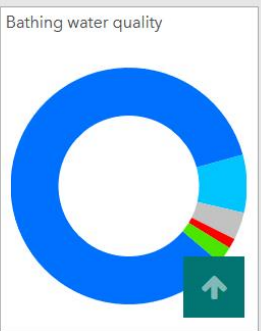
State of bathing waters in 2019

Water type **All** Coastal Lake River Transitional

- Albania
- Austria
- Belgium
- Bulgaria
- Croatia
- Cyprus
- Czechia
- Denmark
- Estonia
- Finland
- France
- Germany
- Greece
- Hungary
- Ireland
- Italy
- Latvia
- Lithuania
- Luxembourg
- Malta
- Netherlands
- Poland



Number of bathing waters
22,295



Drinking Water Directive

Article 1 Objective

1. This Directive concerns the quality of water intended for human consumption.
2. The objective of this Directive shall be to protect human health from the adverse effects of any contamination of water intended for human consumption by ensuring that it is wholesome and clean.
 -
 - (a) is free from any micro-organisms and parasites and from any substances which, in numbers or concentrations, constitute a potential danger to human health, and
 - (b) meets the minimum requirements set out in Annex I, Parts A and B;

New directive is expected to come into force in late 2020

https://ec.europa.eu/environment/water/water-drink/review_en.html

Drinking Water Directive

Volume of water distributed or produced each day within a supply zone (Notes 1 and 2) m ³	Check monitoring number of samples per year (Notes 3, 4 and 5)	Audit monitoring number of samples per year (Notes 3 and 5)
≤ 100	(Note 6)	(Note 6)
> 100 ≤ 1 000	4	1
> 1 000 ≤ 10 000	4 + 3 for each 1 000 m ³ /d and part thereof of the total volume	1 + 1 for each 3 300 m ³ /d and part thereof of the total volume
> 10 000 ≤ 100 000		3 + 1 for each 10 000 m ³ /d and part thereof of the total volume
> 100 000		10 + 1 for each 25 000 m ³ /d and part thereof of the total volume

Article 7 Monitoring

1. Member States shall take all measures necessary to ensure that regular monitoring of the quality of water intended for human consumption is carried out, in order to check that the water available to consumers meets the requirements of this Directive and in particular the parametric values set in accordance with Article 5. Samples should be taken so that they are representative of the quality of the water consumed throughout the year. In addition, Member States shall take all measures necessary to ensure that, where disinfection forms part of the preparation or distribution of water intended for human consumption, the efficiency of the disinfection treatment applied is verified, and that any contamination from disinfection by-products is kept as low as possible without compromising the disinfection.

2. To meet the obligations imposed in paragraph 1, appropriate monitoring programmes shall be established by the competent authorities for all water intended for human consumption. Those monitoring programmes shall meet the minimum requirements set out in Annex II.

ANNEX I

PARAMETERS AND PARAMETRIC VALUES

PART A

Microbiological parameters

Parameter	Parametric value (number/100 ml)
<i>Escherichia coli</i> (<i>E. coli</i>)	0
Enterococci	0

The following applies to water offered for sale in bottles or containers:

Parameter	Parametric value
<i>Escherichia coli</i> (<i>E. coli</i>)	0/250 ml
Enterococci	0/250 ml
<i>Pseudomonas aeruginosa</i>	0/250 ml
Colony count 22 °C	100/ml
Colony count 37 °C	20/ml

PART B
Chemical parameters

Parameter	Parametric value	Unit	Notes
Acrylamide	0,10	µg/l	Note 1
Antimony	5,0	µg/l	
Arsenic	10	µg/l	
Benzene	1,0	µg/l	
Benzo(a)pyrene	0,010	µg/l	
Boron	1,0	mg/l	
Bromate	10	µg/l	Note 2
Cadmium	5,0	µg/l	
Chromium	50	µg/l	
Copper	2,0	mg/l	Note 3
Cyanide	50	µg/l	
1,2-dichloroethane	3,0	µg/l	
Epichlorohydrin	0,10	µg/l	Note 1
Fluoride	1,5	mg/l	
Lead	10	µg/l	Notes 3 and 4
Mercury	1,0	µg/l	
Nickel	20	µg/l	Note 3
Nitrate	50	mg/l	Note 5
Nitrite	0,50	mg/l	Note 5
Pesticides	0,10	µg/l	Notes 6 and 7
Pesticides – Total	0,50	µg/l	Notes 6 and 8
Polycyclic aromatic hydrocarbons	0,10	µg/l	Sum of concentrations of specified compounds; Note 9
Selenium	10	µg/l	
Tetrachloroethene and Trichloroethene	10	µg/l	Sum of concentrations of specified parameters
Trihalomethanes – Total	100	µg/l	Sum of concentrations of specified compounds; Note 10
Vinyl chloride	0,50	µg/l	Note 1

Compliance rates at national level in the Member States (2011-2013)

	Microbiological parameters	Chemical parameters	Indicator parameters*				
Austria	99,84	99,9	99,6	Lithuania	100	99,3	99
Belgium	99,75	99,9	99,1	Luxembourg	99,77	100	99,5
Bulgaria	99,25	99,5	99,3	Latvia	99,92	100	98,7
Cyprus	99,01	99,9	96,3	Malta	100	99,9	90,1
Czech R.	99,91	99,9	99,2	the Netherlands	99,97	100	100
Germany	99,88	99,9	99,7	Poland	100	100	99,8
Denmark	99,8	99,8	98,6	Portugal	99,57	99,9	99,3
Estonia	99,99	99,8	99,1	Romania	99,69	99,7	99,2
Spain	99,62	99,8	99,4	Sweden	99,94	100	99,1
Finland	100	99,9	99,6	Slovenia	99,25	100	98,7
France	99,84	99,8	99,4	Slovakia	99,52	100	99,4
Greece	99,64	99,9	99,5	United Kingdom	99,98	99,9	99,9
Hungary	99,71	98,6	97,1	Source: European Commission, Drinking water reporting requirements and synthesis reports. pp. 12-13, Link to report *except odour, taste colour and turbidity			
Ireland	99,97	99,5	99,3				
Italy	99,2	99,6	99,6				

Water Framework Directive

Article 1

Purpose

The purpose of this Directive is to establish a framework for the protection of inland surface waters, transitional waters, coastal waters and groundwater which:

- (a) prevents further deterioration and protects and enhances the status of aquatic ecosystems and, with regard to their water needs, terrestrial ecosystems and wetlands directly depending on the aquatic ecosystems;
- (b) promotes sustainable water use based on a long-term protection of available water resources;
- (c) aims at enhanced protection and improvement of the aquatic environment, inter alia, through specific measures for the progressive reduction of discharges, emissions and losses of priority substances and the cessation or phasing-out of discharges, emissions and losses of the priority hazardous substances;
- (d) ensures the progressive reduction of pollution of groundwater and prevents its further pollution, and
- (e) contributes to mitigating the effects of floods and droughts

and thereby contributes to:

- the provision of the sufficient supply of good quality surface water and groundwater as needed for sustainable, balanced and equitable water use,
- a significant reduction in pollution of groundwater,
- the protection of territorial and marine waters, and

Article 4

Environmental objectives

1. In making operational the programmes of measures specified in the river basin management plans:

(a) for surface waters

(i) Member States shall implement the necessary measures to prevent deterioration of the status of all bodies of surface water, subject to the application of paragraphs 6 and 7 and without prejudice to paragraph 8;

(ii) Member States shall protect, enhance and restore all bodies of surface water, subject to the application of subparagraph (iii) for artificial and heavily modified bodies of water, with the aim of achieving good surface water status at the latest 15 years after the date of entry into force of this Directive, in accordance with the provisions laid down in Annex V, subject to the application of extensions determined in accordance with paragraph 4 and to the application of paragraphs 5, 6 and 7 without prejudice to paragraph 8;

(iii) Member States shall protect and enhance all artificial and heavily modified bodies of water, with the aim of achieving good ecological potential and good surface water chemical status at the latest 15 years from the date of entry into force of this Directive, in accordance with the provisions laid down in Annex V, subject to the application of extensions determined in accordance with paragraph 4 and to the application of paragraphs 5, 6 and 7 without prejudice to paragraph 8;

(iv) Member States shall implement the necessary measures in accordance with Article 16(1) and (8), with the aim of progressively reducing pollution from priority substances and ceasing or phasing out emissions, discharges and losses of priority hazardous substances

without prejudice to the relevant international agreements referred to in Article 1 for the parties concerned;

Water Framework Directive

1.2. Normative definitions of ecological status classifications

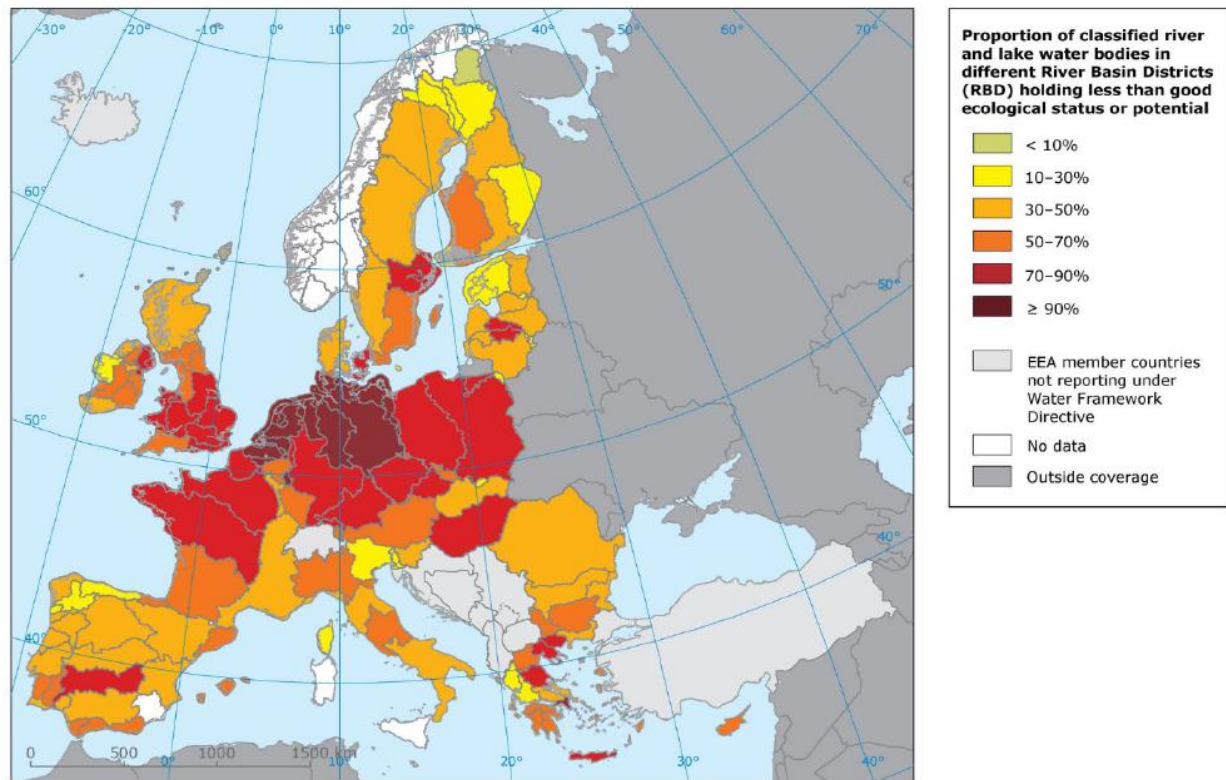
Table 1.2. General definition for rivers, lakes, transitional waters and coastal waters

The following text provides a general definition of ecological quality. For the purposes of classification the values for the quality elements of ecological status for each surface water category are those given in tables 1.2.1 to 1.2.4 below.

Element	High status	Good status	Moderate status
General	<p>There are no, or only very minor, anthropogenic alterations to the values of the physico-chemical and hydromorphological quality elements for the surface water body type from those normally associated with that type under undisturbed conditions.</p> <p>The values of the biological quality elements for the surface water body reflect those normally associated with that type under undisturbed conditions, and show no, or only very minor, evidence of distortion.</p> <p>These are the type-specific conditions and communities.</p>	<p>The values of the biological quality elements for the surface water body type show low levels of distortion resulting from human activity, but deviate only slightly from those normally associated with the surface water body type under undisturbed conditions.</p>	<p>The values of the biological quality elements for the surface water body type deviate moderately from those normally associated with the surface water body type under undisturbed conditions. The values show moderate signs of distortion resulting from human activity and are significantly more disturbed than under conditions of good status.</p>

Waters achieving a status below moderate shall be classified as poor or bad.

Proportion of classified river and lake water bodies in different River Basin Districts (RBD) holding less than good ecological status or potential



Related content

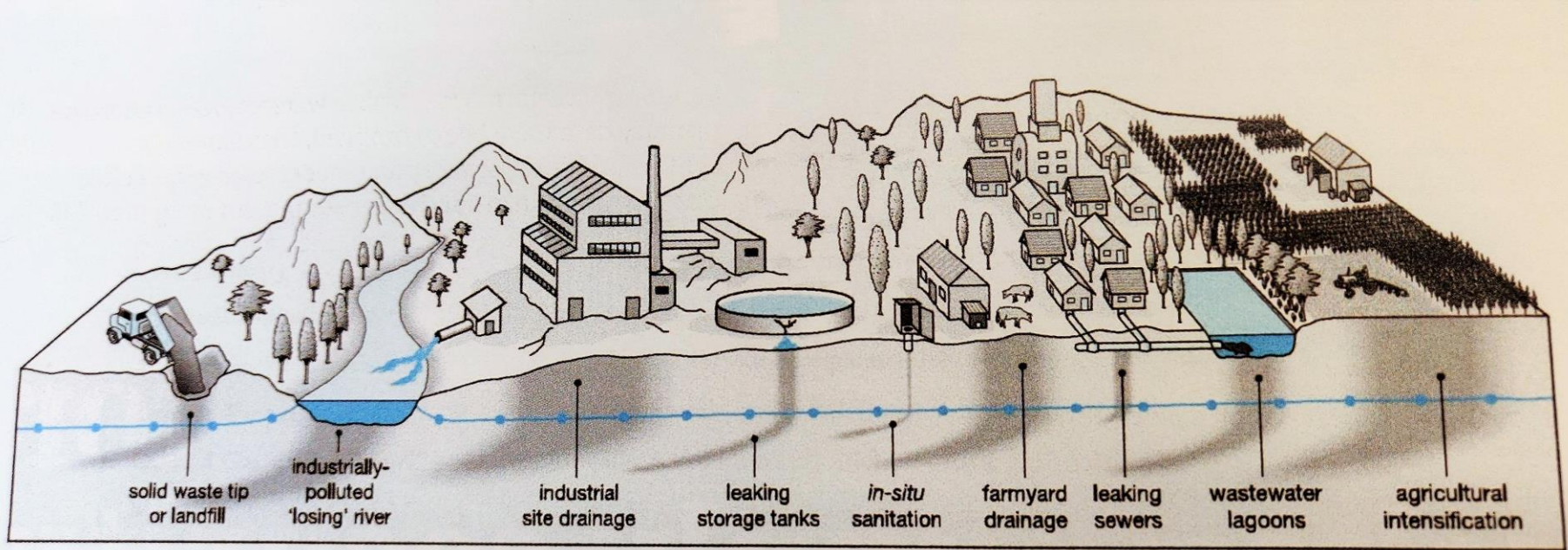
Industrial pollution to air, soil and water	Water quality and nutrient loading	Climate change impacts on ecosystems	Freshwater quality
Water pollution & related envi. health risks	Urban systems and grey infrastructure	Chemicals & related envi. health risks	Water use and water stress
			Ecol. status of freshwater bodies

Source: WISE WFD Database.

Other relevant directives

- **Dangerous Substances and its 'daughter' directives**
 - **Nitrates Directive**
 - **Freshwater Fisheries Directive**
 - **Urban Waste Water Treatment Directive**
 - **Directive on the Exchange of Information on the Quality of Surface Freshwaters**
 - **Protection of Groundwater Directive**
 - **Sewage Sludge Directive**
 - **Floods Directive**
 - **https://ec.europa.eu/environment/water/index_en.htm**
-

Land-use activities commonly causing groundwater pollution hazard



From: Source – The Magazine of
International Water Association, July 2020

Nitrates in groundwater

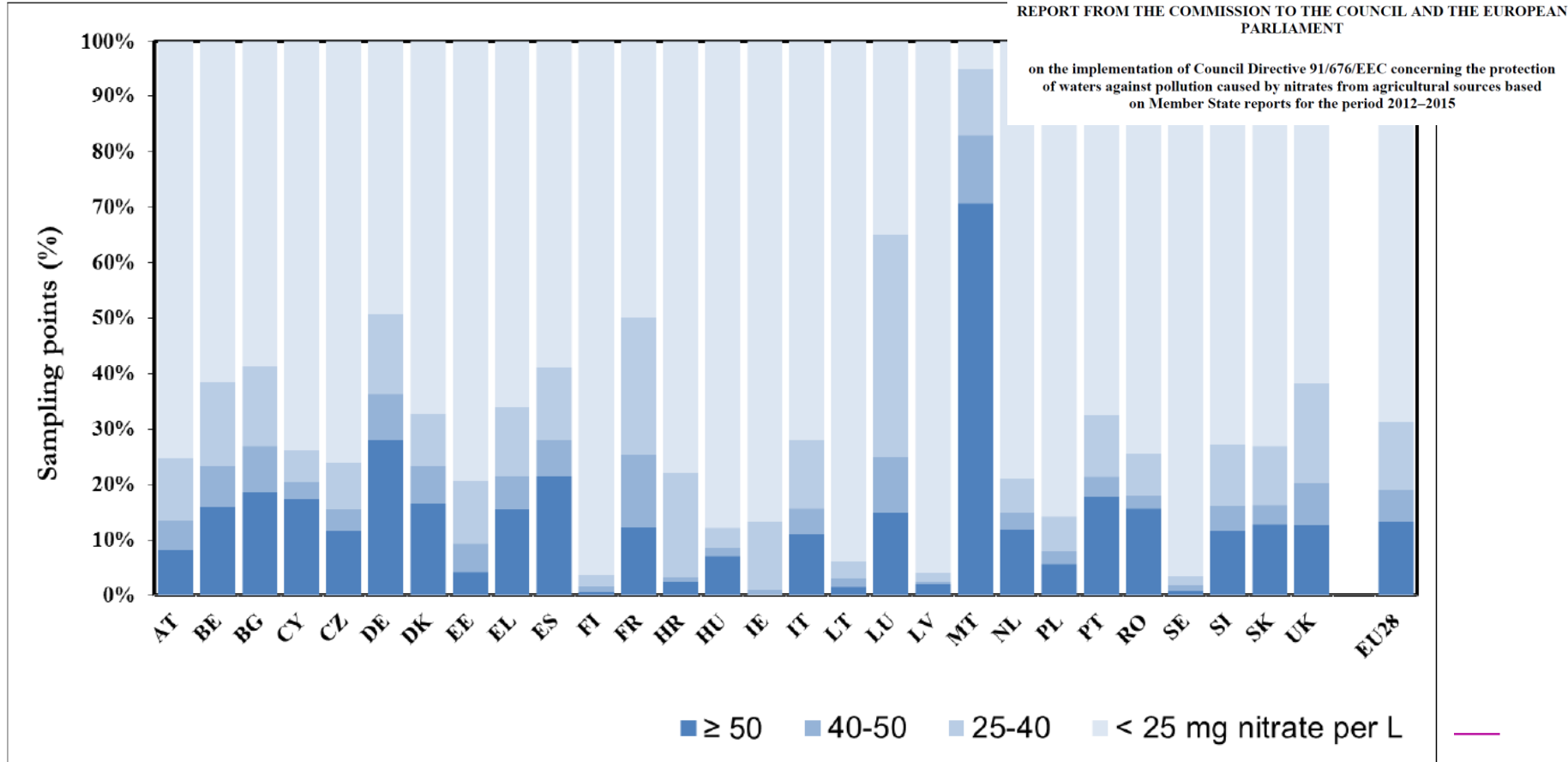


Figure A. Frequency diagram of annual average nitrate concentrations in groundwater²⁷. Results are presented for all groundwater stations at different depths.

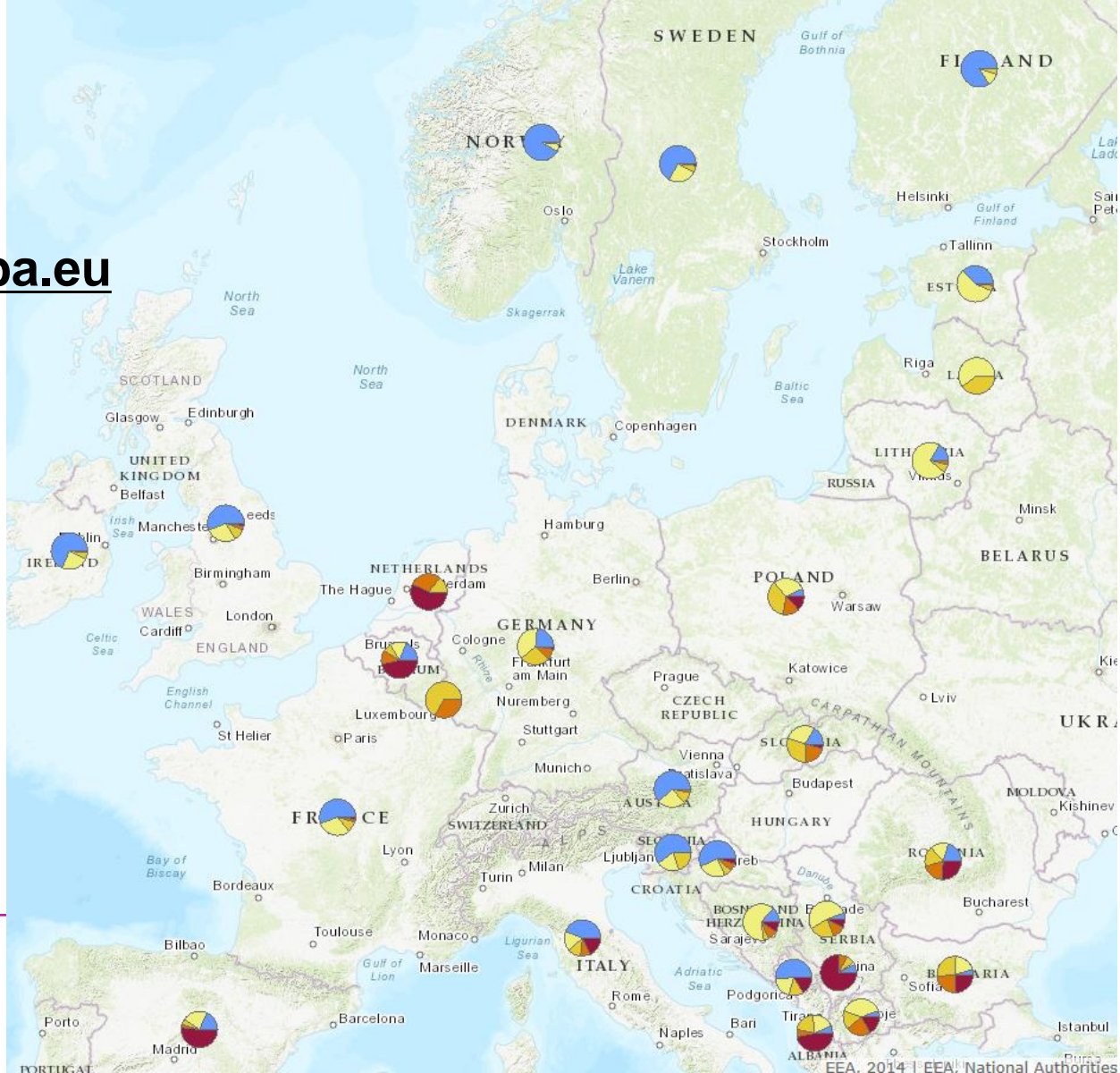
Ammonium in rivers

<https://www.eea.europa.eu/data-and-maps>

WISE SoE Ammonium in Rivers

Mean annual Total ammonium / Ammonium in rivers by country

- Class1: < 0.04 mg/l N
- Class2: $\geq 0.04 < 0.10$ mg/l N
- Class3: $\geq 0.10 < 0.20$ mg/l N
- Class4: $\geq 0.20 < 0.40$ mg/l N
- Class5: ≥ 0.40 mg/l N



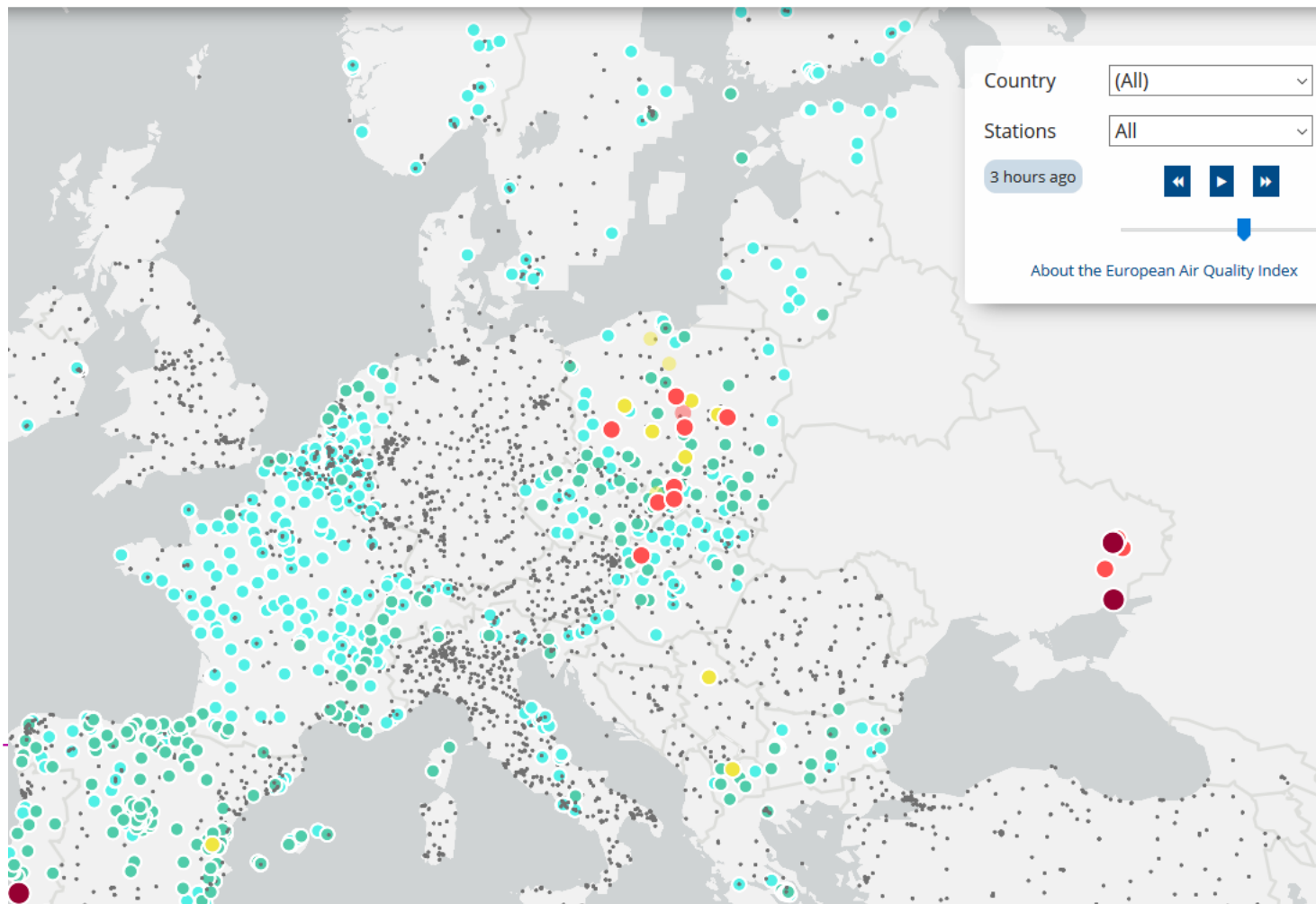
What about environment (soil, air etc.)?

Air quality

European Air Quality Index

<http://airindex.eea.europa.eu/>

2020-10-12 05:00 UTC+3



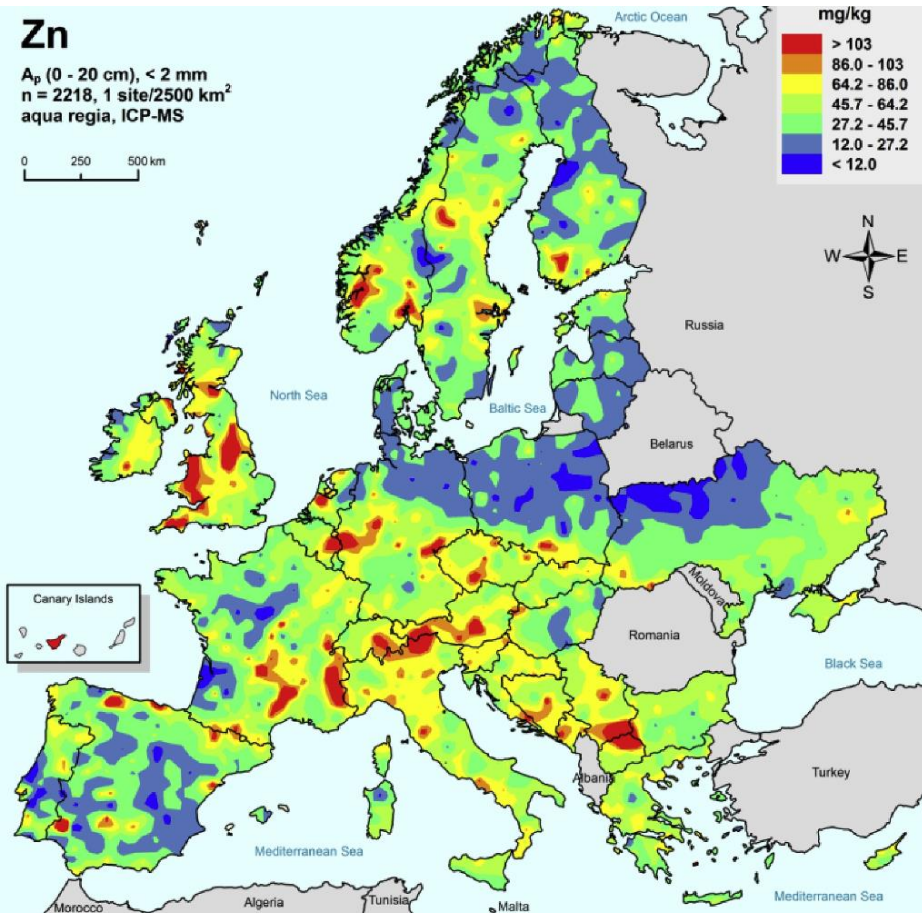
Air quality

- Good
- Fair
- Moderate
- Poor
- Very poor
- No data

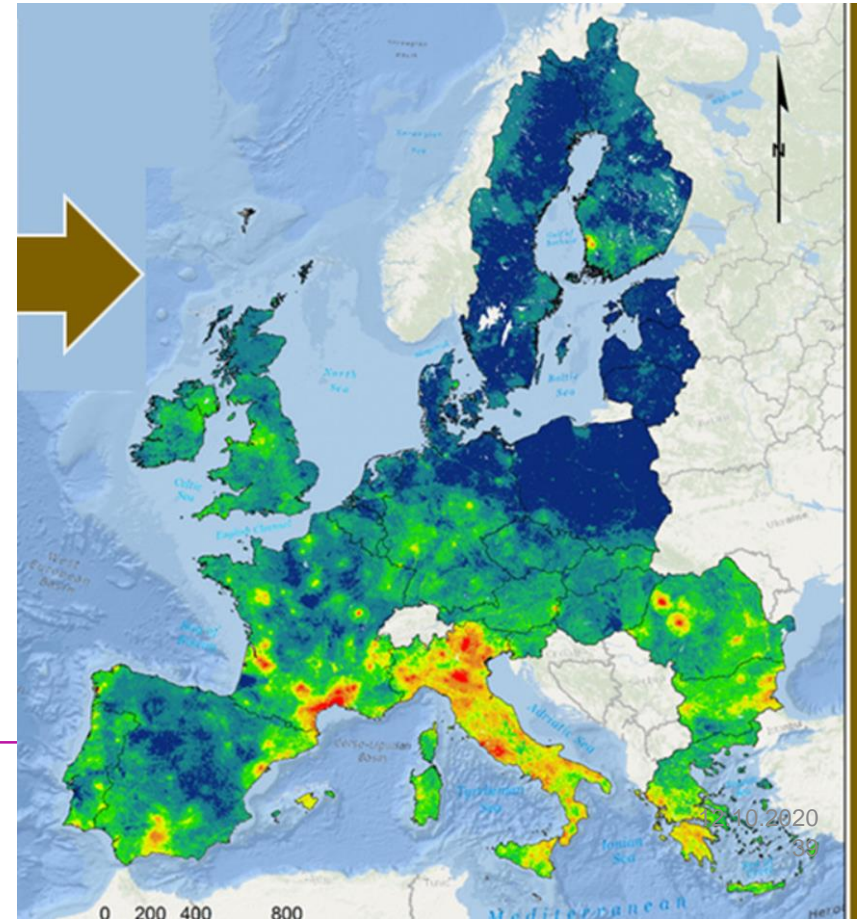
[Legend explained](#)

Soil quality

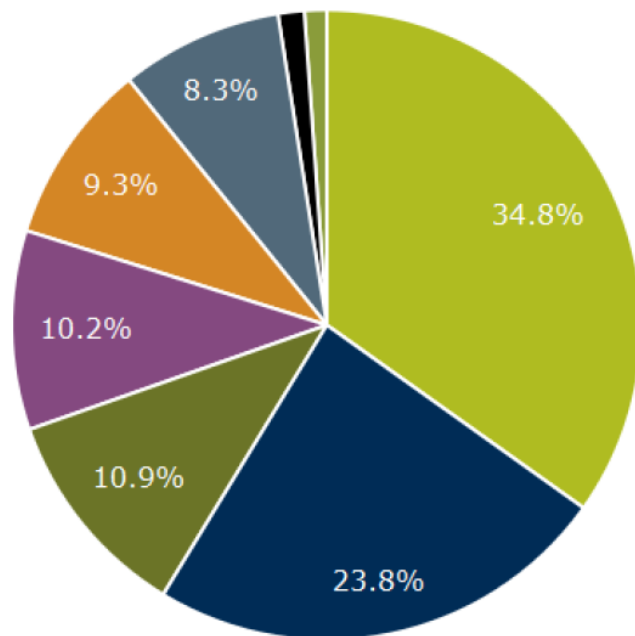
Zinc (Noulas et al., 2018)



Copper (Ballabio et al., 2018)



Contaminants affecting the solid matrix (soil, sludge, sediment) (2011)

SYNTHESIS
REPORTGLOBAL
MEGATRENDSEUROPEAN
BRIEFINGSCOUNTRY
COMPARISONSCOUNTRIES &
REGIONS

- Heavy metals
- Mineral oil
- Polycyclic aromatic hydrocarbons
- Aromatic hydrocarbons
- Others
- Chlorinated hydrocarbons
- Phenols
- Cyanides

Data sources: JRC. Eionet NRC Soil data collection on contaminated sites; EEA – Indicator LSI003

Related content

Industrial
pollution to air,
soil and water

Two examples of environmental pollution

Next speaker

Dr. Antonina Kruglova

Post-doctoral researcher, microbiologist

Together with increasing public awareness on the antibiotics resistance issue, her current research aims to provide new computational models and tools to assess preferable wastewater treatment strategy for controlling antibiotic resistance dissemination in cold regions.

