Introduction to "Water Resources Quality and Management in Baltic Sea Countries"

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Abstract This chapter introduces the book titled "**Water Resources Quality and Management in Baltic Sea Countries**" by presenting a summary of each chapter. The chapters are grouped into five themes to cover a variety of topics on water resources quality and management in Baltic countries including (Denmark, Sweden, Finland, Russia, Estonia, Latvia, Lithuania, Poland and Germany). Thirteen chapters are presented in this book. The subjects include characteristics of water bodies in Baltic countries, water resources and their Baltic Sea reliability and overview of publications. The volume also discusses groundwater quality, wetlands, and water contamination management.

Keywords Water resources · Management · Contaminant · Groundwater · Constructed wetlands · Water bodies · Baltic Sea countries · Latvia · Germany · Russia · Estonia · Water quality

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1 Background

The Baltic Sea is an extremely specific and unique body of water along which nine countries lie: Denmark, Sweden, Finland, Estonia, Lithuania, Latvia, Russia, Poland, and Germany. The location of these countries is shown in Fig. 1. All of these countries, except Russia, belong to the European Union. The unique nature of the Baltic Sea makes it particularly vulnerable to current changes. This volume discusses issues related to water resource management in the Baltic countries, which significantly affect the state and quality of water in the Baltic Sea.

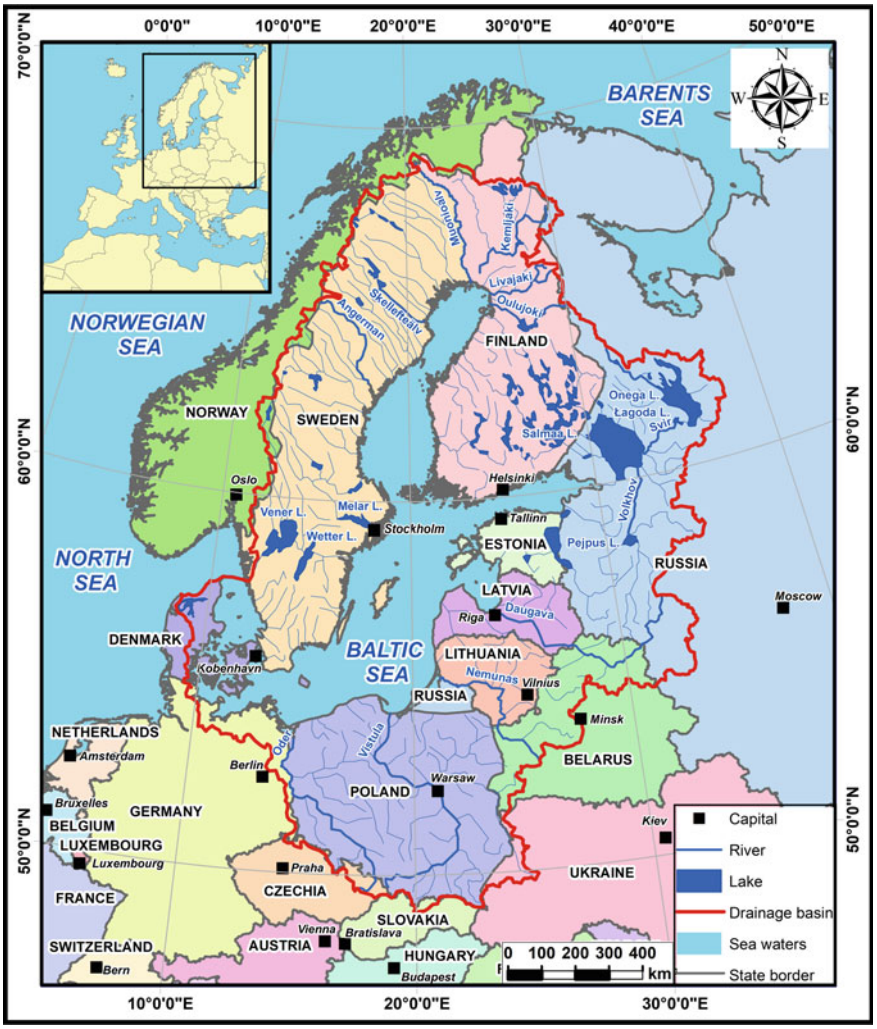

Fig. 1 The Baltic Sea region with political borders

The area of the Baltic Sea catchment is about four times larger than the surface of the sea. A comprehensive review of the state of water resources, quality and management in the countries of the Baltic Sea is made in Chaps. 2, 3 and 4. The remaining chapters discuss the management of water resources, their size and water quality, and management in individual countries (Russia, Niemcy, Estonia, Latvia, Lithuania).

In Chap. 2, the water bodies of the Baltic Sea countries are introduced while in Chap. 3, the basic information on water resources and their qualities and their related publication from Scopus and Web of Science are presented. These two chapters are introduced in Sect. 3.1.

Due to the importance of groundwater as freshwater for Baltic Sea countries, Chap. 4 (Sect. 3.2) discusses the quality of groundwater in Baltic countries.

Due to a large number of submitted qualified chapters from Poland scientists, authors and researchers, it was not possible to include them in this book and instead, two volumes on Water Resources in Poland covering all details of Polish water resources are being under production, Zeleňáková et al. [1, 2].

2 Themes of the Book

The book intends to address the following main themes in more detail:

- Overview of Water Bodies and Water Resources in Baltic Sea Countries
- Quality of Groundwater in Baltic Sea
- Water Quality and Wetlands in Latvia
- Potential Management of Water Contaminates in Germany
- Potential Stresses on Water Resources in Russia
- Estonian Water Resources.

3 Chapters' Summary

The next subsections present the main technical elements of each chapter under its related theme.

3.1 Overview of Water Bodies and Water Resources in Baltic Sea Countries

Two chapters are presented under this theme. The first one is titled "**Overview of the Water Bodies in the Baltic Sea Countries**". It used remote sensing to provide the audiences with information on the various aspects of the Baltic Sea to develop a

synthesis of the existing knowledge and add a new perspective on the water bodies in the Baltic Sea Countries. The authors focus on the following Baltic Sea issues: geography, development and history of the Baltic Sea, Eastern Baltic Sea dynamic coastline, Baltic Sea drainage basin, fragile ecosystem, Baltic Sea surface topography and its North Sea transition zone, general water types considered in Europe's Coastal Seas. Also, they discuss where the land is going up or the water is going down to understand the future Baltic Sea level rise and to enable different adaptation approach to climate change. Some of the problems facing the Baltic Sea are provided to highlight that they need solutions.

The second chapter is titled "**Overview of Water Resources, Quality, and Management in Baltic Sea Countries**". It provides an overview of the water status and features for the Baltic Sea countries. This objective is attained based on a systematic literature review method and an analysis of relevant documents and reports about the Baltic Sea Basin. Most information is collected from peer-reviewed journals available in the Web of Science, Scopus, and Google Scholar databases. Some recommendations that could be used to improve the Baltic Sea quality are considered. Lastly, a summary of the essential conclusions and perspectives for further researches is demonstrated.

The Baltic Sea region consists of 8 EU member states (Denmark, Poland, Germany, Finland, Sweden, Estonia, Latvia and Lithuania) and one non-EU member state (Russia). The economic condition of these countries is varied. The countries forming the European Union before the accession of new members in 2004 are Germany, Finland, Denmark, Sweden. Other countries: Poland, Lithuania, Latvia and Estonia joined the EU in 2004.

Surface water and groundwater resources differ widely among these countries due to the existence of various rivers, lakes, streams, dams, drains, reservoirs, and aquifers. Due to the importance of the resources of the Baltic Sea, numerous studies have recently been carried out to cover the Baltic countries' water status. According to the Scopus database, the total number of published documents using the research keywords "Water", "Baltic", and "Countries" was 140 during 2001–2010, which increased to 186 documents from 2011 to 2019. The documents were funded by the European Commission, Academy of Finland, California Environmental Protection Agency, Norges Forskningsråd, and other sponsors. The peer-reviewed and highly ranked international journals that handled these publications include Marine Pollution Bulletin, Agriculture Ecosystems Environment, Ambio, Hydrobiologia, Ecological Economics, and Water Science and Technology.

The Baltic countries have agreed on a number of international cooperation and European agreements to ensure long-term protection of the quality of the Baltic Sea environment. An example of such cooperation is the Convention on the Protection of the Baltic Sea Environment (Helsinki Convention), which referred to the comprehensive protection of the Baltic marine environment (http://stateofthebalticsea.helcom.fi/in-brief/). The Baltic countries have pledged to take appropriate steps to reduce pollution of the Baltic Sea. The Helsinki Convention did not enter into force until May 3, 1980. The Helsinki Commission—HELCOM, which is the executive body of the convention, has become a permanent organizational structure of the convention.

National efforts have also been made to obtain healthy ecosystems throughout the Baltic Sea region and to solve major problems affecting marine eutrophication.

In recent years, there has been a systematic decrease in pollution introduced into the Baltic Sea. The good quality of river waters flowing into the sea is of key importance for achieving good environmental status of marine waters. Further reduction of pollution coming from individual catchments depends on the progress of introducing solutions in individual countries. Lithuania, Latvia, Estonia and Poland are still facing these challenges.

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3.2 Quality of Groundwater in the Baltic Sea

Only one chapter was selected to discuss issues related to the groundwater quality in Baltic Sea countries. This chapter is titled "Environmental Quality of Groundwater in Contaminated Areas—Challenges in Eastern Baltic Region". The chapter provides an insight into the Eastern Baltic region's problems with contaminated sites and groundwater quality. Case studies provide a comprehensive perspective on groundwater quality, monitoring, treatment options, and future challenges for practical solutions for contaminated areas. Globally, the growing coastal population, including the Baltic Sea region, is facing new challenges. Agricultural, housing, industrial, and transport activities affect the environmental quality of water resources.

In addition to research conducted in the field of pollution of the Baltic waters with petroleum products and heavy metals there appear, new dangerous pollutants such as pharmaceuticals and plastics.

In chapter also nutrient problems creating excessive eutrophication and saltwater intrusions in groundwater by excessive pumping are described. Environmental contamination of Eastern Baltic is mainly of historical origin however we may scale it

further as it is a worldwide issue. Remediation is compulsory where prescribed risk is based on numerical criteria or standards and we must learn how to assess, monitor and choose prevention and treatment options through the case studies that are already performed in industrial scales.

3.3 Water Quality and Wetlands in Latvia

The chapter with the title "Water Quality Assurance With Constructed Wetlands in Latvia" is presented under this theme. It outlines the experience of Latvia in wastewater treatment and nutrient retention in constructed wetlands. Constructed wetlands for water quality assurance were implemented since 2003 in Latvia. Several constructed wetlands with different technical constructions were adapted to retain nutrients and to reduce organics from the water. Vertical subsurface flow constructed wetland was designed and built to receive wastewater from the Tervete Rehabilitation centre located in the Zemgale region, Tervete Municipality as a pilot-scale demonstration object. The domestic wastewater from a small village Birze after a partial treatment was discharged in a surface flow constructed wetland. Horizontal subsurface flow constructed wetland was installed at the farm Mezaciruli, Zalenieki county to purify stormwater from the hard surfaces from the farmyard. Two wetlands built by surface flow were implemented to retain nutrients from the waters when runoff was formed in a tile-drained agricultural catchment basin.

3.4 Potential Management of Water Contaminates in Germany

Three Chaps. (6, 7 and 8) are presented in the book under this theme. The chapter entitled "Phosphors Fluxes in the Baltic Sea Region - a Meta Data Analysis" focuses on the analysis of phosphorus analyzes to help understand the P use efficiency of countries or regions and guide stakeholders and decision-makers in the right direction as to what action needs to be taken to boost P use performance. Phosphors budgets and fluxes in 8 countries of the Baltic Sea Region who share a direct coastline to the Baltic Sea (Denmark, Sweden, Finland, Estonia, Latvia, Lithuania, Poland and Germany) are assessed and suitable strategies are discussed to identify and improve the P use efficiency in these countries. Eurostat provides data on gross P budgets, but such budgets are limited to quantifying an agricultural system's inputs and outputs. To provide more insight into how nutrients flow through the system, the literature compares and explores these data in relation to P flow analyzes of these countries. Flow analyses allow to take a look at internal P flows and to identify P losses from the system into the environment. The authors claimed that substantial efforts were needed to protect the Baltic Sea from further agricultural eutrophication. Consequently, the

chapter titled "Regulatory Scenarios to Counteract High Phosphorus Inputs into the Baltic Sea" discusses the regulatory scenarios that could help to counteract the high phosphorus inputs into the Baltic Sea by harmonizing European regulation. To this end, regulatory measures need to be taken to control the application of manure and sewage sludge to reduce the nutrient surplus in agriculture and to mitigate the eutrophication of water bodies such as the Baltic Sea.

Nutrient surpluses in agriculture with the consequence of eutrophication of water bodies like the Baltic Sea are a problem, which needs to be addressed by legal restrictions in all European partner countries. In the current chapter different possibilities are discussed that can be implemented alone or as a package of measures to face this problem.

It is mandatory to harmonize European regulations on analytical methods for determining soil nutrient status and guidelines for fertilizer derivation algorithms. Sewage sludge application should be harmonized as well and recycling procedures instead of field application should be favoured for contaminated material. Moreover manure application rates should be directed by its nitrogen (N) and phosphorus (P) content as the ratio of N to P differs in relation to the source (cattle, pig, poultry) and kind of manure (slurry, liquid, solid). Therefore it is necessary to take both nutrients into account.

Such measures will result in manure and sewage sludge surpluses that can be addressed through useful recycling procedures. Their regional emergency is one problem with manures, as livestock businesses are concentrated regionally. Transportation is no economic option, because of the high transportation costs. This problem can be addressed by recycling procedures and by changing the legal status of big livestock enterprises from farm to industry. This change would make these enterprises accountable for acts and decrees for industrial companies and responsible for handling their wastes in an environmentally friendly way.

The third chapter from Germany is titled "Challenges of Flood Risk Management at The German Coast". It highlights key challenges of flood risk management at the German coast. The chapter highlights the hydrological boundary conditions of coastal systems, describes the shift from a safety-based approach to a risk-based approach while dealing with floods, highlights the role of impacts of climate change and analyzes the perception of flood risks in North West Germany. A modern understanding of dealing with floods and coastal development requires an integrative risk-based approach. While good practice examples exist and the EU floods directive explicitly demands such approaches, they are not yet implemented along the German North Sea coast. According to the definition of risk, the implementation of a risk management approach requires the consideration of economic values and potential damages. For a heterogeneous area, the idea of equal safety is no longer appropriate. Since dimensioning of dikes due to climate change assumptions directly affects the coastal drainage system, integrative planning and dimensioning of coastal protection and drainage system is essential but not yet common practice in Germany. This includes funding schemes which are not yet available. Taking decisions for an uncertain future requires explicit consideration of uncertainties, e.g., by applying

scenario-based impact assessments to adapt coastal protection and drainage. Moving from a safety-based approach to a risk management approach also demands for activities in multiple fields of action such as prevention, spatial measures and emergency management. Since different actors are responsible for these topics, multiple actors also need to be mobilized and involved, including public organizations, aid organizations and citizens. Available investigations for North–West Germany show that not all actors are sufficiently aware of their responsibilities. Collective action is recommended to implement a risk-based management approach in coastal regions based on these challenges. This action is explicitly required in North–West Germany, but will also generally assist in other coastal regions.

3.5 Potential Stresses on Water Resources in Russia

Two Chaps. (9 and 10) from Russia are presented in the book. Chap. 9 is titled "Water Resources of the Russian Part of the Baltic Sea Basin and Their Possible Changes Under Global Warming". It summarizes the results of studies on water resources issues carried out in Russia (and in the State Hydrological Institute (SHI) in the first place). Starting with the publication of the monograph "Water Resources and Water Balance of the Soviet Union" (1967), which for the first time conducted a comprehensive assessment of the Baltic Sea Basin's water resources and water balance, and ending with generalized and systematized materials presented in the Integrated Use and Protection of Water Bodies Schemes. The changes in water resources and hydrological regime of the rivers occurring since the end of the 70s—the beginning of the 80s of the last century on the territory of Russia under the influence of climate change are described. Predictive estimates of possible changes in river streamflow of the Russian Part of the Baltic Sea Basin based on an ensemble of 24 Atmosphere-Ocean General Circulation Models are presented. Finally, conclusions are given regarding the prospects for solving problems in the study of water resources presented at the last VII All-Russian Hydrological Congress.

The second chapter is titled "Schemes of Integrated Use and Protection of Water Bodies in the Russian part of the Baltic Sea Basin as a Basis for Water Resources Management". It describes the regulatory and legal provision of integrated use and protection schemes for water bodies, including development standards for the permissible impact on water bodies developed and approved for river basins flowing from Russia's territory into the Baltic Sea. Schemes for integrated use and protection of water bodies: are the basis for the implementation of water management actions and measures to protect water bodies in river basins; include the latest systematized materials on the status of water bodies and their use; are instruments (information and intellectual supporting tools) for making management decisions on river basins (achieving water quality targets for water bodies and reducing the negative consequences of floods and other negative water impacts); within the next 15–20 years will remain the only approved documents recommended by the Government of the Russian Federation. Basin management principle applied in Russia in the field of use

and protection of water bodies as well as the content and structure of Schemes are described. Schemes and PIW, which were developed and approved for the Russian part of the Baltic Sea basin are also listed.

3.6 Estonian Water Resources

Under this section, two Chaps. (11 and 12) from Estonia are presented in the book. Chap. 11 is titled "Joint Methodology for the Identification and Assessment of Groundwater Dependent Terrestrial Ecosystems in Estonia and Latvia". It presents a methodology to identify and assess the groundwater-dependent terrestrial in Estonia and Latvia. It will help to define quantitative and qualitative effects on terrestrial ecosystems based on groundwater in the groundwater body. Groundwater Dependent Terrestrial Ecosystems (GTDEs) are valuable ecosystems, and its existence and good health rely on groundwater supply. As the Water Framework Directive aims to protect all water resources, including groundwater bodies, the assessment of GDTE should be a part of groundwater management. Groundwater body could have a two type of negative effect on the GDTE: (a) quantitative effect—human influence (such as groundwater abstraction) has lowered groundwater level, so that does not provide enough water to sustain the GDTE in its natural state; (b) qualitative effect—human influence (such as fertilizer application) has affected the groundwater body in a way that it is chemical composition causes the deterioration of the ecosystem. Estonia and Latvia are two northernmost Baltic states, sharing the common border, long history and shared water resources. In Estonia, a methodology for identification, assessment, and monitoring of the groundwater-dependent terrestrial ecosystems has been developed. Similar conditions enabled Latvia to adapt and jointly develop this methodology. A two-step approach is used to define GDTEs in Estonia and Latvia. First, habitat types listed in the EU Habitats Directive were selected. Second, additional criteria were applied to select GDTEs for assessment. Identification of GDTEs in the landscape is a difficult task considering the need for research in multidisciplinary teams, time, and funding resources. Since groundwater threshold values for GDTEs are missing in many countries, the authors suggest using indirect data (such as quantities of fertilization, location of polluted sites and data on land cover). Such analysis will indicate if there are any significant human-induced chemical pressures, their type and will point out the relevant parameters to be monitored and analyzed in the future.

Chapter 12 is titled "Estonian Fluvial Water Bodies and Inundation Directive". The chapter is based on project results of "Assessment of wetland status and setting of environmental objectives", initiated and financed by the Estonian Ministry of Environment during 2011–2012. Nonetheless, the performance of this work only partly fulfills the overall objective of the EU Water Framework Directive (WFD) concerning the use of wetland safety and restoration in order to achieve the WFD objectives in a cost-effective and sustainable manner. The Introduction part of the chapter offers a brief overview of the WFD's goals of protecting various surface water bodies

(WBs), WB management concepts, and methods for assessing the importance of WFD's significant wetlands with associated WBs hydro-ecological interface status. The Material part includes a short overview of Estonian water bodies, and wetlands, divided into the four main types: (1) inland wetlands or mires, (i.e, bogs, poor fens and fens); (2) floodplain wetlands; (3) spring mires; and (4) coastal wetlands.

The Methods part presents the soil-based methods for the determination of WFD important wetlands associated with different types of water bodies, i.e., identification of the areal extent of the wetlands or their parts on the landscape, and identification of the areal extent of the wetland within the catchment of defined WBs.

The book ends the conclusions part which contains two chapters. The "Update, Conclusions, and Recommendations for "Water Resources Quality and Management in Baltic Sea Countries"" and the special chapter on "Estonian Wetlands and the Water Framework Directive". In the concluding chapter, an update of the literature is made to cover some of the interesting topics which are relevant to the themes of the book. Some of these sources include Ahlhorn et al. [3], Bormann [4], Burlakovs et al. [5], Eurostat [6], Hogland [7], Serinaldi [8], Ahlhorn and Meyerdirks [9], Berbel [10], EU Water Framework Directive [11], Kiisler [12] and Terasmaa [13] among others. While Chap. 14, for the first time, Estonian wetlands were identified, their extents were calculated and ecological status were assessed; pressure factors and key management measures were described. However, in order to implement integrated water management, classification of functional relationships between wetlands and WBs should be conducted.

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References

1. Zeleňáková M, Kubiak-Wójcicka K, Negm AM (Eds) (2020a) Water resources in Poland: quality. In Springer Water, Springer (in print)
2. Zeleňáková M, Kubiak-Wójcicka K, Negm AM (Eds) (2020b) Water resources in Poland: management. In Springer Water Series, Springer (in print)
3. Ahlhorn F, Kebschull J, Bormann H (2018) Risikowahrnehmung und Informationsbedarfe der Bevölkerung über die Auswirkungen des Klimawandels auf Hochwasser und Sturmfluten. Wasser und Abfall 20(11):44–51
4. Bormann H (2018) Hydrology of (shallow) coastal regions. In: Ahlhorn F Integrated coastal zone management. Springer, pp 49–62
5. Burlakovs J, Jani Y, Kriipsalu M, Vincevica-Gaile Z, Kaczala F, Celma G, Ozola R, Rozina L, Rudovica V, Hogland M, Viksna A, Pehme KM, Hogland W, Klavins M (2018) On the way to 'Zero Waste' management: recovery potential of elements, including rare earth elements, from fine fraction of waste. J Clean Prod 186:81–90
6. Eurostat (2018) Gross nutrient balance on agricultural land. Eurostat—Agriculture, Forestry and Fisheries—Agriculture—Agricultural Production—Crop Products—Crop Products: Areas and Production-Land Use (1000 ha) Annual data (apro_crop_luse). Eurostat, European Commission, Luxembourg. Last updated 23.08.2018. Date Accessed 04.09.2018 at http://ec.europa.eu/eurostat

7. Hogland M, Burlakovs J, Celma G, Vincevica-Gaile Z, Hogland W (2018) Preliminary analysis of elements in water supply sludge at Ronneholms Mosse fields, southern Sweden. In: SGEM2012 Conference Proceedings, Book no. 1.4, pp 111–118
8. Serinaldi F, Loecker F, Kilsby CG, Bast H (2018) Flood propagation and duration in large river basins: a data-driven analysis for reinsurance purposes. Nat Hazards 94(1):71–92. https://doi.org/10.1007/s11069-018-3374-0
9. Ahlhorn F, Meyerdirks J (2019) Multifunktionale Küstenschutzräume im Rahmen eines Küstenrisikomanagements. Wasser und Abfall 21(3–4) (in press)
10. Berbel J, Borrego-Marin M, Exposito A, Giannoccaro G, Montilla-Lopez N, Roseta-Palma C (2019) Analysis of irrigation water tariffs and taxes in Europe. Water Policy 21(4):806–825
11. EU Water Framework Directive (2019) Introduction to the EU water framework directive. In: European Commission, Environment. N.p., n.d. Web. 8 Aug 2019. https://ec.europa.eu/environment/water/water-framework/index_en.html
12. Kiisler S (2019) Üleujutusega seotud riskide ajakohastatud hinnangu kinnitamine. Keskkonnaministri käskkiri nr 105 (Approval of an updated flood risk assessment. Regulation No. 105 of the Minister of the Environment). N.p., n.d. Web. 7 Oct 2019. https://www.envir.ee/sites/default/files/hinnang_kaskkiri_lisaga.pdf
13. Terasmaa J, Bartout P, Marzecova A, Touchart L, Vandel E, Koff T, Choffel Q, Kapanen G, Maleval V, Vainu M, Millot C, Qsair Z, Al Domany M (2019) A quantitative assessment of the contribution of small standing water bodies to the European waterscapes—case of Estonia and France, Heliyon (in press)