Chapter 2
Water Resources and Management of Poland in SCOPUS Database

Mahmoud Nasr, Michael Attia, and Abdelazim M. Negm

Abstract Recently, Poland has faced significant issues in the sector of water resource, availability, and management because of the sharp increase in various domestic, agricultural, and industrial activities. This chapter gives an overview of the status, challenges, and management of water in Poland. The major water resources, e.g., rivers, lakes, and dams/reservoirs in Poland are also listed. Moreover, the chapter mentions the grant-funded researches, leading international journals, institutional affiliation, and acknowledged sponsors and projects available in the SCOPUS database, covering the water aspects in Poland. The findings of this work would support local residents, investors, government officials, industrialists, and academics, dealing with water concerns in Poland.

Keywords Poland · SCOPUS database · Water resources

2.1 Introduction

Poland is a Baltic Sea country located in Central Europe, having a population of 37,921,592 capita in 2018 [1]. Recently, the water consumption profile in Poland has enlarged due to national economic development, population growth, and

M. Nasr (✉)
Sanitary Engineering Department, Faculty of Engineering, Alexandria University, Alexandria 21544, Egypt
e-mail: mahmmoudsaid@gmail.com; mahmoud-nasr@alexu.edu.eg; mahmoud.nasr@ejust.edu.eg

Environmental Engineering Department, Egypt-Japan University of Science and Technology (E-JUST), Alexandria 21934, Egypt

M. Attia
Irrigation Engineering and Hydraulics Department, Faculty of Engineering, Alexandria University, Alexandria 21544, Egypt
e-mail: eng.michael_george@yahoo.com

A. M. Negm
Water and Water Structures Engineering Department, Faculty of Engineering, Zagazig University, Zagazig 44519, Egypt
e-mail: amnegm85@yahoo.com; amnegm@zu.edu.eg

M. Zeleňáková et al. (eds.), *Management of Water Resources in Poland*, Springer Water,
https://doi.org/10.1007/978-3-030-61965-7_2

climatic change [2]. The increases in social practices, agricultural activities, and industrialization have also contributed to the rise in water consumption [3, 4].

The status of water in Poland can be described as follows [5]:

- In 2017, water precipitation in depth = 600 mm per year, corresponding to an annual volume of 187.6 billion m^3.
- In 2017, renewable water resources = 61 billion m^3/year, providing a yearly water resource of 1585 m^3 per capita. However, the average freshwater availability in Poland is considered one of the lowest values in Europe.
- In 2016, the percentages of water utilization were 19% for municipal use, 71% for industrial use, and 10% for agricultural use. These percentages were covered by a total water withdrawal of 10.58 billion m^3.
- In 2015, about 1.7% of the population in Poland had no access to safe drinking water.

This chapter provides an overview of the trends and statistics of water resources (e.g., surface water and groundwater) in Poland. Moreover, the chapter includes sufficient information on the institutional affiliations, countries, and funding agencies and sponsors, concerning the management of water bodies in Poland.

2.2 Rivers in Poland

The river system in Poland is recognized as an essential source of drinking, domestic, and agricultural purposes [6]. The river system has also played an important role in the growth and development of Poland's economy and civilization. Vistula River is the most important river in Poland [7], having a total length of about 1022 km. The river is associated with a basin area in Poland, equivalent to 168,868 km^2. Warta River is the second largest river in Poland, with a total length of 795 km and a basin area = 54,520 km^2. Another important river in Poland is known as Oder, representing a length of 726 km and a basin area = 106,043 km^2 in the country. These rivers are followed by Bug, Narew, and Noteć, having lengths of 590, 443, and 391 km in Poland. However, the rivers have recently received untreated and/or partially treated wastewater; hence, several parts of the river water became unfit for direct potable use.

2.3 Lakes in Poland

Lakes are recognized as large water bodies (either fresh- or salt-water) surrounded by land. Śniardwy Lake is the most important lake in Poland, with an area of 113.8 km^2 and a maximum depth of 23 m. This lake is followed by Lake Mamry with an area of 104 km^2 and Łebsko Lake (71.4 km^2). Other lakes in Poland include Lake Jamno, Lake Wigry, Lake Gopło, Lake Orzysz, Lake Karwowo, Lake Karaś, Lake

Licheńskie, Lake Ełk, Lake Gosławskie, Lake Leśnias, Nyskie Lake, and Lake Słupca [8–10].

2.4 Dams in Poland

Generally, dams are constructed for water storage in associated reservoirs, the control of disasters (i.e., floods and droughts), and navigation purposes. The major dams in Poland can be described as follows [11], viz., Name (capacity in 10^6 m^3 and maximum depth in m): Leśna (16.8 and 35.8), Pilchowice (50.0 and 46.7), Złotniki (12.1 and 27.5), Otmuchów (130.5 and 18.4), Kozłowa Góra (17.6 and 6.5), Porąbka (27.2 and 21.2), Rożnów (159.3 and 31.5), Czchów (12.0 and 9.5), Goczałkowice (161.3 and 13.0), Tresna (96.1 and 23.8), Solina (472.4 and 60.0), Włocławek (453.6 and 12.7), Nysa (124.7 and 13.3), Sulejów (84.3 and 11.3), Słup (38.7 and 19.1), Chańcza (24.2 and 12.8), Mietków (71.9 and 15.3), Bukówka (16.8 and 22.4), Dobromierz (11.4 and 26.7), Dobczyce (141.7 and 27.9), Jeziorsko (202.0 and 11.5), Dzierżno Małe (12.6 and 13.1), Czorsztyn (231.9 and 54.5), Nielisz (28.5 and 8.6), Wióry (35.0 and 23.4), and Sulejów (84.3 and 11.3).

2.5 Reservoirs in Poland

Generally, the reservoirs are used for the aims of water storage and supply, irrigation, hydroelectric production, and land protection against flooding. Poland includes a number of reservoirs such as Czorsztyn Reservoir in Dunajec; Dobczyce Reservoir in Raba; Goczałkowice Reservoir in Vistula; Jeziorsko Reservoir in Warta; Koronowo Reservoir in Brda; Nysa Reservoir in Nysa Kłodzka; Otmuchów Reservoir in Nysa Kłodzka; Rożnów Reservoir in Dunajec; Solina Reservoir in San; Turawa Reservoir in Mała Panew; Włocławek Reservoir in Vistula; Zegrze Reservoir in Narew; Żywiec Reservoir in Soła.

2.6 Water Management in Poland

The "Water Law" act of 1974 and a series of laws, regulations, and guidelines have been established to handle the issues of water management in Poland [12]. For instance, a framework for the river basin management was proposed in the late 1980s, followed by the initiation of Regional Water Management Boards (RWMBs) in 1991. With a further modification of the sub-basin boundary agreement in 1999, the RWMBs became responsible for the planning and co-ordination of the polish river basins and lakes. The management of waterworks and wastewater treatment systems was undertaken by counties and municipalities, whereas the water use tasks were

considered and regulated by provincial governments. In 2004 (after Poland's entry into the EU), the EU Water Framework Directive (WFD) comprised an official agenda for Polish water management, in which ten river basin districts were defined. Further, the National Water Management Authority (i.e., a sector in the Ministry of Environment) was established in 2006 to share the competent authority for water resources management with the RWMBs. For example, the national authority arranges and regulates the river basin management plans (RBMPs), whereas the Boards make reporting, provide the required data, and establish consultations. However, these management regimes have recently experienced some water-related issues, which were beyond the jurisdiction of Poland's Ministry of Environment. Currently, the Ministry of Environmental Protection, Natural Resources and Forestry is responsible for the water framework directive in Poland (i.e., measures and implications). Moreover, some individual and small pilot water management projects are carried out to reduce the water and wastewater treatment costs.

2.7 Poland's Water Statistics from SCOPUS Resource Library

Figure 2.1 shows the number of published documents for the study period from 2001 to 2019, handling and addressing the major water issues in Poland [13]. Figure 2.1a represents the records retrieved from the SCOPUS database using "Water", "Quality", and "Poland" as the keywords for search. A total number of documents of about 503 was reported during 2001–2010, which increased by two-fold during 2011–2019. Furthermore, the documents were searched in the SCOPUS database by using "Water", "Resource", and "Poland" as keywords (Fig. 2.1b), depicting 220 documents during 2001–2010 and 545 documents during 2011–2019. The entire number of publications using the search keywords "Water", "Management", and "Poland" was 335 documents during 2001–2010, and it increased to 777 documents during 2011–2019 (Fig. 2.1c). The recent improvement in the number of published articles indicates that the title of "Water Quality, Resource, and Management in Poland" has become a crucial field of investigation.

The search signified different types of documents, including article (~84%), conference paper (~10%), review (~3%), and book chapter (~1%). The articles covered various subject areas such as Environmental Science; Earth and Planetary Sciences; Agricultural and Biological Sciences; Engineering; Social Sciences; Chemistry. The articles have been published in several international journals, including Ecological Indicators; Smart Innovation, Systems and Technologies; Science of the Total Environment; Environmental Management; Environmental Pollution. The aims and scopes covered by these journals include the minimization of environmental pollution related to human health, and the use and conservation of natural resources. The journals were managed by several publishers, viz., Springer,

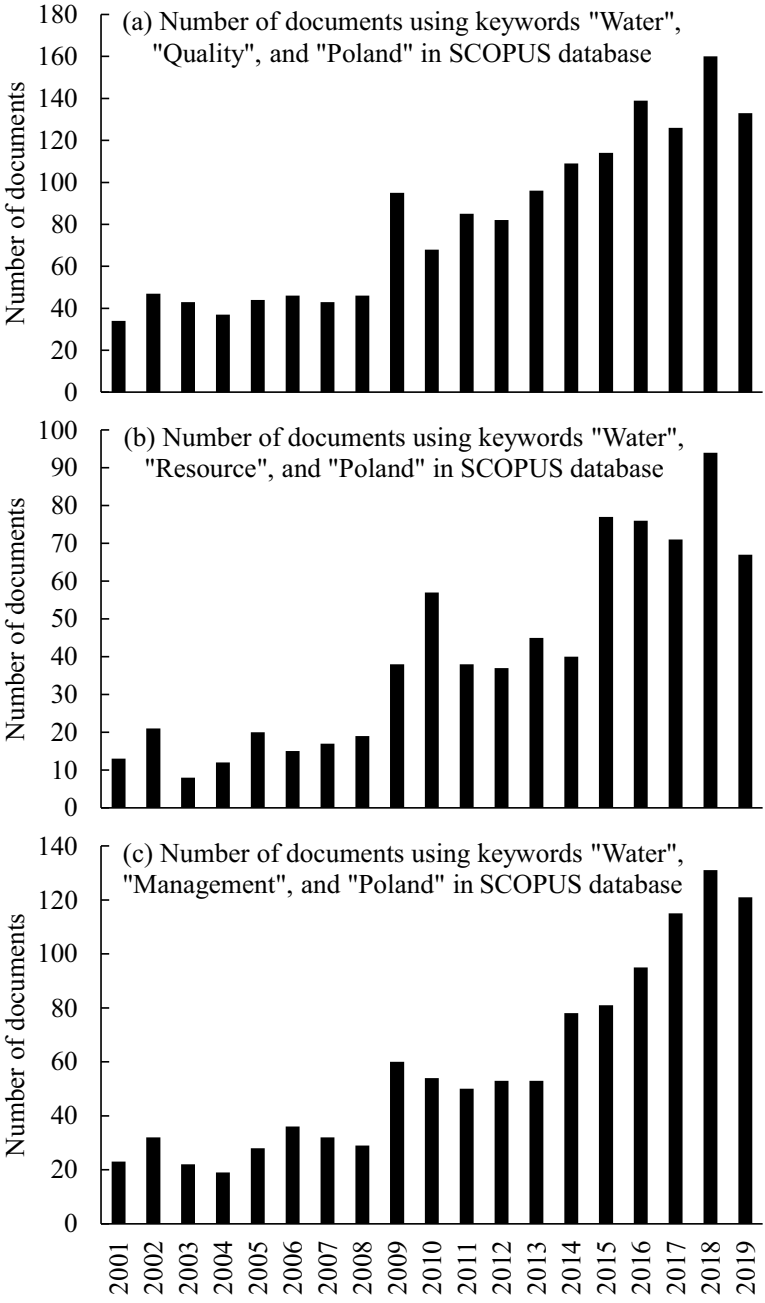

Fig. 2.1 Increasing number of published documents retrieved from SCOPUS database from 2001 to 2019 using research keywords **a** "Water", "Quality", and "Poland", **b** "Water", "Resources", and "Poland", and **c** "Water", "Management", and "Poland"

Taylor & Francis, Nature Publishing Group, Sage Publications, Wiley-Blackwell, and Elsevier.

The authors of publications associated with "Water Quality, Resource, and Management in Poland" are affiliated to Polish Academy of Sciences; Uniwersytet im. Adama Mickiewicza w Poznaniu; Uniwersytet Warminsko-Mazurski w Olsztynie; University of Lodz; AGH University of Science and Technology; University of Silesia in Katowice; Uniwersytet Przyrodniczy w Poznaniu; Gdańsk University of Technology; Szkoła Główna Gospodarstwa Wiejskiego; Polish Geological Institute – National Research Institute. The main funding sponsors acknowledge in the documents were Narodowe Centrum Nauki; European Commission; European Regional Development Fund; Ministry of Higher Education; Scientific Committee on Antarctic Research; Narodowe Centrum Badań i Rozwoju; Ministerstwo Nauki i Szkolnictwa Wyższego; Komitet Badań Naukowych; National Centre for Atmospheric Science; European Social Fund. Poland was the top country that contributed to the subject of "Water Resources, Quality, and Management in Poland" in the SCOPUS database during 2001–2019, with more than 90% of the published documents. Based on the previous information, Poland country was followed by Germany, United Kingdom, United States, Netherlands, and Czech Republic, revealing the importance of Poland water resources on the Baltic region and other countries with similar climatic regimes.

2.8 Recommendations

Poland has relatively small water resources; hence, some recommendations should be considered to maintain water availability in the country:

- Scientific, academic, environmental, and engineering contributions should be interacted to solve the recent and upcoming challenges essential to the water availability in Poland.
- Feasible and cost-effective frameworks for the long-term management of water resources in Poland are required.
- Regular spatial and temporal surveys on various physicochemical parameters of water bodies (e.g., temperature, pH, turbidity, solids, dissolved oxygen, organic matter, and nutrients), as well as pathogenic *Escherichia coli*, *Salmonella typhimurium*, and *Vibrio cholera*, should be assessed.
- Adaptation strategies and proper wastewater treatment technologies should be considered to avoid the release of wastes from the agricultural and industrial sectors into Polish water bodies.
- Water resources planning and management should consider additional water supply infrastructures.
- More stakeholders should contribute to the Regional Water Management Boards, dealing with water resources planning and management, flood and erosion control, and water purification.

- The amendments of the "Water Law" act signed by Poland should harmonize with the EU legislations and international agreements.

2.9 Conclusions

This chapter aims at providing an overview of the essential water resources in Poland. It can be concluded that:

- Poland comprises several freshwater resources retained in surface water bodies and within soil layers.
- In Poland, the main four rivers are Vistula, Warta, Oder, and Bug; the essential three lakes are Śniardwy, Mamry, and Łebsko; the main dams are Solina, Pilchowice, Czorsztyn-Niedzica, Swinna Poreba, and Roznow; the major reservoirs are Czorsztyn, Dobczyce, Goczałkowice, Jeziorsko, and Koronowo.
- In 2017, renewable water resources in Poland reached 61 billion m^3 per year, providing an annual water resource of 1585 m^3 per capita.
- Based on the SCOPUS database, the total number of published documents that handled the water issues in Poland during 2011–2019 was approximately two-fold that during 2001–2010.
- Proper awareness, frameworks, and scientific meetings that address the environmental and health issues should be delivered to residents and farmers.
- The government should give significant actions for rainwater harvesting and wastewater reuse to overcome future water demands.
- The findings obtained from this chapter would support the government, policymakers, and scientists dealing with all problems of water resources in Poland.

Acknowledgements The first author would like to acknowledge Nasr Academy for Sustainable Environment (NASE).

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