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Beata Szymczycha
Janusz Pempkowiak

The Role of Submarine Groundwater Discharge as Material Source to the Baltic Sea

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Beata Szymczycha · Janusz Pempkowiak

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Beata Szymczycha
Institute of Oceanology
Polish Academy of Sciences
Sopot
Poland

Janusz Pempkowiak
Institute of Oceanology
Polish Academy of Sciences
Sopot
Poland

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Preface

Global environment consists of a variety of ecosystems of different sizes and compositions. Within each of them, and between them, of particular interest are zones characterized by gradients of properties. This concerns both transfers between phases (solid–gaseous, solid–liquid, and liquid–gaseous) and gradients of properties within a phase (redox, density, temperature, chemical composition). Many of the features are characteristic of areas where land meets ocean. Seawater properties and processes are largely different from those appearing in freshwater. Thus, the land–sea interface is interesting by itself. Moreover, land and coastal zones are areas of intensive anthropogenic activity. The unwanted results of the activity are contamination of freshwater and degradation of coastal areas. Therefore, zones where freshwater meets seawater are of particular interest due to both natural phenomena and transfer of contaminants to the marine environment.

Discharges of freshwater to the sea are well characterized as long as river runoff is considered. This, without doubt, is in relation to the importance of the discharges and relative ease of collecting representative samples of river runoff. Another way of discharge from land to the sea is direct discharge of groundwater. Groundwater flows under the seafloor and seeps through porous sediments to the overlying seawater. The phenomenon is called submarine groundwater discharge (SGD). Numerous problems occur regarding identifying SGD sites, quantification of SGD fluxes, and collecting the SGD representative samples. Thus, studies on SGD are difficult and require specific methods.

Appreciation of SGD has a long history. For example, both Romans and middle-aged Europeans used SGD as a source of freshwater. However, it was only recently that the importance of SGD for coastal ecosystems was recognized. The appreciation has come with the discovery of the SGD role as a source of nutrients and other chemical substances in the coastal zone. This was followed by studies on the role of SGD as a factor influencing benthic biota in the discharge zone. Recently, the importance of carbon species loads, both organic and inorganic, delivered to the marine environment with seeping groundwater was documented. Interest in the SGD-derived carbon species is due to the common appreciation that

carbon dioxide concentration in the atmosphere is a primary driving force of climate warming.

Decades of research on the qualitative and quantitative composition of groundwater seeping to the coastal zone led to the conclusion that SGD plays important role in developing equilibria in the coastal zone environment. Both enrichment of seawater with inorganic ions and dilution of ions occurring in seawater have been documented. The range of seawater–groundwater interactions depends on many factors such as individual characteristics of aquifers, including rock type, groundwater flow velocity, and anthropogenic contribution. New studies are undertaken in order to increase the amount of data characterizing SGD so that appropriate generalization and scaling up could be carried out.

This volume summarizes recent achievements in the field of SGD studies performed in the Baltic Sea, a European landlocked brackish water body in the temperate climate. For a number of years, SGDs in the area had been investigated with respect to the groundwater flow rate. Within the last 5 years, new findings regarding chemical composition of seeping groundwater have been presented. In the book, concentrations, in groundwater seeping through sandy bottom sediments to the coastal zone along the southern coast of the sea, are presented and discussed. Research on speciation changes of chemical constituents on mixing of groundwater and seawater has also been carried out, and the results are presented in the book. Studies on chemical composition were accompanied with detailed studies of the discharge rates. These have made possible estimation of the chemical loads delivered to the study area and scaling up the loads to the entire Baltic Sea using the literature-derived discharge rates. Some of the loads have been scaled up to the World Ocean. Although both the former and the latter results should be regarded as indicative, they underline the worldwide importance of SGD.

The authors hope that the readers will find the data themselves, the discussion, and conclusions of interest, and that the book will strengthen the appreciation of the SGD's importance to the coastal marine environment.

Beata Szymczycha
Janusz Pempkowiak

Contents

1	Introduction	1
	References	2
2	State of Art and Theory of Submarine Groundwater Discharge (SGD)	3
2.1	Definition and Drivers of SGD	3
2.2	The Worldwide Studies of SGD	6
2.3	Significance of SGD	7
2.3.1	SGD as a Source of Nutrients and Biological Effects on the Coastal Ocean	8
2.3.2	SGD as a Source of Metals to the Marine Coastal Ecosystems	10
2.3.3	SGD as a Source of Mercury to the Marine Coastal Ecosystems	12
2.3.4	SGD as a Source of Dissolved Carbon Species to the Coastal Marine Ecosystems	14
2.3.5	SGD Impact on Coastal Ecology	18
2.4	Methods Used to Measure SGD	19
2.4.1	Seepage Meter	19
2.4.2	Piezometers	21
2.4.3	Natural Tracers	22
2.4.4	Infrared Imaging	23
2.4.5	GIS Topology	23
2.4.6	Hydrologic Approach	24
2.4.7	Mathematical Models	24
	References	25
3	Characteristic of the Baltic Sea	33
3.1	The Baltic Sea. General Outline	33
3.2	Baltic Proper	37
3.3	The Baltic Sea-Surface Sediments and Sedimentation Processes	38

- 3.4 Gdańsk Bay, Bay of Puck and Pomeranian Bay 40
 - 3.4.1 Gdańsk Bay 40
 - 3.4.2 Bay of Puck 41
 - 3.4.3 Pomeranian Bay 42
- 3.5 Estuaries 43
 - 3.5.1 Water Exchange Conditions 43
- 3.6 Bottom Sediments 44
- 3.7 Characterization of Submarine Groundwater Discharge in the Baltic Sea 45
 - 3.7.1 Submarine Groundwater Discharge to the Ocean 45
 - 3.7.2 Groundwater Discharge to the Baltic Sea 46
 - 3.7.3 Groundwater Discharge to the Eckernförde Bay (Western Baltic Sea). 46
 - 3.7.4 Groundwater Discharge to the Gulf of Finland 48
 - 3.7.5 Groundwater Discharge to the Southern Baltic Sea. 48
- References 51
- 4 Research on Submarine Groundwater Discharge in the Baltic Sea 53**
 - 4.1 Aims, Scope and General Characteristics. 53
 - 4.1.1 Aims of the Study 53
 - 4.1.2 Description of the Study Area and Sampling. 54
 - 4.1.3 The Studied Properties of Seeping Water 59
 - 4.2 Research on Salinity, pH, ORP, Nutrients, Metals, Dissolved Organic Carbon and Dissolved Inorganic Carbon Distribution in SGD Impacted Area 69
 - 4.2.1 Salinity Distribution 69
 - 4.2.2 The Sediment Pore Water pH 72
 - 4.2.3 The Sediment Pore Water ORP 73
 - 4.2.4 Nutrients Distribution 75
 - 4.2.5 Dissolved Organic and Inorganic Carbon Distribution. 82
 - 4.2.6 Distribution of Trace Metals 89
 - 4.3 The Processes Influencing Chemical Substances Concentrations in the Groundwater Impacted Area. 97
 - 4.3.1 Conservative Mixing 97
 - 4.3.2 Unconservative Mixing. 98
 - 4.3.3 The Importance of Groundwater Redox Chemistry. 105
 - 4.4 Upscaling Nutrients, Dissolved Carbon, and Metals Loads Delivered to the Southern Baltic Sea Via SGD 109
 - 4.4.1 Nutrients, Dissolved Carbon, and Metals Fluxes Via SGD to the Study Area. 109
 - 4.4.2 Nutrients, Dissolved Carbon and Metals Fluxes Via SGD to the Bay of Puck. 111
 - 4.4.3 Nutrients, Metals and Dissolved Carbon Loads Via SGD to the Baltic Sea 116

4.5 Assessment of the Global Chemical Substances	
Fluxes Via SGD	122
References	126
5 Conclusions	133
References	134
Index	135

List of Figures

Figure 2.1	General scheme of SGD. Groundwater located in the shallow, unconfined aquifer can discharge directly to the coastal ocean or can mix with seawater already in the sediment and be discharged as brackish water (seepage water). SGD is determined by both terrestrial and marine forces. Based on Burnett et al. (2006).	4
Figure 2.2	Pore water exchange forced by differential pressure gradients. Based on Moore (2009)	5
Figure 2.3	Lee-type, manual seepage meter (Lee 1977). Water seeps through the sediment into the chamber and is forced into a plastic bag attached to a tube in the top of the drum. The change in volume over a measured time interval provides the groundwater seepage rate.	20
Figure 3.1	The Baltic Sea and the sea drainage basin divided among the countries. 1 The Gdańsk Basin, 2 the Gulf of Riga, 3 the Gulf of Finland, 4 the Bothnian Sea, 5 the Bothnian Bay, 6 the Baltic Proper, 7 the Danish Straits, 8 the Kattegat, 9 the Skagerrak. Based on BALTEX-The Baltic Sea experiment website (http://www.baltex-research.eu)	34
Figure 3.2	Bay of Puck cross-section presenting hydrogeological conditions of the sediments (modified after Falkowska and Piekarek-Jankowska 1999). 1 Cretaceous, 2 tertiary, 3 quaternary-pleistocene, 4 quaternary-holocene, 5 marl, 6 clay, 7 slit, 8 boulder, 9 clay, 10 sand, 11 well, 12 top of a aquifer, 13 piezometric groundwater level, 14 direction of groundwater flow	42
Figure 3.3	Surface sediments in the Polish part of the Baltic Sea (based on Uścińowicz 2011; simplified)	43

Figure 3.4 The macro ions composition of pore water in the Bay of Puck. St.5 corresponds to the groundwater non-impacted area, while st.15 corresponds to groundwater impacted area (modified from Bolałek 1992) 50

Figure 4.1 A map of the Baltic Sea showing the location of the study areas: the Bay of Puck (*P*), Międzyzdroje (*M*), Kołobrzeg (*K*), Łeba (*L*), Władysławowo (*W*) and sampled rivers: Reda, Zagórska Struga, Płutnica and Gizdepka 55

Figure 4.2 Salinity distribution in sediment pore water samples collected at 5 cm and 25 cm depth on 31.08.2009. GL I, GL II and GL' correspond to positions of groundwater lances while S1, S2, S3 and S' correspond to seepage meter positions (Szymczycha et al. 2012) 56

Figure 4.3 Pourbaix diagram for manganese 63

Figure 4.4 The pore water salinity profiles. The samples were collected during four sampling campaigns: September 2009; November 2009; February 2010 and May 2010. Sixteen pore water profiles represent the groundwater impacted area (*hollow symbols* represent GLI location and *solid symbols* represent GLII location), while one profile is attributed to groundwater non-impacted area (*triangle symbols* represent GL' location) 71

Figure 4.5 The pore water pH profiles. The samples were collected during four sampling campaigns: September 2009; November 2009; February 2010 and May 2010. Sixteen pore water profiles represent the groundwater impacted area (*hollow symbols* represent GLI location and *solid symbols* represent GLII location), while one profile is attributed to groundwater non-impacted area (*triangle symbols* represent GL' location) 72

Figure 4.6 The pore water ORP profiles. The samples were collected during four sampling campaigns: September 2009; November 2009; February 2010 and May 2010. Sixteen pore water profiles represent the groundwater impacted area (*hollow symbols* represent GLI location and *solid symbols* represent GLII location), while one profile is attributed to groundwater non-impacted area (*triangle symbols* represent GL' location) 74