

# Report on measuring geochemical composition of groundwater seepage

**Beata Szymczycha<sup>1</sup>,**

Susan Vogler<sup>2</sup>, Olaf Dellwig<sup>2</sup>, Michael Schlüter<sup>3</sup>, Maria Schafmeister<sup>4</sup>, Michael Böttcher<sup>2</sup>, Lech Kotwicki<sup>1</sup>,  
Jan-Marcin Weslawski<sup>1</sup>, **Janusz Pempkowiak<sup>1</sup>**

<sup>1</sup> Institute of Oceanology Polish Academy of Science (IOPAS)

<sup>2</sup> Leibniz Institute for Baltic Sea Research (IOW)

<sup>3</sup> Alfred Wegener Institute for Marine and Polar Research (AWI)

<sup>4</sup> University of Greifswald

- WP B.4 Identification and quantification of submarine groundwater discharge
- WP B.5 Geochemical composition of groundwater seepage
- WP B.6 Groundwater seepage impact on Biota

# Deliverables:

- ❑ Identification of sites of significant SGD
- ❑ Collecting samples:
  - Water column
  - Groundwater
  - Sediments
- ❑ Characterization of geochemical composition of groundwater discharged to the coastal environment at seepage sites

## Environment component

## Parameter

Water column

Trace elements, Pb isotopes,  
N,P , DOC, DIC,

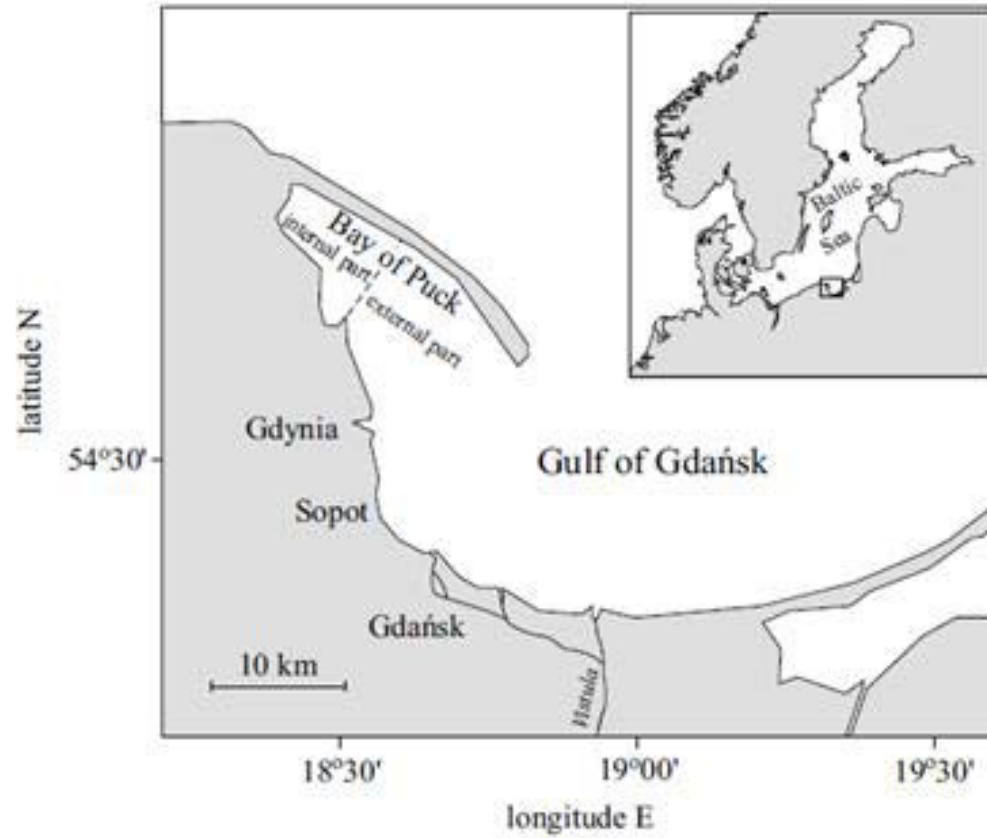
Groundwater seepage

Trace elements, Pb isotopes,  
N,P , DOC, DIC,

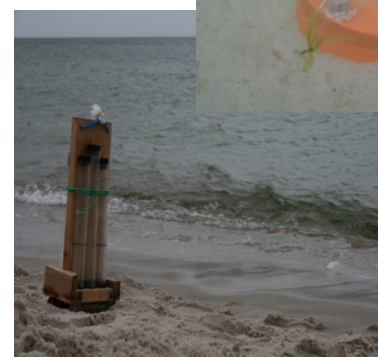
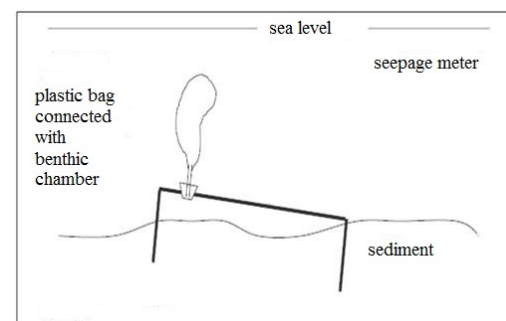
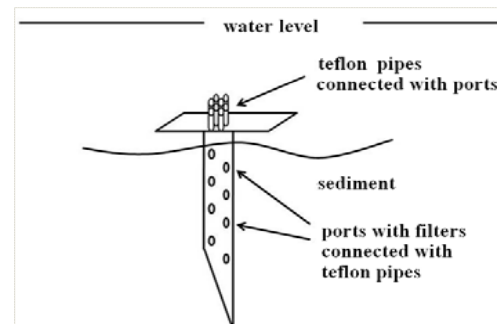
Sediment

Trace elements, Pb isotopes,  
N,P

# Study area



Study site	Date	Type/number of samples
Hel Peninsula	23-26.03.09	Seepage water/ 20
The Bay of Puck	25-27.06.09	Water column/20 Pore water/40 Cores /6
Hel Peninsula	31.08.09- 04.09.09	Seepage water, pore water, groundwater, marine water/60 Cores/4
	3-6.11.09	Seepage water, pore water, groundwater, marine water/60 Cores/4
	27-29.02.10	Seepage water, pore water, groundwater, marine water/40 Cores/4
	4-7.05.10	Seepage water, pore water, groundwater, marine water/60 Cores/4
	1-6.10.10	Seepage water, pore water, groundwater, marine water/20 Cores/4



# Measurements

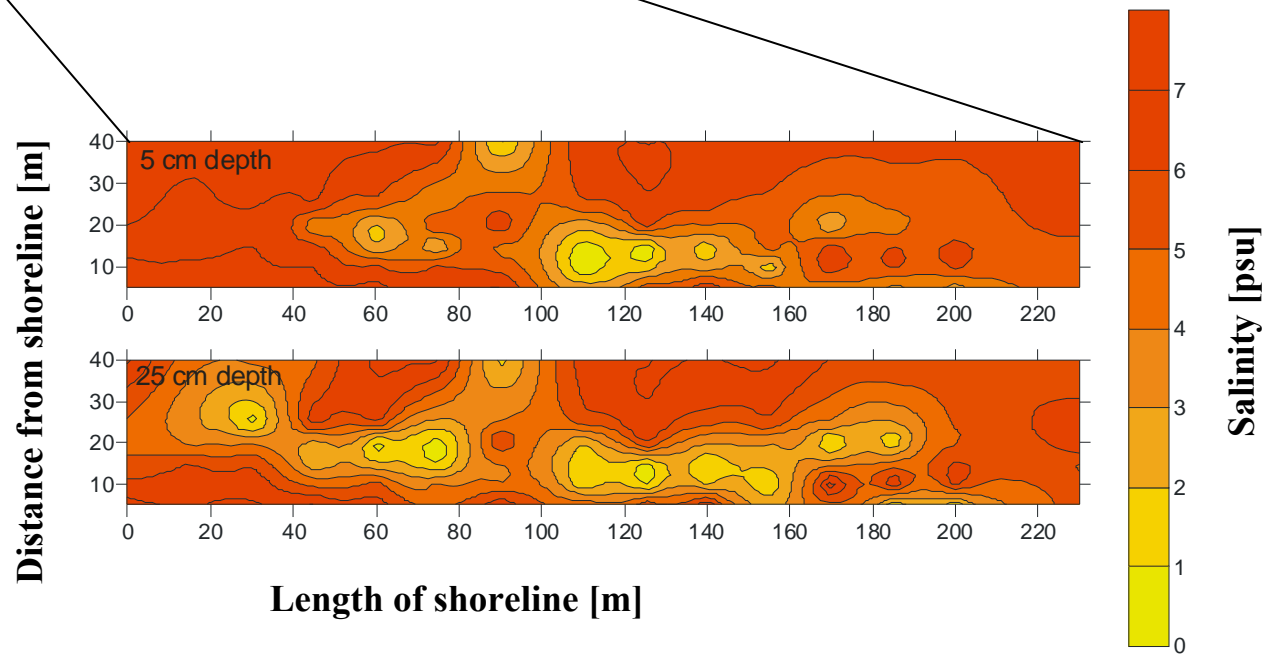
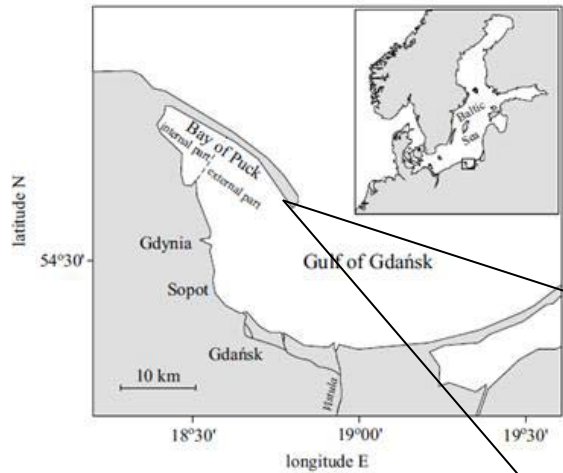
Sample type	Number of performed analysis				
	Cd, Pb, Cu, Co, Ni, Zn/ ICP-MS	Hg/ TECRAN	<sup>204</sup> Pb, <sup>206</sup> Pb, <sup>207</sup> Pb, <sup>208</sup> Pb/ ICP-MS	NH <sub>4</sub> <sup>+</sup> , NO <sub>3</sub> <sup>-</sup> , NO <sub>2</sub> <sup>-</sup> , PO <sub>4</sub> <sup>3-</sup> / SPECTROFOTOMETER	DIC, DOC/ HyPerTOC analyser
Water samples	200 (*2)	120	100	200(*4)	160(*2)
Sediment	80(*2)	x	80	80(*2)	x

X- not analysed

## Approach to results :

1. Identifying SGD,
2. Quantifying SGD,
3. Processes at seepage/sea water interface:
  - mixing process,
  - speciation dynamics,
4. Loads of chemical substances via SGD.

# 1. Identifying SGD- Location of seepage water sites

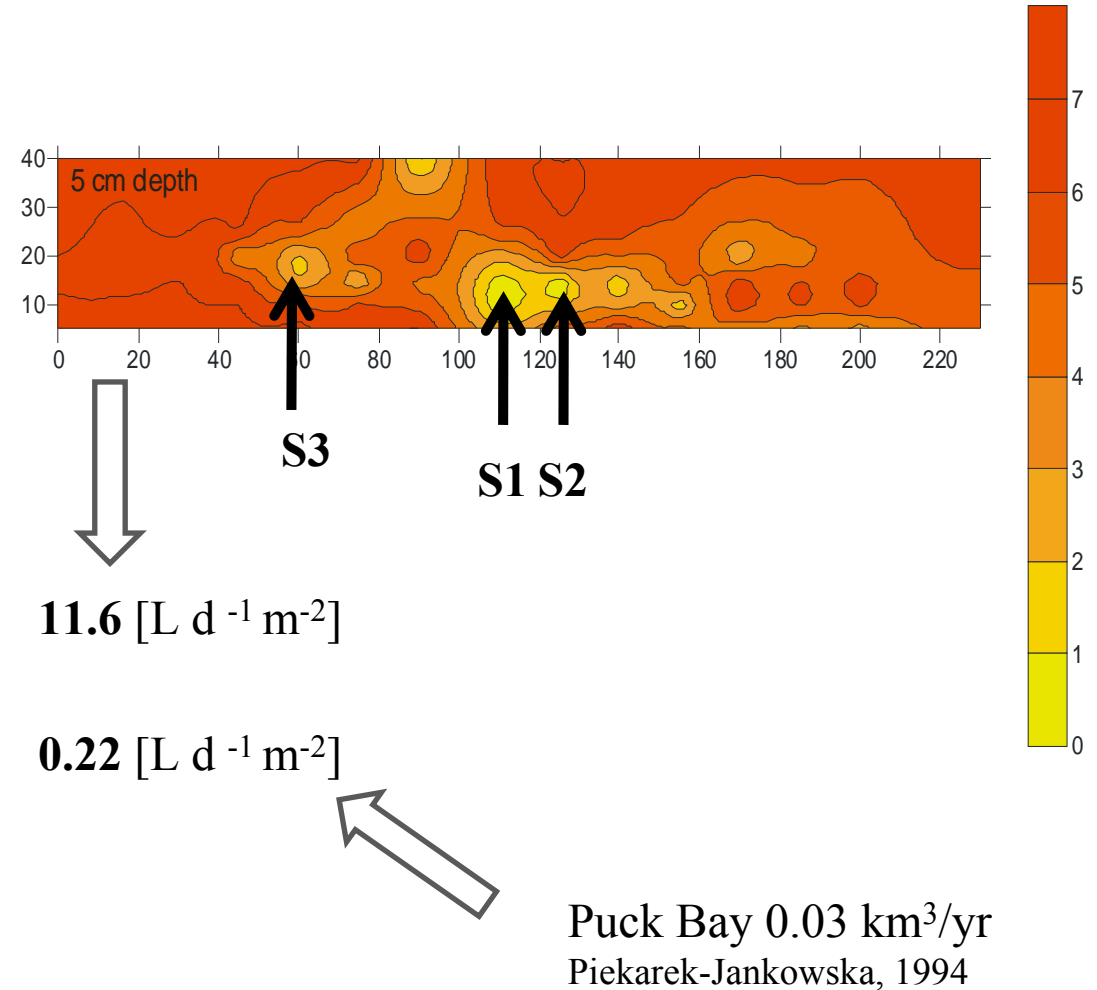




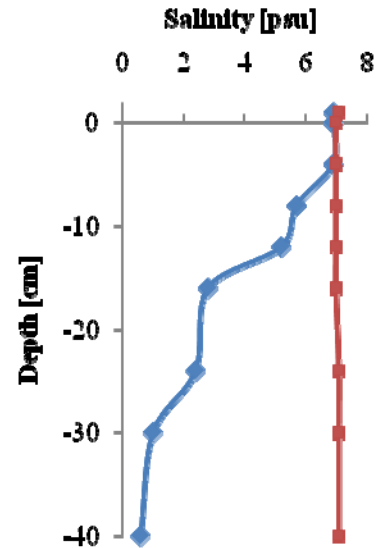
# 2. Quantyfication SGD

## Seepage meter measurements

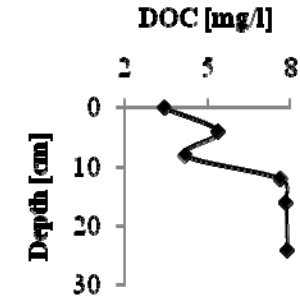
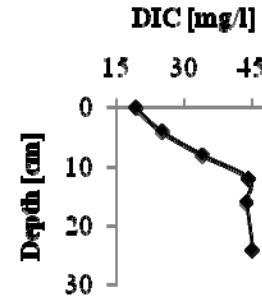
Date	S [psu]	F [L d <sup>-1</sup> m <sup>-2</sup> ]	F[L d <sup>-1</sup> m <sup>-2</sup> ] – using end member method	
<b>2.09.09</b>				
S1	4.1	64.4	28.5	
S2	5.6	23.2	5.3	21.3
S3	5.2	89.7	25.6	
<b>4.11.09</b>				
S1	6.3	99.9	12.8	
S2	6.5	187.1	18.7	18.4
S3	6.1	150.4	23.6	
<b>28.02.10</b>				
S1	5.8	7.1	1.4	
S2	5.6	10.2	2.3	3.0
S3	4.7	15.1	5.4	
<b>5.04.10</b>				
S1	5.9	19.3	3.6	
S2	3.7	7.3	3.7	3.6
S3	6.5	36.7	3.7	



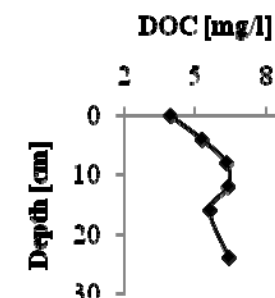
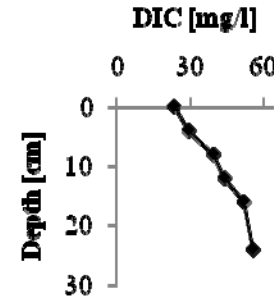
# 3. Seepage/seawater interface- DIC and DOC profiles



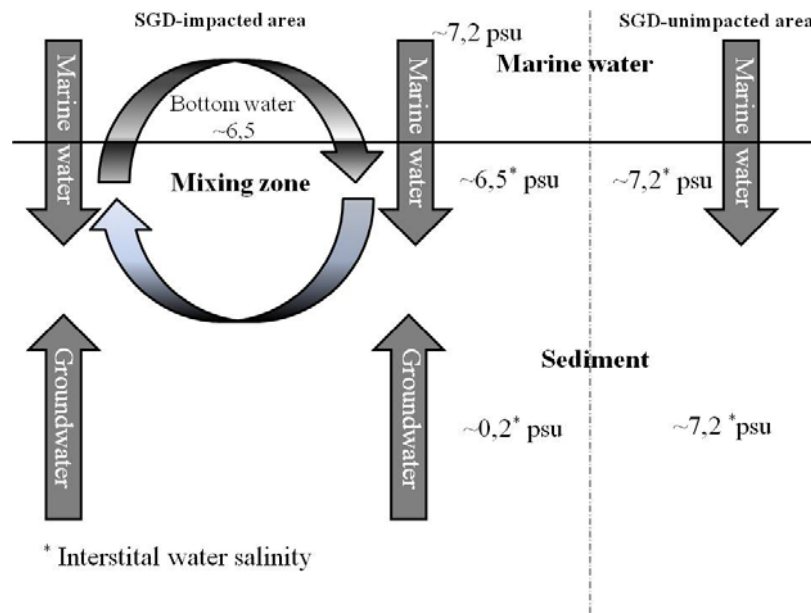
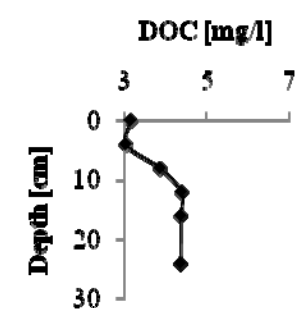
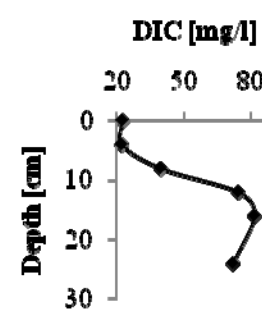
2-6.11.2009



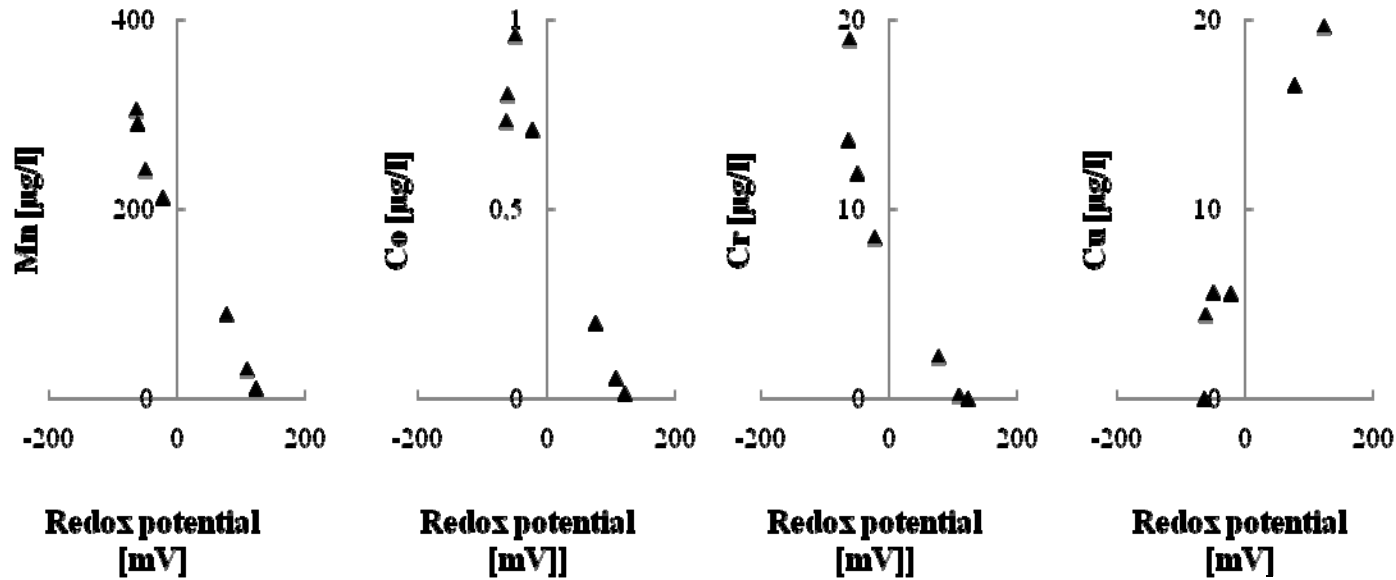
28.02-1.03.2010



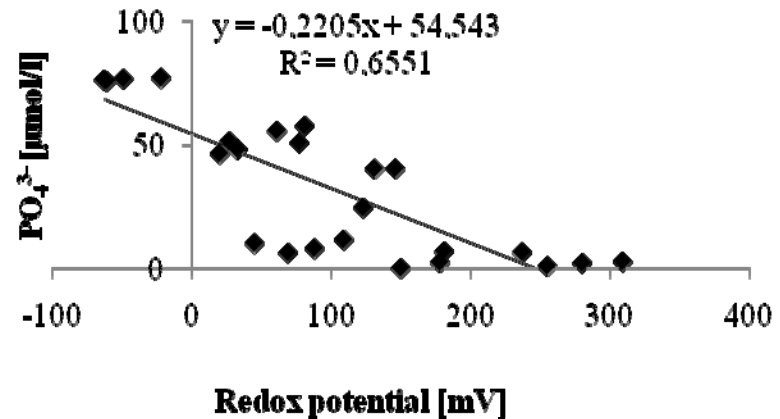
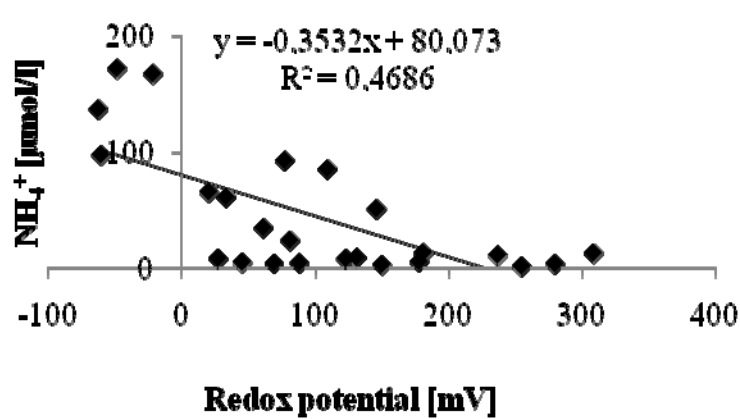
5-7.05.10



# Speciation changes- red-ox reactions



2-6.11.2009



## 4. Loads chemical substances fluxes via SGD- nutrients example.

Nutrients [ $\mu\text{mol/l}$ ]	August,2009	November,2009	February,2010	May,2010	
$\text{PO}_4^{3-}$	55.17 $\pm$ 0.4	76.56 $\pm$ 0.3	61.2 $\pm$ 21.8	49.02 $\pm$ 18.1	SGD to Puck Bay 0,03 km <sup>3</sup> /yr Piekarek-Jankowska, 1994 <b>DIN 49.9 <math>\pm</math>42.5 t/yr</b> <b>DIP 56.3 <math>\pm</math>14.4 t/yr</b>
$\text{NH}_4^+$	239 $\pm$ 130.2	117.01 $\pm$ 27.9	60.5 $\pm$ 21.8	55 $\pm$ 4.2	SGD to Baltic Sea 4,4 km <sup>3</sup> /yr Peltonen,2003
$\text{NO}_3^-$	0.37 $\pm$ 0.1	0.25 $\pm$ 0.07	0.58 $\pm$ 0.1	0.33 $\pm$ 0.18	<b>DIN 7175.6 <math>\pm</math> 6237 t/yr</b>
$\text{NO}_2^-$	0.28 $\pm$ 0.007	0.3 $\pm$ 0.15	0.23 $\pm$ 0.02	0.17 $\pm$ 0.1	<b>DIP 8667.7 <math>\pm</math> 1823/yr</b>

Fluxes to Puck Bay	DIP [t/year]	DIN [t/year]
Atmosphere	18	485
Rivers and colectors	70	220
SGD	56	50

# Summary

- **Presentations:**
  - **Submarine Groundwater Discharge to the Gulf of Gdańsk**, Szymczycha B., Vogler S., Kotwicki L, Dellwig O., Pempkowiak J., 2010. 6<sup>th</sup> Study Conference on BALTEX.
  - **Mercury concentrations in the seepage water discharged to the Puck Bay.2010..** B. Szymczycha, M. Miotk, L. Kotwicki, J. Pempkowiak. 2010. 15<sup>th</sup> International Conference on Heavy Metals in the Environment.
- **DIC and DOC fluxes to the Baltic Sea-originating from the Submarine Groundwater Discharge (SGD). Extrapolation based on the Bay of Puck study.** B. Szymczycha, A. Maciejewska, K. Kuliński, J. Pempkowiak. 2010. Baltic C – meeting, Lund, Sweden.
  - **Publications:**
    - **Accepted:** **Submarine Groundwater Discharge (SGD) to the Baltic Sea**,2010. B.Szymczycha,L.Kotwicki, J. Pempkowiak. Ann. Set Envir. Prot.
    - **Conference proceedings:** **The impact of submarine ground water discharge on a coastal ecosystem of the southern Baltic Sea: Results from the BONUS+ project AMBER. 2010.** S. Vogler, B. Szymczycha, T. Gentz, O. Dellwig, L. Kotwiki, R. Endler, J. Pempkowiak, J., M. Weslawski, M. Schlüter, M. E. Böttcher. Geo. Res. Abs. Vol. 12, EGU2010-2974-1.
    - **Mercury concentrations in seepage water from the Hel district.** Szymczycha B., Miotk M., Bełdowski J., Pempkowiak J., 2010. II ogólnopolska Konferencja Naukowa, „Rtęć w środowisku- Identyfikacja zagrożeń dla zdrowia człowieka”. II, 87-93.
    - **Almost finished:** **Nutrients fluxes via Submarine Groundwater Discharge to the Baltic Sea, extrapolation based on the Bay of Puck study.**
    - **Planned:** **Speciation dynamics of chemical substances in mixing area between groundwater and sea water.**
- **PhD dissertation planned for 2012**