DIC and DOC fluxes to the Baltic Sea -originating from the Submarine Groundwater Discharge (SGD).

Extrapolation based on the Bay of Puck study.

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Submarine groundwater discharge to the marine environment

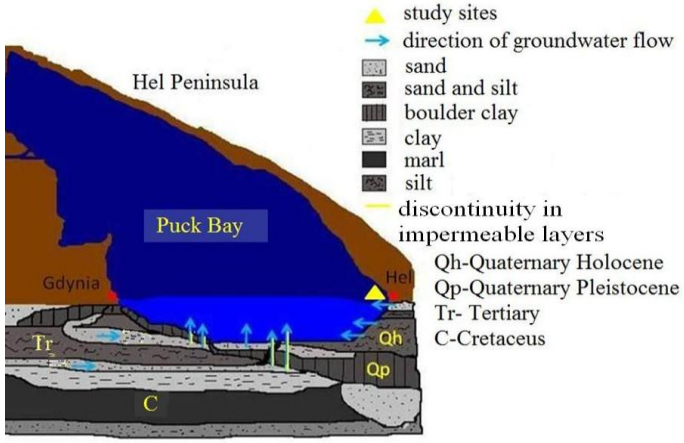


Fig.1 Hydrogeological layers of the study area (modified after Piekarek-Jankowska H. i in., Oceanologia. 1994).

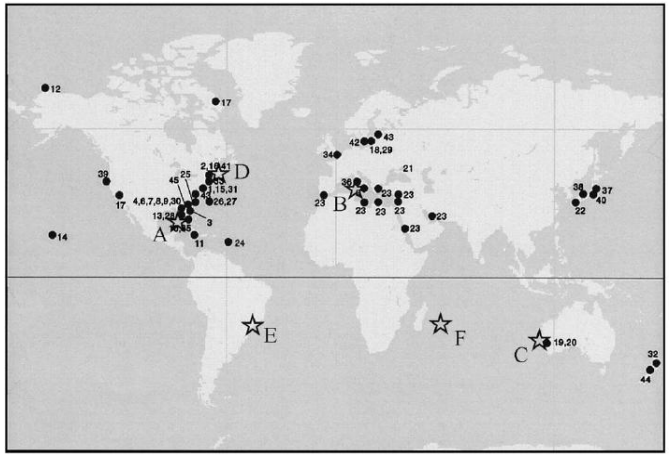


Fig.2 SGD study areas**.** Burnett et al., 2006.

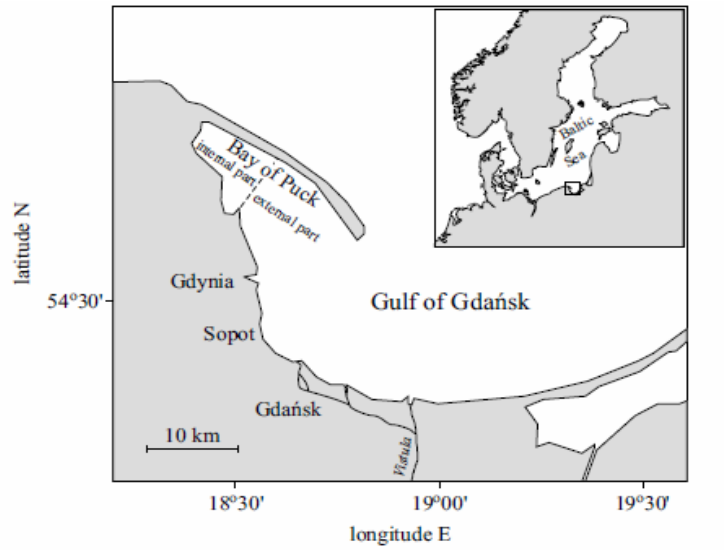


Fig.3 The study area.

Main goals:

- ❑ Measuring concentrations of listed below water components:
  - Selected trace metals: **Cr, Cu, Co, Ni, Mn, Zn, Pb, Cd, Hg** and metals: **Na, K, Ca, Fe,**
  - Nutrients: **NH_4^+, NO_3^-, NO_2^-, PO_4^{3-}, SiO_2,**
  - **DIC, DOC**: (dissolved inorganic carbon and dissolved organic carbon).

- ❑ Investigating speciation dynamics of the measured substances in the mixing zone between groundwater and sea water.

- ❑ Quantification the geochemical fluxes connected to seepages.

Details of sampling campaigns and methods of samples collection

Study area	Date	Samples type / samples amount
The Bay of Puck	23-26.03.09	Seepage water, sea water, interstitial water, groundwater/12
	31.08.09-04.09.09	Seepage water, sea water, interstitial water, groundwater/60 Sediment cores/4
	3-6.11.09	Seepage water, sea water, interstitial water, groundwater/60 Sediment cores/4
	27-29.02.10	Seepage water, sea water, interstitial water, groundwater/60 Sediment cores/4
	4-7.05.10	Seepage water, sea water, interstitial water, groundwater/40 Sediment cores/4

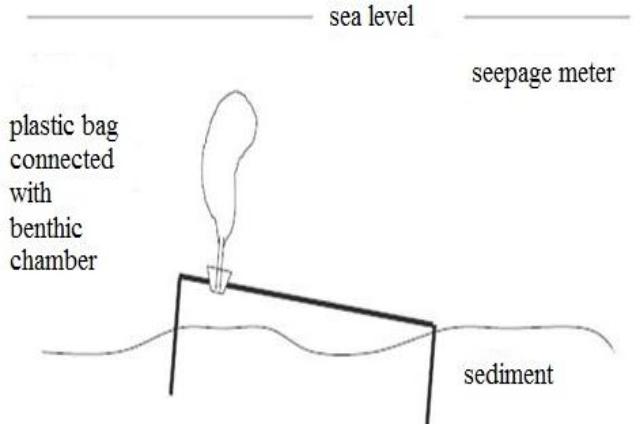


Fig.5 Seepage meter, (modified after Lee, 1977).

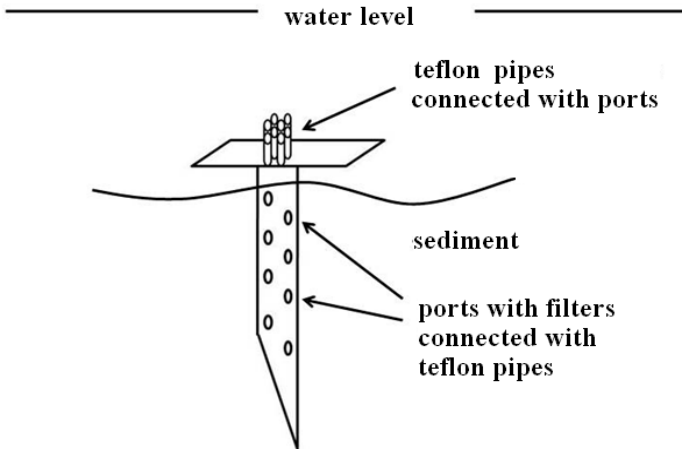
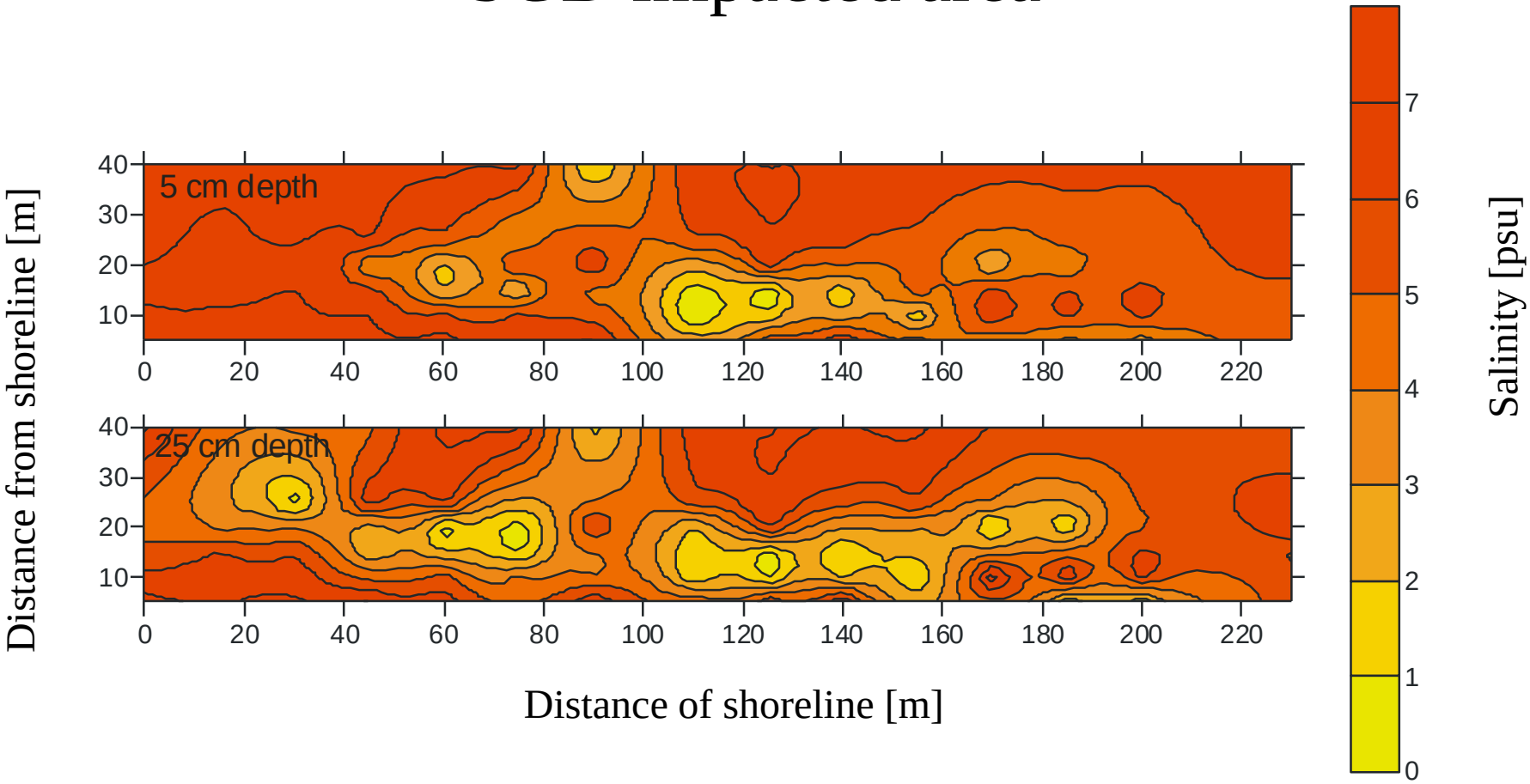


Fig.6 Groundwater lance.

Salinity of interstitial water collected from layers 5 cm and 25cm deep in sediments SGD impacted area



Salinity influence on DIC and DOC concentrations

Date	November, 2009		February, 2010			May, 2010	
Salinity [psu]	**2.1-2.8 (2.45)**	**7.1-6.9 (7)**	**0.4-1 (0.7)**	**6.9-7.2 (7.05)**	**Well 170m 0.2**	**0.6-1 (0.8)**	**6.9-7.1 (7)**
DIC [mgC/l]	**63.6-313**	**21-32**	**44-64**	**0.3-23.5**	**40**	**61.8-73.4**	**18.3-19.3**
DIC [µmol/l]	**5300-26083**	**1750-2666**	**3666-5333**	**25-1958**	**3333**	**5150-6117**	**1525-1608**
DOC [mgC/l]	**3.8-12.59**	**2.98-3.16**	**x**	**x**	**x**	**x**	**x**
DOC [µmol/l]	**316.7-1049**	**248.3-263.3**	**x**	**x**	**x**	**x**	**x**

- groundwater

- sea water

- water from well 170m

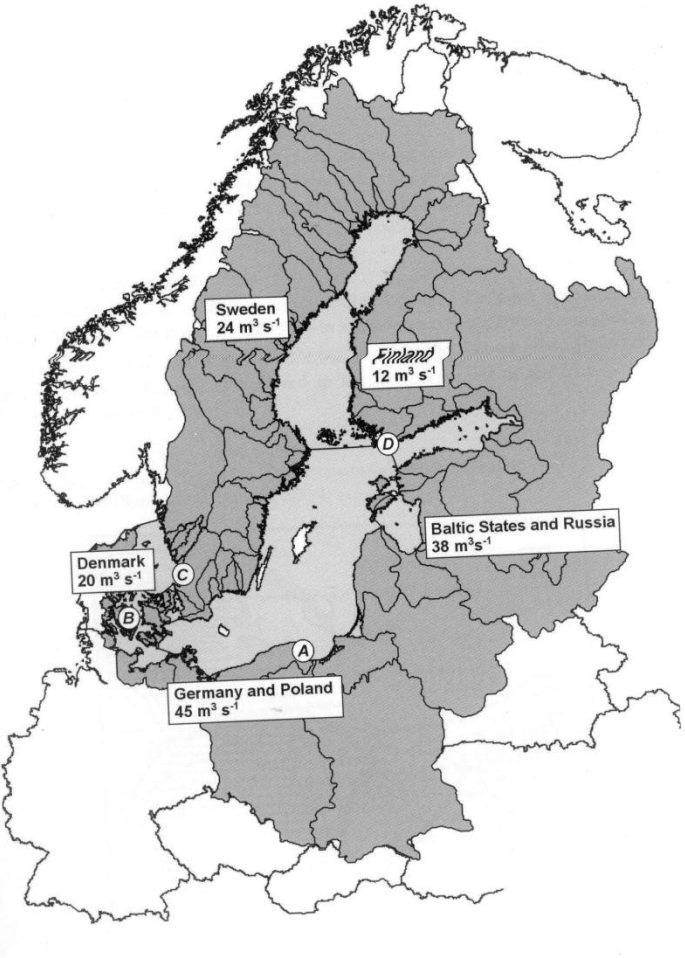
X- analysed but not calculated

Salinity influence on other water components

Chemical components of water	31.08.09-04.09.09		3-6.11.09	
	1,1-2,8 psu	7,2 psu	1,1-2,8 psu	7,2 psu
Cr [µmol/l]	$4,4 * 10^{-3}$	$0,2*10^{-3}$	0,1	$8,7*10^{-3}$
Co[µmol/l]	$1,1*10^{-3}$	$0,8*10^{-3}$	$6,8*10^{-3}$	$0,7*10^{-3}$
Mn[µmol/l]	1,9	0,02	1,9	0,1
Cu[µmol/l]	0,5	0,5	0,06	$2,2*10^{-3}$
PO_4^{3-}[µmol/l]	45	0,4	64	12
NO_3^-[µmol/l]	0,325	0,8	1,5	3
NO_2^-[µmol/l]	0,228	0,6	0,8	0,4
NH_4^+[µmol/l]	264,5	49	115,9	15
SiO_2[µmol/l]	801	9	71	18

Approximate SGD to the Baltic Sea

Fig. 5 Approximate direct groundwater inflow to the Baltic Sea. Peltonen, 2002.



Approximate SGD to the Baltic Sea	m^3/s	m^3/h	km^3/yr
Puck Bay[1]	0.97	3500	0.03
Germany and Poland[2]	45	162000	1.4
Baltic states and Russia[2]	38	136800	1.2
Finland[2]	12	43200	0.4
Sweden[2]	24	86400	0.8
Denmark[2]	20	72000	0.6
$\sum^2$	139	500400	4.4

[1]Piekarek-Jankowska. 1994

[2] Peltonen. 2002

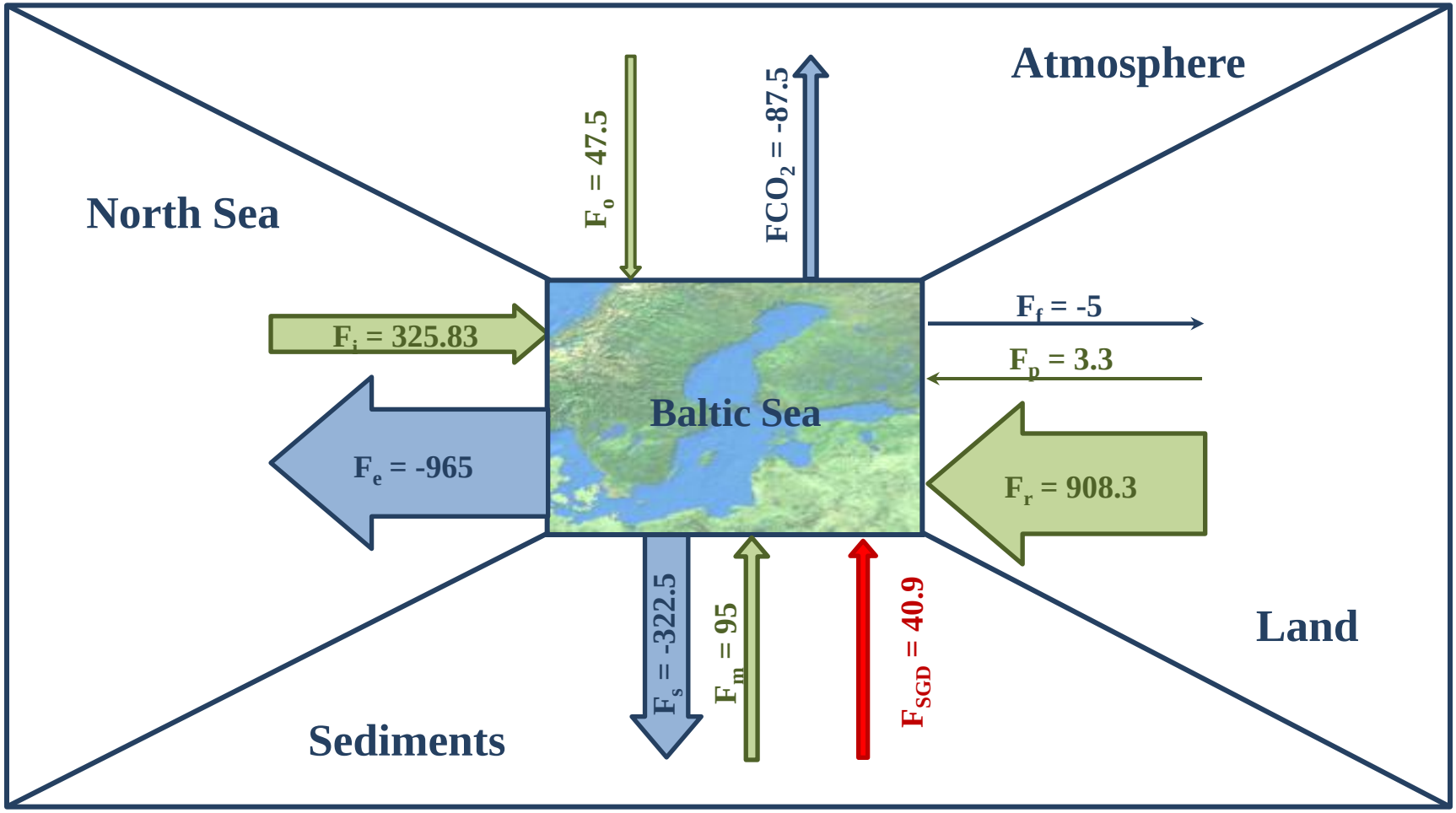
DIC and DOC fluxes to the Puck Bay and Baltic Sea

	SGD [km³/yr]	DIC [µmol/l]	DOC [µmol/l]	DIC Gmol/yr	DOC Gmol/yr	∑ DIC+DOC [Gmol/yr]
Puck Bay[1]	0.03	8608.2	682.85	0.3	0.02	0.3
Germany and Poland[2]	1.4	8608.2	682.85	12.1	1	13
Baltic states and Russia[2]	1.2	8608.2	682.85	10.3	0.8	11.1
Finland[2]	0.4	8608.2	682.85	3.4	0.3	3.7
Sweden[2]	0.8	8608.2	682.85	6.9	0.5	7.4
Denmark[2]	0.6	8608.2	682.85	5.2	0.4	5.6
∑ 2	4.4	8608.2	682.85	37.9	3	40.9

[1]Piekarek-Jankowska, 1994.

[2] Peltonen, 2002.

The quantitative carbon circulation for Baltic Sea



(modified after Kuliński, 2010).

Conclusions

- Submarine Groundwater Discharge is the important flux influencing geochemical cycle of elements in marine environment, especially the coastal areas.
- Carbon flux via Submarine Groundwater Discharge should be taken into account while speaking about the carbon budget.

I thank you for your attention