

# USING ENVIRONMENT TRACERS FOR INVESTIGATION OF BLACK SEA POLLUTION

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## Abstract

*In order to determine the groundwater discharge (SGD) areas into the sea during studies had been implemented and selected the new methodology of using ecological tracers, such as stable isotopes  $^{18}O$  and  $^2H$ , radionuclide Rn and Ra and other parameters. On the territory of Kobulety had been defined the groundwater flow direction and the areas of their submarine discharge. Within the identified areas was defined the intensity of eutrofication – the value of nitrate and phosphate content in groundwaters and in the sea. Also, had been studied their distribution on the surface and intensity of outwash into the sea.*

## 1. Introduction

Whereas river and sewage discharge into the sea are bound to distinct locations, thus allowing straightforward quantification of discharge rates and material budgets, the investigation of material transport via submarine groundwater discharge (SGD) is more challenging. Adding to the general difficulties in locating and investigating groundwater sources on the coastal seabed is the spatial and temporal variability that is typical for SGD.

SGD provides a major potential pathway for solute and particulate transport across the aquifer/ocean interface. Nutrients and contaminants carried by the groundwater have a significant potential to cause deterioration of the overall quality of the coastal environment. Related detrimental environmental impacts include contamination and eutrophication of the coastal sea, contamination of seafood, coral reef damage, and harmful algal blooms.

Aqueous tracers provide an appropriate tool for investigating SGD. “Environmental tracers” are defined as natural or anthropogenic substances that are ubiquitously present in the environment originating from defined sources. In contrast to artificially injected tracers they have the general advantage of not contaminating the studied environment by introducing chemicals that may prove persistent into the water body of concern. In addition, due to their ubiquitous occurrence environmental tracers are most suitable for large-scale and/or long-term studies, which are essential for comprehensive SGD investigation.

The scientific aim of the “SGD Black Sea” research project was the application of a multi-tracer approach for SGD research at two exemplary sites on the Black Sea coast. It was the intention to combine several appropriate aqueous tracer methods for SGD localization and quantification and to confirm the achieved findings by a novel approach based on satellite data. The applied satellite-based information allow (i) a water flow accumulation modelling approach based on a terrestrial digital elevation model (DEM) and (ii) an assessment of large scale and long term temperature patterns of the coastal sea. The two suggested study sites have been chosen in order to show strong exposure to anthropogenic pressure on the mountainous eastern coast of the Black Sea (Georgia).

### 2.1. FIELD WORK ON THE GROUND SURFACE

The coastal zone of study area is located between confluence of river Kintrishi and Kelenderi cape (Sarphi). The coastal zone has a concave form. The coastal zone is built by the sediments transported by rivers. Sediments are distributed by the coastal sea flows –for the south part of study area sea flow changes its directions - from the south to the north.

During the 2012-2013 on the territory of Adjara the field work along the coastline and the surrounding areas had been started. The main research goal was to explore and outline the contaminated areas along the coastline, which represent the potential sources of sea contamination. Along the coastline were sampled every kind of underground water outflow (river, spring, well and borehole). During field work the mobile group was moving by car, which was equipped with special devices (for Ph, conductivity, temperature, free oxygen as well as for Radon and Helium measurements). Besides, the selected points were sampled and the samples were shipped to the laboratory (Tbilisi) for further analyzing.

The sampled points were mapped by GPS and on the next step the data was processed by ArcMap. By the same software was mapped geological, hydrogeological and hydrochemical data. Above mentioned gave us possibility complex studies.

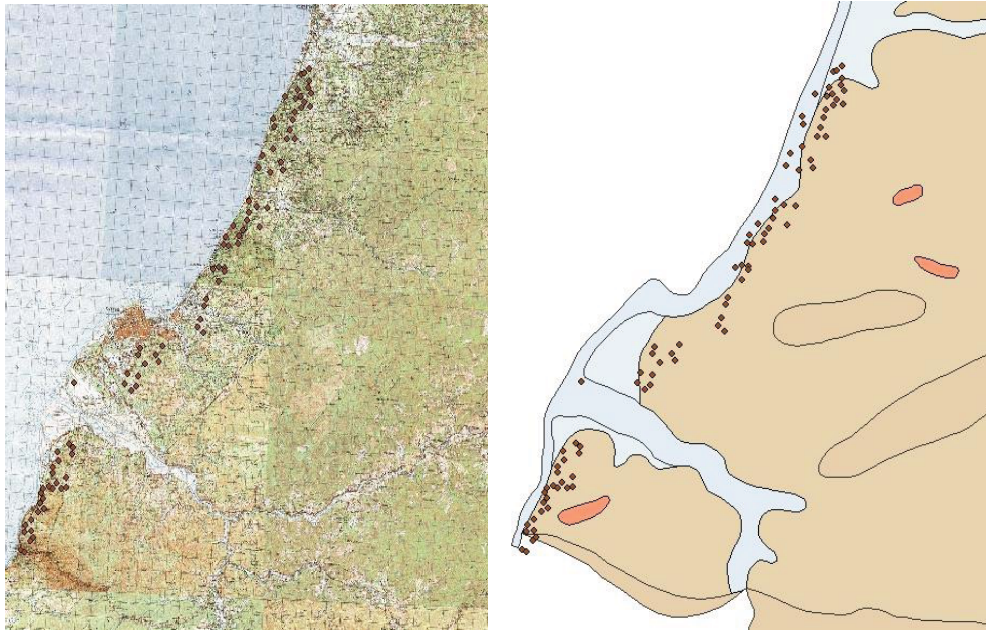


Fig. #1 Dislocation of sampled point on the Topographical and Geological map Had been observed the radon and helium distribution [1], [2] and their background values as well as hydrochemical parameters (Na, Ca, K, Mg, HCO<sub>3</sub>, SO<sub>4</sub> and Cl) in underground waters.

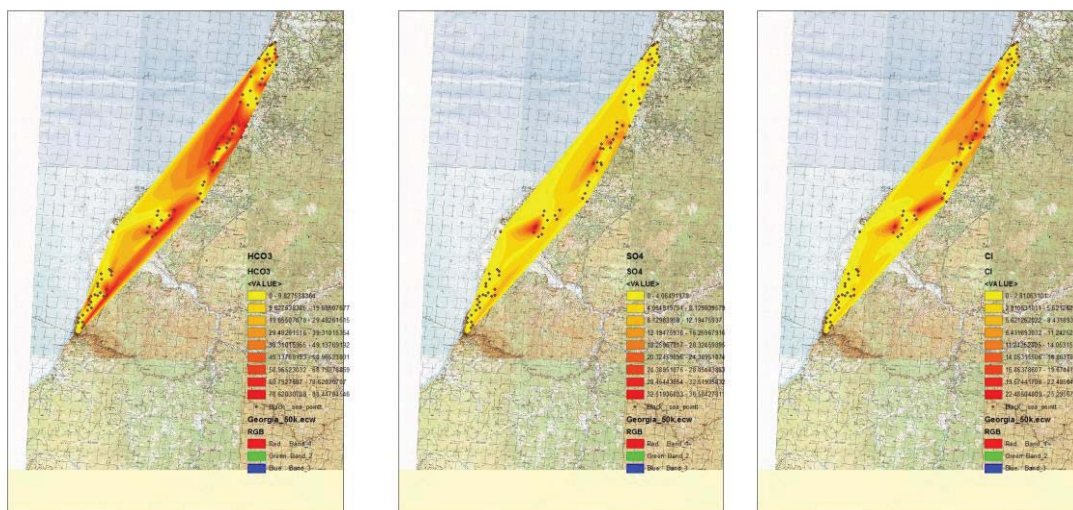


Fig. #2 Distributions of HCO<sub>3</sub>, SO<sub>4</sub>, Cl in the groundwater along the seaside There are fixed some anomalies located Northern from Batumi and on the territory of Kobuleti

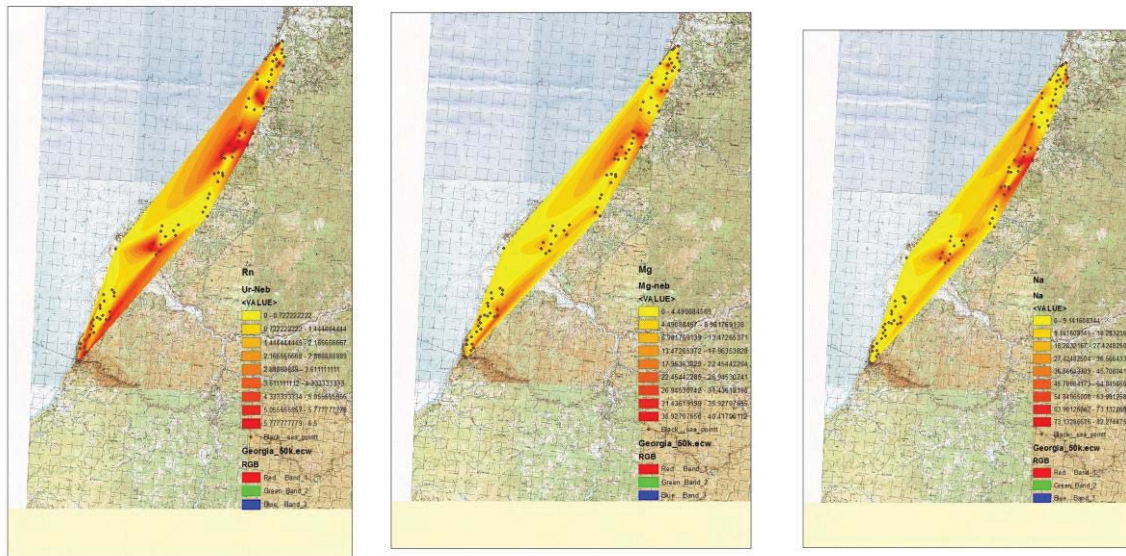


Fig. #3 Distributions of Rn, mineralization and Na in the groundwater along the seaside. During mapping arte fixed anomalies in the distribution of Rn in the groundwater. This zone consisted with anomalies zone of hydrochemical parameters. The observed anomalies may indicate on the polluted areas and represent the object of our interest for further detail studies.

## 2.2. MARIN SURVEYS

The preparation work for marine expedition had been done together with German colleagues. Namely, the satellite data processing was done by German colleagues. Had been processed and analyzed thermal background data of sea and ground surface.

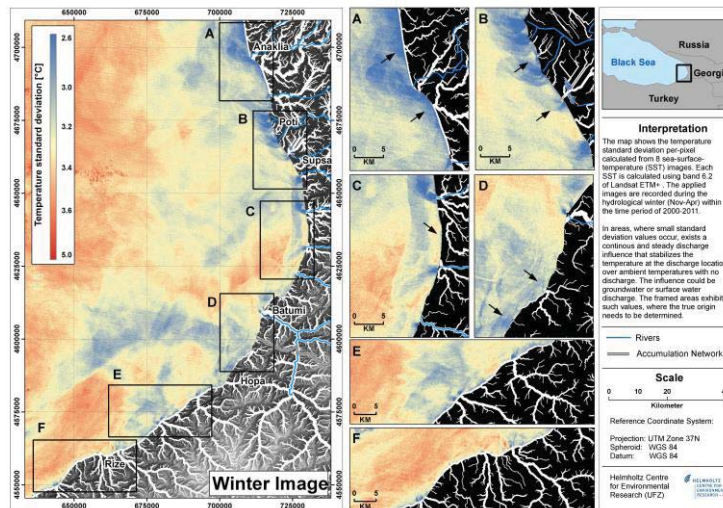


Fig. #4 Satellite data

On the picture shows the cold water discharge areas in the sea at the confluences of rivers as well as at the underground water discharge places. After analyzing two areas had been selected – the one North from Batumi and another one close to Kobuleti, where was expected to reveal the areas of underground waters discharge.

In September 2012 German colleagues arrived in Georgia. During their scientific visit the marine expedition in the Black sea coast was organized. There was done a profile From Batumi till Choloqi by boat and the water physical properties (conductivity, temperature and etc) and Radon concentration were measured continuously.



Fig. #5 Marin investigation



Fig. 6 Illustrates the radon concentrations and the related salinities that were detected along the coastline and on the perpendicular profile. Fig. 7 shows the same information as diagrams.

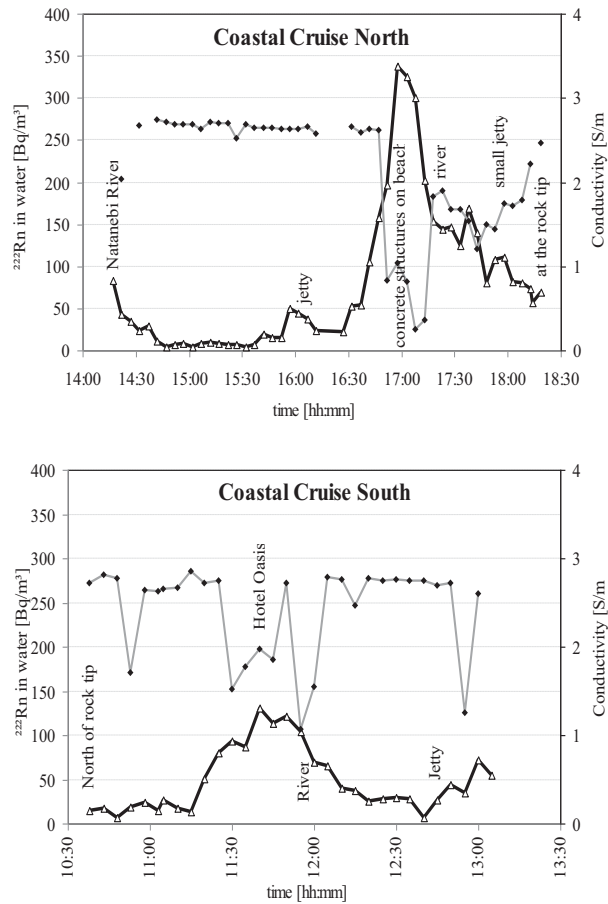


Fig. 7 Radon and salinities data recorded on the north (left) and South (right) profiles during the 1<sup>st</sup> sampling campaign in September 2012.

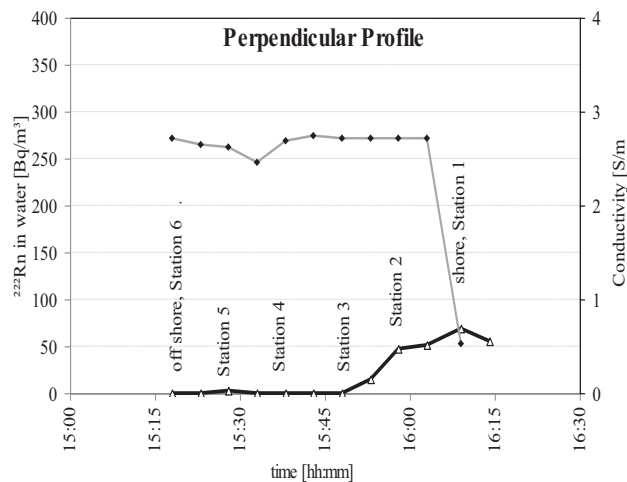


Fig. 8 Radon and salinity recorded during along the perpendicular profile in September 2012. As an additional parameter the pH of the seawater was recorded. As it becomes obvious in Fig. 8A the pH showed a distinct peak at the same location where elevated radon concentrations occur, indicating strong SGD. The data displayed in Fig. 8B, illustrating the findings along the southern part of the coastal survey, do also show a negative correlation between radon and pH, which is however not as distinct as the observation displayed in Fig. 8A.

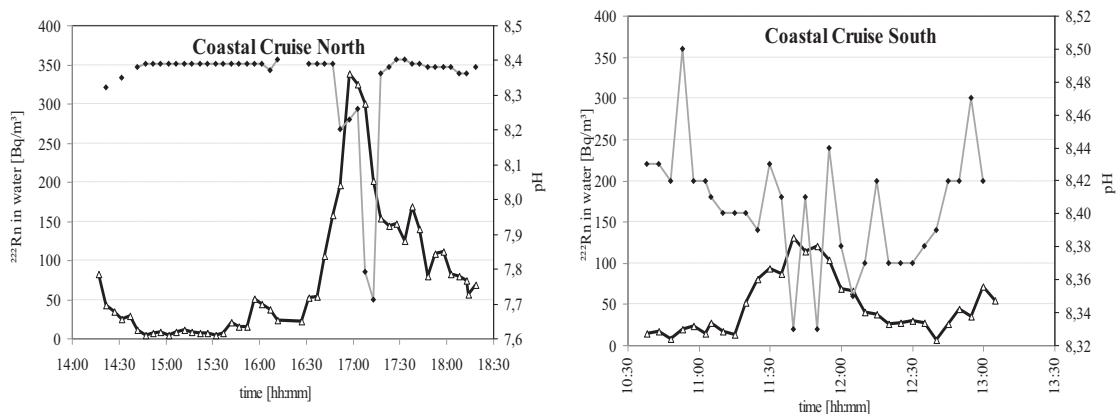


Fig. 9 Radon and pH data recorded during along the north (left) and South (right) part of the coastal survey in September 2012.

Along the perpendicular profiles also had been done sampling of stable isotopes –  $^{18}\text{O}$  and  $^2\text{H}$  in order to use them as additional tracers. The results showed that mixing of underground water with sea water occurs about 300 meters from the shore and the contribution of underground water is about 5%. By The joint marine and land investigations showed that found anomalous areas can be identified as continuation of each other.

In order to determine the intensity of eutrophication (nitrate and phosphate pollution) had been measured the nitrate and phosphate content in groundwater and sea water in areas of revealed groundwater submarine discharge. Their values are less than the allowable standard for nitrates and range from 0.2 - 3 mg / l and for phosphates 0.18 -1 mg / l.

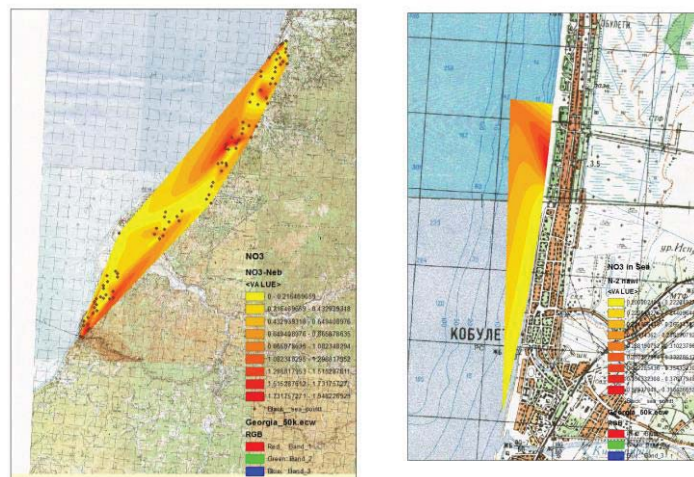


Fig. #10 Distributions of  $\text{NO}_3$  in the groundwater (left) and sea water (right) along the seaside

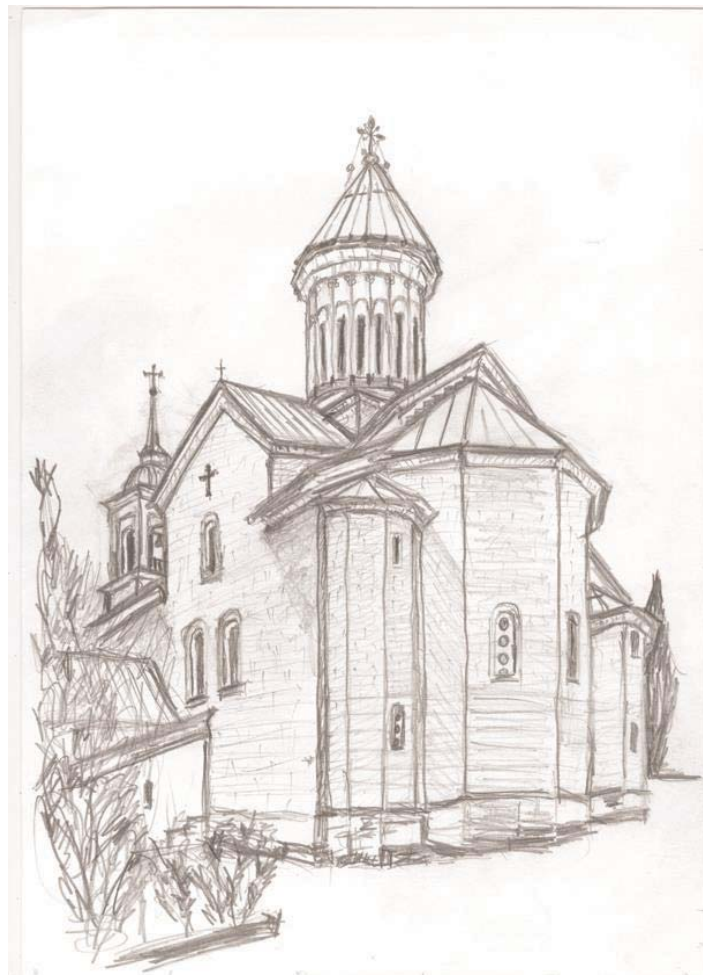
But, the mentioned tendency will decrease in time if the arable lands are not enriched by chemicals in future.

### 3. CONCLUSIONS

On the territory of Kobulety had been defined the groundwater flow direction and the areas of their submarine discharge; had been defined the surface character of contamination. Within the identified areas was defined the intensity of eutrofication – the value of nitrate and phosphate content in groundwater and in the sea. Also, had been studied their distribution on the surface and intensity of outwash into the sea.

#### 4. REFERENCES

- [1] Janja Vaupotič, Mateja Bezek, Nino Kapanadze, George Melikadze, Teona Makharadze, RADON AND THORON MEASUREMENTS IN WEST GEORGIA, Journal of the Georgian Geophysical Society 2012, in print
- [2] George I. Melikadze, Avtandil G. Amiranashvili, Kahha G. Gvinianidze, David G. Tsereteli, Mariam Sh. Todadze “Correlation Between Radon Distribution and prevalence of lung Cancer in West Georgia”, “Environment and Recourses”, Association of Academics of Science in Asia Workshop, 25-27 September 2009, Izmir, Turkey, pp 176-180



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