ERI-ONLINE-1-CT(R)-02

CROSS-BORDER REGIONS COLLABORATE FOR BLUE GROWTH PART 1. EXPLORATORY MONITORING OF AQUATIC ECOSYSTEMS

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Abstract: *Black Sea, with its water catchment area and coastal ecosystems, could be considered as a natural laboratory of global importance for fundamental science, sustainable policy and blue economy. That is why its protection is a task that can be solved with a long-term program for reasonable management and consumption of this valuable resource and will be successful if it uses as a basis the existing scientific capacity and knowledge and the created opportunities for research and monitoring of the ecological condition of Black Sea local ecosystems and implements various initiatives related to nature conservation and responsible behavior, involving the local community. Nowadays-in the time of changes and scientific discoveries for the success of this task are especially important also, the development and implementation of innovative projects - to increase the value of the local services, related to the water ecosystems and sustainable use of resources and the development and implementation of common methodologies and approaches in the applied research of the Black Sea at national and international level.*

Keywords: *Black Sea, water ecosystem, environmental monitoring, Blue Growth*

INTRODUCTION

Black Sea and its adjacent ecosystems are a resource of great importance to all Black Sea countries. Its scientific research aims its conservation and sustainable consumption and is a major task of Black Sea countries' scientific and research organizations and when these activities are held in partnership - their value and importance increases [Pokazeev et al., 2021].

The exploratory monitoring, which is the subject of this article, is carried out on the basis of a partnership research project in the cross-border Black Sea region Bulgaria - Turkey. For the purposes of the project, the Bulgarian side has selected some aquatic ecosystems of different types - Lake Vaya (Burgas Lake), Karaagach River (Kitenska River) and Burgas Bay on the Black Sea. All of them fall within the territorial scope of the Basin Directorate Black Sea Region Varna. The purpose of the exploratory monitoring is to create and implement a systematic approach for assessment and analyses of the ecological status of the studied ecosystems, to define and study the factors that put pressure on them, causing changes in their status and to propose measures to minimize their harmful effects, through:

- Use of the existing capacity and the created opportunities for research and monitoring of the ecological status of the local ecosystems;
- Filling the existing gaps in data and information on the ecological status of local aquatic ecosystems andassessment of the impact of the anthropological activities on it;

- Development and implementation of various initiatives related to nature conservation and responsible behavior, involving local communities;
- Development and implementation of innovative projects to increase the value of local ecosystem services and sustainable use of resources;
- Development and application of common methodologies and approaches in applied research in the cross-border region.

EXPOSITION

Exploratory monitoring indicators

By their nature, indicators provide information, about the current state of an ever-changing system, while the estimationing values of the indicators describe the dynamic relationships in the system [Boicenco et al., 2018]. Most sets of indicators currently used by countries and international bodies are used to characterize main environmental issues: climate change, acidification, toxic pollution and the waste, related to geographical levels. These problems can be observed in the ecosystems and therefore solutions are sought to suppress and / or eliminate them [Kudelsky, 2011]. For the purposes of this project, it is planned to study the monitoring indicators, divided by the components of the environment - water, climate and soils, for the three selected ecosystems:

Component - Water:

1. Physicochemical parameters - conductivity, temperature, pH, dissolved oxygen, dissolved organic matter, Keldal nitrogen ($N\text{-}NO_3$, $N\text{-}NO_2$), chlorophyll, dissolved solids, turbidity and salinity;
2. Pesticides - 28 organochlorine pesticides and polychlorinated biphenyls in surface, water column and sediment;
3. Gamma background;
4. Field measurement of polymers in surface waters;
5. Determination of micro polymers - surface, water column and sediment;
6. Determination of heavy metals (Table 1).

Component: Soils

1. Pesticides (28 organochlorine pesticides and polychlorinated biphenyls);
2. Gamma background;
3. Field measurement of polymers on the soil surface;
4. Keldal nitrogen in soils - N-nitrate, N-nitrite.

Component: Air

1. Fine dust particles ($PM_{2.5}$);
2. Fine dust particles (PM_{10});
3. Black carbon;
4. Gamma background.

Component: Climate

1. Air temperature
2. Sea water temperature;
3. Amount of precipitation;
4. Atmospheric pressure;
5. Dew point;
6. Relative humidity;
7. Wind direction - wind rose;
8. Wind speed;
9. Visibility;

10. Intensity of brightness;
11. Equivalent noise level.

Table 1. Heavy metals in surface and salt (sea) waters

Surface waters	**Salt (sea)waters**
Arsen, As	Arsen, As
Vanadium, V	Vanadium, V
Ferrum /iron (total), Fe	Ferrum/iron (total), Fe
Mercury, Hg	Mercury, Hg
Cadmium, Cd	Cadmium, Cd
Cobalt, Co	Cobalt, Co
Manganese / common /, Mn	Manganese / common /, Mn
Cuprum, Cu	Cuprum, Cu
Nickel, Ni	Nickel, Ni
Plumbum, Pb	Plumbum, Pb
Selenium, Se	Selenium, Se
Argent/Silver, Ag	Argent/Silver, Ag
Uranium, U	Uranium, U
Chromium, / common /, Cr	Chromium, / common /, Cr
Zinc, Zn	Zinc, Zn
Aluminum, Al	Aluminum, Al
Barium, Ba	Barium, Ba
Sodium, Na	-
Lithium, Li	Литий, Li
Strontium, Sr.	Стронций, Sr
Bismuth, Bi	Бисмут, Bi
Bohr, B	Бор, B
Beryllium, Be	Берилий, Be
Magnesium, Mg	-
Potassium, K	Potassium, K

EXPLORATORY MONITORING – DATA

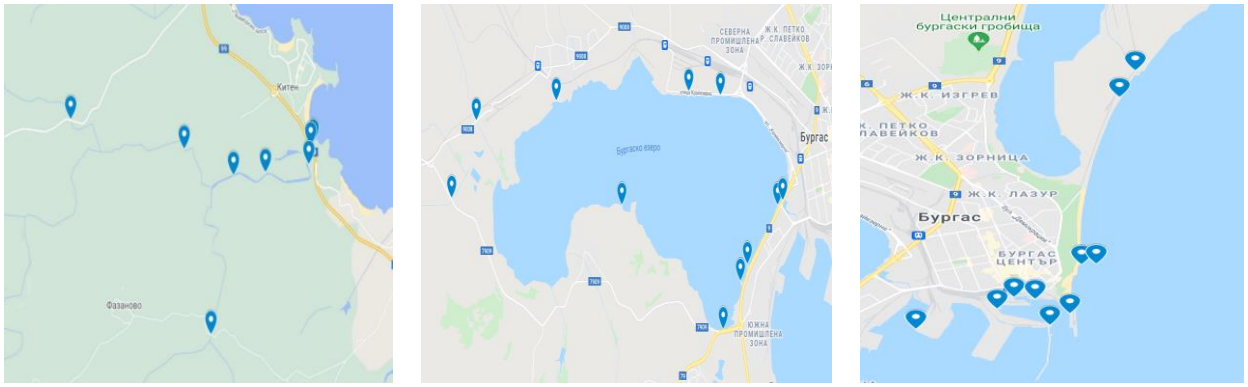
The data provided by the Executive Environment Agency - Laboratory Burgas, the Regional Health Inspectorate - Burgas, Regional inspectorate of environment and water -RIEW - Burgas and the Basin Directorate "Black Sea Region ", was used, for a detailed study on the environmental state of the explored ecosystems for the period 2018-2020 [http://www.eea.government.bg/; http://www.rzi-burgas.com/; http://riosvbs.com/; https://www.bsbd.org/]. For the three ecosystems, the obtained data was summarized on the basis of the indicators:

Radiation γ-background;
Noise pollution;
Physicochemical parameters;
Heavy metals in surface water;
Organochlorine pesticides in surface water;
Heavy metals in soils;
Organochlorine pesticides in soils and polychlorinated biphenyls in soils.

Based on the processed data from past studies in each of the observed ecosystems, are proposed sampling points, for monitoring of the selected indicators for the four components of the environment, listed above (Fig. 1).

Karaagach river ecosystem

Radiation γ-background: The provided data is from the available automated monitoring system for continuous monitoring of gamma radiation background monthly values from the Local Monitoring Station of the town of Ahtopol (LMS-Ahtopol), ie. do not coincide with the territory of the Karaagach River ecosystem and its sampling points set out in the sampling plan of this project. The measurement data is monthly average. For the period 2018-2020, the measured values are in the norm and no exceedances are reported.



Karaagach river *Burgas Lake* *Burgas Bay*

Fig. 1. Sampling points in the three selected ecosystems

Noise pollution: No data available for the period 2018-2020.

Physicochemical parameters: Excess values are observed for conductivity, ammonium, nitrate, phosphate ions, total nitrogen and phosphorus. The reasons for these higher values, could be related to the discharge of wastewater from the WWTP and the impact of the adjacent arable land and breeding of farm animals, as well as unregulated discharges of watercourses, including during the active tourist season. The measurements are once a month except for the winter period. The conductivity indicator is comparable with the data for salinity of river water, ie. with increasing salinity, the conductivity also increases.

Heavy metals in surface water: An one-time increase in the indicators of aluminum and iron for 2018 was reported. The high conductivity reported during the same period is most likely due to the high value of the salts of these metals. In 2019 and 2020, an one-time excess of manganese values was observed, which also contributes to the increase in conductivity.

Organochlorine pesticides in surface water: Data is available only for 2018, with all values far below normal.

Heavy metals in soils: Available data is from sample points that are not in the Karaagach ecosystem, but are the close located. No exceedances were reported. Data is available only for 2018, and all values are far below the norm.

Organochlorine pesticides in soils and polychlorinated biphenyls in soils: The available data is from sample points that are not in the Karaagach ecosystem, but are the closest sampling points. No exceedances were reported. Data for 2018 and 2019 is available, and all values are far below the norm.

Meteorological parameters and air quality with respect to PM have not been measured on the territory of Karaagach ecosystem.

Burgas Lake Ecosystem

Radiation γ-background: The data provided is from the territory of the Burgas Lake ecosystem, but doesn't coincide with the sampling points set in the sampling plan of this project. The data is annual. For the period 2018-2020 the measured values of gamma radiation background in this ecosystem are the lowest in comparison with the data on the other two ecosystems, they are in the norm and no exceedances are reported.

Noise pollution: No data available for the period 2018-2020.

Physicochemical parameters: Exceedances are observed for conductivity, dissolved oxygen for 2018 and 2020, with the largest excess detected in 2020 for total phosphorus. This is the only one of the ecosystems observed under the project, in which the amount of the biological parameter Chlorophyll A is monitored. Data is available for 2018 and 2020, and is in the norms. The water quality in Burgas Lake is controlled by regulating the water flows, which exert anthropogenic pressure. Additional pressure is exerted by the rivers that flow into Lake Burgas.

Heavy metals in surface water: All data provided is in the legal norms, and no exceedances of any indicator have been reported.

Organochlorine pesticides in surface water: Data is available for 2019 and 2020, with all values far below normal.

Heavy metals in soils: The available data is from sample points that are not on the territory of the Burgas Lake ecosystem, but are the closest sampling points and the measurements had been done once a year. An excess of nickel was reported in 2019, but data for 2020 is missing.

Meteorological parameters: No meteorological parameters have been measured on the territory of the Burgas Lake ecosystem, but those from Bourgas Airport and NIMH are representative for the region.

Air Quality (PM): The air quality assessment station is located in Dolno Ezerovo village area and is not in close proximity to the Burgas Lake ecosystem. It had been measured only, the concentration of fine dust particles with an aerodynamic diameter of 10 microns, but not, those of 2.5 microns. An excess was reported in 2018, and at this sample point the reason for this is the local domestic heating.

Burgas Bay Ecosystem

Radiation γ-background: The provided data is from the territory of the city of Burgas (central area) and does not coincide with the sampling points set in the sampling plan of this project. The data is annual and among of all the considered ecosystems has the highest values, but doesn't exceed the safe limits.

Noise pollution: For the period 2018-2020 data can be borrowed from the noise monitoring of the Municipality of Burgas, but the points are far from those set in the current project and the influence of local sources is too strong.

Physicochemical parameters: Available data is for the second half of 2020 and not for all parameters. No exceedances are observed.

Heavy metals in surface water: No data available.

Organochlorine pesticides in surface water: No data available.

Heavy metals in soils: No data available.

Meteorological parameters: On the territory of Burgas Bay ecosystem, the meteorological parameters were measured by NIMH, but also those from Bourgas Airport are representative for the region. The temperature of the sea water from the month of May 2020 is measured on the territory of the Port of Bourgas.

Air quality (PM): The station for assessment of atmospheric air quality is located on the territory of the Port of Bourgas, but the measurements are indicative because they are not exactly following the Bulgarian National standard and are from June 2020. The data is from the measurement of the concentration of only fine dust particles with an aerodynamic diameter of 10 microns, without those of 2.5 microns. The reported concentrations are far below the norm.

CONSLUSION

The available measurement data is incomplete and cannot give a clear idea of the current state of ecosystems in the region. Conducting of systematic planned exploratory monitoring will allow the tracking of the trend of indicators, their interconnectedness, the impact of external pressure, opportunities for self-purification and sustainable ecological response of the explored ecosystems.

ACKNOWLEDGMENT

The study was developed within the project "Cross-border regions cooperate for BLUE GROWTH COLLABs", CB005.3.12.001, funded by the Interreg Program - IPA for cross-border cooperation Bulgaria - Turkey 2014-2020 (Interreg IPA Cross-border Cooperation Bulgaria - Turkey Program**)**.

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