# THE ANALYSIS OF RIVERS MONITORING IN BLACK SEA REGION

VOINA A., ALECU G., CÎRCIUMARU G., CHIHAIA R
National Institute for Research and Development in Electrical Engineering ICPE-CA, Bucharest, 313 Splaiul Unirii, District 3, Bucharest, Romania
andreea.voina@icpe-ca.ro

**Abstract - The rivers coming to the Black Sea (BS) are the most significant source of pollution and eutrophication of the Sea. Their water quality monitoring is a prerequisite for establishing the BS pollution level and their share to the nutrient enrichment and hazardous substances input. This can contribute to building programmes of measures based on proper nutrient assessment and pollution-reduction schemes. At the Black Sea countries level, the rivers monitoring is done using different approaches, based mainly on national regulations and less on European Directives, which are not entirely transposed in certain national legislations, like in Georgia, Ukraine and Turkey. Therefore, the Black Sea rivers monitoring harmonization in the region is a pending issue in the regional agenda of environment protection, since each country should quantify the amount of total load of nutrients and hazardous chemicals coming to the Black Sea using the same methodologies. In this regard, this paper is focusing on reviewing and managing the current rivers monitoring strategies and practices in the Black Sea countries (Bulgaria, Georgia, Romania, Turkey, Ukraine) in order to compare them and outline the harmonization needs.**

**Keywords:** Black Sea rivers, pollution, monitoring, legislation, harmonization.

## 1. INTRODUCTION

The total riverine discharge (water and substances) to the Black Sea differs considerably (for the same reporting/monitoring period) in level and sometimes in trends, according to various bibliographical sources [1] [2]. Moreover, there can be also found cases when there are different estimates even for a single river case. The most famous is the case of the Danube River, which is a transboundary river, the largest one in the Black Sea catchment area. In Fig. 1 and Fig. 2 can be seen that both for inorganic nutrients load and total phosphorus and N-$NO_3$ loads are appreciable differences between the monitoring points/sources.

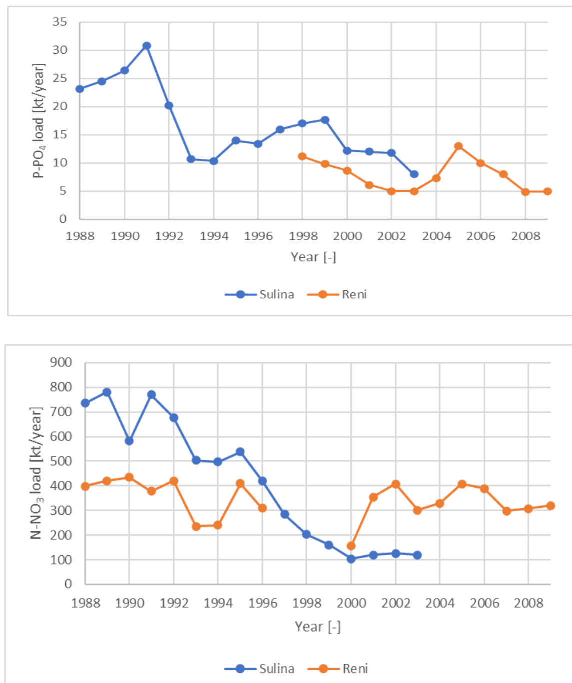
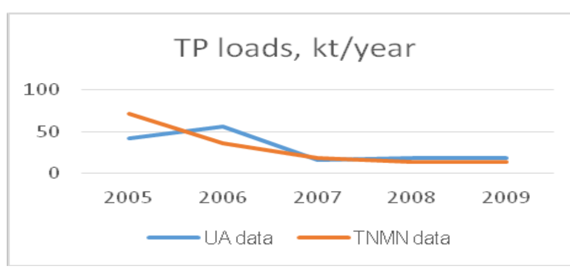



**Fig. 1. Inorganic nutrient (phosphates and nitrates) loads (kt/year) stemming with Danube waters to the Black Sea (period 1988-2009) [1, 2]**

***Note***: Blue line (Sulina station) – data source NIMRD Grigore Antipa (Constanta, Romania) [1]; orange line (Reni station) – data source Trans-national monitoring network of ICPDR (TNMN) [2].



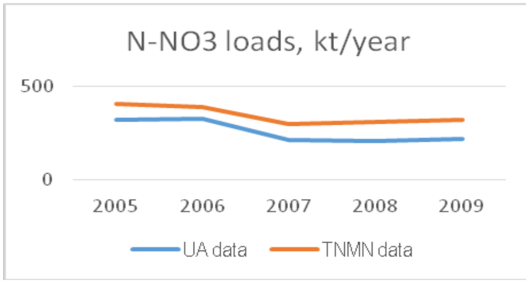



**Fig. 2. Total phosphorus and N-NO$_3$ loads (kt/year) stemming with Danube waters to the Black Sea (period 2005-2009) [2, 3]**

***Note***: Blue line – Ukrainian data source (measurements in the Chilia branch of Danube) [3]; orange line – TNMN data source (measurements at Reni) [2]

Another example of different reported data is for the case of the transboundary Cherokhi[1] (Choruh in Turkish) River, where Georgia (GE) and Turkey (TR) estimates do not match (Fig. 3). Unfortunately, since almost each country in the Black Sea Region, except the EU member states, has its own rules, modalities and parameters to be monitored, a comparison for phosphorus or orthophosphates cannot be provided as such data are absent (or at least not accessible) in Georgia.

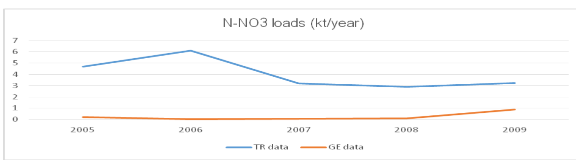



**Fig. 3. N-NO$_3$ loads stemming with Cherokhi (Choruh) River as estimated by GE and TR (period 2005-2009) [4]**

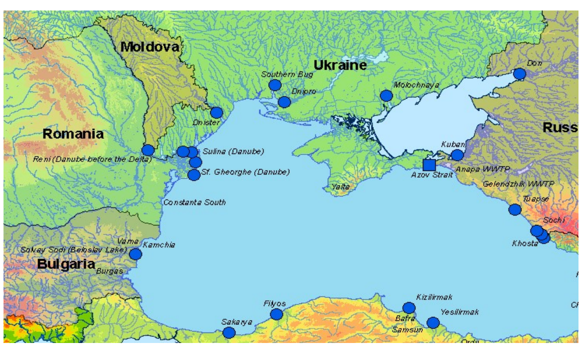



**Fig. 4. Black Sea largest rivers (see also stations at Sulina and Reni, used for calculation of Danube loads to the Black Sea) [4]**

The present paper analyses the data regarding rivers monitoring in Black Sea Region, countries Bulgaria, Georgia, Romania, Turkey and Ukraine in order to compare them and outline the needs in harmonization of the strategies and practices in each country. To make a proper comparation and to take measures when the case, it is necessary to apply the same measuring and monitoring methods for the set parameters. Thus, a database with correct information can be achieved, allowing to establish the contribution of each river to the nutrient enrichment and hazardous substances in the Black Sea. It is well known that the BS rivers are the most significant source of pollution and eutrophication of the Sea. Therefore, correct data on their contribution to certain physico-chemical parameters is of great importance. Otherwise, it is impossible to build knowledge-based nutrient and pollution reduction schemes with respective programmes of measures.

[1] In GE the River is also written Tchorokhi or Chorokhi.

## 2. RIVERS MONITORING AND ASSESSMENTS AS REQUIRED BY EU AND INTERNATIONAL LEGISLATION

### 2.1. Rivers monitoring and assessments as required by EU legislation

The European Water Framework Directive (WFD, Council Directive 2000/60/EC) is the centrepiece of European policy in the field of surface waters management, including monitoring. Full List of Guidelines under the WFD is given in [5]. The List includes a Guideline on monitoring, which inter alia explains how rivers should be monitored. Meanwhile, under the EU neighbourhood policy or other instruments, a number of EU-funded projects have been implemented during the last decade, which aimed at developing a WFD-compliant monitoring in Georgia, Turkey and Ukraine, with consequent preparation of river-basin management plans. Presently, the Water Framework Directive (WFD) has not been transposed yet in Georgia. However, a new draft Law on Water Resources Management, based on its principles, has been drafted and it is currently in the process of adoption [6]. In Ukraine, the WFD implementation is being also under development [7]. Although, in Turkey the alignment to WFD is complete, this country has planned to have 25 river basin management plans (RBMP) ready by 2023 [8]. With the River Basin Management Plans, the integrated water resources management is drafted considering the river protection and its uses.

Currently, WFD-compliant monitoring takes place in BG and RO only, the rest of the countries (GE, TR and UA) having their river-monitoring strategies under development. It is to be mentioned that the WFD requires a long-list of physico-chemical parameters, and also a number of hydromorphological and hydrobiological elements to be included in two major types of monitoring: surveillance and operational [9].

The purpose of ***surveillance monitoring*** is to provide the necessary data/information to:

- Supplement and verify results of anthropogenic pressure reviews and related risk assessments;
- Effective planning of future monitoring programs;
- Assessment of long-term changes under natural conditions;
- Assessment of long-term changes resulting from widespread anthropogenic activities.

The results of surveillance monitoring are analysed and used also in conjunction with the procedure for impact assessments, to develop or revise river basin management plans.

Operational monitoring covers all water bodies classified as water bodies at risk of failing to meet quality objectives (EcoQO). Operational monitoring is also applied to water bodies where priority substances are released.

The purpose of ***operational monitoring*** is:

- To establish the status of those bodies which are at risk in terms of achieving the WFD objectives;
- To evaluate the changes in the state of the water bodies at risk as a result of the implementation of a measures programme.

When choosing monitoring stations, the following basic requirements from Annex V to the WFD [9] are considered:

- For water bodies at risk from significant point sources of pressure, control points are scheduled in each body so that to assess the magnitude and nature of the impact of the point source. When water body is under the pressure of several point sources, the stations are selected so that to determine the cumulative effect of all types of pressures;
- For water bodies at risk from significant diffuse sources, control points in each body are chosen so that to assess the magnitude and influence of this type of pressure;
- For water bodies at risk from significant hydromorphological pressure – the same as above.

In choosing monitoring parameters in each water body, the most sensitive elements are considered in view of predetermined types of anthropogenic pressures to which the respective body is subjected (e.g., organic pollution, priority and specific substances, etc.).

Both under surveillance and operational monitoring, the ***frequency of sampling*** is determined in line with Annex V of the WFD [9], taking into account local specifics of variability. General criteria also include:

- Provision of results reliability;
- Provision of information on the seasonal variability of the impact of natural and/or anthropogenic pressures influencing the water bodies condition;
- Provision of information for understanding the structure and functioning of the ecosystem, referring to: the spatial and temporal variability of the ecosystem components, the dynamics of water in water bodies (residence time), the results of previous monitoring studies.

Before building monitoring programmes, the WFD requires a number of important preparatory steps. In the case of rivers, they are as follows:

- Identify the river type;
- Specify the water body type;
- Classify the water body based on risk assessment (to distinguish between operational and surveillance monitoring);
- Set reference conditions,
- Set environmental targets (they are traced actually in the 6 years cycles of the WFD implementation).

Under the WFD, a third type of monitoring is included – ***Investigative monitoring***. The WFD [9] states that this type of monitoring is required in the following situations:

1. In cases when the reason for failure to meet environmental standards is unknown;
2. When surveillance monitoring indicates that it is unlikely the environmental targets set in protection to be achieved, and operational monitoring has not yet started to verify the reasons of failure to achieve the set environmental targets for a water body or for some water bodies;
3. To clarify the magnitude and impacts of accidental pollution.

The list of parameters in investigative monitoring is dynamic and its validity in time is limited, in order to respond to new information on the potential risks posed by emerging pollutants and by any other alterations.

However, the WFD is not the only EU legal document requiring rivers monitoring. According to [10], relevant legislation includes also:

- Birds Directive (Directive 2009/147/EC of the European Parliament and of the Council of 30 November 2009 on the conservation of wild birds);
- Habitats Directive (Council Directive 92/43/EC of 21 May 1992 on the conservation of natural habitats and of wild fauna and flora);
- WWTP Directive (Council Directive of 21 May 1991 concerning urban waste water treatment (91/271/EEC));
- Nitrate Directive (Council Directive of 12 December 1991 concerning the protection of waters against pollution caused by nitrates from agricultural sources (91/676/EEC));
- Directive 2006/113/EC of the European Parliament and of the Council of 12 December 2006 on the quality required of shellfish waters;
- Directive 2010/75/EU of the European Parliament and of the Council of 24 November 2010 on industrial emissions (integrated pollution prevention and control;
- Directive 2007/60/EC of the European Parliament and of the Council of 23 October 2007 on the assessment and management of flood risks;
- Regulation (EU) 2017/1004 of the European Parliament and of the Council of 17 May 2017 on the establishment of a Union framework for the collection, management and use of data in the fisheries sector and support for scientific advice regarding the common fisheries policy and repealing Council Regulation (EC) No 199/2008;

Very important Directives, which are taken into account in conducting of rivers monitoring, are:

- Commission Directive 2009/90/EC of 31 July 2009 laying down, pursuant to Directive 2000/60/EC of the European Parliament and of the Council, technical specifications for chemical analysis and monitoring of water status;
- Directive 2008/105/EC of the European Parliament and of the Council of 16 December 2008 (Priority substances) on environmental quality standards in the field of water policy, amending and subsequently repealing Council Directives 82/176/EC, 83/513/EC, 84/156/EC, 84/491/EC, 86/280/EC and the supplementing Directive 2000/60/EC of the

European Parliament and of the Council. The Directive 2008/105/EC is amended by Directive 2013/39/EC.

All the above-mentioned EC Directives are transposed into the national legislation of BG and RO, and also partially in TR. Transposition is planned in GE and UA with deadlines specified in their Association Agreements (AA) which entered into force in 2016 [11, 12] (AA signed in 2014, with its Association Agenda replacing the European Neighbourhood Policy Action Plan (ENP AP)). The AA is part of a new generation of Association Agreements with Eastern Partnership countries and provides a long-term foundation for future EU-Georgia and EU-Ukraine relations, without excluding any possible future developments in line with the Treaty on European Union.

It is to be mentioned that rivers monitoring solely is not enough to build measures programmes in the so-called river-basin management plans. The latter require knowledge on all pressures – natural and anthropogenic – which influence the rivers. Thus, not only land-based sources (LBS) pressures are in need for tracing, but also pressures related to shipping, fishery, coastal zones development, rivers regulation, natural hazards, etc.

### 2.2. Rivers monitoring and assessments at Black Sea regional level

At regional level, rivers monitoring is required by the Bucharest Convention and its Protocols, namely the Protocol on Land-Based Sources and Activities (LBS). The latter was revised in 2005-2008 and signed by the BS coastal states on 17th of April 2009. However, the revised Protocol is not in force as being so far ratified by GE only. Thus, the acting Protocol [13] is the one from 1992 (ratified in 1994), which is considered quite outdated.

The Strategic Action Plan for the Environmental Protection and Rehabilitation of the Black Sea BS SAP2009 [14] is the Guiding document toward improvement of the environment protection governance at the regional level. It contains targets which are directly or indirectly addressed to rivers monitoring:

***Target 30***: Introduce cost efficiency approach to nutrient management in all BS countries;

***Target 37***: Harmonise the monitoring and assessment of N & P (concentrations and loads) in major rivers and straits;

***Target 51***: Develop/improve the existing monitoring system to provide comparable data sets for pollutant loads (from direct discharges and river inputs) and for other parameters;

***Target 52***: Improve the “List of Black Sea-specific priority pollutants” to help target monitoring priorities.

Therefore, the BS SAP2009 approaches rivers monitoring and the importance of its harmonization at regional level.

However, the regional Black Sea Integrated Monitoring and Assessment Programme (BSIMAP) [15] does not regulate rivers monitoring. It only requires reporting on river loads (specifies on what parameters) and such reporting takes place on annual basis.

Thus, there is no regional document which would ensure rivers monitoring harmonization and would specify how exactly this or these types of monitoring should take place.

Under the Black Sea Commission (BSC), reports on LBSs are being annually prepared, including Black Sea Basin rivers. However, the reports include very limited information on riverine loads; besides, it is not publicly available. The BSC 5-yearly Reports do not include amounts of nutrients and pollutants where loads of all Black Sea rivers should be taken into consideration.

## 3. RIVERS MONITORING IN BLACK SEA REGION

The analysis of the legislation and strategies on current rivers monitoring in the Black Sea region focused on rivers monitoring performed in Bulgaria, Georgia, Romania, Turkey and Ukraine. Serious differences in strategies have been found, thus making the comparation of generated data questionable.

Even in the very short List of parameters reported to the BSC, the BS countries rivers monitoring programmes have little in common as demonstrated below [4].

**Table 1. List of parameters reported by the BS countries to the BSC**

| Parameters (Estimated loads per year) | BULGARIA | GEORGIA | ROMANIA | TURKEY | UKRAINE |
|---|---|---|---|---|---|
| Nitrate (N-$NO_3$) | Yes | Yes | Yes | Yes | Yes |
| Nitrite (N-$NO_2$) | Yes | Yes | Yes | Yes | Yes |
| Orthophosphate (P-$PO_4$) | Yes | Yes | Yes | Yes | Yes |
| Total Nitrogen | Yes | | Yes | Rarely | No (TIN only) |
| Total Phosphorus | Yes | | Yes | Rarely | Yes |
| Ammonia (N-$NH_4$) | Yes | Yes | Yes | Yes | Yes |
| Zinc (Zn) - Dissolved | Yes | | Yes | | |
| Copper (Cu) - Dissolved | Yes | | Yes | | |
| Chromium (Cr) - Dissolved | | | Yes | | |
| Lead (Pb) - Dissolved | Yes | | Yes | | |
| Cadmium (Cd) - Dissolved | Yes | | Yes | | |
| Mercury (Hg) - Dissolved | | | Yes | | |
| Nickel (Ni) - Dissolved | Yes | | Yes | | |
| Total Zinc | | | Yes | Yes | Yes |
| Total Copper | | Rarely | Yes | Yes | Yes |
| Total Chromium | | Rarely | Yes | Yes | Yes |
| Total Lead | | | Yes | Yes | |
| Total Cadmium | | | Yes | Yes | |
| Total Mercury | | | Yes | Yes | |
| Total Nickel | | | Yes | Yes | |
| Iron | Yes (dissolved | Yes | Yes | | Yes |

| Parameters (Estimated loads per year) | BULGARIA | GEORGIA | ROMANIA | TURKEY | UKRAINE |
|---|---|---|---|---|---|
| | since 2010) | | | | |
| Lindane (instead of Gamma-HCH) | | | Yes | | Yes |
| TSS (instead of Suspended Particulate Matter) | Yes | Yes | Yes | | Only Suspended Particulate Matter |
| Total Hydrocarbons | | Rarely | Yes | | Yes |
| Anionic active surfactants (instead of detergents) | | | Yes | | Yes |
| Phenols | | | Yes | | Yes |
| PCB-28 | | | | | |
| PCB-52 | | | | | |
| PCB-101 | | | | | |
| PCB-118 | | | | | |
| PCB-153 | | | | | |
| PCB-138 | | | | | |
| PCB-180 | | | | | |
| Total PCBs | | | | | |
| BOD-5 | Yes | Yes | Yes | Yes | Yes |
| COD-Cr | Yes | | Yes (occasionally) | Yes | Yes |
| TOC | Yes | | Yes (occasionally) | | |
| AOX | | | | | |
| Tritium | | | | | |
| Other Radionuclides | | | | | Yes (Strontium-90; Cesium-137)-occasionally |
| Average Riverine Flow for the Year | Yes | Rarely (only for some rivers) | Yes | Yes | Yes |
| Long Term Annual Average for the Riverine Flow | Yes | Yes | Yes | Yes | Yes |

Other parameters than those from the BSC reporting are enlisted in the table 2. Among them, only pH is measured by all BS states.

**Table 2. Other parameters monitored in the BS states rivers**

| Parameters | BULGARIA | GEORGIA | ROMANIA | TURKEY | UKRAINE |
|---|---|---|---|---|---|
| pH | Yes | Yes | Yes | Yes | Yes |
| Temperature, T°C | Yes | Yes | | Yes | |
| Odour | | Yes | | | Yes |
| Chromaticity | | | | | Yes |
| Transparency | | Yes | | | Yes |
| Colour | | | Yes | | |
| Turbidity | | | Yes | | |
| Fluoride | | | Yes | | |
| Conductivity (electroconductivity, fixed residue), µS/cm | Yes | Yes | Yes | | Yes |
| $CaCO_3$-Hardness, mg $CaCO_3$/l | Yes | Yes | | | Yes |
| Dissolved oxygen, mg/l | | Yes | Yes | Yes | Yes |
| Oxygen saturation | | Yes | | | Yes |
| Total mineralization | | Yes | | | Yes |
| Sulphates | | Yes | Yes | | Yes |
| Chlorides | | Yes | Yes | | Yes |
| Ca | | Yes | | | Yes |
| Total magnesium (Mg) | | Yes | | | Rarely |
| Carbon dioxide | | Yes | | | Yes |
| Potassium | | Yes | Yes | Yes | Yes |
| Total silicon | | | | | Yes |
| Alkalinity | | | Yes | | Yes |
| Total manganese (Mn) | | Yes | Yes | Yes | Yeas |
| Total sodium | | Yes | | | Rarely |
| Oil products (visual) | | Rarely | | | Yes |
| Permanganate oxidation (COD-Mn) | | | Yes | | Rarely |
| Hydrogen sulphide | | | | | Rarely |
| Alachlor | Yes | | Yes | | |
| Anthracene, µg/l | Yes | | Yes | | |
| Atrazine, µg/l | Yes | | Yes | | |
| Benzene | | | Yes | | |
| (Benzo (a) pyrene), µg/l | Yes | | Yes | | |
| Benzo (b) floroanthene), µg/l | Yes | | Yes | | |
| Benzo (g,h,i) perylene, µg/l | Yes | | Yes | | |
| (Benzo (k) fluoroanthene), µg/l | Yes | | Yes | | |
| Brominated diphenylethers | | | Yes | | |
| C10 – 13 chloralkanes | | | Yes | | |
| Chlorfenvinphos | | | Yes | | |
| Chlorpyrifos µg/l | Yes | | Yes | | |
| 1,2-Dichloroethane, µg/l | Yes | | Yes | | |
| Dichloromethane, µg/l | Yes | | Yes | | |
| Di(2-ethylhexyl) phthalate (DEHP) | | | Yes | | |
| Diuron | | | Yes | | |

| Parameters | BULGARIA | GEORGIA | ROMANIA | TURKEY | UKRAINE |
|---|---|---|---|---|---|
| Endosulfan | | | Yes | | |
| alpha-endosulfan | | | Yes | | |
| Flouranthene, µg/l | Yes | | Yes | | |
| Hexachlorobenzene | | | Yes | | |
| Hexachlorobutadiene, µg/l | Yes | | Yes | | |
| Hexachlorocyclohexane | | | Yes | | |
| (gamma-isomer, lindane) | | | Yes | | |
| Isoproturon | | | Yes | | |
| Indeno (1,2,3-cd) pyrene, µg/l | Yes | | Yes | | |
| Naphthalene | | | Yes | | |
| Nonylphenols | | | Yes | | |
| (4-(para)-nonylphenol) | | | Yes | | |
| Octylphenols | | | Yes | | |
| (para-tert-octylphenol) | | | Yes | | |
| Pentachlorobenzene | | | Yes | | |
| Pentachlorophenol | | | Yes | | |
| Polyaromatic hydrocarbons | | | Yes | | |
| Simazine, µg/l | Yes | | Yes | | |
| Tributyltin compounds | | | Yes | | |
| (Tributyltin-cation) | | | Yes | | |
| 1,2,4 – Trichlorobenzene, µg/l | Yes | | Yes | | |
| Trichloromethane (Chloroform), µg/l | Yes | | Yes | | |
| Trifluralin, µg/l | Yes | | Yes | | |
| Prometon, µg/l | Yes | | | | |
| Prometryn, µg/l | Yes | | | | |
| Propazine, µg/l | Yes | | | | |
| Ametrin, µg/l | Yes | | | | |
| Simetryn, µg/l | Yes | | | | |
| Terbutryn, µg/l | Yes | | | | |
| Chl *a* | | | Yes | | |
| Macroinvertebrates | Yes | | | | |
| Macrophytes | Yes | Rarely | | | |
| Phytobenthos | Yes | | | | |
| Fish | Yes | | | | |
| Hydromorphological parameters | Yes | Rarely | Yes | | Yes |

Related to the monitoring frequencies for some major parameters, the table 3 shows the current situation.

**Table 3. Frequency of parameters sampling**

| Parameters | Frequency of measurements per month | | | | |
|---|---|---|---|---|---|
| | BULGARIA | GEORGIA | ROMANIA | TURKEY[2] | UKRAINE[3] |
| Nitrate ($N\text{-}NO_3$) | 1 (4 times per year) | 1 (12 times per year) | 1 (12 times per year) | 1 | 1 |
| Nitrite ($N\text{-}NO_2$) | 1 (4 times per year) | 1 (12 times per year) | 1 (12 times per year) | 1 | 1 |
| Orthophosphate ($P\text{-}PO_4$) | 1 (4 times per year) | 1 (12 times per year) | 1 (12 times per year) | 1 | 1 |
| Total Nitrogen | 1 (4 times per year) | | 1 (12 times per year) | 1 | 1 |
| Total Phosphorus | 1 (4 times per year) | | 1 (12 times per year) | 1 | 1 |
| Ammonia ($N\text{-}NH_4$) | 1 (4 times per year) | 1 (12 times per year) | 1 (12 times per year) | 1 | 1 |
| Silica | | | | | 1 |
| Zinc (Zn) - Dissolved | 1 (4 times per year) | | 1 (6 times per year) | - | - |
| Copper (Cu) - Dissolved | 1 (4 times per year) | | 1 (6 times per year) | - | - |
| Chromium (Cr) - Dissolved | | | 1 (6 times per year) | - | - |
| Lead (Pb) - Dissolved | 1 (12 times per year) | | 1 (6 times per year) | - | - |
| Cadmium (Cd) - Dissolved | 1 (12 times per year) | | 1 (6 times per year) | - | - |
| Mercury (Hg) - Dissolved | | | 1 (6 times per year) | - | - |
| Nickel (Ni) - Dissolved | 1 (12 times per year) | | 1 (6 times per year) | - | - |
| Total Zinc | | 1 (4 times per year) | 1 (6 times per year) | 1 | 1 |
| Total Copper | | 1 (4 times per year) | 1 (6 times per year) | 1 | 1 |
| Total Chromium | | | 1 (6 times per year) | 1 | 1 |
| Total Lead | | | 1 (6 times per year) | 1 | - |
| Total Cadmium | | | 1 (6 times per year) | 1 | - |
| Total Mercury | | | 1 (6 times per year) | 1 | - |
| Total Nickel | | | 1 (6 times per year) | 1 | - |
| Iron | Depends on type of monitoring | 1 (12 times per year) | 1 (6 times per year) | - | 1 |
| Manganese | | 1 | | | 1 |
| Lindane (instead of Gamma-HCH) | | | | | 1 |
| TSS (instead of Suspended Particulate Matter) | 1 (4 times per year) | 1 (12 times per year) | 1 (12 times per year) | | 1 |
| Total Hydrocarbons | | | 1 (12 times per year) | | 1 |
| Oil products (visual) | | | | | 1 |
| Anionic active surfactants (instead of detergents) | | | 1 (12 times per year) | | 1 |
| Phenols | | | 1 (12 times per year) | | 1 |
| PCB-28 | | | | | |
| PCB-52 | | | | | |
| PCB-101 | | | | | |

[2] Only conventional parameters like TSS, BOD5, COD, nitrate, nitrite, orthophosphate, total nitrogen, total phosphorus, ammonia, and trace metals (Hg, Cd, Cr, Cu, Zn, Ni) are analysed monthly or on 2 months intervals.

[3] As per the Hydromet monitoring system. The frequency depends on the stations sampled. Some stations with their set of parameters are observed every 10 days, others monthly, and there are stations with parameters monitored on a seasonal basis.

| Parameters | Frequency of measurements per month | | | | |
|---|---|---|---|---|---|
| | BULGARIA | GEORGIA | ROMANIA | TURKEY[2] | UKRAINE[3] |
| PCB-118 | | | | | |
| PCB-153 | | | | | |
| PCB-138 | | | | | |
| PCB-180 | | | | | |
| Total PCBs | | | | | |
| BOD-5 | 1 (4 times per year) | 1 (12 times per year) | 1 (12 times per year) | 1 | 1 |
| COD-Cr | 1 (4 times per year) | | 1 (12 times per year) | 1 | 1 |
| TOC | 1 (4 times per year) | | occasionally | | |
| AOX | | | | | |
| Tritium | | | | | |
| Other Radionuclides *(please name)* | | | | | |
| Average Riverine Flow for the Year | daily | daily (water level) | daily | 1 | 1 |
| Long Term Annual Average for the Riverine Flow | | | | | |
| **Hydrobiology** | | | | | |
| Phytoplankton | - | | once every 3 years | | |
| Macroinvertebrates (zoobenthos) | once every 3 years | | once every 3 years | | |
| Macrophytes | once every 3 years | | once every 3 years | | |
| Phytobenthos (microalgae) | once every 3 years | | once every 3 years | | |
| Fish fauna | once every 3 years | | once every 3 years | | |
| **Hydromorphology** | | | | | |
| *Water level (rivers)* | continuous | daily | 2 times daily | | |
| *Water flow (velocity/quantity and dynamics of rivers)* | monthly | | 2-60 times per year | | 1 |
| *Connectivity with groundwater bodies* | continuously 1 month | | once per 3 days | | |
| *River continuity* | once per 6 years | | once per 6 years | | |
| Variation of river depth and width | once per 6 years | | once per year | | 1 |
| Structure and substrate of the riverbed | once per 6 years | | once per 6 years | | |
| The structure of the riparian area (for rivers) | once per 6 years | | once per 6 years | | |

The national gaps in hydromorphological and hydrobiological monitoring can be noticed in Table 3. Additionally, in rivers monitoring, the BS countries poorly study biota contamination and sediments pollution.

## 4. CONCLUSIONS AS PER PRIORITIES IN HARMONIZATION

The analysis of the current situation in the Black Sea region regarding the physico-chemical parameters monitoring, the applied methods, the sampling stations, the monitoring frequency, the legal framework in each country, etc. revealed a series of steps to be followed and priorities to be applied in order to improve the water management of the BS and to ensure a better environmental protection of this area. To overcome the current bottlenecks and to achieve a proper rivers monitoring, the below specified actions should be taken.

### 4.1. Definitions

The terminology, hence, definitions are common for BG and RO, as required by EU legislation/policies. However, in GE, UA and TR national legislation does not identify or differently identifies important elements of monitoring and assessments, such as: types of monitoring, of rivers, of water bodies, reference conditions, environmental quality standards, environmental targets. Common definitions for the above specified terms are needed in the BS region to ensure national rivers monitoring programmes are built in a compatible way.

### 4.2. Identification of river types, water bodies and those which are at risk or not

The identification has already taken place in BG and RO. The monitoring conducted in GE, TR and UA does not take into account the river type or its water bodies classifications (first as a hydromorphologically homogeneous entity, and second – depending on the status – at risk or not at risk).

Harmonization in river types and water bodies identification at regional level would ensure the countries common approach revising their stations networks, choice of monitoring parameters and frequencies.

### 4.3. Choice of monitoring parameters and frequencies

Table 4 shows that there are very few parameters (basic physico-chemical) which are monitored in all BS countries, but not with the same sampling frequencies. As shown in table 2, there are differences regarding the monitored physico-chemical parameters, whereas priority and specific substances are mostly not monitored in GE, TR and UA.

**Table 4. Common parameters in the monitoring programmes of the BS countries**

| Parameters (Estimated loads per year) | BG | GE | RO | TR | UA |
|---|---|---|---|---|---|
| pH | Yes | Yes | Yes | Yes | Yes |
| Nitrate (N-$NO_3$) | Yes | Yes | Yes | Yes | Yes |
| Nitrite (N-$NO_2$) | Yes | Yes | Yes | Yes | Yes |
| Orthophosphate (P-$PO_4$) | Yes | Yes | Yes | Yes | Yes |
| Ammonia (N-$NH_4$) | Yes | Yes | Yes | Yes | Yes |
| BOD-5 | Yes | Yes | Yes | Yes | Yes |
| Average Riverine Flow for the Year | Yes | Rarely | Yes | Yes | Yes |
| Long Term Annual Average for the Riverine Flow | Yes | Yes | Yes | Yes | Yes |

The choice of monitoring parameters and frequencies is especially important to ensure comparability of data at regional level. As shown in tables 1-3, even in BG and RO the chosen frequencies differ substantially as well as the lists of parameters. However, the stations used for calculation of loads stemming to the Black Sea should follow the same Protocol in choice of parameters and frequencies.

A serious gap is that BSIMAP does not contain anything about riverine sediments. It is well known that these sediments are a major factor controlling the Black Sea ecosystem functioning.

### 4.4. Quality assurance/Quality control (common procedures in sampling and processing of samples)

In this regard, the situation is as follows: BG, GE and RO are applying ISO standards, UA uses national standards, and TR applies national standards, taking into consideration ISO standards. Common procedures in sampling and samples processing are not yet agreed in the BS region for rivers monitoring. A Set of recommended standard operational procedures (SoPs) and Guidelines are missing.

### 4.5. Environmental standards, reference conditions and environmental targets

Reference conditions and environmental targets exist in BG and RO only. Environmental standards differ considerably in the BS region. A common approach to identification of reference conditions and environmental targets for rivers is strongly needed in the Black Sea region. At regional level, another significant gap is the lack of knowledge on threshold loads for the BS rivers. Riverine loads might be poorly comparable due to different frequencies of parameters measured or different methods used in sampling, laboratory analysis and calculation of loads. The missing threshold loads are of high priority because in their absence the impact of a river on the Black Sea cannot be assessed. The simple loads comparison says nothing about the negative impacts on the Black Sea, as naturally some rivers are larger than others, and logically, their loads are larger. This means that a larger load does not automatically mean a larger negative impact.

### 4.6. Calculation of riverine loads

The calculation of riverine loads is not well defined in the policy of the BS countries. Thus, the comparability of riverine loads reported to the BSC is questionable. Also, a regional methodology for riverine loads is missing.

### 4.7. Quality classifications of rivers status

The national classifications used in rivers quality identification (hydromophological, chemical, biological and general ecological, where available) are not harmonised, except between BG and RO. Thus, the respective approaches of countries differ very much and results cannot be compared to conclude on which BS rivers have deviated mostly from their pristine status in the long-term run. A regional methodology on identification of rivers ecological status is missing.

### 4.8. Data management and assessments

The data management and assessments are also among the weakest links in the BS countries, as well as at regional level. None of the BS countries has a tool for rivers data (all available) storage and management; Excel or Word files are used for data storage. Data are manually managed to generate data products. Sharing of data/information is critically low if any, especially at the public level. At regional level, data on riverine loads are stored in Excel files and are also manually managed. There are no pressure/impact analyses in regional annual or 5-yearly reports prepared under the BSC.

The BSC LBS Advisory Group agreed also to include in the annual reports of the BSC the following parameters: annual flow, TP, TN, inorganic N, inorganic P, trace metals, TSS, TPH, BOD5. All the parameters are expressed in tonnes/year.

As discussed above, the BS countries have little parameters in common in rivers monitoring. Among the previously mentioned indicators, a feasible short list of parameters for regional compilations of riverine loads would presently consist of: inorganic N, inorganic P, BOD5, expressed in tonnes/year. But an assessment based only on these parameters would hardly contribute to an improved understanding of the Black Sea functioning, since inorganic nutrients are not the only source of environmental problems of the sea.

## 5. CONCLUSION

Each country produces assessments on rivers following own practices. The main problem at regional level is the absence of common understanding on how to assess the level of BS rivers influence on the status of the Black Sea.

The harmonization of rivers monitoring for the rivers coming to the Black Sea is of great importance at regional level and adequate measures should be taken as soon as possible. Consequently, the share of each Black Sea country in the overall environmental issues and on the amount of total load of nutrients and hazardous chemicals coming to the Sea should be very well quantified. The general perception is that the Danube River is the largest source of any pollution to the Black Sea. However, recent investigations showed that the loads of total petroleum hydrocarbons, originating from other rivers, might be of higher magnitude. The same may be the case for other harmful substances.

The lack of a regional requirement (in BSIMAP) to monitor and/or report on riverine sediments –flow and pollution – is seen as one of the major gaps at regional level as well.

Still, no comparison of data is worth undertaking until river monitoring strategies and practices of the Black Sea coastal states remain non-harmonised.

## ACKNOWLEDGEMENT

The authors acknowledge the financial support of the Romanian Ministry of Regional Development and Public Administration through the project "Integrated hotspots management and saving the living Black Sea ecosystem" MIS-ETC 2303 financed under the Joint Operational Programme "Black Sea Basin 2007-2013 and of the project number 25PFE/30.12.2021 - Increasing R-D-I capacity for electrical engineering-specific materials and equipment with reference to electromobility and "green" technologies within PNCDI III, Programme 1.

The authors also acknowledge the significant contribution of MIS ETC 2303 entire project research team for providing valuable information regarding the Black Sea rivers monitoring status in Bulgaria, Georgia, Turkey and Ukraine, especially to Violeta Velikova†, Velichka Velikova, Manana Devidze, Gulsen Avaz, Kateryna Utkina.

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The authors also acknowledge the significant contribution of MIS ETC 2303 entire project research team for providing valuable information regarding the Black Sea rivers monitoring status in Bulgaria, Georgia, Turkey and Ukraine, especially to Violeta Velikova†, Velichka Velikova, Manana Devidze, Gulsen Avaz, Kateryna Utkina

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