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CASA CĂRȚII DE ȘTIINȚĂ
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Black Sea Cooperation Network MONITOX Monitoring Toxicants

Black Sea CROSS BORDER COOPERATION

Common borders. Common solutions.

Abstract Book

International Conference

"Environmental Challenges in the Black Sea Basin: Impact on Human Health"

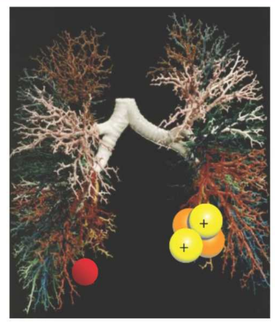
September 23rd-26th, 2020
Galati, Romania

BSB27-MONITOX

Black Sea Basin interdisciplinary cooperation network for sustainable joint monitoring of environmental toxicants migration, improved evaluation of ecological state and human health impact of harmful substances, and public exposure prevention

Editors

Antoaneta Ene
Liliana Teodorof



CASA CĂRȚII DE ȘTIINȚĂ

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Editors Preface

The **International Conference "Environmental Challenges in the Black Sea Basin: Impact on Human Health"** is organized by Dunarea de Jos University of Galati (UDJG), Romania, in the frame of the project with code BSB27, *"Black Sea Basin interdisciplinary cooperation network for sustainable joint monitoring of environmental toxicants migration, improved evaluation of ecological state and human health impact of harmful substances, and public exposure prevention" (acronym "MONITOX")*, funded under the EU CBC Joint Operational Programme "Black Sea Basin 2014-2020" framework, in collaboration with the partner institutions - "Danube Delta" National Institute for Research and Development, Tulcea, Romania, Institute of Zoology, Republic of Moldova (IZ), Institute of Geology and Seismology, Republic of Moldova (IGS) and the International Hellenic University (IHU), Greece.

The Conference is focused on the current developments on environmental monitoring and management of deltaic and wetland areas with an emphasis on the results obtained so far in the frame of research activities of the Project BSB27. It provides an opportunity for members of the target groups, scientists, decision-makers and stakeholders to meet each other and to establish new relations and partnerships. This fact will promote the cooperation in environmental research and management among countries from the connected regions - Black Sea Basin and the Mediterranean Basin.

Participation as authors or members of the scientific committee was very encouraging, from researchers and specialists members of the project BSB27, to scientists and young researchers representing other institutions from Romania, Republic of Moldova, Greece, Ukraine, Russian Federation, Germany, Poland, Norway, Azerbaijan, Armenia, Turkey, as well as volunteers – undergraduate students, magisters, doctoral students, alumni. 63 abstracts were selected for plenary, oral and poster presentations, covering a wide range of topics grouped in four interrelated sections.

The **sections** of the conference are:

1. *Toxic and carcinogenic substances in Black and Aegean Seas Basins – levels, distribution, modeling, monitoring techniques*
2. *Evaluating exposure to toxicants and their impact on ecological state of aquatic ecosystems and human health*
3. *Environmental technologies, remediation and management of riverine, deltaic and coastal ecosystems*
4. *Health and environmental education, innovative solutions to improve scientific information dissemination.*

The editors would like to thank: the authors of the papers, the international scientific committee for their assistance in reviewing, EU CBC Joint Operational Programme "Black Sea Basin 2014-2020" for their funding.

We hope that the International Conference of MONITOX network will provide a suitable background for the exchange of information and ideas in virtually all areas of environmental research specific to deltas and wetlands ecosystems, leading us towards a better scientific and academic interdisciplinary networking in the Black Sea Basin.

Editors:
Prof. dr. habil. **Antoaneta Ene** - *Project Manager, Leader Partner 1, UDJG, Romania*
Dr. **Liliana Teodorof** - *Project coordinator Partner 5, DDNI, Romania*

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SUMMARY

SECTION 1. Toxic and carcinogenic substances in Black and Aegean Seas Basins – levels, distribution, modeling, monitoring techniques

SECTION 2. Evaluating exposure to toxicants and their impact on ecological state of aquatic ecosystems and human health

SECTION 3. Environmental technologies, remediation and management of riverine, deltaic and coastal ecosystems

SECTION 4. Health and environmental education, innovative solutions to improve scientific information dissemination

ABSTRACTS

SECTION 1. Toxic and carcinogenic substances in Black and Aegean Seas Basins – levels, distribution, modeling, monitoring techniques

S1.01. International interdisciplinary cooperation for monitoring of inorganic and radioactive toxicants in the Lower Danube Euroregion, Black and Aegean Seas Basins

Antoaneta Ene[1,2], Elena Zubcov[2,3], Thomas Spanos[2,4], Oleg Bogdevich[2,5], Liliana Teodorof[2,6], Yuriy Denga[2,7], Marina Frontasyeva[2,8], Claudia Stihi[2,9], Ana Pantelică[2,10], Octavian Duliu[11]

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The paper presents a synthesis of results obtained in the period 2014-2020 by the INPOLDE international network created in the frame of MIS ETC 1676 Project (Romania, Republic of Moldova, Ukraine) and developed through BSB27-MONITOX, JINR-Romania and COST Action CA18130 ENFORCE TXRF international/EU-funded projects, concerning the monitoring of the toxic substances levels in the Danube River (Lower sector) Prut and Dniester Rivers, Danube Delta, Black Sea coast, Nestos River and Northern Aegean Sea coast.

Maps of pollution of water, sediments, soils and biota with trace metals and radioisotopes were built using ArcGIS and Q-GIS.

Preliminary results of the interdisciplinary studies performed in the first period of BSB27-MONITOX project implementation on a large range of inorganic toxic pollutants in an extended target area in the Black Sea Basin (including NE part of Greece) are emphasized, as well as the assessment of toxicants' impact upon human health using the developed health risk calculator.

The analytical methods employed in collaborating institutions from Romania, Moldova, Ukraine, Greece and Russian Federation and used in complementarity for elemental and isotopic determination in environmental materials sampled from Lower Danube Euroregion, Black and Aegean Seas Basins (about 50 chemical elements), are the following: atomic absorption spectrometry (AAS), including High Resolution Continuum Source (HR CS-AAS) technique, X-ray fluorescence analysis with energy dispersion (ED-XRF), including portable technique (p-XRF); instrumental neutron activation analysis (INAA); inductively-coupled plasma mass spectrometry (ICP-MS); inductively-coupled plasma optical emission spectrometry (ICP-MS); ion beam techniques Particle-Induced X-ray (PIXE), Gamma-ray (PIGE) Emission and Rutherford Backscattering Spectrometry (RBS) using accelerated proton beams and high resolution low background gamma-ray Spectrometry (GS). The accuracy and precision of the results were evaluated by measuring certified reference samples of similar matrix and organizing several intercomparison exercises between research laboratories.

Acknowledgement: We acknowledge the funding from ENPI project code MIS ETC 1676 INPOLDE (2013-2015), Joint Operational Programme Romania-Ukraine-Republic of Moldova 2007-2013; ENI project with eMS code BSB27 MONITOX (2018-2021), Joint Operational Programme Black Sea Basin 2014-2020; Project nos. 63/2019 and 71/2020 and Grants nos. 24/2016, 21/2019 and 32/2020 of Joint Institute for Nuclear Research (JINR), Dubna, Russian Federation and Plenipotentiary Representative of Romanian Government at JINR; COST Action CA18130 ENFORCE TXRF (2019-2023).

S1.02. Control and assessment of the risk of population exposure to radon in Republic of Moldova

Liuba Coretchi

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Population exposure to natural radioactive sources is primarily due to radon (^{222}Rn), accounting for over 50% of total exposure (1). Radon is a radioactive gas that is continuously produced by ^{226}Ra, a descendant of uranium. Radon is the element with order number 86 in the periodic table, being part of group VIII, so it is an inert gas, which once formed by the disintegration of heavy elements in the earth's crust diffuses into the gases in the soil or water and then is emitted in the atmosphere. Radon migrates to the surface through the spaces of soil pores, cracks, etc.

Radon can enter homes due to the pressure difference in the building and its foundation in the ground. Gas migrates through cracks in walls, drains, communications pipelines, construction materials and drinking water (2).

The contribution of radon and strand in the internal and external exposure of the population consists in the fact that they produce a whole series of other radioactive isotopes on the one hand, and on the other hand as inert gases they can reach any part of the body, being more especially involved in affecting the respiratory system (2).

Radon is considered a toxic substance in the environment and poses health risks, which has led to increased awareness of the population, conducting extensive research on the assessment of radon levels in homes (3, 4). Indoor radon increases the risk of developing bronchopulmonary cancer, ranking second after active smoking, which is the highest risk of lung cancer. More than 85% of deaths from bronchopulmonary cancer are among smokers (2, 5, 6). Tobacco control policy is the most promising direction in achieving public health goals in terms of radon exposure control (8).

Recent epidemiological and ecological studies demonstrate the impact of radon on the development of bronchopulmonary cancer. The risk increases depending on the duration of exposure and the concentration of radon inside. Total radon exposure consists of exposure in homes, schools, workplaces and leisure facilities (3, 7).

The study by statistical models, applied to the most recently published data in the field of estimating the incidence and mortality for 25 major cancers, conducted in 40 countries of the European Union. 2018 showed impressive results. Thus, an estimated 3.91 million new cases of cancer (excluding non-melanoma skin cancer) and 1.93 million deaths from cancer in Europe were detected. The most common were: breast cancer (523,000 cases), followed by colorectal cancer (500,000), lung cancer (470,000) and prostate cancer (450,000). These four cancers account for half of the total cancer burden in Europe. The most common causes of death from cancer were lung cancer (388,000 deaths), colorectal cancer (243,000), breast cancer (138,000) and pancreatic cancer (128,000). The estimated number of new cases of oncological diseases was about 1.6 million in men and 1.4 million in women, with 790,000 deaths for men and 620,000 for women (9). It is of interest to organize the system for communicating the risk of radon exposure (10, 11, 12).

In order to implement the EC Directive No. 2013/59/ (13) and hygienically estimate the level of exposure of the population of the Republic of Moldova to natural sources of ionizing radiation and the development of prophylactic measures in 2010-2015 by ANSP specialists were performed about 2982 measurements of ^{222}Rn concentrations by active methods:

- 1779 measurements of the concentration of ^{222}Rn in the indoor air (residential houses, kindergartens, schools, Public Medical Institutions (occupational exposure), new residential blocks put into operation, etc.) by active methods of radon measurement;
- 891 measurements of the ^{222}Rn concentration in various drinking water sources, including in the waters from wells and mine wells;
- 312 measurements of the concentration of ^{222}Rn when exhaling it from the ground.

To perform measurements of radon concentrations and its short-lived descendants: ^{220}Rn, ^{218}Po, ^{214}Pb, ^{214}Bi and ^{214}Po in the main components of the environment, as well as in the air inside homes, the German device was used, the company SARAD - Radonometer RTM 1688-2.

In the period 2018-2019 it was developed and implemented long-term radon measurement methodology. The methodology in question was used in measuring ^{222}Rn in the indoor air of different types of housing (n=2500) in rural and urban areas of the main Areas of the Republic of Moldova. RADTRACK2 detectors, provided by the IAEA within the Technical Cooperation Project MOL9007 "Development of the National Program (Strategy and Action Plan) for the control of the exposure of

the population of the Republic of Moldova to radon", were placed in guest rooms' or bedrooms for a period of about 90 of days.
In order to carry out investigations/surveys of indoor radon concentrations by long-term methods, the following requirements/methodologies have been developed:
✓ Requirements for placing detectors in the home;
✓ Questionnaires to identify the conditions/type of housing;
✓ Agreement between radon investigators and the homeowner;
✓ Questionnaire for assessing the knowledge of the population regarding radon.
In accordance with the "Fundamental Norms of Radiation Protection, Hygienic Requirements and Rules" (NFRP-2000) and the "Regulation and hygienic norms regarding the regulation of radiation exposure of the population from natural sources" the national reference level of ^{222}Rn was set at a concentration of 100 Bq/m^3 for new buildings and 150 Bq/m^3 for existing buildings (14).
In case of detecting increased concentrations (over 200 Bq/m^3), radiation protection measures must be taken to reduce the penetration of ^{222}Rn into the air of residential spaces and to improve the ventilation of rooms. The relocation of tenants (with their consent) and the reshaping of rooms, buildings can take place in cases when it is impossible to reduce the equivalent annual average equilibrium activity per unit volume of ^{222}Rn to values less than 300 Bq/m^3 (15).
It should be noted that these values were stipulated as national reference standards in theory, not based on measurements in the air in homes. Recently, in the period 2018-2019, as a result of the implementation of the national project MOL9007, financed by the IAEA, the results being presented in the paper in question, it was observed that in 1277 homes (51%) the radon concentration was higher than national/EC norms. Based on these results, it is proposed to modify the national reference values - 300 Bq/m^3, which are to be implemented as a result of the approval of the Government Decision's draft in this regard.
Conclusions:
1. Monitoring of radon concentrations in the air in different types of dwellings (n=2500), placed in rural and urban localities of different areas of the Republic of Moldova, by using long-lasting alpha detectors of RADTRAK2 type with an exposure period of 90 days, established the variability of the indicator depending on the geographical area, abiotic conditions, type of house, type of floor and walls.
2. The study showed an increase in radon concentrations in the air in homes in the southern part of the country, the average value per area being 330 Bq/m^3, followed by the Center area - 250 Bq/m^{3}and North - 240 Bq/m^3.
3. The study of the variability of radon concentration in the air of dwellings placed in different geographical districts of the Republic of Moldova showed increased values in Causeni district and decreased in Chisinau municipality.
4. Research shows that the average value of radon concentration in homes was higher in rural areas, amounting to 260 Bq/m^3, compared to urban ones - 241 Bq/m^3.
5. Mapping radon concentrations in residential air across the country will be useful to line ministries, including construction specialists, in selecting land for the construction of buildings at reduced risk of radon exposure.

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S1.03.Heavy metals concentrations in Danube sediments on Romanian territory in the last 375 km

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The characteristics and the quality of Danube bottom sediments reflect human developments but, at the same time, the problems of environmental state and socio-economic situation of the river region.

This paper aims to discuss the data obtained, in terms of heavy metals concentrations, from the surface sediment samples collected in 2019 from 32 sampling points situated along the Lower Danube, starting from the Calarasi-Silistra sector (km 375) until the Danube ends, through its 3 distributaries, into the Black Sea. The sediment samples were first subjected to a wet digestion technique and then analyzed by inductively coupled plasma mass spectrometry (ICP MS). The concentration values of Cd, Cr, Cu, Mn, Ni, Pb and Zn were reported to the quality limits for sediments of MMGA Order 161/2006 which establish the ecological status of the water bodies.

The results indicate that these pollutants generally depend on many interrelated factors from natural background (geological substrate rich in mineralization) to the pollution processes (uses of chemicals in industrialization, agriculture, urbanization). The presence of metals in sediments is often caused by the processes of transport and erosion, but is also related to the remobilization phenomena, sediments representing a source of a secondary contamination with heavy metals.

Acknowledgement: We acknowledge the funding from ENI project eMS code BSB27 MONITOX (2018-2021), Joint Operational Programme Black Sea Basin 2014-2020.

S1.04. Danube River influence on the North-Western shelf of the Black Sea

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This paper aims to present the ecological influence of the Danube waters and sediments on the Black Sea, with major impact on human health and biodiversity.

In the context of EU enlargement, the strategic importance of the Danube-Black Sea region is rapidly increasing. But the intensive use of the Danube waters, starting from the supply of drinking water for million of people and continuing with industry, agriculture, tourism, power generation and navigation, caused huge problems of water and sediments quality and quantity. With the Danube River average multiannual water discharge of about 6550 m^3/s, Danube waters quality are also affecting the ecological conditions in the North-Western shelfs of the Black Sea. A part of these waters, about 10%, are retained into the Danube delta, Europe's largest remaining natural wetland,

continuously developing due to the Danube interaction with the sea. Together with water and sediments of the river, an important amount of pollutants are retained by the Danube delta, with negative impact on the aquatic ecosystems causing disfunctions through their negative effects.

Acknowledgement: We acknowledge the funding from ENI project eMS code BSB27 MONITOX (2018-2021), Joint Operational Programme Black Sea Basin 2014-2020.

S1.05. Changes in nutrients concentrations in two years of monitoring in Danube River waters between Calarasi-Silistra and the discharge area into the Black Sea

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In this paper 7 representative indicators were selected to assess the Danube River water quality between Calarasi-Silistra sector until the river flow into the Black Sea. A comprehnsive comparison between 2 years of investigations in terms of nutrients contribution, such as different forms of nitrogen ((ammonium nitrogen ($N\text{-}NH_4$), nitrite nitrogen ($N\text{-}NO_2$), nitrate nitrogen ($N\text{-}NO_3$), organic nitrogen, total nitrogen)) and phosphorus ((orthophosphate phosphorus ($P\text{-}PO_4$), total phosphorus)), was made in order to provide information on the spatial and temporal variations of this river water quality. Sampling was performed according to European standards (SR ISO 5667-3/2018) preserved and properly stored in polypropylene containers. The method used for quantitatively determination of the selected nutrients in the Danube River surface waters was molecular spectrophotometry using Perkin Elmer Lambda 650S.

The obtained results showed differences in nitrite nitrogen loads in surface water samples with higher values in the samples collected from the sampling points situated at the mouths of the Danube River into the Black Sea in 2020. Concerning the total nitrogen levels in Danube waters, significant higher values were obtained in 2019, when the organic nitrogen fraction of the total nitrogen was much higher than the others nitrogen fractions, different from the data obtained in 2020, when the organic nitrogen and the sum of its inorganic forms from the total nitrogen had similar values. Regarding the phosphorus compounds, the concentrations determined in the two studied periods are not significantly diferrent.

Acknowledgement: We acknowledge the funding from ENI project eMS code BSB27 MONITOX (2018-2021), Joint Operational Programme Black Sea Basin 2014-2020.

S1.06. Chlorophyll ,,a'' distribution from surface waters in MONITOX Romanian network, in 2019 and 2020

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The development of chlorophyll a is dependent on a number of physico-chemical factors, with high sensitivity to changes in water properties. Among the factors that influence the development of chlorophyll the most important are pH, temperature, solid suspensions, salinity, light, transparency, hydrology, human activities.

The method for determining chlorophyll in this case was made using the submersible multiparameter ExoYsi 2, which uses the light spectrum of different wavelengths to determine chlorophyll and phycocyanin, a pigment found in blue algae. The sampling was carried out along the Danube from km 375, until the flow of the three arms into the Black Sea. A number of 23 points were selected along this length, which includes the eastern Pontic sector, the Predobrogean sector and the Deltaic sector.

The determinations were performed in June, in the years 2019 and 2020, a period in which the course of the Danube usually has a tendency to reduce the flow. In the determinations performed along the Danube were identified low values of chlorophyll varying between 2.77 µg / L and 7.23 µg / L in 2019, and between 1.98 µg / L and 9.91 µg / L in 2020, values corresponding to class I quality according to the Order of the Minister of Waters and Environmental Protection 161 / 16.02.2006.

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S1.07. Sediments quality assessment in terms of integrated indices from Romanian MONITOX network (2019 – 2020)

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The assessment of sediments quality from Romanian part of MONITOX Network, was established using singles indices: Single Ecological Risk Index (E_r^{Me}), Contamination Factor (CF^{Me}), Enrichment Factor (EF^{Me}), Geoaccumulation Index ($I_{geo}{}^{Me}$) and integrated indices: Ecological Risk Index (RI), Global Pollution Index (PLI) and Nemerow Pollution Index (PI_N), considering the heavy metals concentrations. The sediments were collected in 2019 and 2020, from 32 sampling points, in the system of Danube river - Black Sea, as follows: Lower Danube RO-BG (1), Lower Danube RO (10), Lower Prut RO-MD border (2), Danube Delta RO-UA border (7), Danube Delta –RO (2), Black-Sea area-RO (10). The selected heavy metals are: Cd, Cr, Cu, Pb, Zn, Mn). The samples were digested using the microwave oven Anton Paar and analysed using ICP-MS Elan DRCe Perkin Elmer. For the evaluations of defined indices, it was also used the standard quality levels and background concentrations corresponding for the selected heavy metals.

At the individual and integrated levels, there were observed no important differences between 2019 and 2020 and as a general trend, the sediments from the Black Sea area are much less contaminated with heavy metals than those from the Lower Danube (Romania), attributed to the historical pollution resulting from anthropogenic activities.

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S1.08. Study of metals in water, suspensions and sediments in the lower part of the Dniester River during 2019

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The research of metals in the "water-suspension-sediment" system in the lower part of the river allow evaluating the processes that take place in the river basin and to assess the migration variability and pollution level of the Dniester estuary and the Black Sea coast, adjacent to the estuary.

The main objective of the paper was to assess the dynamics of metals, especially heavy metals, their ratio in the water-suspension-sediment system and assess the pollution level of water

and bottom sediments with heavy metals in the lower Dniester, in accordance with the requirements of the Water framework Directive 2000/60/EC.

The joint monitoring also aimed to test the methods of collection and analysis of metals in aquatic ecosystems used by the Institute of Zoology, Chisinau, Republic of Moldova and SRI Ukrainian Scientific Center of Ecology of the Sea, svetakovalish@gmail.com, Odessa, Ukraine in project BSB165 - HydroEcoNex and BSB 27 -MONITOX.

The samples were collected at 55 and 51 km upstream of the confluence of the Dniester with the estuary. The water samples were filtered directly in the field through membrane filters with a pore diameter of 0.45 microns to detect suspensions using the Sartorius filter system.

For the analysis of sediments layers of up to 3-5 cm were collected.

The following equipment was used to analyze the content of metals and trace elements:

- Thermo Scientific iCAP 6000 Inductively Coupled Plasma Optical Emission Spectrometer (ICP-OES),
- Perkin Elmer AAnalyst 400 atomic absorption spectrometers,
- Atomic-absorption spectrophotometer AAS «ZEEnit 650P»,
- Plasma spectrophotometer AAS «Spectr-AA-220» (Varian).

The content of macro- and trace elements was analyzed: Ca, Mg, Mn, Na, K, Ba, Al, Li, Sr, Be, Bi, Cd, Cr, Co, Cu, Hg, Fe, Ar, Pb, V, Mo, Ni, Zn, Sb, Tl and some metalloids and non-metals.

The content of metals in the analysed samples of water varied within a wide range, but no concentrations exceeding water quality category III (moderately polluted) was detected.

It should be noted that the concentration of metals in suspensions, compared to previous years is considerable lower than the concentrations of dissolved metals which is not characteristic for the rivers and is related to the low concentration of suspensions in water. The dynamics of some metals in sediments exceeded the content in the soils of the given region.

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S1.08. The study of PAHs and BTEX pollution spectrum of petrol contaminated site: distribution pattern and risk assessment

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Polycyclic aromatic hydrocarbons (PAHs) and mono-aromatic hydrocarbons (benzene, toluene, ethylbenzene, and xylene - BTEX) are common water resource pollutants that have strong negative impact to environment and public health. PAHs are persistent, bio-accumulative, and toxic for humans and aquatic organism. BTEX due their polarity and good soluble characteristics are able to enter the soil and groundwater systems and cause serious environmental problems. All PAHs have a carcinogenic effect to human. BTEX group has a negative impact to respiratory and central nervous system. The long BTEX exposure can also effect the kidney, liver and blood systems. The principal pollution sources of these substances are municipal waste, transport, petrol deposits and other industrial sites. Republic of Moldova, as well as other countries, has many old contaminated sites by petrol products (petrol deposits, military bases, transport enterprises etc.) sites. The aim of this study is an evaluation of PAHs and BTEX in the surface soil and groundwater of an old petrol contaminated site. The studied site was in the operation as a petrol deposit in the period 1970 – 2000 years and principal pollution source is a diesel and gasoline leakage. Actually, it is a territory for the industrial purposes. The sampling plan was elaborated due to the specific local conditions for soil and groundwater. Five sampling units were sampled for the soil with the depth intervals 0 – 50 cm and 50 – 100 cm. Ten boreholes were drilled for the determination of groundwater contamination level and distribution patterns of toxic substances. The determination of PAHs and BTEX concentration in soil and water samples was made by GC-MS technology using international methodology (ISO 17943:2016; ASTM D 6889, D6520; ISO 28540:2011; ISO 13859:2014; ISO 18287:2006). The groundwater level is situated at the depths 5 – 6 m. The layer of petrol products was determined under groundwater level with the thickness 2 – 3 cm. The groundwater samples

below of this layer were analyzed. The obtained results showed that PAHs contamination is accumulated in the top soil layers and in less quantity in deep horizons. The intervals of the total PAHs concentration is 0.4 – 1.43 mg/kg for soil layer 0 – 50 cm and 0.11 – 0.24 mg/kg for soil layer 50 – 100 cm. The distribution of PAHs by the number of the benzene rings following: 2 rings – 1.9 – 8.7%; 3 rings – 7.2 – 19.4 %; 4 rings – 42.2 – 58.1 %; 5 rings – 15.1 – 33.9 %; 6 rings – 0 – 25.2 %. This composition corresponds to PAHs in gasoline and diesel. The four ring PAHs were found in groundwater samples (pyrene, benz[a]anthracene). Fluorene (3 ring PAH) was determined in one groundwater sample. Other PAHs were below of the detection limit in groundwater samples. The BTEX substances are found mostly in groundwater. The groundwater system is close and BTEX are stored here for a long time. The total BTEX concentration in groundwater samples is in the interval 12.08 – 13.80 mg/l. The principal pollutant is Benzene (with the concentration interval 9.26 – 10.86 mg/l (76.7 – 78,7 % of the total BTEX). The next BTEX pollutants are m-xylene (1.56 mg/l) and p-xylene (0.58 – 0.66 mg/l). Other have the following concentrations: toluene 0.26 mg/l; ethylbenzene 0.23 mg/l; o-xylene 0.20 – 0.23 mg/l. The volume of contaminated soil and groundwater was evaluated for the elaboration of remediation actions. This study suggests that exposure to BTEX and PAHs from petrol contaminated sites is correlated with an increased risk of health effects need to take proper measures. The bioremediation is recommended as one of environmental friendly approach for the reduction of the contamination level by PAHs and BTEX substances at petrol-contaminated sites.

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S1.10. Highly sensitive multiresidue analysis of antibiotics and anti-inflammatory drugs from the aquatic ecosystems

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Worldwide, the pharmaceutical pollution of the aquatic ecosystems is an urgent need and measures must be taken to monitor the emerging pollutants from various sources of water and wastewater and, at the same time, to determine the ecotoxicological risks that this type of compounds exert on the aquatic environment and human health. The major entrance sources in the environment and pathways of these emergent contaminants and their by-products (metabolites and transformation products) are the municipal, agricultural, and industrial wastewater. Antibiotics and anti-inflammatory drugs not only affect the targeted population but also influence the non-targeted population leading to a high toxicity impact. An important class of emergent pharmaceutical contaminants is represented by the non-steroidal anti-inflammatory drugs that are considered as one of the most relevant therapeutic class, being largely used worldwide for their painkiller, antipyretic and anti-inflammatory properties. Over the years, due to the high consumption of antibiotics, a complex process was highlighted, namely, the antibiotic resistance. Several types of antibiotics such as amoxicillin, cefuroxime, ciprofloxacin etc. are massively administered to humans and animals and usually persist in the environment for an unknown period through a complex vicious cycle of biotransformation and bioaccumulation.

A sensitive, rapid and robust method was developed and validated for the detection and quantification of antibiotics and non-steroidal anti-inflammatory pharmaceuticals in water. Solid-phase extraction (SPE) was used for the samples' pretreatment. The analysis was carried out with a LC-Q Exactive Orbitrap high resolution MS method. The high mass resolution of 70,000 full width at half maximum (FWHM) and the corresponding narrow mass windows permitted a very selective and sensitive detection of the analytes in the complex matrix. A single-laboratory validation procedure was carried out to evaluate the selectivity, sensitivity, linearity, precision and accuracy. The method showed a satisfactory analytical performance for the precision trueness and sensitivity. The level of detection was lower than 10 ngL^{-1}.

The linearity of the analytical methods was demonstrated plotting the calibration curves for each compound. Correlations of $R^2>0.99$ were obtained over a concentration range 2,5–50 ng L^{-1}.

The average mass accuracy in this experiment ranged within 0.2-3 ppm. The Q Exactive HR-MS system is equipped with a quadrupole mass filter, providing the capability of "data-dependent" fragmentation which enables the confirmatory analysis using the same equipment.

The existing data on the fate and the ecotoxicological effects of antibiotics and anti-inflammatory drugs in the environment is crucial in order to perform proper risk assessment studies. The future research should be designed to improve the European legislation, to stop the pharmaceutical pollution and the antibiotic resistance, as well as to underline the development of rational water and wastewater management practices for the protection of humans and ecosystems.

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S1.11. Review of measurements data for natural radioactivity and risk to population in selected areas from MONITOX network

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This work presents a review of results obtained for nuclear dose rates measured by MONITOX network teams in the period 2018-2020 in outdoor spaces in various target areas of the project BSB27 in Romania, Moldova and Greece, in Lower Danube, Prut and Dniester rivers basins, Danube Delta, Black Sea and Aegean Sea coasts, in Galati, Tulcea, Constanta counties (RO), Cahul, Dubasari regions (MD), Kavala prefecture and Thassos island (GR).

The minimum average outdoor gamma radiation dose rates was recorded in Danube Delta, Romania, and the maximum in Nea Peramos, Kavala prefecture, Greece, which exceeds the limit stipulated by United Nations Scientific Committee on the Effects of Atomic Radiation (UNSCEAR).

Acknowledgements: The work was carried out in the frame of the Project BSB27 MONITOX, Joint Operational Programme Black Sea Basin 2014-2020.

S1.12. Study of microbiological contamination level of surface water in MONITOX network areas before and after COVID-19 pandemic

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The microbiological contamination of the water with faecal bacteria resulted from anthropogenic activity is an important issue for population health and the assessment of the presence of pathogenic bacteria in water is a major concern for the protection of human and animal. Coliform bacteria are indicators for the assessment of faecal pollution and a potential presence of pathogens, which is caused mainly of untreated wastewater.

In this paper a comparative study was carried out in 32 sampling sites of MONITOX network in two periods, June 2019 and June-July 2020, before and after COVID-19 pandemic, regarding the rate of the water microbiological contamination in Lower Danube (Calarasi/Silistra-Galati-Tulcea sectors,

Danube Delta and Black Sea coast, from SE part of Romania, by counting of the bacteria indicators of the organic pollution (heterotrophic bacteria and total coliforms).

The results demonstrate a decrease of microbiological contamination of surface water in 2020 during the COVID-19 lockdown in all the samples collected form Black Sea coast, Danube branches, Danube-Black Sea confluence, and Danube river downwards Galati town.

Acknowledgment: The work was performed in the frame of BSB 27 MONITOX project (Joint Operational Programme Black Sea Basin 2014-2020 of the European Union).

S1.13. Instrumental neutron activation analysis on *Herring Tissue* (M-3 HerTis reference material)

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Analytical investigations on *Herring Tissue* as a reference material candidate using Instrumental Neutron Activation Analysis (INAA) at the Horia Hulubei National Institute for R&D in Physics and Nuclear Engineering (IFIN-HH) in Bucharest-Magurele are presented in this paper.

The sample was supplied by the Institute of Nuclear Chemistry and Technology (INCT), Laboratory of Nuclear Analytical Methods, in Poland in the frame of an international inter-laboratory comparison organized for the certification of trace elements in the marine biota M-3 HerTis sample. Our laboratory contribution to this exercise was based on the results of INAA, with neutron irradiation at the TRIGA reactor in Pitesti, Romania.

The results for the following elements were reported: Ag, As, Au, Ba, Br, Ca, Cd, Ce, Co, Cr, Cs, Eu, Fe, Hf, Hg, K, La, Na, Ni, Rb, Sb, Sc, Se, Sm, Sr, Tb, Th, U, Yb, Zn, Zr (31 elements). The elements of certified mass fractions were grouped as: macro constituents of percent (Cl, K, Na, P) and tenths of percent (Mg and S) dry matter contents, as well as trace elements expressed in $mg \cdot kg^{-1}$ (ppm) (As, Ba, Br, Cu, Fe, Mn, Rb, Se, Sr, Zn) or $\mu g \cdot kg^{-1}$ (ppb) (Ag, Cd, Co, Cr, Cs, Hg, Li, Mo, Ni, Pb, Sb, Sc, U, V). Information values were given for Ca, Sm and Y. A comparison of our results against other laboratories and certified values was performed.

S1.14. Assessment of heavy metals concentrations in different components of an aquaculture pond ecosystem

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Fish are among the most important groups of wild species, from the ecological but also from the economic perspective, representing a valuable food resource for both humans and wildlife. In the same time, fish are recognized bioindicators for the assessment of aquatic pollution with different substances. Thus, it is possible to monitor the dynamics of heavy metals concentrations in aquatic organisms for the assessment of water pollution. In order to avoid a polluting disaster, such as the one in Minamata, Japan, manifested by the chronic mercury and cadmium intoxication of human population, following the consumption of contaminated fish, continuous monitoring of heavy metals concentration in fish is required. Therefore, the aim of the present study is to determine the level of different heavy metals (Pb, Cd, Ni, Cu, Fe, Zn) and metalloid (As) in 3 components (water,

sediment and fish) of a single pond production system. Samples of water, sediments and fish (Silurus glanis, Cyprinus carpio and Carrassius gibelio) were collected in april 2016 from a aquaculture pond (Mălina Pond) situated in the South-East part of Romania. The analysis of heavy metals concentrations was realised by atomic absorption spectrometry (Analytik Jena, ContrAA 700), flame and graphite furnace tehnique. The results point out the following accumulation descending trend in: water – Fe (299 µg.L-1)>Zn>Ni>As>Pb>Cu>Cd (0.014 µg.L-1), sediments – Ni (36.153 µg.g-1)>Cu>Fe>As>Pb>Cd>Zn (0.128 µg.g-1) and fish muscle tissue – Fe (14.83±1.48 µg.g-1 in catfish, 19.64±4.79 µg.g-1 in carp, 18.02±0.56 µg.g-1 in prussian carp)>Zn>Cu>Pb>Cd>As (LOD = below the detection limit). The estimated daily intake (EDI) was calculated for each analysed metal as it follows: EDICd = 0.003 for catfish, 0.004 for carp, 0.001 for prussian carp, EDIPb = 0.006 for catfish, 0.007 for carp, 0.004 for prussian carp, EDICu = 0.749 for catfish, 0.663 for carp, 0.093 for prussian carp, EDIZn = 1.828 for catfish, 3.5 for carp, 5.33 for prussian carp. The EDI values were below the maximum tolerable values recommended by the WHO (World Health Organization) and FAO (Food and Agriculture Organization of the United Nations). The main conclusion of this research is that the fish produced in Mălina Pond is safe for human consumption, from the heavy metals content point of view. Also, the present paper can help identify specific heavy metals accumulation trends in the water environment in future research.

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S1.15. Low-background high resolution gamma-ray spectrometry applied for assessment of natural and artificial radioactivity of industrial soils in Danube River region (SE Romania) and health risk

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The aim of this study was to investigate the level of soil radioactivity around metallurgical industry in Galati, Danube river region, SE Romania and to assess the health risk of gamma-emitting radionuclides. Gamma-ray spectrometry proved to be a powerful non-destructive analytical tool for the qualitative and quantitative determination of the gamma emitters. The low-background high resolution gamma-ray spectrometry (LB-HRGS) technique was applied in conjunction at GamaSpec laboratory of "Horia Hulubei" National Institute of Physics and Nuclear Engineering (IFIN-HH) in Magurele-Bucharest, Romania, and Experimental nuclear physiscs and dosimetry Laboratory, INPOLDE research center at Dunarea de Jos University of Galati, Romania, in order to determine the natural and artificial radioactivity of several soil samples collected from the surface layer (0–5 cm) in the nearby of the iron and steel industry at Galati.

The gamma spectrometric chains were equipped with an Ortec HPGe detector (2.0 keV resolution at 1332 keV of ^{60}Co, and 30% detection efficiency relative to 3"x 3" NaI (Tl) standard), coupled to a PC based multichannel analyzer.

In order to achieve a low-level background counting of environmental samples, a lead shield of 10 cm thickness, coated with foils of 1 mm Sn and 1.5 mm Cu thickness, were used to reduce the ambient background radiation in the energy spectrum ranging from 0 to 2000 keV.

The dried and homogenized soil samples were measured in Sarpagan beakers placed on the detector end cap, for counting times > 5 h, after 3 weeks of keeping sealed in the measuring box, in order to establish the radioactive equilibrium between ^{226}Ra and its gaseous radioactive descendant ^{222}Rn (radon).

The analyzed natural radionuclides were the following: ^{226}Ra (from ^{214}Pb and ^{214}Bi activities, descendents of ^{222}Rn from ^{238}U-^{226}Ra series), ^{238}U (from ^{234}Th activity), ^{232}Th (from ^{228}Ac, ^{212}Pb and

^{208}Tl activity), ^{235}U, ^{210}Pb (^{238}U-^{226}Ra series) and ^{40}K. The highest natural radioactivity level presented the soil samples collected in the vicinity of the slag dump.

The analyzed artificial radionuclides were ^{60}Co, ^{137}Cs and ^{241}Am, but their concentrations were not correlated with the natural radioactivity levels.

Results obtained by epithermal neutron activation analysis (ENAA) at the reactor IBR-2 of the Frank Laboratory of Neutron Physics, Joint Institute of Nuclear Research in Dubna, Russia, for total uranium and thorium activity concentration are in good agreement with those calculated on the basis of LB-HRGS results. The concentrations of U and Th were calculated taking into account that 1 g natural U yields 12352.5 Bq ^{238}U and 568.8 Bq ^{235}U, 1 g natural Th yields 4057.2 Bq ^{232}Th.

Based on the activity values, the hazard risk was calculated using the total outdoor absorbed dose rates at 1 m above the ground surface due to γ-rays emission in air from ^{226}Ra, ^{232}Th, and ^{40}K terrestrial radionuclides.

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S1.16. Quantification of heavy metals and trace elements in industrial materials and wastes by combined analytical techniques

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The paper presents the results obtained by using a high sensibility and precision methods for the determination of **heavy metals and trace elements** from industrial materials and waste samples resulted from selected industrial activities.

Capabilities of the following analytical techniques were compared: energy- (ED-XRF) and wavelength-dispersive (WD-XRF) X-ray fluorescence, atomic absorption spectrometry (AAS), High Resolution Continuum Source AAS and Particle-Induced X-ray (PIXE), Gamma-ray (PIGE) Emission ion beam techniques.

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SECTION 2. Evaluating exposure to toxicants and their impact on ecological state of aquatic ecosystems and human health

S2.01. Arsenic, selenium, phosphorous and copper in the fish of *Cyprinidae* and *Percidae* families of the Prut river

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The chemical composition of fish organs is a significant part in the processes of monitoring and evaluation of the circuit of chemicals in aquatic ecosystems with both an environmental aspect but is also an important direction for assessing the quality of fish food in toxicological and hygienic aspects.

Of no less interest is the establishment of the biological role of trace elements in the life of the ichthyofauna of aquatic ecosystems, which can be used in aquaculture.

Based on the importance of the investigations, three elements (arsenic, selenium and phosphorus) were chosen, which are different according to their chemical properties, but whose role is important both for the assessment of aquatic ecosystems and the special role they play in fish development and quality of fish products. The dynamics of these elements was studied in 5 species of *Cyprinidae fish -Aspius aspius, Cyprinus carpio, Abramis brama, Vimba vimba, Hypophthalmichthys molitrix and a species of Percidae family - Sander lucioperca collected in the inferior zone of the Prut river (in the Giurgiulești zone),* during spring. The concentration of these trace elements in the muskles of the body, skin, gills, liver and gonads (soft roe and roe) was determined.

It is well known that arsenic is a toxic metal especially, its inorganic compounds. The organic compounds of arsenic have a much lower toxicity, which encouradged many countries not to set maximum allowable limits for the content of this metal in fish products. However, it might be possible that fish with a strong homeostasis is able to control its content in its body, by not allowing the accumulation of this element in large amounts. During current study, the highest concentrations were determined in the skin of fish (up to 0.5 μg/kg of wet weight), the lowest - in the muscles of the body, in the roe and soft roe – this metal was not detected).

Selenium is an antioxidant trace element of major importance but at high concentrations it may have toxic or even dangerous effects. In the investigated species the maximum quantities were recorded in the liver, varying within the limits of 1.8-5.8 μg/kg of wet mass. On the 2nd place is the roe, then the skin and the gills, and on the last place - the body muskles – where the concentration does not exceed 1.1 μg / kg of wet mass.

Phosphorus is an important nutrient in aquatic ecosystems. The role of this element is determinant by eutrophication processes but also by the metabolic activity of hydrobionts. The maximum values of this element were detected in the gills and skin of fish (13.0-24.9 mg / kg of wet weight) and minimum in the muscles of the body (2.0-2.5 mg / kg of wet weight).

Copper is a dynamic trace element, which concentration in the environment depends on the use of its compounds in agriculture. Copper is always concentrated in the liver of fish, the current study found the highest concentration in the liver (22.5-58.7 μg / kg wet weight), followed by gonads (2.5-10.2 μg / kg) and other organs - less than 1 μg /kg.

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S2.02. Soil contamination and risks for human health in Low Danube Region

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Republic of Moldova, as well as other countries, has a problem with contaminated sites by toxic organic substances (POPs, PAHs, BTEX, etc.), which potentially have a strong impact to human health. It is also important for major challenges of natural resources: 1) provision of food and fiber; 2) energy security; 3) water security; 4) climate change abatement; 5) biodiversity protection; 6) ecosystem service delivery. By being able to perform five functions, among them storing, filtering and transforming of nutrients, substances and water, soil largely contributes to the quality of air, food and water, which has a direct link to human health. There are two kinds of soil contamination: local soil contamination due to the intensive industrial or agriculture activities or accidents, which introduce excessive amount of contaminants in soil; diffuse soil contamination from different sources due to their emission, transformation and transport to soil by natural media (air, water). At global level, the estimates of contaminated sites and potentially contaminated are then between 10 million and 20 million sites. At the same time European countries have undergone, only 5% remediation of the identified and potentially contaminated sites and the number of recorded polluted sites across whereas the number of recorded contaminated site Europe is expected to increase by 50% by 2025. People are mainly exposed to toxic organic pollutants by dust and vapor coming from soil, ingestion of contaminated soil particles or contaminated food, and dermal absorption through the skin. The ranking by possible health effect at the regional level was made in this study for POPs contaminated sites by example of Republic of Moldova using GIS approaches.

The obtained results showed zones with high dangerous for human health from POPs contaminated sites. The population density was included in the regional risk evaluation of POPs impact to public health. Other contaminated sites were evaluated also for potential risk for human health (PAHs, BTEX). The local exposure of toxic substances and human health risk was evaluated by example of the conceptual models for individual contaminated sites. Toxic organic compounds depend mainly on their potential absorption in the food chain measured by their distribution coefficient (octanol/water), Henry constant, water solubility, half-life and bio-concentration factor. Remediation of contaminated soil is considered as the management of the contaminant at a site to prevent, minimize or mitigate damage to human health, property or the environment. The bioremediation technology is a perspective method for the reducing of risks the environment and public health from contaminated site. The scientifically based program is essential for the realization of risk mitigation actions. Contaminated site management needs in the further development of legislative framework, the strengthening of the institutional capacity for the realization of remediation projects and respective monitoring and control of the carried out work.

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S2.03. Ecological risk assessment of pharmaceuticals in aquatic ecosystems

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Pharmaceuticals have been recognized as a potentially hazardous group of substances with respect to the environment and an increasing number of published papers highlight the results of monitoring studies performed worldwide on various classes of these emerging compounds, especially in surface waters.

The main approach for risk assessment of pharmaceuticals in aquatic ecosystems is based on the PEC/PNEC (predicted environmental concentration/predicted no effect concentration) ratio according to EUR 20418 Technical Guidance Document (TGD) on Risk Assessment; we propose a quantitative MEC/PNEC estimation comparing compartmental measured concentrations (MEC) with the concentration below which unacceptable effects on organisms will most likely not occur (PNEC), calculation of PNEC of each substance according the procedure shown in TGD on risk assessment, cumulative ecological risk (EQ) for each sampling site considering the possible interactions between pollutants detected according to European Commission, an integrated ecological (ERA) and human (HRA) potential risk. QSAR models can also be used to obtain data for compounds with no adequate experimental data in the literature.

Another approach is the calculation of the cumulative ecological risk (EQ) for each sampling site is done considering the possible interactions between pollutants detected according to European Commission (*EQ = measured concentration of the substance/ PNEC (algae, Daphnia and fish); EQ cumulative = Σsingle EQ for each sampling site).* Risk quotients (RQ) are calculated by dividing the lowest LC_{50} value for fish, algae or daphnia by each of the PECs calculated. An assessment factor of 1000 is usually applied in order to account for any uncertainties and provide a more conservative assessment. Those compounds with a RQ > 1 are considered to be hazardous to the environment.

A procedure for risk assessment for human health based on the Admissible Daily Intake (ADI) and on Reference Doses (RfD) can also be used. ADI is based on the ratio of the no-observed-adverse-effect level (NOAEL), established experimentally, to the safety factor (SaF), as follows: *ADI* (*human dose*) = (*NOAEL* (*experimental dose*))/*SaF,* where: SaF is usually a multiple of 10 and represents a specific area of uncertainty inherent to the validity of the data considering possible differences in response between humans and animals in long target studies. In the case of missing NOAEL (or NOEL) data, the ADI may be determined by referring to a lowest-observed-adverse-effect level (LOAEL), and applying an additional SaF. The RfD derives from the ratio of the NOAEL data to various safety factors and is defined as an estimate of the daily exposure of the human population (including sensitive subgroups) deemed to be without risk of health adverse effects even when exposure persists throughout life.

Toxicological risk index (HQ) for each substance could be expressed as the ratio of the chronic daily intake (CDI) to the reference value (*HQ = CDI/ADI; HQ cumulative = Σsingle HQ for each sampling site).* For each sampling site, integrated ecological (ERA) and human (HRA) potential risk could be associated as following: *ERA numerical index = EQc score/8; HRA numerical index =Σ[(HQc score ILCRc score)/16].*

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S2.04. Environmental impact of clandestine laboratories manufacturing drugs of abuse: an overview and a new analytical solution

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The drug residues resulting from the activity of clandestine laboratories can enter surface waters. Another polluting source are the drugs metabolized by drug users and then excreted in trace amounts into the sewer system. This waste may pass through treatment systems and get into the water supply.

Amphetamines are a family of increasingly abused synthetic stimulants and hallucinogens. Their production requires a series of noxious compounds that can damage the nearby soil to such a degree that plants cannot grow there anymore. In addition, when they dissolve into the surface waters, they can cause the death of a large number of aquatic animals and fish, severely affecting the ecosystem for the foreseeable future.

This paper presents an overview of the environmental impact of clandestine laboratories manufacturing illicit drugs and a new portable scanner able to detect amphetamines *in situ*, in solids or liquids, from bulk to trace level.

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S2.05. Prooving the environmental impact of NBOMe clandestine laboratories: a new analytical tool

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The research performed during the last decades has allowed a better understanding not only of the moral, but also of the environmental implications of drug abuse. It has indicated that the traditional approaches for reducing the drug abuse are no longer enough. New and more efficient analytical tools are needed for the detection of clandestine laboratories and for bringing to courts of law irrefutable evidence for their environmental impact.

NBOMes are a family of synthetic psychotropic drugs that have increasingly been detected in seizures made by the law enforcement all around the world. This paper presents a new analytical tool that can be used for detecting not only these substances of abuse, but also the main precursors that are used for their manufacture.

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S2.06. Improved detection of 2C-x and Dox amphetamines – an analytical tool mitigating the environmental impact of their illicit manufacturing, consumption and disposal

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Numerous studies made worldwide have indicated that treated and untreated wastewater entering surface waters contains illicit drugs, as a result of human consumption and excretion, illicit manufacturing processes and improper disposal. The results indicate that these wastes, and hence the drugs of abuse exposure, influences the plants and animals and the associated health of streams.

The hallucinogenic 2C-x and DOx amphetamines are synthetic psychotropic drugs that have been increasingly reported in seizures, especially in Europe and the US. This paper presents a new combination of artificial intelligence techniques that improves the celerity of the detection of these illicit drugs based on their ATR-FTIR spectra, while decreasing the required computational resources.

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S2.07. Accumulation potential for heavy metals of the edible snail *Helix Pomatia* L

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The accumulation capacity of toxicants by organisms is an important criterion for their selection as biological indicators. Metal accumulation can be expressed by the bioaccumulation coefficient, which is the ratio between the metal content in the body of an organism and the metal content in the soil or vegetation. Many investigations on terrestrial mollusks have included them in the category of heavy metal macroconcentrators, due to their mode of nutrition as well as the permanent use of soil as a source of calcium, necessary for the growth and repair of the shell).

Research on the species *Helix pomatia* L. (Andreev, 2000) collected from Chisinau, has shown that this species is a macroconcentrator of cadmium, copper and zinc (in the latter case only in relation to vegetation) and deconcentrator for lead and chromium. The bioaccumulation coefficient K for cadmium is quite high both in relation to the soil and in relation to vegetation and litter. Its values in the visceral mass in *Helix pomatia* are usually up to 25 higher than in the shell. A higher concentration of cadmium in both the visceral mass and in the shells compared to that in the environment could be that although present in smaller quantities than other metals in the environment, it is more mobile and thus "more available" in the environment for its assimilation by organisms. A high efficiency for cadmium in invertebrates is caused by the mobility of this metal in the environment and its fast release from food by digestive enzymes.

The bioaccumulation of copper in the visceral mass of snails could be conditioned by the metabolic role of this metal, as a basic component of hemocyanin. Studies show that snails are very effective copper accumulators with an efficiency of 89-91%, that could be particularly high with a high concentration of this metal in the environment. Land gastropods are able to store copper in special organs, which are found in the hepatopancreas and are called cuprosomes.

Zinc also plays an important role in the vital activity of terrestrial gastropods as a component of many enzymes. However, the ability of *Helix pomatia* L.to accumulate zinc is less than the storage capacity for copper and cadmium. The K coefficient for zinc was higher than 2 only in relation to vegetation. In relation to the soil and litter, *Helix pomatia* is a microconcentrator or even a deconcentrator.

The bioaccumulation coefficient K in *Helix pomatia* for lead and chromium was less than 1 in all cases. The deconcentration of such toxic metals as lead and chromium could be caused by the fact that in most soils insoluble forms of chromium predominate. Chromium was not bioaccumulated even at a significant concentration in the soil (1074.7 ▫g-g) (Andreev, 2000). Lead, compared to other metals, is less soluble in the intestines of gastropods and as a result is less accumulated in the body of snails. Another peculiarity could be the existence of possible regulatory mechanisms of this metal such as for example some metabolic mechanisms by triggering detoxification processes (synthesis of proteins able to bind toxic metals and store them in certain special organs, such as copper).

Considering that the species *Helix pomatia* L is used for food in many countries that in order to reduce health risks, it is recommended to avoid their collection from the wild close to the areas with high pollution level of copper or cadmium.

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S2.08. Distribution of chemical elements in mosses collected from north-western part of Romania

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The distribution of 34 chemical elements (Na, Mg, Al, Cl, K, Ca, Sc, Ti, V, Cr, Mn, Fe, Co, Ni, Cu, Zn, As, Br, Rb, Sr, Cd, Sb, Ba, Cs, La, Ce, Sm, Tb, Hf, Ta, W, Pb, Th, and U) in mosses collected from the north-western part of Romania, is presented. Determination of the contents of the investigated elements was performed by Mass Spectrometry with Inductively Coupled Plasma (ICP-MS) and Neutron Activation Analysis (NAA) in the frame of the research collaboration between Valahia University of Targoviste, Dunarea de Jos University of Galati and Joint Institute for Nuclear Research, Dubna. All data obtained for the analyzed samples were statistically processed and the maps of spatial distribution of the contents for each element regions were prepared.

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S2.09. Inorganic and organic nitrogen in the Prut waters

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In natural waters the content of dissolved inorganic and organic nitrogen depends on a range of physico-chemical and biological factors and its monitoring is of high importance in the assessment of water quality and identification of sources of water pollution.

The investigations have been carried out during vegetation seasons of 2018-2020 in the Lower Prut (Braniste-Giurgiulesti sector). The forms of inorganic nitrogen (N_{inorg}) (ammonium, nitrite and nitrate ions) were determined by applying the standards SM SR ISO 7890-2:2006, SM SR ISO 7890-3:2006 and SM SR ISO 7150-1:2005, and of organic nitrogen (N_{org}) - SM SR EN 25663:2012.

The registered values of N_{inorg} varied between 0.20 and 1.21 mgN/L in 86.1% of cases and were higher, up to 2.27 mgN/L, in all other cases. Most frequently, the nitrate nitrogen has prevailed on other two inorganic forms of nitrogen during the vegetation season, its amount reaching 1.65 mg/L. Nitrite forms of nitrogen in waters were always the lowest and their concentrations not exceeded 0.03 mgN/L.

In 9.3% of analysed water samples, the values of N_{org} were below 0.29 mgN/L, in 7.0% of cases they were higher - up to 0.54 mgN/L, in 60.5% - up to 1.48 mgN/L and in 23.2% of cases - up to 9.47 mgN/L. The highest values of N_{org} were observed in relatively warm winter of 2020 and also after floods from May-June 2020, which were caused by heavy torrential rains.

The considerable predominance of N_{org} over N_{inorg} during the August 2019 - June 2020 indicates the prevalence of production processes over the destruction ones, and, consequently, an increase in the level of eutrophication of river waters, or, in some cases – the penetration of allochthonous organic matter in river.

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S2.10. Analysis of BOD_5/COD_{Cr} relation in the Prut River water

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Biological oxygen demand (BOD) and chemical oxygen demand (COD) are globally used as quality parameters for the evaluation of organic pollution in water environment. COD and BOD_5 analyzes were carried out in accordance with national standard methods in water samples collected in 2020 from the Prut River.

COD_{Mn} values have not varied essentially from site to site during the winter and spring periods and ranged from 5.8 – 7.4 mg/l and 4.6 – 4.9 mg/l, respectively. High COD_{Mn} values in winter, comparing to those from spring, were due to the low water level in the river. The COD_{Cr} values showed a clear increase in winter along the Costesti – Giurgiulesti river section from 18.9 to 45 (mg/l). During the low water period high COD values could be provoked by the discharge of insufficient treated wastewaters. In spring time the higher water level in the Prut River contributed to dilution effect, and the COD values were quite stable on the studied river segment.

The BOD_5/COD_{Cr} relation is often used to assess the efficiency of biological treatment for industrial wastewater: if the index value is > 0.2, biological treatment can be effective. On the other hand, the BOD_5/COD_{Cr} index calculated for a water body allows evaluating the capacity of self-purification at different sections of the river. A higher value of the index characterizes a greater ability to self-purification of water. A comparative analysis of the BOD_5/COD_{Cr} index has been done based on the results of a winter and spring expeditions at the Prut River. To mention that the spring expedition was carried out at the end of May, when the rain flood began on the Prut River. As for

rainwater, the BOD_5/COD_{Cr} index is very low. The index values in spring samples of the Prut River, containing a significant proportion of rainwater, were also low and ranged from 0.052 to 0.068. Index values in winter samples varied significantly: from 0.05 at Braniste station to 0.16 and 0.18 at Cislita and Leuseni stations, respectively. Thus, the biological purification process can be most effective at the Leuseni and Cislita stations.

Conclusion: the proportion of the organic component in the substances, which are oxidized during the determination of COD_{Cr}, varies significantly depending on the hydrological situation on the Prut River. At the same time, applying the BOD_5/COD_{Cr} index helps to identify points of risk for reaching a good ecological state.

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S2.11. Phytoplankton state and water quality in the Dniester River lower sector

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Research on phytoplankton was carried out during 2019, samples were collected from lower sector of Dniester river, part of Republic of Moldova. Sampling and analysis of phytoplankton was carried out by conventional hydrobiological methods [1,2]. During 2019 year the diversity of quantitative parameters of phytoplankton, as well as the water quality, using algae species as indicators of saprobity were assessed.

In phytoplankton compositions of the lower sector of Dniester River were identified 40 species. It was found that the phytoplankton species of the following groups predominated: *Cyanophyta-4, Bacillariophyta-26*, *Chlorophyta-7* and *Euglenophyta-3*. The basis of the floristic diversity consists of species: *Aphanizomenon flos-aquae*, *Synechocystis aquatilis*, *Oscillatoria lacustris* from green algae, *Cocconeis placentula*, *Cyclotella kuetzingiana, Gomphonema olivaceum, Navicula cryptocephala, Nitzschia acicularis* from diatoms algae, *Monoraphidium Komarkovae, Dictyosphaerium pulchellum, Monoraphidium contortum* and *Scenedesmus quadricauda* from green algae, *Euglena polymorph*a, *Monomorphyna pyrum* and *Trachelomonas hispida* from *Eulglenophyta* algae.

The number of phytoplankton species in Dniester River lower sector was in limits 1.35-17.65 mln. cell/l, with higher values at Sucleia and Palanca stations of collecting samples. It was attested the preponderance of *Cyanophyta* (*Synechocystis aquatilis*) in the forming of the number of algae species, during spring and autumn. The biomass of planktonic algae was in limits 0.61-8.47 g/m^3, with the high value in spring. The main part in the formation of phytoplankton biomass was *Bacillariophyta* algae.

The saprobic index values were established within 1.87-2.39, being higher in summer time. The values of saprobic indices were estimated on the basis of species-indicators (33 species) from phytoplankton composition, which were in proportion of 55 % typically β-mezosaprobic (*Aphanizomenon flos-aquae, Nitzschia sigmoidea, Synedra ulna, Trachelomonas hispida, Pediastrum boryanum, Scenedesmus quadricauda*), 15% - α-mezosaprobic (*Navicula cryptocephala, Nitzschia palea, Euglena polymorph*a). According to these indices, the water quality of Dniester River lower sector was attributed mainly to II-III (good-moderately polluted) quality classes.

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S2.12. Investigation of the phenol- and hydrocarbon-degrading microorganisms in the Prut River bacterioplankton

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The Prut River is the second main sources of fresh water in the Republic of Moldova, following the Dniester River. Both rivers are part of the Black Sea Basin. Each of these transboundary rivers has its own critical points, which were taken into account when sampling. The study of the Prut River bacterioplankton, as part of the comprehensive scientific monitoring, was carried out during the vegetative season (spring-summer-autumn) 2018, 2019 and 2020 at the stations Costesti (dam), Braniste, Leuseni, Cahul, Cislita-Prut and Giurgiulesti. The petroleum hydrocarbon-degrading and phenol-degrading microorganisms (MOs) were cultured on the selective nutrient media at (20 – 22)ºC. Enumeration of colonies was performed in accordance with the national standard SM SR EN ISO 6222:2014 (direct method of colony counting). The numerical density of studied microorganisms was presented in colony-forming units (CFU/mL). The water quality based on microbiological indices was performed according to the methodological guide [1].

The microbial community of a water body is the most variable component of aquatic biota that responds quickly to environmental changes. Biodegradation of hydrocarbon and phenol compounds in aquatic and soil environment can be carried out by various organisms, including actinomycetes (*Nocardia paraffinae*), fungi (molds), yeasts (*Candida lipolytica, Candida tropicali*), anaerobic and aerobic bacteria (*Pseudomonas fluorescens*, *Corynebacterium petrophillum*, *Mycobacterium paraffinicum*). The listed MOs are not strictly specific for degradation of these organic substances only. Their detection on nutrient media containing petroleum hydrocarbon or phenol is not direct evidence of contamination of the water body with oil products or phenolic compounds. However, the presence of these MOs in the water sample indicates that in this station (or upstream) there are currently (or slightly earlier) organic substances that served as a substrate for the accumulation of these microorganisms.

The studied groups of microorganisms were detected in water samples at all stations of the Prut River. Their numerical density varied in the range of (22 – 1976) CFU/mL for phenol-degrading MOs and (25 – 680) CFU/mL for hydrocarbon-degrading MOs. Peak values were distributed differently in different years depending on the hydrological situation in the river basin. Seasonal dynamics was registered for bacteria that biodegrade phenolic compounds: the highest values were observed in the autumn season. Such dynamics characterizes natural seasonal processes in the aquatic ecosystem: when the biomass accumulated during the summer season dies, phenolic compounds accumulate in the water. Regarding spatial dynamics, the highest numbers of these MOs were recorded in autumn 2018 at Giurgiulesti and Cahul stations: 1156 and 1976 (CFU/mL) respectively. In the autumn of 2019, the largest number of this group of microorganisms was 486 UFC/ml at Giurgiulesti station. As for this last station, it is located at a distance of 940 m from the confluence of the Prut River with the Danube, therefore its characteristics directly depend on the hydrological situation on the Danube River.

No seasonal or spatial trend was observed in the dynamics of petroleum hydrocarbon-degrading MOs. The highest number was detected in autumn 2018 at Cahul station (680 CFU/mL), in spring 2019 – at Sculeni station (317 CFU/mL), in spring 2020 – at Giurgiulesti station (211 CFU/mL). Contamination of the Prut River with petroleum products is associated with human activity: the oil production unit is located in Lake Beleu, from where hydrocarbons can enter the Prut River during the spring or rain floods. One of the constant sources of oil product pollution is urban and industrial wastewater, the prescriptive treatment of which in the Republic of Moldova is not currently provided by any treatment facilities. The Prut River water quality based on number of phenol-degrading MOs varies from II (relatively polluted) to III (moderately polluted) class; based on number of petroleum hydrocarbon-degrading MOs varies from III to IV (polluted) class.

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S2.13. The dynamics of the destruction activity of bacterioplankton in the Lower Prut in 2018-2019

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Aquatic planktonic microorganisms (bacterioplankton), like other aquatic organisms, play a very important role in the mineralization of autochthonous and allochthonous substances.

The investigations have been carried out during the vegetation periods of 2018-2019 at six sampling points on the Lower Prut (from Braniste to Giurgiulesti) and aimed to assess the bacterial destruction of organic matter and the total number of aquatic microorganisms.

The dynamics of the bacterial destruction of organic matter, both in seasonal and annual aspects, is extremely ambiguous. Its average values (p=0.95) in different seasons of the investigated vegetation periods varied from 1.26±0.63 cal/l/24 h (summer) to 1.85±0.96 cal/l/24 h (spring), which indicates the absence of significant differences. At the same time, the activity of mineralization processes oscillated from 0.01 to 12.71 cal/l/24 h.

The amount of total bacterioplankton in the studied period varied from 0.3 to 1.5 million cells/ml in the spring, from 0.5 to 5.0 million cells/ml in the summer, with an average of 1.0±0.14 million cells/ml.

Despite the fact that the destruction activity of bacterioplankton is mainly determined by its amount, the data obtained so far indicate that there is no reliable relationship between bacterial destruction of organic matter and the total number of bacterioplankton. This suggests that the intensity of the metabolic (destruction) processes of bacterioplankton in the Prut River is determined by other factors and, first of all, by the qualitative composition of their trophic substrate.

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S2.14. Suspended substances of the Prut River

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The suspended substances of the aquatic ecosystems are formed depending on the nature of the rocks, the soils in the aquatic ecosystems, the character of the precipitations, the hydrological parameters of the river, the metabolic activity of the hydrobionts and the pressure from the human activity. In riparian ecosystems, where human influence is limited, suspended substances and their characteristics are an indicator of the degree of erosion-denudation processes and the ability of chemicals to migrate, being also a basic criterion in determining the state of rivers and their basins.

The concentration of the suspended substances determines the turbidity and transparency of the water and, consequently, the penetration of light, the intensity of heating, as well as the absorption processes and the intensity of photosynthesis. All this affects the quality of the water and the activity of the aquatic organisms. And when we talk about the life of aquatic organisms we are referring to the whole food chain of the ecosystem, the disturbance of which can contribute to its degradation, but is also an important part of food and nutrient cycles in lotic ecosystems.

In riparian ecosystems with normal activity, the total amount of suspended substances differs depending on the season. During floods the total amount of suspensions is higher due to flooding of adjacent territories and the high speed of the water flow carrying a larger amount of suspensions, compared to the drought season when the amount of particles in the suspensions decreases considerably.

For the Prut River in the period February-July 2020, in the winter period (February) small values for the total amount of suspended particles were found. In May-June, higher amounts of suspended substances were determined compared to February, and in July at most stations we also noticed a trend of increasing the total amount of suspended substances. In most of the sampling the total amount of suspended substances was in mineral form.

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S2.15. Fish fauna from Danube Delta Biosphere Reserve

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The huge protected area of Danube Delta Biosphere Reserve (DDBR) (5800 km^2) shelters 137 fish species from Animal Kingdom, Phyllum Chordata, Subphyllum Vertebrata, belonging to 3 Classes (Actinopterygii bony-fish which are mostly present, Petromyzontida-lampreys species accidentally present in the area and Chondrichthyes - marine sharks species) and 20 Orders, 45 Families, representing about 75 % Romanian fish fauna, clasified in:

- 129 native fish species:
    1. 53 freshwater fish (including *Carassius gibelio* and *Cyprinus carpio* considered to be native to Danube delta after long debates).
    2. 21 euryhaline species divided into: 12 euryhalin half-migratory or expansion species like gobiids, aterina, *Syngnathus abaster* and 9 long distance migratory fish species: anadromous like shads and sturgeons, but also catadromous like eel).
    3. 55 exclusively marine fish species (probably much more in number considering other species are around in Black Sea basin waiting to enter in Danube Delta Biosphere Reserve limits). Some of them enter in freshwater gulfs for feeding like young mullets.
- 8 exotic non-native fish species: 7 freshwater fish species (*Hypophthalmichtys molitrix, H. nobilis, Ctenopharyngodon idella, Pseudorasbora parva, Percarina demidoffi, Perccottus glenii*) and 1 marine fish species (*Mugil soiuy*).

But the species number is not fixed in DDBR; being an open system, it is variable due to continuous dynamics of fish movements, so new species appear regularly in the system (like *Perccottus glenii* in 2007 another 69 species are around DDBR and can increase the number of fish species).

Totally 56 exclusively marine, 21 euryhaline and 60 freshwater fish species are present in Danube Delta Biosphere Reserve but sometimes in freshwaters gulfs or paramarine lakes enter some marine species or some freshwater fish species can penetrate Black Sea brackishwater.

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S2.16. Assessment of the process of copper stabilization from polluted soils

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Contamination of soil with heavy metals has become a serious problem in some industrial and agricultural sites. One of the most commune soil pollutant is copper. Usually high concentrations of Cu have been reported in vineyard soils due to the use of copper-based fungicide and also on wood treatment sites where in order to protect against insects and fungal a solution containing Cu, Cr, and As is used.

The most important problem that occurs in copper polluted soils is the bioavailability of the element to living organisms.

In general, the contaminated land is found in a large areal, and the old methods of excavation and burial of the contaminated soil are not practical, so are needed alternative methods of stabilization less invasive, with small costs, and predictable results. This objective can be achieved by using natural amendments in order to fix the contaminant in soils. It can be considered that stabilization had success if the amount of the pollutant remains constant over the time. Because the concentrations of Cu are associated with soil texture and several other parameters, in particular pH and organic matter, many remediation treatments are based on organic mixture by converting the element into less exchangeable and thus less bioavailable forms.

In order to assess the efficiency of the applied amendment it was used the sequential chemical extraction (SCE). Usually SCE is fractioned, applied on a soil sample, starting with the weakest reagent and ending with the strongest one. According to Tessier, SCE has five fractions: exchangeable, carbonate bound, Fe and Mn oxide bound, organic matter bound and residual. In general metals of anthropogenic origin are found in the first four fractions and in the last fraction are found those from the parental rock.

The soil samples were collected from a field experiment where for almost 70 years, in order to prevent infestation with insects and fungi, wood was treated using copper sulphate, or arsenate copper chromate. Due to the lack of legislation and guidelines regarding waste management, the soil became polluted, in particular, with Cu, Cr and As.

In this case the experiment had two stages. The first stage was to immobilize the pollutants with the help of organic amendments and the second one consists in highlighting the efficiency of the applied treatments by using sequential chemical extraction.

The applied organic amendments where: organic matter (OM), dolomite (DL), organic matter and dolomite (OMDL), organic matter and zero-valent Fe (OMZ).

In order to confirm the treatment efficiency, and to find the fraction in which Cu becomes instable, the soil samples were analyzed by applying a particular protocol of sequential chemical extraction. After each extraction, the obtained solution was analyzed using Atomic Adsorption Spectrometry (AAS).

The metal content avaible for plants is given by the *mobility index*. The metal concentration from the first two fractions are considered to be bioavailable and the elements found into the last tow, tend to be more stable in soils. In this study the mobility index for Cu for untreated soil was 19.27 (%) and in general for unpolluted soils, Cu has a mobility index smaller than 10 (%).

The results of the SCE technique underline the fact that a high percentage of the total concentration of Cu was presented in exchangeable and organic fraction indicating an anthropogenic source of the soil pollution. Also, the application of OM treatment was the most efficient in the attempt of stabilize cooper into the soil, preventing the future leaching into the underground water and also the plant uptake.

Acknowledgement: The systematization of data was carried out in the frame of BSB27 MONITOX project, JOP Black Sea Basin 2014-2020 and Romanian-JINR project no. 71/2020.

S2.17. *Vibrio fischeri* photobacteria used to determine the toxicity of the soil

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Bioluminescence is a phenomenon in which light is produced by living organisms such as bacteria, fungi or animals. Of these, bacteria that live in the marine environment are the most common.

The most studied luminescent bacteria are *Vibrio fischeri* and *Vibrio harveyi*, both classified as photobacteria. *Vibrio fischeri* is a symbiotic bacteria that lives in the organs of fish such as those from the *Monocentridae* family and cephalopods, respectively *Sepiola* and *Euprymna*.

In general, the organisms that have these bacteria use them either to attract prey, to intimidate predators, or to communicate. Bioluminescence is an energy-consuming reaction because, in order to produce light, these organisms can consume up to 20 (%) of cellular energy.

The reaction of luminescent bacteria is catalyzed by *luciferase* which is composed of two subunits, α and ß, genetically represented by the *luxA* and *luxB* genes. The reaction leads to the oxidation of FMNH2 into FMN and aldehydes into organic acids and an additional product which is the amount of light.

In vivo luminescence is a sensitive indicator of xenobiotic toxicity towards microorganisms because it is directly linked to the respiration through the electron transport pathway reflecting the metabolic status of the cell. Thus, if there are toxic substances in the environment, the light intensity emitted by bacteria decreases. The higher is the concentrations of harmful substances, the lower is the light intensity emitted by luminescent bacteria.

These techniques provide quantitative information, but do not specify anything about the availability of pollutants in the environment. Recent studies on bacterial biosensors have indicated the possibility of their application to environmental issues, for example the presence of toluene or the toxicity of domestic water.

One of the most popular kits for such analyses is *MicroTox*, which identifies solution toxicity, using the *Vibrio Fisheri* bacterium.

In conclusion, this type of method can be used with success for: (1) solutions with lower concentrations of pollutants that would no longer require any analysis, (2) the development of toxicological profiles of some waste waters in the vicinity of industrial sites, (3) the identification of pollution points for surface waters and (4) the analysis of the toxicity of accidentally discharged pollutants.

For this study the soil samples were collected from a contaminated site, mainly with cooper. On this soil were applied different types of amendments: phytoremediation (*Populus nigra, Salix Viminalis, Salix caprea, Amorpha fructicosa*), organic matter (OM), dolomite (DL), organic matter combined with dolomite (OMDL), organic matter combined with Fe (OMFe). The analysis using *Vibrio Fisheri* cells was used to establish the efficiency of the applied amendments, regarding the reducing of the soil toxicity.

The analyses were accomplished by a Sirius Luminometer and the luminous signals were recorded by a FB12 Sirius Software-Single Kinetics Protocol Vr 1.4. (Berthold Detection System, PorZheim, Germany). For the analysis, 2 grams of soil were suspended with 8 ml of NaCl solution, agitated for 5 minutes and left to rest for 30 min. The solutions were adjusted at 7 ± 0.2 pH units and 22 Scm^{-1} using NaCl. If the obtained inhibition factor is less than 20 % then, the solution is toxic. The results indicated that the toxicity for the untreated (UNT) soil has the higher value and the most efficient treatments were the dolomite and the phytoremediation.

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SECTION 3. Environmental technologies, remediation and management of riverine, deltaic and coastal ecosystems

S3.01. Nature-based solutions for streams to reduce sediment and litter pollution in the Black Sea

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Reducing the pollutants and litter that originate from the streams and rivers that end in the Black Sea is a major priority to sustainably manage this closed Sea. Pollutants and litter are major concern in regard to the degradation of the Black Sea. In regard to the pollutants sources the focus will be on surface and stream bank erosion. For surface erosion, at the local scale, gerlach traps and runoff plots will be installed and measured under different land-uses/vegetation covers and/or burnt areas or frequently flooded areas. A Hydrologic model, will be also be applied to determine the potential pollutant sources at the watershed scale. The model will estimate the potential that different land-uses (agricultural, grassland, forests, urban etc.) and natural disaster (e.g. wildfires and floods) have as pollutant contributors. The model will be validated based on the data from the local scale measurements. The model will also incorporate climate change forecasts (IPCC predictions) to estimate future pollutant contributions. Emphasis will be given to nonpoint source pollutants that cause eutrophication in closed seas (e.g. the Black Sea). Indices developed in a GIS environment based on satellite images will identify the most vulnerable areas to erosion at the watershed scale. The use of UAVs at the local scale for the different land use/vegetation covers will more accurately identify the areas that are most likely to have high surface erosion risk and collect litter. From stream bank erosion, traditional (e.g. erosion pins, cross-section surveys) and innovative methods (e.g. laser scanning) will be used at the local scale along with the GIS Stream Bank Erosion Index that utilizes satellite images at the watershed scale. Again, UAVs will be deployed to capture more accurately the locations of litter gathering, sediment erosion or deposition. Overall, the surface and stream bank erosion methods applied at the local and watershed scale will provide estimates of their potential contributions of nonpoint source pollutant ana litter to the Black Sea.

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S3.02. Role of GIS (Geographic Information Systems) on management of riverine (sample area along Kura River)

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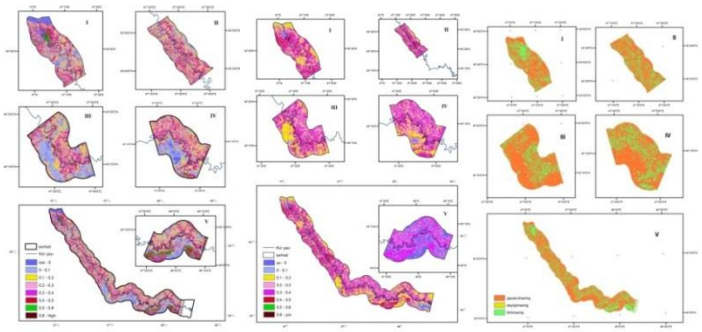
Analysis of multispectral images more effectively reflects the dynamics of landscapes in the vegetation as a result of anthropogenic impact. To analyze this more accurately, maps were prepared showing the NDV index (June 14, 2002 and June 9, 2019) of the study area and their analysis (Figure 1 a, b, c).The study area covers 1,764 km^2, extending 255 km along the Kura river. The area extends from Mingachevir reservoir to Jarli village of Kurdamir district. The study area is divided into 5 sectors at a distance of 50 km for a clear view of the dynamics of landscapes. The results of the research are analyzed in detail in Table 1.



a) b) c)

Figure 1. NDV indexes (a-2002, June 14, b-2019, June 9) and dynamics of NDV indexes (c-comparison of materials 2002, June 14 and 2019, June 9) in selected model areas in river-valley landscapes along the Kura river

In order to analyze the impact of anthropogenic activity on the dynamics of landscapes in the investigated area, the level and directions of land use of the area were studied. We analyzed settlement areas, growing zones, pastures, forests, swamp and etc. To determine anthropogenic effect we analyzed settlement area dynamic during 1975 and 2019 years, and we determined that area of them has decreased (Table 2).

Table 1.Dynamics of NDVI in river-valley landscapes along the Kura river

NDV indexes	Year 2002		Year 2019		dynamics	
	km^2	%	km^2	%	km^2	%
low-0	126	7.1	41	2.3	85	67.5
0-0,1	392	22.2	43	2.4	349	89.0
0,1-0,2	357	20.2	347	19.7	10	2.8
0,2-0,3	320	18.1	514	29.1	-194	-60.6
0,3-0,4	279	15.8	509	28.9	-230	-82.4
0,4-0,5	205	11.6	284	16.1	-79	-38.5
0,5-0,6	81	4.6	33	1.8	48	59.3
0,6 -high	10	0.57	0	0	10	100

Table 2. Dynamics of land use and indicators of the current situation in the model areas

Model areas	area		settlements					growing zones		pastures		forests		swamps
	km^2	%	1975 km^2	1975 %	2019 km^2	2019 %	dynamics %	(km^2)	%	(km^2)	%	(km^2)	%	(km^2)
I	387	22	34.9	10	64.5	17	54	70.6	18	120.7	31	2	1	-
II	390	22	13.95	4	28.3	7	49	156.3	40	87.5	22	37.8	10	-
III	320	18	8.3	3	24.7	8	34	139.9	44	131.4	41	12.4	4	-
IV	272	15	12.5	5	34.1	13	37	91.1	33	146.6	54	4	1	-
V	395	23	21	5	41.9	11	50	123.2	31	240.2	61	3	1	64
total	1764	100	90.65	5	193.5	11	47	581.1	33	726.4	41	59.2	3	64

S3.03. Estimating flood risk for Dendropotamos torrent of Thessaloniki, Greece

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Floods are natural disasters that can cause damages to infrastructures and also lead to the loss of human lives. Climate change has and will continue to increase the frequency and magnitude of floods. Floods are a serious problem in urbanized areas since most cities and towns are built around rivers and streams and because of the high density of people. Flash floods that are quite frequent in the Mediterranean region, are a major concern in urban areas that have build along or in torrents. In this study a flood risk analysis was implemented for the Dendropotamos torrent that pass through the city of Thessaloniki in Northern Greece. Specifically, the softwares HEC-Ras, QGIS and Ras Mapper were utilized. Initially stream field cross-sectionσ of the torrent were taken as in it goes through the city. A total of 35 cross-section were taken using a GPS and these points were afterwards entered into the HEC-RAS program. In QGIS that Digital Elevation Model (DEM) for Dendropotamos watershed was developed. HEC-RAS is a hydraulic model that allows you to perform one-dimensional steady flow, one and two-dimensional unsteady flow calculations, sediment transport/mobile bed computations, and water temperature/water quality modeling. In this case, the level of stream flows in each cross-section that indicated the areas that have the potential of flooding. Finally, Ras Mapper was used to develop maps based on the results of the study. Overall, the results of the HEC-RAS, indicate that several urban areas of Thessaloniki have a high flood risk. Based on these results the following recommendations were suggested to mitigate flood risk: a) cleaning and widening (when possible) of the torrent bed, b) protecting the stream banks with concrete walls or gabions, c) demolition of illegal buildings in the torrent bed, d) implementation of other flood protection infrastructures in areas indicated as high flood risk by HEC-RAS and e) greater awareness of the flood risks through events and workshops for the citizens of Thessaloniki. Finally, efforts should be made to adopt, integrated watershed management plans, ecosystem-based approaches and nature-based solutions to restore the degraded torrential ecosystem.

S3.04. The use of GIS to determine stream bank erosion prone areas in two watersheds of Greece

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Stream bank erosion is a major source of sediment and nutrients to water bodies. High sediment and nutrient concentrations can degrade aquatic ecosystems and cause eutrophication. For decades major conservation efforts have been made to reduce stream bank erosion, not always successfully. The key for the successful mitigation of stream bank erosion is identifying the areas that are the most prone to such a type of erosion. The implementation of targeted approaches for stream bank conservation practices can reduce efficiently and cost-effectively sediment and nutrient from reaching the water bodies. The purpose of this study was to showcase, with the use of GIS, the areas more prone to stream bank erosion for two sub-watersheds. The two sub-watersheds belong to Axios River transboundary Basin that ends in the Thermaic Gulf of Northern Greece. Specifically, the different reaches of the streams of the two watersheds were separated in different categorizes based on how prone they were to stream bank erosion. The categorization was done within GIS, and the eight parameters utilized were: a) erosive rainfall, b) geology, c) stream

bank slope, d) meandering index, e) stream channel slope, f) watershed erosion coefficient, g) watershed vegetation cover and f) anthropogenic factors. The stream bank erosion categories for the reaches based on the above parameters were: a) no erosion, b) very low erosion, c) low erosion, d) moderate erosion, e) high erosion and f) very high erosion. Once the maps were developed in GIS, they showcased the stream bank erosion susceptibility for the different reaches. Several field measurements were afterwards taken in both sub-watersheds to validate these maps. The field measurements indicate that maps were quite accurate in highlighting reaches with high and very high erosion. Overall, this is an easily adopted method that could be utilized to identify areas highly prone to erosion. This could allow the targeted placement of conservation practices on stream bank that contribute most of the sediment and nutrients in a watershed.

S3.05. Economic valuation of ecosystem services in the Dniester basin

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Hydropower plants, their dams and reservoirs are usually built to generate electricity and to store water for compensating river flow fluctuations, thereby providing a means for human control of water resources. However, the effectiveness of dam technology in delivering these services is being hotly debated currently, especially from ecological points of view due its numerous adverse biological effects on the aquatic and water-related ecosystems.

Economic valuation (EV) is a tool for valuing ecosystems and their services in monetary terms; it quantifies both the benefits provided by ecosystems and the consequences of their changes for wellbeing of people. In turn, ***ecosystem services (ES)*** are the many and varied benefits that humans obtain from the natural environment and properly functioning ecosystems *for free*. Based on goods the ecosystems provide, their services are categorized into four broad categories:

- *Provisioning services:* products directly obtained from ecosystems (e.g., food, timber, fish);
- *Regulating services:* benefits from regulating the natural processes (e.g., climate or water flow regulation);
- *Habitat services:* everything that an individual plant or animal needs to survive (e.g., food, water, shelter);
- *Cultural services:* non-material benefits people obtain from ecosystems (e.g., recreation, aesthetic enrichment).

The values that are captured by the EV concept depend on how they are implemented and what approaches and methodologies are used. As a result, there are multiple values and multiple valuation metrics. Based on the analysis of different methods and specific of the BSB165 "*HydroEcoNex*" project the ES economic valuation, carried out in its framework, has entailed the following main steps:

- *Setting the Scene* that includes: determination of the spatial boundaries of an area; identification of ecosystems and ecosystem services to be evaluated and their size;
- Identification of valuation method: directly via market prices or through 'benefit transfer' (by analogy);
- Assessing the values of selected ecosystems services.

Here, only the part of *EV* of the Dniester River ecosystems service is presented.

Water. The total cost of water providing includes its full economic cost and environmental externalities, associated with public health and ecosystem maintenance. In this duality, the first component consists from water supply cost, e.g., operating and maintenance expenditures and capital charges. Such approach, as useful for EV of impacts on water resources, was applied to evaluate losses of the Dniester River's provisioning services due to the Dniester Hydropower Complex (DHPC) operation. The estimations were based on comparing the streamflow volume *(Q)* upstream and downstream of DHPC in periods before (1951-1980) and after (1991-2015) this complex construction. Q decrease downstream the DHPC in the second period, against its some increase upstream, indicates its adverse impact that resulted in annual economic losses of $90 million (at a water price of $25/m^3).

Water protection and regulation. This service consists in equalizing seasonal fluctuations in the Dniester runoff, preventing its sharp reductions, in order to reduce floods intensity by redirecting a surface runoff into ground. So, depending on a forest slope area in the Lower Dniester, the underground water accumulation here is ~485,000 m^3.

Carbon deposit by the Low Dniester forest ecosystems. Annual CO_2 accumulation for Moldova's main forest-forming species (oak, poplar, white acacia and other species) is 7.7, 10.7, 8.4 and 4.1 ton/ha, respectively. As of March 2020, with an average price of CO_2 allowance of 24.1 EUR, the resulting current economic value of forests annual carbon deposit service is 1.53 million USD, varying across the territory from <5 to 105 thousand USD.

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S3.06. Assessment of pressures as the first step in economic valuation of changes in ecosystems services

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Different conservation organizations, governments and donor agencies make intensive efforts to save life on the Earth. An accomplishment of this urgent task is consistent with another challenging mission – conservation of ecosystems and their biodiversity. Despite numerous actions, the biodiversity is continuing to lost, ecosystems are degrading and a consequent decline in ecosystem services threatens to undermine human health and well-being. These processes are a challenge for ecosystems both in the terrestrial and aquatic environments, especially for river systems that everywhere are being fragmented by natural forces such as changes in streamflow, extreme water events or due to human activities. To date, the knowledge in this sphere is quite enough to describe the physical disruptions in river flow and biogeochemical alterations or to carry out the economic valuation of the observed effects on ecosystems and their services that provide benefits to people. Likewise, any damage to ecosystems as well as their losses can be also evaluated economically. In the last case, any assessment or valuation of changes in ecosystems services, caused by a new status of the environment, should begin from the assessment of drivers, or impacts, which have caused these changes. In particular, in Project BSB165 "HYDROECONEX" the impacts under study include the hydropower development and climate change in the transboundary Dniester and Prut River basins.

Climate change studies were based on historical observations of air temperature and precipitation at weather stations located in the lower parts of these basins below the Dniester hydropower complex (DHPC) and Costesti-Stanca Hydropower Plant (HPP), respectively. To identify climate change evidences, two climatic periods have been compared: 1961-1990, which reflects a relatively "normal" basin-wide climate, and 1991-2018, which characterizes the period of intensive global warming. The statistical analysis of change in selected variables included the comparison of their trends and seasonal/annual averages in these periods. In the last decades, in both river basins there is observed a sharp increase of temperature against their very small positive trends in 1961-1990. Changes in precipitation are not significant to be taken into account for practical purposes. A resulting increase of aridity in both basins should be considered as unfavorable for their ecosystems functioning.

Hydrological studies were based on the long-term observations of Dniester and Prut Rivers flow at hydrological posts located upstream and downstream of the corresponding HPPs. The upstream posts record the rivers' flow in upper parts of their basins that is not disturbed by the HPPs construction and functioning; such position allows also assessing the possible contribution of climate change in water discharge. The downstream posts register hydropower impacts on streamflow total volume and annual regime. To assess their transformation under HPPs operation there were chosen time periods characterizing the river flow before and after HPP reservoirs filling and beginning of their operation: 1951-1980 vs. 1991-2015 in the case of DHPC and 1950-1975 vs. 1980-2017 – in the case of Costesti-Stanca.

A slight increase in both river water discharge, observed in the 1950-1990s, over next decades has changed on a decrease that is in good agreement with changes in climate. However, in the

absence of statistical significance, there is no reason to argue about stability of this decrease (by 3.6% of the Dniester annual flow and by 1.8% – of the Prut). The assessment of a hydropower impact on two rivers streamflow showed that it depends on the HPPs capacities. In particular, the creation of Dniester reservoir and construction of DHPC, with its HPP-1 design capacity of 702 MW, has led to a decrease in the Dniester flow annual volumes by above 6% in close proximity to its dam and by about 9% – in the Lower Dniester. At the same time, the creation of a reservoir and construction of a mean-capacity HPP (32 MW) did not showed statistically significant effect on Prut downstream water discharge. However, HPPs operation has transformed the seasonal distribution of both rivers streamflow due to interests of certain water users.

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S3.07. The water quality in transboundary Dniester River as a factor of impact on human health

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The Dniester/Nistru River is a transboundary watercourse shared by Moldova and Ukraine. Both countries are Parties of the Protocol on water and health (London, 1999). Currently the Dniester River management is regulated according to the bilateral Dniester Treaty (Rome, 2012), which covers all issues of water use, quality monitoring protective policy. The Dniester River is a source of potable water for many upstream towns as well for the cities of Balți, Chișinău and Odessa. In the years of independence many sewage treatment plants became obsolete and are now either out of function, or realize the only physical treatment from particles. The bacteriological treatment is usually absent. The middle-size town of Soroca with population over 37.000 does not have the sewage treatment plant at all. The monitoring of Dniester River water quality demonstrates its relatively good level of hydrochemical parameters (classes I, II, III), when water bacteriological data mostly correspond to IV and V quality classes.

The bacteriological quality and organic pollution of waters in small and middle rivers, the Dniester tributaries, is even worth – here are two main polluters – communal sewage waters and spills of the processing industry. The major part of these rivers water belongs to classes IV and V. The main source of drinking water supply in rural Moldova is groundwater sources, of which about 100% of the rural population and 30% of the urban population, or 65% of the total population of the country. From the surface sources, the most important is the Dniester River, which accounts for 32%, the Prut River - 3%, other surface sources make up 0.2%. The Water and Health Protocol target level of the quality indicators of surface water used for drinking water supply in terms of the content of enterococci and *E. coli* to the level: by 2025 to the 2nd quality class - was partially achieved. The results show that in most areas this has been achieved: Dniester River - 66% corresponds to I-II classes, p. Prut - 76% corresponds to I-II classes. These data indicate that microbial pollution of the waters of the Dniester. So the water supply and sanitation are still remaining the challenges for the wellbeing of the population and the authorities of the Republic of Moldova. Currently in Moldova is revising the National Program for the implementation of the Protocol on Water and Health in the Republic of Moldova until 2030.

S3.08. Investments in the field of drinking water and wastewater in Galati County

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Water quality, whether for human consumption and what is a living environment for aquatic organisms, is a permanent concern of contemporary societies.In accordance with the Treaty concerning the accession of the Republic of Bulgaria and Romania to the European Union (2005), Romania has undertaken obligations involving significant investments in water supply and sewerage services in order to comply with EU environmental standards.

The Intercommunity Development Association - Galaţi Water Service (IDA-GWS) established in 2010, has 44 members. The purpose of this association is to jointly carry out infrastructure

development projects related to water supply and sewerage services based on the development strategy in Galati county and the provision of water - sewerage services by each local authority. Water- Sewerage Company S.A. Galati was designated as Regional Operator for IDA-GWS, thus in Galati county, the concern regarding the quantitative and qualitative assurance of the water resource to the population is managed unitarily. This fact is highlighted in this article by presenting the projects, infrastructures and technologies implemented with the help of European funds in the field of water supply and wastewater management.

The first projects carried out in Galati County were those financed by the Instrument for Pre-Accession Policies (ISPA) of the European Union. Through ISPA funds the city of Galati obtained funding for the project "Modernization of drinking water and sewerage systems and construction of a new wastewater treatment plant in Galati, Romania". This project was implemented by Water-Sewerage Company S.A. Galati and the technical assistance and supervision of the project was provided by an international consortium Germany - Denmark. The total value of the ISPA project was approx. 75 million Euros. For the period 2007-2013, the Sectoral Operational Program for Environment (SOP-Environment) was the document that established the strategy for allocating European funds for the water / wastewater sector in Galați. SOP-Environment continued the ISPA program for the development of water / wastewater infrastructure in Galati. The project "Rehabilitation and expansion of water and wastewater infrastructure in Galati county" was accepted for co-financing through the SOP-Environment 2007-2013 in the second half of 2011. Completion of works was registered on April 11, 2016. The value of the works within the contract was 80,436,910.16 lei.

For the period 2014-2020, the Large Infrastructure Operational Program (LIOP) was the document that established the strategy for allocating European funds for the water / wastewater sector in Galati county. The Water-Sewerage Company S.A. Galati signed on December 20, 2017 with the Ministry of Regional Development, Public Administration and European Funds the financing agreement for the investment "Regional project for the development of water and wastewater infrastructure in Galati county, in 2014-2020". The duration of the contract is 105 months, respectively until 31.12.2023, and the total value of the financing contract is 822,694,181 lei. The project aims to carry out works in 22 territorial administrative units in Galati County, both in the field of water supply and wastewater. The provision of safe drinking water and the provision of efficient sanitation services are some of the greatest achievements in the medical field. A functional and modern public water supply and a wastewater collection and treatment system are key requirements of the public service and also an essential condition for creating good living conditions and ensuring the existence of the population. Therefore, water and sanitation are very important topics on the agenda of policies and strategies.

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S3.09. The repercussions of the construction of hydropower plants on the fish populations

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Fish populations are conditioned by the characteristics of their aquatic habitats. These habitats support both the perpetuation of the species, ensuring their favorable environmental conditions for breeding, and the food source. The lack of a single characteristic of their habitat will force them to migrate to search of another habitat with optimal characteristics for the species.

Degradation of aquatic habitats occurs due to natural phenomena and anthropogenic works. The anthropic works that have a major impact on the natural habitats are the hydrotechnical

constructions. By damming the major riverbed and streams, the natural breeding habitats of many fish species have been eliminated. The presence of dams on rivers can block or delay the migration of fish upstream, thus contributing to the decline or extinction of some fish species whose existence depends on this migration.

Accumulation lakes function as a decanter for alluvium from the river basin, aspect that leads to the reduction of their quantity by 25-30%. This phenomenon can contribute to the reduction/ disappearance of the breeding areas of fish species which prefer a substrate made from the deposition of alluvium.

The functionality of aquatic ecosystems is dependent on the thermal regimes from rivers and streams. Water temperature influences the physiological processes of fish and other aquatic organisms. (Neuheimer and Taggart 2007; Buisson et al. 2008; Pörtner și Farrell 2008; Durance și Ormerod 2009). Also, water temperature plays a decisive role in the distribution and abundance of aquatic organisms. Fish will migrate to search for new habitats that provide them thermal comfort for physiological processes. (Brannon et al. 2004). Depending on the requirements of the hydropower, the water flows of the rivers downstream of the dam can be modified. Increasing water flow can change the environmental factors of fish habitats: depth, substrate, temperature, water speed. (Rivinoja et al. 2010). A variation of 3-5^{0}°C of the water temperature, during the incubation and fry period, leads to a mortality of over 80-90%. A decrease in water flow over a long period will lead to the movement of natural fish habitats.

Following the hydro-technical constructions, the amount of sediments and organic matter, transported, is lower. As a result, aquatic biodiversity is changing due to hydroelectric dams. The changes of the water flow regime, of the quantities of alluvium and organic matter, of the temperature as well as of the surfaces of the floodable areas lead to the appearance of new types of habitats. These habitats cannot meet the optimal conditions for sensitive taxa, leading to their disappearance from that river basin.

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S3.10. Determination of PCBs concentrations in waste oils from industrial high voltage electrical equipment by gas chromatographic method

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This article aims to highlight the pollution caused by persistent organic compounds such as polychlorinated biphenyls (PCBs) in waste oils. This form of environmental pollution with negative influence on human health would not be possible without the utilization of high-voltage industrial electrical equipment having dielectric fluids contaminated with different polychlorinated biphenyl isomers. For the achievement of the experimental program, samples of dielectric fluids originating both from Romania and from Indonesia have been investigated and the quantification of PCBs was carried out using an Agilent 7890 gas chromatograph equipped with ^{63}Ni μECD detector with a 15 mCi activity. The PCBs concentrations were calculated using the standard calibration method based on the internal standard according to appropriate normative documents.

S3.11. Nitrogen, phosphorus and potassium investigation in topsoil layers from temperate agroecosystems, SE Romania

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Chemical assessment of soils is very important for a sustenable agriculture, safe food production, a long-term soil resources conservation and forecasting the environmental impact. Systematically evaluation of chemical composition in topsoils gives information about nutrients status and toxicological risk estimation. Rational use of organic and mineral fertilizers and soil protection against accelerated erosion generate production increases and, also, prevent the pollution of groundwater and surface water. We must not forget that thousands of hectares of agricultural land are lost annually due to mismanagement of all agricultural practices. So that, fertile horizons, formed over the years, end up being washed away by heavy rainfall and the material transported to the slopes, along the valleys and further into the rivers, causing significant material loss.

This study presents the concentrations of total nitrogen (TN, %), mobile phosphorus (P_2O_5, ppm) and potassium (K_2O, ppm) in 0-5 cm and 5-30 cm of soils from plots cultivated with wheat, corn and sunflower, situated in Galati and Braila agricultural lands, SE Romania. 36 soil samples were collected from 3 territories (Tulucesti, Sendreni and Vadeni), air-dried and analyzed according to the following methods: Kjeldhal method (nitrogen investigation), Egner-Riehm-Domingo+UV-VIS spectrometry (phosphorus determination) and Egner-Riehm-Domingo +Flame Photometry (potassium concentration).

Results showed an accentuated nitrogen deficiency, with global values below 0.140 % on both researched depths. P_2O_5 concentration is in low (8.00-17.90 ppm) - very high (72.20-133.80 ppm) limits, even excessive (151.20-172.30 ppm) in some plots. Excess phosphorus may induce Zn and Fe deficiencies. Greater attention must be paid to the correct normalization of nitrogen and phosphorus fertilizers, which, when applied in excess, may be taken together with the eroded material and generate intense anthropogenic eutrophication processes. Potassium ranged from low (70-114 ppm) to very high (230-396 ppm). Values above 400 ppm of K_2O are considered excessive and may generate secondary Ca and Mg deficiencies.
Imbalances in soil's supply of nutrients must be addressed in a sustainable manner, so as to avoid deficiencies and excesses, to the same extent.

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S3.12. Challenges for use the microalgae cultures in bioremediation of the waters contaminated with emerging pollutants

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Contaminants of emerging concern (CECs) are micropollutants (MPs) released into the environment from a wide variety of sources, industrial, agricultural, and domestic activities, which pose a prominent threat to the environment. Most of the emerging contaminants (ECs) endanger the public health, but the antibiotics urged the research towards developing effective degradation technologies due to fact that they induce antibiotic resistance. It is know that the conventional physicochemical treatment technologies are inefficient in treating MPs containing wastewater or involve high cost, require high input, or generate a large amount of toxic sludge. Thus, the recent focus in this area is towards the biological treatment system. Numerous species of bacteria and fungi capable of degrading micropollutants are reported in the literature (Ahmed et al, 2017).

Microbial degradation of MPs is associated with catabolic activity of microbes, and during the process they get assimilated as growth substrates. Microbial growth on micropollutants depends on various operating conditions such as optimum temperature, pH, doubling time, light requirement, and agitation, which indirectly affects the pollutant degradation. Pollutant properties such as surface properties, aqueous solubility, and charge are some important factors that determine the treatment efficiency.Nowadays, the microalgae are considered good candidates for the bioremediation of wastewaters (Tolboom et al., 2019) and, more than that, the biodegradation of ECs (Díaz-Quiroz et al. 2020; Sutherland and Ralph, 2019; Gentili and Fick, 2017; Hom Díaz, 2016). Numerous recent studies were made to explore the potential of microalgae to treat the contaminating ECs in wastewater by adsorption, accumulation, photodegradation and hydrolysis (Ge and Deng, 2015; Leng et al., 2020; Sun et al., 2020, Yu et al., 2017).

A major advantage of microalgae as biocatalysts is that they can use a variety of carbon sources nutrients, capacity to develop in natural media without sterile conditions, but the more attractive is their potential to sustain photoautotrophic metabolism that is the use of light, as energy source, to fix the CO_2. Supplementary the microalgae biomass is a valuable resource for added value compounds such as long chain polyunsaturated fatty acids, neutral lipids, proteins, carbohydrates, pigments, vitamins etc. (Cuellar-Bermudez et al., 2015) which can be an approachable alternative for the bioremediation process. The valuable bioremediation solutions for the contaminated water, using algae cultures in controlled cultivation conditions will take in account the follow steps: (1) selection of microalgae strains based of their resistance of the toxicity of the targeted ECs; (2) ECs content reduction in aquatic simulated media using selected strains; (3) bioprocess parameters optimization using design of experiments; (4) bioprocess control and mathematical modelling; (5) bioremediation process validation and propose the solutions to be applied in the wastewater pilot plants.

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S3.13. Results on fish catches in Dubasari reservoir in the first half of 2020

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The ecological monitoring of fish communities is one of the key elements of a sustainable management of fish resources, which shall ensure both the conservation of aquatic biodiversity and the maintenance of opportunities for industrial fishery.

The investigations were carried out in Dubasari reservoir – the largest reservoir located on the Dniester River within the territory of the Republic of Moldova. The scientific fishing was done

near Holercani village in the first half of 2020, by using the net for juveniles (length – 10 m, depth – 2 m, mesh size - 5 mm), which allows capturing of body small sized species and juveniles of large sized fish species.

Fifteen species of fish in total, belonging to three orders and five families (order Cypriniformes with families Cyprinidae and Cobitidae; order Sygnathiformes with family Sygnathidae; order Perciformes with families Percidae and Gobiidae) were registered. In March, the highest contribution to the production of ichthyocenosis was brought by the opportunistic euritope species of small and medium size, such as *Alburnus alburnus*, *Neogobius gymnotrachelus*, *Rutilus rutilus* and *Rhodeus amarus*. Based on catches, the density of fish in March in the bank area was estimated to be of 1113.3 individuals/ha, and biomass - 19.65 kg/ha.

The scientific control fishing in June highlighted the following dominant and eudominant species: *Perca fluviatilis*, *Alburnus alburnus, Rutilus rutilus* and *Rhodeus amarus.* The estimated density of fish in bank area was of 1406.7 individuals/ha, and the biomass – of 32.65 kg/ha.

The results demonstrated the need of stocking of Dubasari reservoir with the ichthyophagous fish species, e.g. *Sander lucioperca*, *Aspius aspius*, *Esox lucius*, *Silurus glanis*, towards transformation of the production of non-valuable fish species into a fish biomass of a high value, and the development of fishery infrastructure.

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S3.14. Toxicity, chemical composition of particulate matter and their relationship to microclimate conditions inside and outside of Roman Mosaic Edifice area

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This research is the first attempt to decipher the effect of PM composition on public health and historical artefacts, in correlation with the monitoring of the daily and seasonal microclimate inside and outside the Roman Mosaic Edifice area. The aim of this study was to investigate the indoor and outdoor conditions of the Roman Mosaic Edifice by several parameters: temperature, apparent temperature (AT), relative humidity (RH), and particulate matter composition. The novelty of this study is highlighted by the multitude of reported data (indoor and outdoor) with direct correlations between climatic factors and PM chemical composition, which has a direct influence on artwork in the museum and on visitor's health. The particulate matter analyses showed variability related to indoor microclimate conditions as well as to outdoor, coastal anthropic activities. The FTIR and ICP-MS techniques, used for the investigation of PM2.5–10 samples, revealed high concentrations of Fe, Al-rich, and soluble particles inside the investigated museum area. The high values of the measured RH in outdoor areas (99% in the monitoring process in the autumn of 2018 and spring of 2019, and over 50% in the indoor area in all seasons), correlated with the temperature and influenced the chemical composition of PM2.5–10 samples. A strong relationship was found between Cr, Ni, Cu, Cd, and Pb concentrations, temperature, and AT inside the Roman Mosaic Edifice area. On the other hand, a high correlation was found between Al concentrations, temperature, and AT. A low correlation was observed between Al concentrations, temperature, and AT in the outdoor area of the Roman Mosaic Edifice as well as a high correlation between Mn and Cu concentrations, temperature, and AT. In this respect, a strong relationship was remarked between Cr, Fe, Ni, Zn, Cd, and Pb concentrations, temperature, and AT inside the investigated area. The order of the metals analyzed in terms of their abundance in the cold seasons (i.e., autumn and winter, when the temperatures ranged between 0 °C and 10 °C), inside and outside the investigated area, were found be the same. However, the rise in temperature led to a change in the order of the metals inside the Roman Mosaic Edifice area. The data obtained indicated that as the temperature increases (i.e., in the summer and spring seasons), the Pb concentrations both inside and outside the investigated area are much higher than expected, mainly because of the anthropic activities conducted in the port of Constanta. In conclusion, the final results allowed an estimation of indoor and outdoor air quality,

from the point of view of the PM chemical composition, thus giving insight into the health risks for visitors and within the Roman Mosaic Edifice museum space hosted in buildings with natural ventilation.

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S3.15. Study on the dynamics of the Prut river flow and level in Romania

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The Prut River is one of main tributaries of the Danube River, its flow being regulated by Stanca-Costesti (SC) reservoir, built in 1978. The SC hydropower plant is jointly operated by Romania and Republic of Moldova.

The Prut river flow and level dynamics studied in this paper is based on the public information provided at request by *Apele Romane* National Administration, performed monthly at 8 hydrological stations (Oroftiana, Radauti-Prut, Stanca, Ungheni, Dranceni, Prisacani, Falciu, Oancea) located upstream and downstream of the dam, before and after the Costesti-Stanca reservoir construction. For the period in which the data were recorded, the flow dynamics pattern is correlated with the variation of water volume in SC reservoir.

Knowing the trends of seasonal water flow variation along with water level variations can help to take appropriate measures to prevent and mitigate the negative effects of hydropower on ecosystems of this transboundary river in the Black Sea Basin.

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S3.16. The alien substances diffusivity in the marine water based on fractional calculus

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In the present paper, the author aimed to develop a model in the frame of the mathematical physics which is based on the fractional anomalous differential Fick's equation. The fractional calculus although as old as the integer calculus, beginning with the nineties, is in plain development. The main feature of the mathematical instrument, referred to above, it is the non-locality and so the tacking into consideration of the past evolution of the system. The diffusivity (the rate of diffusion) describes the movement of the matter from high level concentration to low level concentration and so the actual state depends on every state, in the past.

We conclude that the proper way to approach to the subject is the non-locality and so, the proper treatment of the diffusivity is the fractional calculus. The author has tried to put some real parameters in this model, considering different properties for the alien substances and the marine water as well. The concluding remarks insist on the comparison between the anomalous and the normal diffusivity, highlighting how important is to let the solution to be determined by the past evolution of the system.

SECTION 4. Health and environmental education, innovative solutions to improve scientific information dissemination

S4.01. MONITOX health risk calculator and ICT tools for improved dissemination of scientific information in the Black Sea Basin

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The project BSB27-MONITOX is aiming at enhancing regional cross-border cooperation in the Black Sea Basin (BSB) to improve joint monitoring of environmental toxic pollution and better share and exchange of new analysis methodology, data and information on ecological state and human health impact of harmful substances. This implies: 1) to build a strong BSB network of analytical laboratories and experts to elaborate a common ecotoxicological monitoring system supporting regional programmes for environmental protection and sustainable management; 2) to produce a scientific platform with harmonized information on toxics in soil, water, sediments and biota in shared riverine, deltaic and sea areas, and their potential impact on ecosystems and people. One of the specific objectives of BSB27 project is boosting awareness of the population in the Black Sea region on the environmental issues related to spread of toxicants by education and sharing scientific information and knowledge on health effects of inorganic, organic and radioactive pollutants. Pollution has NO borders/does not stop at national borders. Evaluation of people exposure to toxics (TOXs) can be accomplished only in partnership, through cooperation based on knowledge, exchange of good practices and interdisciplinary research, conducted only in transnational networks.

The paper presents a synthesis of results obtained in the period 2018-2020 in the frame of **MONITOX international network** created and developed through the **BSB27 project**, regarding the strategy of monitoring of six classes of toxic substances in interconnected environmental compartments (surface water, groundwater, sediments, soils and biota) in the Black Sea Basin and border regions and dissemination of information to various target groups through *ICT tools*, including the assessment of toxicants impact upon human health, thus raising the level of awareness of the population in the Black Sea region regarding the environmental issues with cross-border impact: preservation of common natural resources and protected areas, prevention of spread of toxicants, hazardous waste disposal, changing behaviour on release of pollutants and reduce litter generation.

Digital maps of pollution with trace metals, persistent organic pollutants (organochlorinated pesticides (OCPs), polychlorinated biphenyls (PCBs)), polycyclic aromatic hydrocarbons (PAHs) (16 compounds, 7 carcinogenic), nutrients, pharmaceuticals/endocrine disruptors and radionuclides, built using *Q-GIS* software, will be distributed through an *IT platform* created on the *project website*, together with scientific information regarding the impact of toxicants on population and aquatic ecosystems, possible sources in environment, modality of cross-border migration and accumulation in trophic chains in target areas of Black Sea region (rivers basin, deltas, sea littoral, marine environment), maximum allowed concentrations, and related legislation issues. The observed key patterns of elemental accumulation and migration in environmental compartments may be used in various environmental management programs and specific ecological studies in the Black Sea Basin.

Through the created *project social page* on Facebook (fb.me/Monitox.project.BSB27), news on pollutants' spread in environment, their levels and danger to population (through ingestion, inhalation, dermal contact), carcinogenic effects, presence of microplastics in rivers, biota and personal care products, and good practices to reduce the TOXs health and ecological impacts are permanently distributed.

Innovative tools for the assessment of toxicants' impact upon human health and ecological state of aquatic ecosystems using a *health risk calculator* were developed. The health risk calculator (HRC) is designed as a Web page connected by a link to the project website. The page is made using PHP, HTML, CSS and MySQL. The selection of the area for which we want to calculate the health risk

index is done using a selection list defined in a HTML form or by clicking on an active area of an image map created using CSS. Health risk index calculation formulas are implemented in PHP using area-specific data from the MySQL database (which stores historical data or data obtained during the project activities). The results are displayed using HTML and CSS. HRC will also include a *food toxicant calculator* in order to evaluate the potential risk to human health of consumed fish, based on the estimate daily intake (EDI), the target hazard quotients (THQs), and carcinogenic risk ratio (R) as risk assessment elements; THQ<1 denotes that the daily exposure seems to cause no deleterious effects to human health.

A collection of *digital materials* in the form of a *"Citizen's guide for evaluating exposure to toxicants"* will be prepared for different categories of public.

Acknowledgement: We acknowledge the funding from ENI project with eMS code BSB27 MONITOX (2018-2021), Joint Operational Programme Black Sea Basin 2014-2020.

S4.02. Factors influencing the variation of radon and thoron activity concentration in selected indoor spaces in Romania

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The paper presents a review of results obtained during complex studies performed in the frame of international projects of Dunarea de Jos University of Galati, regarding the investigation of indoor radon (^{222}Rn) and thoron (^{220}Th) concentrations and their temporal variations in selected dwellings and public spaces in Romania. For the active measurements calibrated instruments of SARAD type have been used and the data were processed with the aid of SARAD Radon Vision 6.3.4 software. The factors which might have influence on the variability of radon/thoron levels in a dwelling or public space are: the type of construction material, location, ventilation degree of the space, existence of basement, floor level, measuring time, geological features, etc. The obtained values showed that the radon concentration variation in several nuclear physics laboratories greatly depend on the aeration of the respective room, increasing 2-4 times in the case of unventilated space even over a period of 3-4 days.

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S4.03. Real time monitoring data of radiation doses in Lower Danube Euroregion and South-eastern part of Romania

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This work presents a synthesis of results obtained through modelling of real time monitoring data provided by European Commission for nuclear outdoor dose rates measured in April-May 2020 in outdoor environments, in various sites in Lower Danube Euroregion and South-eastern part of Romania, including some target areas of the project BSB27 MONITOX (Ostrov-Cernavoda, Galati, Braila, Tulcea, Sf. Gheorghe). For each targeted location, results put in evidence an hourly and daily variation of the outdoor gamma dose rate. The results will be used in the frame of MONITOX project for the elaboration of Q-GIS maps of gamma dose rates and calculation of the health risk for population.

Acknowledgement: The work was carried out in the frame of the project BSB27 MONITOX.

S4.04. Assessment of quality of Danube River sediments in Romania, ecological and health risk

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This paper presents the results of metals concentrations in Danube bottom sediments measured by combined atomic and nuclear techniques XRF, PIXE and PIGE, and SEM-EDX. The samples were collected from Galati - Isaccea sector and Danube Delta Chilia branch. The results are compared with previously obtained data on Danube sediments collected in expedition campaigns between 2014 and 2016, as well as literature data.

A review of methodology used for the assessment of soil and sediments heavy metals pollution in Danube river region in Romania and the ecological risk is described, based on *indices of ecological risk*: Potential Ecological Risk Index (PERI), Mean ERM Quotient (MERMQ), and Contamination Severity Index (CSI) and *health risk indices* - Hazard Index (HI) (non-carcinogenic) and Risk Index (RI) (carcinogenic).

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S4.05. Investigation of surface water quality from Lower Danube Region, Galati County

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The pollution of surface water could have a negative impact upon the ecosystems and population health and its regular monitoring is imposed, especially in urban communities and industrial zones. In this paper we present a review of results of the analysis of the quality of some surface water samples from the Lower Danube and Lower Prut rivers (Galati county, SE part of Romania), using various investigation methods at INPOLDE research center of "Dunarea de Jos" University of Galati. The obtained results for the physical-chemical parameters and chlorophyll *a* in water samples were generally found within the Romanian admissible values for surface water. On-going research is performed regarding the modelling of seasonal variations of quality parameters and assessment of the health risk for the population in the target region.

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S4.06. Granite slabs between radiation emission and design

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Granite paving is a hard wearing product, being ideal for use in driveways, patios, pathways, streetscapes and market places. Recently, several sidewalks were arranged in the Galati town, using as pavement materials granite slabs in various shapes and colors.

Because the levels of ambient radiation are not known, we measured the gamma radiation dose values with the aid of a DIGILERT portable radiometer1\0000+. Central areas of the municipality were chosen, where the granite slabs were mounted over long distances. Measurements results highlighted that in some areas granite sidewalk showed higher radioactivity level than in other locations and public parks of the town, the average dose rate ranging between 185 nSv/h and 234 nSv/h, with maximum values in the range 218-327 nSv/h.

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S4.07. The impact of recreational fishing on fish resources of the transboundary Lower Dniester River

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The Dniester/Nistru River is a transboundary watercourse shared by Moldova and Ukraine. Currently its management is regulated according to the bilateral Dniester Treaty (Rome, 2012), which covers all issues of water use, including water biodiversity resources and aquatic ecosystems conservation. The Dniester fish resources suffered with hydropower and deterioration of the river morphology substantially diminished the spawning areas. The commercial fishery was applied during last 70 years, and only recently – from 2016, was prohibited in Moldovan sector of the river. Ukraine is still not rejected from this activity. The scope of current evaluation was to determine the impact of the amateur fishery on the fish resources of the Lower Dniester – the part of the river downstream from the Dubasari Hydropower Plant (HPP). In fact, the Lower Dniester River sector is managing by Moldova (right bank), its secessionist Transnistrian region (left bank), and the lower part including the estuary – by Ukraine. The number of amateur fishermen has raised significantly during last decades.

The impact of recreational fishing on fish stocks was assessed on the Dniester mainstream section from the Dubasari hydropower plant to the mouth on both banks, including its branches, by counting the fishermen per unit length of the coast in areas with extrapolation of average values to other similar sites. The groups of experts of the right bank (Institute of Zoology & Eco-TIRAS NGO), the left bank (Transnistrian State University) and the Lower Dniester National Natural Park (Odessa region) participated in the accounting. The NGO Eco-TIRAS (Chisinau) coordinated the activities.
In the summer period in Moldova (both banks) 144.9 tons of fish were caught, in Ukraine - 118 tons, then in the autumn period in the upper Moldovan area, including Transnistria, - 19.2 t., and in the Ukrainian - 232.6 t. In total, during summer and autumn there were catched by anglers more than 500 tons, but in spring – 33.1 tons.

It means that amateur fishing in this part of the Dniester basin has serious impact on fish resources due to the significant number of anglers, their use of modern gear and baits, and is not only comparable to the commercial one, but also surpasses it in some areas. At the same time Moldovan experts note that the greatest damage to the fish resources of the Dniester River is achieved by poaching gears, and not regulated ones. Under the guise of "amateur" fishing, such forbidden methods and fishing tools are often used as docking in places of concentration of fish, setting seine with multiple hooks, screens, etc. This is facilitating by extremely weak control by the state authorized bodies, which in recent years has been further weakened by the restructuring.

The main species of amateur fishermen catches by weight were presented by crucian carp, roach, bream and common carp. The remaining species: pikeperch, pike, and rudd were also recorded. In fact, recreational fishing in the Lower Dniester is practically not controlled by the fisheries protection agencies, and the regulatory framework that regulates it is outdated and requires significant revision. Anglers in the Lower Dniester in fact do not use the "catch-release" approach, while the volumes of fish caught often violate the requirements of the Rules for amateur fishing.

The transboundary status of the river requires the development of uniform rules for angling for this region. It is advisable to consider the inclusion of mandatory fees for the use of fish resources in the rules of amateur and sport fishing in Ukraine and in Transnistria by introducing permits for amateur and sport fishing. The funds obtained from this should be transferred to environmental or special funds and used only for stocking the Dniester River with native fish species.

The evaluation was realised in the frame of Eco-TIRAS project supported by the GEF UNDP/OSCE/UNECE Dniester middle size project.

S4.08. Phytoremediation strategies applied for industrial pollution of the soil

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Industrial activities have negative results on the environment and also on the soil quality. One of the most common problems is represented by soil degradation which leads to changes in physical, chemical and biological properties.

Soil pollution represents the retention of persistent pollutants such as chemicals, salts, radioactive materials, that on long term have negative effects on plant growth and animal health, therefore, indirectly on human health.

If the level of soil pollution became higher than the intervention threshold it is mandatory to start some actions in order to remediate the soil state and to reassure a healthy environment.

One of these types of techniques that can be used is phytoremediation. It represent an ecological technology that uses plants to transform, translocate, seize and extract pollutants from sediments, soil, groundwater or surface water and even from the atmosphere, with a final target of remedying and restoring the contaminated sites.

In recent years, the interest regarding phytoremediation had increased due to the fact that using plants as an alternative solution to clean up polluted soils had proven to be financially efficient, with a minimal impact on the environment and on the soil properties.

To benefit of maximum efficiency of phytoremediation it is recommended the use of plants that have a fast growing rate, a high soil-plant transfer factor, tolerates large amounts of pollutants and develops large biomass in a short time.

Plants developed two strategies in order to tolerate heavy metals: metal exclusion and metal accumulation. Through exclusion they avoid excessive metal uptake and restrict its transport to the shoots, this way heavy metals tend to accumulate in the roots. Metal accumulation strategy entails transport of heavy metals from roots in order to accumulate in shoots.

In a previous study that involved the quantification of soil pollution nearby an industrial area from Galati county, exceedance of normal values were observed for some of the organic and inorganic pollutants. The results suggested that the industrial complex is a source of pollution for elements such as: as As, Cr, Cu, Ni, Pb, V and also for persistent organic pollutants. All these elements exceeded the normal values, and chromium and vanadium have exceeded even the alert threshold values for sensitive areas. In this case, are present evidences for an older and constant pollution, because the contaminants where found in high concentrations even at 30 centimetres depth (As, Ni and V).

For the industrial pollution with heavy metals is recommended to use willow (*Salix*), a fast growing tree, but beside the fact that is efficient only for low concentrations of pollutants, if there is Cd in soil, it tends to accumulate into leaves that fall in autumn, and this can lead to an increases of concentration and availability of the pollutant. Beside trees, can be used any plant from *Brassicaceae* (mustard) or *Compositae* (lettuce, spinach) that are extreme accumulator families. They tend to grow and develop on contaminated sites and retain high amounts of contaminants.

Another plant that can be used in this case is alfalfa (*Medicago sativa L.*), that is recommended because has growing conditions in that area and also has obtained good results in terms of degradation of PAHs. Alfalfa is the most grown perennial plant in the world with a deep root and with the ability of remediates the soil pollution with organic pollutants. The next level of phytoremediation is represented by the genetically modified plants with improved properties that leads to qualities that can be used with success in this type of method for clean up the soil.

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S4.09. Machine Learning and Artificial Intelligence for health monitoring

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Data acquisition and monitoring systems for healthcare are important elements of a proactive health care system. The care system used Machine Learning (ML) which contains algorithms capable of learning from precedents or based on its experience. The main goal is prevention and diagnosis of diseases using information provided by diagnostic advanced equipment like CT, MRI, PET, SPECT, etc. A wide range of health parameters can be used for this purpose such as: blood pressure, body temperature, heart rate, blood glucose levels, pixels information on the visible signs indicating changes in the skin health condition or images containing brain tumors or retinal information. Artificial Intelligence (AI) and Machine Learning (ML) are important tools allowing the scalability in healthcare services (i.e. patient prioritization and analysis process) or in brain tumor classification and prediction. Brain tumor classification is a challenging task as a misclassification and misdiagnosis of the tumor could have serious consequences on the survival chances of patients. On the other hand, an accurate and timely prognosis of some brain tumors increase the chance of survival of patients. Also, AI has specific application, such as aiding rehabilitation through constant monitoring of a patient's progress.

S4.10. Noise: a risk factor for sailors' health and navigation safety

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Occupational noise affects the health of sailors. Following health checks, it was found that almost a quarter of a pusher's navigating crew lost their hearing in a proportion of 10-40%. For this reason, determinations were made to see which the most important sources of noise are. These determinations showed that the noise in the engine room exceeds 90-100 dB, and in the control cabin, the sound level is 75-80 dB. Noise also impedes communication between sailors, making it extremely dangerous for the safety of people and vessels. For these reasons, companies must take all measures to ensure that the work of seafarers does not affect their health and it runs safely.

S4.11. Evolutionary trends of oncological pathology in Galati county and role of environmental factors

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Oncological disease represents an important problem of public health and the second worldwide death cause with complex etiology and increasing incidence. We are presenting evolution's tendency at global level, at national level, and specifically in Galati County; we have observed an increasing of prostate, breast, colo-rectal cases with predominance of male patients; in 2019 we observed an increasing of new cases with 36% respect of 2018.

Even if, in principal, in oncological disease occurring are involved genetic causes, lifestyle and environment, almost 80% of neoplasias are determined of lifestyle, food, smoke; between genetic factors we are mentioning radiation exposure and radon.

Pollution, itself, plays a minor role and is involved in etiology of approximate 1% of cancers. Also, the occupational risk factors are incriminated in oncological disease occurring.

Endogenous and, also exogenous factors strongly interact in neoplasias etiology, so it's difficult to quantify the contribution of each of them.

Hereditary history is the only factor that reaches the predictive value, such that can justify a medical personalized monitoring.

Regarding hereditary component, genetic evaluations can contribute to personalize the monitoring of patients.

S4.12. Environmental factors' contribution in skin cancer etiology

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Skin cancers are the most frequent types of malignant tumors worldwide, being mostly found in light-skinned populations, with a ratio of 30%. Approximately 3 million non-melanoma skin cancers and 132000 melanoma cases are diagnosed globally each year. The most frequent skin cancers are the basal cell carcinoma, squamous cell carcinoma and malignant melanoma. The incidence, morbidity and mortality of skin cancers are on the rise and have become a major public health concern.

We aim to review the most important environmental factors involved in the development of skin cancers, along with the incidence rates and preventive behaviors or strategies (including personal behavioral changes and public educational initiatives). Ultraviolet radiation (UVR) is a well-known physical hazard, responsible for photoaging, photoallergy and phototoxic reactions, being heavily involved in carcinogenesis, including melanoma development. Overexposure to natural and artificial UVR is a public health problem. Sunburns, especially in childhood, are an important risk factor for melanoma development. Excessive exposure causes cumulative damage which determines immune suppression and skin cancer initiation. Transplant patients and AIDS patients have an increased incidence of skin cancer. Some treatment methods, including radiotherapy, phototherapy and psoralen and ultraviolet A (PUVA) therapy can lead to skin cancer development. Viral infections such as those with human papilloma virus can trigger the initiation of squamous cell carcinoma. Patients with familial genetic syndromes are highly sensitive to certain types of skin cancers. Ionising radiation, environmental pollutants, chemical carcinogenic agents and work exposure have been associated with skin cancer. Artificial UV radiation exposure (tanning beds and lamps), aging, skin color, personal diet and smoking are important risk factors. Ultraviolet radiation is the main etiological agent in skin cancer development. A better understanding of the causative factors is an essential step in skin cancer prevention.

S4.13. Integrating LMS and IoT in the educational system

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Smart classroom bring new experience for both students and teachers not only in this current context, by increasing safety, data availability, teaching and learning optimized processes and much more. *Method*: For improving the transmission and receiving process (TX and RX) performances of the educational experience, we propose a system based on Learning Management System (LMS) and Internet of Things (IoT).

The results of this concept can be perceived at a theoretical level for now. LMS and IoT offers high tech solutions for a sustainable and smart classroom. The immediate result is the improvement of everyday activities and learning methods. The aim of this paper is to describe the efficiency of the LMS and IoT infrastructure in restructuring the traditional learning methods.

IoT is a concept that has the potential to influence the way we live and how we work. Even though this is a complex concept, once this inconvenience is overcome, the implication of our living and working experience gains new levels of optimization and sustainability. Recently, the IoT concept penetrated one of the most important domain of our society. This is the educational sector.

The aim of this paper is to draw a comprehensive picture of a propose concept that combines the IoT concept along with LMS. By applying these concepts, both faculty and students can benefit by allowing more focus on the primary tasks. This also implies less focusing on managing classroom workflow.

Traditionally classrooms are designed to provide face-to-face learning experience to students group work. Even though in some same cases laptops and hand held devices are used, the behind curtain experience is produces in cyberspaces (Internet). Our society needs to move from the physical world to smart spaces. We propose a concept that brings to live traditionally classrooms turning them into smart classrooms. This can happen by combining IoT (integrating smart boards and walls, interactive projectors, new input and output devices, and sensors) (Figure 1), with LMS (software for learning and development programs, tracking, documentation, administration, reporting and training program) (Figure 2).

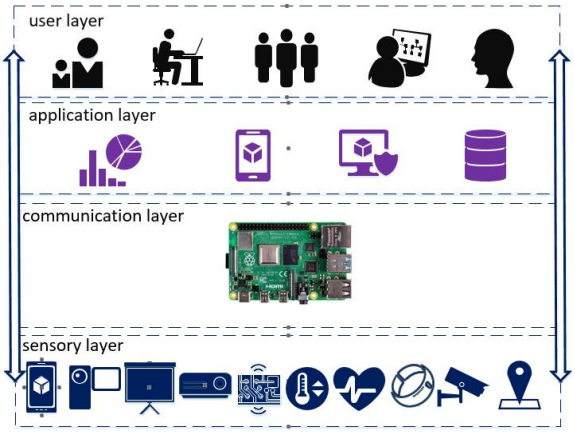

Fig. 1. The IoT layers

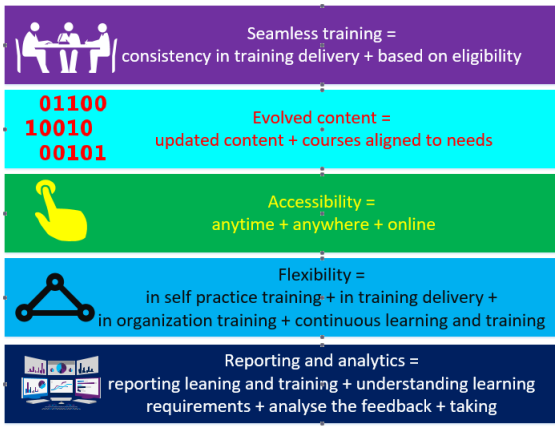

Fig. 2. LMS

S4.14. QR code based access control system for hotels

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The actual situation facing mankind due to the new Coronavirus is pushing researchers to develop new technologies that involve physical distancing for people, in many domains. But live goes on, and although some activities can be carried out online, there are some domains that require human presence. For example, analysis of environment, evaluating exposure to different toxicants to different ecosystems are some of the activities in the environment sector that need to be carried out involving human presence. This is why this paper will propose a system that limits human contact during hotel stay for scientists, researchers or tourists.

This paper proposes a combined Hotel Management System (HMS) that can replace the front desk activities of a hotel or different accommodation units. The special developed system provides self check-in capabilities using a QR (Quick Response) code. The code will be generated when the booking is made. Also, after the check-in, the users can access their rooms using the same unique QR code. The same code will also be used for entering the hotel facilities. This paper also brings an energy saving solution that is integrated in the HMS. The idea is to limit the waste of energy in the hotel room, but in such a manner that doesn't affect the commodity of the tourist. For security issues the HMS will be equipped with a CCTV (Closed Circuit Television) system.

The system is based on Raspberry Pi processors that is integrated in a server application which is able to generate access codes for each room and to monitor the activities inside the hotel using the integrated cameras. The software for the HMS is based on Phyton language, customized for Linux operating system. It allows settings of cards, generation and transmission of QR codes for each accommodation to customers, room status monitoring, employee and customer access monitoring for any form of access such as QR Code, RFID (Radio Frequency Identification) card, face-recognition, secure opening of remote doors, firmware updates for each black box, reboot actions etc.

Each door has an independent Raspberry Pi control unit (black box) which is connected via USB (Universal Serial Bus) to the video camera outside the room. The camera reads the QR code and if it is correct the server gives access to the door. With the camera the user also finds a LCD (Liquid Crystal Display) screen that gives information about how to use the code and if the access is granted. In case of code problems, the system is developed with a back-up RFID access device controlled also by the Raspberry Pi. The same code generated to access the hotel room gives access to the main door of the accommodation unit. Figure 1 shows the architecture of the existing system.

The implemented system is now being tested in a hotel facility and as future steps in the current development could be the integration of facilities such as climate control, food cooling, windows control, lights control in the existing access control system.

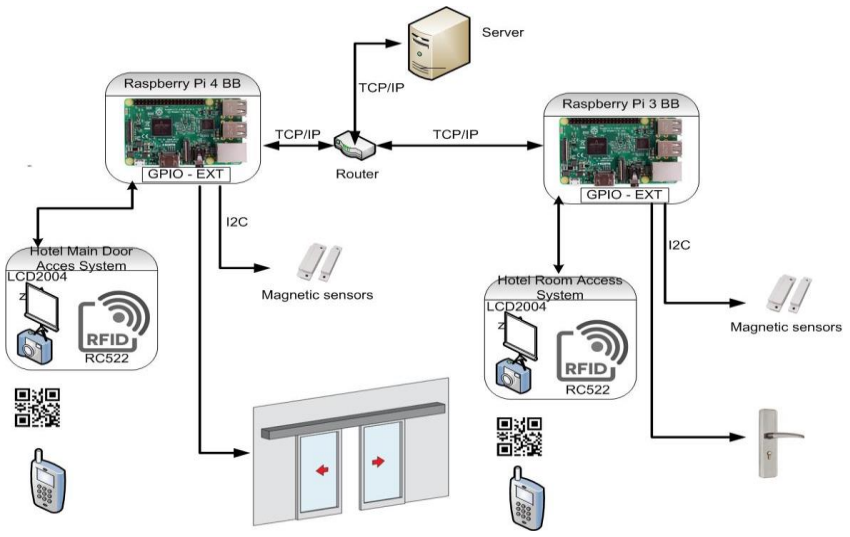

Fig. 1. HMS architecture