MONITORING OF BALTATA RIVER POLLUTION BY SOIL EROSION AS A PART OF A NEW BLACK SEA PROJECT IN MOLDOVA

МОНИТОРИНГ ЗАГРЯЗНЕНИЯ РЕКИ БЭЛЦАТА ОТ ПОЧВЕННОЙ ЭРОЗИИ В РАМКАХ НОВОГО ПРОЕКТА ЧЁРНОГО МОРЯ В МОЛДОВЕ

E. Kuharuk[1], Iu. Corman[2]

Е. Кухарук[1], Ю. Корман[2]

[1]AO "Ecostrategii", Chisinau,Moldova
ecotiras@mail.ru
[2]Technical University of Moldova, Chisinau,Moldova
iu.corman1958@gmail.com

[1]АО "Ecostrategii", Кишинёв, Молдова
[2]Технический Университет Молдовы, Кишинёв, Молдова

The content of the regional project "Protecting streams for a clean Black Sea by reducing sediment and litter pollution with joint innovative monitoring and control tools and nature-based practices" (short title: Protect_ Streams_4Sea) started in 2020 is presented. This two-year project is currently executed within the framework of the EU Black Sea Regional Cooperation Programme (2014-2020) by five partners from Greece (leader is International Hellenic University from Drama, project manager is Dr. George Zaimes, associate professor), Armenia, Moldova, Romania and Turkey. The Baltata River (a right-bank of Dniester River tributary) basin is selected as a pilot area for the project tasks realization in Moldova. The goal of this study is to evaluate the non-point sources of pollutions in the Dniester basin as a part of measures of its protection and ecological rehabilitation and as a result to mitigate the basin's contribution to the Black Sea general littering. The experts on hydrology, climatology, soil science, botany, GIS, etc. are participating in this project's implementation.

Представлено содержание стартовавшего в 2020 году регионального проекта «Защита рек для чистого Черного моря за счет сокращения загрязнения наносами и мусором с помощью совместных инновационных инструментов мониторинга и контроля и природоохранных практик» (сокращенное название: Protect_ Streams_4Sea). Этот двухлетний проект реализуется в настоящее время в рамках Программы Черноморского регионального сотрудничества ЕС (2014-2020 гг.) пятью партнерами из Греции (руководитель – Международный Греческий Университет Драмы, руководитель проекта – д-р Джордж Займес, доцент), Армении, Молдовы, Румынии и Турции. Бассейн реки Балтата (правобережный приток Днестра) выбран в качестве пилотного участка для реализации задач проекта в Молдове. Целью данного исследования является оценка источников загрязнения в бассейне Днестра в рамках мероприятий по его охране и экологической реабилитации для снижения вклада бассейна в общее загрязнение Черного моря. В реализации этого проекта принимают участие специалисты в области гидрологии, климатологии, почвоведения, ботаники, ГИС и др.

Keywords: Erosion, soil protection, pollution, drone shooting, digital map.

Ключевые слова: Эрозия, защита почв, загрязнение, сьёмка дроном, электронная карта.

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Introduction. Any monitoring should take into consideration the main natural and anthropogenic factors. At present, the current catchment areas in Moldova are not always in good conditions, and an environmental situation in river basins raises concern about their future as of the clean drinking water sources. A substandard ecological situation in the Baltata basin is centered around such issues as water biota's degradation and water sources pollution, deposition of silt due to soils water erosion on adjacent cover areas. All these factors cause a necessity of this basin protection and ecological rehabilitation.

Study area and methods. Study area. Baltata River is a right tributary of the Dniester River, with the length exceeding 27 km [2]. It basin comprises an area of more than 165 square kilometers and consists of various types of land-use: agricultural lands, forests, pasture lands, meadows, perennial plantings and built-up areas (Fig. 1). The Baltata basin is one of many other where the basic water resources of Moldova are formed. The well-being of the water courses conditions, the population living conditions and many aquatic and near-water biocenoses depend on its basin ecological state. The anthropogenic factor has changed the natural watershed of the river, and now it is almost completely accumulated in artificial ponds. Water for the needs of the population is taken out only from these reservoirs, and the main riverbed has turned into a shallow watercourse. Under the influence of erosion processes in a territory with a heterogeneous relief, its soil fertility decreases that leads to a crop loss by 40–70 % [3]. Moreover, in a case of water erosion from 10 to 30 % of applied fertilizers and pesticides are washed off the slopes together with soil.

Thus, without achieving a good environmental situation in the Baltata River basin, as in other Dniester River sub-basins in Moldova and Ukraine, it is impossible to achieve well-being of the north-west Black Sea area. It is also necessary to pay particular attention to the soil and water pollution from unauthorized dumps and household waste, as well as from water erosion of soils, since the relief here varies from 0° to 17°; the most common - from 2° to 5°.

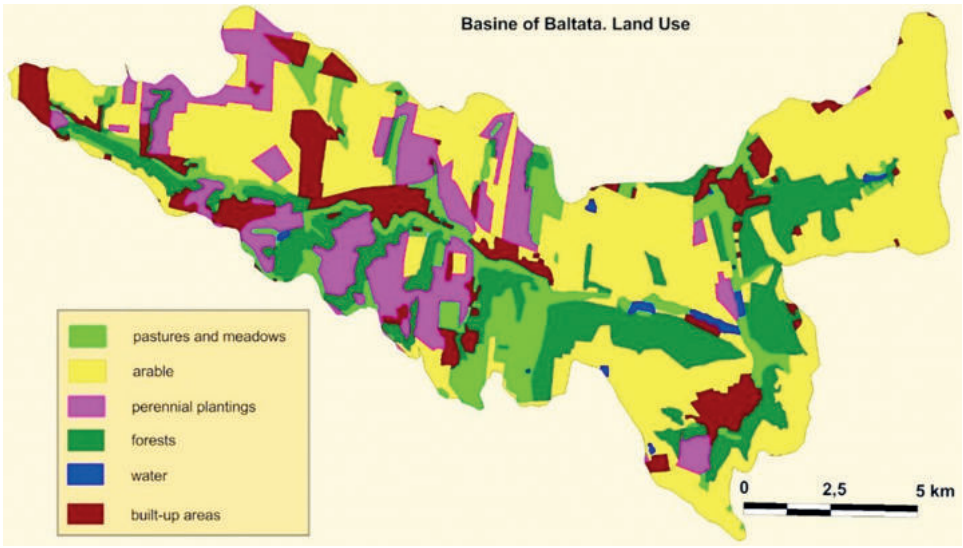

Figure 1 – Land use in Baltata River basin

Table 1

Land Use in Baltata River Basin

Land Use	Area, km^2
Pastures and meadows	76.99
Arable	19.01
Perennial plantings	22.94
Forests	28.90
Surface water	1.07
Built-up areas	17.58
Total	166.49

The project content. The Protect-Streams-4-Sea BSB963 project focuses on a joint environmental monitoring of nonpoint source pollutants and litter that end up in the Black Sea. This is a main priority of the Black Sea Programme, because if the enclosed Black Sea is polluted, it is essentially very difficult to de-pollute it. Most cleaning efforts are focusing on the sea itself or along the coastal areas. The watersheds that end in the Black Sea have not been focal points earlier despite they provide many pollutants and litter. A similar example is the Mississippi Basin that transports pollutants, which created a dead zone in the Mexico Gulf. The idea of this project is to stop the nonpoint sources of pollutant and litter reaching the streams and rivers, and thus to prevent their entry the Black Sea. In a case of success, this can maintain cost-effectively a clean Black Sea and will benefit to welfare of the entire region.

Methods. This task will be achieved by using innovative methods (e.g., fingerprinting) to correlate landscape position with the pollutants in the stream water and riverbed. Soil samples will be taken along stream banks, soil surfaces and in-stream. By this way, the origins and contributions of sediment and other nonpoint source pollutants to the stream water and riverbed will be estimated. The pollutant origins could be the stream banks (e.g. steep, non-vegetated area, etc.) or soil surface with different land covers (e.g. burnt areas, flooded areas, forests, degraded or specific crops). In addition, traditional (erosion pins, runoff plots) and new innovative methods (remote sensing indices and drones) will be used for the pollutant estimations. Hydrologic models will be applied to simulate the pollutants at a watershed scale based on the project data from the fingerprinting method as well as from the stream bank and bed, and soil surface plots. A Multi-Criteria Decision Analysis and a Decision Support System will be used to find the "hot spots" and to recommend the best management practices in each pilot area. The recommended practices will be nature-based and applicable to the entire region. The study of the soil cover of Baltata River's basin, soil samples collection for the following laboratory analysis will be executed according to the European practices [1].

In our work we use resources FAO Soils Portal – where are national and FAO legacy maps (scan), also soil profiles and reports, soil degradation, management, biodiversity (http://www.fao.org/soils-portal/data-hub/soil-maps-and-databases/en/). Another source of data is GloSIS Global (Beta) from the FAO. Data Hub for Global Soil Information System

(GloSIS) country-driven global datasets. Includes Global Soil Organic Carbon (GSOS) map, C sequestration potential, Harmonized World Soil Database (HWSD) derivatives (soil proprieties, soil quality indicators, digital Soil map of the World). [4]

For examples southern region of the Republic of Moldova we used a drone to study the soils of this area.

Phantom 4 Pro drone flight and photography.

The flight was carried out with the following parameters:

- Flight altitude from the ground - 100m;
- Image resolution - 20 megapixels;
- Drone speed - 10 m / s;
- Image overlap 80%;
- Image capture angle - 90%

After the flight, 434 pictures were taken.

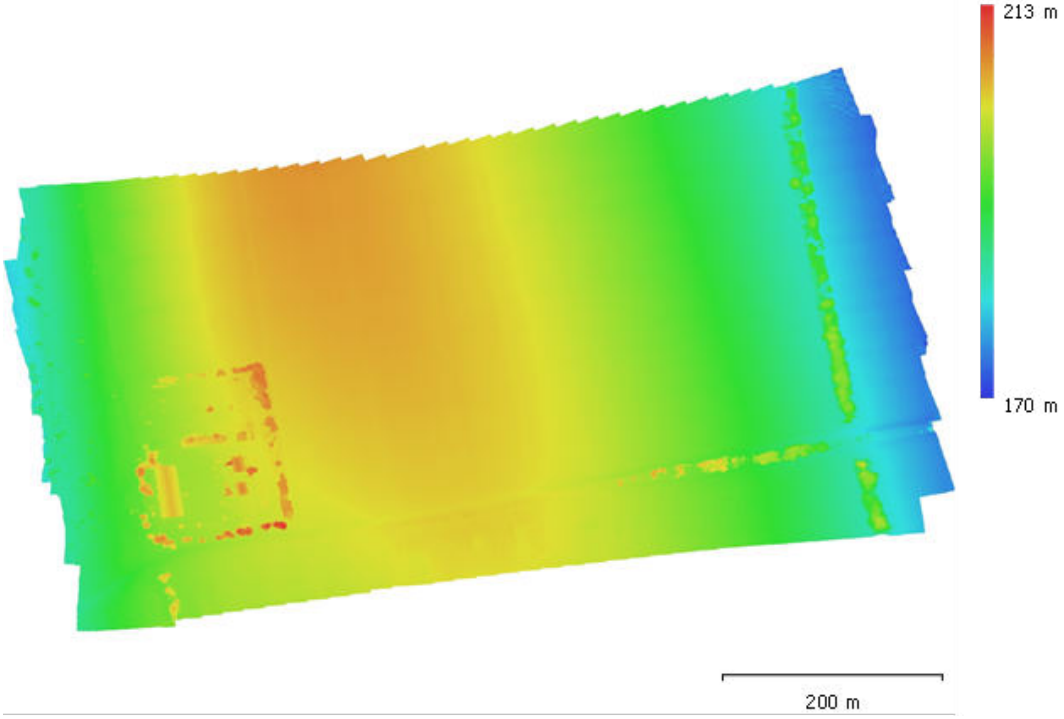

Figure 2 – Digital elevation map

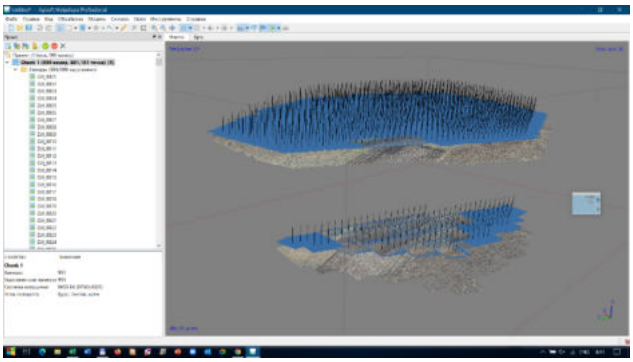

Figure 3 – Drone images

After completion of the field work, cameral work is carried out. Office calculations are performed using specialized software Agisoft Metashape Professional.

The tone and color of the upper horizons of soils that are not fixed by vegetation (for example, on arable land) are determined by certain soil characteristics, such as the degree of erosion, the degree of moisture, and the humus content.

Drones cannot determine information about the soil, therefore, detailed field studies of soils with the determination of the physicochemical characteristics of soils in the laboratory are necessary.

As a result of deciphering images from drones, we get the structure of the relief, the geological structure of the area, the result of human economic activity.

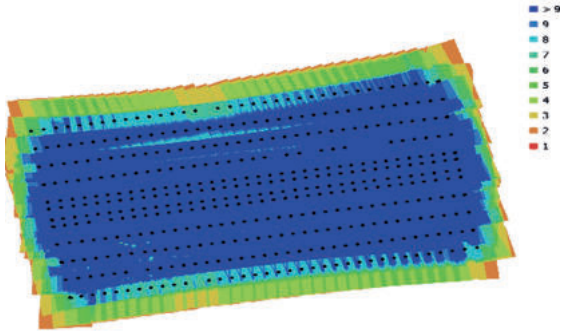

Figure 4 – Camera position and image overlay

Table 2

Drone processing data

Number of images:	434	Camera stops:	434
Flight altitude:	92.9 m	Equality points:	425,333
Resolution at soil:	2.36 cm/pix	Projection:	1,673,567
Coverage area:	0.421 km²	Reprojection error:	0.532 pix

Camera's Model	Resolution	Focal distance	Pixel's size	Precalibrated
FC6310 (8.8mm)	5472 x 3648	8.8 mm	2.41 x 2.41 μm	Nu

To develop an erodibility map, based on measurements with the help of a drone, the direction of the flow of water flow was determined.

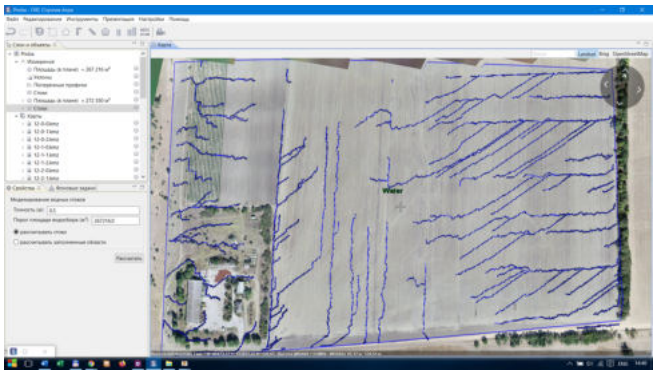

Figure 5 – Water flow direction model

This material is used to develop anti-erosion measures in the area under study, to prevent pollution of the river basin.

Thus, drone work complements field research and provides reliable information about water runoff as a result of erosion processes.

At the final part of the project, in the pilot area water bodies there will be developed and/or tested innovative tools/ machines: 4 litter traps (in Armenia, Greece, Moldova and Turkey) and one skimmer vessel (in Romania) to collect litter and other pollutants to test them in different environments, representative for the region. This should help their adoption by all Black Sea countries and lead to a joint monitoring program for inland nonpoint source pollutants and litter. Finally, numerous and diverse communication activities will help to reach all target groups and lead to the adoption of these joint monitoring methods and tools in the regions. The project also includes the educational and public awareness components to share the knowledge on the main sources of river and Black Sea pollution and ways of its minimization.

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ГЕОГРАФИЧЕСКИЕ ИНФОРМАЦИОННЫЕ СИСТЕМЫ МОНИТОРИНГА МИГРАЦИИ ЗАГРЯЗНЯЮЩИХ ВЕЩЕСТВ В ПОЧВАХ И ВОДАХ В КОНТЕКСТЕ УЛУЧШЕНИЯ ЭКОЛОГИЧЕСКОЙ ОБСТАНОВКИ

GEOGRAPHIC INFORMATION SYSTEMS FOR MONITORING THE MIGRATION OF POLLUTANTS IN SOILS AND WATERS IN THE CONTEXT OF ENVIRONMENTAL IMPROVEMENT

В. В. Плесканев[1,2], П. К. Шалькевич[1,2], Л. А. Липницкий[1,2]

V. V. Pleskanev[1,2], P. K. Shalkevich[1,2], L. A. Lipnitsky[1,2]

[1]Учреждение образования «Международный государственный экологический институт имени А. Д. Сахарова» Белорусского государственного университета, МГЭИ им. А. Д. Сахарова БГУ
г. Минск, Республика Беларусь
shalkevich@iseu.by

[2]Белорусский государственный университет, БГУ, г. Минск,, Республика Беларусь
[1]International Sakharov Environmental Institute of Belarusian State University, ISEI BSU
Minsk, the Republic of Belarus
[2]Belarusian State University, BSU, Minsk, the Republic of Belarus

Рассмотрены географические информационные системы (ГИС) для мониторинга миграции загрязняющих веществ в почвах и водах. Представлен обзор архитектуры создания программного продукта ГИС: их интерфейса, функций, преимуществ и ограничений. Сформулированы условия, при которых возможно решение экологических проблем для будущих исследований в этой области.

Geographic information systems (GIS) for monitoring the migration of pollutants in soils and waters are considered. An overview of the architecture for creating a GIS software product: their interface, functions, advantages and limitations is presented. The conditions under which it is possible to solve environmental problems for future research in this area are formulated.

Ключевые слова: геоинформационные системы, ГИС, мониторинг окружающей среды, миграция загрязняющих веществ.

Keywords: geographic information systems, GIS, environmental monitoring, contaminants migration.

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В современном мире геоинформационные системы используются человеком во многих отраслях: сельское хозяйство, городское планирование, здравоохранение, коммунальные услуги, недвижимость, управление природными ресурсами и чрезвычайными ситуациями, управление окружающей средой. Это обусловлено тем, что ГИС – это универсальная технология, которая широко используется и постоянно развивается, и ее потенциальные области применения расширяются по мере появления новых источников данных [1].

Загрязнение почв и вод является глобальной экологической проблемой и может иметь серьезные последствия для здоровья человека и окружающей среды. ГИС являются эффективным инструментом мониторинга миграции загрязняющих веществ в почвах и водах. Они позволяют визуализировать пространственное распределение загрязняющих веществ, выявлять потенциальные очаги загрязнения и разрабатывать эффективные меры по предотвращению загрязнения [2].

На сегодняшний день на рынке доступен широкий выбор программных продуктов ГИС, каждый из которых имеет свои сильные стороны и возможности. Большинство этих продуктов использует множество методов из различных дисциплин: картографические методы, дистанционное зондирование, геодезические методы, пространственный анализ, методы управления базами данных и визуализация данных и т.д. [3]. Наиболее распространенные ГИС:

• ArcGIS: разработанная кампанией Esri, это одна из наиболее широко используемых программ ГИС в мире. Он известен своим всеобъемлющим набором инструментов и возможностей для анализа пространственных данных.