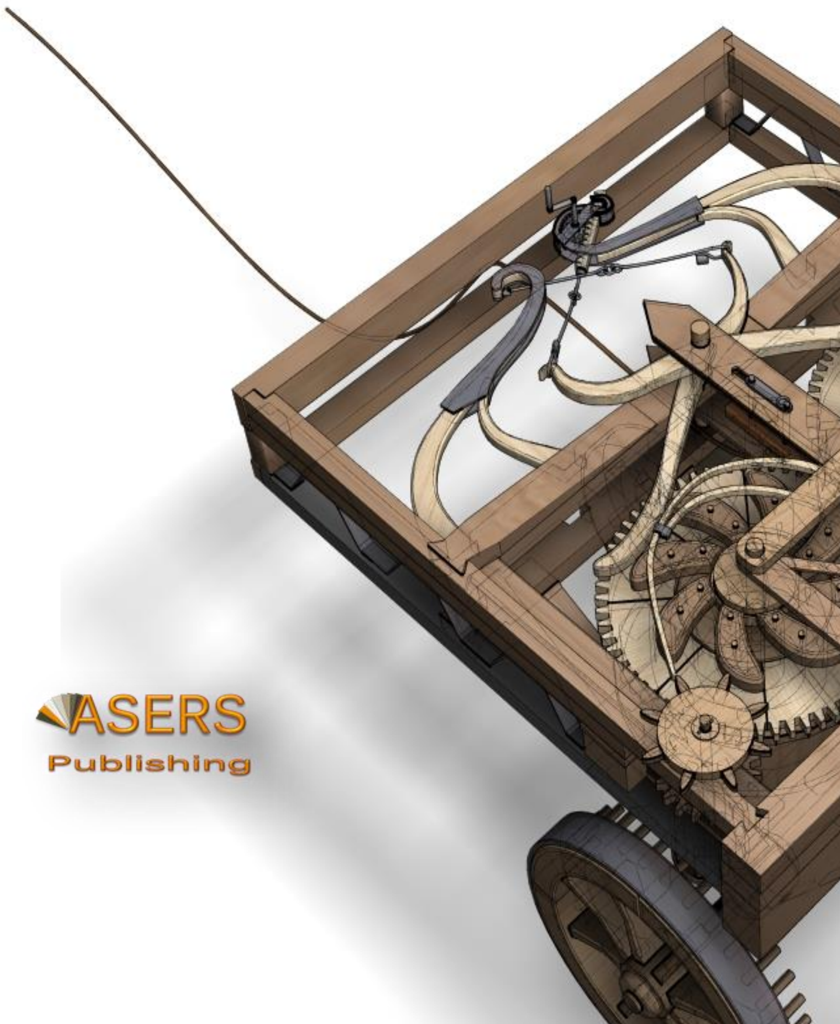
ASERS

Journal of Environmental Management and Tourism



Quarterly
Volume XIV
Issue 5(69)
Fall 2023
ISSN 2068 – 7729
Journal DOI
https://doi.org/10.14505/jemt

ASERS Publishing

Fall 2023
Volume XIV
Issue 5(69)

ASERS Publishing
http://www.aserspublishing.eu
ISSN 2068 – 7729
Journal DOI: https://doi.org/10.14505/jemt

Table of Contents:

1	**Waste Utilization Potential of Oil Palm Industry in North Kalimantan Province, Indonesia** Mohamad Nur UTOMO, Ahmad MUBARAK, Sulistya Rini PRATIWI, Najmudin NAJMUDIN	2159
2	**Legal Regulation of Civil Liability for Environmental Damage: How Appropriate are Civil Liability Provisions with the Privacy of Environmental Damage?** Lana AL-KHALAILEH, Tareq AL-BILLEH, Majd MANASRA, Abdullah ALKHSEILAT, Noor ALZYOUD, Noor AL-KHAWAJAH	2174
3	**Study the Nexus between Indicators of Surface Water Quality on the Small River for Better Basin Management** Olena MITRYASOVA, Andrii MATS, Ivan SALAMON, Victor SMYRNOV, Vadym CHVYR	2187
4	**Attracting Investment for Rural Development: Introduction of Organic Agriculture and ESG Principles in Kazakhstan** Marzhan KUANDYKOVA, Aidos AKPANOV, Santay TLEUBAYEVA, Anuar BELGIBAYEV, Askar MAKHMUDOV, Aigul ATCHABAROVA	2196
5	**Forty-Seven Years of Environmental Management Accounting Research: A Bibliometric Analysis** Chetanraj DB, Senthil Kumar JP	2207
6	**Accumulation of Heavy Metals in the Needles of Scots Pine of the Semipalatinsk Pre-Irtysh Region and Burabay National Park** Botakoz YELKENOVA, Raikhan BEISENOVA, Rumiya TAZITDINOVA, Zhanar RAKHYMZHAN, Nurziya KARIPBAEVA	2242
7	**Identifying Karst Aquifer Recharge Area Using Environmental Stable Isotopes and Hydrochemical Data: A Case Study in Nusa Penida Island** I Ketut ARIANTANA, Made Sudiana MAHENDRA, I Wayan NUARSA, I Wayan Sandi ADNYANA, Lambok HUTASOIT, Irwan ISKANDAR, MUSTIATIN, Putu Doddy Heka ARDANA	2253
8	**Regulatory and Legal Support for the Development of Digital Infrastructure in Rural areas as a Factor in Improving the Level of Sustainable Development and Quality of Life of the Rural Population** Serikbai YDYRYS, Nazgul IBRAYEVA, Fariza ABUGALIYEVA, Mira ZHASKAIRAT, Aiman UVALIYEVA	2271
9	**Do Environmentally Responsible Practices in Accommodation Establishments Matter?** Lulama NDZUNGU, Carina KLEYNHANS, Antoinette ROELOFFZE	2281
10	**Development of a Model of Strategic Priorities for Sustainable Development of Rural Areas in Kazakhstan until 2030. Example of the East Kazakhstan Region** Kalamkas NURALINA, Raisa BAIZHOLOVA, Yergali ABENOV, Dinara MUKHIYAYEVA, Yerkezhan MOLDAKENOVA	2290
11	**Investing in Human Capital for Green and Sustainable Development** Ansagan BEISEMBINA, Alla GIZZATOVA, Yerlan KUNYAZOV, Takhir ERNAZAROV, Nurlan MASHRAPOV, Sergey DONTSOV	2300
12	**Top Management Support, Green Intellectual Capital and Green HRM: A Proposed Framework for Sustainability** Abdur Rachman ALKAF, Mohd Yusoff YUSLIZA, Amauche Justina EHIDO, Jumadil SAPUTRA, Zikri MUHAMMAD	2308
13	**Human Capital Management Based on the Principles of Green Economy and the Creation of Green Jobs for Sustainable Territorial Development** Gulmira RAKHIMZHANOVA, Aigul MAIDYROVA, Ainura KOCHERBAEVA	2319

Fall 2023
Volume XIV
Issue 5(69)

ASERS Publishing
http://www.aserspublishing.eu
ISSN 2068 – 7729
Journal DOI: https://doi.org/10.14505/jemt

14	**Integrated Urban Solid Waste Management: Knowledge, Practices, and Implementation** Riza Stephanie A. ALFARAS	2328
15	**Issues Concerning the Improving Organizational and Legal Support of Victimological Prevention for Environmental Crimes** DaurenMALIKOV, Natalya SIDOROVA, Saltanat ATAKHANOVA, Manshuk RAKHIMGULOVA, Sholpan MALIKOVA, Larissa KUSSAINOVA	2336
16	**Management of Bioculture Potential with Environmental Perspective Based on Local Wisdom** Trio Beni PUTRA, Thamrin THAMRIN, Zulfan SAAM, Sofyan HUSEIN	2345
17	**Analysis of the Environment Impact on the Inclusion of Children with Special Educational Needs** Marzhan TURLUBEKOVA, Valeriy BIRYUKOV, Zulfiya MAGRUPOVA, Galiya KISHIBEKOVA, Roza BUGUBAYEVA	2354
18	**Perception and Awareness of Marine Plastic Pollution in Selected Tourism Beaches of Barobo, Surigao del Sur, Philippines** Sherley Ann T. INOCENTE, Carlo S. GUTIERREZ, Maria Pia M. SISON, John Roderick V. MADARCOS, Judea Christine M. REQUIRON, Christine Joy M. PACILAN, Shiela Mae M. GABOY, Jayson Leigh M. SEGOVIA, Hernando P. BACOSA	2367
19	**Role of State Institutions in Protecting the Environment. Improving Management System of the Public Services** Yuliya KIM, Serik DARIBEKOV, Laura KUNDAKOVA, Dinar SIKHIMBAYEVA, Gulnara SRAILOVA	2379
20	**Interactive Planning as Part of a Territorial Strategy to Develop Tourism Sites** Edwin RAMIREZ-ASIS, Abu Bakar Bin Abdul HAMID, Nor Hazila Binti Mohd ZAIN, Mohsin RAZA, Jose RODRIGUEZ-KONG, Cinthy ESPINOZA-REQUEJO	2390
21	**Travels and Sustainable Tourism in Italy. Selected Dilemmas** Michał MROZEK	2398
22	**Safety Management Model of Tourism City Municipalities in Eastern Economic Corridor** Chayapoj LEE-ANANT	2406
23	**Impact of War on the Natural Preserve Fund: Challenges for the Development of Ecological Tourism and Environmental Protection** Anatolii KUCHER, Anna HONCHAROVA, Lesia KUCHER, Mariia BIELOBORODOVA, Liudmyla BONDARENKO	2414
24	**Sustainable Development and Environmental Tourism. The Case of Lake Karla – Thessaly, Greece** Georgia TRAKALA, Aristotelis MARTINIS, Georgios KARRIS, Charicleia MINOTOU, Achilleas TSIROUKIS	2426
25	**Post-COVID-19 Community-Based Tourism Sustainable Development in China. Study Case of Hebian Village** Mingjing QU, Wong Ming WONG	2440
26	**Predicting the Intention to Implement Green Practices by Small and Medium Sized Hotels in South Africa** Proceed Lerato MASEBE, Olawale FATOKI	2455

Call for Papers
Winter Issues 2023
Journal of Environmental Management and Tourism

Journal of Environmental Management and Tourism is an open access, peer-reviewed interdisciplinary research journal, aimed to publish articles and original research papers that contribute to the development of both experimental and theoretical nature in the field of Environmental Management and Tourism Sciences. The Journal publishes original research and seeks to cover a wide range of topics regarding environmental management and engineering, environmental management and health, environmental chemistry, environmental protection technologies (water, air, soil), pollution reduction at source and waste minimization, energy and environment, modelling, simulation and optimization for environmental protection; environmental biotechnology, environmental education and sustainable development, environmental strategies and policies.

Authors are encouraged to submit high quality, original works that discuss the latest developments in environmental management research and application with the certain scope to share experiences and research findings and to stimulate more ideas and useful insights regarding current best-practices and future directions in Environmental Management.

Also, this journal is committed to a broad range of topics regarding Tourism and Travel Management, leisure and recreation studies and the emerging field of event management. It contains both theoretical and applied research papers and encourages obtaining results through collaboration between researchers and those working in the tourism industry.

The journal takes an interdisciplinary approach and includes planning and policy aspects of international, national and regional tourism as well as specific management studies. Case studies are welcomed when the authors indicate the wider applications of their insights or techniques, emphasizing the global perspective of the problem they address.

This issue has a special importance for us, marking a new stage in the history of this journal. So, starting with Issue 5(69), Fall 2023 **Journal of Environmental Management and Tourism** will be published in Open Access system. Journal of Environmental Management and Tourism' articles are published under the Creative Commons Attribution 4.0 International License BB CY, which permits unrestricted use, distribution, and reproduction in any medium, provided the original authors and the source are credited.

Journal of Environmental Management and Tourism is indexed in SCOPUS, RePEc, CEEOL, ProQuest, EBSCO and Cabell Directory databases.

Details regarding the publication in this journal are here: https://journals.aserspublishing.eu/jemt/about

Deadline for submission:	21st October 2023
Expected publication date:	December 2023
Website:	https://journals.aserspublishing.eu/jemt
E-mail:	jemt@aserspublishing.eu

To prepare your paper for submission, please see full author guidelines in the following file:

JEMT_Full_Paper_Template.docx, then send it via email at jemt@aserspublishing.eu.

Journal of Environmental Management and Tourism

DOI: https://doi.org/10.14505/jemt.v14.5(69).03

Study the Nexus between Indicators of Surface Water Quality on the Small River for Better Basin Management

Olena MITRYASOVA
Petro Mohyla Black Sea National University, Ukraine
ORCID: 0000-0002-9107-4448; Researcher ID: L-4705-2018
lesya.solis28@gmail.com

Andrii MATS
NGO «Open Environmental University», Ukraine
ORCID: 0000-0002-1226-5343
andrejmac3@gmail.com

Ivan SALAMON
University of Presov, Slovakia
ORCID: 0000-0001-5379-3989
ivan.salamon@unipo.sk

Victor SMYRNOV
Petro Mohyla Black Sea National University, Ukraine
ORCID: 0000-0003-3809-6098
vnsmirnov79@gmail.com

Vadym CHVYR
Petro Mohyla Black Sea National University, Ukraine
ORCID: 0000-0003-3136-4408
vip.chvir@gmail.com

Article info: Received 9 February 2023; Received in revised form 7 March 2023; Accepted for publication 31 July 2023; Published 1 September 2023.

Abstract: Purpose is determination of interdependencies between hydrochemical indicators of surface water quality in the example of a small river as a limiting factor of formation of aquatic ecosystem of territories. Correlation analyses of the studied indicators of water quality was conducted on an average value of each indicator (pH, phosphates, nitrates, BOD, COD, soluble oxygen). Found a significant increase in phosphates with time, with a coefficient of correlation R=0.71, indicating contamination of the water facility. This can be explained by the arrival of various surface-active substances and, to a lesser extent, the lack of quality sewage treatment facilities. Positive changes are founded in water object that is related to a decrease in the value of BOD. This is due to a decrease in the use of oxygen on oxidation of inorganic and organic substances. In general, the use of river runoff of the river above normal, and the overall environmental state of river basin is defined as "extremely poor".

Keywords: pollution; quality water indicators; small river; correlation analysis.

JEL Classification: Q53; R11.

Introduction

The problem of natural water pollution is especially important in terms of monitoring studies and studying the interdependencies between water quality indicators. It is especially true in regions with developed infrastructure and agriculture, where there is a significant source of pollutants in water systems. On the other hand, aquatic ecosystems consist of various elements, some of which are small rivers. Small rivers form the water resources of medium and large rivers, hydrochemical water quality and creating lands large areas. Environmental monitoring is one of the country's priorities for achieving the goals of sustainable development. The one is the goal of the roadmap for the implementation of environmental policy in Ukraine, as a country that has set a course for European integration in terms of implementing programmes aimed at national security and sustainable development of society. Environmental issues outlined in the legislation and regulations of the European Union, namely: Millennium Development Goals (Millennium Development Goals, 2015); Objectives of 2050 of the Seventh Environment Action Programme (7th Environment Action Programme, 2013; Ishchenko *et al.* 2019), Water Framework Directive 2000/60/EC (Directive 2000/60/EC of the European Parliament and of the Council, 2000; Charis and Galanakis 2010); Industrial Pollution Directive 2010/75/EU (Directive 2010/75/EU of the European Parliament and of the Council, 2010); Water Code of Ukraine (Water Code of Ukraine,1995).

1. Research Background

The scientific works of scientists have acquired significant scientific significance in the study of environmental problems related to water resources management and anthropogenic impact on the state of water bodies. Staddon C. *et al.* study the socio-economic issues of water resources management, the structure of water consumption in different countries (Staddon 2016).

Meyer A.M., Klein C., Fünfrocken E., Kautenburger R., Beck H.P. *et al.* study the correlations between chemical components, as well as the patterns of distribution of pollutants in the aquatic environment, study the problems of pollution of small rivers (Meyer *et al.* 2019; Mitryasova and Pohrebennyk 2017; Mitryasova *et al.* 2020).

Obolewski K., Glinska-Lewczuk K., Szymanska M., Astel A., Lew S. study the issues of green chemistry of water bodies, search for patterns between the content of chemical components of the aquatic environment and its biological component (Obolewski *et al.* 2018).

Issues of assessing the impact of industrial enterprises on the water resources state present in the works Kapelewska J. *et al.* (2019). Schickele A. *et al.* (2020) investigate the influence of temperature on the morphological composition of water bodies.

The works of Snizhko S. *et al.* became especially important issue - multifactorial impact on surface water quality (Snizhko 2004); Grebin V. *et al.* - regional landscape-hydrological analysis of the modern water regime of the rivers of Ukraine (Grebin and Khilchevskyi 2016). Thus, the study of Grebin V. and Khilchevsky V., following the requirements of the Water Framework Directive developed a method of hydrographic zoning of rivers of Ukraine, assessment of aquatic ecosystems.

Vasenko O. *et al.* develop methods of comprehensive assessment of water bodies taking into account the factors of degradation processes, carry out scientific research to improve the methodology for establishing environmental standards of surface water quality, taking into account landscape and geographical features of aquatic ecosystems, ranking of observation points (Vasenko *et al.* 2016; Bezsonov *et al.* 2017; Pohrebennyk *et al.* 2019; Mitryasova and Pohrebennyk, 2020a).

However, a comprehensive analysis of water resources from the standpoint of assessing the state of small rivers for effective integrated management for sustainable development of the region and achieving proper environmental status of water bodies, under Ukrainian legislation and the Water Framework Directive, processes of adaptation to EU environmental policy.

Small rivers are an important component of the natural environment. Small rivers form the hydrochemical conditions of water resources and water quality of medium-sized and large rivers, creating landscapes large areas. An important feature of small rivers in the fact that they are the starting point of the river network, and any changes that occur in their mode, marked on the hydrological chain (Tanriverdi *et al.* 2010; Pohrebennyk *et al.* 2016; Zeinalzadeh and Rezaei, 2017; Zhang *et al.* 2018; Alifujiang *et al.* 2021; Thuy *et al.* 2021; Mitryasova *et al.* 2021b; McBean *et al.* 2022; Tha *et al.* 2022; Ward 2021). Water resources of small rivers are part of the shared water resources and are often the main and sometimes the only one source of local water. Small rivers have some features that need to be considered when developing environmental management measures (Petrov *et al.* 2020). The first is the dependence of water content, hydrological regime and water quality of small rivers on the state of the catchment. The second is climatic and weather factors (Mazlum *et al.* 1999; Mitryasova *et al.* 2021a; Arndt *et al.* 2022).

The object of the research is a small river Mertvovod in Mykolaiv region (Ukraine).

The length of the river is 114 km, the area of the drainage basin is 1820 km². The river valley is predominantly trapezoidal, width up to 3 km, depth up to 40-50 m. The floodplain is 200-300 m wide, up to 1-1,5 km below the ground. The generator is twisted; its average width in the lower reaches is up to 20 m. The slope of the river is 1,8 m/km (Southen Bug River Basin Management in Mykolaiv Region, 2021).

Monitoring studies are conducted by Southern Buh River Basin Management in Mykolaiv region at the point of monitoring near Voznesensk (Mykolaiv region, Ukraine) (fig. 1).

Figure 1. The sampling point location on the Mertvovod River

2. Methodology

The study methods used: observation; comparisons and analogies; analysis; synthesis; generalization. Also, we have used research: Google Maps, Microsoft Excel, Origin software. Calculations are made using the correlation formulas 1 and 2 (Buda and Jarynowski 2010; Kupalova 2008; Mitryasova *et al.* 2021):

$$r = \frac{\sum(x-\bar{x})(y-\bar{y})}{\sqrt{\sum(x-\bar{x})^2\sum(y-\bar{y})^2}} \quad 2.1$$

r = -1; +1

where x, y are the numeric values of the variables, which set the correlation connection; where $\bar{x}$, $\bar{y}$ are average arithmetic values.

$$R = \sqrt{1-(1-r_{yx1}^2)(1-r_{yx2/x1}^2)} \quad 2.2$$

r = 0; +1

where r_{yx1} – doubles correlation coefficient;

$r_{yx2/x1}$ – partial correlation coefficient.

To describe the magnitude of the correlation coefficient are the following, which are presented in table 1.

Table 1. Correlation coefficient interpretation

Value	The correlation coefficient interpretation
≤ 0,2	very weak
≤ 0,5	weak
≤ 0,7	average
≤ 0,9	high
≥ 0,9	very high

Correlation analysis was used to find quantitative relationships between natural water quality indicators (pH, phosphates, nitrates, COD, soluble oxygen). Trend analysis using the Shapiro-Wilk test in the Origin program allowed determining changes in the water body.

3. Case Studies

To study the relationship between the indicators of surface water quality on the small river example, three integrated indicators were selected, namely soluble oxygen, pH, COD, BOD as well as hydrochemical parameters that fall into the risk zone are: nitrates, phosphates and ammonium for the period from 2007 to 2021.

The value of pH characterizes the active acidity, its value is influenced by the following factors:

- the content of carbon dioxide and oxygen in the water;
- content of humic acids;

- the presence of heavy metal ions;
- temperature regime of the reservoir.

The content of hydrogen ions of natural reservoirs is determined by the quantitative ratio of carboxylic acid and its ions by chemical equation 3.1:

$$CO_2 + H_2O \leftrightarrow H_2CO_3 \leftrightarrow H^+ + HCO_3^- \leftrightarrow 2H^+ + CO_3^{2-} \quad 3.1$$

The formation of bicarbonates occurs due to the dissociation processes of equations 3.2 and 3.3:

$$Ca(HCO_3)_2 \leftrightarrow Ca^{2+} + 2HCO_3^- \quad 3.2$$

$$Mg(HCO_3)_2 \leftrightarrow Mg^{2+} + 2HCO_3^- \quad 3.3$$

Due to the hydrolysis of bicarbonates, the pH increases according to the chemical equation 3.4:

$$HCO_3^- + H_2O \leftrightarrow CO_2 + OH^- \quad 3.4$$

Surface waters with low carbon dioxide content have a slightly alkaline reaction medium; pH≤7 with large amounts of CO_2. pH values are closely related to the processes of photosynthesis due to the consumption of carbon dioxide by aquatic vegetation. The source of hydrogen ions is also humic acids, which are contained in soils.

During the hydrolysis of heavy metal salts, strongly acidic waters with pH≤3 are formed (chemical equation 3.5):

$$FeSO_4 + 2H_2O \leftrightarrow Fe(OH)_2 + 2H^+ + SO_4^{2-} \quad 3.5$$

Such waters are formed when significant amounts of iron, aluminum, copper and many other heavy metals ions enter the water. A similar process of oxidation of heavy metal sulfides occurs during the discharge of mine water by chemical equations 3.6 and 3.7:

$$2FeS_2 + 7O_2 \rightarrow 2FeSO_4 + 2H_2SO_4 \quad 3.6$$

$$4FeSO_4 + 2H_2SO_4 + O_2 \rightarrow Fe_2(SO_4)_3 + H_2O \quad 3.7$$

The sources of hydrogen ions are humic acids. Acidic, weakly acidic waters (pH = 3-6.5) are formed during the decomposition of organic compounds, as well as the influx of carbon dioxide and sulfonic acids. Therefore, the pH value of natural waters depends on the content of carbon dioxide, humic and other organic acids, as well as the content of cations of weak bases (ammonium ions, aluminum, iron, organic bases). In these cases, the pH is not below 4.5.

High values of COD and BOD in natural waters are due to some indicators, namely the high content of inorganic and organic pollutants, humic substances, hydrogen sulfide, sulfites, sulfides, nitrites, ammonium nitrogen.

The correlation nexus between COD, phosphates, and nitrates. Phosphates and nitrates, as the main forms of the most important nutrients of Phosphorus and Nitrogen, often limit the development of water productivity. Therefore, the inflow of excess phosphorus and nitrogen compounds from the catchment (in the form of mineral fertilizers with surface runoff from fields (for example, from a hectare of irrigated land is taken out 0 4-0.6 kg of phosphorus), with runoff from farms (0.01-0.05 kg/day per animal), with untreated or untreated domestic wastewater (0.003-0.006 kg/day per capita), as well as with some industrial waste leads to a sharp uncontrolled increase in plant biomass of the water body (This is especially true for stagnant and low-flowing reservoirs.) There is a so-called change in the trophic status of the reservoir, accompanied by the restructuring of the entire water community and most importantly to the predominance of putrefactive processes.

The presence of nitrates in natural waters is associated with: internal processes in the reservoir - nitrification of ammonium ions with the participation of oxygen under the action of nitrifying bacteria; atmospheric precipitation, which absorbs oxides of nitrogen formed during atmospheric electric discharges (the concentration of nitrates in precipitation reaches 0.9-1 mg; industrial and domestic wastewater, especially after biological treatment, when the concentration reaches 50 mg/dm^3; runoff from agricultural lands and runoff from irrigated fields where nitrogen fertilizers are applied.

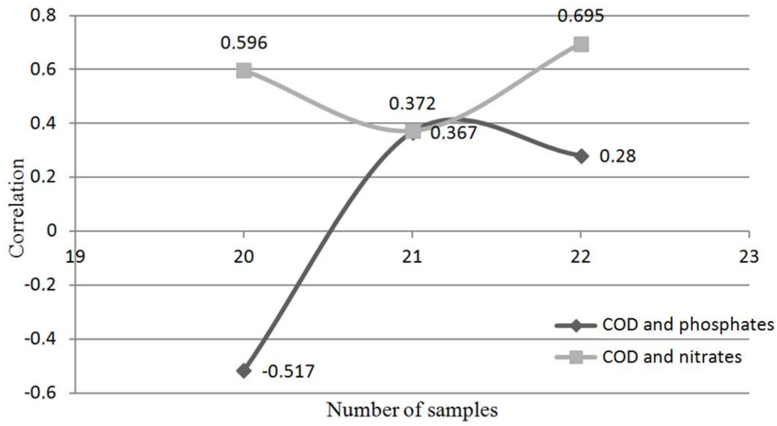
The main processes aimed at reducing the concentration of nitrates are their consumption by denitrifying bacteria and phytoplankton, which in the absence of oxygen use nitrate oxygen to oxidize organic matter.

In surface waters, nitrates are in dissolved form. The concentration of nitrates in surface waters is subject to seasonal fluctuations: minimal in the growing season, it increases in autumn and reaches a maximum in winter, when the minimum consumption of nitrogen is the decomposition of organic matter and the transition of nitrogen from organic to mineral forms. The amplitude of seasonal fluctuations can be one of the indicators of eutrophication of a water body.

The value of COD in all investigated samples exceeded the maximum permissible concentration, minimum value of – 15.24 mgO_2/dm^3 and maximum – 68,6 mgO_2/dm^3 (MPC < 15 mgO_2/dm^3).

Exceeding the maximum permissible concentrations by phosphates and nitrates were observed. Exceeding the maximum permissible concentration of COD is associated with oxidation of organic substances which fall into natural water from surface runoff and dumping sewage. There was a weak correlation between indicators (fig. 2).

Figure 2. The nexus between COD and phosphates, and nitrates



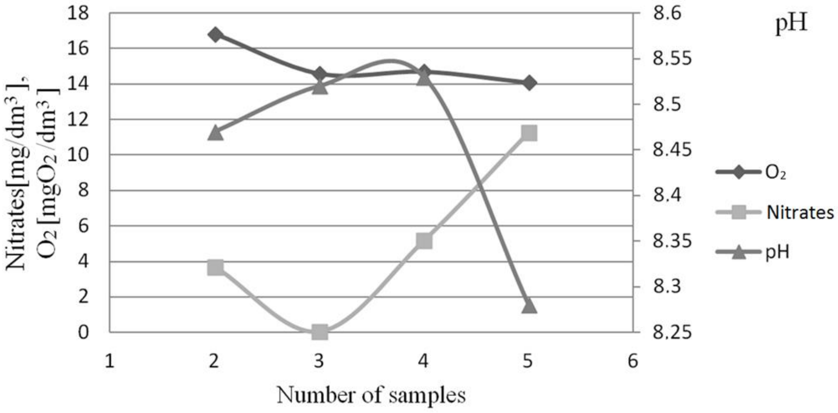
This confirms the fact that high COD values may be due to oxygen-free compounds of nitrogen and phosphorus, such as ammonium phosphide forms. So, with the increase of phosphates COD vice versa decreases, which is typical. The increase of phosphates is caused by deterioration of the river water quality due to the discharge of domestic sewage.

The correlation nexus between soluble oxygen, nitrates, and pH. The values of soluble oxygen in the water were in the norms and were > 4.00 mgO_2/dm^3. The values of nitrates were in the norms and not exceeded MPC. The value of pH was in the rules in not all the samples and was up 8.74 (MPC of pH = 6.5–8.5).

The smallest dependence observed between O_2, nitrates and pH (fig. 3.) Correlation coefficient equals about 0.36, that is, there is a weak dependence between parameters. In the period the soluble oxygen (O_2) decreases, and nitrates on the contrary increase that is typical of data indicators and associated with the maximum increase of COD in the given period that makes up 52.47 mgO_2/dm^3 (MPC < 15 mgO_2/dm^3).

Such excess allows the claim about water pollution by organic and inorganic substances. Oxidation-reduction process of conversion of nitrogen-containing compounds into nitrates occurs.

Figure 3. The nexus between by soluble oxygen, nitrates and pH

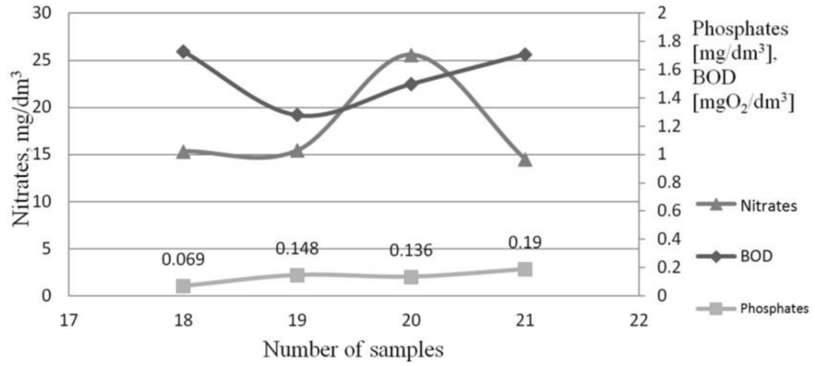


The correlation nexus between BOD, phosphates, and nitrates. In the studied period there was observed exceeding of MPC by BOD, the maximum value of which was 20.4 mgO_2/dm^3 (MPC < 3 mgO_2/dm^3). The correlation changes in most cases from 0.6 to 1.0 which indicates a close functional connection.

Excess value of BOD confirms receipt of the organic substances of plant and animal origin. With a high content of organic matter in the water, aerobic bacteria multiply rapidly, which require oxygen to function. This can lead to a decrease in the content of dissolved oxygen, create hypoxic conditions and the death of certain species of organisms that live permanently in the aquatic environment. The smallest correlation is observed between BOD, phosphates and nitrates (r = 0.31) that is a weak link between indicators. Also, this confirms the fact that high BOD values may be due to oxygen-free compounds of nitrogen and phosphorus, such as ammonium phosphide forms. So, with the increase of phosphates BOD vice versa decreases, which is typical also.

A sharp increase of nitrates is observed, which is 25.6 mg/dm^3 (with MPC=45 mg/dm^3) (fig. 4). The concentration of nitrates is subject to seasonal variations: the minimum is in the growing season, the maximum is in autumn, when the organic substances decay and nitrogen compounds transition from organic forms in the mineral. Nitrates come mainly from surface runoff, which contains residues of used nitrogen fertilizers.

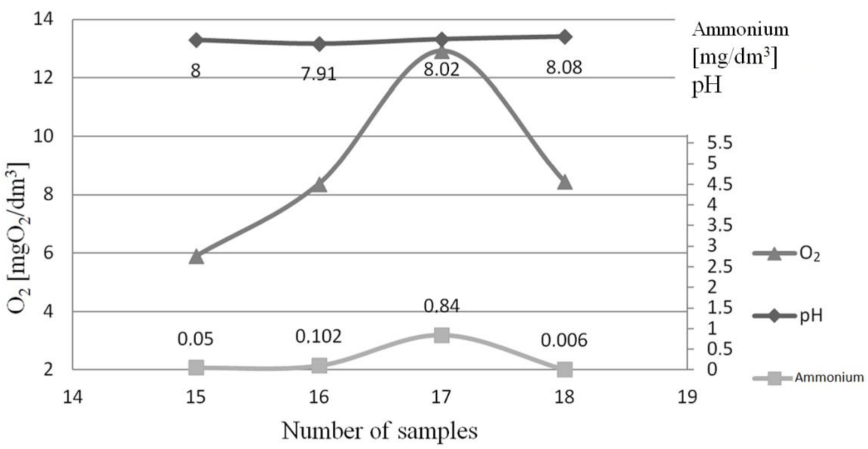
Figure 4. The nexus between BOD, phosphates and nitrates.



Another source of no-waste is groundwater, which can have fairly high concentrations (up to 100 mg/dm^3) and increase the content of nitrates in the areas of discharge into surface waters. Groundwater is the main source of nitrates in the limited period when the supply of surface water is mainly due to groundwater runoff. There are also a significant many other sources of nitrates in surface waters: surface runoff from landfills, urban areas, wastewater from animal complexes, urban wastewater. In the research period, the maximum concentration of nitrates was observed in autumn. The amplitude of seasonal fluctuations of the nitrates is an indicator of the eutrophication of the water object.

The correlation nexus between pH, ammonium, and soluble oxygen. There is excess of MPC on pH that is 8.74 (MPC = 6.5-8.5), exceeding by ammonium, which is 0.84 mg/dm^3 (MPC = 0.39 mg/dm^3), the value of dissolved oxygen is normal and is 4.00 > mgO_2/dm^3. The smallest dependence between parameters observed in the sample №15 and the coefficient of multiple correlation is weak 0.223 (fig. 5).

Figure 5. The nexus between pH, ammonium and soluble oxygen.



At the all-test period the highest concentration of ammonium is 0.84 mg/dm^3 (MPC = 0.39 mg/dm^3) and meets the sample №17. A sharp increase of ammonium is associated with agricultural ranges, growing downpours the day before sampling.

Conclusion

The status of the small river is an indicator of the water security of natural surface water. Correlation analysis of dependences between COD, phosphates, and nitrates; and also, soluble oxygen, nitrates and pH; BOD, phosphates and nitrates; pH, ammonium and dissolved oxygen show stable links between chemical components that are caused by chemical interconversions, the influence of external factors (weather conditions, the hydrological regime of the river, the anthropogenic factor).

As a result of the environmental analysis of the river Mertvovod identified periods of excess MPC by hydrochemical indicators of water quality. The sources of pollutants in the water are discovered and analyzed.

Using correlation analysis gave a clear idea about weak correlations between BOC, COD and nitrates, phosphates. These confirm the fact of increasing BOC and COD due to non-oxine-containing forms of phosphorus and nitrogen compounds. A significant increase in phosphates is detected, which is associated with the collection of cleansers with domestic waters and more with the lack of quality sewer facilities. A significant reduction of COD over the years is detected.

A further perspective is to study ways to reduce the supply of phosphates to the water body. It is also relevant to further study the dependencies between water quality indicators, as well as their interpretation.

Acknowledgements

This study was made possible with the support of the EU Erasmus+ JM Programme during the implementation of the "European Green Dimensions" project. We are grateful for the cooperation and support of colleagues from the University of Presov. We would thank the Regional office of water resources in the Mykolaiv region for creative collaboration during the research, for the opportunity to conduct the experimental work.

Credit Authorship Contribution Statement

Olena Mitryasova: Conceptualization, Methodology.
Andrii Mats: Software, Writing –review and editing.
Ivan Salamon: Validation, Supervision.
Viktor Smyrnov: Formal analysis.
Vadym Chvyr: Data curation.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

References

[1] Alifujiang, Y., J., Abuduwaili and Yo., Ge 2021. Trend Analysis of Annual and Seasonal River Runoff by Using Innovative Trend Analysis with Significant Test. *Water* 13(1): 95. DOI:https://doi.org/10.3390/w13010095

[2] Arndt, J., J.S., Kirchner, K.S., Jewell, M.P., Schluesener, A., Wick, T. A., Ternes, and L., Duester 2022. Making Waves: Time for Chemical Surface Water Quality Monitoring to Catch up with Its Technical Potential. *Water Research*, 213 (15). DOI: https://doi.org/10.1016/j.watres.2022.118168

[3] Bezsonov, Ye., O., Mitryasova, V., Smyrnov, and S., Smyrnova 2017. Influence of the South-Ukraine electric power producing complex on the ecological condition of the Southern Bug River. *Eastern-European Journal of Enterprise Technologies*, 4/10 (88): 20–28. DOI: https://doi.org/10.15587/1729-4061.2017.108322

[4] Buda, A. and A., Jarynowski 2010. Life-time of Correlations and its Applications. *Wydawnictwo Niezalezne* 1: 5–20.

[5] Charis, M. and E.A., Galanakis 2010. *Sustainable Water and Wastewater Processing*. Elsevier: Amsterdam, The Netherlands, 393 p.

[6] Grebin, V. and V., Khilchevsky 2016. Retrospective Analysis of Research of the River Network of Ukraine and Application of the Typology of Rivers of the EU Water Framework Directive at the Present Stage. Hydrology, Hydrochemistry and Hydroecology, 2, 32-47 (Hrebin, V.; Khilchevskyi, V. 2016. Retrospektyvnyi analiz doslidzhen richkovoi merezhi Ukrainy ta zastosuvannia typolohii richok Vodnoi ramkovoi dyrektyvy EU na suchasnomu etapi, Hidrolohiia, Hidrokhimiia i Hidroekolohiia, 2, 32-47) (in Ukrainian)

[7] Ishchenko, V., V., Pohrebennyk, R., Kochan, O., Mitryasova, and S., Zawislak 2019. Assessment of Hazardous Household Waste Generation in Eastern Europe. International Multidisciplinary Scientific Geoconference SGEM 2019, Albena, Bulgaria. 30 June – 6 July 2019, 6.1, 19, 559−566.

[8] Kapelewska, J., U., Kotowska, J., Karpińska, A., Astel, J., Suchta and K., Algrzym 2019. Water Pollution Indicators and Chemometric Expertise for the Assessment of the Impact of Municipal Solid Waste Landfills on Groundwater Located in Their Area. *Chemical Engineering Journal* 359: 790-800. DOI:https://doi.org/10.1016/j.cej.2018.11.137

[9] Kupalova, G.I. 2008. *Theory of Economic Analysis, tutorial*, Ukraine, K.: Znannya, 639 p. (Kupalova, G.I. 2008. Theoriia Economichnogo Analysu, posibnyk, Ukraina, K.: Znannya, 639 s.) (in Ukrainian)

[10] Mazlum, N., A., Ozer and S., Mazlum 1999. Interpretation of Water Quality by Principal Components Analysis. *Tropical Journal of Engineering and Environmental Science* 23: 19–26. Available at: https://aj.tubitak.gov.tr/engineering/issues/muh-99-23-1/muh-23-1-3-96116.pdf

[11] McBean, E., M., Bhatti, A., Singh, L., Mattern, L., Murison, and P., Delaney 2022. Temperature Modeling, a Key to Assessing Impact on Rivers Due to Urbanization and Climate Change. *Water* 4(13): 1994. DOI:https://doi.org/10.3390/w14131994

[12] Meyer, A.M., C., Klein, E., Fünfrocken, R., Kautenburger and H.P., Beck 2019. Real-time Monitoring of Water Quality to Identify Pollution Pathways in Small and Middle Scale Rivers. *Science of the Total Environment* 651: 2323-2333. https://doi:10.1016/j.scitotenv.2018.10.069

[13] Millennium Development Goals. 2015. Available at: https://www.un.org/millenniumgoals/

[14] Mitryasova, O., M., Cieśla, A., Nosyk, and A., Mats 2021a. Hydrochemical Indicators Dynamic in Surface Water. *Journal of Ecological Engineering* 22(8): 111–122. DOI:https://doi.org/10.12911/22998993/140264

[15] Mitryasova, O., P., Koszelnik, R., Gruca-Rokosz, V., Smyrnov, S., Smyrnova, Ye., Bezsonov, M., Zdeb, and S., Ziembowicz 2020. Features of Heavy Metals Accumulation in Bottom Sediments of the Southern Bug Hydroecosystem. *Journal of Ecological Engineering* 21 (3): 51–60. DOI:https://doi.org/10.12911/22998993/118299

[16] Mitryasova, O., P., Koszelnik, R., Gruca-Rokosz, V., Smyrnov, S., Smyrnova, M.,Kida, S., Ziembowicz, Ye., Bezsonov and A., Mats, 2021b. Environmental and Geochemical Parameters of Bottom-Sediment from the Southern Bug Estuary. *Journal of Ecological Engineering* 22(2): 244–255. DOI:https://doi.org/10.12911/22998993/131120

[17] Mitryasova, O. and V., Pohrebennyk 2017. The Status of the Small River as an Indicator of the Water Security of Natural Surface Water. Conference Proceedings «17th International Multidisciplinary Scientific GeoConference SGEM 2017», Vienna, Austria, 27 November – 29 November 2017, ISSUE 33, Vol. 17. Hydrology and Water Resources. 391– 398. Available at: http://toc.proceedings.com/37951webtoc.pdf

[18] Mitryasova, O. and V., Pohrebennyk, 2020a. Hydrochemical Indicators of Water System Analysis as Factors of the Environmental Quality State. Sustainable Production: Novel Trends in Energy, Environment and Material Systems. Studies in Systems, Decision and Control In: Królczyk G., Wzorek M., Król A., Kochan O., Su J., Kacprzyk J. (eds), Vol. 198. Springer, Cham., 91−104.

[19] Mitryasova, O., V., Pohrebennyk, I., Salamon, A., Oleksiuk, and A., Mats 2021. Temporal Patterns of Quality Surface Water Changes. *Journal of Ecological Engineering* 22(4): 283–295. DOI:https://doi.org/10.12911/22998993/134199

[20] Obolewski, K., K., Glińska-Lewczuk, M., Szymańska, A., Astel, S., Lew, and E., Paturej 2018. Patterns of Salinity Regime in Coastal Lakes Based on Structure of Benthic Invertebrates. *PLOS ONE* 13(11). DOI:https://doi.org/10.1371/journal.pone.0207825

[21] Petrov, O., S., Petrichenko, A., Yushchishina, O., Mitryasova and V., Pohrebennyk 2020. Electrospark Method in Galvanic Wastewater Treatment for Heavy Metal Removal. *Applied Sciences*, Special Issue «Determination and Extraction of Heavy Metals from Wastewater and Other Complex Matrices» 10(15): 5148. DOI: https://doi.org/10.3390/app10155148

[22] Pohrebennyk, V., M., Cygnar, O., Mitryasova, R., Politylo, and A., Shybanova 2016. Efficiency of Sewage Treatment of Company «Enzyme». 16th International Multidisciplinary Scientific Geoconference SGEM 2016, Albena, Bulgaria, 30 June – 6 July 2016, Book 5, Ecology, Economics, Education and Legislation, Volume II, Ecology and Environmental Protection, 295–302. Available at: http://toc.proceedings.com/31816webtoc.pdf

[23] Pohrebennyk, V., P., Koshelnik, O., Mitryasova, E., Dzhumelia and M., Zdeb 2019. Environmental Monitoring of Soils of Post-Industrial Mining Areas. *Journal of Ecological Engineering* 20(9): 53–61. DOI:https://doi.org/10.12911/22998993/112342

[24] Schickele, A., B., Leroy, G., Beaugrand, P., Francour, and V., Raybaud, 2020. Modelling European Small Pelagic Fish Distribution: Methodological insights. *Ecological Modeling* 416. DOI:https://doi.org/10.1016/j.ecolmodel.2019.108902

[25] Snizhko, S. 2004. Theory and methods of analysis of regional hydrochemical systems, K.: Nika-Center, 394 p. (Teoriia i metody analizu rehionalnykh hidrokhimichnykh system, K.: Nika-Tsentr, 394 s.) (in Ukrainian)

[26] Southen Buh River Basin Management in Mykolaiv Region. Available at: http://www.vodhoz.com.ua/water_resources

[27] Staddon, C. 2016. Managing Europe's Water Resoirces: Twenty-first Century Challenges, UK, University of the West of England, 279 p.

[28] Tanriverdi, Ç., Alp A., Demirkiran, A.R. and Üçkardeş, F. 2010. Assessment of Surface Water Quality of the Ceyhan River basin, Turkey. *Environmental Monitoring and Assessment*, 167(1–4): 175–184. DOI:https://doi:10.1007/s10661-009-1040-4

[29] Tha, Th., Piman, Th., Bhatpuria, D. and Ruangrassamee, P. 2022. Assessment of Riverbank Erosion Hotspots along the Mekong River in Cambodia Using Remote Sensing and Hazard Exposure Mapping. *Water* 14(13): 1981. DOI: https://doi.org/10.3390/w14131981

[30] Thuy, P.T.T., Viet, N.V., Phuong, N.K.L. and Lee, C.H. 2021. Water Quality Assessment Using Water Quality Index: a Case of the Ray River, Vietnam. *TNU Journal of Science and Technology*, 226(06): 38–47. DOI: https://doi:10.1007/s10661-009-1040-4

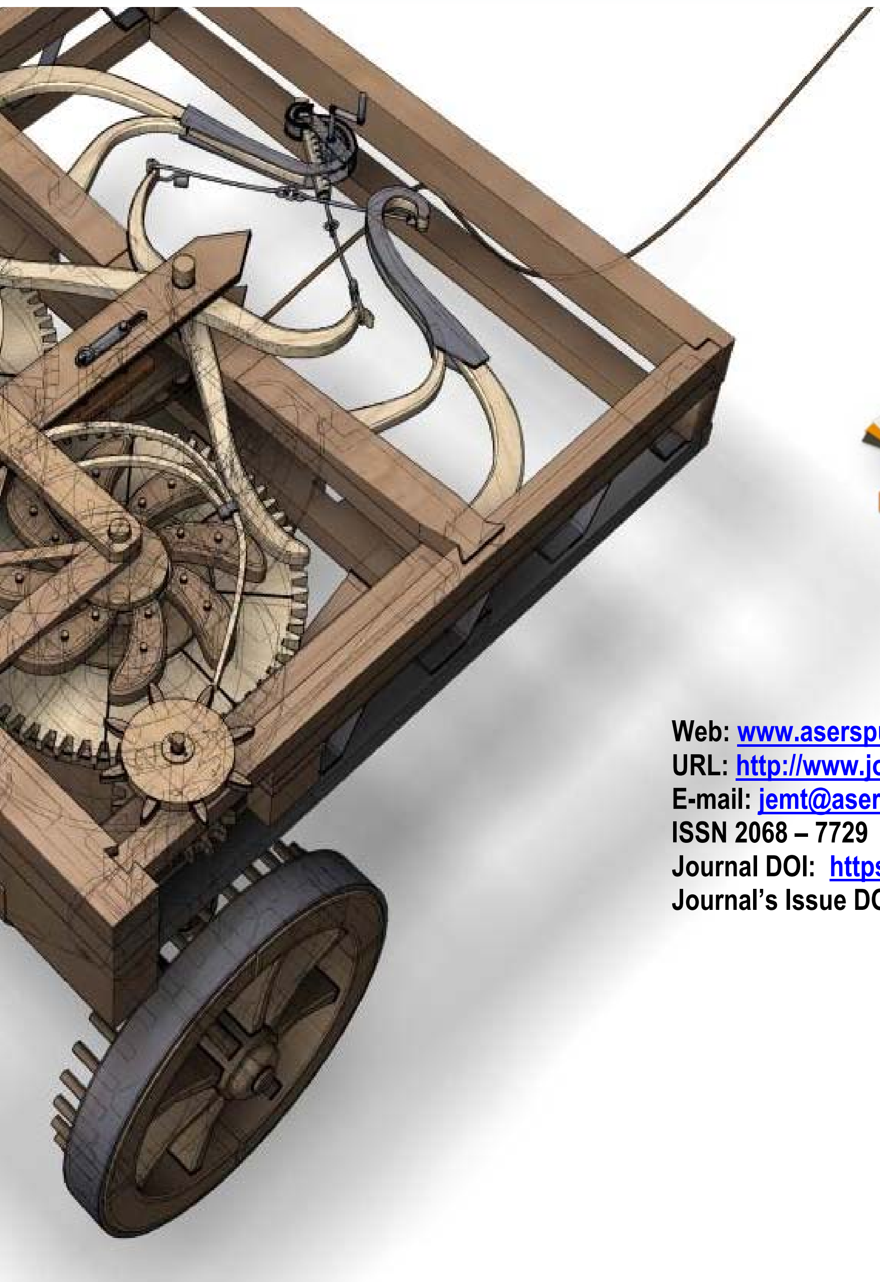
[31] Vasenko, O., Rybalova, O. and Korobkova, G. 2016. Determination of Ecological Standards of Surface Water Quality Taking into Account Forecast Models and Regional Features. *East European Scientific Journal*, 8 (12), 3: 5-13. (Vasenko, O.; Rybalova, O.; Korobkova, H. 2016. Vyznachennia Ekolohichnykh Normatyviv Yakosti Poverkhnevykh Vod z Urakhuvanniam Prohnoznykh Modelei ta Rehionalnykh Osoblyvostei. East Europian Scientific Journal, 8 (12), 3, 5-13.) (in Ukrainian)

[32] 7th Environment Action Programme. 2013. Access mode: https://www.eea.europa.eu/policy-documents/7th-environmental-action-programme

[33] Directive 2000/60/EC of the European Parliament and of the Council, 2000. Available at: https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=celex%3A32000L0060

[34] Directive 2010/75/EU of the European Parliament and of the Council of 24 November 2010 on industrial emissions (integrated pollution prevention and control). 2010. Available at: https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=celex%3A32010L0075

ASERS



ASERS Publishing

Web: www.aserspublishing.eu
URL: http://www.journals.aserspublishing.eu/jemt
E-mail: jemt@aserspublishing.eu
ISSN 2068 – 7729
Journal DOI: https://doi.org/10.14505/jemt
Journal's Issue DOI: https://doi.org/10.14505/jemt.v14.5(69).00