ECOLOGICAL AND ECONOMIC CONSIDERATIONS FOR WATER RESOURCES AS WATER CAPITALS /THE CASE OF FISH TOXICOLOGY IN THE "VITA PLUS" PROJECT/

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Abstract: This paper is focused on presenting some ecological and economic aspects related to reconsider water resources as water capitals, in the forthcoming concept of introducing bioeconomy in the new EU sets of strategies, policies, and regulations. **Financing** of this paper is provided by the "Vita Plus" project (2021-2022) – a transdisciplinary project, executed by researchers of the University of Plovdiv. **The object** of this paper is to conduct a research and demonstrate through the "Vita Plus" project-complex methods of detecting toxicity in waters. Furthermore, **the focus** of the paper is to provide an adequate model for measuring toxicity levels of waters by conducting reliable toxicology research on fishes from polluted waters. **We aimed to** set a reliable laboratory practice, which may be utilized to deliver comparable indicators, as prescribed by EU policies and regulations in the forthcoming programming period 2021-2027, as there will be a general shift towards circular economy of no to minimum waste in nature.
Keywords: EU Water Framework, EU Directives, bioeconomy, circular economy, water resource/s, water capital/s, polluted waters, waste waters management, pollution, pollutants, fish toxicology, pesticides, biomarkers, bioremediation

1. INTRODUCTION

Introduction of new standards in economic activities is a global trend to protect our planet and safeguard nature. This call for changing for good our daily habits and business patterns has been translated into shifting economic societies to adopt bioeconomy as a sustainable mode of comforting the dynamics of plant, animal, and human behaviors. Taking into consideration the anthropogenic factor, as the main driver for polluting environment, it is noteworthy to build a sustainable nature-aligned model for economic and social interactions. This leads to adopting new and reliable methods of delivering ecological and economic evaluations of productivity of ecosystems, climate regulations, waste management policies, including waste waters management regulations, and other environmental considerations. These are issues of day, related to preserving sustainable biodiversity and diminishing human imprint on nature, including preserving air, soils, and waters clean. Thus, one of the central themes worldwide is the issue of preserving waters clean, as they are considered to have significant impact upon sustainability of ecological systems, and upon human health.

Following global and EU recent strategies and regulations, national policies of water management of Bulgaria in the recent years are also a subject to alarming consideration, related to delivering greater institutional, business, academic, and civil awareness on the ecological and economic impact on waters. In recent years there is a distinct dichotomy of how waters shall be treated – as "water resources", or as "water capitals". Standing on the viewpoint that waters are "resources", it is necessary to adopt the concept of freshwater depletion and scarcity; while – taking the side that waters are "capitals", it is a sign of introducing perspectives that things are reversible and sustainable models of balancing economic and ecological interests are available. Thus, the present research is centered upon demonstration of delivering toxicological analyses of fishes, which may assist experts in determining the nature, characteristics, and sources of contamination of certain water basins. This, on its turn, will provide policymakers and different stakeholders with reliable tools to design appropriate and adequate policies and decisions for preserving waters and nature, in general.

2. NATURE OF THE RESEARCH AT THE UNIVERSITY OF PLOVDIV "VITA PLUS" PROJECT

As it was mentioned, the discussion of this passing decade was whether waters are "resources" or "capitals". For example, there are some analysts (Paul, 2017), who stand on the position that water is the key resource required to sustain life on this planet and it is important to both society and ecosystems. In addition, other analysts (Lomsadze et al., 2017) do consider that freshwater is the most important resource for mankind, crosscutting all social, economic and environmental activities. However, on the other hand, it was the Honorable Ban Ki-moon, the UN Secretary-General (UN Secretary-General, 2012), who stated that "human capital and natural capital are every bit as important as financial capital", equating financial capital to natural capital to human capital. Therefore, as waters are part of the "nature capital", it is reasonable to introduce and stand on the position that "water capitals" is the most appropriate term for the forthcoming age of shifting from classical economic paradigms to bioeconomy. Furthermore, there are some analysts (Vladikov & Arnaudova, 2019), who also support the term "water capital", as waters – if smart-managed may bring economic values and business capitalization to all sectors of an economy. Waters are needed for sustainable agriculture, fisheries, aquacultures, energy production, recreational activities, and surely – for industrial needs. On the other hand, it is of no question that humans depend on reliable and clean supply of drinking water to enjoy healthy lifestyles. However, in recent years, water contamination has been considered a global, EU, and a national issue.

Focusing on EU level – there is an EU Bioeconomy strategy (European Commission, 2018), which gives way to the new shift to bioeconomy to all EU member-states to go "green" and think of the nature first. Speaking of observing nature clean, there is a serious room for discussions on pesticides as pollutants. According to the EU Environmental Protection Agency (EPA) pesticides are the group of chemical substances, which are being used to control and repel the pest population. Also, pesticides are defined as chemicals, as well as natural agents applied to control or kill the harsh pests like harmful insects, organisms causing plant diseases and weeds (Rani et al., 2021). However, employment of pesticides in farming could contaminate surface waters through draining, drift, runoff, and leaching. Thus, contaminated surface waters have adverse effect on living organisms (Bachmat et al., 1994; Rani et al., 2021); this, also, decapitalizes water-dependent businesses, as more complex and expensive wastewater management processes and installations are needed. Therefore, to maintain waters and extract individual, industrial, and ecological gains – adequate quality standards shall be maintained. This is critical not only for industrial enterprises, or farms and fisheries ponds, but also to humans, ecosystems, and biodiversity.

For instance, global figures demonstrate that two-thirds of world consumption of fresh waters is due to agricultural businesses in 2010 (Weizsacker & Wijkman, 2018, p. 174). Further economic data demonstrate that for the preceding 50 years the population on Earth increased 5 times, while global economic turnover increased 40 times; at the same time, the global fish catch increased 35 times, and global consumption of water – 9 times (ibid, p. 45). Hence, it is essential to provide a global institutional approach and a framework of coherent activities and prescriptions, which shall keep nature and waters safe and preserve the intrinsic economic values they contain.

Taking into consideration that Bulgaria is a full-member state of the EU, it is worth mentioning that all EU member-states have national water agencies, which strictly follow EU policies and regulations, set by the EU Water Framework and the corresponding Directives and Documents (Directive 2000/60/EC; Directive 2008/105/EC; Directive 2008/56/EC; European Communities Environmental Objectives 272/2009; European Commission Technical Report, 2014. As some analysts earlier stated these set of documents are to implement regular water monitoring with the aim to control and prevent pollution (Milačič et al., 2017).

Bulgaria, as a EU member-state has also a significant corpus of legal documents. For example, Bulgaria adopted the above-mentioned EU Directives, including adoption of a Plan to execute Council Directive 91/271/EEC, concerning urban waste-water treatment. Also, the country recently modified the Law on Environment Protection, and the Law on Waters – both amended in 2018, to align to best EU legal standards and practices. The country also adopted two plans – the Plan for River Basins Management /2016-2021/ and the Plan for Risk Management of Floods /2016-2021/; there is also adopted a National Strategy for Management and Development of the Water Sector in Bulgaria /2013-2037/.

Having into consideration all the legal documents in force, thus, the scope of the research at the "Vita Plus" project is to investigate influence of the dynamics of living organisms, quality of environment, and anthropogenic factor on polluting waters by conducting toxicology analyses on fishes. It must be mentioned that from scientific point of view, the use of living organisms in the study of environmental quality is widely accepted (Stamenković et al., 2013). In addition, it is well-reasoned in some reviews (Yancheva et al., 2015, 2016) why fish is deemed to be the major vertebrate model for eco-toxicology modelling. Fishes are among the group of aquatic organisms, which represent the largest and most diverse group of vertebrates. Virtually, they are present in all environments; and many species have been found to be susceptible to environmental pollutants (Van Der Oost et al., 2003).

Furthermore, a great number of characteristics make fish excellent experimental models for toxicological research, especially for the contaminants, which are likely to exert their impact on aquatic systems (De La Torre et al. 2010).
For instance, according to some researchers (De La Torre et al., 2005) monitoring sentinel fish species is widely used to assess the degree of health status. Thus, at "Vita Plus" project, combined ecological and economic expertise is deemed to provide sustainable modelling on designing modern water management policies and safeguard health of humans, plants, animals along with adding greater economic benefits to preserved or purified waters, in order to capitalize upon their intrinsic value.

3. IMPORTANCE OF THE SCIENTIFIC PROJECT

Global figures demonstrate that according to some analysts (Chivian & Bernstein, 2008), there global fish catch was about 130 million tons of fisheries, and approximately 100 million tons of them were maritime catch, while the other 30 million tons were fresh waters catch. Also, some other data demonstrate that wildlife fish catch is often converted to commercial fish meal (Gross, 2008). More recent data demonstrate that the global fish catch increased to 179 million tons in 2018, estimated at approximately 400 billion worth US dollars at first sale, of which 156 million tons are deemed for human consumption (FAO, 2020). These global figures demonstrate that human health status may be strongly dependent of fish health status on the one hand, and the capacity to regenerate clean waters and reuse them again in the circular economy. Therefore, it is of high importance to comprehend the magnitude of the possible application of the method of detecting fish toxicology, as it directly relates to draw sound conclusions on the status of the water basin, on environment, on human health status (if fish is consumed), and on enterprises' propensity to enter the paradigm of bioeconomy.
Retrieving reliable data results of any contents of pesticides in the waters is crucial to comply to the legal set of indicators in force; thus, these indicators shall be strictly observed in all lab tests and studies. The greatest challenges are because although there is some legal set of documents in force, there are no specific stipulations, which refer to regulating the residues of the active substances of the pesticides above the thresholds of pathological changes. Furthermore, there is no control and assessment of the degree of impact of widely applicable pesticides on the aquatic environment. It is therefore important to assess the risk of application of different pesticides, based on their bioaccumulation potential in relevant organisms and the subsequent biomagnification at trophic levels. That is why, it is crucial to develop a model for assessing aquatic ecosystem pollution with application in monitoring and agricultural practice. This model is deemed to be constructed to comply to the legal basis, regulating the presence of organic pollutants in aquatic ecosystems. This is the cornerstone of the research, conducted within the "Vita Plus" project.
Speaking in terms of the scientific tool, aiming to investigate this problem it may be clearly stated that there is an increasing number of studies, related to the use of histological biomarkers. This is executed so, as histological biomarkers indicate more correctly the health status of fish – compared to other methods, which might be employed. In addition, histochemical changes associated with a change in the amount of glycogen and lipids in the hepatocytes, serve as an indicator of the change in carbohydrate metabolism, due to pesticide contamination (Stoyanova et al., 2019; Yancheva et al., 2019). To substantiate the tests, changes in the hepatic enzyme activity can be successfully used as reliable biomarkers, associated with aquatic environmental contamination. As a result of the study, the change in their activities serves as a diagnostic index of the impact of pollutants. This is one of the fastest growing areas of aquatic ecosystems monitoring. We consider that the disturbances in the specific enzymatic activity could be applied as indicator of the metabolic disturbances and oxidative stress (Stoyanova et al., 2020).

4. METHODOLOGY - RESEARCH DESIGN AND DATA COLLECTION

From methodological point of view, the research design and data collection are based on biomarkers data. For instance, a biomarker of exposure is a xenobiotic substance or its metabolite(s), or the product of an interaction between a xenobiotic agent and some target molecule(s) or cell(s) that is measured within a compartment of an organism (NAS/NRC1989). The preferred biomarkers of exposure are generally the substance itself or substance-specific metabolites in body tissues and fluids. Depending on the properties of the substance (e.g. biological half-life) and environmental conditions (e.g. duration and route of exposure), the substance and all of its metabolites may have left the body by the time samples can be taken (Napierska et al., 2018). Thus, data collection is based on biomarkers' data, which are to be retrieved by verifiable biological modes of operations and research. Then, collected data panels are analyzed to diagnose, investigate, compare, and summarize aggregated data by scientifically comprehensive equipment to produce the final output of research. For example, there could be measured the levels of toxicity of pesticide mixtures in environment. Hence, toxicity of pesticide mixtures in environment will depend on bioavailability and chemical reactivity of the compounds, detected in laboratories.

Since there is large number of contaminants, which makes it impossible to perform eco-toxicity tests for each potential mixture – a robust approach for prospective environmental risk assessment of chemical mixtures is to be executed. Application of such a complex research is necessitated by the need to develop a reliable model for pollution assessment of aquatic ecosystems with organic pollutants. This model can be applied both in water monitoring and in agricultural practices, to provide an adequate legal basis for indicating the presence of organic pollutants in aquatic ecosystems and modifications under concentrations equal to those permitted under European and Bulgarian legislation (Stoyanova et al., 2020).

On the other hand, bioremediation of hazardous wastes is a relatively new technology that has undergone more intense investigation as of recent years, which generally have a high public acceptance and can often be carried out on site (Wang et al., 2018; Vidal, 2019). Bioremediation is an option that offers the possibility to destroy or render harmless various contaminants using natural biological activity (Kralj et al., 2007; Derbalah et al., 2013). Various types of remediation techniques are being used to overcome the issues caused by pesticides in contaminated environment (Rani et al., 2021).

Our opinion agrees with Rani et al. (2021) that different stakeholders, such as environmental protection organizations, academia, research organizations, farmers, health officials, pesticides manufacturers, and government authorities must come forward to find a solution to efficient management of pesticides and its toxicity regulations. Therefore, collaboration between different stakeholders will help reduce the risks of pesticide toxicity on living organisms, as well as on environment.

5. CONCLUSION

In summation, traditional ecological and economic assessment models shall be subject to reconsider, as new methods and standards are adopted to search for adequate solutions, related to solving the problem of polluted waters. At present, quality standards and quality assurance of waters, utilized for different purposes – may be defined by legitimate provision of toxicological tests of fish catch. These tests may serve to assess nature and levels of water pollution as well as characteristics of pollutants. This necessitates cardinal reasoning on the anthropogenic factor impact on nature and waters, as bioeconomy is fostering regenerative forms of capitalism, which are deemed to allow regeneration of ecosystems in nature, including water ecosystems. Environmental and water regeneration are taken to stand as pillars of economic capitalization, as safe waters provide safe businesses, and safe health standards of human beings, as well as other beings – plants, fishes, animals.

Test toxicology results are deemed to turn into a reliable policy-making tool to provide an integrated and intelligent water management policies for the benefit of society, animal, and plant kingdoms, as well as industrial advancement of modern economies, based on circular economy models. Therefore, possible inter-related topics for further investigation may be of various nature, in dependence for the problem-solving issue. Such issues are strongly related to spillover effects, analyzed by the water sector economics, to sanitation and public health concerns, to hydraulic infrastructures, installations, and pipelines for water management and purification, to eco-hydrological externalities, and many others sub-sets of the overall water capital management in a country.

The nature of strategic priorities and recommendations, which might result, due to implementation of this scientific transdisciplinary approach – relates to creation of a special "package of measures", which public stakeholders and interested parties may consider to engage with. For example, this directly correlates to rethinking the way available information resources, databases, maps, registry systems, and other depository registries for availability of contaminated waters are designed and maintained, at present. Further research may demonstrate that "internet of the things" and "big data" tools are to be utilized to analyze in real-time different algorithms of quick and reliable testing procedures on fishes whether waters are environmentally safe. Also, future research may reshape the way of thinking about potable, irrigational, and industrial waters, as specialized software could be connected to modern media and communicate and signal immediately for any disturbing processes and alarming levels of pollutants. Thus, construction of methodologically sound toxicological fish tests may turn into a competitive tool for delivering environmental, social, and economic policies.

It is of no doubt that establishing a modern system of water management, monitoring and controlling is of increasing importance to designing adequate national policies and decision-making on preserving and regenerating nature capital in a natural way.

Overall, this ecological and economic consideration~~s~~, adopted in the "Vita Plus" project could possibly serve as a good point of reconsidering waters as water capitals and the benefits and gains, which clean waters bring to all economic systems and living organisms.

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