IMPLEMENTATION OF THE WATER DIRECTIVE IN SLOVENIA (SELECTED CASES)

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The paper presents the Water Framework Directive (Water Directive), which is a strategic document for water management (in Slovenia since 2004). As this document is little known to the general public, including geographers, in the first part of the article we analyzed the composition of the Water Directive and in the second presented the implementation of this document in the case of selected water bodies in Slovenia. The geographical role in the implementation of the Water Directive is to respect the terminology prescribed by the EU with the Water Directive, to carry out field measurements in accordance with the required parameters and to interpret the results, which must be comprehensive and refer to the entire aquatic ecosystem. The importance of the article is in the awareness that geography must immediately become involved in the implementation of strategic documents and thus increase its influence in interpreting landscapes, which is its primary mission.

Key words: European Union, aquatic ecosystem, Water directive, water body, Slovenia.

INTRODUCTION

The purpose of the Water Directive is to establish a framework for the protection of inland surface waters, brackish waters, coastal waters and groundwater. In order to comply with the Water Directive, Slovenia has prepared and adopted Water Management Plans (WMP) and Water Management Measures Programs (WMMP) for each watershed. The preparation of action programs had to include basic and, if necessary, complementary measures. Basic measures are those measures that a Member State must comply with. They apply to the minimum requirements. They must comply with the requirements of the other Directives set out in the Water Directive (Annex VI, Part A). Complementary measures are understood to mean all those measures that are implemented further in order to achieve the objectives of the Water Directive.

Water management and management of waterlogged and coastal land include water protection, water planning and water usage decision making. This law also regulates the public goods and public services in the field of water, water objects and facilities and other issues related to water (Zakon o vodah ZV-1, 2002). As an EU Member State, Slovenia is also obliged to comply with legislation in the field of water protection issued by the European Parliament. On 22 October 2000, the latter adopted the Water Directive 2000/60/EC (Directive 2000/60/EC of the European Parliament and of the Council of 23 October 2000 establishing a framework for Community action in the field of water policy). The directive was published in an EU official journal on 22 December 2000 and has entered into force on that date. Some changes to the Water Directive were added later (The EU Water Framework Directive – Integrated River Basin Management for Europe, 2016). As part of the implementation of the Water Directive, Slovenia issued Water Management Plans in 2009. It is a national document that defines the management of water policy in accordance with the objectives and principles of the Water Directive (Upravljanje voda v Sloveniji, 2011). As Slovenia comprises of two watersheds (the Danube river watershed and the Adriatic Sea watershed), the Water Management Plans are prepared in six-year cycles for each watershed. Bizjak (2008), who was leader of of the WMP, wrote what is the main environmental objective of the Water Directive: "The environmental objective of the Water Directive is to achieve good status of all waters in the EU by 2015, with conditional exceptions by the year 2021, or by 2027 at the latest". In this context, protection or preservation of inland surface waters, brackish waters, coastal seas as well as especially groundwater is intended (Upravljanje voda v Slovenji, 2011). It is important that the Water Directive is based on the holistic principles, cooperation between responsible decision makers and public participation, which is seen as the basis for achieving the desired goals in improving the status of water (Skupna skrb za trajnostno in celovito upravljanje voda, 2007).

Water status is monitored separately for surface and groundwater. For surface waters, their ecological and chemical status is monitored, and for groundwater the volume or amount and chemical status of water is monitored. The chemical status and amount of groundwater are classified into two classes. These are good or worse. The ecological status of surface waters can be classified into five classes: very good, good, moderate, worse, bad. For the chemical status of surface waters, however, two classes are used to describe the condition, namely good or good status has not been achieved. Based on the results obtained and the classes identified, maps of ecosystem are then drawn (Vodna direktiva 2000/60/ES, 2000).

The full implementation of the Directive is a process that involves many factors. From initial characterization (identification of water bodies, assessment of current loads of an aquatic ecosystem, economic assessment), evaluation of results, classification of surface water bodies by ecological and chemical status to implementation of measures. All with the aim of reducing pollution of water bodies and achieving the goal of good status of aquatic ecosystems. Particularly important is the cooperation of Member States in shared aquatic ecosystems, since otherwise objectives are difficult to achieve (Globevnik, 2006).

METHODOLOGY

The purpose of the paper is to contribute to the identification of the strategically important document Water Directive (originally Water Framework Directive WFD) based on different aquatic ecosystems. In selected cases, we have verified and explained compliance with Water Directive 2000/60/EC in 2019, that is, 15 years after this document entered into force setting out the management of aquatic ecosystems in Europe.

The main objective of the research is to use the Water Directive to check the status of five selected water bodies (pond Gaj, Sestrško lake, Bistrica stream, Dravinja river and spring of Topli stream in Studenice) and compare the results of measurements taking into account the Water directive.

The goals we have pursued are as follows:

1. identify the types of water bodies,
2. analyze the biological elements of water quality of surface ecosystems,
3. analyze the hydromorphological elements of water quality of all four surface ecosystems,
4. measure the physicochemical elements of water quality,
5. analyze the chemical status of the underground ecosystem,
6. determine the quality classes of individual aquatic ecosystems based on the results obtained.

IMPLEMENTATION OF THE WATER DIRECTIVE IN SLOVENIA

Slovenia has coordinated its WMP with neighboring countries for the Sava and Danube rivers. All biological elements of quality were monitored on aquatic ecosystems. The exceptions were fish in lakes and in the Adriatic watershed and macrophytes in some rivers. Hydromorphological elements of quality were not included in the monitoring. The methods are not related to sensitive biological elements of quality. There is still very little monitoring in rivers and lakes regarding fish classification and hydromorphological quality elements. There are gaps in the standards set for general physicochemical elements of quality for rivers and coastal waters, and some do not comply with the moderate limit of the relevant sensitive biological elements of quality. Surface water bodies are classified according to their chemical status, except for one. Between the two WMP, there was a decrease in the share of surface water with good chemical status from 95% to 0.6%, and an increase in the proportion from 5% to 99% in aquatic ecosystems that do not achieve good status. The reason is the additional monitoring of the mercury parameter in the second WMP. As much as 100% of groundwater has a good amount status. 1/3 of the bodies are still not subject to monitoring of amount, but the assessment of the status is based on direct and indirect monitoring methods (hydrological and meteorological parameters are also taken into account). Depending on the groundwater chemical status, all groundwater bodies are monitored. All substances that cause deterioration of the chemical status of underground bodies are monitored. The situation has improved compared to the first management cycle. The number of bodies that did not reach the appropriate chemical status decreased from 4 to 3 compared to the two cycles (SWD (2019) 55 final, 2019).

Implementation of the Water Directive in neighboring countries

Like Slovenia, the implementation of the Water Directive had to be addressed in other EU countries, including neighboring countries Austria, Italy, Hungary and Croatia.

Austria is working with neighboring Members on the Danube, Elbe and Rhine ecosystems. In the planning of the WMP, Austria included different groups. They use variety of websites to inform the public, thereby seeking the attention of the general public to participate. The WMP was delayed. The proportion of rivers covered by monitoring increased from 6% to 20% compared to the first management cycle. Austria has not issued individual operational monitoring programs for lakes, but all lakes that are ecologically deteriorated are included in monitoring. In Austria, all biological elements of quality are monitored in all rivers and lakes at specific locations. The same applies to hydromorphological elements of quality. The report also cites chemical pollution of ecosystems, which, however, did not affect biological measurements. In the second WMP, Austria also monitored the environmental standards for mercury, which in turn reduced the proportion of surface water bodies with good chemical status from 99% to 0% compared to the first WMP. The proportion of water bodies that do not achieve good status has also increased from 0.2% to 100%. Looking at groundwater, the proportion of those monitored has increased. In the second management cycle, 17 groundwater bodies were not monitored because they did not have access to the measuring sites. The quantitative assessment was therefore based on an experimental water balance. In total, 98% of groundwater bodies were directly monitored, but it is clear whether all parameters were monitored (SWD (2019) 64 final, 2019).

Based on comprehensive report sent by Austria to the EU, the Commission then wrote up recommendations for Austria to follow in the preparation of third management plans in order to achieve the desired environmental status.

Individual water bodies or areas are evaluated against the elements mentioned above. The results shall be presented in the form of a map showing the ecological status classification for each water body and divided into classes from the Water Directive.

Color scale of water bodies classification by ecological status

Ecological classification	**Color scale**
Very good	**Blue**
Good	**Green**
Moderate	**Yellow**
Worse	**Orange**
Bad	**Red**

Source: Vodna direktiva 2000/60/ES, 2000.

If a water body complies with all the environmental quality standards set by the relevant legislation, we designate it as a body that has achieved a chemical status. For the chemical status, the results are also presented in the form of a map showing the chemical status for each water body.

Color scale of water bodies classification by chemical status

Chemical classification	**Color scale**
Good	Blue
Good status has not been achieved	Red

Source: Vodna direktiva 2000/60/ES, 2000.

Assessment of watercourses in relation to the Water Directive – groundwater

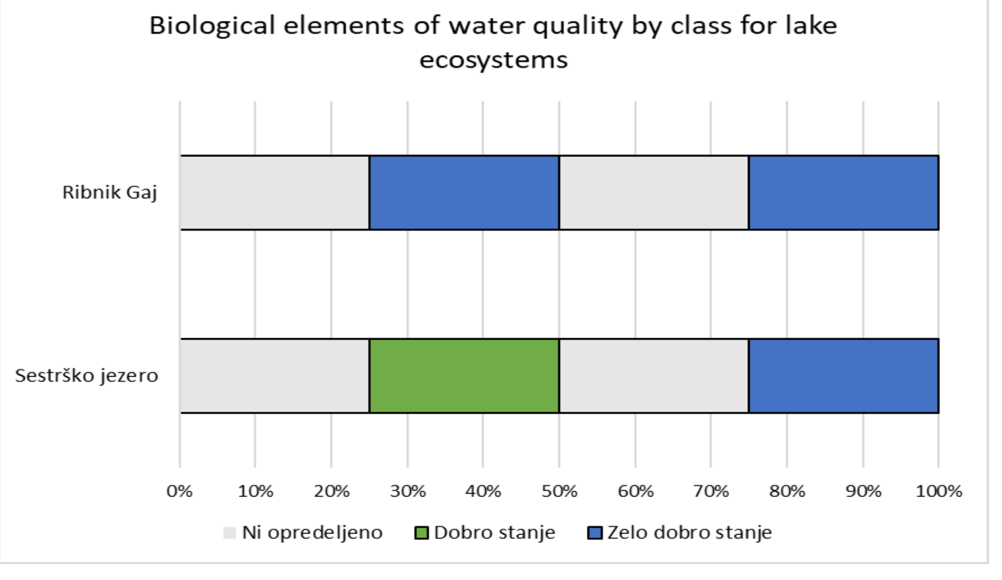
In the case of groundwater, the identification of all groundwater bodies must first be carried out. Individual groundwater bodies can be grouped together. Numerous existing hydrological, geological, pedological and land use data can be used. However, data for each groundwater body are urgently required.

The main parameters for determining the chemical status are electrical conductivity and pollutant concentration.

ACHIEVING THE WATER DIRECTIVE IN SLOVENIA ON SELECTED CASES

The method used for graphical presentation of data is used in various Slovenian documents that show the results of analysis and the status of aquatic ecosystems according to the indicators required by the Water Directive. Measurement results are displayed by quality classes using graphs showing the results by percentages or shares of measuring points in different quality classes. An example is found in the document Kakovost voda v Sloveniji (Ambrožič, Svitanič, Dobnikar Tehovnik et al., 2008) and shows the chemical status of watercourses in Slovenia between 2002 and 2006. Another illustrative example is from a press release issued by the Ministry environment and space on 10 May 2019, and shows the ecological status of surface waters at European level.

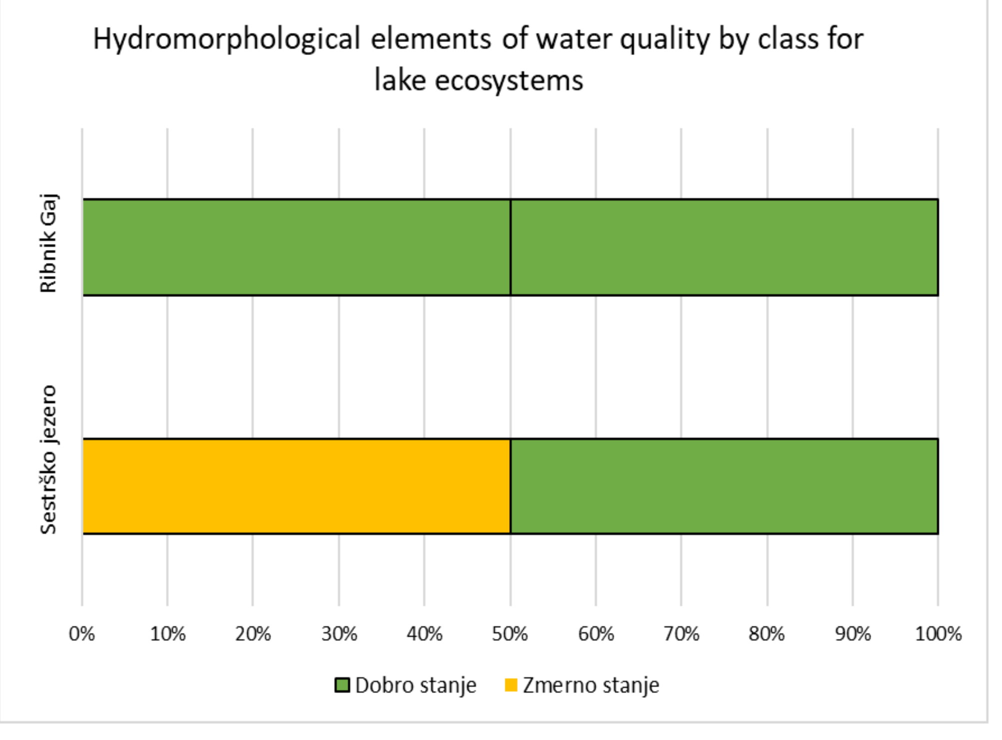
As mentioned in the introductory chapter, in surface waters ecological and chemical status is monitored. We basically analyzed only the ecological status, since we did not have sufficient equipment to determine the chemical status in more detail.



Graph 1: Biological elements of water quality by class for lake ecosystems

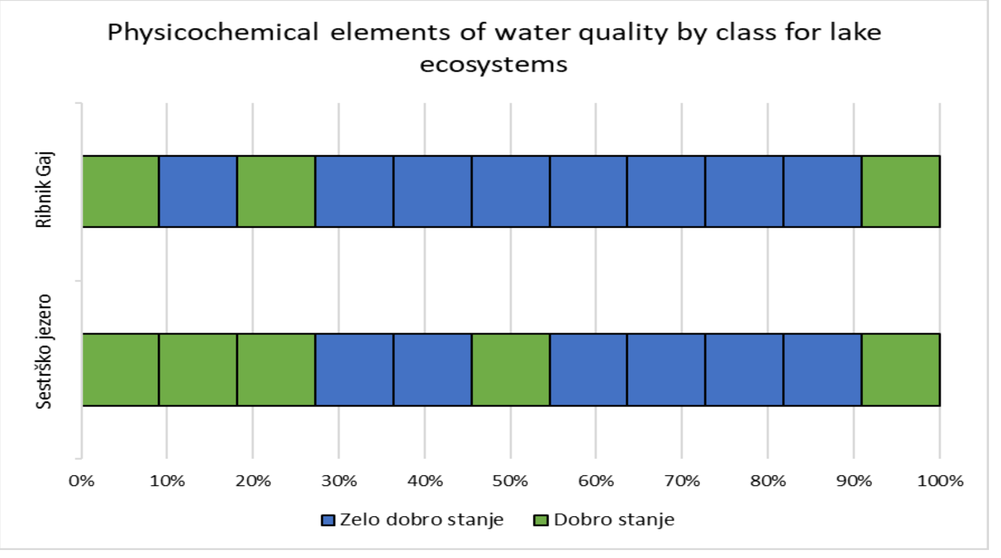
Graph 1 shows the biological elements of water quality by class for the lake ecosystems of pond Gaj and Sestrško Lake. The percentages (%) represent the proportions of individual classes according to the results obtained, which are defined in the Water Directive. The graph shows that no lake ecosystem defines the phytoplankton categories and the composition and abundance of benthic invertebrates (gray). According to the results obtained, the composition and abundance of other aquatic vegetation classifies the pond Gaj in the class for good status of the ecosystem (green) and the Sestrško Lake in the class for very good (blue). Both lake ecosystems are in very good condition in terms of the composition, abundance and age structure of the fish.

For the lake ecosystem pond Gaj 50% of ecological status surveys have no defined water quality classes due to inability to perform measurements, 25% of the ecosystem has good ecological status, and 25% of the ecosystem has very good ecological status. For the Sestrško Lake ecosystem, 50% of the surveys are not defined by water quality class, and 50% of the ecosystem has very good ecological status.



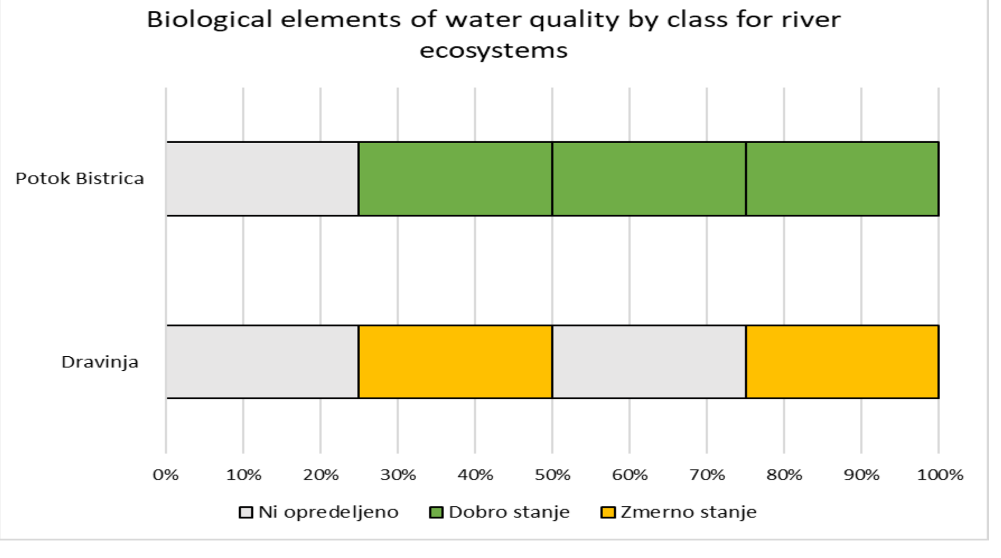
Graph 2: Hydromorphological elements of water quality by class for lake ecosystems

Graph 2 shows the hydromorphological elements of water quality for lake ecosystems, which are defined by two indicators, namely hydrological regime and morphological conditions. According to the results obtained, both ecosystems, have a good status of water quality. The pond Gaj also has good status with respect to hydrological quality elements, while Sestrško Lake has moderate status according to these indicators. In terms of proportions, we can see that the pond Gaj has 100% good status in terms of water quality, and Sestrško Lake has 50% (green) good and 50% (yellow) in moderate water quality in terms of hydromorphological elements.



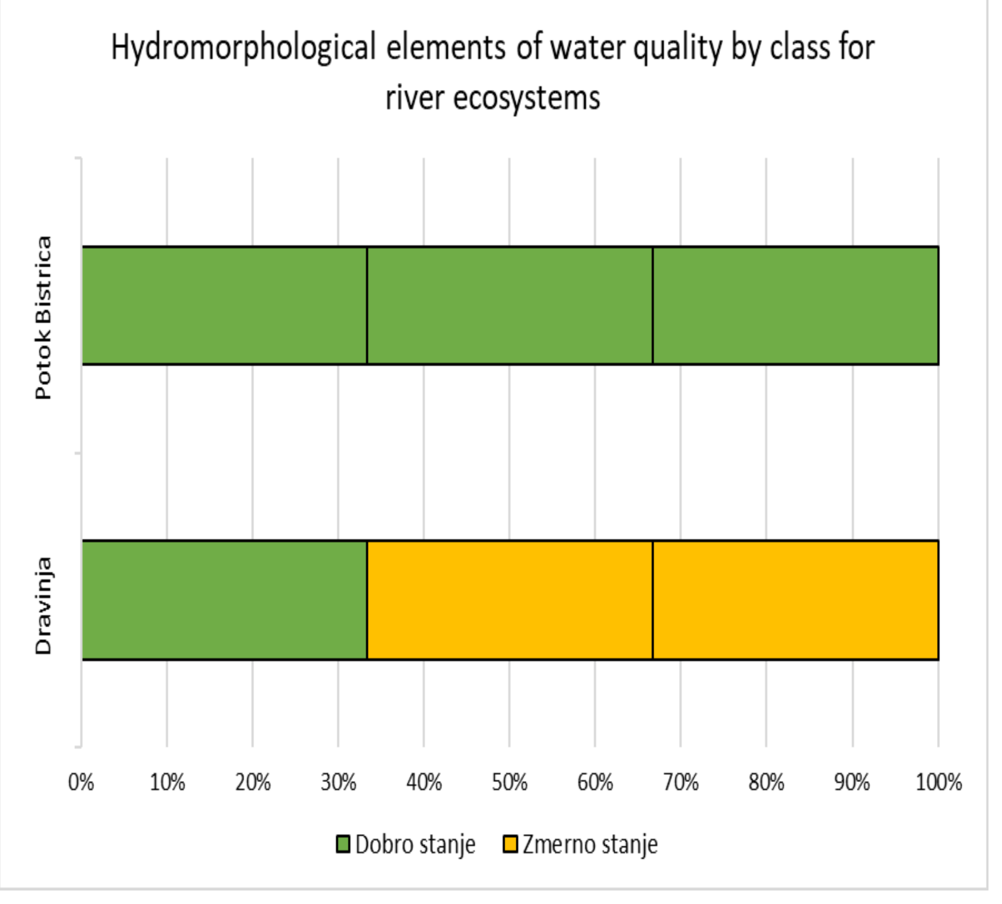
Graph *Error! No text of specified style in document.*: **Physicochemical elements of water quality by class for lake ecosystems**

Graph 3 shows the status of lake ecosystems with respect to the physicochemical elements of the analysis. 73% (blue) of the lake ecosystem pond Gaj belongs to the "very good physicochemical status" class, and 27% (green) to the "good status of the lake ecosystem" class. The picture is slightly worse at Sestrško Lake, as 55% of the ecosystem belongs to a very good quality class and 45% to a good quality class.



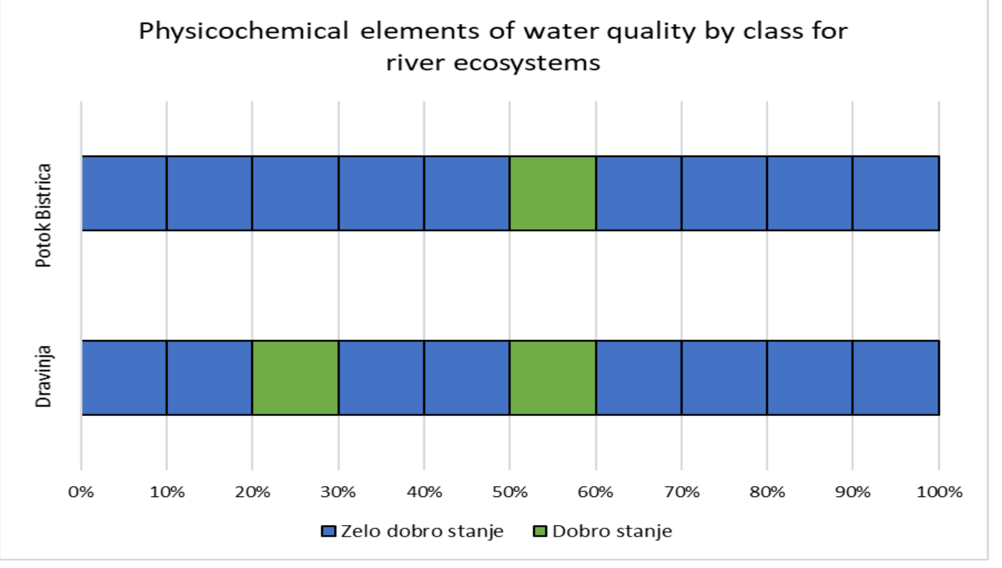
Graph 3: Biological elements of water quality by class for river ecosystems

Graph 4 shows the biological elements of water quality by class for the river ecosystems of the Bistrica stream and the Dravinja river. According to the measured indicators, 25% of the ecosystem of the Bistrica stream cannot be classified in any quality class. 75% of it belongs to the good status quality class. The Dravinja River does not have a defined quality class in 50%, and the other 50% of the ecosystem, according to the measured results, has a moderate status with respect to biological elements of quality.



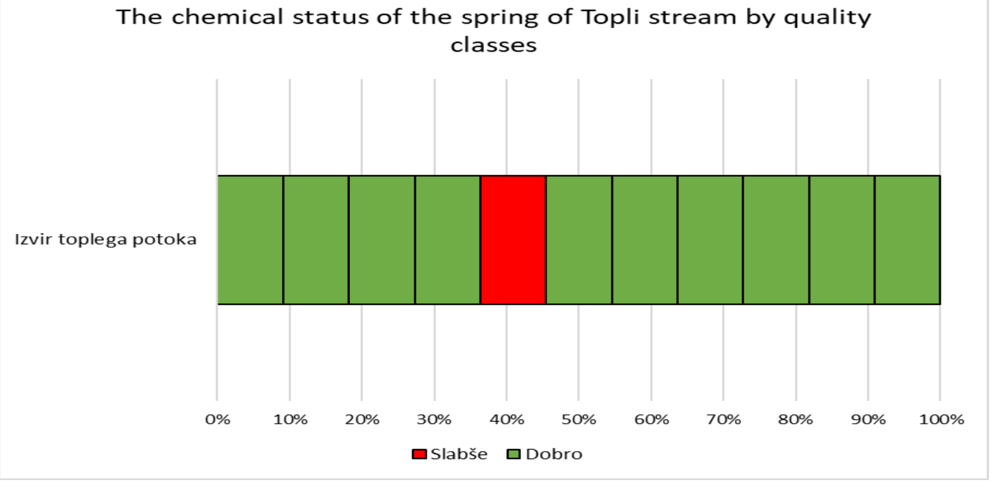
Graph 4: Hydromorphological elements of water quality by class for river ecosystems

The hydromorphological status of the river systems is shown in graph 5. According to all indicators, the Bistrica stream is in good condition - 100% (green) according to the indicators in the Water Directive defining the hydromorphological status. 67% (yellow) of the Dravinja River has moderate status and 33% (green) has good status according to hydromorphological indicators of water quality.



Graph 5: Physicochemical elements of water quality by class for river ecosystems

Graph 6 shows the physicochemical elements of the analysis according to the criteria defined in the Water Directive. According to the indicators, the Bistrica stream has very good status in 90% (blue). The situation is slightly worse for the Dravinja River, which has good status in 80% with respect to the physicochemical elements of the analysis.



Graph 6: The chemical status of the spring of Topli stream by quality classes

As mentioned above, in groundwater, two main parameters are assessed, namely the amount and chemical status of groundwater. In the case of the amount, for the spring of Topli stream can only be said by visual estimation that the amount of water abstracted is proportional to the amount of water available, so that no visible problems are encountered with this parameter.

When analyzing the chemical status of groundwater in the selected ecosystem, we can see that as much as 92% (green) of the analyzed aquatic ecosystem has good status according to the chemical quality indicators. 8% (red) shows the pH indicator, which classifies the aquatic ecosystem as worse. The culprit for measured value is most likely the bedrock on which the ecosystem flows.

By comparing the selected aquatic ecosystems, we can conclude that, in terms of the biological elements of quality, they mostly have very good, good or moderate status. No ecosystem is observed in very bad status, which does not mean that there is no possibility of improving the quality of water in ecosystems.

Considering the hydromorphological elements of water quality, all analyzed ecosystems have good or moderate status. To sum up, to a certain extent, in all these ecosystems the impact of humans that interfere with ecosystems can be seen, thereby deteriorating their normal functioning. Human impact on ecosystems is an important factor that can be completely contained and thus improve the status of ecosystems.

One of the major impacts on aquatic ecosystems is certainly the encroachment on the ecosystem, by releasing various types of sewage or waste, thereby greatly affecting the ecosystem from a physicochemical perspective. Considering the physicochemical parameters measured in all five ecosystems, the results are surprising. All ecosystems fall into quality classes that define very good or good status. This is certainly due to the fact that there are no large agricultural areas near the ecosystems. Settlements in the surroundings of ecosystems are quite dense, however, the greater influence of humans from a chemical point of view is not visible. So, ecosystems do not have bad status, which does not mean that any improvements are not be possible. The only indicator that represents a problematic aspect in groundwater is the pH below the prescribed standard, which is because the ecosystem has worse status. However, this is not a concern as the value of the indicator is probably due to the bedrock on which the water flows.

In summary, the analyzes that must be carried out on different ecosystems and are defined by the Water Directive are feasible in practice. All the analyzes were done with the help of home-made tools and instruments we borrowed from the faculty. The results obtained are very well comparable to those performed by other institutions or individuals before us. The problem arises with the somewhat more specific measurements required by the Water Directive (measurement of groundwater properties), where special instruments that are not easily available.

The presentation of results by classes in graphs is very transparent. Given the colors identified, we have full insight into what the actual state of an ecosystem is and what areas need improvement.

In the beginning, we had some difficulties in understanding the Water Directive. Because it is quite complex, we had to delve deeper into it in order to understand what it required. Basically, in some cases, there is a lack of interpretation of additional terms. analysis that are largely understandable only by experts in various fields. In general, the Water Directive could be simplified, as we have simplified it. In practice, we followed its instructions and performed analysis of selected ecosystems, which can be considered successful.

CONCLUSION

In geography, we still use the old notions of determining water quality, linked to the quantity of chemical compounds or to physical parameters, and then express the situation in four quality classes. This way of monitoring water is still in all textbooks and other educational materials. However, since the Water Directive has been in force since 2004 and it is being followed by all other disciplines, it is time for geography to take over the dictations and procedures contained in this strategic document. The article outlines the ways in which the Water Directive is applied and points out that cross-sectoral cooperation is needed. We have also found that, in particular, the use of physical and morphological features is in the domain of geography, and it is precisely in the implementation of the Water Directive that we see new opportunities for greater recognition of our geographical profession.

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