ECOLOGICAL STATUS OF UPPER PART OF ISKAR RIVER CATCHMENT ACCORDING REGULATION N4 BASED ON MACROZOOBENTHOS AND FISH FAUNA

Lyubomir Kenderov, Dimitriy Dashinov, Emil Kanev, Lyubomira Lyubomirova, Eliza Uzunova

Abstract: Recent information about the ecological status of upper part of Iskar River and some tributaries was given. Ecological assessment according WFD and national water legalisation (Regulation N4) was applied. For estimation of fish based indices (BRI and TRI) the following ichthyologic parameters were used: total abundance and biomass of ichthyofauna, abundance and biomass of *Salmo trutta*, occurrence of introduced species, sensitive and migrants. For calculation of BI and TTN indices were used taxa composition of the macroinvertebrate fauna. Ecological situation of Iskar River and tributaries was assessed as “high” according macroinvertebrate based indices and “moderate” to “bad” according fish based indices. Deterioration of ecological quality of lower river sites was recorded.

Keywords: ecological status, fishes, macrozoobenthos, Iskar River

INTRODUCTION

Iskar River is the longest Bulgarian river (368 km) and flows through highly urbanized regions (Sofia City) and agriculture territories (Samokov Valley, Sofia Valley, Western Danube Valley). The ecological status and water quality of Iskar River in its middle and lower reaches during the 70s to 90s of the 20th century has been very poor [6, 16,17, 19]. This is caused by the household water loading, industrial pollution (including heavy metals) and loading of nitrates and phosphates from agriculture [12]. The latest studies (2004 - 2006) show a significant improvement in the ecological situation [8]. The worst pollution (bad ecological status or polysaprobity) is limited only in the area downstream Sofia region. Along the lower part of the river, significant self-purification processes are realized (up to β-mesosaprobity). On the contrary, in the mountainous part of the Iskar River (Rila Mountain), the ecological situation has always been acceptable [9, 16]. The main tributaries that form the Iskar River are the Beli Iskar, Cherni Iskar, Levi Iskar, Maliovishka, Preka, Lopushka, Pravi Iskar, Lakatitsa, Musalenska Bistritza, as well as numerous smaller streams. The upper reaches of these rivers run through the territory of “Rila” National Park. The waters of some of them are included in a drinking water supply system. In the lower reaches of these rivers are situated small villages, several HPPs and numerous water abstractions. Consequently, the main negative factors that are expected to influence the ecological status in these mountain rivers are fragmentation and organic water pollution. The control of the ecological status of these river stretches is important because they have the meaning of drinking water (flow into the Iskar Reservoir) and on the other hand, they are valuable places for preserving biodiversity. In recent years there has been a growing tourist activity and construction of tourist complexes and local household pollution.

The aim of this study is to give recent information about ecological situation of mountain part of Iskar River catchment according different biotic indices using fish and macrozoobenthos communities.

MATERIAL AND METHODS

Sampling sites

For the purposes of this study we selected 17 sampling stations along the upper Iskar River and its tributaries (Fig.1). Sampling sites were selected according potential anthropogenic impact from villages and hydroengendering structures. The site codes and their geographical coordinates are presented in Table 1.

Fish sampling

Fish sampling was conducted during the low water level period (July-August-September, 2015-2016). For assessment of fish abundance electrofishing has been applied following the CEN standard [1]. A single electrofishing transect without block nets was applied in every testing site. Sampling transects were between 50 to 165 m long, depending on river width (which varied from 5 to 30 m). The total fishing area per site varied between 380 to 1100 m². The electrofishing was conducted from one bank to the other over the entire river stretch. The collected fish were counted and body mass was measured (total...
weight, $W$ in 0.1 g) \textit{in situ} and then returned to the locations of their capture.

The taxonomic status of the species was determined \textit{in situ} according to [10]. The conservation status was determined according to the Biological Diversity Act (OJ 77/2002), EU legislation and international conventions.

\textbf{Macrozoobenthos sampling}

Macroinvertebrates were sampled using hand net or Surber bottom sampler [4]. Up to 10 sub-samples in one site using the “multi-habitat approach” [5] were collected. Sampling of the predominant substrate - stones and gravel from up to 100m river sector in each site was preferred. Totally 19 macrozoobenthic samples were collected. Sampling was performed during June 2015 – August 2016.

\textbf{Data analyses}

The fish abundance was expressed as number of fishes caught per 1 ha and the biomass in kg per 1 ha. For sites located in river type R4 index BRI [11] was used. For sites located in river types R1 and R2 Trout River Index, TRI [15] was used.

Ecological assessment according macrozoobenthic community was done by metrics “Biotic index” (BI) and “Total taxa number” (TTN), Regulation N4 (OJ 22/2013). Metric ranges for river types “R2” (mountain rivers) “R4” (semi-mountain rivers) after national river typology [2] were used.

![Fig. 1. Site map of upper part of Iskar River catchment. (Site codes are explained in Table 1)](image)

\textbf{Table 1. Sampling sites of Iskar River catchment during 2015 - 2016}

<table>
<thead>
<tr>
<th>Sites (river, place)</th>
<th>Site codes</th>
<th>Geographic coordinates</th>
<th>Altitude (m)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Iskar River upstream Samokov Town</td>
<td>IR.S</td>
<td>N42.289183° E23.535658°</td>
<td>1035</td>
</tr>
<tr>
<td>Iskar River near Dragushinovo Village</td>
<td>IR.D</td>
<td>N42.363972° E23.555447°</td>
<td>895</td>
</tr>
<tr>
<td>Iskar River near Zlokuchene Village *</td>
<td>IR.Z</td>
<td>N42.393161° E23.552722°</td>
<td>865</td>
</tr>
<tr>
<td>Beli Iskar River upstream Beli Iskar Village</td>
<td>BI.B</td>
<td>N42.213806° E23.548083°</td>
<td>1420</td>
</tr>
<tr>
<td>Cherni Iskar River upstream Govedartsi Village</td>
<td>CL.G</td>
<td>N42.254814° E23.451667°</td>
<td>1180</td>
</tr>
<tr>
<td>Lakatitsa River upstream Govedartsi Village</td>
<td>LA.G</td>
<td>N42.265933° E23.469900°</td>
<td>1140</td>
</tr>
<tr>
<td>Levi Iskar River upstream Mala Tsarkva Village</td>
<td>LI.U</td>
<td>N42.243531° E23.516719°</td>
<td>1295</td>
</tr>
<tr>
<td>Levi Iskar River near Mala Tsarkva Village</td>
<td>LI.M</td>
<td>N42.270510° E23.508550°</td>
<td>1130</td>
</tr>
</tbody>
</table>
RESULTS AND DISCUSSION

Fish study

A total of 9 fish species belonging to 5 families were caught in the investigated zone. Three of the species are listed in Annex II of the European Commission Council Directive 92/43/EEC on the conservation of natural habitats and wild fauna and flora (Habitats Directive): *Barbus petenyi*, *Sabanejewia balcanica* and *Cottus gobio*. Some of the species are European endemics [10] (Table 2). The brown trout *Salmo trutta* was caught at all investigated for fish sites, except one (IR.D). According to the ecological characteristics, the fish communities were dominated by rheophilic species (82 %). The environmental status of the surveyed sites according to the used fish indices belongs to the categories “moderate”, “good”, “bad” and “very bad” (Table 3). The stations located above settlements were assessed mainly in category “bad” and stations below - in category “moderate” (Fig. 2). The main reason for the observed scores is the low carrying capacity of the high-mountain rivers in relation to the fish fauna. The numerous river fragmentations along studied rivers have additional negative impact on the size composition of the ichthyofauna [7, 18]. In the areas around villages, fishing (legal and illegal) can also affect the fish abundance and biomass. However, due to the scarce scientific information about the fish fauna in the past, this cannot be claimed with certainty [13, 14]. General lower values of fish indices observed in the upper Iskar River are probably associated with the specifics in the hydrological regime of rivers in the region. It is characterised by periods of extremely high water levels and velocities during the snow melt and rain in the spring, followed by extremely low water levels in some rivers during the summer-autumn period. Unsustainable hydrological conditions over the years require conducting more frequent monitoring studies [3].

Table 2. Fish species presented in the sampling sites in upper reaches of the Iskar River during the period 2015 – 2016

<table>
<thead>
<tr>
<th>Fish species</th>
<th>IR.D</th>
<th>IR.S</th>
<th>CLG</th>
<th>BLQ</th>
<th>BLB</th>
<th>LI.K</th>
<th>LL.M</th>
<th>LA.G</th>
<th>LO.G</th>
<th>MA.L</th>
<th>PI.C</th>
<th>PR.C</th>
<th>UR.U</th>
<th>MU.B</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>Barbus petenyi</em></td>
<td>+</td>
<td>+</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td><em>Salmo trutta</em></td>
<td>-</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td></td>
<td></td>
<td></td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td><em>Squalius cephalus</em></td>
<td>+</td>
<td></td>
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<td></td>
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<td></td>
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<td></td>
</tr>
<tr>
<td><em>Gobio gobio</em></td>
<td></td>
<td>+</td>
<td></td>
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<td></td>
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<td></td>
<td></td>
<td></td>
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<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>Phoxinus phoxinus</em></td>
<td>+</td>
<td>+</td>
<td></td>
<td>+</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td><em>Sabanejewia balcanica</em></td>
<td>+</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<td></td>
</tr>
</tbody>
</table>
Barbatula barbatula + +  
Cobitis strumicae + +  
Cottus gobio + + + + +  

Table 3. Ecological assessment of the sampling sites in upper reaches of the Iskar River, based on fish fauna indices (BRI and TRI), 2015-2016

<table>
<thead>
<tr>
<th>Sampling sites</th>
<th>IR.D</th>
<th>IR.S</th>
<th>CL.G</th>
<th>BL.Q</th>
<th>LI.K</th>
<th>LL.M</th>
<th>LA.G</th>
<th>LO.G</th>
<th>M.A.L</th>
<th>P.R.C</th>
<th>P.R.C</th>
<th>U.R.U</th>
<th>M.U.B</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ecological status according fish fauna</td>
<td>good *</td>
<td>moderate*</td>
<td>good</td>
<td>good</td>
<td>bad</td>
<td>very bad **</td>
<td>bad</td>
<td>moderate</td>
<td>bad</td>
<td>good</td>
<td>moderate</td>
<td>bad</td>
<td>moderate</td>
</tr>
</tbody>
</table>

* calculated according BRI  
** calculating according TRI

Fig. 2. Distribution of environmental assessments by fish indices (BRI, TRI) in the river areas situated downstream the villages (left) and upstream the villages (right) in upper River Iskar and tributaries, 2015-2016

**Macrozoobenthos study**

Ecological status according the biological quality element “macrozoobenthos” was “high” in most of the cases (Table 4). Biotic index has maximal score values (BI = 4/5 or 5) with the exception of PA.S and IR.Z sites. In the last cases both rivers have “good” ecological status according the BI (BI=4) due to deterioration of ecological quality. Such situation demonstrated TTN index– most sites have relatively big number of taxa, except lower parts of the catchment (IR.D, IR.Z and PA.S). In these sites we found some changes of macrozoobenthos communities; dominant taxa were relatively tolerant to organic pollution (Erpobdella octoculata Linnaeus, 1758 – Hirudinea; Tubificidae g.sp. – Oligochaeta; Hydropsyche incognita Pitsch, 1993 – Trichoptera; Chironomidae g.sp. – Diptera). Taxa with declining abundance were xenosaprobic or oligosaprobic indicators (Gammarus balcanicus Schaferna, 1922 – Amphipoda; Epeorus sp., Ecdyonurus sp., Rithrogena sp. – Ephemeroptera; Protonemoura sp., Perla marginata Panzer, 1799, Perlodes intricatus Pictet, 1841 – Plecoptera, Blepharicera fasciata, Liponeura sp. – Blephariceridae, Diptera).

Table 4. Ecological quality (EQ) of upper part of Iskar River catchment after BI and TTN indices (Regulation N4) during 2015 – 2016

<table>
<thead>
<tr>
<th>Site codes</th>
<th>Date</th>
<th>BI</th>
<th>EQ</th>
<th>TTN</th>
<th>Site codes</th>
<th>Date</th>
<th>BI</th>
<th>EQ</th>
<th>TTN</th>
</tr>
</thead>
<tbody>
<tr>
<td>IR.S</td>
<td>2.6.2015</td>
<td>5</td>
<td>high</td>
<td>33</td>
<td>LA.G</td>
<td>19.8.2015</td>
<td>5</td>
<td>high</td>
<td>27</td>
</tr>
<tr>
<td>IR.S</td>
<td>11.8.2015</td>
<td>5</td>
<td>high</td>
<td>20</td>
<td>LI.U</td>
<td>21.8.2015</td>
<td>5</td>
<td>high</td>
<td>20</td>
</tr>
<tr>
<td>IR.D</td>
<td>2.6.2015</td>
<td>5</td>
<td>high</td>
<td>29</td>
<td>LL.M</td>
<td>12.8.2016</td>
<td>5</td>
<td>high</td>
<td>30</td>
</tr>
<tr>
<td>IR.D</td>
<td>11.8.2015</td>
<td>4</td>
<td>good</td>
<td>21</td>
<td>LO.G</td>
<td>30.7.2016</td>
<td>5</td>
<td>high</td>
<td>23</td>
</tr>
<tr>
<td>BL.B</td>
<td>2.6.2015</td>
<td>5</td>
<td>high</td>
<td>27</td>
<td>PA.S</td>
<td>11.7.2016</td>
<td>4</td>
<td>good</td>
<td>19</td>
</tr>
<tr>
<td>BL.B</td>
<td>20.8.2015</td>
<td>5</td>
<td>high</td>
<td>23</td>
<td>PL.C</td>
<td>4.8.2016</td>
<td>5</td>
<td>high</td>
<td>19</td>
</tr>
<tr>
<td>CL.G</td>
<td>2.6.2015</td>
<td>5</td>
<td>high</td>
<td>36</td>
<td>PR.C</td>
<td>11.8.2016</td>
<td>5</td>
<td>high</td>
<td>26</td>
</tr>
<tr>
<td>CL.G</td>
<td>7.8.2015</td>
<td>4</td>
<td>high</td>
<td>23</td>
<td>UR.U</td>
<td>10.8.2016</td>
<td>5</td>
<td>high</td>
<td>25</td>
</tr>
</tbody>
</table>
CONCLUSION

In summary, it can be concluded that the environmental situation after criteria of Regulation N4 in the upper reaches of the River Iskar is acceptable. Despite this, deterioration of ecological quality in lower part of catchment was reported. This is probably due to settlements and agriculture activities and river fragmentation (for fishes). The growing tourist activity in the region may increase the anthropogenic pressure on these vulnerable mountain ecosystems, not only by organically loaded water inflow but also by fishing activities. The latest may have great impact in small mountain rivers. A more precise analysis of the dynamic changes in the ecological quality according to the criteria laid down in Regulation N4 is not possible. This is due to the limitations in the accepted methodologies used in characterization of surface waters. For instance, BI used scores (1 to 5) not numbers or percentages (EQR), and TTN is dependent on the natural dynamics of communities. In order to adequately assess of the ecological situation on the basis of the fish fauna, it is necessary to increase the number of investigated sites and the frequency of the monitoring events.

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REFERENCES

ЕКОЛОГИЧНО СЪСТОЯНИЕ НА ГОРНОТО ТЕЧЕНИЕ НА РЕКА ИСКЪР И НЯКОИ ПРИТОЦИ СЪГЛАСНО НАРЕДБА Н4, СПОРЕД МАКРОЗООБЕНТОСА И РИБНАТА ФАУНА

Любомир Кендеров, Димитрий Дашинов, Емил Кънев, Любомира Любомирова, Елиза Узунова

Резюме: Представена е актуална информация за екологичното състояние на горното поречие на р. Искър, включително някои нейни приотоци. Извършена е екологична оценка съгласно РДВ и националното законодателство (Наредба Н4). За изчисляване на базирани на риби индекси (BRI и TR1) са използвани следните икстолигични параметри: общо численост и биомаса, численост и биомаса на Salmo trutta, срещаемост на интродуцирани видове, чувствителни и мигранти. За определяне на индексите BI и TTN е използван таксономичния състав на макрозообентоса. Екологичната ситуация на река Искър и приотоците е определена като „отлична“ според индексите на макрозообентоса и „умерена“ до „лоша“ според базирания на риби индекси. Наблюдава се известно влошаване в някои участъци.

Ключови думи: екологично състояние, икстолигична, макрозообентоса, река Искър

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