Evaluation of the Ecological Status of Surface Water in Poland – Experiences and Problems to Solve

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Abstract: The author of the paper concentrates on the analysis of the hydromorphological quality elements of the surface flowing waters, indicating the difficulties in the identification of the pressures and impacts, which are caused by the lack of proper monitoring in Poland. Furthermore the paper discusses: types of the characteristics accepted as the base for an initial identification of the hydromorphological status of the surface water body, evaluation criteria of the quantity and morphological status, threshold values of the indicators allowing to evaluate the hydromorphological status, principles of making an initial evaluation of the hydromorphological status of surface waters, and identification principles of significant hydromorphological pressures on water bodies in risk of failing the specified objectives.

The paper also discusses the difficulties and basis of the accepted procedure of the initial evaluation of risk of failing the objectives.

Finally, the kinds of measurements needed in Poland to verify the result of the presented methodology are indicated.

Keywords: hydromorphological status, pressures and impacts analysis

1. Introduction

In May 2004 Poland became a member of the EU. Since that moment the timetable of Water Framework Directive implementation has been obligatory for Poland as it is for all other EU members. One of the first and very urgent tasks was to indicate the water bodies at risk of failing the proper environmental objectives. Consequently, the need to draft the methodology of the realization for this task arose.

The presented methodology was prepared within the framework of a grant entitled “Methodological basis of national plan of integrated development of water management in
Poland”, financed by the Polish Ministry for Science. The work was presented in the monograph: “Identification and evaluation of anthropogenic pressures and impacts on water resources for indication of water bodies at risk of failing their environmental objectives”. It should be pointed out that the methodology described in the above mentioned monograph refers to the initial identification of risk for all types of surface and ground water bodies.

**In this paper the methodology for running surface waters is presented.**

The environmental objective for the running surface waters until 2015, defined in the Water Framework Directive, is a good status, which means good ecological and good chemical status. Ecological status is defined by three groups of elements: biological elements, hydromorphological elements and chemical and physico-chemical elements. Hydromorphological elements should be treated as elements supporting the evaluation of ecological status. In principle this evaluation should be based on the biological elements. No systematic biological monitoring has been performed in Poland till now. As a result, the initial evaluation of the ecological status has been based on the analysis of the physico-chemical and hydromorphological elements (hydromorphological elements enable to evaluate the biological quality indirectly).

In the paper the methodology of the initial identification of the water bodies at risk of failing good hydromorphological status, adequate to Polish conditions is presented.

**2. Hydromorphological quality of rivers and Polish conditions of its evaluation**

The Water Framework Directive and the respective decree of Polish Ministry of Environment (DzU Nr 32, poz. 284, 2004) distinguish the following hydromorphological quality elements:

- hydromorphological regime,
- river continuity
- morphological conditions described by the variation of river depth and width, structure of substrate and riparian zone.

Both of the above mentioned documents provide analogical definitions of a very good, good and moderate ecological status respectively.

The full assessment of the hydromorphological status requires:

- reference conditions defined for specified types of the river landscapes,
- morphological monitoring,
- characteristics of the river dynamic (including data about flow regulation) and the dynamic of floodplains as a result of survey.

Methodology of the initial assessment of the hydromorphological status of rivers proposed in Poland has been based on such data which is attainable for the whole country only. It is not therefore the whole evaluation. The basic scarcity concerns reference conditions and systematic morphological monitoring. The surveying and mapping of the river and floodplain structure, riparian vegetation and type of floodplain use has not been done too.
Methodology of the first (initial) evaluation of the status, which should help to indicate the water bodies at risk of failing to achieve the good hydromorphological status was based on the identification and evaluation of the significant pressures on the river hydromorphology.

3. **Indicators for identification of hydromorphological status**

It has been assumed, that the identification of the hydromorphological status would be based on the following parameters (indicators):

a) for changes of the flow regime:
   - value of the not returned water abstraction,
   - ratio of the active capacity of all retention reservoirs to the mean annual outflow,
   - ratio of the mean annual flow for the period 1981 – 2000 to the mean annual flow for the period 1951 – 1970 (admitted as natural);

b) for morphological changes in the channel and floodplains:
   - ratio of the total length of both sides levees to the river length,
   - ratio of the total height of cross structures to the total drop of analysed river section¹,
   - ratio of the total length of the river sections, which are separated by the cross structures h>0,7 m to the length of the significant rivers,
   - ratio of the river stretches with the longitudinal regulation structures to the river length.

4. **Methodology of the initial identification of the surface, flowing water bodies at risk of failing to achieve the good hydromorphological status**

The presented methodology of the initial identification of the surface, flowing water bodies at risk of failing the good hydromorphological status comprises two stages. The aim of the first one is to identify the water bodies of a good hydromorphological status and the water bodies of a hydromorphological status worse than good. The second stage comprises a more detailed analysis of the water bodies of a worse than good hydromorphological status. This analysis allows for an identification of the water bodies, which are actually at risk of failing the good hydromorphological status.

4.1 **First stage of the evaluation of the hydromorphological status**

Selection of the water bodies of an unquestionably good hydromorphological status and water bodies, which are potentially at risk of failing the good hydromorphological status is done on the basis of the threshold values of the coefficients, which are listed in the tables 1 and 2.
Table 1 includes the coefficients enabling to assess the hydrological status and table 2 helps to assess the morphological status of the water body.

**Table 1** Threshold values of the coefficients for the evaluation of the hydrological status of the water body

<table>
<thead>
<tr>
<th>No</th>
<th>Description of the coefficient</th>
<th>Definition of the coefficient</th>
<th>Threshold value</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Ratio of the total active capacity of the retention reservoirs $V_a$ to the mean annual outflow in the cross-section closing the water body catchment $V_{MA}$.</td>
<td>$e_1 = \frac{\sum V_a}{V_{MA}}$ [mln m³/ln m³/year]</td>
<td>0.03 (3%)</td>
</tr>
<tr>
<td>2.</td>
<td>Ratio of the total unreturnable water abstraction $P_{ua}$ to the mean annual flow (MAF)</td>
<td>$e_2 = \frac{\sum P_{ua}}{MAF}$ [m³/s/m³/s]</td>
<td>0.05 (5%)</td>
</tr>
<tr>
<td>3.</td>
<td>Absolute value of the complement to 1 of the ratio of the mean annual flow (MAF) calculated for the last period (e.g. years 1981 – 2000) to the mean annual flow for the period acknowledged as natural $MAF_n$.</td>
<td>$e_3 = \left</td>
<td>1- \frac{MAF}{MAF_n} \right</td>
</tr>
</tbody>
</table>

**Table 2** Threshold values of the coefficients for the evaluation of the morphological status of the water body

<table>
<thead>
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</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Ratio of the total levee length $L_l$ to the total length of the significant rivers $L_r$.</td>
<td>$e_4 = \frac{\sum L_l}{\sum L_r}$ [km/km]</td>
<td>0.3 (30%)</td>
</tr>
<tr>
<td>2.</td>
<td>Ratio of the total height of the structures $H_s$ to the total fall of the rivers $H_r$.</td>
<td>$e_5 = \frac{\sum H_s}{\sum H_r}$ [m/m]</td>
<td>0.1 (10%)</td>
</tr>
<tr>
<td>3.</td>
<td>Ratio of the total length of the river riches $L_c$ cut off by the cross structures having the height $h&gt;0.7$ m to the total length of the important rivers $L_r$.</td>
<td>$e_6 = \frac{\sum L_c}{\sum L_r}$ [km/km]</td>
<td>0.30 (30%)</td>
</tr>
<tr>
<td>4.</td>
<td>Ratio of the total length of the regulated river riches (longitudinal structures and/or alteration of the river course) $L_{reg}$ to the total length of the signif. rivers $L_r$.</td>
<td>$e_7 = \frac{\sum L_{reg}}{\sum L_r}$ [km/km]</td>
<td>0.2 (20%)</td>
</tr>
</tbody>
</table>

A water body is assumed to have a good hydromorphological status if values of all coefficients listed in the tables 1 and 2 are less than their threshold values. Water bodies, which don’t fulfil this condition are initially classified as the water bodies at risk of failing the good hydromorphological status. They undergo more detailed analysis to indicate the water bodies, which are really at risk in perspective of the year 2015.
4.2 Second stage of the initial evaluation of the hydromorphological status

The second stage of the initial evaluation of risk of failing to achieve the good hydromorphological status consists of the identification of risk causes and of possibilities to prevent this risk. The evaluation of the risk causes consists in the identification of the significant pressures. The evaluation of their impact and possibilities to limit them takes the form of an expert assessment.

Significant pressures on a hydrological state

Water abstractions and influence of the retention reservoirs are the causes of the changes in the hydrological regime.

The proposed procedure for the identification of the significant water abstractions in the area of the water body consist of:

- identification of water intakes causing changes of the hydrological regime (great number of small, dispersed water intakes or specified number of great, listed water intakes);
- assessment of the range of impact of the significant water abstractions on the hydrological regime of the water bodies downstream.

The evaluation of the hydrological changes caused by the retention reservoirs have to be based on a case-by-case analysis.

Significant pressures on the morphological state

Identification and evaluation of the significant morphological pressures have to be done by expert assessments at the present time. Criteria of this evaluation are adjusted to the particular cases.

Indication of the water bodies at risk of failing the environmental objectives

The list of the water bodies at risk, indicated in the first stage of the analysis, should be completed by adding the list of those water bodies which have been admitted as being at risk during the analysis of the significant pressures. The decision about identifying a water body as being at risk is based on an expert assessment.

The classification according to the degree of exceeding of the threshold values, listed in the tables 1 and 2 can be helpful. The classification by the degree to which the threshold values listed in tables 1 and 2 have been exceeded is presented below:

- up to 10 % - low
- up to 30 % - medium
- up to 100 % - high
- more than 100 % - very high.
5. Example – Raba river catchment

Raba river catchment (Figure 1) is one of the pilot areas for the implementation of the WFD in Poland.

![Figure 1 Raba river catchment – water bodies aggregated for the pressures and impacts analysis](image)

In the first stage of the evaluation of the hydromorphological status it was determined that the threshold values of the hydromorphological coefficients in the aggregated water body No 4 (Stradomka river catchment) had been exceeded. The values of the exceeded coefficients are as follows:

a) hydrological status

\[ e_3 = \left| 1 - \frac{MAF}{MAFn} \right| = 21.8\% \quad \text{(threshold value - 10%)} \]

b) morphological status

\[ e_6 = \frac{\sum L_c}{\sum L_r} = 45.6\% \quad \text{(threshold value - 30%)} \]

\[ e_7 = \frac{\sum L_{regul}}{\sum L_r} = 42.1\% \quad \text{(threshold value - 20%)} \]
In the second stage of the hydrological status evaluation the identification of the significant quantity pressures was attempted. In the case of the analyzed water body the following could be stated:

- no significant water intakes but high population density (117 inhabitants per km²),
- middle level of farming (44 heads per 1000 ha of arable land)
- middle level of water supply needs (0,033 l/s/km²)
- intensive exploitation of ground water resources (on the base of the quantity evaluation of the relevant ground water body).

It can be stated, that the distinct drop of MAF for the period 1981 – 2000 compared to the period 1951 – 1970 is a result of the greater water use by households, supplied from springs and wells and of the periodical, significant, natural MAF changes. The water body №4 should therefore be counted among the water bodies at risk of failing the good hydrological status but this evaluation should be verified in the future.

In the second stage of the morphological status evaluation the causes of such an intensive longitudinal and cross regulation was recognized as well as its efficiency and the consequences for the conditions of fish life.

It was found that the regulation was done for the stabilization of the channel. This regulation is not fully justified. The cross structures (thresholds), which are 70 or more cm high make the free migration of fish impossible. Artificial character of cross sections of some river reaches causes inconvenient changes in the life conditions for the characteristic (for this river) fish kinds.

Morphological pressures could be estimated as significant enough for the water body to be acknowledged as being at risk of failing the good ecological status but only if the rehabilitation of the river would not have been done.

The above mentioned situation is an example indicating the need to analyze the risk level and the social conditions from the point of view of the „heavily modified” status for the water body under discussion.

6. Problems to solve

The methodology of the initial evaluation of risk of failing the environmental objectives in case of surface water bodies and its first applications indicate that the list of the water bodies at risk should be verified in the next years and the base of this verification (despite the proper designed monitoring) should be:

- screening of the channels and river valleys from the point of view of their morphological status,
- more detailed hydrological analysis based on available data.

Screening of the river channels and valleys should be based on the maps and aerial photography as well as on the field survey. Different descriptive and numerical data should be also used in the screening. Especially the following should be done:
• the characteristics of the water course in relation to the planform of the water bodies of good ecological status,
• identification of causes and functions of artificial cross structures in relation to the existing land-use in the adjacent area,
• identification of vegetation types and range of their existence,
• identification of types and range of flood protection structures (e.g. levees) in relation to the land-use in the adjacent area,
• identification and characteristics of bank zone,
• evaluation of the possibilities for river to overflow the adjacent area.

The scope and the method of data gathering is now being investigated. The evaluation procedures are also being tested. The problem of the designation of the heavily modified water bodies is still open.

7. Summary

The presented methodology concerns the initial evaluation of the risk of failing the environmental objectives in case of surface, flowing water bodies in Poland. It is based on the existing data/information only. List of the water bodies at risk should be verified in the coming years. This verification has to be based on the output from the diagnostic monitoring, which should be properly planned and properly realized. In the case under discussion the river channels survey from the point of view of their morphological status is of basic importance. The creation and development of an adequate data base is of equal importance.

1 A dam is taken into consideration if a reservoir has not been qualified as a heavily modified water body only
2 If there is no information about unreturnable surface water abstraction (water loses at users) this abstraction can be estimated, using loses coefficient typical for the given type of user

References
Nachlik E. (Ed.) (in the press), Identification and evaluation of anthropogenic pressures and impacts on water resources for indication of water bodies at risk of failing their environmental objectives- in Polish

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