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ECOLOGICAL RISK CLASSIFICATION IN THE REGULATED AND CONSERVED WATERCOURSES

KLASYFIKACJA RYZYKA EKOLOGICZNEGO W REGULOWANYCH I KONSERWOWANYCH CIEKACH

Abstract: The subject of the following study is ecological risk in regulatory and maintenance works conducted in small and medium-sized lowland watercourses. Risk has not been identified enough for the designers and contractors to take any actions for its limitation. The following research presents a proposal of solving the problem on an example of alternations in hydromacrophytes communities. The results of the field work conducted between 2007 and 2008 on 10 regulated, maintained and unmodified Lower Silesian lowland watercourses form a basis for this analysis. The research included hydromacrophytes identification and the degree of the bottom coverage by these aquatic plants. The analysis of quality and quantity alternations in aquatic plants communities concerning the range and conditions of works conduction enabled assigning measures to the factors of considered risk. It served as a basis for describing the matrix of risk classification. Three risk levels were accepted - low, moderate and high.

Keywords: aquatic vascular plants, ecological risk, maintenance works, watercourses regulation

In spite of knowledge base accessible in the matter of the impact of regulatory and conservation works on the water courses biocenosis there is no method allowing for biocenosis changes forecast being a result of technical works occurring in the river bed. The lack of such a tool results in the possibility of the assessment of the project after it has been done. Decisions taken by designers and contractors are assessed after the works completion. Taking into account that the effects of some decisions are irreversible for the environment it is crucial to take fast actions on solving the problem to assure environmental safety. The following research shows the proposal of using an assessment of ecological risk to cover the problem. The term "risk" defines a degree of exposure to harmful events and their possible consequences [1]. Determination of the level of ecological risk in regulated and conserved water courses serves a possibility of changes forecast in river beds ecosystems [2-4].

The aim of the following work is the determination of the principle to assess and classify ecological risk of regulatory and conservation works basing on one element of watercourse ecosystem - hydromacrophytes. These water plants are good bioindicators of the quality of water environment [5, 6]. Therefore, they are one of the basic factors considered in an assessment of the ecological state of flowing waters [7].

Study objects and methods

Field work was performed during vegetation periods in 2007 and 2008 in 10 small and medium Lower Silesian watercourses. These watercourses were divided into 34 experimental sections 100 meters long each. Experimental sections were located in similar climate, geological and soil conditions. Adjacent field was used agriculturally with

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a domination of arable lands and grasslands. Water in experimental sections was contaminated neither with urban or industrial wastes. Particular sections varied with the degree of anthropogenic transformation - 11 were located in the watercourses where conservatory works were done while other 13 were located in regulated watercourses. Each watercourse had one section where no works were conducted.

In the framework of the following field work macrophytes species was identified on the examined sections and the degree of the bottom coverage with them was determined. All hydromacrophytes rooted in water for at least 90% of the vegetation period and plants flowing naturally on the water surface or under it were taken into account. Five levels Braun-Blanquet scale was used for the determination of the density degree [8].

In order to assess species variety in the examined sections Shannon-Wiener index - H [9] was calculated. Risk level connected with conservation and regulatory works performance was defined according to the following formula [1]:

$$R = P \cdot S$$

In this formula: P - stands for the possibility of changes occurrence in the community of the hydromacrophytes in a result of works performance, S - stands for the size of these changes.

These factors were ascribed with different measurements. They were indicated by the field work results. In both cases 5 levels scales were used. Product of P and S parameters formed a basis of the risk level assessment. It was followed by two parametric matrix of the risk assessment [10]. According to accepted scales, matrix was marked due to observed changes in the plants community concerning works conducted in the examined watercourse.

Results

In the examined sections 20 species of aquatic macrophytes were determined altogether. According to Method of Macrophytes Rivers Assessment (MMOR) [11] these species have a wide or medium wide ecological scale and low or medium index value - W measured at 1 or 2. Figure 1 shows statistic data referring to aquatic plants occurrence in the examined river sections.
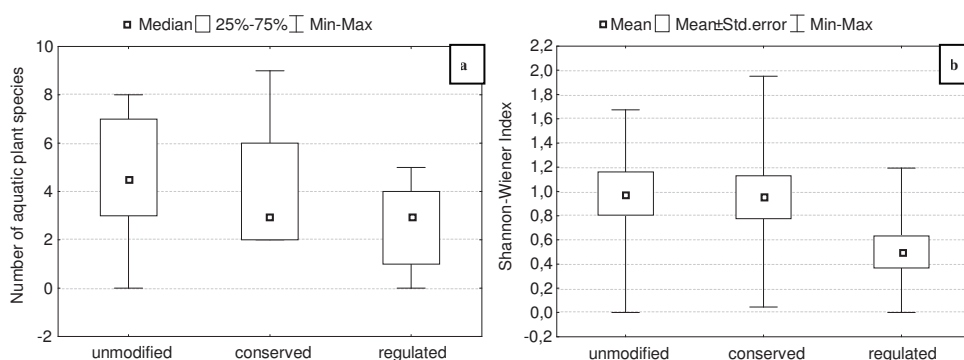

Fig. 1. Diversification of the number of species (a) and species variety Index Shannon-Wiener (b) in the examined sections

The highest mean number of species was observed in natural sections while in modified sections especially those which were regulated a lot less. Values of the diversity Index by Shannon-Wiener observed in compared sections were slightly different. In unmodified and conserved examined sections they were similar while in regulated watercourses they were considerably lower. The mean index value in unmodified, conserved and regulated river beds was calculated at 0.98; 0.95 and 0.5 respectively. Using results of the following research ecological risk factors - P and S - were defined and classified (Tables 1 and 2).

Table 1

Scale of the changes occurrence probability in the aquatic plant communities in the river beds as a result of the watercourses regulation and maintenance works - P

Probability of changes occurrence	
Point scale	Description scale
1 Very low	Slopes mowing, river bed elutriation with the removal of the aquatic plants.
2 Low	Slopes mowing, river bed elutriation with the removal of the aquatic plants, reparation and completing fascine strengthening.
3 Medium	Changes in cross-section parameters, modification of scarps incline to 1:1.5 and more, strengthening the foundation of riverbank with fascine.
4 High	Changes in cross-section parameters, strengthening scarps with stone or net stone mattresses coatings.
5 Very high	Changes in cross-section parameters, modification of vertical section with horizontal scarps, strengthening slopes with net stone baskets or retaining walls.

Table 2

The scale of the consequences of the watercourses regulation and maintenance works in the river bed for the aquatic plant communities - S

Susceptibility to changes in aquatic plant species composition	
Point scale	Description scale
1 Lack	There are no hydromacrophytes in the watercourse.
2 Mild	There are 1-3 species of hydromacrophytes with low and medium index values $W = 1$ or 2 in the watercourse.
3 Moderate	There are above 4 species of hydromacrophytes with dominating taxons of a low index value $W = 1$ in the watercourse.
4 Severe	There are above 4 species of hydromacrophytes with dominating taxons of a medium index value $W = 2$ in the watercourse.
5 Very severe	There are taksons with high index value $W = 3$ in the watercourse.

Classifications of considered risk factors showed in Tables 1 and 2 formed a basis to compile ecological risk matrix in both maintained and conserved watercourses (Fig. 2).

The following matrix shows the level of risk may be placed between 1 and 25 points. Information obtained during the field work was used for determination of point range for small risk - usually accepted, medium and high - unaccepted. Each section located in modified watercourses was defined with the area of matrix where observed changes in plants communities took place (Fig. 3). The matrix was also marked with the direction of the observed changes referring to the number of species and Shannon-Wiener index. In case of conservatory works the most common situations were those with a growth in both values

Regulated sections in most cases show that the result of river beds regulation is lowering the number of species of aquatic plants and the values of Shannon-Wiener index. This served as a basis for ecological risk classification taking into account its 3 levels - low, medium and high risk.

Fig. 2. Matrix of ecological risk in maintained and regulated watercourses

[ ]   - shows a trend of changes in the number of species: „+" - increase, „–" - decrease, „=" - no changes
28   - the number of the examined section
[ ]   - shows a trend of changes in the Shannona-Wienera index: „+" - increase, „–" - decrease

Fig. 3. Ecological risk classification on the basis of alternations in aquatic plants communities in maintained and regulated watercourses

Conclusions

1. The range of performed works and ecological tolerance of the plants occurrence in watercourses had a big influence on the size of alternations in the aquatic plants communities.
2. Basing on the risk matrix ecological risk was classified in three different levels. Low risk was determined ranging from 1 to 4, medium risk was found between 4 and 8 while high risk was determined at the level of 9 points or more.
3. Performed analysis showed that maintenance works are connected with low or moderate risk. Regulatory works comprise moderate or high risk area.
4. In order to limit adverse alternations in aquatic plants community risk assessment should be performed when planning works. It requires detailed environmental valorization in the river bed and detailed analysis of the range of planned works.

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KLASYFIKACJA RYZYKA EKOLOGICZNEGO W REGULOWANYCH I KONSERWOWANYCH CIEKACH

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Abstrakt: Przedmiotem pracy jest ryzyko ekologiczne w robotach regulacyjnych i konserwacyjnych wykonywanych na małych i średnich ciekach nizinnych. Ryzyko to nie jest jeszcze rozpoznane w stopniu pozwalającym projektantom oraz wykonawcom robót na podjęcie działań mających na celu jego ograniczanie. W pracy przedstawiono propozycję rozwiązania tego problemu na przykładzie zmian w zbiorowiskach naczyniowych roślin wodnych. Podstawę analizy stanowią wyniki badań terenowych prowadzonych w latach

2007-2008 na 10 uregulowanych, konserwowanych oraz nieprzekształconych nizinnych ciekach Dolnego Śląska. Badania obejmowały identyfikację występujących w korycie gatunków naczyniowych roślin wodnych oraz określenie stopnia pokrycia przez nie dna. Wykazały one, że w następstwie prac regulacyjnych i konserwacyjnych zachodzą zmiany jakościowe i ilościowe w zbiorowiskach naczyniowych roślin wodnych. Analiza tych zmian, z uwzględnieniem zakresu oraz warunków wykonania robót, pozwoliła na przypisanie miar czynnikom rozpatrywanego ryzyka. Stanowiło to podstawę opracowania macierzy klasyfikacji ryzyka. Przyjęto w niej 3 poziomy ryzyka - niskie, umiarkowane oraz wysokie.

Słowa kluczowe: ryzyko ekologiczne, naczyniowe rośliny wodne, roboty konserwacyjne, regulacja cieków