



Review

The comparison of environmental flow assessment - The barrier for investment in Poland or river protection?

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ARTICLE INFO

Article history:

Received 28 January 2018

Received in revised form

18 April 2018

Accepted 12 May 2018

Available online 15 May 2018

Keywords:

Environmental flow

Minimum acceptable flow

Water ecosystems

Water management

ABSTRACT

Investments that make use of renewable resources of flowing waters must be based on the absolute necessity of protection of the water environment and that dependent on water. In practice, it means the obligation of leaving environmental flow in the river bed in the cross section below the place of water abstraction. The places of surface water abstraction for drinking and industrial purposes are thus limited with the volume of water obligatorily left in the flow for water organisms. In case of hydropower plants located directly in the watercourse, the environmental flow value corresponds approximately with the volume of water run in the fish pass obligatorily provided to maintain patency of the watercourse, in particular in the aspect of migration of diadromous fishes. Environmental flow is ineffective in investment terms, but highly important from the point of view of environmental protection. Thus, the proper calculation of the environmental flow value should be the compromise between the protection of the environment and the economics of the investment. No unanimous methodology in this respect has been applied in Poland for many years, and calculations were done with one of subjectively selected methods functioning in the literature. This work presents the methodology of environmental flow calculations broken down into water regions. Calculation path has been presented along with the possible inconveniences resulting from the effective legal regulations in Poland as regards the possibilities of carrying out projects that take advantage of flowing surface waters.

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Contents

1. Introduction	576
1.1. Main definitions	576
1.2. Methods of EF assessment	576
1.3. Formal and legal regulations in Poland as regards the conditions of use of waters in water regions	578
1.4. Obligatory calculations methodology in Poland	578
1.5. Selection of the coefficient “k”	579
2. Hydrological data for chosen rivers	581
2.1. Upper Vistula water region	582
2.2. Warta water region	582
2.3. Lower Vistula region	582
2.4. Middle Vistula water region	582
2.5. Assessment of stability of river flows	582
3. Basic analyses	584
3.1. Environmental flow calculations	584
4. Comparison of results	584
4.1. Percentage of time in an average year with water use limited by environmental flow	584
4.2. Comparison with other methods	586

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5. Conclusions and recommendation	587
References	591

Nomenclature

MAF	average mean annual flow [m^3/s]
MLF	average mean low flow [m^3/s]
LF	average low flow [m^3/s]
Q_{50}	median monthly flow [m^3/s]

Abbreviations

EF	environmental flow [m^3/s]
RZGW	Regional Water Management Authority
SWB	Surface Water Bodies

1. Introduction

In the public opinion, “environmental flow” intuitively means the volume of water that should be obligatorily left in the river so that the balance of the environment is not disturbed.

1.1. Main definitions

According to the Brisbane Declaration (2007), “environmental flows describe the quantity, quality and timing of water flows required to sustain freshwater and estuarine ecosystems and the human livelihoods and well-being that depend on these ecosystems”. Environmental flows can be defined as the flows to be maintained in rivers through management of the magnitude, frequency, duration, timing, and rate of change of flow events (O’Keeffe, 2009). It appears that the proposed general definition is sufficient that has been functioning in the common consciousness: “the lowest volume of water that is required to be left in the watercourse to ensure optimum conditions for the existing ecosystems; determined according to the properly selected criterion based on the knowledge of hydrological and environmental conditions with the maximum respect for biological balance”.

The “minimum acceptable flow” term has been present in the consciousness of hydrologists and hydrogeologists in Poland for over half a century, although with no precise definition and methodology to determine its value. “Biological flow” was the term initially used, with the intention of providing protection against potential biological degradation of river waters in view of the expected intensification of economic processes and the resulting quantity and quality changes in water resources of rivers (Kostrzewa, 1977), as well as the inefficient water management in water pipeline systems supplying water for community and business purposes, continued in Poland until the end of 1990s (Bergel and Pawełek, 2007). This definition, just like those that came later, has not had any legal grounds for over 60 years (Żurek, 2014). This caused situations hazardous for the protection of the water environment, due to the lack of formal requirements for those developing the strategic document (the statement of water management conditions) which is the basis to obtain the water management authorisation for use of surface waters.

The projects that include surface waters use usually understand “inviolable flow” solely as the volume of the flow left in the watercourse, omitting the needs of water-dependent ecosystems,

i.e. water and wetlands areas (Młyński et al., 2015), as well as specific determinants in protected areas, such as national parks (Kaczor et al., 2014). The flow that ensures fulfilment of water needs of both water and water-dependent ecosystems is the so-called environmental flow (EF). The concept of EF was evolved to determine how much water is needed for the survival of ecological species (Poff and Matthews, 2013) or as implications for river ecosystem management in water-stressed basins, particularly in terms of the design of fair and effective water sharing mechanisms (Sisto, 2009). EF is defined as the portion of natural flows that should be left in the watercourse and in flood plains to maintain high valours of water and water-dependent ecosystems, with the simultaneous accounting of environmental protection requirements (Tharme, 2003). Environmental flows aim to influence river hydrology to provide appropriate physical conditions for ecological functioning within flow regulation restrictions (Vietz et al., 2017).

The above definitions are often used interchangeably in Poland, especially in the environments related to the projects that use waters – unlike the nomenclature used in scientific circles. Pursuant to the effective Polish legal regulation (the Water Law), in practice only the Polish term “przepływ nienaruszalny” is used. In the consciousness of the persons who use water resources (e.g. hydropower plants), this term corresponds with “minimum acceptable flow” and means the minimum volume of water that allows to maintain biological life in streams. It thus allows to maximize profits by using the surplus volume of water run through the river. The “environmental flow” term is intuitively perceived as larger volume of water that ensures not only survival of but also the optimum conditions for water species. In scientific terminology and based on ensuring the optimum conditions for river ecological systems (and not only the minimum of maintenance), the proper time to be used should be “environmental flow”. The flow left in the stream under these conditions restricts the economy of the enterprise, but is highly justified from the point of view of sustainable development. As the paper presents, it is not possible under Polish conditions to select any method used to state the EF value in water use permit procedures. Therefore, “environmental flow” is commonly used in the further part of the paper to correspond with the Polish “przepływ nienaruszalny”. As free choice of the definition and the method of calculation is not possible, interchangeable use of “environmental flow” and “minimum acceptable flow” is admissible.

1.2. Methods of EF assessment

Dynamic development of ecohydraulics resulted in developing over 200 methods of assessment of environmental flows (Acreman and Dunbar, 2004). The methods are most often broken down into four categories (Acreman and Dunbar, 2004; Piniewski et al., 2011; King et al., 2003; Hirji and Davis, 2009; Gupta, 2008):

- (1) formulas of hydrological indicators, the so-called “look-up tables”, based on simple hydrological indicators presented in tables;
- (2) indoor analyses, the so-called “desktop analyses”, based on the analysis of the existing data, mostly hydrological data without focusing on specific species or biotic communities;

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