PROBLEMY EKOROZWOJU – PROBLEMS OF SUSTAINABLE DEVELOPMENT
2014, vol. 9, no 2, 139-147

Perspectives for Development of Hydrotechnical Infrastructure in Poland in view of the European Union Water Policy

Perspektywy rozwoju infrastruktury hydrotechnicznej w Polsce na tle unijnej polityki wodnej

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Abstract

The article presents general conditions and perspectives for development of hydrotechnical infrastructure in Poland, as compared to the European Union water policy, which take into account demands of sustainable development. The hydrotechnical infrastructure analyzed in the article includes technical projects associated with flood control, water power engineering and water transport. Poland is in a particular situation because, due to historical determinants, including partition of its territory and war damages, the development of water management processes which may be observed in western European countries proceeded at a slower pace or simply did not take place at all. The current water policy stemming from the *Water Framework Directive* should be based on harmonization of economic growth and environmental requirements. In addition, cohesive sectoral planning documents are required. It is also imperative that water management plans for river basins take priority over other water management plans.

Key words: directive, hydromorphology, flood, water power engineering, shipping, development

Streszczenie

W artykule przedstawiono uwarunkowania i perspektywy rozwoju infrastruktury hydrotechnicznej w Polsce na tle unijnej polityki wodnej, uwzględniającej wymagania zrównoważonego rozwoju. Infrastruktura hydrotechniczna analizowana w artykule obejmuje przedsięwzięcia techniczne związane z ochroną przed powodzią, hydroenergetyką i transportem wodnym. Polska znajduje się w szczególnej sytuacji, bowiem, z racji uwarunkowań historycznych w tym zaborów i zniszczeń wojennych, procesy dotyczące rozwoju gospodarki wodnej zauważalne w krajach Europy Zachodniej zostały spowolnione lub wręcz nie zaistniały. Obecna polityka wodna wynikająca z *Ramowej Dyrektywy Wodnej* powinna być oparta na harmonizowaniu rozwoju gospodarczego i wymagań środowiskowych. Ponadto wymagana jest spójność sektorowych dokumentów planistycznych i nadrzędność planu gospodarowania wodami dla dorzecza w stosunku do innych planów z zakresu gospodarki wodnej.

Słowa kluczowe: dyrektywa, hydromorfologia, powódź, hydroenergetyka, żegluga, rozwój

1. Development of hydrotechnical infrastructure in the context of sustainable development

Based on various open definitions of sustainable development (*Agenda 21*, 1992), it may be assumed that it is development which meets the basic needs of human beings and preserves, protects and restores health and integrity of ecosystems without jeopardizing the ability to meet the needs of future generations and without exceeding long-term limits of their capacity. The definition of sustainable development indicates that it should be analyzed in ecological, economic and social terms. The development of each infrastructure, including hydrotechnical, should take

into account the requirements acknowledged in the above-mentioned categories.

In terms of the environment, development of hydrotechnical infrastructure must take into account the demands of ecosystems. In this respect, compliance with the binding legal regulations is the primary requirement in the EU member states. In course of the design process, technical solutions which do not generate changes in hydromorphological conditions and provide appropriate compensation should be taken into account. Directive 85/337/EEC on assessment of the effects of certain public and private projects on the environment, as amended by Directive 97/11/EEC, ensures that environmental consequences of projects are identified and evaluated before issuing relevant permits. Projects should take into account the overriding public interest and detailed justification for such decisions.

In economic terms, plans for development of hydrotechnical infrastructure should be accompanied by economic analysis. Possible external costs generated by the planned infrastructure should also be taken into account in the analysis. Thus, in the case of water transport, economic reasoning must not be restricted exclusively to simple analysis of transport costs. Published analysis (*White paper*..., 2011) indicate that it is possible to transport by water 127 tons of goods at a distance of one kilometer using a liter of fuel, while by rail it is 97 tons and by roads only 50 tons. Economic analysis should also take into account the environmental costs associated with construction and operation of waterways. In the case of water transport, external costs of environmental impact amount currently to about 10 euro per 1000 ton-kilometers (35 euro for road transport and 15 euro for rail transport). The socio-economic effects of sudden breakdowns, air and noise pollution, climate changes and changes in the environment should also be taken into account. It is estimated that in case of the transport sector, they increased by 91,5 % in road transport, by 6% in air transport, by 2% in rail transport and by 0.5% in water transport.

From the social perspective, development of hydrotechnical infrastructure should be regarded in a broader framework, not only within the context of fulfillment of social needs in the area of security and flood protection, ensuring power supply or alternative forms of transport. Implementation of such projects creates jobs, during the implementation phase of the investment and continues to provide them during facility operations. This is emphasized in the latest European Union documents (NAIADES II, 2013). On the other hand, it may also change and restrict the existing practices associated with the use of water for recreation and tourism, influence landscape changes and consequently harmony and social aesthetic sensitivity. Implementation of infrastructure projects also causes major changes in spatial development and creates problems which are particularly arduous during in the implementation stage of investment.

In program documents on water management it is stressed that decentralization is the key element of decision-making (Catley-Carlson, 2001). Local authorities have at their disposal the appropriate means, know-how and organisational structure to ensure proper sensitivity to problems associated with hydrotechnical infrastructure plans. Thus understood decentralization does not interfere with the government's statutory control of overall water resources and fundamental decision making.

It is as well fundamental to strengthen the dialogue between competent authorities responsible for sectoral policies. Furthermore, to assure appropriate balance between different water use and protection of water resources, cooperation between experts and interested parties is also indispensible. Each sectoral policy has its own set of laws for planning. Implementation of Directive 2001/42/EC on the assessment of the effects of certain plans and programmes on the environment can actively assist in the processes of coordination and integration between the various policies.

Most of the problems associated with water management materialize at the local level (Garrido, 2001). In many cases they are also resolved locally. In addition, in many countries, representatives of local authorities and communities play an important role in river basin committees which undertake important decisions on planning and implementation of water resources.

For many decades, the key tasks of water management concerned exclusively the sphere of use and technology. Achieving short-term use effects, a number of rivers were transformed from natural watercourses into uniform channels, devoid of any natural values, limited to the function of water drainage. At the same time, without any control, dynamically growing land development of flood lands for construction purposes as well as their use for agricultural purposes forced further and more intense regulation measures (*Rhine 2020…,* 2001).

In the history of water management it is possible to chronologically specify given periods of development. Among them, it is possible to define respectively the following:

- development of water transport, river control, city development, intensification of structural activities in flood control of cities located on the banks of larger rivers and their tributaries;
- progressive deterioration of water quality in consequence of pollution from industry, communities and agriculture;
- development of warning systems for flood control;
- development and progressive execution of water control programs;

- implementation of water quality monitoring systems, including monitoring of warning systems for incidental occurrences;
- renewal and reconstruction of water ecosystems which take into consideration:
  - ✓ the *status quo* of current spatial management;
  - ✓ transport functions of rivers and their tributaries;
  - ✓ flood control including, above all, reconstruction of flood lands where it is possible and safe.

The up-to-date approach to water management is the result of its gradual, historic development and is currently based on the principles of IWRM – Integrated Water Resources Management (*A Handbook for…,* 2009). This approach is the basis of sustainable development which should include various forms of flood control, electric energy production and transport.

Initially, integrating activities on the level of a river basin were of limited character. Particular sector problems and needs were analyzed and solved individually (*Gestion des Ressources…,* 1994). Next, activities aiming at integrated development of infrastructure emerged. According to assumptions, they were to carry out numerous tasks, i.e. water supply, water power engineering, flood control, shipping. The final stage of evolution took into account the management process of various dimensions of the natural environment (*Dorzecze Wisły...*, 2012; Lampart-Kałużniacka, Wojcieszonek, Pikuła, 2012). During the Dublin conference (*Rhine 2020…,* 2001), the adopted key IWRM principles stipulated, among others, that:

- water is a limited and sensitive resource, significant for maintaining life, development and the environment;
- development of water resources and their management should be based on cooperation between users, planners, and management of all levels;
- water has an economic value in all competitive kinds of use and should be regarded as an economic good.

The key directive of the EU water policy, based on the IWRM, is the Directive of the European Parliament and of the Council of 23 October 2000, known as the *Water Framework Directive – WFD* (Directive 2000/60/EC, 2000). It established the framework for Community actions in the field of water policy to achieve good status of all water bodies. Rescheduling is possible in achieving good status of water bodies, i.e. deferment of implementing the objectives of the *Water Framework Directive* till 2027. Such a postponement should be supported by analyses of the unworkability of technical solutions or by economic analyses indicating that activity costs are unproportional to the results. The *polluter pays principle* should be used (Miłaszewski, 2003; Miłaszewski, Walczykiewicz, 2004).

At the same time the WFD implements, in the EU member states, the obligation to plan and manage water economy within boundaries of river basins. Supplementary to the WFD is the *Floods Directive*, i.e. the Directive of the European Parliament and of the Council of 23 October 2007 (Directive 2007/60/EC, 2007) on the assessment and management of flood risks. Classification of flood control actions was developed within framework of research programs financed by the *EU Framework Program V* and *VI* (*Best practices…,* 2003) allowing for technical activities.

Poland is an example of a country in which, due to historical determinants, including the partition of its territory and war damages, the development of water management processes which may be observed in western European countries, proceeded more slowly or simply did not take place at all.

Unlike western European countries, Poland was not a beneficiary of 19th century achievements when other countries were creating a basis for an integrated technical infrastructure. Independence and building of a foundation for statehood presented authorities with a series of tasks which aimed at integrating territories which, for dozens of years, were included in three different political bodies (the Polish territory was partitioned among the Kingdom of Prussia, the Russian Empire, and Old Austria). Despite numerous years which have passed since that time, dissimilarities in development of the territories are still visible. Differences in the development of hydrotechnical infrastructure are also characteristic. Years following World War II did not favor growth of investments.

Admittedly, several programs were initiated but not completed. For example, the Upper Vistula watercourse was constructed in 1949-2002 and of the eighteen planned barrages only six were built. In practice, the watercourse has no transport function. In turn, the barrage build in Włocławek in 1963-1970 is the only completed construction on the planned Lower Vistula stepped falls. The current spatial distribution of cross river constructions (barrages, dams, groynes) and lengthwise river constructions (embankments, regulations) is presented in a schematic form in Figure 1. It illustrates, on the national scale, the differences stemming not only from natural conditions but also from the aforementioned historical circumstances. In consequence, in planning hydrotechnical infrastructure in Poland, it is pertinent to take into consideration (*Projekt…,* 2008):

- the country's economic history and civilization delays,
- geopolitical changes,
- condition of the existing infrastructure,

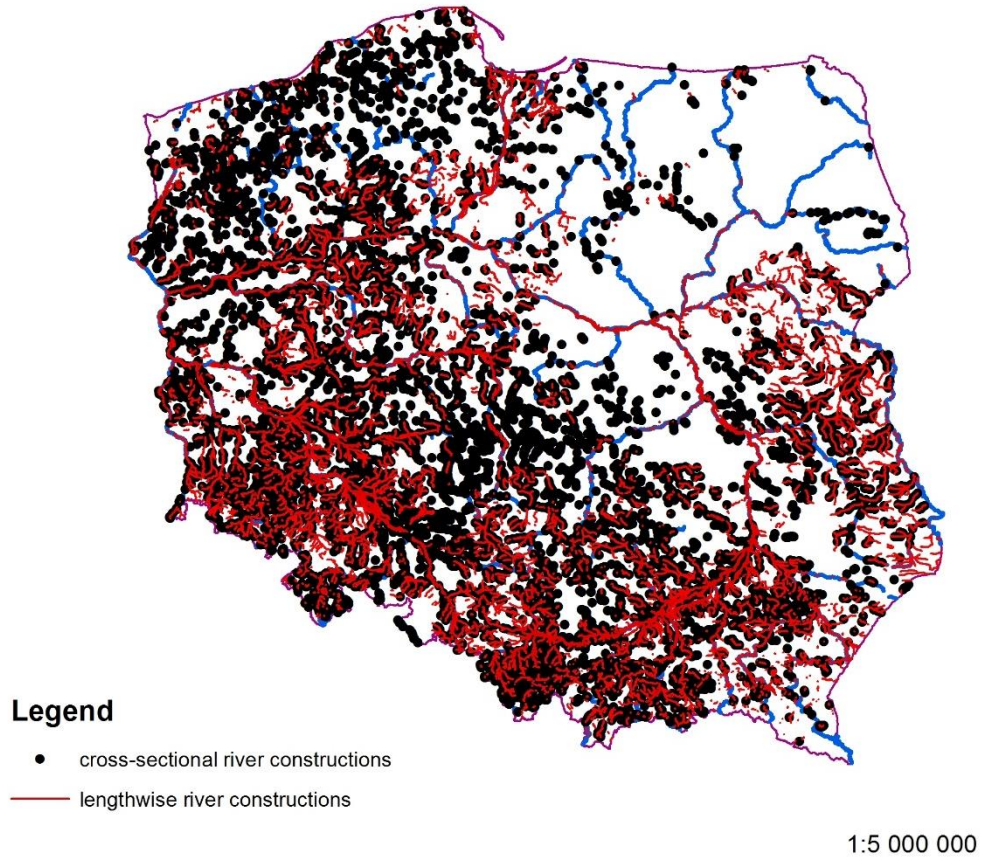

Figure 1. Spatial distribution of cross-sectional and lengthwise river constructions in Poland. Source: Author's own work

- considerable expenditures which have to be incurred,
- search for a compromise between the need for the protection of water and ecosystems stemming from the EU water policy and the development of hydrotechnical infrastructure necessary to assure water security and sustainable development.

2. Plans and programs of hydrotechnical infrastructure development in Poland in view of the EU water policy

The respective EU member states have their tradition of water economy planning. It is generally considered that the best solution in planning is the one in which spatial planning and water economy management are linked into one coherent, synthetic plan (*Integrated Flood…,* 2004; *A Handbook for…,* 2009). In Poland, the *Draft State Water Policy* was based on the EU concept of sustainable development which integrates political, economic and social actions while maintaining the natural balance (*Projekt...*, 2010; Gromiec, Winnicki, 2011). At the same time it stresses the need to guarantee fulfillment the fundamental needs of a particular population or citizens.

All activities should be characterized by a comprehensive approach to both the broad concept of environmental protection and water resources, water economy and associated water pollution control, taking into account sustainable development. Cohesive sectoral planning documents are required as well as for water management plans for river basins to take priority over other water management plans.

Despite these guidelines, the sectoral approach to water management dominates in Poland. It is taken for granted that water management plans for a river basin area are defined by the *Water Framework Directive* as a specific *master plan* for a river basin. There is also space for specifying new investment projects justified by social and civilization reasons. Their need must be supported by economic analyses which take into account environmental costs.

As mentioned earlier, efforts were undertaken in Poland in the area of hydrotechnical infrastructure development programs. They underwent multiple modifications and transformations. Their current status and range are presented in Figure. 2. Among them, the *Odra Program* has the longest history (*Program…,* 2009). It takes into account both flood control, development of water transport as well as retention and water power engineering in the Odra River Basin.

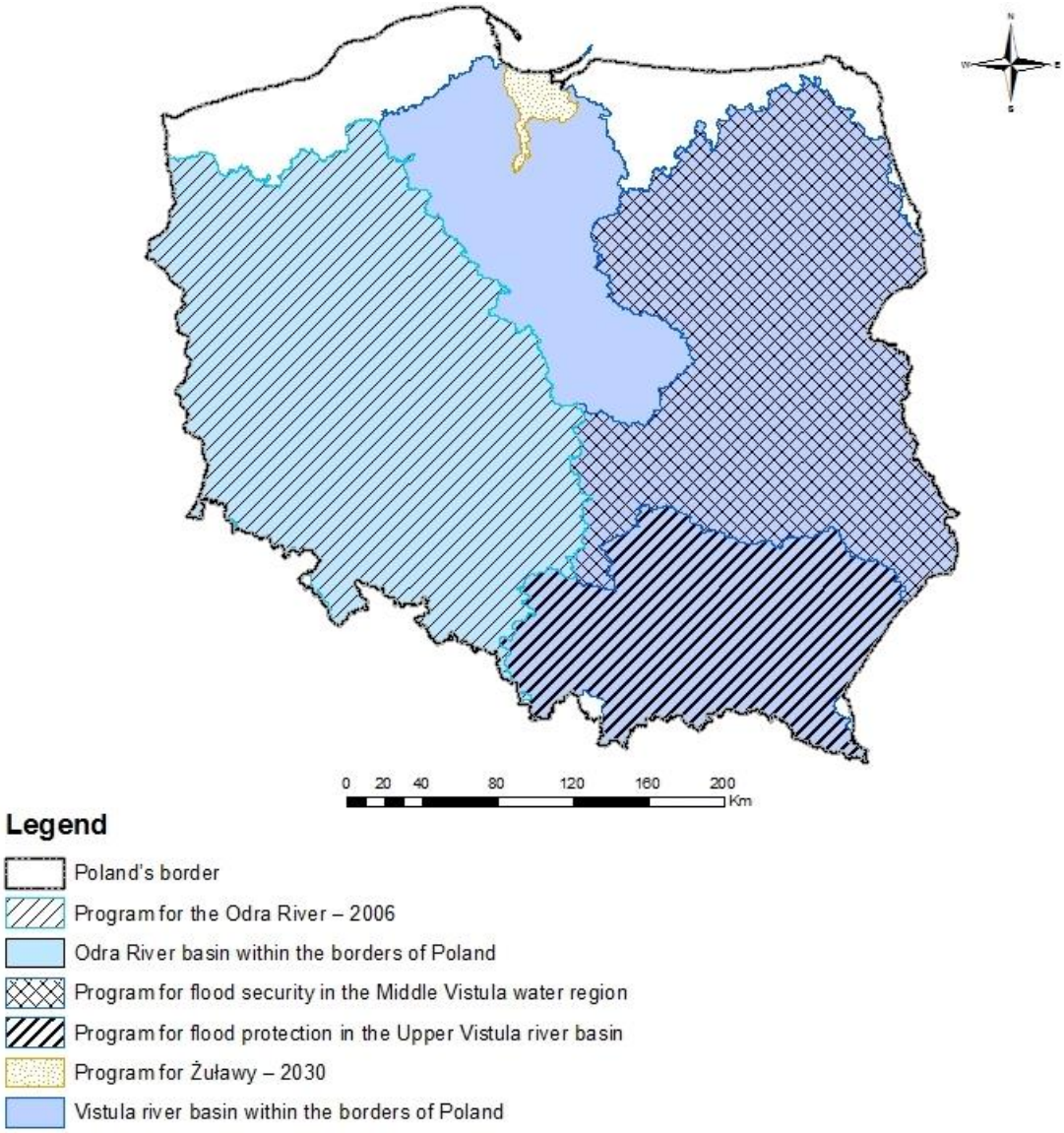

Figure 2. Programs affecting development of water infrastructure. Source: Author's own work

In turn, the *Program of flood control in the Upper Vistula River Basin*, adopted by the Council of Ministers in 2011, includes the area of five voivodeships (*Resolution no. 151/2011 ...*, 2011). It is an investment program which establishes regulation of waterbeds, construction of water retention reservoirs and protection of inhabitants of large municipal agglomerations against floods by technical measures.

In 2011, in order to reinforce the safety of citizens living in the area of the Central Vistula, the idea of the *Program for flood safety in the Central Vistula water region* was established (*Program…,* 2012). Next, in the area of the Lower Vistula, especially endangered by floods are Żuławy Wiślane. Comprehensive precautionary flood measures for Żuławy are to the carried out in 2009-2030, within framework of the *Żuławy Program 2030* (*Program…,* 2010).

3. Problems in implementing the EU water policy within the framework of development of hydrotechnical infrastructure

Implementation of the EU water policy is a difficult task and it demands cooperation of all the interested parties. The analysis of experience in implementing water management directives allows to determine the elementary sources of difficulties associated with implementation by each of the EU member states (Walczykiewicz, 2006). Along with them may be distinguished, among others, the lack of laid down action plans stemming from the directives or their general character, improper interpretation of regulations and above all, too general an interpretation of detailed requirements formulated in the directives. The problems also affect Poland. In the case of projects on flood control, water power engineering and

water transport, problems manifest themselves in an improper and too general an interpretation and incomplete regulation transposition. In consequence, in 2012, the European Commission presented the Polish authorities with its standpoint in which it questioned the programs undertaken in Poland in the area of hydrotechnical infrastructure, including the aforementioned programs. The disparity between the formulated plans for water management of river basins and the hydrotechnical infrastructure development programs was stressed. It was recommended to carry out a review of water management plans for river basin areas and harmonize them with the requirements of the WFD, in particular in the area of article 4, that is in the part dealing with the planned hydrotechnical investments.

4. Planning procedures and tools in agreement with the EU water policy

Undoubtedly, where it is justified, the WFD stresses the significance of the natural condition of water bodies as well as the need to review existing modifications of the physical characteristics of water from the perspective of function and economics. The planned investment projects should be the result of broader, coordinated by water management plans for water basin areas, sectoral plans which were subject to strategic environmental impact assessment. It is necessary to justify the planned projects in regard to the social and economic needs which take into account demands of the sustainable development policy and to subject these plans to bone fide assessment. In the Directorate-General for the Environment in the European Commission, within framework of the *Common Implementation Strategy* for the *Water Framework Directive*, documents were developed (*WFD and Hydro-morphological pressures…,* 2006; *Good practice…,* 2006) which specify the planning strategy and actions in this area.

Within framework of water control this strategy should take into consideration:

- close coordination with the spatial planning policy which regulates growth in flooded areas, allows more open space for floods and in consequence decreases the need for construction of new flood control equipment,
- protection and development of agriculture and forest economy for improvement of natural retention.

In Europe, structural solutions for flood protection are based on dams which usually accomplish multipurpose tasks, washlands and embankments. There are about 7,000 large dams in Europe and thousands of smaller dams. The pace of implementation of new facilities has decidedly declined in the second half of the 20th century. Currently, flood protection in western European countries is based on the following four fundamental principles:

- structural solutions, taking into account that they do not provide full flood protection,
- providing more space for rivers and reducing sealed surfaces of catchment areas,
- providing local and individual flood protection by the local community,
- acquiring insurance against floods and financial measures, taking into account that 100% protection is not possible.

It is certain that (*Good practice…,* 2006) traditional technical solutions (dams, canalization of rivers, embankments) have exhausted all the means of impact on flood control. In consequence, it is necessary to strive toward creating space for rivers and floods in places where danger to the population and economy is at a low level.

The possibility of producing electric energy in hydroelectric power plants depends on natural conditions, including surface features of the terrain. For example, the possible water power engineering potential of Austria is 53 700 GWh/year and the share of energy production by hydroelectric power plants is 67,4% (World Atlas, 2001). In turn, in Spain where the territory is larger , the water power engineering potential is 41 000 GWh/year and the share of electricity produced by hydroelectric power plants is 20%. Norway is the leader in producing energy by hydroelectric power plants, where this share is 99,4% and the useable potential amounts to as much as 179 600 GWh.

In the area of water power engineering, it is necessary to aim setting clear guidelines for issuing permits for construction of water energy facilities, in accordance with the WFD requirements. First, in order to limit the number of new locations for water power stations, the existing facilities should be technically upgraded and their capacity be increased.

In regard to water transport, according to the Communication of the European Commission (2006) on promotion of inland navigation, it is stressed that the development of the water course infrastructure should progress in a manner coordinated and integrated with the management plans for river basins. Renewed revitalization is observed in Europe in the area of development of water transport. In September 2013, the European Commission presented NAIADES II, a new action program which aims to increase freight transport by rivers and channels in Europe. In twenty EU member states there is approximately 37.000 km of inland waterways. Every year 500 million tons of cargo is transported there. However, the transport is principally concentrated in densely populated areas with high traffic density. The Commission proposes to improve waterborne transport of cargo by upgrading water gates, bridges and shipping channels. The NAIADES II action program aims to create a stable long-term framework for investments in high-quality innovate inland waterway transport. In the *Connecting Europe* facility for the period 2014-2020 and guidelines for develop-

ment of the Trans-European (TEN-T) Transport Network emphasis was put on new possibilities of financing inland waterways.

5. Perspectives for Poland

The current model for water management planning must be subordinated to the plans formulated in the *Water Framework Directive*. The binding regulations on execution of new investment projects in the area of environmental requirements considerably draw out the preparation phase of an investment. As mentioned before, cohesive sectoral planning documents are required as well as the priority of water management plans for river basins over other water management plans must be established. Implementation of these mechanisms in consecutive planning cycles also calls for additional time. In consequence, in comparison with the practice in the past years, it may be expected that the phases for planning and investment preparation will be prolonged, whereas the construction phase is expected to be reduced. Also, current financial determinants will be of significance. It should be understood that accomplishment of most hydrotechnical investment projects will still be based on the state budget and EU funds. Unfortunately, according to the opinions of experts, the next financial perspective of these funds is to be the last of any significance for the development of infrastructural projects in Poland. Only some investment projects may count on support of capital groups interested in potential profits. In practice this may only regard some water power engineering investment projects. Therefore, further to meeting significant environmental requirements, it will be necessary to guarantee financing by the state budget. This would stipulate currently and in the foreseeable perspective, that water management be accorded special status and that the condition of the Polish and EU budgets consequently improve. However, this perspective is uncertain, given the current financial situation of the European Union. It will be necessary to look for other solutions, including public-private partnership. Subsequent determinants regard changes of climate and policies related to adaptation to these changes. Analyses of the results of forecasts on changes in water resources, in perspective of the year 2020 (Walczykiewicz, 2012), do not point toward any significant changes in the near future. Results of the analyses show that changes in waste management will mainly involve waste decomposition in time with slight changes of the mean annual values. However, taking into consideration that our country is relatively deprived of water, these changes may be the reason for problems in areas where the water use index is high today. In addition, the increasing need for water which stems from projected economic growth, despite the observed tendency of decreasing water absorption per product unit, must also be taken into consideration. Variability of the time schedule of precipitation will also have impact during rainfall occurrence on increasing flood risks. In consequence, the pressure to plan and construct new retention reservoirs will grow. This will mainly concern small retention reservoirs. The natural geographic conditions in central and northern Poland and the dispersed development of river valleys in southern Poland limit opportunities to localize new facilities. Only for very few of them, for over forty years, land reserves are have been kept for their future construction.

The technical condition of the existing infrastructure represents a considerable challenge. Most water power facilities have been operating for over fifty years. The majority of these operating over one hundred years are located in the Kujawsko-Pomorskie Voivodeship. In addition, in the Podlaskie Voivodeship are ten flood gates built over one hundred eighty years ago and they are still functioning (*Dorzecze Wisły...*, 2012). Over eighty five percent of the length of all embankments has been built over forty years ago and an additional thirteen percent were built over one hundred years ago. Thus, in the future, a new modernization program will be enormous financial objective.

Taking into consideration the aforementioned conditions it is possible to approximate the real perspective of changes in infrastructure used in flood control, water power engineering and water transport. It must be stressed that these changes should be accompanied by water protection actions aiming at minimizing threats to aquatic ecosystems and water-dependent eco-systems. Revitalization of the existing facilities, such as retention basins, will also be necessary to reduce the risk of environmental disasters.

This perspective reaches the year 2030, taking into consideration the procedures and time needed for realization of new investment projects and the existing documents on the country's spatial economy. According to the Author of this article, significant changes in this matter should not be expected. Mainly, infrastructure for flood control will be modernized. It will, above all, comprise flood embankments. Taking into consideration their current condition it is a long-term task. Small retention reservoirs will be upgraded. Neglected irrigation systems will be renovated as often they are the cause of local flooding. There will be a need for consequent support of infrastructural activities by a spatial planning policy which will limit land development in areas threatened by floods. Resettlements should also be allowed in economically and socially justifiable cases as a measure of reducing the risk of flooding.

It is expected that a minor increase in the share of energy produced by water power stations will take place in the area of water power engineering. In this respect Poland, despite being a country with a large territory, has a small potential of only 7 000 GWh/year. In consequence, the share of electricity produced by hydroelectric power plants is 1,5%.

First and foremost small water power stations will dominate at the locations of already existing dams.
In Poland, an increase in the importance of inland shipping is determined by management and modernization of the existing, in a limited range, water courses, construction of links for transport and trans-shipment which allow to carry out intermodal transport. Due to the deteriorating condition of waterways, there is slight interest in inland waterway shipment as an alternative form of transport. The development of river transport in Poland is determined by the construction of a network of waterways of suitable quality and adjacent to infrastructure. Social education is also of considerable importance. River transport is among the cheapest and most environmentally friendly means of transportation. The total length of waterways in Poland is about 3800 km. Only a small part of them meets the relevant standards.
According to the report on the *Condition and perspectives for development of inland shipping in Poland*, inland water transport, regardless of low participation in the service of joint transport needs, may play a very important role in selected segments of the market (*Stan i perspektywy…,* 2013). This will include passenger transport as well as transport of aggregate dredged from river bottoms. Transport of other stock, due to the fact that for many years competing forms of transport are being developed, will not be possible in the analyzed time perspective. Investment activities for the creation of conditions for water transport will concentrate on the Odra River. A short segment of the Upper Vistula watercourse, which in practice is not used for any form of transportation, will remain as an unresolved problem.
At the same time, taking into consideration the requirements of the EU water policy, in planning in Poland new infrastructural projects, the following two premises will be of significance:

- decisions undertaken on investment matters in water management will have to constitute a compromise taking under consideration not only the expectations of various social groups, historical conditioning as well as the aforementioned requirements;
- modernization of the existing hydrotechnical infrastructure, implementation of programs compensating losses caused by changes in the physical characteristics of surface waters are tasks which, within framework of the EU water policy, will be regarded as being of a more compromising character than realization of totally new projects.

Western European countries are in a decidedly less complicated situation in regard to the possibilities of choosing paths of sustainable development based on optimally balanced share of different energy sources, diverse forms of transport and flood control infrastructure which will be modernized. In Poland, the search for complex solutions which allow to maintain and use the existing facilities will remain a problem. In many cases, such as the Włocławek drop or the Upper Vistula water course, they constitute only a fragment of great projects which are in the planning stage. In other words, hydrotechnical infrastructure will not partake in an important manner in the process of enforcement of sustainable development policies.

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