MIDDLE POMERANIAN SCIENTIFIC SOCIETY OF THE ENVIRONMENT PROTECTION
ŚRODKOWO-POMORSKIE TOWARZYSTWO NAUKOWE OCHRONY ŚRODOWISKA

Annual Set The Environment Protection
Rocznik Ochrona Środowiska

Volume/Tom 19. Year/Rok 2017 ISSN 1506-218X 65-80

Hydropower Structures in the Natura 2000 Site on the River Radew: an Analysis in the Context of Sustainable Water Management

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1. Introduction

Hydropower is a potentially "clean" and "environment-friendly" renewable energy source (RES). In Poland, the interest in hydropower is stimulated by the international commitments of Poland to increase the share of RES in its overall gross energy usage. The "Energy Policy of Poland until 2030" assumes an increase of the use of RES up to 15% by 2020 and up to 20% by 2030. This indicator has been growing continuously since 2012, when it stood at 7.2% (Wiatkowski & Rosik-Dulewska 2012). Water energy – comprises to as much as 20% of power installed in various power plants around the world. In world's scale Norway and Brazil are among water tycoons (Pawłowski 2010). It is worth noting that the hydropower capacity of Poland is used only in 12% whereas, for example, France makes use of 100% of its capacity.

In the literature, one can find information on the advantages and drawbacks of small water power plants, as well as on their influence on the environment. These advantages include: there being no harmful pollution from the combustion of conventional fuels, an improvement in the saturation of water with oxygen down the dam, regulation of the water circulation system, integration into the landscape, reduction in flood risk and the formation of bird sanctuaries in the reservoirs used to drive the power plant (Fantin-Cruz et al. 2015; Kasperek & Wiatkowski 2014;

Malm Renöfält et al. 2010; Ždankus & Sabas 2006). However, in the literature information can also be found on the negative influence of such structures on the natural environment. The negative impact depends, among others, on the location of the plant and the adopted technical solution: the hydropower plants with a reservoir are more dangerous than the river hydro plants because of the outflow control and the impact on the hydrological regime down the dam (Anderson et al. 2015; Klaver et al. 2007; Jackson 2011; Malczewska 2010). Equally importantly, hydropower plants prevent the water organisms from migrating. Moreover, the power plants modify the temperatures down the dam and stimulate the bottom erosion which translates to a lower groundwater table. In what concerns the hydromorphology, new processes arise in the valley. In the case of reservoir hydro plants, sudden damming may result in the abrasion of water reservoirs (Benejam et al. 2014; Florek et al. 2008; Mihailova et al. 2013; Szoszkiewicz et al. 2014). Although the reaction of nature to the construction of a hydro plant is unpredictable (Jackson 2011; Vaikasas et al. 2015), one can take some mitigating measures such as, for example, building a fish ladder (Kasperek & Wiatkowski 2008). Therefore, the facilities should be monitored. The authors have begun research on the influence of such facilities on the natural environment. The aim of this paper is to analyze the operation of hydropower facilities "Rosnowo" and "Niedalino" within the network of protected areas Natura 2000, in the Radew river basin, north-west of Poland, in the context of sustainable water management. The natural conditions of the site are described, the legal conditions for Natura 2000 sites have been presented, and social conflicts related to the operation of water management projects in Natura 2000 areas have been highlighted. The article will contribute to the presentation of results of the assessment of the functioning of the hydro plant in the context of requirements for such objects for the protection of nature and the conditions under which they may operate.

2. Characterisation of the Radew river basin

The research area is located in the north-west of Poland, in the eastern part of the zachodniopomorskie province. According to Kondracki's classification, the area is located in the south-eastern part of the Pobrzeże Koszalińskie macro-region (Kostrzewski 1998).

The Radew is a lowland river, i.e. has a steady flow, muddy bottom and small slope. Side erosion is dominant, the course is strongly meandering and the river basin is located below 200 m ASL (KZGW 2014). The river is 93 km long, it flows out of the Kwiecko lake in the region of Żydowo and falls into the Parsęta in the region of Karlino. The surfrace area of the basin is 1082.4 km^2, which classifies this watercouse as the biggest–tributary of the Parsęta. The river has 20 tributaries. The river belongs to the water region of Przymorze Zachodnie. The basin of the river under study is part of two Natura 2000 sites, namely "Dolina Radwi, Chocieli i Chotli" and "Wiązogóra", and of other protected areas (GDOŚ 2015; Obolewski et al. 2016). The research area is shown on the map below (Fig. 1).

Fig. 1. The map of the research area (base map: geoportal.kzgw.gov.pl/imap/; date of access: 02/09/2017)
Rys. 1. Mapa obszaru badań (podkład: geoportal.kzgw.gov.pl/imap/; data dostępu: 02.09.2017 r.)

3. Hydropower use of the Radew

There are four hydropower plants operating on the Radew: "Żydowo", "Rosnowo", "Niedalino" and "Karlino". These facilities, with different power ratings, are located at different reaches of the watercourse. Although built in the 20th century, they correspond with the present EU policy on power generation. The key parameters of these small hydropower plants are given in Table 1.

Table 1. List of hydropower plants on the Radew with a short overview of each facility (Kostrzewski 1998; Obolewski et al. 2016)
Tabela 1. Wykaz elektrowni wodnych na rzece Radwi wraz z ich charakterystyką (Kostrzewski 1998; Obolewski i in. 2016)

No	Name of the plant	Km	Year built	Installed power [MW]
1.	Pumped storage power plant "Żydowo"	82+300	1971	157
2.	Hydropower plant "Rosnowo"	44+700	1922	3.3
3.	Hydropower plant "Niedalino"	36+000	1912	4.4
4.	Small hydropower plant "Karlino"	0+880	1926	0.1

Thanks to the properties of its basin and the hydrologic, geomorphic and climate conditions, the Radew has a hydropower potential and is an interesting option for water management projects despite its being part of a Natura 2000 site. As explained in, the reason for this is the high precipitation in the basin, but also the location of the river source high above its mouth and the favourable shape of the valley. The rough power of the river is 3.3 MW (Kostrzewski 1998; Obolewski et al. 2016).

There are three water sills in the middle course of the Radew, namely: the watermill at Niedalino (km 33.8, installed power: 220 kW) and the cooperating hydropower plants – Niedalino and Rosnowo. The damming of the Radew with an earth dam at km 44+700 of its course formed the Rosnowo reservoir. This reservoir supplies water for the hydropower plant Rosnowo through a supply channel. The water flows to another reservoir called Hajka, which supplies the power plant at Niedalino. Eventually, water is discharged through an outflow channel to the lower course of Radew at km 36 (Obolewski et al. 2016).

Initially, the rivers were used primarily for the generation of electricity in the pumped storage power plants of Rosnowo and Niedalino. They were also used as retention reservoirs during freshets (the idea of increasing the water retention is important due to the meager water resources of the Poland, as pointed out, among others, by Liberacki et. al 2016). Today the role of this entire hydrotechnical system has increased. It is also used for recreational purposes, as well as for fishing and as a water source in case of fire. At Mostowo, km 55+500, there are deep

water wells and water treatment stations – the water serve the city of Koszalin, as well as Mielno and Unieście (Obolewski et al. 2016).

4. Natural assets of the area

Because of the hydromorphological changes made to the middle reach of Radew, the natural conditions in a 8+ km long river section have changed drastically. The changes affected both the wetness of the terrain and its hydrological character. On a fast, shallow watercourse reservoirs were formed with a quiet flow, greater depths and a much broader channel than that of the Radew. Consequently, on the forested lands, in places with no constant presence of water ecosystems have formed characteristic of marshes. Water vegetation has appeared and these places have become a sanctuary for aquatic birds. Moreover, the area from Rosnowo to Hajka has value landscapes (GDOŚ 2015; Kostrzewski 1998).

All these factors have lead first to the creation of a protected landscape area "Dolina Radwi (Zegrze-Mostowo)" and then – in March 2009 – to the formation of a special protected habitat "Dolina Radwi, Chocieli i Chotli" in the framework of the European network of protected areas Natura 2000. The hydropower system described in this paper is part of this protected habitat. The entire site has an overall area of 22.000 ha including 4 priority sites and protects 39 species of flora and fauna listed in the annexes to the Habitats Directive and the Bird Directive (GDOŚ 2015; Kostrzewski 1998).

5. Legal factors for undertakings in the Natura 2000 sites and the principles of environmental protection and rational water management

The area being characterized is highly attractive, but its inclusion as a Natura 2000 site has also some consequences related to the specific, imposed type of usage. The main document which sets out the international policy on water is the Water Framework Directive. Being a member state, Poland is committed to adhere to its regulations. Consequently, its policies have been implemented in the Polish legal framework. For each member state there is an imposed time schedule. In the case of our country, the first deadline for the achievement of environmental goals is set to end of 2015. Consequently, important changes were made to the

Water Resources Law, the Environmental Protection Law and to many others. Lastly, new executory provisions were enacted.

In view of the above legal conditions and the new philosophy based on the approach to water as an "inherited resource", this paper thoroughly describes the hydropower plants starting from the water dam in Rosnowo and ending with the power plant in Niedalino. This description is made in the context of the requirements set out for the protected Natura 2000 sites (provided mainly in the Habitats Directive and in the Bird Directive), but also analyses the rational water management (Directive 2000; Okoński 2014).

In what concerns the provisions of the Bird Directive and the Habitats Directive, the most important principle is that of "not worsening", i.e. activities should be undertaken in such a way that the existing status of the environment. Importantly, a reference is made to the "current" status, i.e. that at the time when the Natura 2000 site was created. The main idea is to preserve at least those parts of the environment, because of which the site is considered notable, distinctive or locally representative. The reference point is the year in which the site was added to the European network of protected areas. Clearly, the actions aimed at improving the natural status are recommended, but not strictly necessary. The Natura 2000 sites are supposed to promote internationally a given area. Similar provisions can be found in Polish legislation, such as e.g. the Environmental Protection Act. Based on the example presented in our paper – the reservoirs formed about 100 years ago, the derivation channel, hydro-engineering structures and the hydropower plants in Rosnowo and Niedalino are an integral part of the landscape – this is precisely the status, to which one must refer when taking actions. The way they are they form a fully functional complete system with its specific environmental, social and economic conditions. Such unjustified actions would have been harmful not only to the environment, but also to the safety, health and well-being of people (Directive 2009; Directive 1992).

It is worth noting that at present the procedure of building a new hydropower plant in a Natura 2000 site would have been a lot more complicated. For any such investment an environmental impact assessment would have been required, in line with the Regulation of the Council of Ministers from 9 November 2010 on the undertakings with a significant potential impact on the environment. Since such an undertaking qualifies

to group II, i.e. an investment with a potentially significant impact on the environment, it would have been recommended to create a report on the environmental impact. As can be seen, the persons intending to launch new initiatives in water management will have to face several challenges, which were unheard of several dozen years ago (Rozporządzenie 2013; Ustawa 2008). This is consistent with the multidimensionality of sustainable development. As pointed out by Pawłowski should be taken into account, among others, the following aspects: the ethical dimension (the issue of humanity's responsibility for nature), the ecological dimension (nature conservation, protection of the environment created by humankind, spatial planning), the technical and technological dimension (new technologies, being economical with raw materials) (Pawłowski 2009).

6. The hydropower plants "Rosnowo" and "Niedalino" on the river Radew – an assessment of their operation in terms of the fulfilment of the environmental protection requirements

With reference to the hydropower plants "Rosnowo-Niedalino", several documents are in force which set out the rules for rational water management for the facility. These documents are based on the Water Resources Law and include: water management instructions, station instructions and operating instructions of the power plant, water permits and the aquatic legal surveys. These documents not only specify the function of the facility and its hydro-engineering structures, but also the methods and procedures for their safe operation so as to ensure a balance in the hydrographic conditions and safety of the staff and the population in line with the requirements of the current water policy (Ustawa 2001).

In what concerns the hydrotechnical system "Rosnowo", it consists of the following: the Rosnowo reservoir (formed by constructing a dam on the Radew, its retention capacity is 0.57 mln m^3 and an area of 154 ha); an earth dam with a weir, which directs the water from the reservoir to the old river bed; an evacuation channel leading to the power plant and to the Hajka reservoir, with an intake; the hydropower plant – the built part and the hydrotechnical part (3 water turbines – chambers with Francis turbines; power: 1100 kW and the nominal slope 16.4 m). Apart from these, there are also control structures (Obolewski et al. 2016).

Recently, during the period from June to August 2015, several works were completed, including the modernization of the intake lock and the supply channel. Moreover, several components in the power plant building were replaced. These works were necessary to ensure the correct functioning of the power plant and safety of the staff. Additionally, the grate at the intake to the power plant building was replaced.

Currently, the construction of a fish ladder is planned, which is the result of an order by the RZGW (Regional Board of Water Management) (RZGW 2014). Apart from that, renovation is also required for the sluice weir, which conducts the water in the case of a freshet, emergency or maintenance – an automatic weir will have to be installed, because the present capacity of the idle sluice exceeds the control discharge. In what concerns the Rosnowo reservoir, its maximum operating water level must not be exceeded and the minimum level must be maintained. This is required not only for the technical equipment to operate correctly, but also for the biological balance in the reservoir and because of safety concerns.

The silting up and shrinking of the Rosnowo reservoir is a well-documented and clearly perceivable environmental trend. Over the period of 40 years its surface decreased from 189 ha to 154 ha. Importantly, the present water permit points at the necessity of maintenance works on the river bed of the Bielica, which falls into the reservoir at a point within the reach of backwater. Such substantial works are scheduled for 2018. It is expected that this investment may not achieve some of the environmental goals under the Water Framework Directive and that some time derogation with regard to these goals should be considered. This reservation has been included in the updated draft Water Management Plan for the Odra drainage area (KZGW 2014).

The second hydropower plant "Niedalino" consists of the following structures: the Hajka reservoir with its dam (useful capacity: 0.242 mln m^3, surface area: 90 ha; dam length: 325 m and width: 4-80 m); the hydropower plant Niedalino – consisting of the above-ground part and the underground part (4 hydro-systems – turbine chambers with 3 operational Francis turbines and the following parameters: power: 1100 kW, flow rate: 5 m^3/s); a weir with a bottom sluice – a reinforced concrete weir with a 3-stage cascade and baffle piers in the spillway slab; evacuating channel, reinforced with stone material, in the Radew river bed.

Similar to the "Rosnowo" power plant, also here the usage of the Radew does not the water needs determined for the water region, i.e. the intake does not exceed the maximum flow rate determined for the hydro-engineering structures. Also the ordinates of damming between the minimum level are maintained, as well as those for letting the water pass so as to maintain the inviolable flow. The inviolable hydrobiological flow required for the maintenance of biological life and for the sake of landscape has also been determined. The hydro-engineering structures should fulfil their role, therefore their condition should be monitored and checked and maintenance should be provided. Hydrological measurements should be carried out for the flows and water levels and the Radew river bed below the dam should be kept in good condition. In what concerns the environmental protection and the consequences of operation on a Natura 2000 site, the owner is obliged to construct a fish ladder, and until this requirement is fulfilled – to restock the Hajka reservoir every year with eel, so as to maintain its population.

The latest document, which affected the direction in which the hydropower plants were rebuilt is the above mentioned order no 3/2013 of the Head of RZGW in Szczecin, dated 3 June 2014, on the terms and conditions of water usage for the regions of Dolna Odra and Przymorze Zachodnie. The most important goal of this document is to maintain the good status of the watercourses, which can be achieved by eliminating any obstacles to the inviolable flow. The most important decision is that all the hydro-engineering structures on rivers listed in a separate annex must be equipped with devices ensuring free fish migration. The changes must be made until the first rebuilding or development of the structure or until the deadline specified in the Water Management Plan for the Odra river basin area for the appropriate bodies of water. Another requirement is to install the grates with a maximum grid size of 15 mm at the entrance to the hydropower plants. These hydropower plants had such grates installed in June 2015 in Rosnowo and in August 2015 in Niedalino. The deadline for the completion of the solution for fish migration, specified in the water permit is end of 2021 for the hydropower plant in Niedalino and end of 2018 for the hydropower plant in Rosnowo (RZGW 2014). The plans outlined above prove a sensible approach to the issues of environmental protection.

7. Social conflicts related to water management in the Natura 2000 sites

Social conflicts related to water management undertakings implemented in the Natura 2000 sites stem from many various sources. The following are worth mentioning:

1) the concentrations of protected areas with valuable environmental assets and playing an important role in terms of water management;
2) ecological corridors in the areas important for water management;
3) neglect and poor financing of water management, and consequently the need to undertake tasks in protected natural sanctuaries;
4) non-compatibility between the legal framework of water management and the environmental protection laws; there being no cooperation procedures for the institutions supervising the environmental protection and those responsible for the water management system.

Such conflicts often result from decisions taken a long time ago; these conflicts were present already at the time of creation of a Natura 2000 site – in such cases it is necessary to take the right steps and find a solution. Simultaneously, a conflict is an obstacle in the implementation of water management goals or environmental protection goals for a Natura 2000 site. The causes and the course of social conflicts will be shown on the examples of the Trout Farm in Ubiedrze and the allegations of pollution into Chociel river (Badora 2013; Wiatkowski & Tomczyk 2015).

Some water management investments in the river basins located in the Natura 2000 sites are particularly controversial. One such example was the construction of a trout farm in Ubiedrze, which began in June 2011. The key charge made by the members of the Polish Angling Association was the destruction of habitats suitable for spawning grounds for endangered fish. Apart from this, the terrain includes protected wetlands, and the only known location of callitriche in Poland. Moreover, anglers voiced their concerns that the breeding of rainbow trout could adversely affect the water ecosystems by introducing a non-local species which might drive out the native species. Their observations hint that in the area of Mostowo a large proportion of the population of speckled trout has become extinct due to the fry being eaten by the "runaway" trout from the farm, leading to the homogenization of species found in the environment and to the disturbance of the biocenotic balance (Vowles et al.

2014). Therefore, there is a conflict of interests of the naturalists with those of the investor and the contractor.

The second example of social conflicts is the allegations of pollution in the upper reaches of the river – that is, discharges from the storm water treatment plant (storm outlet) of Bobolice, but also the leaky sewers of the sanitary sewage system, which overwhelmed the sewage system, significantly worsening oxygen conditions and physicochemical parameters of water. In July 2011 and in November-December 2012, inspections of the Voivodeship Inspectorate for Environmental Protection (WIOŚ), the Delegation in Koszalin, where no adverse changes were observed or legal actions were carried out. These were one-off checks, and those who had been watching for a long time noticed the change of color to dark brown and unpleasant odor – which caused death of fishes. It is worth mentioning, however, that the Regional Water Supply and Sewerage Company in Bialogard – Bobolice region, intervened several times to ensure the wells and their security. Eventually, in January 2013, appropriate action was taken, and there is currently no problem with leaks of impurities into the Chociel river (Atalap 2011, 2013).

8. Conclusions

The use of water management facilities, including those designed for power generation, located in the Natura 2000 sites requires cooperation between the specialists in the fields of both water management and environmental protection. Adhering to the principles of water management helps with achieving the targets of environmental protection.

The hydropower plants discussed in this paper have contributed to the formation of ecosystems related to water, already in existence at the time of creation of the "Dolina Radwi, Chocieli i Chotli" site. They also contributed to the specific species composition and the hydrological regime as well as other properties of the animate and inanimate world.

The hydropower plants play various roles in the environment and economy, they generate inexpensive clean energy to be used by man. This way both the power production policy and the environmental policy are implemented. The use of this alternative energy source should be promoted also in the Natura 2000 sites.

The analysis of the hydropower use of the river Radew in the "Dolina Radwi, Chocieli i Chotli" Natura 2000 site indicates that rational

actions are being taken to maintain sustainable water management in the hydrotechnical facilities in question, with particular emphasis on the principles of environmental protection. The operational assessment of the hydropower plants "Rosnowo" and "Niedalino" on the river Radew has shown that the hydropower facilities together with the entire hydro-engineering infrastructure contribute to the tasks of rational management of water resources, mainly in terms of maintaining the river and the hydrotechnical structures, using the water resources for power generation and providing protection against floods.

To sum up, the water management facilities located in the Natura 2000 sites may operate quite well; however, certain social, legal and environmental obstacles exist. These problems can be eliminated and the users manage the water resources in a more or less rational manner. Moreover, as can be seen in the paper, several water management works have been carried out in the Radew river basin and despite the rich hydro-engineering infrastructure in the area, the unique natural qualities of the site are preserved.

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Analiza funkcjonowania obiektów hydroenergetycznych na obszarze Natura 2000 w zlewni rzeki Radew w aspekcie zrównoważonej gospodarki wodnej

Streszczenie

Praca dotyczy zagadnień dotyczących infrastruktury gospodarki wodnej ze szczególnym uwzględnieniem obiektów hydroenergetycznych i ochrony przyrody na obszarze Natura 2000 „Dolina Radwi, Chocieli i Chotli" w zlewni rzeki Radwi. Przedstawiono zalety i wady energetyki wodnej, charakterystykę zlewni rzeki Radew oraz wykorzystania hydroenergetycznego omawianego obszaru. Opisano warunki przyrodnicze terenu i scharakteryzowano uwarunkowania prawne dla przedsięwzięć na obszarach Natura 2000 (Ramowa Dyrektywa Wodna, Dyrektywa Ptasia i Siedliskowa, Ustawa Prawo wodne, akty wykonawcze w formie rozporządzeń i inne). W pracy przedstawiono ocenę funkcjonowania hydroelektrowni „Rosnowo" i „Niedalino" na rzece Radwi w kontekście wymagań stawianym takim obiektom ze względu na ochronę przyrody. Zwrócono także uwagę na konflikty społeczne związane z funkcjonowaniem przedsięwzięć z zakresu gospodarki wodnej na obszarach Natura 2000. Z pracy wynika, że na obszarze Natura 2000 „Dolina Radwi, Chocieli i Chotli" prowadzone są racjonalne działania mające na celu osiągnięcie zrównoważonej gospodarki wodnej na obiektach hydrotechnicznych, z zachowaniem zasad ochrony środowiska. Omawiane w artykule elektrownie wodne przyczyniły się do wykształcenia ekosystemów związanych z wodą, zastanych w momencie tworzenia „Doliny Radwi, Chocieli i Chotli", a także określonego składu gatunkowego, reżimu hydrologicznego oraz innych właściwości świata ożywionego i nieożywionego. Elektrownie wodne pełniąc różne zadania w środowisku i gospodarce wytwarzają energię, z której korzysta człowiek. W ten sposób realizuje się zarówno politykę energetyczną, jak również środowiskową. Obiekty związane z gospodarką wodną mogą dobrze funkcjonować, jednakże pod pewnymi warunkami społecznymi, prawnymi i środowiskowymi. Jakiekolwiek problemy są jednak minimalizowane, a użytkownicy w sposób racjonalny gospodarują poprawnie zasobami środowiska, planując i dokonując modernizacji tych budowli czy też stosując środki kompensujące. Ponadto w zlewni Radwi wykonano szereg prac z zakresu gospodarki wodnej i mimo bogatej infrastruktury wodnej na tym obszarze, zachowane zostały unikalne walory przyrodnicze terenu.

Abstract

This paper deals with the water management infrastructure, with a particular emphasis on the hydropower structures and environmental protection in the "Dolina Radwi, Chocieli i Chotli" Natura 2000 site in the Radew river basin

(the zachodniopomorskie province in the north-western Poland). Advantages and drawbacks (environmental, economic and social) of water power generation and a characterization of the Radew basin and characterization of hydropower usage of this area are discussed. The natural conditions of the terrain are described and the legal setting is characterized for undertakings in the Natura 2000 sites (Water Framework Directive, the Birds Directive, the Habitats Directive, Water Resources Law, the Nature Conservation Act, Act on Access to Information on the Environment and Its Protection and on Environmental Impact Assessments and executory provisions in the form of regulations). The paper presents an assessment of the operation of the hydropower plants "Rosnowo" and "Niedalino" on the river Radew in the context of the environment protection requirements for such facilities. Attention is also given to the social conflicts related to the operation of water management facilities in the Natura 2000 sites (on the example of the Trout Farm in Ubiedrze on the river Chociel). The authors conclude that in the "Dolina Radwi, Chocieli i Chotli" site rational actions are being taken for sustainable water management of hydraulic engineering facilities and that the principles of environmental protection are observed. The hydropower plants discussed in this paper have contributed to the formation of ecosystems related to water, already in existence at the time of creation of the "Dolina Radwi, Chocieli i Chotli" site. They also contributed to the specific species composition and the hydrological regime as well as other properties of the animate and inanimate world. The hydropower plants play various positive roles in the environment and economy, they generate inexpensive clean energy to be used by man. This way both the power production policy and the environmental policy are implemented. The use of this alternative energy source should be promoted also in the Natura 2000 sites. The structures related to water management may operate properly, but certain social, legal and environmental conditions apply. Any arising problems are minimized and users manage the natural resources in a rational and appropriate manner, both in terms of planning or modernizing these structures or by using compensation means. Moreover, several water management works have been carried out in the Radew river basin and despite the rich hydro-engineering infrastructure in the area, the unique natural qualities of the site are preserved.

Słowa kluczowe:
elektrownie wodne, odnawialne źródła energii, obszary Natura 2000,
rzeka Radew, Ramowa Dyrektywa Wodna, gospodarka wodna

Keywords:
hydropower plants, sustainable energy sources, Natura 2000 sites,
the Radew river, Water Framework Directive, water management