

ENVIRONMENTAL PROTECTION IMPROVEMENT POSSIBILITIES FOR SMALL HYDROPOWER PLANT PROJECTS

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Abstract. The existing solutions for small hydropower plants were considered convenient from the technical point of view over a long period, while general environmental concerns of society increased in all directions during the last decades. This paper refers to how to include environmental protection measures during the selection of the sites for a small hydropower plant and its water intake, during the preparation of the project, and then during operation. Investments for modernization of old small hydropower plants have to also include improvements regarding especially the protection of the river ecosystem. Specific environmental training for those who will be designers of small hydropower plants can be useful for environmental protection improvement in such projects.

Introduction

River hydropower potential is an important resource in many countries and various technical solutions and specific equipments were developed for its use. A large number of hydropower plants having very different total powers, according to local conditions, were built in several European states, and also in Romania [12].

In the last decades, the hydro-energy producers with smaller installed power have been called small hydropower plants, the present limit for this category being generally up to 10 MW.

Small hydropower plants, which produce clean energy, allow the avoidance of fossil fuels consumption increase, and therefore act towards environment protection.

However, this does not result in automatic compliance with environmental protection requirements, because many of them need constructions in river

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channels and on river banks and they influence water flow [2][3][4][8], with various effects [5] that have to be analyzed for each case.

Actually, the existing solutions for large hydropower plants and small hydropower plants were considered convenient from the technical point of view over a long period, while general environmental concerns of the society increased in all directions in the last decades, in order to avoid long term degradation of some environment factors or components, with serious effects, caused by the whole range of human activities.

Environmental legislation of the European Union and Romania comprises now high environmental requirements for economic activities, with the purpose of orienting economy and society towards sustainable growth models, environment protection becoming one of the main concerns.

Hydropower plant projects, technically very good, have to follow environmental procedures that are more complicated than stakeholders expected, with public discussions and sometimes encountering difficulties in the approval by environmental protection authorities.

That is why it is necessary, even in the preparation phase of a small hydropower plant project, to know the applicable environmental requirements and to develop solutions in order to comply with them and avoid important difficulties and delays in the subsequent phases.

The need to provide support and orientation in environmental problems to those who prepare small hydropower plant projects has been recognized by groups of specialists concerned with sustainable development in hydro-energy use.

The present paper shows some more frequently applicable requirements, and some approaches towards complying with these demands.

1. Consideration of environmental protection during the selection of the sites for a small hydropower plant and its water intake, and during the preparation of the project

A project for a small hydropower plant has to be prepared step by step, taking into consideration the environmental legislation (Fig. 1).

From the point of view of designing hydropower plants, the most important change of environmental legislation has been generated by the Water Framework Directive, implemented in the Law of Waters in Romania.

According to these new legal provisions, water bodies, e.g. rivers or lakes, have to be protected, enhanced and restored with the aim of achieving good surface water status by 2015, or, for artificial and heavily modified water bodies, to be protected and enhanced with the aim of achieving good ecological potential and good surface water chemical status in a certain period.

This means achieving an adequate quality of the biological elements (for rivers: aquatic flora, benthic invertebrates, fish fauna), hydro-morphological elements (hydrological regime, river continuity, morphological conditions), chemical and physical-chemical elements (thermal conditions, oxygenation conditions, salinity, acidification status, nutrient conditions, priority pollutants, other specific pollutants).

Some impacts of small hydropower plant projects are related to fish fauna and hydro-morphological conditions.

Modifications of water bodies may be hardly accepted under the provisions of this directive, and only if several conditions are met: adverse impact mitigation, explanation of reasons, overriding public interest, lack of other significantly better environmental options because of technical feasibility or disproportionate cost.

The main problems faced by small hydropower plant projects (Fig. 2) are related to:

- water flow quantity
- longitudinal continuity
- migration possibility for some fish species.

Another important change in environmental legislation is due to the Habitats Directive and the development of the corresponding network of natural protected areas.

Direct impact on natural protected areas can be prevented or limited by avoiding to locate the constructions of the project or the access roads in such areas or near them.

For projects and their auxiliary constructions that are proposed to be located in such areas, it is necessary to carry out a very detailed assessment of potential adverse impacts on every protected habitats and species of that area. In order to improve environmental protection in a small hydropower plant project, it has to be in agreement with the management measures for the protected area.

Therefore, it would be better to select a site for a small hydropower plant outside the natural protected areas and so that to avoid as much as possible the potential impacts on such areas. Such an approach saves time in the environmental impact assessment procedure for the project.

If a site within a natural protected area is taken into consideration, it is absolutely necessary to discuss with the specialists who take care of that protected area, so that to know if they can agree to the proposed project with some technical requirements, or if they cannot agree because of specific features of the natural protected area.

Actually, the site for a small hydropower plant and its auxiliary constructions has to be selected so that it is both technically convenient and environmentally acceptable, as for other types of investments [11].

The really usable hydropower potential results after taking into account the necessary flow to the downstream river sector for the protection of the water body ecosystem and for other uses.

Sufficient downstream flow is necessary for avoiding modifications of some habitats and this is very important for the protection of biodiversity [6]. The downstream water flow can be specified as a minimum value, or by a set of values, taking into consideration some hydrological conditions.

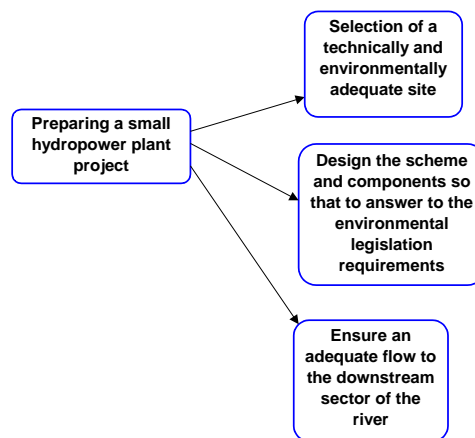


Fig. 1 – Project preparation steps considering environmental legislation

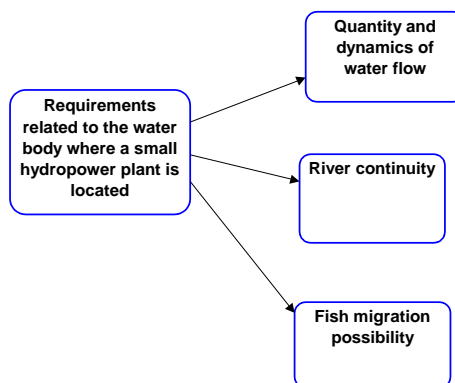


Fig. 2 – Main requirements for water body protection

To select the site, it is advisable to start from a classification of river sectors, taking into account their ecological importance for the whole river and the hydropower potential.

It is also necessary to know that the project can be compatible with the river basin management plan, which has in view certain objectives regarding the state of the water body, according to the environmental legislation.

During the selection of the site and preparation of the project, it is necessary to take into account the users of water from the respective river.

Where it is the case, the correlation with the background elements of the management plans for natural protected areas and with the provisions of these plans is useful.

The preferable zones are those where activities are possible in order to prepare the access roads and the water intake, and for construction, with an impact on the environment as low as possible.

Therefore, site selection criteria that take into account only technical and economical aspects can lead to difficulties and a longer duration for going through with the procedure to obtain the environmental agreement.

Under the present environmental legislation, for preparing a project for a small hydropower plant that can be approved without many modifications, it is absolutely necessary to take into consideration the environmental criteria, besides the technical and economical aspects. Actually, this leads to schemes that include some costs for the environment.

This approach is in agreement with the policy of orientation towards sustainable development, preparing medium-term and long-term sustainable projects without unacceptable effects on environment and society.

Finally, selecting with care the site for a small hydropower plant and its water intake and auxiliary constructions, it is possible to reduce as much as possible present and future potential environmental costs, which would consist of:

- environmental monitoring contracts
- environmental reports to authorities
- discussions with the public
- modifications of constructions and components in order to answer to some requirements that will appear later
- eventually, compensation measures if the project is located in a natural protected area.

Moreover, there are more chances to comply with future requirements of environmental legislation and to have long operation duration.

Adequate selection of the site and of technical and construction solutions for a small hydropower plant is decisive for environmental effects, because only management is flexible in the operation period.

In comparison with the projects for new water intakes, the impact is smaller in case of modernization of old small hydropower plants where repairs or replacement of equipments have to be done.

The investments for such old production plants have to also include environmental protection improvements, for example fish passes and the specification of the needed flow towards the downstream river sector taking into account the conclusions of specialists with regard to the ecosystem.

During the operation period of a small hydropower plant, some project proposals can be useful for the environment, for example referring to:

- Measures for correction of negative effects, immediately after they are observed.

- Modernization from time to time, taking into account the present requirements and the expected ones, on the basis of existent or proposed environmental legislation and best practices.

Consideration of environmental protection while designing a small hydropower plant and its auxiliary constructions has to be based on experience regarding good technical solutions, looking also for possible answers towards complying with present environmental requirements.

Besides technical and economic aspects, optimization of solutions for each case has also to be guided by reasonable limitation of the environmental impact.

There are different types of small hydropower plant schemes:

- Small hydropower plant with water intake and water supply canal, then energy generation and water discharge.

- Small hydropower plants on the river.

- Small hydropower plants located at man-made lakes with multiple uses.

- Small hydropower plants set in action by water for irrigation or by water discharged after use in some industrial installations. A small hydropower plant does not contribute to the impact on the water use in such cases.

A proposed scheme for answering to the requirements of longitudinal continuity and protection of migrating fauna, presented in the figure below (Fig. 3), keeps a free flow part of the river cross-section.

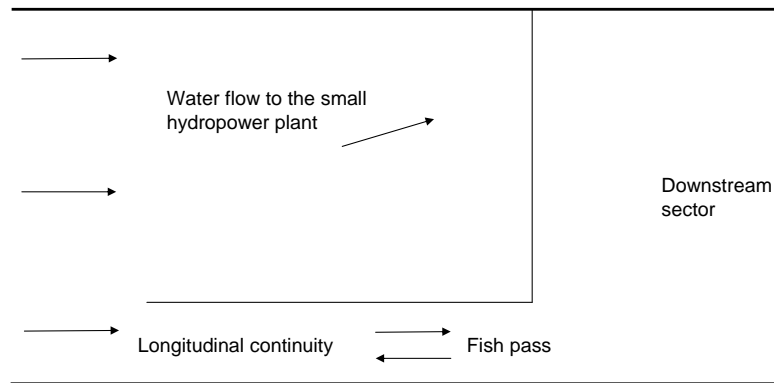


Fig. 3 – Local scheme for keeping longitudinal continuity in a part of the river cross-section and protection of migrating fauna

For diminishing the impact of the constructions of a small hydropower plant on the natural environment, it is recommended to integrate them into environment as much as possible, taking into account local landscape features and using local materials: cover with location - specific materials, e.g. stone from that zone, use of wood for some auxiliary constructions.

The water intake installations provide water for electric energy production and can also be useful for some environmental problems:

- Cleaning the river by removing some wastes that do not have to go farther in the environment (PET bottles, other plastic materials, packages, etc.), collecting them from the water intake grid.
- Additional point for observing and communicating some accidental pollution.

The mentioned ideas can also be taken into consideration for modernization and adaptation of some existing small hydropower plants to environmental requirements for the next period.

Modernization can improve environmental protection and offer higher energy production from a renewable source (river water flow) using more efficient generators.

It is advisable to take into account environmental aspects as much as possible in a small hydropower plant design, following notes from the authorities or the public, and to take into consideration the requirements of the existing or planned water users. Proceeding in this way, it will be possible to go through the procedures in a shorter time for obtaining the necessary approvals for construction, putting into service and operation of a proposed small hydropower plant. Moreover, the

approvals will probably specify less obligations regarding environmental protection if the project answers better the environmental requirements.

2. Environmental protection improvement during construction and operation of a small hydropower plant

Environment protection measures during the construction of a small hydropower plant with its water intake and all the other components are especially important for preventing and limiting effects on the natural environment. Various measures are needed (Fig. 4).

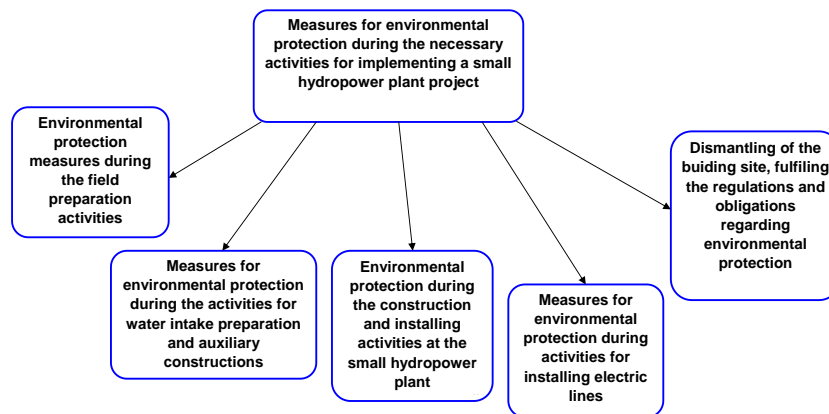


Fig. 4 – Project implementation steps that need measures for protecting the environment

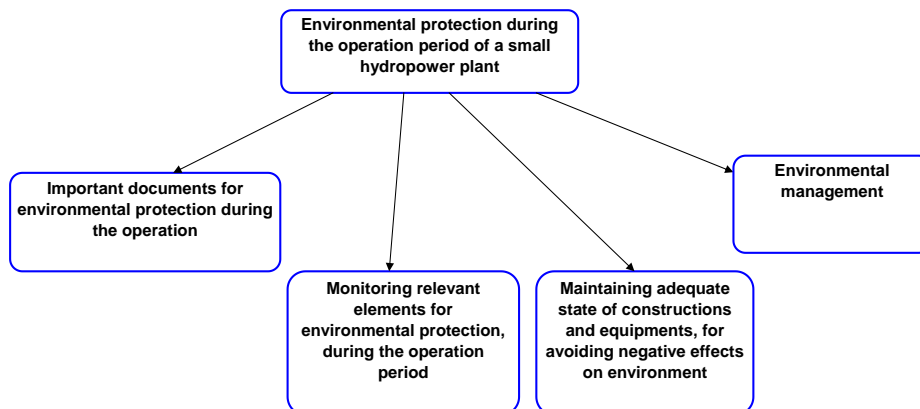


Fig. 5 – Measures for ensuring protection of the environment during the operation period

Specific environmental training for those who will be designers of small hydropower plants can be useful for environmental protection improvement in such projects. Environment protection measures are also necessary during the operation period of a small hydropower plant (Fig. 5).

Conclusions

New projects of small hydropower plants have to comply with the environmental legislation, and the most difficult steps refer to the Water Framework Directive and to the legislation for natural protected areas.

The decisive steps for preparing a small hydropower plant project to meet environmental requirements are: selection of a technically and environmentally adequate site, design the scheme and components so that they answer to the environmental legislation requirements, ensure an adequate water flow to the downstream sector of the river.

Selection of a site in a natural protected area has to be in agreement with the management plan and conservation objectives of the protected area. For projects proposed in natural protected areas, more detailed studies are needed because the main subjects are habitats and species for which the areas have been delimited.

Small hydropower projects can be prepared and implemented faster for sites outside natural protected areas.

Projects of small hydropower plants have to be compatible with the objectives for water bodies. Especially fish migration, river continuity and downstream flow are the problems of a hydropower plant project in relation to the river state.

Environmental protection improvement possibilities focus on fish pass and water intake design, which are very important for answering to these requirements.

Water intake solutions proposed to allow the natural river flow through a part of the cross-section would be good for preserving river continuity and fish migration.

To have a well-argued value of an adequate flow to the downstream sector of the river, it has to be identified on the basis of a specialized study after examining the specific fauna and conditions of the river. The needed downstream flow can be specified as a minimum value, or by a set of values for different periods of the year and different hydrological conditions.

Modernization of old small hydropower plants offers the possibility to include positive environmental actions for improving the state of the water bodies where they are located.

Following the objectives of the Water Framework Directive, investments for modernization of small hydropower plants can also contribute to:

- improvement of river continuity and migration possibility for some species of aquatic fauna

- ensure adequate flow values (ecological flow) for the downstream aquatic ecosystem according to a specialized study.

Construction of a fish pass has to be included in such projects where it is the case, as concluded by a specialist in biodiversity after examination of the river state and fauna.

Replacement of old equipments by new more efficient ones results in clean energy production increase, which is a contribution to environmental protection, and also covers costs related to environment protection.

Small hydropower plants can be better integrated in the natural environment by using natural materials specific to the zone where they are located.

In addition to energy production, small hydropower plants can contribute to environmental protection by collecting wastes (e.g. plastic materials) brought by the river to the water intake, and also by observation and communication of unusual effects on the river that may be due to an accidental pollution from upstream.

Environment protection measures during the construction of a small hydropower plant with its water intake and all the other components are especially important for preventing and limiting the effects on the natural environment. There are various necessary measures and their application can be supervised periodically.

Specific environmental training for those who will design a small hydropower plants can be useful for environmental protection improvement in such projects.

Environment protection measures are also necessary during the operation period of a small hydropower plant. Especially the water flow to the downstream river sector and the state of the fish pass are important.

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