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Strategy of bilateral cooperation on joint monitoring of transboundary rivers affected by hydropower

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Abbreviations

BSB	Black Sea Basin
EIA	Environmental Impact Assessment
GEF	Global Environmental Facility
HPP	Hydropower Plant
ICPDR	The International Commission for the Protection of the Danube River
iRBMP	international River Basin Management Plan
PSPP	Pumped storage power plants
QE	Quality Elements
RBMP	River Basin Management Plan
ROR	Reservoir Operation Rules
SEA	Strategic Environmental Assessment
SHPP	Small hydropower plants
UNECE	United Nations Economic Commission for Europe
WFD	EU Water Framework Directive

Introduction

This document reviews and provides recommendations on how to develop joint environmental monitoring of transboundary rivers affected by hydropower in the Black Sea Basin. While there are other major transboundary rivers flowing to the Black Sea such as Danube and Dnieper, the two rivers Dniester and Prut are used in this document to demonstrate the situation, challenges and opportunities.

The overall aim of the Strategy is to minimise the negative impact of hydropower and it is prepared for stakeholders with this interest. It will analyse the legal as well as institutional basis, the necessity and opportunities for joint monitoring of the impact of hydropower on transboundary rivers. It will draw conclusions on practical approaches and arrangements to such monitoring including how monitoring results could feed into decisions on water management. Section 10 describes principles and actions related to monitoring that are likely to have a positive impact on decision-making on hydropower promoting sustainability, shared prosperity and good neighbourliness among Black Sea Basin countries.

This Strategy covers existing and planned installations. There is a distinction between investigating and describing the overall impact of existing or future hydropower installations, and monitoring the day-to-day impact of a dam or other installation. In the latter case the short-term meteorological variations, energy production and related regulation of water flow are reflected. While changing the overall impact could be done by adapting/rebuilding/level installations, changes of the day-to-day situation is achieved by the management within the set parameters of installations.

In a transboundary basin the joint production of data and information should be preferred as it has the advantage of minimising conflicts and optimising opportunities for a joint and efficient decision making. This is also explicitly expressed in the terms of reference for this work. However, this does not exclude that there may be a need for unilateral approaches where joint work may not be possible.

The term “monitoring” will have a broad interpretation in this document. It includes the traditional aspect of monitoring the ambient environment but also research-related investigations, and environmental, economic and social impact assessments.

The general impact of hydropower is relatively well understood but there are still aspects and quantifiable parameters that need to be better investigated and analysed. This Strategy is an attempt to outline directions of work to achieve a better understanding for transboundary rivers in the Black Sea Basin with the focus on the rivers Dniester and Prut.

There are some basic principles to be followed by Riparians to develop and agree on joint, coordinated monitoring. First, the process on how to develop joint monitoring should be defined and agreed on. A few alternatives will be described below. Secondly, the interaction between Riparians must be characterised by a good faith dialogue. If this is not the case building of mutual trust may be needed.

The basin of the 1,362-km long river Dniester is shared by Ukraine and Moldova, with 73% and 26% of the basin area respectively. The river has its source in the Ukrainian Carpathians, and discharges into the Black Sea. The average annual flow volume is 10 km^3 with significant variations between years. Major transboundary tributaries include the Kuchurhan and Yahorlyk rivers. The basin is mountainous in the upper part and characterised by lowlands downstreams. Valuable wetland systems extend along the Dniester Estuary, including some 100 wetland lakes that play a vital role in maintaining the water balance and supporting the basin's biological diversity. There are two major hydropower stations in the basin: Novodnestrovsk HPP in Ukraine on the border with Moldova and Dubosari HPP in Moldova. The latter is managed by the Transdniester authorities.

The Prut River springs in Ukraine from the Carpathians Mountains and flows into the Danube on the Romanian-Moldovan border. It is the second largest tributary of Danube with a total length of 953 km and an annual average flow volume of 2,7 km^3. It stretches along 31 km of the border between Romania and Ukraine and more than 700 km between Romania and Moldova. The turbidity is high. The basin is more or less equally shared between the three Riparians. The Stanca-Costești HPP, the main installation on the river, is operated jointly by Moldova and Romania.

Smaller ponds and dams along tributaries is a common trait of the two rivers. The two rivers have frequent floods that is an important aspect of the management challenges.

The energy sector is a priority in Moldova as well as Ukraine. For the latter country the historic dependence on gas from Russia is a key factor while electricity is provided mainly by nuclear reactors. Moldova has only marginal internal resources of energy and is dependent on its neighbours in this respect. Romania has significant oil and gas reserves and also coal deposits. It has substantial hydroelectric power installed and is developing nuclear energy.

It should be noted that the lead ministries in Moldova and Ukraine for the Dniester River Basin Commission presently includes sectors – agriculture and energy - that contribute to pressures on rivers ecosystems. In the context of this Strategy, energy concerns reflected in policies of the Ukraine Ministry may influence the country´s positions. Similarly, the water use for irrigation is an important issue for the Moldovan Ministry.

Climate change

Regional climate change scenarios in the Dniester and Prut basins foresee drier and more prolonged drought periods in the summer, more moist winters and more frequent extreme floods caused by intensive precipitation in the Carpathian Mountains.

In a recent analysis of climate over the latest 30 years in the Dniester and Prut basins (Corobov, Trombitsky and Syrodoev 2019) a sharp and statistically significant increase of temperature was observed along with insignificant changes of precipitation. In particular in the lower Dniester Basin a more arid climate was observed.

For the Dniester River Basin, a Strategic Framework for Adaptation to Climate Change has been developed and approved by Moldova and Ukraine (Denisov et al. 2015). This may be an instrument to apply also in other river basins. It is an important aspect that climate change is likely to change investment calculations for future hydropower development.

Hydropower and its impact on ecosystems

As a rule, hydropower has a negative impact on the environment and water ecosystems. For example, it deteriorates the habitat, migration and spawning conditions for fish, retains sediments in reservoirs, and creates conditions for eutrophication and water quality degradation. The risk for dam accidents is another aspect.

There is a concern not only of larger HPPs but also with regard to existing and planned smaller ponds and reservoirs as well as derivation HPPs. A large number of such infrastructure may have a transboundary impact and should be taken into account also on the basin-wide level.

But the situation is complex. Water reservoirs may contribute to climate change adaptation by improving flood management and keeping minimum levels/flow of water during drought periods.

Hydropower (including pump storage) plays a key regulatory role in the energy production as it can easily be turned on and off. It is used to cover peak-load (morning and evening) and to balance other renewable but intermittent energy sources such as wind and solar. Hydropower also contributes to climate change mitigation. In the EU the demands for renewable, non-hydrocarbon generated energy is in conflict with the interest of ecosystem protection (see section 6).

New hydropower projects are presently not so common in developed regions such as the EU due to the conflicts of hydropower development with protection of eco-systems including in relation to WFD implementation. In countries such as the US and Sweden old (including not in use) and small dams may even be liquidated.

Hydropower development is more active in less developed regions such as Western Balkans, Caucasus[1] and Eastern Europe[2]. There are tentative plans for new HPPs in the BSB including in the Dniester basin.

Activities and the strength of environmental organizations on the national level are an important factor. In countries with a strong engagement hydropower development is less likely. In countries with a high level of environmental protection, the precautionary principle[3] is applied whenever there are doubts about plans for new installations.

Many environmental organizations are promoting an ecosystem approach to hydropower development. According to this approach preservation and functioning of the ecosystem are seen as essential for the survival of present and future generations. The ecosystem approach stresses high-quality SEA and EIA procedures with proper evaluation of ecosystem services and functioning, and the full involvement of civil society. There is generally a weakness in the instruments applied for making impact assessments as it may be difficult to estimate the full impact of new installations – be it economic, social or biological effects.

An important component of the ecosystem approach is the definition and application of "environmental flow". Joint annual decisions and monitoring of its implementation are central aspects of upstream-downstream cooperation.

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[1] Armenia, Azerbaijan and Georgia.
[2] Belarus, Moldova and Ukraine.
[3] The precautionary principle is used to justify decisions in situations where there is the possibility of harm from making a certain decision when extensive scientific knowledge on the matter is lacking.

Application of guidelines for the sustainable development and use of hydropower aiming to minimise environmental and social negative effects is an approach promoted by investors and the energy sector (e.g. EIB 2019, IHA 2018).

A basin-level approach taken by ICPDR (where the three countries more thoroughly analysed in this document are Parties) could be used as a model. An assessment of the role of hydropower in the Danube (ICPDR 2013a) was made as a basis for the development of Guiding Principles for hydropower (ICPDR 2013b) with the involvement of the energy sector, environmental authorities and organizations along with other stakeholders. The Guiding Principles for the Danube Basin stress factors such as the public interest and participation and aim to serve as a guidance for national decisions. An important aspect in a basin perspective is the cumulative impact of HPPs on the aquatic eco-systems. The Guiding Principles also stress the need for strategic planning processes and conclude that stretches of the river that should be kept free from hydropower should be identified.

A basin-wide approach is also taken in the Mekong basin. The 1995 Mekong Agreement requires that hydropower projects are discussed extensively among all four countries prior to any decision. That discussion, facilitated by MRC, is supposed to consider the full range of social, environmental and cross-sector development impacts within the Lower Mekong Basin. An SEA was published in 2010 on 12 planned HPP in the main Mekong river (Mekong River Commission 2010).

In an on-going "fitness check" of the EU WFD, hydropower interests are arguing for limitation of measures that may decrease hydropower production. A coalition of environmental groups called Living Rivers Europe is lobbying to safeguard the directive and strengthen its implementation and enforcement. The outcome of the fitness check (to be debated in the European Parliament in 2020) will be important for the hydropower development in the EU.

Dniester

The Novodnestrovsk HPP was built in the 1980s and includes a main reservoir (2.7 km^3, HPP-1), a buffer reservoir (31 million m^3, HPP-2) and presently 4 PSPP units. There are plans of Ukrgidroenergo[4] to increase the PSPP units to 7 and there are on-going bilateral negotiations on the request from the Ukrainian side to expand the buffer reservoir on Moldovan territory to serve this expansion (see below).

Further downstream the smaller Dubosari reservoir (41 million m^3) was constructed around 1955. The Dubosari reservoir has a limited impact on water flow but the dam constitutes the main obstacle for fish migration in the lower Dniester. The Dubosari HPP is managed by the Transdniester authorities and there are no formal discussions on release regimes and related issues. Ideally a process to discuss its Reservoir Operation Rules (ROR) with other Riparians should be initiated (see below).

The reservoirs are multiple-purpose and they are supposed to provide different services such as hydropower, irrigation, and flood and drought management. There are also tentative plans in Ukraine to build run of the river HPPs upstream of Novodnestrovsk.

In addition, there are smaller HPPs in the Dniester river basin. In Ternopol oblast of Ukraine there are 15 such objects (Melnichuk and Protsiv, 2019).

[4] The Ukraine state company for hydropower.

Under the GEF project "Enabling transboundary cooperation and integrated water resources management in the Dniester River Basin" a joint Ukraine-Moldova working group produced a report reviewing the effects of hydropower, in particular of the Novodniestrovsk HPPs (OSCE 2019). A Moldovan report on the same theme is being developed by the UNDP project "The Dniester Hydro Power Complex Social and Environmental Impact Study"

Negative effects described in the GEF report are drastic and include (but are not restricted to): significantly changed water flow including strong daily variability, lower levels of sediments and changed water temperature regime (colder water in summer, warmer in winter). The changed water flow and less sediments have led to an increase of vegetation in the river. Fish populations have changed with less economically important species presently dominating. Significant negative effects are found with regard to other aspects of the biological status, including in the delta region where for example the bird populations have declined significantly. The report further describes issues where additional investigations is needed to define the impact of existing hydropower installations, and also what may be done to alleviate the negative impact. The environmental flow regulated by the Novodniestrovsk HPP is a key concern in particular for the Dniester delta (see for example Rusev and Shchegolev, 2019).

Sometimes the effect of hydro-accumulating pumps on bioresources is raised as a problem. Possible water losses into what may be karst formations adjacent to the two Novodnestrovsk water reservoirs may further be an issue. However, a study of karst processes (Aksiom, 2002) indicates that karst influences on the runoff characteristics of the Dniester and its tributaries in the vicinity of the HPP-1 and HPP-2 cascade can only result in an increase due to leakage of underground water through a system of tectonic disturbances from the Prut River basin side. Further studies are needed to clarify the situation with regard to these issues. Improved, joint monitoring of the water flow immediately downstream of the reservoirs has been discussed some time and needs to be established to get a better understanding of the long-term and short-term impact of hydropower.

The Novodnestrovsk buffer reservoir and dam (HPP-2) does not seem to be used fully for its original purpose (to buffer water flow, temperature etc) as there are indications of hydropeaking of the flow[5].

Positive effects of the Novodnestrovsk HPP include opportunities for protection against floods and providing reasonable minimum flows for human consumption (drinking and irrigation) and ecosystems under low-flow and drought conditions.

Prut

In the Prut River Basin there are about 1350 man-made water reservoirs and ponds for different uses (fisheries, irrigation, hydroenergy, recreation etc.) including for regulation of water flow and flood management. There are over 300 reservoirs situated on small rivers that have a direct impact on flow distribution which cannot be evaluated because of lack of monitoring data. (EPIRB 2016). Interest in small HPP has revived in recent years. A number of investors seek to rehabilitate previously operational HPPs or to build new ones. The Sniatyn HPP is one example that has been recently retrofitted.

[5] There is a question mark on how to raise discussions on the full use of the buffer reservoir. While the corresponding HPS is private its regime should be open for discussion in Commission meetings. The buffer reservoir is small but it may be that it could be used as a "buffer" for diurnal variations of flow more efficiently than it is presently.

Some small HPPs in the Carpathians are designed to operate where river slopes are steepest and running water provides the most energy. To maximize power generation, large volumes of water are diverted from riverbeds to HPPs. Frequently this means diverting the entire river water volume and leaving in its stead a dry stone-covered riverbed. For several kilometres on end pipes are found instead of river streams, distorting the natural landscape (EPIRB 2013). This may cause serious environmental and socio-economic problems: Habitats are destroyed, aquatic organisms may disappear and fish fail to reproduce; protected areas suffer adverse impacts; the tourism potential declines, and the water abstraction may activate adverse geological processes.

The joint, Romanian-Moldovan Stanca-Costesti HPP (32 MW, reservoir 1.29 km^3) was built in the 1970s on the basis of a Romanian-Soviet agreement. The two countries are managing their own HPS in close coordination. The central goal of the construction was to protect villages along the Prut river after the worst floods in modern Romanian history in 1970[6]. The reservoir contributes to the reduction of floods even if serious floods such as in 2008 and 2010 continue to trouble the population. It is also used as a source of drinking and irrigation water.

According to the bilateral agreement on Stanca-Costesti, the minimum flow below the reservoir should be 25 m^3/s. In dry years, the water flow may drop below this minimum.

The construction of the reservoir has changed the hydrological regime, sediment transport and as a consequence the habitat of the Prut River. The flow affects the hydrological regime of lakes in the floodplain, as well as the ecological state of the Lower Prut Nature Reserve. The main hydro-morphological pressures consist in the discontinuity of the flow, and the flow regulation. Hydro peaking effect, except flood events, is not characteristic for Stanca-Costesti HPP. From this point of view, it presents a moderate pressure on the hydrological regime downstreams. There are accounts of the impact of the HPP (e.g. Ene and Ion 2019) but it seems that a more thorough analysis is lacking as a basis for future joint monitoring effort.

The two main factors negatively affecting the living and reproduction conditions for fish resources in the Prut river are changed water flow and the building of flood-plain embankments along the river bank. Embankments have caused significant areas of the river floodplain to drain. As a result, hibernation and spawning sites for valuable fish species have disappeared and a decrease of fish species in the basin has been recorded (Ene and Ion 2019).

International law, bilateral agreements

The three core principles of international water law as expressed in the UNECE Convention on the Protection and Use of Transboundary Watercourses and International Lakes (further Water Convention) are to prevent, control and reduce transboundary impact, to ensure a reasonable and equitable use of transboundary waters and that the Riparian Parties shall cooperate on the basis of equality and reciprocity through bilateral and multilateral agreements.

The Riparians analysed in more detail in this report, Moldova, Romania and Ukraine are all Parties to the Water Convention. They are also Parties to the Convention on Environmental Impact Assessment in a Transboundary Context (Espoo Convention) and its Protocol on Strategic Environmental Assessment (SEA Protocol) that ensures that individual Parties integrate environmental assessment into their plans and programmes at the earliest stages.

[6] There was also a significant flood recorded in 1969.

The Water Convention states that "The Parties shall establish programmes for monitoring the conditions of transboundary waters". More specifically article 11 adds: "In the framework of general cooperation mentioned in article 9 of this Convention, or specific arrangements, the Riparian Parties shall establish and implement joint programmes for monitoring the conditions of transboundary waters, including floods and ice drifts, as well as transboundary impact." and "For these purposes, the Riparian Parties shall harmonize rules for the setting up and operation of monitoring programmes, measurement systems, devices, analytical techniques, data processing and evaluation procedures, and methods for the registration of pollutants discharged."

For the planning and decision-making on new hydropower projects and other water infrastructure the Espoo Convention and SEA Protocol are key international instruments. The Espoo Convention regulates the involvement of Riparians in EIA consultations on any new object and the SEA Protocol requires that individual Parties integrate environmental assessment into their plans and programmes at the earliest stages and involves other Parties when there are possible transboundary significant environmental, including health, effects.

Moldova, Romania and Ukraine are all Parties to the Convention on Wetlands of International Importance especially as Waterfowl Habitat (Ramsar Convention). The Convention covers several Ramsar sites that should be protected in the Dniester and Prut basins including: Lower Prut Lakes, Moldova, Prut River Headwaters, Ukraine, Dniester River Valley, Ukraine, Lower Dniester, Moldova and Dniester-Turunchuk Crossrivers Area, Ukraine.

There are bilateral agreements on data exchange including hydrology between Hydromets in Moldova, Romania and Ukraine. Joint hydrology and meteorology data sets between Moldova and Ukraine on the Dniester river are found on http://dnister.meteo.gov.ua/ua and http://nistru.meteo.gov.ua/. Negotiations are on-going between Romania and Ukraine on a new Hydromet data exchange agreement including on Prut-Sireta hydrology.

Dniester

The Agreement between the Government of Moldova and the Government of Ukraine on the Joint Use and Protection of Border Waters was signed in 1994. The corresponding cooperation is managed by Plenipotentiaries. In Article 6 cooperation on monitoring was prescribed. Monitoring cooperation has been established and a regulation on joint sampling and assessment of water quality agreed on and is in principle still operational. This is a good basis for further joint work. but the corresponding working group is now dissolved with the responsibility taken over by the Commission under the 2012 Treaty.

The Treaty between the Government of the Republic of Moldova and the Cabinet of Ministers of Ukraine on Cooperation in the Field of Protection and Sustainable Development of the Dniester River Basin signed in 2012, further strengthened the legal fundament for cooperation on the Dniester River Basin. A remaining concern is the Transdniester region of Moldova that is not formally part of the 1994 and 2012 agreements.

Cooperation on monitoring and exchange of information is reflected in article 16 of the 2012 Treaty: "In order to obtain regular information on the status of the Dniester River basin, the Contracting Parties shall carry out monitoring on coordinated programs. The monitoring data shall be made freely accessible to the Contracting Parties, which shall exchange it according to the coordinated procedure." In the same article access to designated sampling sites is guaranteed: "Each Contracting Party shall, on the basis of reciprocity, ensure access of specially authorized persons to the coordinated joint water sampling stations."

Further, according to the Treaty it is the competence of the newly established Commission to: "develop coordinated or joint programs for monitoring the condition of water and other natural resources and ecosystems of the Dniester River basin, including the use of coordinated techniques, measurement systems, data processing and evaluation procedures". It is also the task of the Commission to implement such programmes with the support of its different working groups.

A Working Group on Monitoring and Information Exchange was instituted during the first meeting of the Commission in September 2018 with the overall task to give technical and other support to coordination of monitoring and information exchange between Riparians.[7] However, due to reorganization of the national monitoring system in Moldova the Working Group has not yet started its work in the end of 2019.

In the context of a proposal from the Ukraine side to expand the Novodnestrovsk buffer reservoir on Moldovan territory an Intergovernmental Agreement on Functioning of the Dniester Hydropower Complex is being negotiated between the two countries. These negotiations give a good opportunity to open up a discussion on the monitoring of hydropower impact.

Concludingly, the formal conditions for the development of coordinated or joint monitoring and information exchange are established. The participation of the Transdniester region of Moldova in the cooperation is an issue that remains to be solved to make it possible to cover the whole basin with joint and coordinated monitoring and information exchange.

Prut

Being a tributary to the Danube, Prut is governed by the "Convention on cooperation for the protection and sustainable use of the river Danube" signed in 1994. Moldova, Romania and Ukraine are all Parties to the Convention.

Between Romania and Ukraine there is a bilateral agreement from 1997 (Agreement between the Government of Romania and the Government of Ukraine on cooperation in the field of transboundary water management).

The 1994 Agreement between Moldova and Ukraine mentioned above also covers the river Prut.

A cooperation agreement between the Romania and Moldova on the protection and sustainable use of the Prut and the Danube Rivers was signed in June 2010. The provisions include a regulation on the maintenance and operation of the Stanca-Costesti dam on the Prut River. A Joint Subcommission for Operation of Stanca-Costesti currently acts on the basis of a Regulation from 1985 and the 2010 agreement. There are further a bilateral 2003 agreement on fisheries cooperation in the Prut River and Stanca-Costesti water reservoir and signed protocols in the early 2000s related to cooperation on hydrology. The two countries have also agreed to consult each other on the application of the requirements of WFD and the Flood Directive. However, the day-to-day cooperation between the two countries on the overall management of the river basin may benefit from a more frequent dialogue.

A transboundary monitoring programme on the Prut river was agreed on between Moldova and Romania in 1992. Moldova and Ukraine renewed the agreement to cooperate on transboundary monitoring in 2009.

[7] The objectives and terms of reference of the Working Group is found at https://dniester-commission.com/en/joint-management/dniester-commission/working-groups/working-group-on-monitoring-and-information-exchange/.

There are on-going discussions to establish an Ad-hoc Group between the three countries under ICPDR. With the exception of an Agreement for the Establishment and Management of a Cross-Border Protected Area between the Republic of Moldova, Romania and Ukraine in the Danube Delta and the Lower Prut Nature Protected Areas (2000) there is no agreement involving all three Riparians.

EU directives

Protection of water resources and water-related ecosystems
Romania is an EU member since 2007 and is fully implementing its directives. In 2014 Moldova and Ukraine signed and ratified association agreements with the EU and are taking steps towards application of EU environmental directives. The legal approximation is largely done in both countries and the adoption of secondary legislation is on-going.

Particularly important in this context are the 2000/60/EC Water Framework Directive (WFD, see below) and 2007/60/EC Floods Directive. The Directive 91/271/EEC on urban waste waters, the Directive 98/83/EC on water quality for human consumption and the Nitrate Directive 91/676/EEC are other water-related legislation of importance.

One legal central aspect is that in cases of deterioration or failure of water status due to hydropower projects Article 4.7 EU WFD requires the examination of significantly better environmental options for the achievement of the same objective (e.g. alternative locations). The requirements for exemptions according to Article 4.7 WFD include that:

1) *The benefits of the new infrastructure are of overriding public interests outweighing the benefits of achieving the WFD environmental objectives,*
2) *There are no significantly better environmental options which are technically feasible,*
3) *All practicable mitigation measures are taken to minimize negative effects on the aquatic ecology and*
4) *The projects are reported in the River Basin Management Plans.*

The organizations technically responsible for WFD implementation are in Moldova Apele Moldovei ("Moldovan Waters"), in Romania Apele Romane ("Romanian Waters") and in Ukraine the State Agency of Water Resources.

RBMP and monitoring

Monitoring of WFD implementation is significantly different from previous systems applied in Moldova and Ukraine. The EU approach is more holistic and integrative taking into account the physical and hydro-morphological changes in water bodies, including of the impact of hydropower. Monitoring results are directly linked to decision-making and not just describing ambient environment.

Transparency related to WFD implementation is important and usually monitoring data and related information in the EU are accessible to the public.

The active involvement of all interested parties in the implementation of the Directive, in particular in the production, review and updating of the river basin management plans is a core demand. Access must be given to background documents and information used for the development of the draft river basin management plan. Member States shall further allow at least six months to allow for active involvement and consultations on draft RBMPs.

According to the WFD a comprehensive assessment and monitoring plan should be specified aiming at collecting data for a status assessment and at controlling the efficiency of water protection measures applied. Three types of monitoring are defined:

1) Surveillance - to identify "where we are", an assessment done at the start of developing RBMPs and in the middle of the cycle,

2) Operational - to monitor effectiveness of implementation of the programme of measures in water bodies that do not meet the environmental objectives, throughout the implementation of measures,

3) Investigative - to investigate an accident, upon a specific request.

WFD implementation is a good framework to establish joint, coordinated monitoring efforts including of the impact of hydropower and is proposed to be a central component of the strategy outlined in section 10 of this document.

Development and implementation of River Basin Management Plans (RBMPs) according to the WFD include the following steps:

1) Delineate the river into segments called water bodies. (In the Dniester basin there are more than 1000 water bodies.)

2) Identify reference conditions. (An expedition was working along the Dniester during the summer of 2019 and the results are available for some of the river types.)

3) Identify pressures and impacts with a desk study. Diffuse and point sources of pollution are defined and calculated based on specific formulas and guidance provided. (This is done for the Dniester river and major tributaries with a catchment over 1000 km^2.)

4) Identify risks of not reaching of so called good ecological or chemical status. All water bodies are coloured in 3 semaphore colours and this is a basis for establishing so called surveillance monitoring. (Risks are being identified for the Dniester river.)

5) Screening and surveillance monitoring to validate results of the desk studies on pressures, impacts and risks. (Screening has been done in the Dniester river transboundary sampling points.)

6) Identify status of the water bodies. Based on the results of screening and surveillance monitoring, status of water bodies is identified. There are ecological and chemical classes for the status of the water bodies.

7) Develop a programme of measures, and set up operational monitoring - based on status of water bodies - in those water bodies which are coloured yellow, orange and red (ecological status classes 3-5).

8) Implement a programme of measures, perform operational monitoring

9) Analyse and initiate the next cycle after 6 years on the basis of a revised RBMP.

Ecological status is measured for:

- Fish fauna, benthic invertebrates, aquatic flora and phytoplankton

- River basin-specific pollutants (RBSPs) - identified after screening

- Physico-chemical Quality Elements (QEs, e.g., temperature, oxygen, pH, nutrient conditions) and

- *Hydromorphological QEs.*

There are 5 ecological status classes: 1: very good, 2: good; 3: moderate; 4: poor and 5: bad. For classes 3-5 RBMP measures should be introduced. Chemical status of water bodies is classified as "good" or "not good - for 45 so called priority substances.

Heavily modified and artificial waters are distinguished from natural waterbodies by the WFD. These were either created artificially (e.g., a canal or dam), or their structure has been modified so extensively that a "good ecological status" can no longer be achieved without significantly impairing an existing, economically significant water use that cannot be achieved by other means (while the objective "good chemical status" still applies). For such waters, the environmental objective of a "good ecological potential" has been defined, which requires Member States to adopt measures to improve the quality of the water body as much as possible (e.g. by building fish passes, setting ecological flows, etc.). Improvements need to be made to the hydro-morphological pressures without impairing "non-substitutable" water uses. These are reasons why WFD implementation and related monitoring could be used to follow and alleviate the impact of hydropower. However, "technical feasibility or disproportionate cost" are legal grounds to restrict demands for changes.

WFD and transboundary waters

WFD stipulates that Member States shall ensure that a river basin covering the territory of more than one Member State is assigned to an international river basin district. Administrative arrangements, including the identification of the appropriate competent authority for the international river basin district shall be established by the Member States. Member States shall ensure that the environmental objectives of the Directive are met in international river basin districts. To this end, Member States shall coordinate at the international level on a programme of measures. In the case of an international river basin district falling entirely within the EU, Member States shall ensure coordination with the aim of producing a single international river basin management plan (iRBMP). If an iRBMP is not produced, Member States shall produce river basin management plans covering at least those parts of the international river basin district falling within their territory to achieve the objectives of the Directive[8].

Transboundary water districts in the EU are categorized as follows:

1. *Cooperation agreement, cooperation body and international RBMP (iRBMP) in place (the Danube is a good example)*
2. *Cooperation agreement, cooperation body, but no international RBMP in place (for example Dniester and Prut)*
3. *Cooperation agreement in place but no cooperation body or international RBMP in place*
4. *No cooperation formalised*

One conclusion reported in the ongoing fitness check mentioned above is that transboundary cooperation had not yet been delivered fully in practice. There has been limited progress between the first and second cycles of RBMPs, even if transboundary cooperation in shared waters has increased since the adoption of the WFD.

[8]https://eur-lex.europa.eu/resource.html?uri=cellar:6cfb451c-39d3-11e9-8d04-01aa75ed71a1.0001.02/DOC_1&format=PDF

As neither Moldova nor Ukraine are EU Member States, there is no strict legal demand of an iRBMP for Dniester or Prut.

National RBMPs are presently being implemented for Dniester and Prut in Moldova and for Prut in Romania. On-going RBMP cycles are in Romania scheduled for 2016-2021, in Moldova for Dniester 2017-2022 and Prut 2018-2023 and in Ukraine the first cycle is scheduled for 2025-2030. The coordination of the Dniester RBMP cycles in Moldova and Ukraine is being discussed with a tentative common starting year of 2024. Moldova aims to start the next RBMP cycle for Prut in 2022 adapting the time period with other Danube Riparians. For the entire Danube data is being collected for the 3rd River Basin Management Plan ahead of a new decision in 2021.

In the Dniester river basin, a process has been initiated to develop and approve a joint plan of measures (iRBMP) during 2020 with support from the GEF Dniester project. This document would define obligatory and additional measures of importance for the joint management of the river. The impact of hydropower is one of the transboundary problems included in the draft documentation. The process and detailed content of this plan is presently being discussed.

Some work has been done to provide a joint RBMP for the shared part of Prut between Ukraine and Moldova (EPIRB 2013).

Renewable energy production

EU energy policy aims for the strengthening of renewable energy production. It is an EU objective that 32% of energy would come from such sources by 2030 (Directive 2018/2001/EU). On the basis of the Directive EU countries are developing National Renewable Energy Action Plans.

In spite of some commitments[9] in the association agreements only marginal efforts have been made in Moldova and Ukraine to develop wind, solar and biomass energy production. The existing HPPs in the two countries are of importance as a contribution towards the EU demands. Romania has produced a comprehensive National Renewable Energy Action Plan and is developing its energy sector with components such as biogas, biomass and hydropower.

The conflict in the EU between renewable energy policy and hydropower development is obvious and some conclusions related to hydropower are found in section 10 on possible water-energy (nexus) approaches.

Reservoir operation rules

“Reservoir Operation Rules” (ROR) guide the use of hydropower and generally water reservoirs, and are developed and approved for each individual installation on the basis of national legislation.

RORs regulate energy production and provide schemes for water levels and releases under different conditions. It defines how the reservoir should handle very high water flows to avoid flooding, minimum flows under drought conditions, and also environmental flow. The regulations further set conditions to achieve a good safety level of dams. RORs usually include a section on monitoring. A possible component of the ROR could be to provide information to stakeholders downstream under certain conditions.

[9] In the Association Agreement with Moldova the approximation to the previous Directive 2009/28/EC is a condition while the corresponding Agreement with Ukraine no such specific reference.

RORs should take into account and be adapted to environmental aspects of water releases which is not always the case (see Rusev and Shchegolev, 2019)

A new draft ROR for the Novodnestrovsk HPP and PSPP have been prepared in accordance with the Water Code of Ukraine. The need to develop the new ROR is due to planned water engineering changes, the extension of the period for calculating discharge parameters and other developments. A more detailed description and analysis is found in Serra (2019).

During the second meeting of the Dniester Commission the Ukraine delegation requested comments from Moldova on the draft ROR and there was also a discussion on the possibilities for the Commission to formally approve the ROR.

There is also a new draft ROR for the Stanca-Costesti HPP that could provide an instrument for cooperation between Romania and Moldova.

It will be highlighted in Section 10 how RORs could become documents that are jointly agreed on and monitored, and thus become an instrument for cooperation.

National monitoring systems – institutions and legal framework[10]

In Moldova the responsibility for surface water quality monitoring is vested with the newly established Environment Agency with some responsibilities (hydrological network and water quantity monitoring) remaining with the State Hydrometeorological Service. The legal basis for this was introduced in 2018 but in late 2019 there are remaining questions on how future monitoring will be organised. As a result, the new monitoring system is not yet fully functional.

In the Transdniester region of Moldova water quality monitoring of the surface waters is the responsibility of the Republican Hydrometeorological Center and Service for Ecological Control and Environmental Protection in Tiraspol. Presently, there is no coordination with other Dniester Riparians.

In Romania Apele Romane manages an ambitious and fully covering “Integrated Monitoring System of Waters” that includes the monitoring of water quality as well as hydrology and groundwater.

In Ukraine a Governmental Resolution on State Water Monitoring (surface, ground, marine waters) was approved in the autumn 2018 with the overall responsibility of the Ministry of Environment and Natural Resources. (In September 2019 this Ministry was merged with the Ministry of Energy.) Operationally, responsible institutions are the State Agency of Water Resources (physico-chemical monitoring), and the State Service of Emergency Situation (Hydromet responsible for hydro-morphological and biological monitoring). In autumn 2019 Ukraine a new WFD-compliant system of monitoring was launched and preparations with regard to training and equipment prepares for implementation planned to start 1 January 2020.

With the possible exception of Romania there is much to do for the establishment of effective national monitoring systems and thus for national and joint monitoring of the impact of hydropower. Presently Moldova seems to be in the weakest position in general terms with regard to monitoring.

[10] This section will not describe in any detail the existing physical monitoring networks nor make any attempt to estimate costs for a proper monitoring system.

Financing of monitoring and investigations

While Moldova and Ukraine have a difficult financial situation that is likely to be reflected in state funding of monitoring, the latter country has found ways to make necessary investments to initiate a WFD compliant system in 2020. The funding situation is also a bottleneck in the Transdniester region. Monitoring the impact of hydropower would benefit from improved national funding.

EU and other projects support the renewal of equipment and strategic, one-time investments as well as building capacity for future monitoring. The on-going project "European Union Water Initiative Plus for the Eastern Partnership Countries" is delivering key equipment for monitoring related to WFD to Moldova and Ukraine. Several components of the GEF Dniester project "Enabling transboundary cooperation and integrated water resources management in the Dniester River Basin" deal with different aspects of water monitoring and is also generally reaching out to the Transdniester region. One output of the project that will be reflected in a Strategic Action Programme is an agreed programme for joint monitoring activities and information exchange between Moldova and Ukraine.

The EU-funded project "Creating a system of innovative transboundary monitoring of the transformations of the Black Sea river ecosystems under the impact of hydropower development and climate change" ("Hydroeconex") is relevant in this context with its focus on monitoring the impact of hydropower. The tasks of the project include the development of indicators, a methodology of economic evaluation of ecosystem services and a strategy of monitoring with a focus on the Prut and Dniester river basins that is described in this document.

Provision of complementing monitoring data for example from energy and agricultural sectors is an option to be investigated. Economic sectors could be given a responsibility to provide relevant data and information.

Strategy on joint monitoring of the impact of hydropower

Principles of the Strategy

The following principles should be applied when developing joint monitoring of transboundary rivers affected by hydropower:

- Riparians should agree on data set of hydrological, hydrochemical and hydrobiological parameters, characterizing the river ecosystem processes, including follow-up of management issues such as spring water discharge.
- Joint and coordinated monitoring should be based on agreed-on processes involving to the extent possible all Riparians and relevant stakeholders.
- Joint monitoring and cooperation should have a long-term perspective following and analysing effects of climate change.
- Key parameters should be part of basin-wide information easily available on-line, preferably on one website, related to water balance, hydrochemistry and hydrobiology.
- National interests are likely to diverge but with efforts made in good faith to resolve disagreements it is possible to establish common positions on research, investigations and monitoring. In some cases, involving outside parties for mediation may be needed.

- A functional legal and institutional basis on the national level for monitoring is a necessity. Presently this is not the case in all countries reviewed. A significant bottle-neck may also be insufficient funding.

- Joint and coordinated monitoring must be linked to assessments and decision-making, not only descriptive reporting.

- The data developed must be trustworthy. Monitoring methodology must be technically and methodologically sound.

- Experiences from other basins should be reviewed and where suitable employed. The ICPDR approach could be used as a model. The development of iRBMPs and assessing the role of hydropower as has been done in the Danube basin (ICPDR 2013a) are two examples.

With regard to the impact of hydropower and for the **Hydroeconex project** partners the following approach is recommended:

- **The methods and results demonstrated in the Hydroeconex project to best characterize the impact of hydropower on the state of the river basin ecosystem and hydrology should be summed up with relevant arguments and results from corresponding research, and presented as an input to the processes described below to be integrated into the officially agreed-on monitoring in the basin.**

Components of the Strategy

Existing installations

For an effective involvement of Riparians there are four basic mechanisms for the monitoring of the impact of existing hydropower identified:

1. **Coordination of RBMP measures and monitoring in shared water bodies**

RBMP development is part of WFD implementation and applicable for the Dniester and Prut river basins. According to WFD Member States shall ensure that the environmental objectives of the Directive are met in international river basin districts.

The development of international river basin management plans (iRBMPs) and corresponding monitoring on the basis of national RBMPs would be feasible for the two rivers. Experiences from the development of the Danube iRBMP can be used.

2. **Decisions on monitoring and investigations taken jointly in established River Basin Commissions**

Where there are river basin commissions or similar in place these should be used to establish joint and coordinated monitoring programmes. Joint bodies can be used as mechanisms for the development of iRBMPs (see item 1).

Decisions taken and activities initiated under the 1994 Agreement between Moldova and Ukraine before the establishment of the Dniester Commission is a good basis for the further work in this river. This includes the exchange of data between Moldovan and Ukrainian hydromets (see item 3 below) that is reflected on a joint webpage and the joint monitoring applied under the 1994 Agreement between the two countries.

3. **Agreements between Hydromets and other organizations on data exchange**

These agreements, mainly between Hydromets, are important for the transparency of the situation with regard to water quantity as well as quality and should be part of any discussion on transboundary cooperation such as in the Dniester Commission and its Working Group on Monitoring and Information Exchange.

4. **Joint decisions on Rules for Operation and monitoring of their application**

Reservoir Operation Rules (RORs) are formally decided on at the national level. Efforts should be made to make RORs a joint document with a joint implementation and follow-up. If RORs are agreed on by Riparians it gives a good basis for monitoring jointly its implementation.

In all these 4 cases a transparent open account of monitoring data should be the objective.

Scientific research preferably involving institutions from all Riparians is frequently needed to clarify the impact of for example hydropower. Where possible there should be a link between regular monitoring managed by state agencies and research. Research can validate and deepen the understanding of regular monitoring. Joint monitoring can provide basic data and hints on issues remaining to be resolved. Research should be linked to WFD implementation as part of the surveillance and operational monitoring.

In case joint efforts and activities cannot be developed there may still be a case for initiatives taken by individual Riparians and stakeholders. If focused and trustworthy, such research and investigations may lead to a dialogue and further joint efforts. Information from unilateral efforts should be well-designed in order to be effective but there is always a risk that results would be seen as a one-sided effort.

Dniester

After the efforts made under the 1994 Agreement, some steps have been taken to deepen the joint/coordinated monitoring at the basin level under the 2012 Treaty. However, while the cooperative legal and institutional basis is in place for Moldova and Ukraine, action is needed to develop and agree on plans for cooperation. This cooperation is suggested to be closely linked with the implementation of the WFD.

In the framework of the GEF Dniester project it is the objective to establish a joint RBMP (iRBMP) in the form of a “Strategic Action Plan”. If an agreed plan would be set up, joint monitoring of the implementation of this plan in line with the WFD would be logical.

In the development of coordinated monitoring the Working Group on Monitoring and Information Exchange of the Dniester Commission will play a key role but it has not yet started its work in the end of 2019. Steps needs to be taken to initiate its activities – to start with involving Kiev and Chisinau and also making sure that representatives of the Transdniester Region of Moldova are invited.

The Dniester Commission will be able to use the Working Group to facilitate development of practical proposals as a basis for decisions on monitoring cooperation. Data and information from the monitoring would provide input to future Commission decisions to improve river basin management. The implementation of the WFD in Moldova and Ukraine is important to define the operational framework for monitoring cooperation.

The on-going negotiations on the expansion of the Novodnestrovsk buffer reservoir (Section 5) may lend itself to the strengthening of monitoring the impact of hydropower. A future Intergovernmental Agreement on Functioning of the Dniester Hydropower Complex could include an article outlining a joint monitoring system.

It is a concern that responsible national agencies in Riparians may be reluctant to share data and information from its past and present monitoring activities while NGOs and the public are are pushing for a free and open exchange of data and information. The regular conferences organized by NGOs can contribute to an open exchange and discussion of information.

The ecological spring flow released from the Novodnestrovsk reservoirs is a particularly important issue. It should be decided on jointly based on close consultations between Riparians. The preparations for as well as the actual releases should be followed by monitoring of the actual water volumes released and the effect on the water-dependent ecosystems downstreams.

There is a need for additional joint research in the Dniester basin, for example on fish species and populations in the river, the environmental effect of PSPPs and to clarify whether there is a risk for water loss from karst formations where HPPs are situated.

Prut

While the impact of hydropower in the Prut river on the environment of the river may be at a lower level compared to the Dniester river, it seems that additional efforts are needed to estimate its impact. It is suggested that, as part of a strategy, the situation is reviewed by the planned Ad hoc group under ICPDR would take the possible effect of hydropower into account when jointly analysing the situation. On-going work on Prut by the EUWI Plus project will provide an important background.

New installations

The WFD regulates strictly the building of new water infrastructure such as HPPs. All practicable steps need to be taken to mitigate the adverse impact and the reasons for approval (that must be of overriding public interest) should be included in and explained in the RBMP.

For the planning and establishment of new hydropower the main national and international instruments to apply are Environmental Impact Assessment (EIA) and Strategic Environmental Assessment SEA[11]. Application of EIA and SEA are reflected in national legislation in the three countries referred to in this Strategy.

In some transboundary basins the joint body has developed frameworks for hydropower development and is recommended as a component in this strategy. Mekong and Danube are two examples (Mekong River Commission, 2010, ICPDR, 2013b) that could be repeated in the Black Sea Basin. If there are tentative agreements on limiting hydropower it is likely that its development could be challenged if new proposed objects are not aligned with these strategies.

The final three hydro-pumping units (no 5-7) of the Novodnestrovsk HPP on the Dniester river are likely to become an issue for transboundary consultations in the near future. Impact assessments were shared and consultations with Moldova (then a Soviet republic) held after the original decision in 1985 and 1988. Consultations with Moldovan participation further took place in 2006

[11] As reflected in the Convention on Environmental Impact Assessment in a Transboundary Context (Espoo Convention) and its Protocol on Strategic Environmental Assessment (SEA Protocol). The EU SEA Directive (2001/42/EC) is further an important legal basis.

and an official letter from Ukraine to Moldova in 2008 shared an impact assessment. However, Ukraine should nevertheless follow the Espoo Convention mechanisms before the final decision is made on the construction of hydro-pumping units 5-7.

A more long-term option discussed is the construction of flow of the river installations upstream of Novodnestrovsk HPP. In this case an EIA followed by consultations with Riparians is a legally appropriate approach. Moreover, as this is a set of infrastructures in cascade and there is a need to investigate its cumulative impacts an SEA and consultations with downstream stakeholders is an appropriate approach.

Finally, it can be stressed that activities of environmental organizations and the public are of significant importance in the decision-making on new installations. This is important in particular where there are strong economic and financial interests in favour of investments. There are many examples where plans have been abandoned because of a strong and well-argued opposition by NGOs, including in the formal processes accounted for above. There are also cases where NGO positions are not reality-based and simplistic, and this should be avoided to be taken seriously in the debate.

Nexus approaches

From a sustainable development perspective, the optimal role of hydropower cannot be defined object by object. There should be a broader national strategy for its development and use that is based not on an immediate economic interest, but taking into account the whole energy system and importantly the impact of hydropower on the environment and other water uses.

The term “nexus” in the context of water, food (agriculture), energy and environment refers to the fact that these sectors are so closely linked that actions in one area have impacts on the others. Policy changes in one sector strongly influence other sectors and alternatives to hydropower development and use may be found in related policy areas. Alternative energy sources, energy saving and improved energy efficiency, energy trade may be solutions that make it possible to optimize and restrict hydropower development.

The WFD states that all practicable steps need to be taken to mitigate the adverse impact and the reasons for approval (that must be of overriding public interest) should be included in and explained in the RBMP. This actually introduces the nexus concept into decision making.

In terms of a Strategy component it is recommended that stakeholders have a broad view on energy and water policy, avoiding a narrow vision of hydropower as the unique solution.

Support to international developments

There is a need for improving EIA and SEA legislation (see for example Tarasova et al. 2019). The important energy sector has a well-established and financially central place in the society with good opportunities to influence decision making. To balance this, methods to define impact by improved SEA and EIA procedures is needed, for example to better investigate effects on the status of downstream aquatic ecosystems. This is a process for the international level and in this context, it is proposed as part of the multilateral work of Riparians and stakeholders. Countries and stakeholders can in this way help to strengthen the protection of the environment in the longer term and this is proposed to be a component of the Strategy.

The important on-going work on water allocation and environmental flow in the work programme of the UNECE Water Convention and also other organizations should be supported. The result in terms of recommendations will clarify experiences and define basic demands on water-related activities including hydropower.

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