Enabling Transboundary Cooperation & Integrated Water Resources Management in the extended DRIN RIVER BASIN

Terms of reference

3 x Whiteboard Animations

(see page 5 onwards for deliverables)

In the framework of:

Memorandum of Understanding
for the Management of the Extended Transboundary Drin Basin

GEF Project "Enabling Transboundary Cooperation and Integrated Water Resources Management in the Extended Drin River Basin"

MAY 2020

www.drincorda.org

The Coordinated Action for the implementation of the Memorandum of Understanding for the management of the Drin basin (Drin CORDA) is supported by the GEF Drin Project. The latter is implemented by the United Nations Development Programme (UNDP) and executed by the Global Water Partnership (GWP) through GWP-Mediterranean (GWP-Med), in cooperation with the United Nations Economic Commission for Europe (UNECE). GWP-Med serves as the Secretariat of the Drin Core Group, the multilateral body responsible for the implementation of the Memorandum of Understanding.

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1. Introduction

The Drin Basin extends in a large part of the Western Balkans. It consists of several sub-basins, the uppermost of which is that of the Prespa Lakes, while the lowest that of the Buna/Bojana River, adjacent to the Adriatic Sea. The Drin River is the “connecting agent” of the Drin Basin, linking tributary rivers, lakes, aquifers, and other aquatic habitats into a complex ecosystem of major importance.

The Prespa Lakes sub-basin comprises of two lakes; the Micro (small) Prespa shared by Greece and Albania, and the Macro (big) Prespa shared by Albania, Greece and North Macedonia. Water flows through underground karst channels from the Prespa to the Lake Ohrid. Shared by Albania and North Macedonia, Ohrid is the largest lake in terms of water volume in SEE. The only surface outflow of Lake Ohrid, the Black Drin, flows north through North Macedonia and it enters Albania where it meets the White Drin -originating from Kosovo- to form the Drin River. Flowing westward through Albania, the Drin joins the Buna/Bojana River 1 km downstream of the outlet of Lake Skadar/Shkoder, near the city of Shkodra. Shared by Albania and Montenegro, Skadar/Shkoder is the largest lake in terms of surface in SEE. The Buna/Bojana River drains Lake Skadar/Shkoder sub-basin and flows into the Adriatic Sea; its final tract (23 km) forms the Albania - Montenegro borderline.

The Drin transboundary system offers an excellent example of interdependencies created among different anthropogenic uses (agriculture, hydropower generation, industry, fisheries, tourism, urban settlements, etc.) as well as among uses and ecosystems, in four major inter-connected inland water bodies and a receiving sea.

1.1 The Drin Memorandum of Understanding

Coordinated action at the Drin Basin level has been absent until the development of the Shared Vision for the sustainable management of the Drin Basin and the signing of a related Memorandum of Understanding (Tirana, 25 November 2011) by the Ministers of the water and environment management competent ministries of the Drin Riparians i.e. Albania, North Macedonia, Greece, Kosovo and Montenegro. This was the outcome of the Drin Dialogue coordinated by Global Water Partnership Mediterranean (GWP-Med) and UNECE.

The main objective of the Drin MoU is the attainment of the Shared Vision: “*Promote joint action for the coordinated integrated management of the shared water resources in the Drin Basin, as a means to safeguard and restore, to the extent possible, the ecosystems and the services they provide, and to promote sustainable development across the Drin Basin*”.

The **ultimate goal** of the work in the Drin Basin is to reach a point in the future where the scale of management lifts from single water bodies to the hydrological interconnected system of the Drin Basin, eventually leading from the sharing of waters among Riparians and conflicting uses, to the sharing of benefits among stakeholders.

1.2 The Drin Coordinated Action

A process called the “Drin CORDA”, Drin Coordinated Action for the implementation of the Drin MoU, was put in place after the signing of the latter.

Following the provisions of the MoU an institutional structure was established in 2012. It includes:

- The **Meeting of the Parties**.
- The **Drin Core Group** (DCG). This body is given the mandate to coordinate actions for the implementation of the MoU.

- Four **Expert Working Groups** (EWG) to assist the DCG in its work:
  - Water Framework Directive implementation EWG.
  - Monitoring and Information exchange EWG.
  - Biodiversity and Ecosystem EWG.
  - Floods management EWG (established in 2019).

The **DCG Secretariat** provides technical and administrative support to the DCG; GWP-Med serves by appointment of the Parties through the MoU as the Secretariat.

An Action Plan was prepared to operationalize the Drin CORDA. This has been subject to updates and amendments in accordance with the decisions of the Meeting of the Parties to the Drin MoU and the DCG. The DCG and its Secretariat guides the implementation of the action plan while its implementation is currently being supported by the Global Environment Facility[1] (GEF); see below.

1.3 The GEF Drin Project

The GEF supported Project "Enabling transboundary cooperation and integrated water resources management in the extended Drin River Basin" (GEF Drin Project) is aligned in content, aims and objectives with the Action Plan and the activities under the Drin CORDA.

The objective of the project is to *promote joint management of the shared water resources of the transboundary Drin River Basin, including coordination mechanisms among the various sub-basin joint commissions and committees*. Albania, Kosovo, Montenegro and North Macedonia are the Project beneficiaries.

The GEF Drin project is structured around five components:

a. Component 1: Consolidating a common knowledge base
b. Component 2: Building the foundation for multi-country cooperation
c. Component 3: Institutional strengthening for Integrated River Basin Management (IRBM)
d. Component 4: Demonstration of technologies and practices for IWRM and ecosystem management
e. Component 5: Stakeholder Involvement, Gender Mainstreaming and Communication Strategies

Under Component 1, the GEF Drin Project has undertaken significant scientific analysis to identify the main transboundary issues affecting the Drin Basin, as well as their causes. This has informed the design of actions to address the issues, now included in a Strategic Action Plan, endorsed at the highest political level by the Drin Riparians.

2. Objective of Assignment

The objective of this assignment is to produce 3 high quality whiteboard animations of 3-minute duration each.

The whiteboards will be used to explain the transboundary issues in simple terms to the stakeholders using visual aids and illustrations. The whiteboards will summarise three of the main transboundary issues that have been identified through the work under the Drin Project (see below). See Annex 2 for example of the content that will inform the whiteboard scripts.

[1] www.thegef.org

3. Scope of work

The topic of each whiteboard is as follows:

Whiteboard #1: Variability of the hydrological regime and disturbance of the natural sediment transport regime.

Whiteboard #2: Deterioration of water quality (i.e. pollution).

Whiteboard #3: Biodiversity degradation.

Climate change is a cross-cutting issue that should be captured in all three whiteboards.

By watching the whiteboards, the aim is for the audience to understand:

- the main transboundary issues affecting the Drin Basin
- the transboundary nature of these issues
- the effects of these issues to the natural and anthropogenic environment
- the environmental/natural processes governing these issues
- the extent of the issues and their effects; this could be accomplished by presenting data and technical elements e.g. by visually presenting statistics with graphs or explaining environmental/natural processes with diagrams (as appropriate)
- examples of solutions/measures to address the transboundary issues, included in the Strategic Action Plan
- the role of the Drin Project in identifying the transboundary issues and possible solutions
- the role of the Drin CORDA process in addressing the transboundary issues in the future

Audiences for whiteboards

The audiences include:

1. Beneficiaries of the Drin Project (primarily Government Ministries and technical experts) i.e. those that are responsible for and will take decisions for the implementations of the solutions/measures;
2. Stakeholders (such as private sector businesses, academia, general public) including:
    - those that are affected by the issues
    - those that will implement the solutions/measures
    - those that will be affected positively or negatively by the solutions/measures
    - those concerned about the future of the Drin Basin;
3. Potential donors (national and international) to support the implementation of solutions/measures.

The whiteboards should meet the following requirements:

Look and feel

- High quality, professional
- Corporate, structured, formal
- Modern, clean
- Accessible, clear
- Aesthetically attractive drawings / illustrations
- Text banners should be modern and clear

Features

- Hand-drawn or hand-drawn effect whiteboard animation. See example: https://www.youtube.com/watch?v=MPhUnPEwQFY
- Opening and closing slides with project and donor details
- Subtitles in English language
- Narration in English language
- Bespoke drawings / illustrations
- Full colour palette
- Non-intrusive background music
- Video covers for YouTube Thumbnail

Whiteboard specification

- The whiteboards must be suitable for social media platforms, including YouTube, Facebook and Twitter.
- Minimum quality of whiteboard animation production at least Full HD

6. Deliverables/ Outputs

The deliverables/outputs of this assignment and the associated timeline is:

Whiteboard	Date
Agree approach	June 2020
GWP-Med provides scripts	June 2020
First drafts of 3 x whiteboards	July 2020
Second drafts of 3 x whiteboards	September 2020
Final drafts of 3 whiteboards	November 2020

7. Monitoring and Progress Controls

The GWP-Med Communications Team will be providing oversight and guidance from the side of the Project Coordination Unit.

Services will be rendered and will be considered completed upon approval of the deliverables by the Drin Project Coordinator.

8. Place of Performance

This assignment is home based. The tasks will be carried out from a place of the successful Tenderer’s preference.

9. Qualifications and Experience

The Tenderer is required to have solid experience in delivering 2D animations. This includes:

Requirements (ON/OFF) <u>(if not met, proposal will be rejected with no further evaluation)</u>

1. Minimum 3 years of experience in animation design and production.
2. Fluency in English.

Qualification and Experience

1. A minimum of three 2D animations (of minimum length 30 seconds each) already produced is required.
2. A minimum of three illustrations for corporate presentations and/or infographics already produced is required.
3. High quality Portfolio:
   - High degree of customization of drawings
   - Full range of colour palette
   - Strong storytelling techniques
   - High inspirational power
   - Attractive and visually appealing artistic approach

4. High quality approach, methodology and project management.

Failure to meet the minimum criteria is considered grounds for disqualification.

The Tenderers Offer will be evaluated against these four criteria (see 'The Call' for full details).

10. Duration of the Contract

This assignment runs from June 2020 – November 2020 (6 months)

11. Contract Price, Deliverables and Schedule of Payment

The maximum available budget for this contract is **20.000 EUR**, **including VAT**.

The amount includes all other costs, income taxes, the 20% Greek tax when non-double taxation is applicable and any other amount payable or cost that may be required for the completion of the work/service apart from travel costs.

All payments except the payment upon signing of contract shall be upon receipt and acceptance/ verification of the deliverables, as laid out in the table below. Claims for payment will be made through an Invoice accompanied by proof of delivery.

Schedule of Payment

A payment of 30% of the offered price is planned upon contract signing with the selected Tenderer.

All other payments shall be upon receipt and acceptance/verification of the deliverables, as laid out in the table below.

Task	Deliverable	Payment	Scheduled
Contract signing	-	30%	June 2020
Whiteboards Editing v.1	Whiteboards x 3 Draft v.1	40%	July 2020
Whiteboards Editing Final	Whiteboards x 3 Final Drafts	30%	November 2020

12. Terms and Conditions

- *Ways of working*

GWP-Med will provide the scripts for the three whiteboards. The Tenderer will propose illustrations / visuals for the script.

- *Availability*

The Tenderer should be available for Skype calls and email correspondence as required.

- *Language*

The language of the deliverables/outputs is English.

- *Intellectual Property*

Subject to agreement, GWP-Med shall have full, unrestricted and exclusive rights to use the products and services listed in this invitation, including the right to broadcast, show and disseminate them in any media and its websites and to exploit the products for any purpose, and the right to make any future adjustments to the contents of the products.

The Tenderer is not allowed to use the products for any purpose other than those set out in the Contract, without the prior consent and authorisation of GWP-Med in writing. The Tenderer shall warrant that any output produced by the Tenderer or on its behalf will not infringe any patent, trademark, copyright, registered design or other intellectual property rights of any third party and agree to indemnify GWP-Med for any such claim, liability, proceedings and costs arising therefrom.

13. Annex 1

About Global Water Partnership Mediterranean (GWP-Med):

Global Water Partnership – Mediterranean (GWP-Med) was established in 2002 as the Mediterranean branch of the inter-governmental organisation, Global Water Partnership (GWP).

Aiming for a water-secure Mediterranean, GWP-Med works at the regional, transboundary, national, basin and local level. GWP-Med promotes action and facilitates dialogue on Integrated Water Resources Management (IWRM); provides technical support to policy making; implements demonstration activities; and contributes to skills and knowledge development. Strategic priorities include leveraging the SDG target 6.5 on IWRM, adaptation to climate vulnerability and change, and river basin/transboundary water management. Gender and youth issues, as well as private sector participation in water financing, are also key, cross-cutting issues for GWP-Med.

GWP-Med facilitates a multi-stakeholder platform that brings together almost 100 water institutions and organisations, including 10 major regional networks of different water disciplines. GWP-Med extends its human resources in 7 Mediterranean countries with the Secretariat being based in Athens.

14. Annex 2

Please see example of Executive Summary from Hydrology Report that will be adapted into a 3-minute script for Whiteboard #1:

Please note: based on this Executive Summary, a script will be provided by GWP-Med to the successful Tenderer.

Executive summary

Thematic Report on Hydrology and Hydrogeology

This *Thematic Report on Hydrology and Hydrogeology* is one of the six thematic reports prepared for the TDA within the framework of the GEF Drin Project.

The Thematic Report provides the core information related to the water resources management in the Drin Basin including the: (i) overall description of the basin; (ii) overview of sub-basins and underground formations; (iii) a first attempt to delineate surface water bodies; (iv) a description of groundwater bodies identified by the Riparians; (v) assessment of sectoral water demands (agriculture/industry/domestic); (v) predicted water budgets under three scenarios; (vi) description of hydromorphological issues. This forms the basis of the TDA.

The information provided in this report, along with the information contained in the rest of the thematic reports and products of the GEF Drin Project provide the elements[2] necessary to developing a Drin Basin Management Plan (DBMP), should such a decision be taken by the Riparians.

The Drin Basin

The Drin Basin sits in the south-east of the Balkan Peninsula. It comprises the sub-basins of the Black Drin,[3] White Drin,[4] Drin, and Buna/Bojana[5] Rivers, of the Prespa, Ohrid, and Skadar/Shkodër[6] Lakes, and the adjacent coastal and marine area. The water bodies and their watersheds are spread across a

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[2] Additional information developed through the TDA Thematic Reports that could be integral parts of a DBMP in accordance to the EU WFD include:

- analysis of pollution pressures, assessment of pollution loads generated, and assessment of chemical pollution
- identification of protected areas
- analysis of the governance of water and environment in the basin,
- initial assessment of the condition of and the pressures to biodiversity etc.
- georeferenced information and data on the above
- preliminary ecological flows assessment.

A Terms of Reference for the DBMP development is one of the outputs of the Drin Project demonstration activities.

[3] The river is called Drin i Zi in Albania and Crn Drim in North Macedonia.

[4] The river is called Drin i Bardhë in Albania and Beli Drin in Kosovo.

[5] The river is called Buna in Albania and Bojana in Montenegro.

[6] The lake is called Skadar in Montenegro and Shkodër in Albania.

geographical area that covers parts of Albania, Greece, Montenegro, North Macedonia and Kosovo. All sub-basins, apart from that of the Drin in Albania, are transboundary. The marine zone in front of the Buna/Bojana Delta is characterised by an extended continental shelf reaching approximately 60–80 km from the coastline. The deepest point in the Adriatic, 1,223 m, occurs here.

With its rich water resources (the third greatest river discharge into the European Mediterranean, after the Po and Rhone), this complex system provides a wealth of services to the Riparians that share the basin. These include: energy supply, recreation and tourism, fisheries, water supply for irrigation and domestic uses, sustenance of unique endemic biodiversity, and livelihoods.

The Drin Basin is home to over 1.61 million people, living in 1,453 settlements. Forest accounts for 32.83 percent, scrub and open spaces for 35.58 percent, with arable land accounting for 21.25 percent of the total area of the basin.[7] Inland waters (natural lakes, rivers, water reservoirs, and wetlands) account for 6.4 percent of the area. Urban fabric and pastures account for 1.9 percent and 1.8 percent, respectively.

Precipitation in the basin is highly variable due to the fluctuating meteorological conditions and different elevations. The annual sum of precipitation in sub-basins varies from 515 mm (Mirusha in Kosovo) to well above 3,000 mm (Cijevna and Shala Rivers).

Analysis of the Drin Basin system: The system boundaries

To analyse the system, the Source-to-Sea approach[8] was used, to the extent allowed by the information available on transitional waters and the marine area.

The boundaries of the extended Drin Basin area were defined using the natural characteristics of the area and the local conditions. The area consists of the natural elements comprising the catchment, aquifers, transitional waters, coastal waters, and the coastal zone.

The land boundary of the Drin Basin area was defined using the physical boundary of the Drin watershed. This boundary conforms in the case of Montenegro to the administrative boundary of the River Basin District. In the case of Albania, Kosovo, and North Macedonia the (watershed) boundary does not always conform to the administrative boundary of the River Basin Districts.

Underlying aquifers extend beyond the boundaries of the watershed. This area was not included, since any measures defined later on as part of the Strategic Action Plan would fall outside of the sub-basins of each Drin Riparian. They are therefore the responsibility of the respective watershed authorities and institutions.

The coastal zone and the adjacent marine area were estimated taking into consideration the primary influence of the surface water flows on inshore marine waters, as indicated by the levels of salinity, as a proxy measure of the main influences of land-based activities.

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[7] Data for 2012.

[8] A Source-to-Sea approach consolidates analysis, planning, policy-making, and decision-making across sectors and scales. It considers the entire social, ecological, and economic system, from the land area that is drained by a river system to the coastal area and even the open ocean it flows into (Source: http://stapgef.org/sites/default/files/publications/S2SBrief.pdf). A Source-to-Sea system includes the land area that is drained by a river system or systems, its lakes and tributaries (the river basin), connected aquifers and downstream recipients including deltas and estuaries, coastlines and near-shore waters, the adjoining sea, and continental shelf, as well as the open ocean. Water, sediment, pollutants, biota, materials, and ecosystem services key flows connect the sub-systems in the Source-to-Sea continuum and their geographies.

Hydrology and interaction with marine waters

Information and data about the hydrology and hydrogeology of the Drin Basin are scattered among institutes and reports, mainly prepared with the assistance of donors. This information has been collected for this report, as well as for use by the beneficiary countries as baseline information for the preparation of sub-basin or basin-wide management plans.

Information related to the areal extent of the sub-basins and their main sub-catchments, including the area of each of these extending into each of the Riparians, was codified and an overview is given in a single table and maps.

The hydromorphological and hydrological elements, water inflows, outflows, and budget are given for each of the sub-basins. This highlights the main issues that have a transboundary effect.

There are two lakes, Micro and Macro Prespa, in the Prespa sub-basin. These are connected by an artificial canal. Prespa is a tectonic lake. Its average depth is 16–18 m and the average water residence time is 11–20 years (depending on the source). The karst geology of the area between Lakes Prespa and Ohrid makes it difficult to define the hydrogeological boundary, resulting in variations regarding the dimension of the Prespa catchment among studies.

The total inflow distribution is estimated as follows: 56 percent from surface runoff, 35 percent from direct precipitation, and 9 percent from Micro Prespa Lake. During 1976–2004, irrigation accounted for approximately 20 percent of the outflow; 17 percent of the total water losses in the same period are undefined outflows.

Water shortages in the watershed occur usually from May to September due to the increased water demands and less precipitation, while in the other parts of the year there is no water deficit.

Under normal hydrological conditions, there are no surface outflows.

Water-level oscillation causes the Macro Prespa surface area to vary from 259.4 to 280.0 km^2. The level of the water has fallen by more than 9 m in the last 60 years. The water level peaked during the flood of 1963 at 853 m a.s.l. After that, the level has fallen, with the sharpest decline between 1986 and 1991. The lowest level recorded was 842.75 m a.s.l.

Even though the reasons for the water-level decline are not fully understood, they are believed to be predominantly related to natural variations in rainfall, combined with human extraction and variations in the karstic outflow regime.

Ohrid is a tectonic lake. Its average depth is 155 m, with a maximum of 289 m. The average water residence time is 70–85 years. The area of the lake is 348.8 km^2.

Lake Ohrid is hydrogeologically connected to Lake Prespa, which sits at an elevation ~150 m higher than Lake Ohrid (depending on water-level variations). The hydraulic connection between Lake Prespa and Lake Ohrid, through the karstic massif, makes Prespa the most important source of water for Lake Ohrid, contributing over 40 percent of its water. It only takes 6 hours for the water to travel through the karstic system from Zavir/Zaveri to Tushemisht, which means that any change in the Lake Prespa ecosystem would also have immediate effects on Lake Ohrid.

The Sateska River in North Macedonia is the main surface tributary. In 1962, the river was diverted from its natural confluence with Black Drin and diverted into Lake Ohrid. The diversion almost doubled the size of the Lake Ohrid watershed and greatly increased siltation (the mean annual sediment yield is over 100,000 m^3). As a result, the pollution levels in the lake, especially with respect to phosphorus, have significantly increased. Ongoing work is rediverting the Sateska River to its natural riverbed.

About two-thirds of Lake Ohrid's water outflows pass into the Black Drin – the only outflow of Lake Ohrid – and the remaining third is consumed or lost through evaporation. Since 1962, the outflow to the Black Drin has been controlled with a weir. This limits water-level fluctuations to within the range of about 1 m.

The main tributary of the Black Drin is the transboundary Radika River, shared by Kosovo and North Macedonia. The upper part of this river enters the artificial Mavrovo reservoir that diverts its flow through a hydroelectric power plant into the Vardar River watershed (out of the Drin River Basin), as an 'inter-basin transfer' of water. Because of this, the upper part of Radika River watershed is classified as an artificial and highly modified water body and, therefore, is not included in the hydrological and water balance analysis.

There are two large dams on the Black Drin River in North Macedonia close to the point before the river enters Albania: Globočica (92 m high) and Špilje (112 m high). There are plans to construct two large-scale hydroelectric power plants (HPPs) – HPP Boskov Most and HPP Lukovo Pole – and over 60 small ones in the Black Drin watershed in North Macedonia. Prior to the confluence with the White Drin in Albania, the Black Drin flow reaches 88 $m^3 s^{-1}$.

The **White Drin** rises in Kosovo in the foothills of the large mountainous area north of the town of Peja. Its basin is the largest in Kosovo. Only a small part of the sub-basin extends into Albania. The only existing dam on the White Drin is in Radoniqi (58 m high).

Altogether, the river discharge represents less than half of the inflow from precipitation and natural springs. Springs make up about 5 percent of the total inflow but contribute some 9.5 percent to river discharge. At the Kukës station in Albania, the White Drin reaches 70 $m^3 s^{-1}$.

After the floods of 1848–1858 and 1896, **the Drin River** in Albania was split into two branches: one flowing in the original channel (old Drin) and a new one flowing towards the Buna/Bojana River, joining the latter at a distance of 1.5 km from the Lake Skadar/Shkodër outlet. Currently, the 'old' Drin communicates with Drin through groundwater discharges in the Gjadër fields and the Gjadër River itself.

There are three major dams and associated reservoirs on the Drin River. Fierza reservoir has by far the biggest storage. The winter level is not exceeded from October to March. During April, a transitional month, the level increases to the maximum operating level. This provides flood protection in winter when most floods occur, allowing the accumulation of the runoff from the last month of snow melt in spring to maximise storage available for summer. The total volume of all three reservoirs on the Drin River equals $3.76 \times 10^9 m^3$, which is greater than the average volume of Lake Skadar.

An analysis for this report, indicated that the operation of the dams in the Drin cascade is an important factor influencing the flow regime in the downstream part of the Drin River and the Buna/Bojana River, thus influencing the hydrological conditions in Lake Skadar/Shkodër. The operation of the three dams alters the natural intra-annual flow distribution downstream of the dams, reducing some of the peak discharges in the wet season and increasing the average discharge during the dry season. Because of the volume of its reservoir, the operation of the Fierza dam can affect the multiannual discharge distribution. Data from KESH (Albanian Power Corporation) would allow more precise results and conclusions.

Lake Skadar/Shkodër is tectonic. It is a relatively shallow lake with a maximum depth of 9 m. The water level of the lake varies widely; extreme observed values are 4.97 m and 10.31 m (flood 2010). The surface area varies between 395 km^2 at the minimum water level and 530 km^2 at the maximum. Respective water volumes are 1.8×10^9 m^3 and 4.25×10^9 m^3. The lake's surface area at the mean water level of 6.52 m is 475 km^2.

The main tributary of Lake Skadar/Shkodër is the Morača River. It drains about 32 percent of the territory of Montenegro and contributes ~60 percent of the lake's water. The lake also receives water from springs and groundwater bodies. The Syri I Sheganit[9] and Syri I Zi are the most important perennial springs in this region. They appear as small round lakes of 15–20 m diameter and their discharge is estimated to be 0.15–10 $m^3 s^{-1}$. Additionally, several temporary springs appear on the shore of the lake after intense rainfall or during the snow melt period.

The **Buna/Bojana River** – 44 km long with a depth that varies from 2 m to 4 m – is the only outflow from Lake Skadar/Shkodër. Discharge from the latter combines with flows from the Drin River about 1.5 km from the lake to produce a mean annual discharge of about 20 $km^3 yr^{-1}$.

Sometimes the outflow from the lake in Buna/Bojana is impeded due to an increase in the flow in the Drin River. This occurs mostly from December to February, but may also occur during the rest of the year, depending on the water released from the three hydropower dams upstream in the Drin River. The management of the dams depends upon the rainfall and electricity demand. Restriction of the out-flowing water in the Buna/Bojana River increases the water level in the lake significantly. With high Drin water levels and low Buna levels, Drin water can enter the lake. The Drin River also deposits sediment, thereby further obstructing the flow in the Buna River and the outflow from the lake.

Land-use changes adjacent to the river channel area have reduced the area of the floodplain, altering ecosystem structure and the hydrological functioning of the river. Before the intensive drainage and melioration of the area, almost 50 percent of the whole Buna/Bojana River and Delta region was regularly flooded.

The Buna/Bojana Delta area comprises a recently developed small delta, several different lagoon complexes and freshwater lakes, as well as typical riverine and coastal landscapes. The growth of the delta by 1.0–1.5 km in the last 100 years is relatively slow compared to other Mediterranean deltas, such as the Rhone and Po (about 4 km in 100 years).

Lake Šaško and Viluni Lagoon are important wetlands in terms of biodiversity. Lake Šaško is situated within the Montenegrin part of the Buna/Bojana Basin (Ulcinj Field), and is fed by the Buna/Bojana River under favourable hydrological conditions. The lake is approximately 3 km long and 1.5 km wide. Viluni Lagoon lies in the Albanian part of the delta and is one of the most important lagoons in the country in terms of biodiversity. The lagoon is approximately 3 km long and 0.9 km wide.

The morphology, hydrography, and the related values of the Buna/Bojana deltaic complex are defined by the balance among the following:

- accumulation of sediments in Drin and Buna/Bojana
- sediment load reaching the mouth of the Buna/Bojana in the Adriatic Sea
- water flow regime in the Skadar/Shkodër–Drin–Buna/Bojana system
- influences from the sea, including variability of the wave activity and sea level in combination with short-term events (storm waves and tides) and long-term processes (sea transgressions).

[9] The annual average discharge is 1,400 litres t^{-1}. Discharge varies.

In the **marine area,** the predominant currents are northward during winter and autumn and reverse during summer. Four main external forces drive marine currents in the area: inflow of Ionian waters from the south; local winds; air–sea heat and water fluxes (collectively termed buoyancy forcing); and freshwater runoff from the Buna/Bojana River. Different factors dominate depending on the season. Freshwater river runoff and the influx of Ionian waters seem to be the dominant forcing factors for circulation in early spring.

As the bottom slope of the Buna/Bojana River is quite flat, tides can travel upstream for several kilometres; seawater may reach Reč, or even further upstream. This phenomenon can be observed during dry periods, when the flow of fresh water is reduced.

River fluxes influence a number of parameters including sea surface salinity. Salinity levels are lowest between Buna/Bojana River and Ulcinj Salina. The area under the direct influence of the Buna/Bojana River is designated using combinations of monthly isolines of 35 PSU as an average sea surface salinity value.

The coastal aquifers interact with the sea, including as submarine groundwater discharges, which contribute to the creation of brackish water habitats in the coastal zone. The submarine groundwater discharges to the Adriatic Sea in the Albanian portion of the study area are estimated to be 0.29 $Mm^2\,yr^{-1}$ while no estimate exists for Montenegro.

Hydrogeology

Information on hydrogeological and geological features in the sub-basins in the Drin Riparians is given and depicted in maps, including hydrogeological formations, the delineated aquifers and groundwater bodies, and groundwater use. There have been in some discrepancies in the information given by Riparians for the same formations or parts of formations (e.g. depth of analysis and presentation of varying hydraulic conductivities estimations). This is because each Riparian presented results differently or made different estimations of the properties of the same formations extending across the borders. Addressing these differences was beyond the scope of this report. However, an attempt was made to present the hydrogeological formations in a harmonised way through the hydrogeological and aquifer maps.

Due to the complex hydrogeological structures, the surface hydrological boundaries often do not coincide with the hydrogeological boundaries of the catchments of surface water bodies. For example, Lake Prespa has an underground hydraulic connection with Lake Ohrid. The catchment area of Radika River is affected by the areas of Resen, Ohrid and Struga, Piskupstina, and Debar Basins, as well as the mountain areas of Galichica, Stogovo, Ilinska planina, Karaorman, and others.

Some of the formations and massifs – aquifers identified and listed in the report – do not exclusively drain into the Drin Basin.

Determination of the exact flow patterns under different seasons and hydrological conditions is necessary to enable integrated surface and underground water resources management within each Riparian, as well as at the transboundary level. This requires detailed analysis and further investigations.

The rich groundwater potential in the Buna/Bojana area has led to high exploitation. There are indications of salinisation issues in aquifers in the coastal area.

Water bodies

In the Drin, apart from Greece where the EU WFD is fully implemented, only some action has been taken to delineate and characterise the water bodies (as per the EU WFD definition). Water bodies in the Drin Basin in Albania have not been delineated. In Kosovo, some have been delineated in White Drin River Basin under Instrument for Pre-Accession Assistance (IPA) Projects, especially regarding groundwater bodies. Further delineation and characterisation is expected to follow through the Sida-supported Framework Environmental Programme for Kosovo. In North Macedonia, River Basin Districts have been officially established. Detailed delineation of water bodies for the Macro Prespa was done under the framework of the development of the Macro Prespa Lake Water Management Plan of 2011 (updated in 2016). The water bodies of Lake Ohrid will be delineated and characterised as part of the Lake Ohrid Watershed Management Plan to be prepared under the framework of the GEF Drin Project. In Montenegro, delineation made in the framework of projects is not yet official.

The preliminary delineation of 68 surface water bodies at the Drin Basin level was done as part of the work to calculate the water balance in the Drin Basin. The main characteristics[10] and the typology of each water body are listed with related maps.

This work will form the basis for the **delineation of the water bodies (in accordance to the EU WFD**) in the Drin Basin level, within the framework of the preparation of Drin River Management Plan, should the Riparians decide to prepare this.

With regard to the **aquifers/groundwater bodies**, some have already been identified and delineated by the institutes responsible for hydrogeology or through projects in specific Riparians. These aquifers or groundwater bodies have not yet been officially adopted by any of the Riparians. Related information in terms of their characteristics and hydrogeological maps from different sources, were systematised by the project and presented at the Drin Basin and sub-basin levels. The information provided includes the Riparians and the sub-basins that these extend to, the area, hydraulic characteristics, type, dominant aquifer/period/lithology, water reserves, groundwater use, etc.; not all information is available for all aquifers.

The main uses of groundwater are potable water supply and irrigation, often through non-registered abstractions**.** Many agglomerations are not connected to the regional water supply systems have their own local water supply systems using groundwater.

An aggregation exercise attempted to visually 'homogenise' the geological formations and aquifers by following purely geological and hydrogeological criteria. The types of aquifers are identified across the borders and a hydrogeological map for the Drin Basin has been prepared.

Karst aquifers with high permeability cover the largest part of the Drin Basin, while almost 28 percent of the total area has no significant aquifers or is nearly impermeable (central and eastern parts of the basin). There are also karst aquifers with moderate permeability (9 percent of the basin) and porous aquifers of moderate to good permeability. Almost two-thirds of the Drin River Basin has hydrogeological characteristics that allow potential groundwater exploitation, while ~ 50 percent is of high permeability.

[10] Name; area; elevation (highest, average); water body length (start–end).

An attempt was made to identify the transboundary aquifers by aggregating similar hydrogeological formations.[11] Nine potential transboundary aquifers were identified and depicted in a map.

The largest identified transboundary aquifer is shared by Kosovo, Albania, and North Macedonia. It comprises intergranular formations of low permeability. The next largest transboundary aquifer, and the most important one, is shared by Montenegro, Albania, and Kosovo (aquifer no. 1). It comprises karst formations of high permeability and has an extent of approximately 2,000 km^2.

Information related to the hydrogeology in the Drin Basin can be used both for policy-making and management planning at Riparian level, as well as for the preparation of river basin management plans integrating management of surface and underground waters.

Water supply services

The total potable water produced is 197.3 Mm^3. Compared to the overall annual discharge, it is about 1 percent of the overall water resources in the Drin River Basin. The actual domestic (including tourism and small-scale industry) consumption in Drin Basin reaches 75.5 Mm^3 per year, with Montenegro having the highest consumption and North Macedonia the lowest (excluding Greece). Tourism still has a relatively low water demand, but this is a growing sector and this rate is expected to increase.

The household water consumption rate varies significantly: 95 litres c^{-1} d^{-1} in Albania, 93 litres c^{-1} d^{-1} in Kosovo, 158 litres c^{-1} d^{-1} in North Macedonia, and 237 litres c^{-1} d^{-1} in Montenegro.

The ratio of consumed versus produced (inflow into the supply network) water from the supply systems varies from roughly 40 percent for Kosovo and Montenegro, to 36 percent for Albania and only 25 percent in North Macedonia. Further, based on the available data at municipal level, there are cases where the consumption is as low as 15 percent of the total production.

The non-revenued water is very high in all cases and varies between 69 percent as a weighted average for utilities in North Macedonia to 56 percent for utilities in Albania. Further, the ratio goes as high as 80–90 percent in some municipalities.

The metering ratio (percentage of metered water from the total consumption) is very low in the Drin River Basin with the exception of Kosovo. For example, in Albania, the overall metering ratio is 32 percent, and even non-existent in some relatively densely populated municipalities.

Another characteristic of the quality of the water supply services is the hours per day that water is supplied. In this respect, Albania attracts particular attention, with an overall value of only 14.8 hours per day of water supply.

Besides the centralised water supply systems, a portion of the population in the Drin Basin uses their own means for domestic water supply. In Albania, the domestic water consumption from own sources is around 15 percent of the consumption of water obtained from public utilities, which is in line with the estimated 78 percent water services coverage. The situation is similar in Kosovo, whereas in North Macedonia and Montenegro, private water sources are estimated to be 10

[11] Similar hydrogeological formations were aggregated using the following criteria:

- formations that may interact in hydrogeological terms, due to their common physical characteristics and their location
- proximity of formations to the boundaries of Riparians.

percent. Nevertheless, the total water produced from own, private sources is 3–5 percent in relation to the water supplied from centralised systems.

Theoretical water demand

The theoretical water demand *per Riparian and sub-basin* was estimated for the main consumptive water uses.[12] This was used to calculate water stress later under different scenarios.

Water consumption is estimated to be significantly higher in the summer period, due to irrigation, which demands the most water in Drin River Basin.

Although the permanent population in Montenegro is not the highest in the Drin Basin, the theoretical **domestic water demand** is the highest (23.78 $hm^3 yr^{-1}$) due to the higher residential water consumption in this country (237 litres $c^{-1} d^{-1}$).

The highest theoretical domestic water demands are found in Lake Skadar/Shkodër sub-basin (26.4 $hm^3 yr^{-1}$, 35.0 percent), followed by the White Drin (18.4 $hm^3 yr^{-1}$, 24.4 percent) and Black Drin (12.7 $hm^3 yr^{-1}$, 16.8 percent).

The highest theoretical monthly domestic water demand is during the tourist season in July and August.

Agriculture is the sector with the highest water consumption, due to irrigation.

The largest cultivated areas in the Drin Basin are in Kosovo (43.2 percent) and Albania (32.2 percent), and in White Drin and Lake Skadar/Shkodër sub-basins (42.9 percent and 20.1 percent, respectively).

The highest percentage of irrigated area covered with drip irrigation is in Montenegro (44.0 percent) and the lowest is in Albania (13.3 percent). The percentage of drip irrigation out of the total irrigated land in North Macedonia is nearly 30 percent.

The total theoretical annual water demand for irrigation in the Drin Basin is estimated to be 1,164 hm^3. The highest needs are found to be in Kosovo and Albania (41 percent and 32 percent of the total, respectively) and in White Drin and Lake Skadar/Shkodër sub-basins (41 percent and 19 percent of the total, respectively). The highest theoretical monthly water demand for irrigation is in July and August.

The total annual theoretical water demand for animal husbandry is 17.44 Mm^3 or 1.45 Mm^3/month (based on the assumption that the water needs of animals are equally distributed during the year). The highest water needs are recorded in Albania (56.8 percent of the total). Black Drin, White Drin, and Drin sub-basins have almost the same share of water needs (27.3 percent, 22.8 percent, and 22.7 percent of total, respectively).

Theoretical water needs for irrigation are the largest, accounting for 95 percent of total needs in the Prespa sub-basin, 91 percent in the Ohrid sub-basin, 88 percent in the Black Drin sub-basin, 95 percent in the White Drin sub-basin, 93 percent in the Drin sub-basin, 88 percent in the Skadar/ Shkodër sub-basin, and 97 percent in the Buna/Bojana sub-basin.

[12] Domestic consumption and industrial consumption; irrigation for agricultural purposes; consumption for animal husbandry.

Water balance

A hydrological model[13] was used to assess the available water resources and establish the water balance in the Drin Basin. The **hydrological model takes into account the consumption in the basin, yielding 'net' results, i.e. the river discharges with the consumption already deducted.** The water outflows from the model represent both surface and groundwater discharge.

The hydrological situation in the Drin Basin is presented giving the annual average discharge and the annual runoff in the delineated sub-basins.

The multiannual monthly average discharge of major rivers and lakes in the Drin River Basin has been calculated and is presented. The discharge in the watercourses varies significantly over the seasons in a year, depending on meteorological variability (precipitation, temperature). The wet period is from November to May with peak discharges in December through March. The dry period is from June to October, with minimum discharges in the summer period.

The average maximum outflow from Buna/Bojana River mouth in dry years is less than 860 $m^3 s^{-1}$, while the respective value in a 'normal' year is more than 1,040 $m^3 s^{-1}$ and in a wet year more than 1,800 $m^3 s^{-1}$.

Water balance scenarios

Three water budget scenarios were used to assess water availability/stress in each one of the sub-basins and consequently related transboundary issues.

1. Business as usual: present climate, present water demands.

This scenario assumes that the hydrological conditions affecting surface water and groundwater availability are similar to conditions that have been observed in the recent historical record (1979–1989 and 2001–2010).

To assess 'water stress', the theoretical consumed water was compared to the hypothetical water resources available (i.e. without any consumption).

According to results, during the irrigation season, the theoretical water consumption increases up to approximately 75 percent of the available resources in the White Drin, while in the Black Drin the corresponding consumption approaches 40 percent of the available resources (demand is highest in July and August). In the rest of the year, the water consumption/demands are limited in relation to the available resources (less than 5 percent).

We can conclude that in a hydrologically average year there are no significant problems in covering all water needs in the Drin Basin. The issues of inadequate and/or inefficient water supply networks, which cause insufficient supply to the users, are related to the design, investment, and operation of appropriate water management infrastructure.

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[13] The Panta Rheihydrological model -adjusted for the Drin River Basin and donated to the hydrometeorological institutes through a GIZ project- was used.
The model was developed and is maintained by the Leichtweiss Institute of Hydraulic Engineering and Water resource (LWI), in collaboration with the Institute of the Water management (IfW), in Technical University of Braunschweig, who share the copyright. The Technical University of Braunschweig was commissioned by GIZ to calibrate and apply the Panta Rhei model to the entire Drin Basin in the framework of GIZ project 'Climate Change Adaptation in the Western Balkans'.

For a dry year, water stress is increased when irrigation needs are increased (summer period; peak is reached in July/August); theoretical consumption in terms of percentage of available water resources reaches ~85 percent in White Drin, 41 percent in Prespa, ~35 percent in Black Drin, ~34 in Skadar/Shkodër, and ~33 percent in Ohrid.

2. Climate change scenario: future climate, present water demands.

This scenario assumes that hydrological conditions affecting water availability reflect changes to the climate that may be expected by the year 2050. Climate changes are estimated using global and regional climate models, as reported in the National Communications to United Nations Framework Convention on Climate Change (UNFCCC).[14] The water demands are assumed to equal current demands (no change in water demands), except in the irrigation sector, where consumptive water-use requirements are assumed to change because of rainfall and evaporation alterations resulting from climate change.

Water stress is estimated by calculating the rate of theoretical water use as part of the available water under the climate change scenario. Water stress in the White Drin significantly increases under this scenario; theoretical consumption will reach 81 percent of available water resources during July when the irrigation needs are at the higher level. The Black Drin sub-basin ranks second; here theoretical consumption will reach ~43 percent of available water resources during July, when the irrigation needs are highest. For the rest of the basins, no significant stress projected.

This implies that water resources will undergo significant stress in parts of the basin in the next 30 years, even if the consumption remains at today's levels (especially during the summer period). Moreover, in the case of dry years, it is likely that the available water resources in large parts of the basin will not be adequate to satisfy the demand.

Mitigation measures should be designed to overcome this problem. Water-saving measures should be implemented and demand managed through economic and other tools.

3. Full development scenario: future climate, future water demands.

This scenario assumes that climate change will affect hydrological conditions and that consumptive water demands (water supply, industry, agriculture) will also change in the future.

This scenario assesses the level of water stress in each basin throughout a year because of the development of economic activities and expansion of water supply networks. Temporal changes in water availability in different parts of the basin as a result of non-consumptive uses – the most important sector in this regard is energy – and possible subsequent transboundary issues is not

[14] There is strong evidence that the surface runoff by the end of the century will fluctuate within ± 10 percent in relation to the 1980–2010 average values in the study area, while in specific, small parts, the possible streamflow reduction may reach 30 percent.

Climate change scenarios for Albania indicate an overall decrease in precipitation and increase in air temperature. Despite the total precipitation being expected to decrease, an increase in intensive rain episodes is also likely. As well as the inland impacts of climate change, Albania is also facing an expected rise in sea level. For Montenegro, similar climate change effects to precipitation and temperature are expected.

Climate change scenarios for North Macedonia indicate overall increase in air temperature and decrease in precipitation. The estimated changes are generally lower (especially for precipitation) than those for Albania and Montenegro. For Kosovo, similar climate change effects to precipitation and temperature are expected.

assessed here, as data that would enable the use and coupling of water and energy models were not available.

An increase in consumption is expected in the coming years in domestic consumption. There are no reliable data to make projections. According to some planning documents, this consumption will increase by approximately 64 percent. A more conservative figure of 50 percent of current consumption was used in this scenario.

Major water-use increases are expected in the agriculture/irrigation sector due to the development of irrigation schemes. For the purposes of this report, and using the best available information from sectoral planning documents, the figures used for the projected increase in irrigation to 2050 were 30 percent of current consumption for Albania, Montenegro, and North Macedonia, and 50 percent for Kosovo. This amounts to an average increase of around 610 Mm^3 annually.

Based on water resources availability in 2050 under the climate change scenario and the increased consumption, water stress in the study area will further increase. Water demands will probably not be satisfied during summer months in dry years at the White Drin, Prespa, and Black Drin sub-basins. Under this scenario, the needs in White Drin during July will be double the available resources.

Hydromorphological changes and their effects

There are more than 110 irrigation reservoirs in Drin River Basin and five big operational HPPs. In North Macedonia the Globočica and Shpilje HPPs have a total installed capacity of 126 MW, in Albania the Fierza, Koman and Vau i Dejës have a total installed capacity of 1350 MW and the Ashta HPP on the Drin River has an installed capacity of 48.2 MW, and in Montenegro the “xxx”. The dams constructed along the Drin in Albania, produce hydropower contributing to around 90% of the total electric capacity in the country. Further, there are currently 22 small HPPs in operation. In Albania’s part of the basin, 55.2 percent of the total main river length (275 km) has been heavily modified (creation of reservoirs). In North Macedonia, 37.3 percent, or 21 km of the 56.3 km of Black Drin River course has been converted into reservoirs.

Apart from the central Drin River itself, rivers are currently largely pristine or only moderately modified. There is concern over small HPPs that have been either built or planned in large numbers. Most of these projects are at the stage of planning or receiving concessions. If they are all built, they will fundamentally change the river habitats and water regime in the basin.[15]

The plans for the construction of new HPPs are concentrated on the Morača, in the Bjeshket e Nemuna/Prokletije, and in the Black Drin Basin. Most of the new small hydropower schemes will not use vertical obstacles (dams) for energy production, but instead will deviate part of the flow, which then returns to the river further downstream. This has less impact on the sediment volume in the total transport in relation to dams, but the temporal distribution of the sediment flow remains high (since the discharge is regulated).

Floods

Floods in the Drin Basin Riparians occurred prior to the construction of dams. They are increasing in frequency.

[15] At national level, since 2008, there have been 178 concession contracts in Albania for the construction of 517 small hydropower plants; 104 are in operation and 75 are under construction. There have been no studies on the possible impacts the construction and operation of the small hydropower plants will have on water flow and the sediment distribution regime.

In Albania, following the devastating floods of 1962–1963, flood defences were built to the 1% return period in some rivers, but such standards of protection are decreasing due to climate change. Historic data on flooding in **Montenegro** show that in the period 1979–1997 there were five major flooding events; but in the six years, 2004–2010, floods occurred six times.

In January and December 2010, floods caused major damage and disruption over a wide area in the lower Drin, Skadar/Shkodër and Buna/Bojana areas. In January 2010, as a result of increasing rainfall, the Drin River flow rapidly increased. The floods were exacerbated by the operation of the three hydropower reservoirs (in Albania), which were forced to release water, increasing discharge to 2,450 m^3/s into the Buna/Bojana River, which has a maximum capacity of only 1,600 m^3/s. The flooding of January 2010 in the district of Shkodra in Albania inundated 10,400 ha of land, affecting 2,500 houses; 4,800 people were evacuated.

Intensive precipitation and snow melt in the northern part of Morača Basin, combined with high tides in the Buna/Bojana River due to the strong south wind and high discharge of the Drin resulted in an increase in the water level in Lake Skadar/Shkodër (10.44 m a.s.l.) in December 2010. It is believed that the floods were exacerbated by reservoirs in Albania (Vaus Deis, Kumana, Fierza) that released 3,000 m^3/s of water into the Buna/Bojana River. The December 2010 flood resulted in unprecedented water levels, extent of flooded areas and damage. In Montenegro, the total countrywide damage and losses exceeded €40 million (1.3 percent of GDP), impacting largely rural areas. The floods led to the evacuation of 1.5 percent of the population.

Due to the retained volume of the dams, the overall hydrological regime has changed to low flow and small flood events (1–10 years). There is no evidence that the dams change extreme flood events, however the magnitude of impact can be more dangerous further downstream after releasing large flood waves. Due to the retention volume, it is estimated that floods of about 5,000 m^3/s can be reduced to about 2,000 m^3/s downstream of the last dam (if the dams are not filled with water).

The hydropower dams in the Drin Basin and their reservoirs could be used for seasonal and long-term regulation of river flow. The operation of hydropower dams and reservoirs within the basin should be included in the flood risk assessment, modelling, and mapping. Based on climate risk information, the current and long-term ability to operate dams in a flood alleviation role should be investigated. Ideally, stakeholders would agree on the optimisation of the dam operations for multiple uses, including power generation, flood alleviation, and dam safety. At the very least, dams should be operated in a manner which avoids exacerbating flood risk and which takes account of the increasing risks posed by climate change.

Further to the dams, land-use changes adjacent to the river channel area have reduced the area of the floodplain, altering ecosystem structure and the hydrological functioning of the river. Before the intensive drainage and melioration of the area, almost 50 percent of the whole Buna/Bojana River and Delta region was regularly flooded.

A preliminary flood risk assessment was done by the Riparian countries in a transnational Technical Working Group (more than 40 representatives from different institutions dealing with flood risk management, such as national water management agencies, river basin authorities, local administration, civil emergency structures, spatial planning, etc.) and guided by international and national experts.[16] The methodology and the steps identifying the areas of potential significant flood

[16] The process was supported by the project "Climate Change Adaptation through Transboundary Flood Risk Management in the Western Balkans", funded by the German Federal Ministry for Economic Cooperation and Development, and implemented by GIZ.

risk (APSFRs) followed the EU Floods Directive, chapter III, article 4. The assessment considers different types of floods according to the European Flood Risk Management guidelines of the EU Working Group on floods.

The assessment identified 46 APSFRs throughout the Drin River Basin; these are presented in overview map in the report prepared by GIZ. Of these, 21 are located in North Macedonia, 12 in Kosovo, 7 in Albania, and 6 in Montenegro. The numbers do not reflect the extent of potential risk or the size of the risk areas. The bigger flood risk areas are situated in Albania in the delta of the Drin River Basin and around Lake Skadar/Shkodër, whereas a number of smaller risk locations are found in the upstream countries. Areas in Kosovo and North Macedonia are facing flash flood and pluvial flood risks (in smaller catchments and along the headwaters of smaller streams that cross the villages).

The rating of the *significance* of potential flood risk areas followed the approach of the EU Flood Directive, using significance criteria for the assets at risk (human life, economic and ecological assets as well as cultural heritage).

The APSFRs were categorised according to two levels of potential significant risks (high and low). High significance characterises an area in which more than two of the significance criteria are met. Low significance stands for areas in which one or two criteria are met. Following this exercise, about 76% of all potential flood risk areas can be considered highly significant (in Kosovo 100%, also because the available level of comparative data is low). One-quarter of the APSFRs are of low significance, meeting just one or two significance criteria.

Sediment distribution and erosion

The construction of the reservoirs and HPPs has resulted in significant modification of the natural river sediment transport. The sediment load has been drastically reduced (by nearly 95 percent) in the downstream part of the basin. Further, high discharge releases downstream of dams with no or little sediment loads cause channel vertical erosion, disconnection from the floodplain, and bank erosion.

A realistic estimation of average annual sediment transport from the Drin River is 6.9 million t. Of this, 0.5 million $t\,yr^{-1}$ passes through the dam turbine and spill gate, while the rest accumulates in the dam reservoirs. Dams are traditionally designed to provide enough reservoir storage to sustain at least 100 years of sedimentation; the current rate of sedimentation may affect the life span of the dams.

Ashta HPP 1 and 2 do not affect the river sediment transport capacity due to construction features that allow sediments to be washed out of their reservoirs. After the Drin–Buna/Bojana confluence, these sediments enter the latter to join the very small quantity of Skadar/Shkodër sediments (mainly clay and sand). The limited movement of water from the lake allows only small amounts of the suspended sediments to flow out, especially during the wet season or during high discharge events (e.g. when the water speed is increased above 1 $m\,s^{-1}$ during the flood season). The Drin joining Buna/Bojana a km after the latter flows from the lake creates a blockage of the discharge outflow from the lake, influencing the sediment transport.

In addition to dam construction, the sediment distribution regime in the Drin and Buna/Bojana Rivers has been altered to some extent by deforestation, and soil and water abstraction. This alteration influences the rivers' morphology and geomorphology, delta evolution, and ecosystem health and stability, as well as the coast (causing erosion – see below).

An estimate of erosion was performed,[17] but the uncertainty is high. The average rate of soil loss in the catchment is estimated to be 10–20 t ha^{-1} yr^{-1}. The rate of soil loss is higher in the Albanian part than in other parts of the catchment. There are also some highly eroded areas in Montenegro, but these are small isolated areas. Moderate soil erosion losses are estimated for Kosovo, while the lowest soil loss rates are in North Macedonia. In the Prespa, Ohrid, and Black Drin sub-basins, two areas on the borders between Albania and North Macedonia stand out; in the North Macedonian part, there is an estimated average soil loss rate of 7 t ha^{-1} yr^{-1} while in the Albanian part the average rate is 12 t ha^{-1} yr^{-1}. In the case of White Drin in Kosovo, the average soil loss rate is estimated to be 9 t ha^{-1} yr^{-1}. The highest rate in terms of soil erosion – 20 t ha^{-1} yr^{-1} – is in the central Drin River Basin. At Lake Skadar/Shkodër, the estimated rate of soil erosion is about 6 t ha^{-1} yr^{-1}.

The theoretical sediment budget and distribution regime in the different sub-basins was estimated[18] for the different sub-basins. The annual average sediment transport of Drin River in the area of Fierza HPP is 4.72 million t km^{-2} yr^{-1}, while the annual average soil loss reaches 557 t km^{-2} yr^{-1}. The annual average sediment transport in the area of Vau i Dejëes HPP reaches 15.4 million t km^{-2} yr^{-1} and the annual average soil loss is 489 t km^{-2} yr^{-1}.

According to Albanian data, sediment transport between Fierza and Vau i Dejëes is estimated to be very high. However, this analysis uses sporadic data and in associated studies, the calculation error ranges from 7 to 20 percent. In the case of Vau i Dejëes, even with a high error (20 percent), the soil loss values are very high; this is confirmed by the dam operators in the Drin cascade.

Gravel extraction is an issue. In the case of White Drin, extraction for more than 20 years has significantly changed the morphology of the river. The gravel excavation process involves the separation of mainly medium coarse material from inert material. In the process, finer particles are washed out leaving a disturbed river landscape of mud heaps. Particularly during floods, the main branch of the river is charged with considerable loads of suspended material, which is then deposited further downstream. The total area affected by erosion in the White Drin sub-basin is estimated to be 1,156 ha.

Coastal erosion

The morphology, hydrography and the related values of the Buna/Bojana Deltaic complex are defined by the balance among the following:

- accumulation of sediments in Drin and Buna/Bojana
- sediment load reaching the mouth of the Buna/Bojana in the Adriatic Sea
- water flow regime in the Skadar/Shkodër–Drin–Buna/Bojana system

[17] An estimate of erosion for the Drin Basin was performed using the revised universal soil loss equation (RUSLE). CORINE land cover data from 2006 were used. Data and models that are at European scale were used as observation data for the soil loss in the catchment are sporadic and not representative. Therefore, the uncertainty of the modelled erosion risk is high, especially at local level.

[18] The main parameters used to evaluate the sediment budget are: ρ_0 : multiannual average suspended sediment; R_0: multiannual average solid sediments passing from the bottom of the riverbed; W_S: yearly volume calculated from the suspended sediments; W_B: yearly volume calculated from the solid sediments; W_T: total of the sediment transport from the river; $r_{0,s}$: multiannual average soil loss distributed in the river

- influences from the sea, including variability of the wave activity and sea level in combination with short-term events (storm waves and tides) and long-term processes (sea transgressions).

The Buna/Bojana Delta was growing in area before the dams' construction, with the most intense deposition occurring in the 1940s, at an average rate of about 45 m yr^{-1}. Decrease of sediment reaching the coast (see factors listed above) caused a decrease and eventual reversal in this trend. Accumulation during the period 1950–1984 is estimated to be from 5 to 10 m yr^{-1}. Erosion during the period 1984–2016 is extensive in some parts, occurring at a rate of 3 m yr^{-1} in Ada and 4 m yr^{-1} in Albania; Ada Island disappeared entirely in 2016. In the same period, some sediment accumulated at the coast of Ulcinj Municipality (0.5–0.8 m yr^{-1}) in Montenegro and in Velipoja beach in Albania (deposition reaches 7–10 m yr^{-1}).

The coastal area in front of the right branch of the delta is a sediment accumulation area. The coastal area in front of the left branch, in contrast, is being eroded.

Sea currents

Predominant currents in front of the marine area of the Drin Basin are northward during autumn and winter, and reverse during summer. Several factors drive marine currents in the area and different factors dominate depending on the season. Freshwater river runoff and the influx of Ionian waters seem to be the dominant forcing factors for circulation in early spring.

Although there are no precise datasets on the tidal regime, the Adriatic Forecasting System time series (Guarnieri et al., 2013) indicates a dominant semidiurnal tidal frequency in the coastal zone, as in the rest of the Adriatic basin. Simulations for the Buna/Bojana River mouth (for the year 2003) showed that the difference between mean higher waters and mean lower waters is approximately 30 cm, while the amplitude between the highest and lowest waters is approximately 50 cm. The maximum values of the zonal and meridional currents are approximately 5-6 cm s^{-1}. They vary greatly across daily, monthly, and yearly timescales. As the bottom slope of the Buna/Bojana River is quite flat, tides can travel upstream in the river for several kilometres; seawater may reach Reč, or even further upstream. This phenomenon can be observed during dry periods, when the flow of fresh water is reduced.

River fluxes influence a number of parameters including sea surface salinity. Salinity levels are lowest between Buna/Bojana River and Ulcinj Salina

END