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ZHMS

Climate Change Adaptation in Western Balkans

Establishment of a Flood Early Warning System in the Drin-Buna Basin (DEWS)

Assessment Study for Gaps and Needs in Establishing a DEWS

Final Report

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1 Introduction

The Drin-Buna river basin is located in the South Western Balkans. The river basin is shared between Albania, Greece, Macedonia, Montenegro and Kosovo. Sub-basins are formed by the Black Drin, the White Drin, the Buna (Bojana), as well as the lakes Prespa, Ohrid, and Shkodër. In addition to these natural lakes, the Drin water basin includes several reservoir cascades. According to the ToR for this study, the system is threatened by river bed depletion and already noticeable effects of climate change, e.g. longer droughts and more frequent floods.

According to the ToR, the riparian countries are “aware of the threat and the necessity for adaptation activities. Climate change investigations indicate that already emerging meteorological and hydrological trends are going to intensify. By instance, Albania is likely to experience an increase of temperatures of up to 6 degrees Celsius, an accumulation of intense rain periods, the reduction of recharge into to the Drin basin, as well as a higher risk of floods. Macedonia fears the loss of the alpine belt within the next fifty years as well as more droughts and floods in general. A sharp decrease of available water resources is expected. Also Montenegro will probably see less precipitation and more intense rain- and drought periods. Additionally, an increase of floods is expected due to extensive snow melting. At this stage there is no such reliable data yet for Kosovo, due to the lack of a National Communication.”

“In order to work contra the effects of climate change on a regional level, a number of important multilateral agreements have been taken and conventions adopted. Particularly relevant in this context are “the Belgrade Initiative on Climate Change”, the “South East European Climate Change Framework Action Plan for Adaptation” (2008, Albania, Bosnia and Herzegovina, Macedonia, Montenegro, and Serbia), the “Joint Statement by the Participants in the Ministerial Meeting - Climate Change Research for Environmental Protection, Adaptation and Risk Reduction” (Serbia 2011) and the “Drin Declaration” (2011, Albania, Kosovo, Macedonia, Greece).

The project “Climate Change Adaptation in Western Balkans“ aims at strengthening the adaptation capacities of the five countries Albania, Macedonia, Montenegro, Kosovo and Serbia in correspondence to the above described climate change forecasts.”

A major component of the project is the establishment of a flood early warning system in the Drin-Buna Basin (DEWS) with special emphasis on the lower Drin and Buna.

Basically, a comprehensive flood early warning system is made up of the following components which must be integrated if the system is to operate effectively:

- Availability of long-term series of **historical hydrometeorological data** for the initial calibration and validation of the combined hydrological-hydraulic model to be used for the forecast.
- **Continuous monitoring of actual hydrometeorological data** of the whole river basin, **online transmission** of data to a central data base.
- **Data base management** including plausibility and consistency checks; database can be integrated into a water information system including further statistical processing tools , geo-data of the basin and modeling tools.
- **Quantitative meteorological forecast** (rainfall, temperature, wind, sunshine duration, radiation etc.).
- **Forecast of flood hydrographs, water levels and inundated areas** by combined hydrological and hydraulic modeling of the whole river basin.

- Interpretation of the forecast; construction and **dissemination of flood warning** to crisis management actors, involved agencies and concerned residents; communication with actors, residents and media.
- **Review** of the flood early warning system after flood events.

The reasons for developing such a DEWS are as follows:

One of the consequences of climate change is the increasing flood risk and its corresponding potential of flood damage in particular in the lower Drin-Buna basin. Presently there does not exist any comprehensive flood early warning system for the lower basin or regional flood warning systems in riparian countries of the middle and upper Drin river basin. Up to now, only fragments of national early warning systems exist in Albania and Montenegro while in Macedonia and Kosovo no activities in this regard have taken place. Considering the future climate change impact on the water balance in the transboundary Drin-Buna basin and the increasing importance of water utilization – in particular for hydropower generation - such an integrated operational system will become even more essential already for the close future.

In the past, in particular the Lower Drin-Buna river basin was exposed to severe floods. The high risk of flooding is partially caused by geological changes 150 years ago which diverted the flow of the Drin River to join the Buna River flowing out from the Shkodër Lake at the village of Bahçallëk. The hydraulic capacity of the actual downstream river bed and its natural flood plains allows passage of minor floods only. Medium to larger floods led to severe inundations and flood damage in the past. In particular in December 2010, enormous inundations along the lower Drin basin and vicinity of the Shkodër Lake caused considerable flood damage. In general, dam authorities being responsible for hydropower generation – like for the reservoir cascade of the Lower Drin in Albania - favor reservoir operation rules which aim at keeping high reservoir water levels all over the year. This constellation does not increase the downstream flood risk of natural floods unless high amounts of stored water are released in order to reduce the reservoir water level as a precautionary measure for preparedness of increasing reservoir inflow. If the dam is operated as a multi-purpose dam including flood protection for downstream areas, the operation rules include a flood retention space which has to be made available to intermediately store inflowing floods during the rainy season. Such an operation could reduce the annual energy production. If the operation according to such a rule is based on a reliable forecast of the reservoir inflow, the losses of hydroenergy production can be minimized and the utilization of flood retention space of the reservoir cascade can be optimized in order to reduce the downstream flood damage. Consequently, development and operation of a DEWS requires a close collaboration between DEWS developers and operators as well as dam authorities.

As mentioned above, the exchange of hydrometeorological (HM) data and flood forecast information between the riparian countries seems to be lacking. Even inside Albania and Macedonia, which have reservoir cascades systems in the Drin basin, the exchange of relevant data between governmental water authorities and dam operating agencies does not work well. Obviously, the dam operators are using their own real-time data network but do not deliver flow data to the HM services in time. On the other hand, only a few ground stations of the HM services are equipped with automatic data recording (data logger). Online data transmission is missing with the exception of some hydrological stations located in Montenegro and one hydrological station located in the Albanian subbasin.

Above statements clearly support that the DEWS should cover the whole basin including the Buna river catchment with the lake Shkodër and its lake catchment. Consequently, the nomination of "Drin flood early warning system" respectively the abbreviation "DEWS" covers the whole Drin-Buna river basin in this Assessment Study report.

For the rivers, lakes and reservoirs, consistent names were chosen, mostly according to international nominations. Otherwise the quality of reading the report would suffer, if double or triple nominations for the same river are used just in order to account for each language spoken in the riparian countries.

2 Methodology and Tasks of the Expert Team

In the framework of this project, a regional round table on a **"Flood Early Warning System for the lower Drin Basin"** was organised in Tirana in September 2012. One of the outcomes of the round table was the necessity to establish an expert team to study the gaps and needs for establishing a flood early warning system. The recruited expert team consisted of two international consultants (Prof. Dr.-Ing. Günter Meon, Germany and Dr.-Ing. Matthias Pätsch, Germany) and national consultants being associated with the hydrometeorological services of the riparian countries Albania, Kosovo, Macedonia and Montenegro. Team leader was Günter Meon. Information was also exchanged between representatives of the World Meteorological Organization (WMO) and of the European Commission Joint Research Center (JCR) in charge for the European Flood Awareness System (EFAS).

With the support of the national experts and GIZ, the international experts performed the following main tasks:

- Visit of relevant institutional providers of hydro-meteorological information in Albania, Macedonia, Kosovo and Montenegro.
- First inventory of the existing hydrometeorological, flood forecast and warning conditions (gaps and needs) with regard to a functioning DEWS.
- Pre-design of the (overall) DEWS for the lower Drin Basin as well as of the upgrade of the national HMSS to contribute to the overall DEWS.
- Identification of steps to be taken for the integration of the DEWS in the European Flood Awareness System (EFAS).
- Workshop in Tirana from 12-13 February, 2013: Persons from all relevant institutions involved in the project participated and discussed the Draft report "**Assessment Study for Gaps and Needs in Establishing a DEWS**", prepared by the international consultants.
- Final report including additional knowledge gained at the workshop.

3 The Drin-Buna River Basin

Figure 3.1 was developed by the international experts on the basis of a digital elevation model using SRTM data. It shows the international Drin-Buna river basin which extends over Albania, Macedonia, Kosovo and Montenegro. In Figure 3.2, the downstream river system is displayed in more detail. This figure is taken from the final report – The flood Risk Management Plan for the Lower Drin & Buna River Basin (Mott MacDonald 2012). In dependence on the assigned subbasins, the catchment has the following size (rough values, source: Wikipedia and others):

Whole Drin-Buna basin	19.700 km^2
Whole Drin-Buna basin without lake Prespa subbasin	17.200 km^2
Buna basin without Drin basin	5.200 km^2 (5.500 km^2 acc. to Mott McDonald, 2012)
Whole Drin basin without Buna basin	14.500 km^2 (14.173 km^2 acc. to Mott McDonald, 2012)

Table 3.1: Catchment size of Drin-Buna river basin

The following short description of the basin is directly taken from the Mott MacDonald report (2012):

"The catchment area is estimated to be 14,173 km^2 with a length of 285 km. The river originates from Lake Ohrid and Lake Prespa in Macedonia where it is called the Black Drini. The upper catchment of the Black Drini drains areas in Greece, Albania and Macedonia.

The Black Drini river leaves Lake Ohrid and crosses into Albania between Debar and Peshkopi. Further downstream, the White Drini river, which originates from Kosovo, converges with the river Drini west of Prizren.

The White Drini rises in Kosovo. It has a length of about 136 km which drains a karstic region of nearly 4,964 km^2 within Albania and 4,360 km^2 in Kosovo with a mean elevation of 862 m. The catchment is largely covered by forestry although recently this has decreased as a result of deforestation. Rainfall is highly variable and an annual average of up to 1500 mm is reported. Peak flows in the upper reaches generally occur in May as a result of snowmelt. In the lower reaches peak flows occur between November and February as a result of the seasonal rainfall pattern.

The Gjadri and Kiri rivers join the Drini downstream of the Vau Dejës dam and have catchment areas of 200 km2 and 264 km2 respectively. Further downstream the Drini converges with the outflow from Shkodra lake and becomes the river Buna which flows south westwards to the Adriatic Sea.

In the past, the paths of the River Buna and River Drini were separate. However, since the natural diversion of the River Drini some 150 years ago, the original channel of the Drini, leading south to the city of Lezha, carries only a relatively small discharge. Most of the Drini flow now joins the Buna river just downstream of the Shkodra lake and continues as a single river along the border with Montenegro until it enters the Adriatic Sea at Ada. Lake Shkodra is the largest lake in the Balkan Peninsula in terms of water surface area. The largest river flowing into the lake is the Moraca river which passes through the capital of Podgorica. The lake has a catchment area of about 5,500 km^2 (of which 80 % is in Montenegro and 20 % in Albania) and the surface area varies between 353 km^2 in dry periods and 500 km2 in wet periods (at maximum level, 67% is in Montenegro and 33 % in Albania). Its volume varies between 1.7 km^3 in dry periods to 4.0 km^3 during wet periods. The maximum length is 44 km and its greatest width is 13 km."

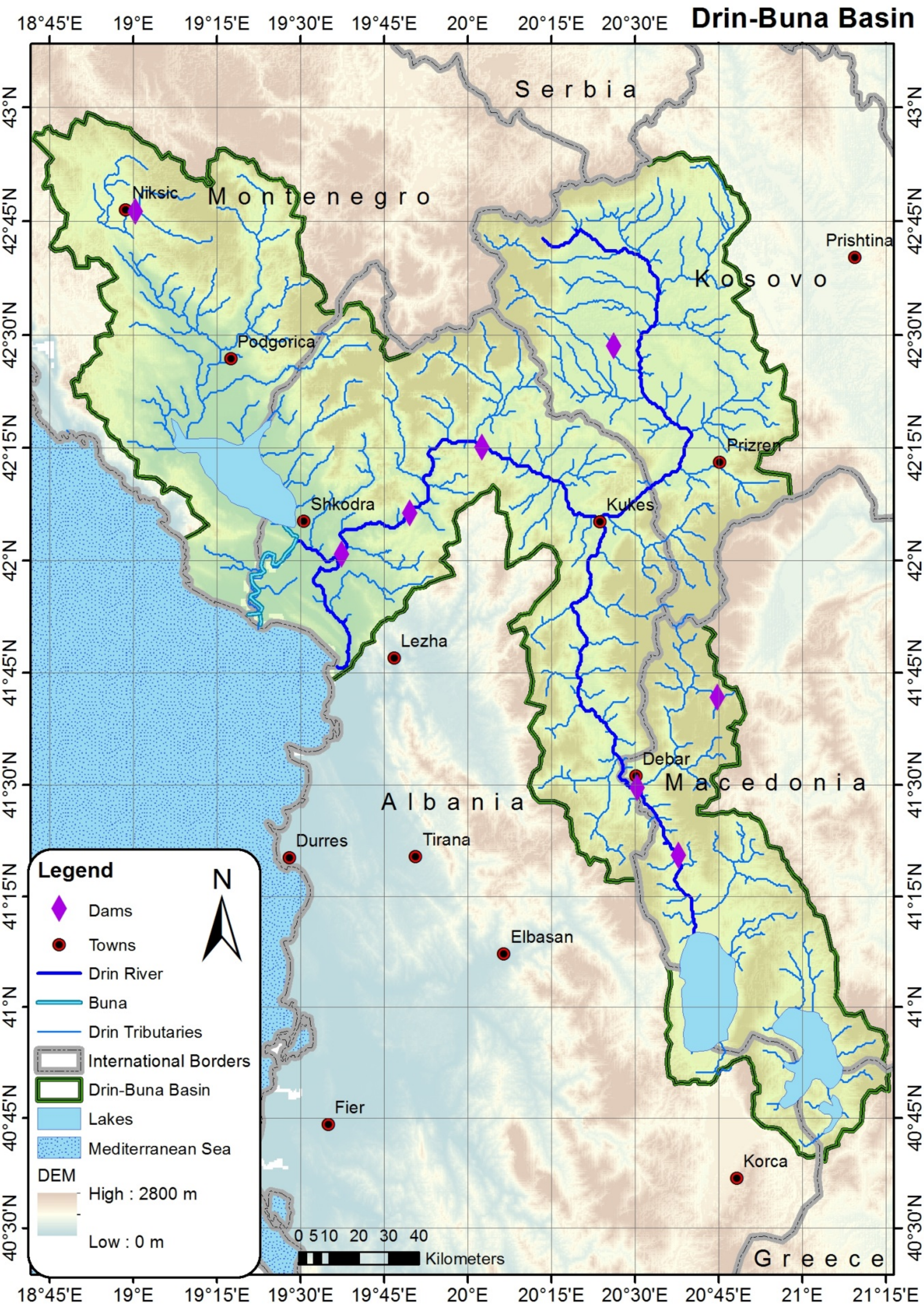

Figure 3.1: Drin-Buna river basin; map was processed from a digital elevation model derived with SRTM data (Source: Meon)

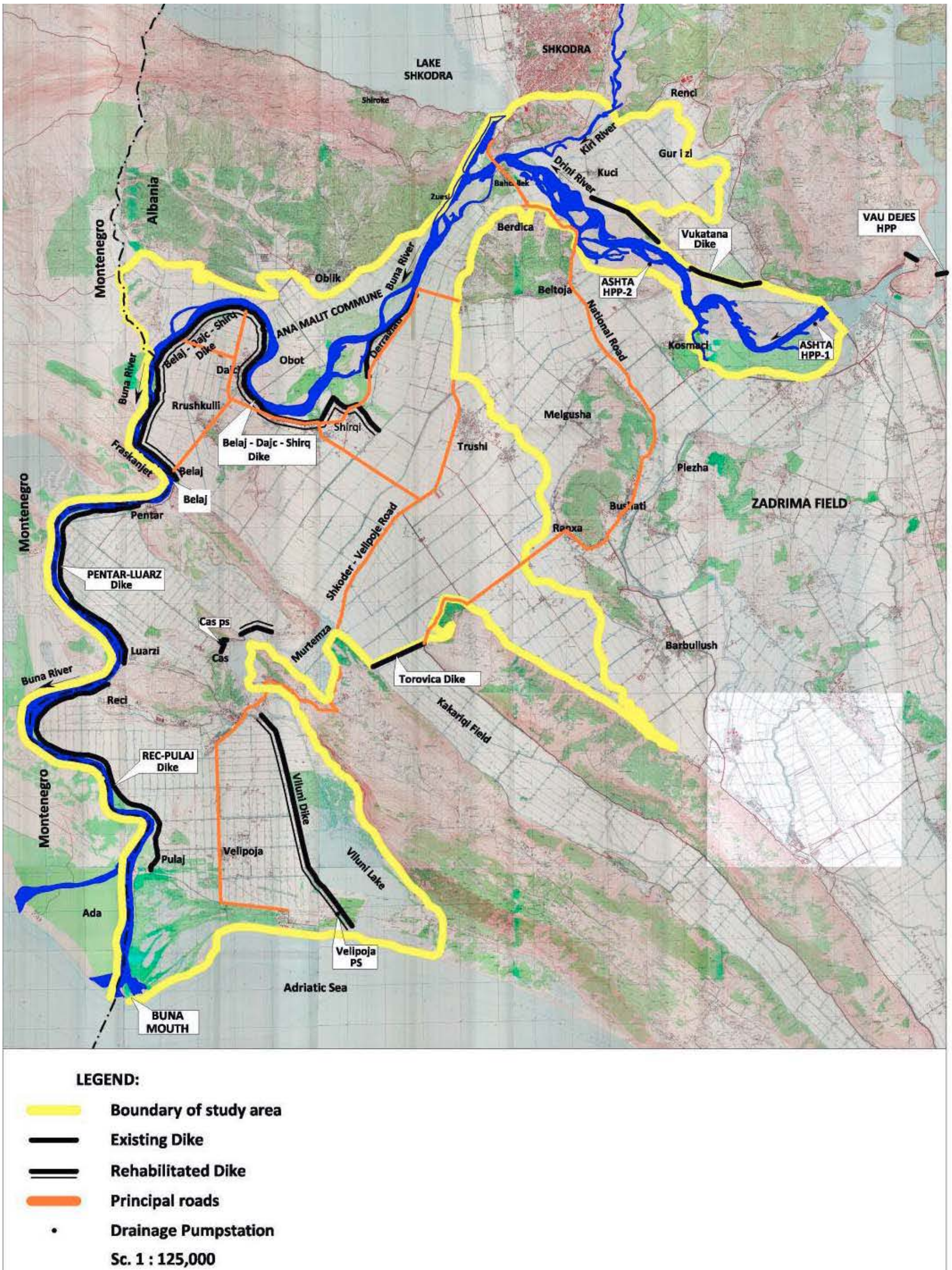

Figure 3.2 : Lower Drin river and Buna river (Source: Mott MacDonald, 2012)

In Figure 3.4, the Drin-Buna river basin system is displayed as a complex water system including the natural lakes Prespa, Ohrid and Shkodër and all reservoirs. Of high importance for the downstream flow regime is the reservoir cascade located in Albania. The reservoirs are used for hydroelectric energy production. Details about additional utilization purposes like flood protection are not available to the expert team for the time being. The Macedonian subbasin, too, contains several reservoirs being used for water supply, flood protection and hydropower generation. The flow regime through the southern Macedonian reservoir system is influenced by the dampening effect of the Lake Ohrid. The outflow from the Debar reservoir passes the border to Albania. After the confluence with two Albanian tributaries, the river is called Drin.

Flow contribution from the Montenegrian subbasin into the lower Drin-Buna river is, in general, dampened by the large Shkodër lake. In case of extreme rainfall covering most of the Drin basin, the outflow capacity from the lake to the lower Drin resp. Buna can be reduced, if – at the same time - a high flood water level of the lower Drin river occurs. As a consequence, the lake water level rises up and may cause inundations along the lake shore. Even backwater effects can occur along the Moraca river flowing into the upper lake Shkodër, as observed in 2010. An example of the complex flow situation under extreme conditions is given in Figure 3.3, which is taken from Mott MacDonald (2012). It shows the outflow from the lake Shkodër into Buna and the Drin flood hydrograph downstream of the Vau Dejës reservoir (upstream of the confluence with the Buna river) during the 2010 flood. The hydrographs had been recorded (Drin) or re-calculated (lake outflow) based on the recorded lake water level. According to this figure, the outflow from the lake Shkodër was first reduced probably because of the high discharge resp. water level in the Drin river. With decreasing flow in the Drin river, the outflow from the lake increased.

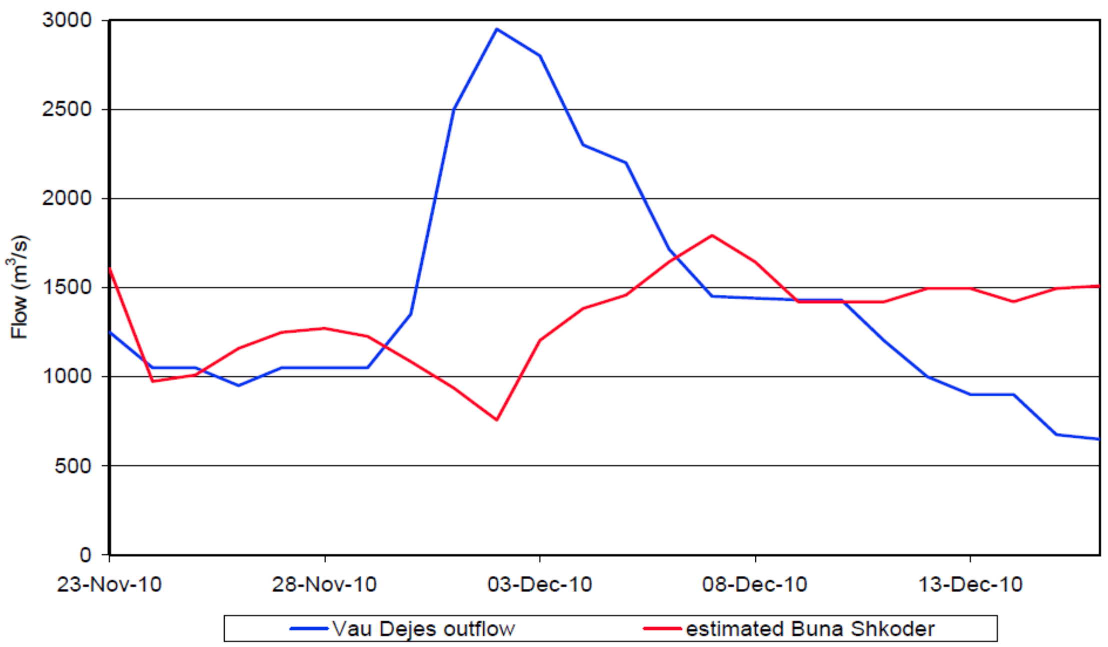

Figure 3.3: Flood event in December 2010: Drin flow downstream of Vau Dejës reservoir and outflow from Shkodër lake (Source: Mott MacDonald, 2012, Fig. A.10)

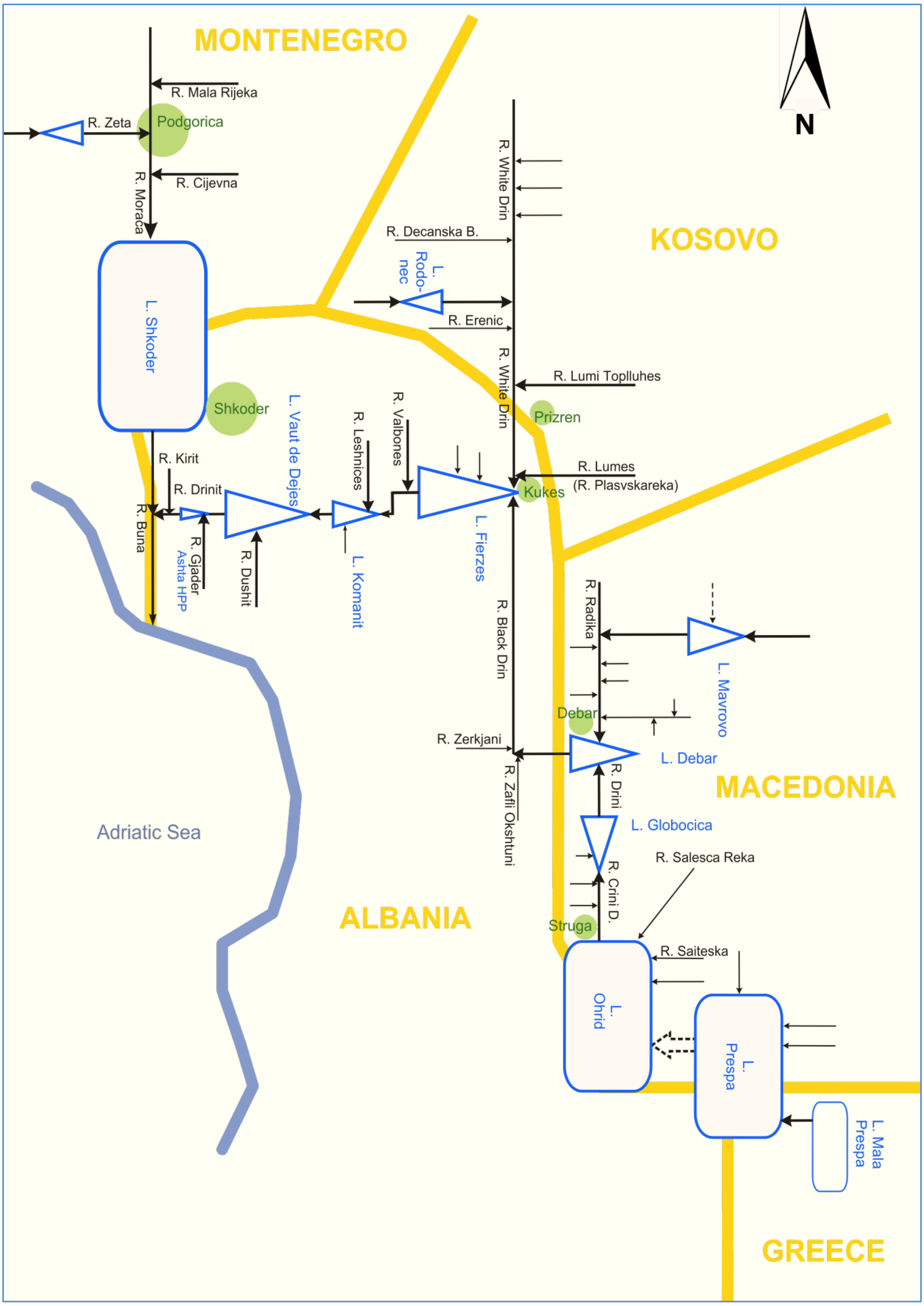

Figure 3.4: Scheme of Drin-Buna river basin (Source: Meon)

4 Relevant documents and activities related to the Drin-Buna River Basin

In the following, documents providing information for the project, or activities interfering with the project are briefly compiled:

WMO (2012): The study report is entitled "Strengthening multi-hazard early warning systems and risk assessment in the western Balkans and Turkey: Assessment of capacities, gaps and needs." Regional Programme on Disaster Risk Reduction in South East Europe Activity 2. DRR-SEE-1 (2012), ROE-2 (2012).

The study refers to Albania, Bosnia and Herzegovina, Croatia, Macedonia, Montenegro, Serbia and Turkey. Each country was analysed with regard to its

- vulnerability to hydrometeorological hazards,
- institutional framework of disaster risk reduction,
- technical capabilities of hydrometeorological services to support disaster risk reduction.

Based on this analysis, technical recommendations to strengthen the national hydrometeorological services in support of disaster risk reduction were given.

The report provides valuable information which is aggregated for each country in total. Details about the hydrometeorological data network and data acquisition of the Drin subbasins of the riparian countries are not available in the report.

Mott MacDonald (July 2012): The study was performed for the Albanian General Directorate of Civil Emergencies. The study report is entitled: "A post-disaster comprehensive flood risk assessment & management study. Final Report – The flood risk management plan for the lower Drini & Buna river basin".

The study contains first a thorough inventory of the flood catastrophe which occurred in December, 2010, at the lower Drin-Buna basin, around the Shkodër lake and in the submerged flood plains of the Moraca river, which flows into the Shkodër lake from the Montenegrin watershed. The study comprises hydraulic modeling and detailed information about the flow regime in the lower Drin basin which is exposed to a high risk of flooding. The report provides well- elaborated recommendations about effective flood risk assessment and management in the study area.

The **"Drin Dialogue":** The following information was processed from http://www.gwp.org/GWP-Mediterranean/gwp-in-action1/News-List-Page/Drin-River-Basin-agreed-at-high-level/ and other related documents available in the Internet. The **Drin Dialogue** was set up in 2009. It is a structured consultation process that aims to develop a shared vision among riparians and stakeholders for the sustainable management of the Drin Basin. The Drin Dialogue is facilitated by UNECE and the Global Water Partnership-Mediterranean (GWP-Med) using the platform of the UNECE Convention on the protection and use of transboundary watercourses and international lakes (Water Convention), and the Petersberg Phase II/Athens Declaration Process. It is part of the work programmes of the Mediterranean Component of the EU Water Initiative (MED EUWI) and the GEF MedPartnership and is financially supported by the Swedish Environmental Protection Agency. The **Drin Core Group**, with representatives from all riparians, has guided the process to establish the **Shared Strategic Vision** for the sustainable management of the basin.

On 25 November 2011 in Tirana, the five Drin river riparians signed a "Memorandum of Understanding on a Shared Strategic Vision for the Sustainable Management of the Drin River Basin" for the benefit of about 1.5 million people relying on the water resources of the basin for drinking water, agriculture, fisheries, industry and hydropower.

Recent floods, in particular, have highlighted the need for closer transboundary cooperation. Ministers and Deputy Ministers responsible for water issues from Albania, Greece, the former Yugoslav Republic of Macedonia, Kosovo (UNSC 1244) and Montenegro signed the Memorandum, which represents a significant step forward in the development of transboundary cooperation in the Drin Basin. The Drin Dialogue process which was set up in 2009 to look into the many competing interests and challenges the Riparians are facing and which led to the signing of the Strategic Vision, is facilitated by the United Nations Economic Commission for Europe (UNECE) and the Global Water Partnership-Mediterranean (GWP-Med); the UNDP provides technical support. The process for the enhancement of the transboundary cooperation in Drin had been initiated already in 2006 with the assistance of the German Ministry of Environment and GEF IWLEARN. Competing uses for the water resources of the basin are addressed. Hydropower is of particular importance, with major dams and associated power stations in the former Yugoslav Republic of Macedonia and in Albania, where hydropower accounts for more than 85 per cent of the total electricity supply. In addition, the basin faces a number of threats to its water quality, such as pollution mainly from agriculture and discharges of untreated wastewater from cities. The exceptional biodiversity and endemic species of the Drin Basin are also under threat without improved and coordinated management of the ecosystem. The Shared Strategic Vision identifies the challenges at the transboundary level such as:

- Improving access to comprehensive data and adequate information
- Developing cooperation and measures to minimize flooding
- Improving management and appropriate disposal of solid wastes
- Decreasing pollution of nutrients and hazardous substances such as heavy metals and pesticides
- Minimizing the effects of the building of dams and other changes of the water system.

The Shared Strategic Vision includes specific objectives in the short, medium and long term and institutes the Drin Core Group with representation from all riparians to manage its implementation; GWP-Med has been entrusted the Secretariat of the Drin Core Group.

The "**Dam Safety Project"** in Albania (e. g. http://www.kesh.com.al/content.aspx?id=4&idd=27): The dam safety programme has been designed as multi-donor programme with independent, logical investment packages to be financed by World Bank (WB), Kreditanstalt für Wiederaufbau (KfW) and Switzerland.

A "**National Centre for Forecast and Monitoring of Natural Risk"** has recently been established at the Institute of GeoSciences, Energy, Water and Environment (IGEWE in English; IGJEUM in Albanian language), Tirana, with the help of the Italian CIMA Research Foundation (CIMA, 2012). The centre was inaugurated in July, 2011 and is now operational at the IGEWE headquarters. Present main tasks are the implementation and operation of early warning systems for wildfire (RISICO) and floods (Flood-PROOFS) as well as personnel training. The international experts paid a visit to the centre in

December, 2012. Based on a first information exchange with the highly qualified experts at place, the operational centre seems to be well equipped with IT components. The implemented software Flood-PROOFS (Flood-Probabilistic Operational Forecasting System) stems from Italia. The software consists of a fully distributed hydrological model which covers the whole Drin basin without the lake Prespa subbasin of about 17.200 km^2. A calibration of the model with long-term series of hydrometeorological data of the whole basin was not presented. Obviously, precise hydraulic modeling of inundation areas using the hydrological output is not yet included, a hydraulic model is going to be built up in the close future.

For the time being, Flood-PROOFS suffers on missing real-time meteorological and hydrological data. Presently, only very few online station data are transmitted to the centre. The numerical meteorological forecast required as an input into the hydrological model seems to stem purely from international forecast models. An adaption of the international meteo forecast data to the region with the help of regional online ground stations and radar is not yet part of the data processing for flood forecast.

Despite of above deficits, the center could be the **ideal location for the operational centre of the DEWS.**

5 Inventory of Hydrometeorological Infrastructure and Data Utilization in Macedonia

The inventory of the hydrometeorological infrastructure and data utilization in Macedonia with focus on the Drin/Drim basin is based on an extensive information exchange between the international experts and the local expert as well as field trips, visits of the institutions listed in Annex 1 and on a literature review of available documents.

5.1 Organization of the Hydrometeorological Service (HMS) and other Institutions involved in the Drin/Drim River Basin Management

Figure 5.1 shows the actual structure of the HMS. In Table 5.1, the number of employees and their educational background are listed. The by far largest number of staff is assigned to the meteorological sector, whereas only a few staff members belong to the hydrometric and hydrological sector.

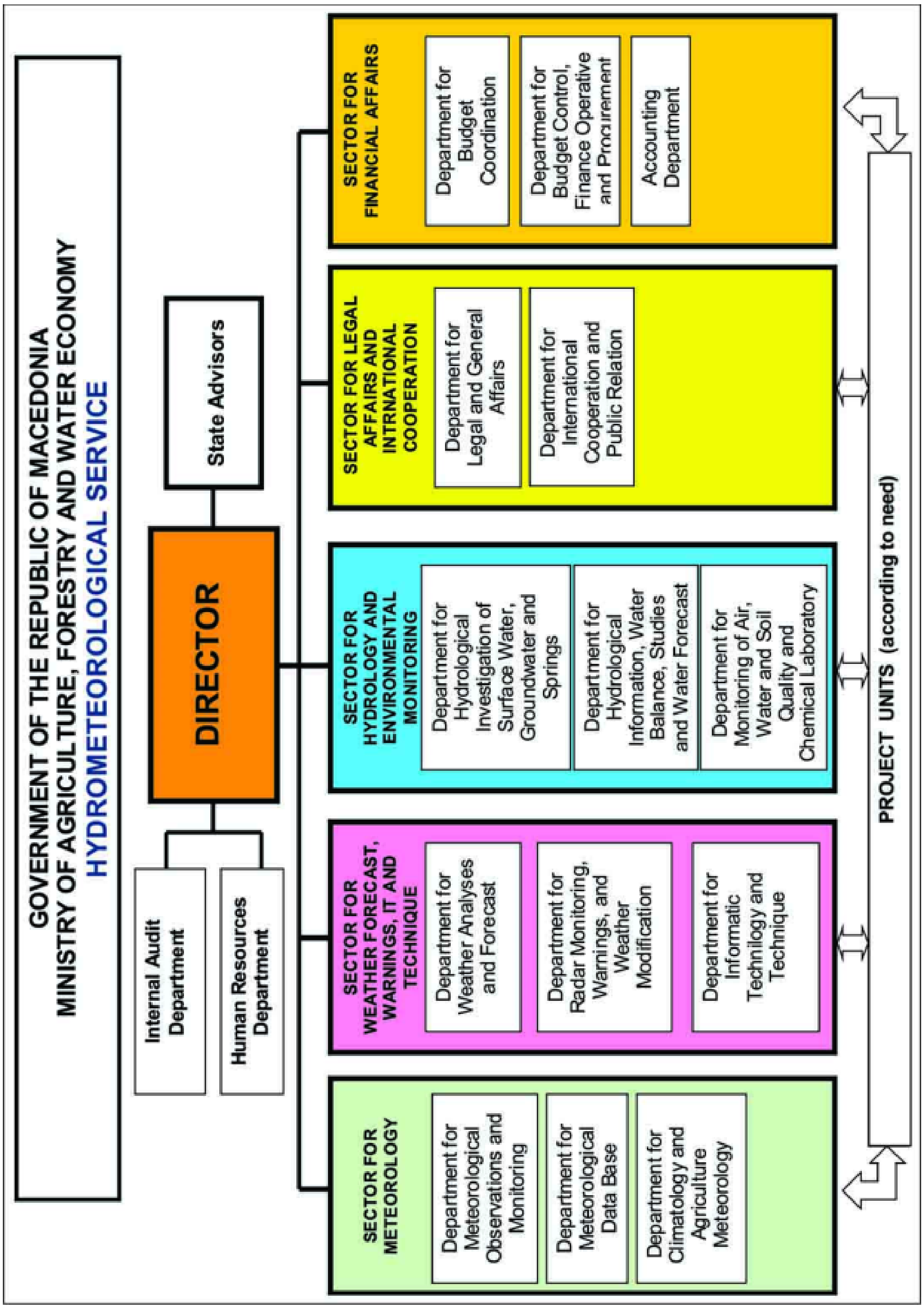

Figure 5.1: Structure of HMS in Macedonia

Branch / responsibility	Field and education														TOTAL
	Meteorologists				Hydrologists		Others - High School and Faculty								
	Weather Forecast		Meteorology		Hydrology		Weather Forecast		Meteorology		Hydrology		Other sectors		
	T	E	T	E	T	E	HS	F	HS	F	HS	F	HS	F	
Observation network	19	1	48	5	4	2	0	2	0	0	1	0	0	0	82
Data management	3	1	3	2	2	0	0	0	0	0	0	0	0	0	11
Weather modeling	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Weather forecasting	0	5	0	0	0	0	0	0	0	0	0	0	0	0	5
Hydrological modeling &forecasting	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Hydraulic modeling & forecasting	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Research & Development	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
ITpersonnel	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Others	1	2	1	3	3	2	13	3	0	4	7	9	24	17	89
TOTAL	23	9	52	10	9	4	13	5	0	4	8	9	24	17	187

T-Technician E- Engineer HS-High school F-Faculty

Table 5.1: Personnel of HMS Macedonia

5.2 Hydrometeorological Monitoring and Available Data Series

5.2.1 Hydrology

Figure 5.2 shows the hydrological, meteorological and rainfall stations located in the Drin/Drim basin of Macedonia. Details on the type of station and data transmission are given in Annex A 2.1. Furthermore, the available data series were checked for gaps. Results are given in Annex A 2.2.

A first analysis shows that about 9 hydrometric stations are presently operated in the Drin river system, 7 are located at the lakes. Data are transmitted as manual lists via post. The water level data recorded at rivers are transformed into flow data in the HMS headquarters with the help of existing rating curves. According to the local expert, the rating curves need to be updated with the help of flow velocity measurements. Available current meters for flow velocity measurements need to be maintained or replaced by new ones, an ADCP equipment for direct flow measuring is not available. Presently the stations are not equipped with automatic recording and online transmission systems.

Some of the available time series of daily discharge exhibit considerable gaps. A number of stations stopped operation since about 2003. Information about the water level series of the lakes was obtained for Lake Ohrid (1951-2010) and Stenje (1951-2010).

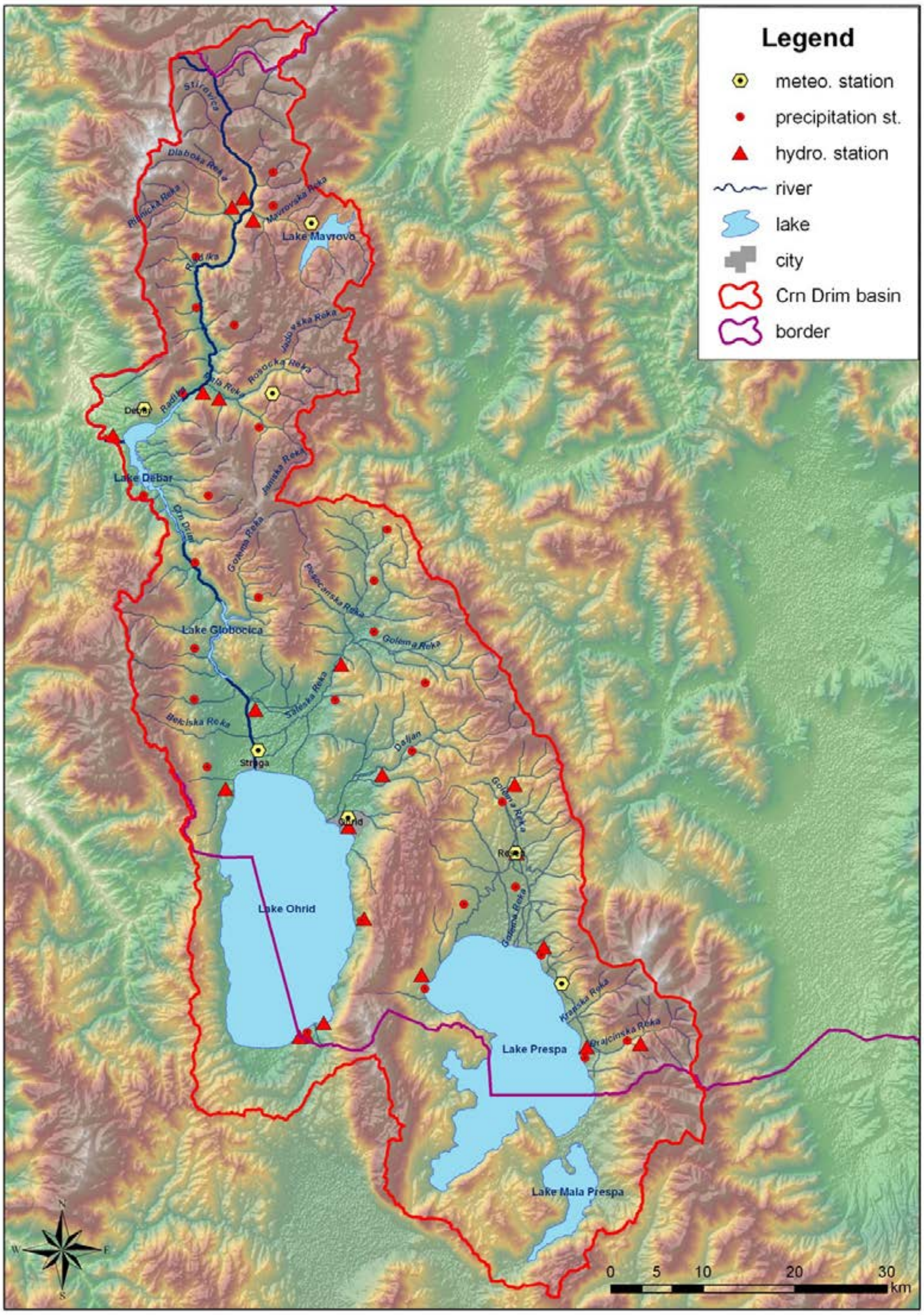

Figure 5.2: Hydrometeorological stations located in the Drin/Drim basin and operated by the HMS (additional stations near dams are operated by dam agencies) (Source: V. Stojov, HMS Macedonia)

5.2.2 Meteorology

About 31 precipitation stations and 7 meteorological stations are listed in the tables obtained from the national expert. Around 20 of all seem to be operated for the time being. Two of the meteorological stations are automatically operated since 2010 respectively 2011. The precipitation data are transmitted via post. The data from the meteorological stations are transmitted via post, internet and/or telephone. Earliest recording of data started in the 40s of the last century, many series extend over 60 years.

5.3 Data Management and Data Quality

The following information is processed from the local expert's contribution. In Table 5.2, information on data bases is summarized.

Type of data base	Period of data storing	Comments (e.g. availability, utilization, etc.)
Meteorological domain		
Excel data base	Since 1996 for practical use	
WISKI data base	--	Not in use
Paper documents	From 1947	
CLIDATA	01.01.1961-31.12.2011	CLIDATA installed in 2001
Others	-	
Hydrological / hydraulic domain		
Excel data base	From 01.01.1951 until 31.12.2010	Since 1996 for practical use
WISKI data base	--	Not in use
Paper documents	From 1923 until now	Digitalization of old limnigraph tracs required
HydroPro	From 01.01.2000 - 31.12.2005	Problems with passwords, license, training
Others	-	

Table 5.2: Overview on data bases used by the HMS of Macedonia (Source: national expert)

The quality of the meteorological data and the density of the meteorological station network is judged to be, in general, reasonably well, but lack of stations in the mountainous regions is obvious. Presently, quality checks of historic data are being performed.

In contrast, the hydrological data exhibit large gaps and are judged to be partially inconsistent. This is due to the uncertainties involved in the basic data like changing cross-sections, partially non-functioning measuring equipment and in the rating curves. Reasons are given in Chapter 5.5.

5.4 Models, Flood Forecasting and Warning System

Table 5.3 provides an overview about existing model applications for the Macedonian Drin basin.

Type of existing forecast	Name of the model	Covered area	Spatial resolution	Temporal resolution	Data assimilation	Times/day
Meteorological						
Weather	NMM	EU/MK	32/3	1h	no	2
Numerical precipitation	NMM	EU/MK	32/3	1h	no	2
Weather/precipitation	NMM-WRF	EU/MK	32/3	1h	no	2
Hydrological (for water quantities)						
Continuous operation	n/a	-	-	-	-	-
Operation for floods	n/a					
Operation for flash floods	n/a					
Hydraulic (for water levels, inundation areas)						
Continuous operation	n/a					
Operation for floods	n/a					
Operation for flash floods	n/a					

Table 5.3: Present model applications with regard to flood forecast (Source: national expert)

In the everyday process, the forecast section of HMS processes the national weather forecasts obtained on forecasts delivered by the non-hydrostatic Mesoscale Model (NMM), the Global Forecast System (GFS) and the European Center for Medium Range Weather Forecast (ECMWR).

In case the forecasted and observed data show a tendency for causing threatening situations, the level of analysis is increased. Forecasted values are compared with the defined thresholds. In case of exceeding certain thresholds, the forecaster on duty - after communication with the responsible hydrologist and responsible officer in charge in the sector of weather forecast – disseminates an emergency weather forecast via fax and/or e-mail to the following institutions:

- Crisis Management Centre (CMR),
- Protection and Rescue Directorate,
- Ministry of Agriculture, Forestry and Water Economy,
- Ministry of Environment and Physical Planning,
- Media.

In addition, the HMS provides a kind of meteorological alarm via HMS website.

The equipment in forecaster center is judged to be satisfactory, the warning procedure is well established. However the forecasting sector, too, lacks personnel.

A quantitative precipitation forecast (QPF) is usually derived from outputs of an international weather forecast model like NMM which have to be correlated with regional ground station data and radar. A QPF is required for flood forecast models, but is presently not available. Hydrological and hydraulic models have not yet been used for the transformation of (real-time and forecasted) precipitation to deliver a quantitative flood forecast.

5.5 Overall Evaluation of Existing Data Acquisition, Data Management and Flood Warning System

A continuous decrease of hydrological personnel coinciding with a decrease of the financial budget of the hydrological section of the HMS is the main reason for the desolate situation regarding hydrological data acquisition and data management. This situation is in contrast to the high professional qualification and motivation of the hydrological staff of HMS.

The gaps in the data series result from various problems that the HMS meets. Hydrological stations in the basin of river Crn Drim are often exposed to a change of the river bed profile directly at the cross section of the station. Sometimes, the constructed concrete cross-sections had been demolished. In addition, diversion channels had been constructed in the vicinity of some stations. These changes directly influence the quality of the rating curves. An update of the rating curves of – at least key gauging station - is urgently required. Because of the reduced staff and budget, partially non-functioning and insufficient station equipment, old vehicles etc., an improvement which is based on own resources seems to be unrealistic. External support is required.

The conditions for the meteorological data acquisition and management seem to be better than the hydrological conditions; however, about 50 % of the stations which provided long data series since mid of the last century, had been given up. A few precipitation and meteorological stations were inspected by the international experts during the field trip in November/December, 2012. Some of the instruments were out of function. Obviously, the decreasing financial budget seems to adversely affect the maintenance of the meteorological station network. The present flood warning system is of a more qualitative type. It is purely based on a (well done) qualitative weather forecast in combination with observed extreme actual rainfall data and water level data. Modeling tools are presently not applied. An overall evaluation is summarized in Table 5.4.

Macedonia: Present Conditions with Regard to EWS

Country	Meteo-Data / Transmission	Hydrological Data / Hydraulic Data / Transmission	Database (Met&Hyd)	Num. Meteo – Forecast (focus on quant. precip.	Modeling Hydrological / Hydraulical	Flood Forecast	Flood Warning Procedure
Macedonia	About 7 meteo (=climat.) stations (part. gaps; 5 presently in operation), about 30 rain gauges (about 19 presently in operation)	About 20 - 23 stations (11 presently in operation - many located at the lakes (Ohrid & Prespa)); rating curves are missing or need update	Meteo: CliData Hydro: HydroPro (in use 2000-2005); presently data stored in EXCEL	General forecast by international forecast models (Non-hydrostatic Mesoscale Model - NMM), Global Forecast System (GFS); Europ. Centre for Medium Range Weather Forecast (ECMRW) EUMETSAT images;	No	No quantitave flood forecast, but sector of weather forecast gives "adequate" alarm	Only qualitatively by weather forecasters – based on extreme weather conditions; data send to Crisis Management Centre
Evaluation	1 - 2	1 - 2	M: 2, H: 1 - 2	1	0	1	2 - 3

0	1	2	3	4
not available / not adequate	poor	fair	good	very good

Table 5.4: Overall evaluation of present conditions at HMS Macedonia with focus on the DEWS

6 Inventory of Hydrometeorological Infrastructure and Data Utilization in Kosovo

The inventory of the hydrometeorological infrastructure and data utilization in Kosovo with focus on the Drin Basin is based on an extensive information exchange between the international experts and the local experts as well as field trips and on literature review of available documents.

6.1 Organization of the Hydrometeorological Institute for Kosovo (KHMI) and other Institutions involved in the Drin River Basin Management

Figure 6.1 shows the actual structure of the KHMI. In Table 6.1, the number of employees and their educational background are listed.

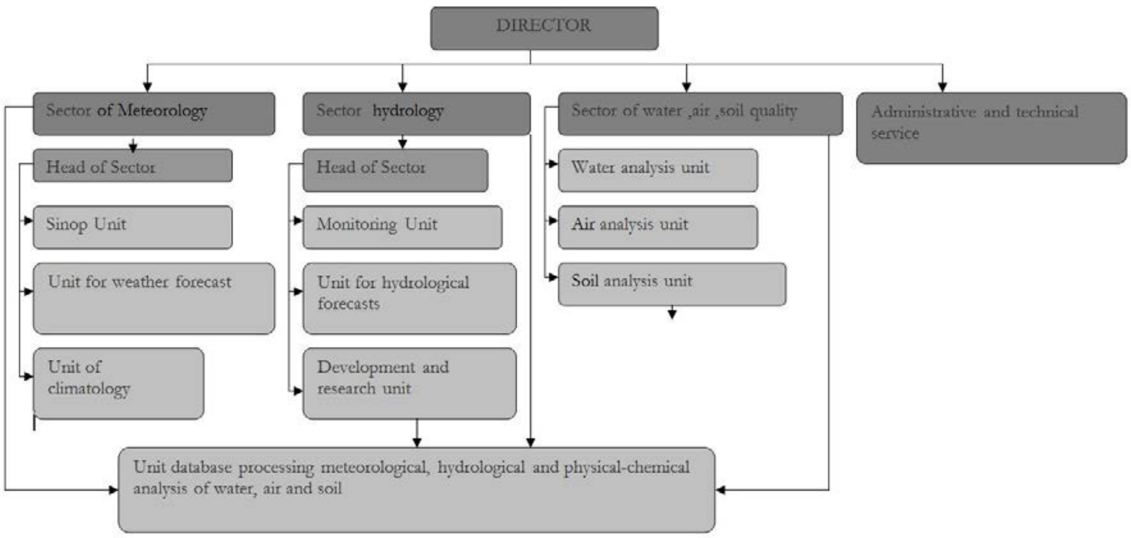

Figure 6.1: Structure of KHMI

The *KHMI* is one of two institutes assigned to the Ministry of Environment and Spatial Planning. With a total number of 10 regularly employees it shows very limited number of staff compared to the type and number of tasks and responsibilities they have to perform. It is obvious that the number of meteorologists (2) and hydrologist (4) is very small. The table shows that there is no regular staff foreseen for hydrological and hydraulic modeling & forecast, there is not any staff for IT and only one person for weather modeling and forecast.

Branch / responsibility	Field and education					TOTAL
	Technicians	Meteorologists	Hydrologists	Engineers	Others	
Observation network	4	1	2			**7**
Data management			1			**1**
Weather modeling &forecasting		1				**1**
Hydrological modeling & forecasting						
Hydraulic modeling & forecasting						
R&D (Research & Development)			1			**1**
IT personnel						
Others						
TOTAL	**4**	**2**	**4**			**10**

Table 6.1: Personnel of KHMI Kosovo

There is currently no specific flood warning system established in the Kosovo. The KHMI is collecting the river water level, discharge and water quality data, performing quality control and data analysis and send it to all relevant institutions like Water Departments, Environmental Protection Agency, Water Council of Kosovo and Water Task Force.

According to the legal regulations on hydro-meteorological activities, relevant responsibilities of the KHMI in the field of water are:

- Construction and maintenance of the basic network of hydrological and meteorological stations,
- Measurements of the meteorological, hydrological, bio-meteorological and limnological data,
- Measurements and observations of the electricity in atmosphere and air, water pollution and rainfall, according to the unique program and methodology that is valid for essential network stations,
- Study, elaboration, conservation, exchange and annunciation of hydrometeorological information,
- Analysis of results of the monitoring network,
- data base management and accomplishing prognosis of the hydrometeorological works,
- Accomplishing the systematic hydrometeorological measurement and observation on the rivers in usual cases and in cases of environmental disturbances,
- Publishing of the hydrological and meteorological analyses,
- Premonition (early warning) about hydrometeorological elementary fatality,
- Weather studies, climate studies, studies on ground and surface waters and their impact on the atmosphere,
- Involvement of hydrometeorological services for flood protection measures.

6.2 Hydrometeorological Monitoring and Available Data Series

6.2.1 Hydrology

The Drin basin in Kosovo contains in total about 18 hydrological stations (Figure 6.1). Most of them are presently out of operation. Details on the types of stations and their operational status are given in Annex A 4.1. In addition to water level measurements, water temperature and water quality parameters are measured. For only four of the stations, rating curves are available. According to the local experts they need to be updated. For the other stations, rating curves have to be generated.

Altogether only four stations are actually in operation. Automatic stations with online data transmission are not available. The four running stations are equipped with logger systems which are read out monthly.

According to the local experts, all operating stations need to be refurbished, for some stations new equipment is needed. Some of them should be kept at the same locations, others should be transposed to different locations (see Annex A 4.1). Currently, cross sections and longitudinal profiles for the river bed of the Drin and tributaries are not available.

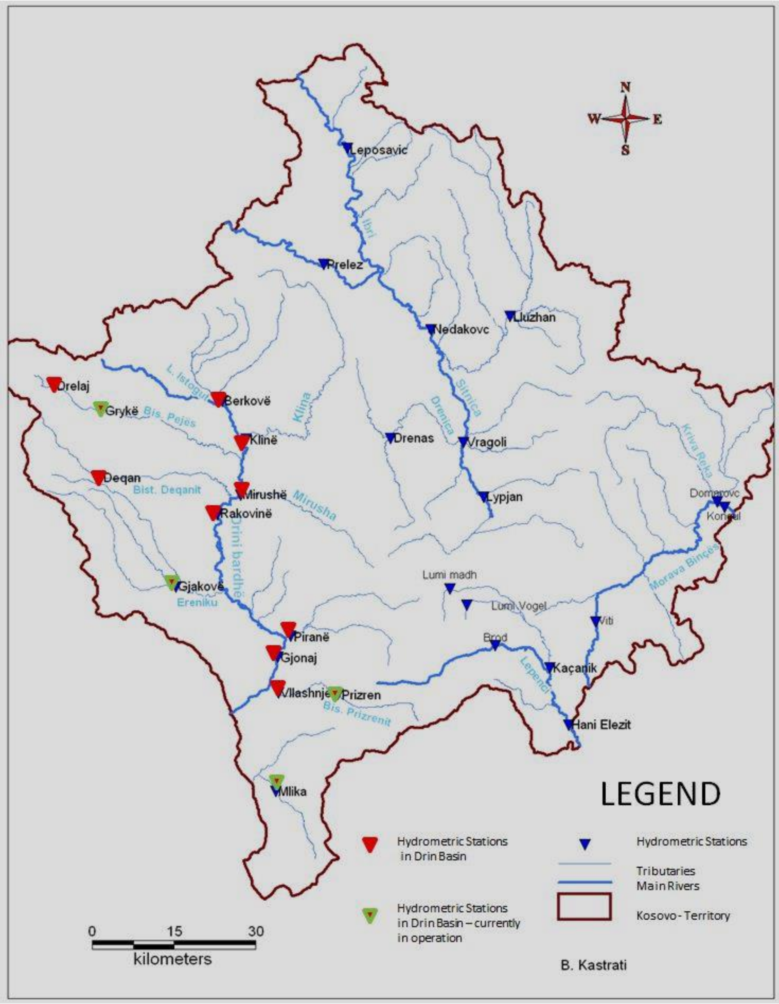

Figure 6.2: Hydrological Stations located in Kosovo (Source: KHMI, Kosovo; adjusted by Pätsch)

The available data series show large gaps. The results are given in Annex A 4.2. Based on information obtained at place, hydrological data seem to be partially inconsistent.

6.2.2 Meteorology

The station in Pejë is currently the only meteorological station in operation in the Drin Basin (Figure 6.3). Until 2007 there were 19 other precipitation stations (see Figure 6.4) but most of them are presently obviously out of operation.

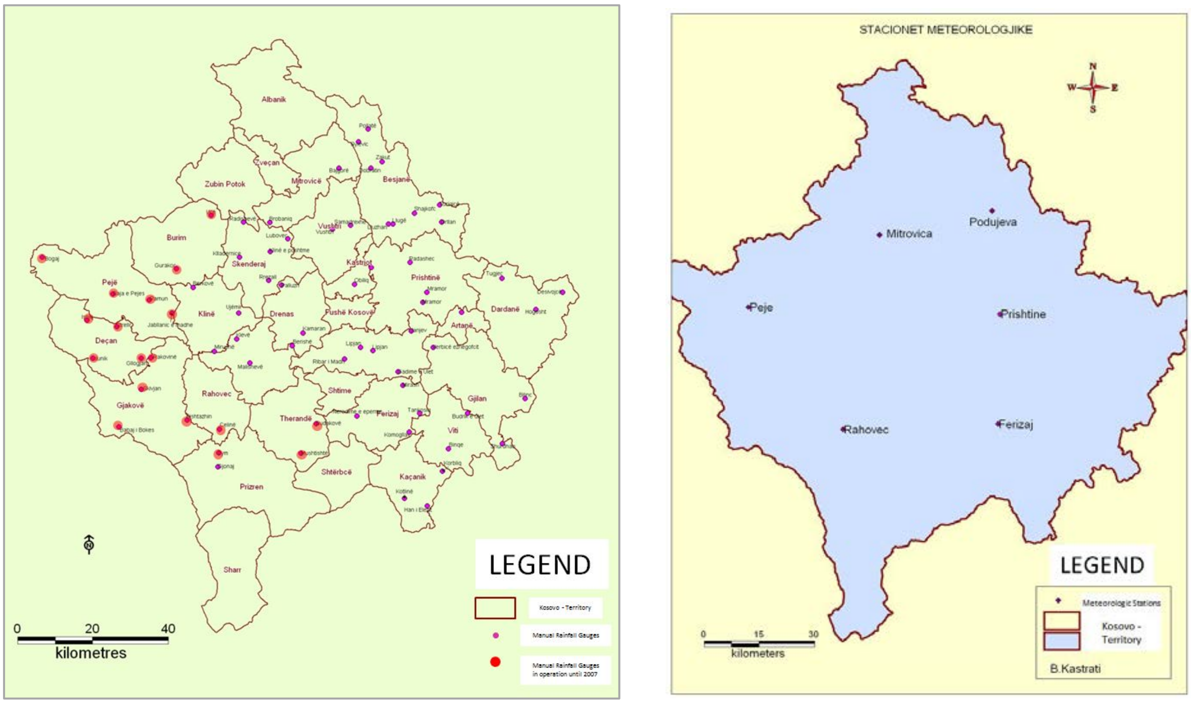

Figure 6.3: Rainfall stations (left) and meteorological stations (right) operated until 2004 in Kosovo; presently, only a few rainfall stations (unclear) and one meteorological station (Pejë) are operated in the Drin river basin (Source: KHMI, adapted by Pätsch).

Details on the type of station Pejë and its operational status is given in Annex A 4.3. The station is a climatologic station, measuring six parameters, but no evaporation.

Presently, automatic recording stations are available. The data transmission is on a manual basis. The Pejë station needs to be rehabilitated, preferably at the current location.

A data check for gaps was performed for the Pejë station only (Annex A 4.4). From 2002 onwards, the data series is complete.

6.3 Data management in KHMI

In general, data base management at KHMI is performed on a relatively low level due to lack of budget, staff, hardware, software and other operational tools. The hydrological data are stored in Excel spreadsheets. In 2003 some of the data had been filed in a WISKI data base, on a software-as-a-service base. WISKI is the Water Resources Information System from KISTERS company – a software system built with a three-tier client-server architecture in which the user interface, business logic, data storage and data access are developed and maintained as independent modules (see: www.kisters.eu). Due to above mentioned problems, application of WISKI had been stopped.

All meteorological data are manually stored in card boxes and then transferred to an Excel data base.

6.4 Models, Flood Forecast and Warning System

A numerical precipitation forecast system, hydrological and hydraulic modeling is not implemented in the KHMI. The state weather forecast is based on the EUMETSAT weather observation data and numerical weather predictions obtained from the ETA model. The ETA Model is an atmospheric model used for research and operational purposes. The model is a descendent of the earlier HIBU (Hydrometeorological Institute and Belgrade University) model, developed in the seventies in the former Republic of Yugoslavia and is further developed until present.

6.5 Overall Evaluation of Existing Data Acquisition, Data Management and Flood Warning System

Considering the required components of an EWS as described in Chapter 1, KHMI is currently unable to provide a comprehensive and reliable flood forecast and early flood warning for the Kosovarian subbasin, and to deliver accurate real-time data to other riparians.

On the other hand, severe flood damage did not occur in the Kosovarian Drin subbasin in the last decades according to the KHMI staff.

In order to improve the regional conditions towards a real-time water information system inside Kosovo and towards submission of relevant data to the downstream riparian country of Albania, the current conditions need to be substantially improved. Details are given in Chapter 9.

In Table 6.2, the international experts' overall evaluation is summarized.

Kosovo: Present Conditions with Regard to EWS

Country	Meteo-Data / Transmission	Hydrological Data / Hydraulic Data / Transmission	Database (Met&Hyd)	Num. Meteo – Forecast (focus on quant. precip.	Modeling Hydrological / Hydraulical	Flood Forecast	Flood Warning Procedure
Kosovo	1 Meteo station (no online stations, 3 meas. per day) about 19 prec. stations – some have data loggers – read out once a month	In past up to about 18 stations – presently about 5 in operation - only water level – some with data logger, read out once a month; no cross sections; uncomplete rating curves (low flow only)	Meteo: Excel (2000 – 2012) Hydrol: WISKI Data base as a service – 2003 (KISTERS) currently in EXCEL, ASCII	No – general weather forecast from international models (EUMET_SAT), ETA model, MEKENZI	No	No	Only qualitatively Major flood problems in other basins
Evaluation	1	1	M: 1-2, H: 1-2	0	0	0	0

0	1	2	3	4
not available / not adequate	poor	fair	good	very good

Table 6.2: Overall evaluation of present conditions at HMS Kosovo with focus on the DEWS

7 Inventory of Hydrometeorological Infrastructure and Data Utilization in Montenegro

The inventory of the hydrometeorological infrastructure and data utilization in Montenegro with focus on the Drin Basin is based on an extensive information exchange between the international experts and the local experts as well as field trips and visits at the institutions listed in Annex 5, and on a literature review of available documents.

7.1 Organization of the Institute of Hydrometeorology and Seismology Montenegro (IHMS) and other Institutions involved in the Buna River Basin Management

Figure 7.1 shows the actual structure of the IHMS.

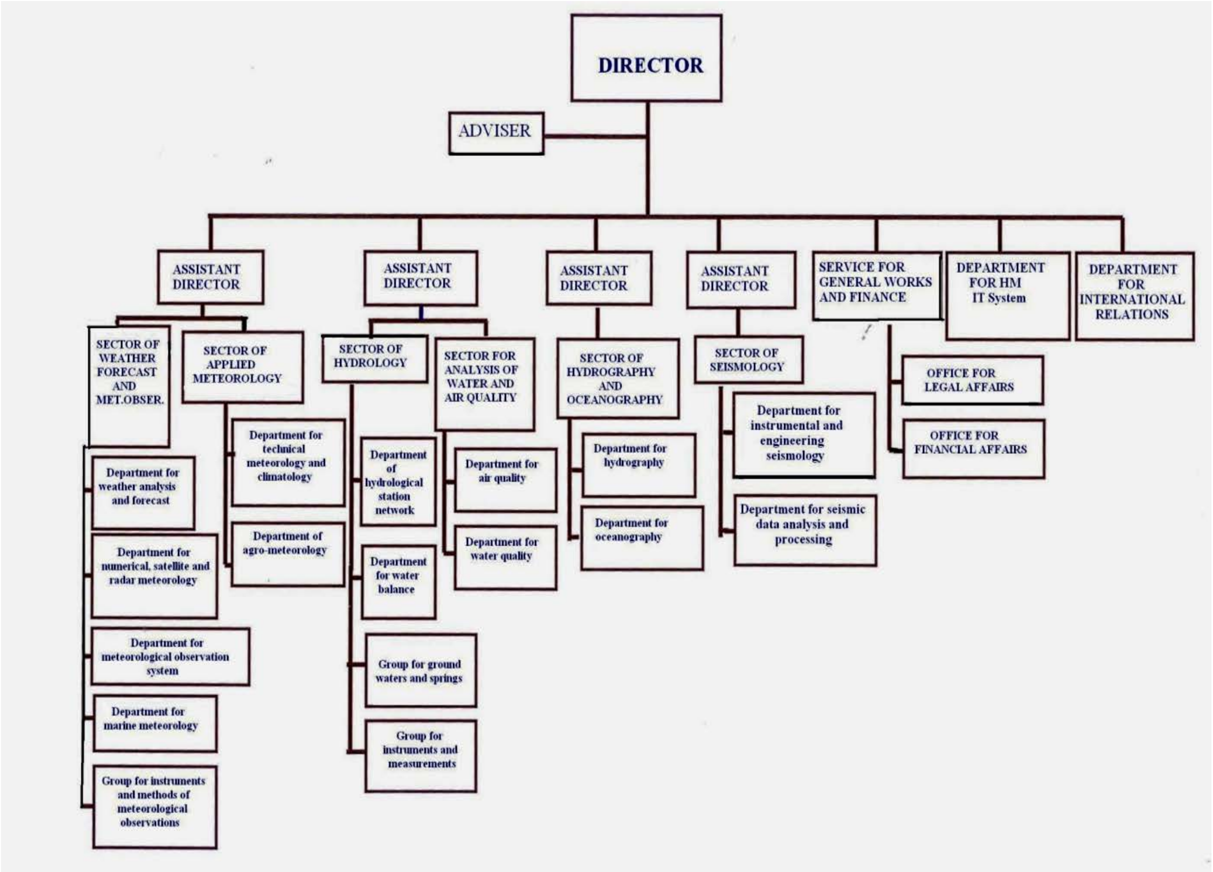

Figure 7.1: Structure of IHMS (Source: IHMS, Montenegro)

The IHMS is under the Ministry of Sustainable Development and Tourism. It consists of six different sectors which are subdivided into departments. All in all the IHMS has clearly defined organisational structures and responsibilities.

In Table 7.1 the number of employees who work in the branch relating to forecast and their educational background are listed. These persons mentioned are from three different sectors – sector of weather forecast, Hydrology Sector and IT sector.

Branch / responsibility	Field and education					TOTAL
	Technicians	Meteorologists	Hydrologists	Engineers	Others	
Observation network and forecasting	5 1 for meteo, 4 for hydrology	1 meteo-observation	1 hydro-observation		3 meteo-observation	10
Data management	4 for input of meteo data in database			2 for input in hyd.database		6
Weather modeling				1 in model running and maintenance		1
Hydrological modeling and forecasting						
Hydraulic modeling and forecasting						
R&D (Research and Development)						
IT Personnel				2 within IT Sector	1 database administrator belongs to IT department	3
Others						
TOTAL	9	1	1	5	4	20

Table 7.1: Personnel of IHMS Montenegro (Source: national expert Montenegro)

There is no regular staff foreseen for hydrological and hydraulic modeling and forecast. The research and development branch is not staffed. The research and development branch is not staffed.

IHMS has in total 120 regular employees. They are divided in 6 Sectors, 2 Departments and 1 Service, as follows:

- Sector of Weather forecast and Meteorological Observations - 52 persons (from this number 5 persons are in the field of weather forecast. Two of them being meteorologists, 1 forecaster and 1 numerical modeller.
- Sector of Applied Meteorology - 6 persons (2 are meteorologists working in climatology)
- Sector of Hydrology - 13 persons (5 of them are hydro–engineers)
- Sector for Analysis of water and air quality - 10 persons
- Sector of Hydrography and Oceanography - 5 persons
- Sector of Seismology - 9 persons
- Department for hydrometeorological IT system - 9 persons

- Department for International Relations – 2 persons
- Service for General works and Finance - 11 persons

The responsibilities in the field of water are according to the WMO report (2012):

- observation and measurement of meteorological, hydrological, hydrographical, environmental and agrometeorological parameters;
- analysing, processing and archiving of measured and observed parameters,
- making studies, surveys, analysis and processing information on climate, soil condition, air, surface and underground waters and coastal sea,
- forecasting and presentation of data in the field of meteorology, hydrology, hydrography, environment and agrometeorology,
- establishment of information systems with the bank of climate, hydrological, hydrographic, environmental and agrometeorological research,
- establishment and maintenance of meteorological, hydrological and agrometeorological stations for monitoring weather, water, and air,
- cadastre of sources, springs and water facilities,
- monitoring of sediment in rivers,
- control and evaluation of the quality of surface and ground water, rainfall, air and soil on the basis of analysis of physical, chemical, biochemical and radiological parameters,
- providing data, information and study for the maritime, air and road transport, electricity, water, agriculture, construction, tourism, military, security of property and persons and other interested parties,
- aero-radiosounding measurements and higher layers of the atmosphere, phenological observations; indirect provision of air navigation,
- implementation and maintenance of standards of meteorological and hydrological instruments and calibration of instruments in meteorological and hydrological stations,
- carrying out international obligations in the field of meteorology and hydrology and
- quality control of air, water.

7.2 Hydrometeorological Monitoring and Available Data Series

7.2.1 Hydrology

About 12 hydrological stations are located in the Drin Basin in Montenegro (Figure 7.2). Details on the station type and operational status are given in Annex A 5.1. The main parameters measured are water level and water discharge, in some of them water temperature as well. Analysis of water quality is done according to the Water Law by IHMS / Sector for Analysis of water and air quality. Analysis are done every year on all water bodies in Montenegro (rivers, lakes and sea), following the Annual programme prepared by Water Directorate.

For six hydrometric stations, rating curves are available. According to the local experts two of them need to be updated, especially for high discharge. For three stations rating curves have to be developed.

Altogether nine stations are actually in operation, all of them are online stations with automatic data transmission. Stations Danilovgrad and Sitnica do not have suitable equipment, and station Orahovstica is excluded from the station network as the water is abstracted at two places for water supplying. According to the local experts, the actual state of the hydrometric monitoring system is good, and only little improvement is considered necessary (see Annex A 5.1).

For the development of rating curves, flow velocity measurements are made using current meters. The main problems are related to the lack of hydrometric cable ways. An Acoustic Doppler Profiler (ADCP) for direct flow measurement is not available. Because of the steep river bed gradients, flow velocities rise up to about 5 m/s during floods. Consequently, measurements at medium and high flows are difficult to perform. Currently surveys of cross sections and longitudinal profiles for the river bed of Drin and tributaries required for hydraulic modeling are not available.

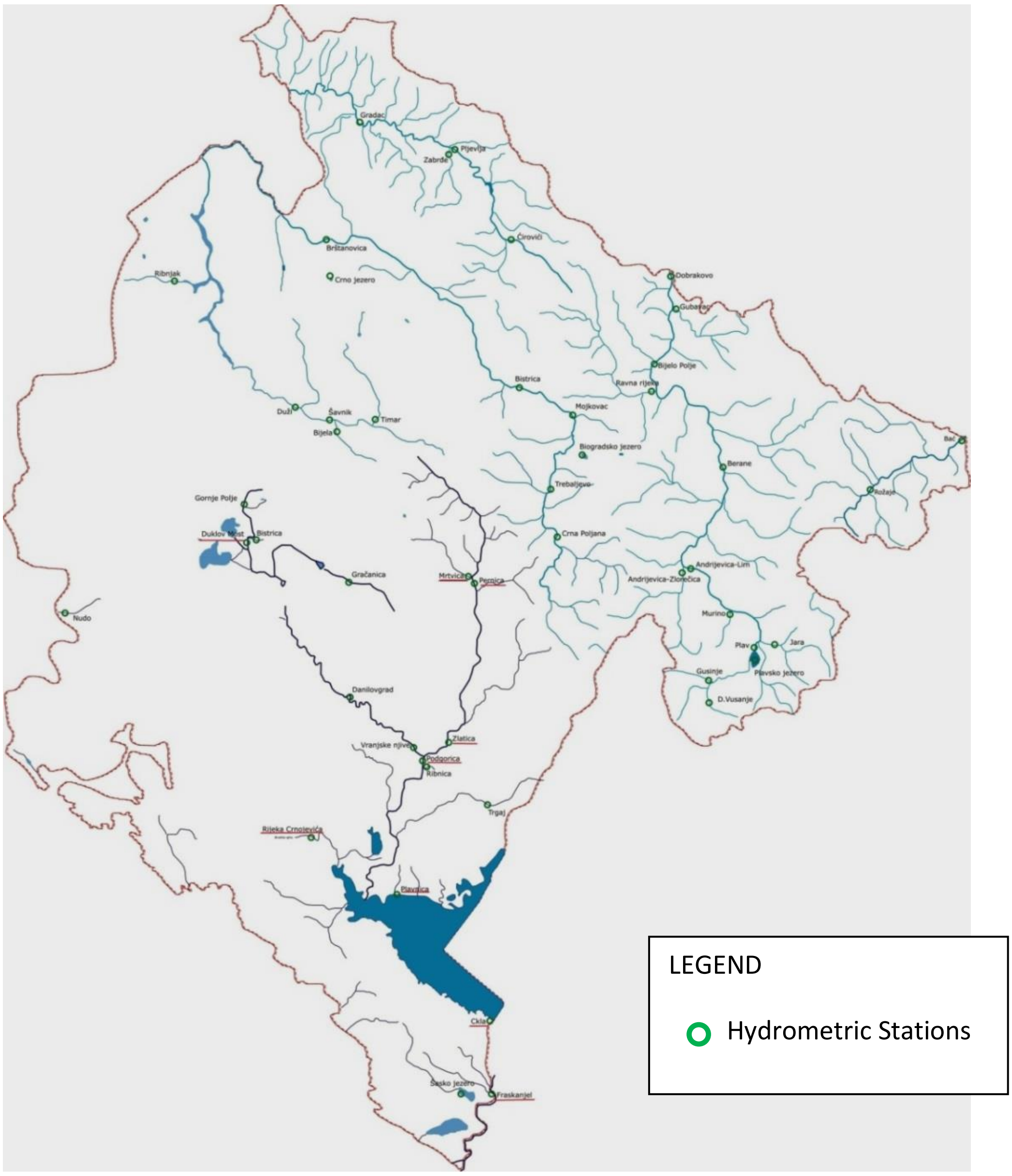

Figure 7.2: Hydrological stations located in Montenegro (Source: IHMS, Montenegro; adjusted by Pätsch)

The available data series were checked for gaps, the results are given in Annex A 5.2. The histograms were created for the following hydrological stations: Plavnica and Ckla (Skadar Lake), Podgorica, Zlatica and Pernica (Moraca river), Fraskanjel (Bojana), Brodska njiva (Crnojevica River), Duklov most (Zeta), Međurječje (Mrtvica).

In general, the hydrological data are considered consistent. Nearly 50 % of the water level series have large gaps between 2002 and today. For historical evaluation of flood events, data from seven out of nine stations are available (1960s until 2002). For discharge data the situation is worse. Only two stations have data until 2012. With existing stations IHMS has problems in maintenance and very often with spare parts (stolen or demolished).

7.2.2 Meteorology

Currently there are seventeen meteorological stations in operation in the Drin Basin, 14 of them are shown in Figure 7.3. The number of operated precipitation stations has decreased from about 100 to 17 active stations being operated in Montenegro in the past 5 to 8 years.

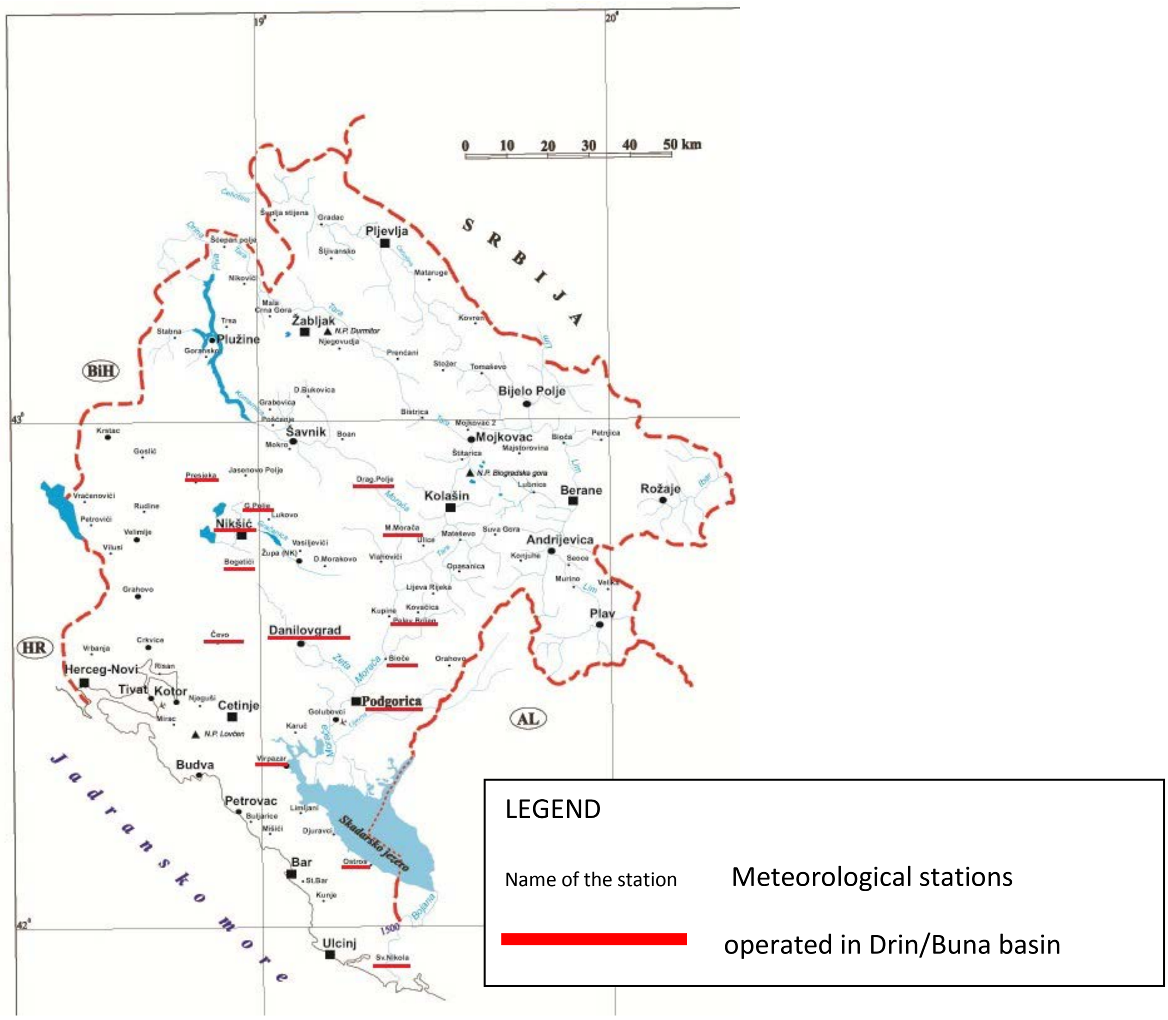

Figure 7.3: Active meteorological stations (Source: IHMS, Montenegro; adjusted by Pätsch)

Details on the type of stations and operational status are given in Annex A 5.3. The network consists of 13 precipitation stations, which are manually read out once per day. Two of them are climatologic stations equipped with data loggers which store the data every 4 hours. Two are automatic meteorological stations (wind, temperature, precipitation, snow depth, radiation, sunshine duration, relative humidity and ground temperature; but no evaporation). Data of these two stations are transmitted online since about 2005. Most stations in the Shkoder lake basin are in a good condition, but at least four precipitation stations need to be renewed according to the national expert, preferably at the current location.

The available data series were checked for gaps. The results are given in Annex A 5.4. A histogram is created for all meteorological stations, except Cetinje, which has been operated as an automatic station till 2009 with online data transmission. Until the late 80's of the last century, nearly no data were missing. After that, gaps started to occur and increased over time. Since about 2000 the stored data series is scattered. In 2011 only 3 stations provided full data throughout the year, 6 stations show up to 8 months of missing data and 4 stations have produced no data over the whole year.
In the annex for meteorological stations, the operation period is the period from when the stations start to work. Digitalization for climatologic stations started in 1949 and for precipitation stations from 1960. The data before digitalization are available in paper form.

7.3 Data Management and Data Quality

Data management is on a medium level. PCs and servers are used (see Table 7.2). The workspace should be larger than currently available.

Server/Workstation/PC	Characteristics	Diskspace	Security
Server Clidata	dual core Intel Xeon 5160(3GHz), 4GB of RAM	300GB	Kaspersky WinWorkstation
Server Kisters	dual core Intel Xeon 5160(3GHz), 4GB of RAM	300GB	Kaspersky WinWorkstation
Server Meteoware	Intel Xeon E5504(2GHz), 4GB of RAM	900GB	Kaspersky WinWorkstation

Table 7.2: Computer capacity in use for data storing and management (Source: IHMS, Montenegro)

According to table 7.3, long-term hydrological and meteorological data series are available, but most of them are still in form of manual archives and need to be digitalized.

Existing databases in use at the IHMS of Montenegro are CLIDATA (meteorological database) and WISKI (hydrological database). Additionally IHMS doesn't have enough trained personal for WISKI use, so for now the old data base is still in use. CLIDATA is fully functional, and for WISKI only some components are missing to be fully functional. Historical meteorological data are mainly inserted in

CLIDATA, but there is still some data in paper forms to be inserted. Hydrological data are mainly stored in the DOS system (ORACLE) and need to be inserted into the WISKI database.

Types of data base	Period	Comments (e.g. availability, utilization, etc.)
Atmospheric domain		
DOS database Clicom	Period in use 1992-2008	
Oracle database- Clidata	Period in use 2008-up	Availability of clidata db is 98.8%
Paper documents	Paper documents is preserved in archive of IHMS from 1949 are digitized from earlier period exist documentations for some stations and not digitized	
Hydrological / hydraulic domain		
Oracle database Wiski	2009-up	

Table 7.3: Past and existing data base (Source: IHMS, Montenegro).

From automatic meteorological stations (9 for Montenegro in this moment) data are sent through GPRS to the headquarters in Podgorica. The data recorded at the automatic hydrological stations are retrieved by hydrological technicians and stored in Excel tables (HYDRAS is operational software). All data from the automatic stations are available online on the meteorologic website (www.meteo.co.me).

According to WMO (2012), there is a decent quality control procedure regarding data organized on three levels: (i) observers make an evaluation of measurements quality; (ii) meteorological technicians check logical consistency of data from paper documentation; (iii) quality control procedures and validation are performed within the database, i.e. CLIDATA for meteorological data and WISKI for hydrology. However, resilient information about the quality of the processed series could not be made available by the international experts.

According to international obligations for data exchange, IHMS is delivering data from 4 stations into GLS. IHMS provides also data to meteorological services for aviation (by request - as airports have their own met. stations) and maritime navigation. Furthermore, according to the national expert, IHMS provides data to neighbouring countries (Serbia, FYROM, Croatia, and Republic of Srpska). Extension of data sharing is under preparation for Slovenia, Bosnia and Hercegovina and Turkey). Hydrological data are provided to the International Commission for the Protection of the Danube River (ICPDR) and the Sava River Commission.

7.4 Models, Flood Forecast and Warning System

The weather forecasting is usually based on the use of the global Numerical Weather Prediction (NWP) model products whereas the initial and boundary conditions are received from the Global Forecast System (GFS) - NCEP Washington (USA) and from the European Center for medium range weather forecast ECMWF (UK). In case of meteorological models, the models have a fine horizontal and vertical resolution by nesting the models.

The numerical weather prediction modelling is done by IHMS using ETA (Mesinger et al., 2012), NMM-Hires and WRF-NMM (V2.2 and V3.3.1).

Currently, numerical hydrological modeling and hydraulic modeling is not in operational use. IHMS has already received and installed on adequate PC the predictive hydrological model. They are now expecting the training for model use and interpretation for their personal. This model has been developed by the Euro-Mediterranean Center for Climate Change from Italy through the World Bank project "Lake Skadar Integrated Ecosystem Management". Installation and training for model use will be done in the first part of this year. Regarding a continuous application of above or other hydrologic and hydraulic modeling software, IHMS has not yet taken any decision.

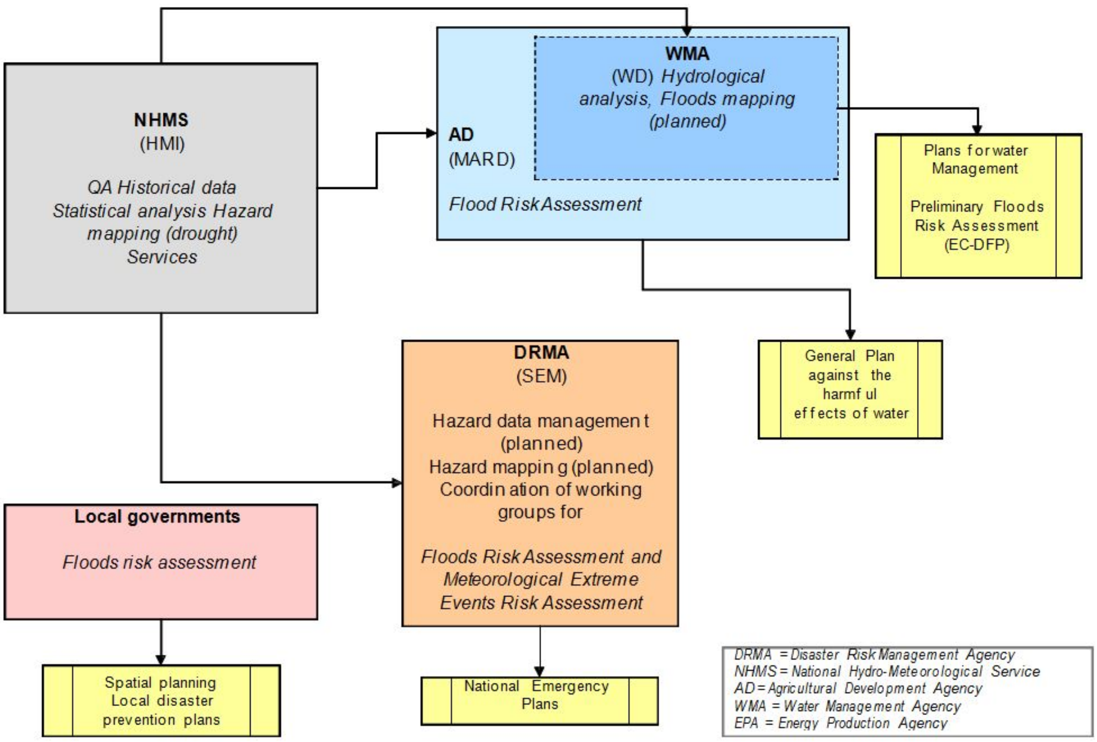

Figure 7.4: Workflow for drought and floods risk assessment in Montenegro (Source: WMO, 2012)

According to WMO (2012), the institutional framework of drought and floods risk assessment is currently in the process to be defined (see Figure 7.4). Concerning floods, the legal framework attributes to:

– DRMA/SEM: duty to perform flood risk assessment for planning emergency management;

- Ministry of Agriculture and Rural Development: the duty to perform floods risk assessment for planning protection against the harmful effects of water,
- WD: duty to prepare Plans for water management of each river basin, including relative flood risk assessments (and the preliminary flood risk assessment according to the EC Directive for floods protection),
- Local authorities: duty to perform flood risk assessment for disaster prevention and for local spatial planning.

Currently the role of IHMS is to provide basic statistics and analyses of extremes and climate variability to be used for strategic planning of disaster risk reduction (DRR).

In case of extreme weather situations IHMS is the institution which "trigger" the action of relevant entities within the country (see Figure 7.5).

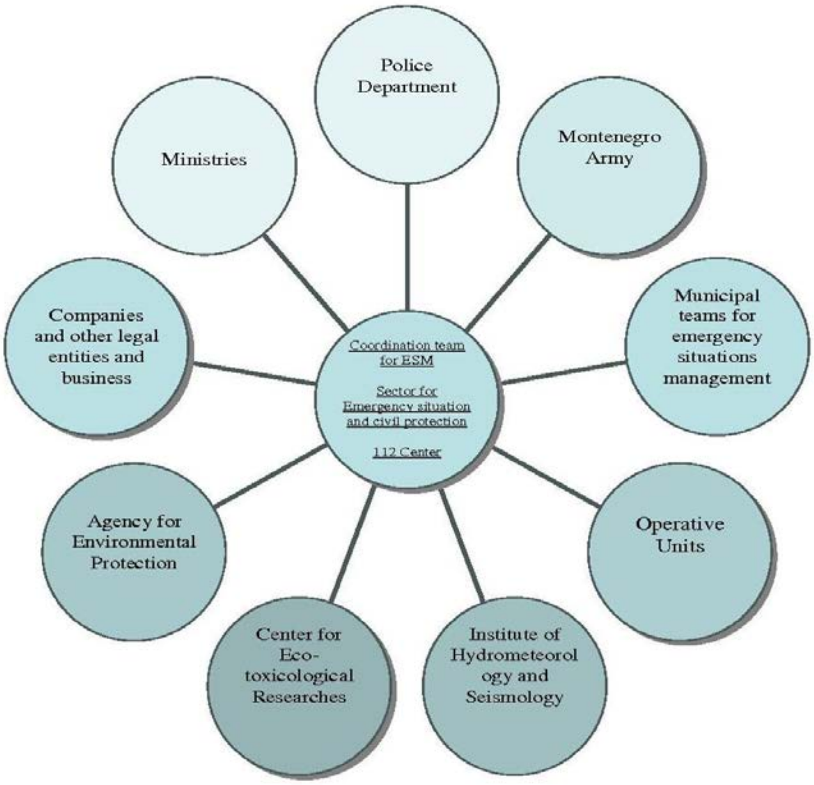

Figure 7.5: Organization scheme for management in emergency situations (EMS) *(Source: Sector for emergency situations and civil protection)*

In sending warnings to the authorities in case of severe weather conditions and flooding, the following procedure is being applied. In case of severe weather conditions (heavy rain) which can lead to the flood occurrence, the head of the Forecast Department informs the director and the head of the hydrology sector. The head of the hydrology sector is then reviewing the hydrological information of, e.g. water levels. In case that the water level is rapidly rising and in association with other meteorological parameters, IHMS produces a statement on the expected conditions which is immediately sent (via e-mail and fax) to the Sector for Civil Protection and Emergency Management

(SCPEM), Water Directorate and the Ministry of Agriculture and Rural Development. The sector for emergency situations is responsible for alerting the government and the public.

In case of an emergency situation a management group is formed in the SCPEM, consisting of representatives of different institutions and ministries. The representative of IHMS of Montenegro is an essential and permanent member of this group.

7.5 Overall Evaluation of Existing Data Acquisition, Data Management and Flood Warning System

Considering the required components of an EWS as described in Chapter 1, the IHMS is basically able to provide a qualitative flood forecast, and to deliver online data of the existing online stations to Albania. Due to the lack of hydrological and hydraulic numerical simulation a quantitative prediction of flood hydrographs and inundations cannot yet be performed.

Despite of the clearly better conditions if compared with other riparian countries, the IHMS needs improvements to compensate for the decrease of the hydrometeorological service since two decades. IHMS needs to invest in the monitoring network, to increase the staff number for the daily maintenance of the network and to implement hydrological and hydraulic modelling as well as to train the staff for model application.

In Table 7.4, the international experts' evaluation of the present HMS system with regard to the DEWS is summarized.

Montenegro: Present Conditions with Regard to EWS

Country	Meteo-Data / Transmission	Hydrological Data / Hydraulic Data / Transmission	Database (Met&Hyd)	Num. Meteo – Forecast (focus on quant. precip.	Modeling Hydrological / Hydraulical	Flood Forecast	Flood Warning Procedure
Montenegro	About 5 meteo – 2 online, 3 manually obs.; 11 rain gauging stations - manually operated and transferred by post	9 stations (all online) – but no station at Zela River Bathymetry of lake Shkoder is available (for Montenegrin part) Partially cross-sections from Buna River available	Meteo: currently CliData – since 2009; WISKI (bought 2003) but problems in applic.; EXCEL, ASCII, Hydras3 (Ott); ORACLE; Hydrol: EXCEL, ASCII and WEBSITE (online-stations); since 2002 strong decrease in data storing	Weather forecast, no numerical forecast (Non-hydrostatic Mesoscale Model; NMM ETA-model)	Currently no models in operational use In close future IHMS will receive a predictive hydrological model from Italy	Qualitative forecast based on water levels and rainfall Observations transferred to Ministry of Civil Protection (MoCP)	IHMS: Announcement to Ministry of Civil Protection (MoCP)
Evaluation	2 – 3	3	M: 3, H: 3	1	1	1	3

0	1	2	3	4
not available / not adequate	poor	fair	good	very good

Table 7.4: Overall evaluation of present conditions at HMS Montenegro with focus on the DEWS

8 Inventory of Hydrometeorological Infrastructure and Data Utilization in Albania

The inventory of the hydrometeorological infrastructure and data utilization in Albania with focus on the Drin Basin is based on an extensive information exchange between the international experts and the local experts as well as field trips and visits at the institutions listed in Annex 1, and on literature review of available documents.

8.1 Organization of the Department of Climate and Environment, Institute of GeoSciences, Energy, Water and Environment, Albania (IGJEUM / IGEWE) and other Institutions involved in the Drin-Buna River Basin Management

The hydrometeorological service of Albania is assigned to the Institute of GeoSciences, Energy, Water and Environment (IGJEUM in Albanian and IGEWE in English language) (Figure. 8.1).

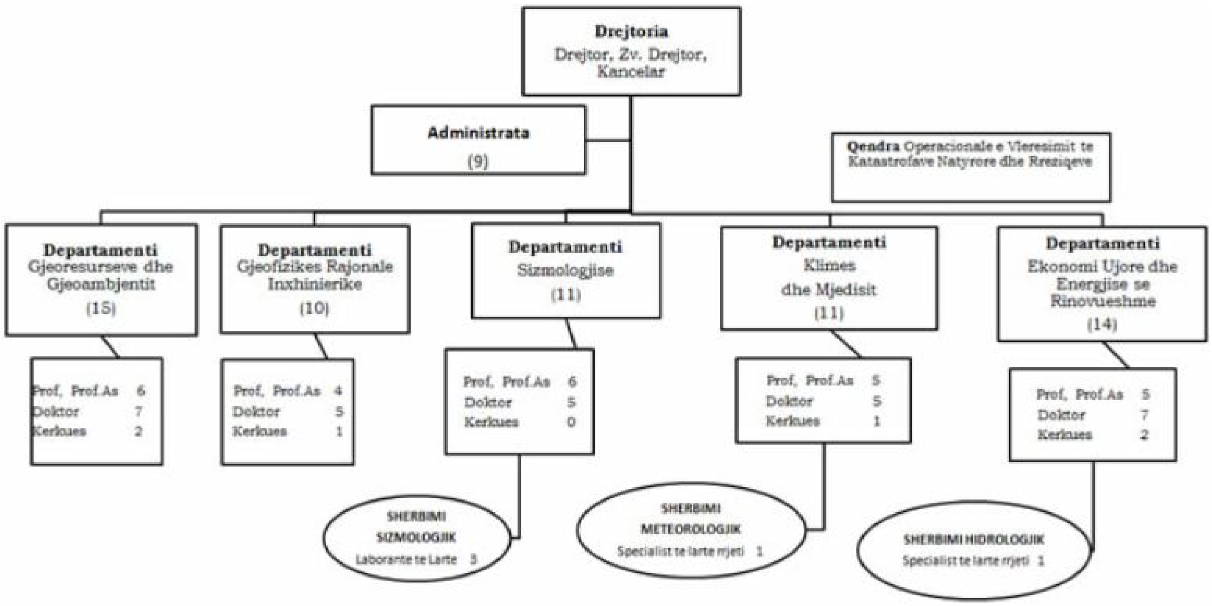

Figure 8.1: Organigram of the Institute of GeoSciences, Energy, Water and Environment, Albania (Source: http://www.geo.edu.al)

According to the Institute's website [http://www.geo.edu.al], the Institute of GeoSciences, Energy, Water and Environment is a national research unit that operates under the umbrella of the Polytechnic University of Tirana. IGJEUM consists of the following main departments, each of them contains up to three research units.

These departments are:

– Department of Climate and Environment **(includes meteorological service)**
– Department of Geophysics and Georisks
– Department of Georesources and Geoenvironment
– Department of Seismology
– Department of Water Economy **(includes hydrological service)**

Main tasks of the institute are related to geotechnics , geophysics and seismics. Water-related tasks are the hydrometric and meteorologic services, studies on the water resources and research on natural hazards as well as those created by human activities (landslides, erosion, flood, earthquakes, environmental pollution etc.).

The meteorological service is integrated in the Department of Climate and Environment, whereas the hydrological service is integrated in the Department of Water Economy. During the expert mission in December 2012, an intensive information exchange especially with the Department of Climate and Environment responsible for meteorology took place. Most of the information regarding hydrology was also obtained from this department.

In Table 8.1, the number of employees of the Department of Climate and Environment and their educational background are listed.

Branch / responsibility	**Field and education**					**Total**
	Technicians	**Meteorologists**	**Hydrologists**	**Engineers**	**Others**	
Observation network	1	1	4	1		**7**
Data management		1	1			**2**
Weather modeling & forecasting		1				**1**
Hydrological modeling & forecasting			2			**2**
Hydraulic modeling & forecasting			2			**2**
R & D (Research & Development)		1				**1**
IT personnel				1		**1**
Others					"We expect to have an increase in the number of staff by 5 people"	
TOTAL	**1**	**4**	**9**	**2**		**16**

Table 8.1: Personnel of IGJEUM Albania – Department of Climate and Environment (Source: national expert)

The total number of 16 regular employees seems to be insufficient, but includes only one technician. Some of the 5 meteorologists and 9 hydrologists are also involved in academic work. In particular, the personnel for the field work (maintenance of stations, data collection and transmission to headquarters etc.) should be increased by several technicians.

The Department of Climate and Environment includes 3 groups:

- The climate unit conducts (research) studies for specific areas or in a national scale for climate and agro-climatic peculiarities as well as for climate changes. It studies and evaluates the energetic potential of solar radiation and wind in the whole country, with the aim of using these components for regenerative energy production.
- The operational meteorology group has the mission of data collection, verification, updating, digitalization and archiving of meteorological and agrometeorological observations (including the phenological observations) in accordance with the WMO standards. It provides information to the central institutions dealing with the management of disasters caused by meteorological phenomena.
- The environmental evaluation unit is responsible for the monitoring and nation-wide studying of the atmospheric and water pollution level, depending on hydrometeorological conditions. It monitors and evaluates the quality of the air and natural waters of Albania. It conducts surveys and complex studies related to water quality and its pollution.

In 2011, a "**National Centre for Forecast and Monitoring of Natural Risk"** has been established at IGJEUM Albania, with the help of the Italian CIMA Research Foundation (CIMA, 2012). Present main tasks are the implementation and operation of early warning systems for wildfire (RISICO) and floods (Flood-PROOFS) as well as training of personnel. Details are given in Chapters 4 and 8.4 ff.

8.2 Hydrometeorological Monitoring and Available Data Series

During our visit, analogue observation data (currently in paper form) of meteorological and hydrological services were digitalized. For meteorological service, data from the period 2001 to 2012 was digitalized, for hydrological service, data from the period 1991 to 2012 was digitalized.

The quality control of these data is still due, hence it was not included in the preparation of the histograms (see Chapters 8.2.1 and 8.2.2).

8.2.1 Hydrology

The following information about the hydrological service was obtained by questionnaire from the national expert from Department of Climate and Environment (meteorologist). The number of existing hydrological stations located in the Drin Basin (River Drin and tributaries) in Albania is about 52 (shown in Figure 8.2). Nine of them are located in the Buna catchment. Details on the type of station and their operational status is given in Annex A 6.1.

Information was obtained for water level series only. Existence and status of rating curves is unknown. Obviously, automatic recording and online-transmission of water level data is not available with the exception of one station. All data are transmitted from the gauging observer to the headquarters by post at the end of each month. It is currently unknown how much of these stations are in operation and in which state they are.

The available data series of water level were checked for gaps, the results are given in Annex A 6.2. The histograms have been created for all mentioned hydrological stations until the year 1990. From 1991 up to now histogram data were not provided. According to the results of the questionnaire, this period is characterised with large gaps on data series of observations.

Presently, the available hydrologic and meteorological data series recorded from about 1991 up to present being digitalized by a private company under supervision of IGJEUM and financial support of the World Bank. The digitalization process should have been finished end of 2012.

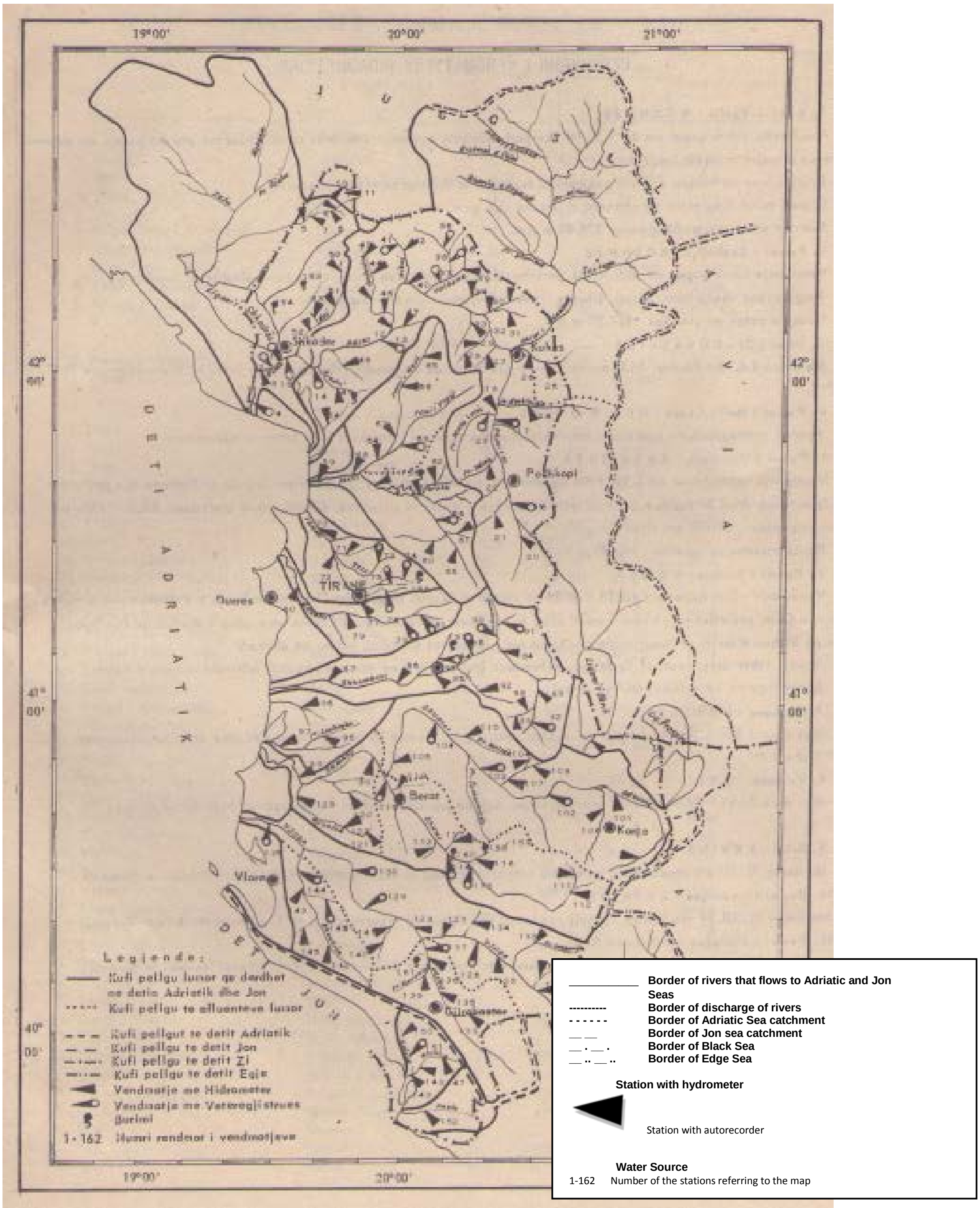

Figure 8.2: Hydrological stations located in Albania (Source: national expert)

8.2.2 Meteorology

Currently there are 76 meteorological and precipitation stations existing in the Drin Basin (shown in Figure 8.3). Mainly temperature, precipitation and radiation is measured. Evaporation is not measured.

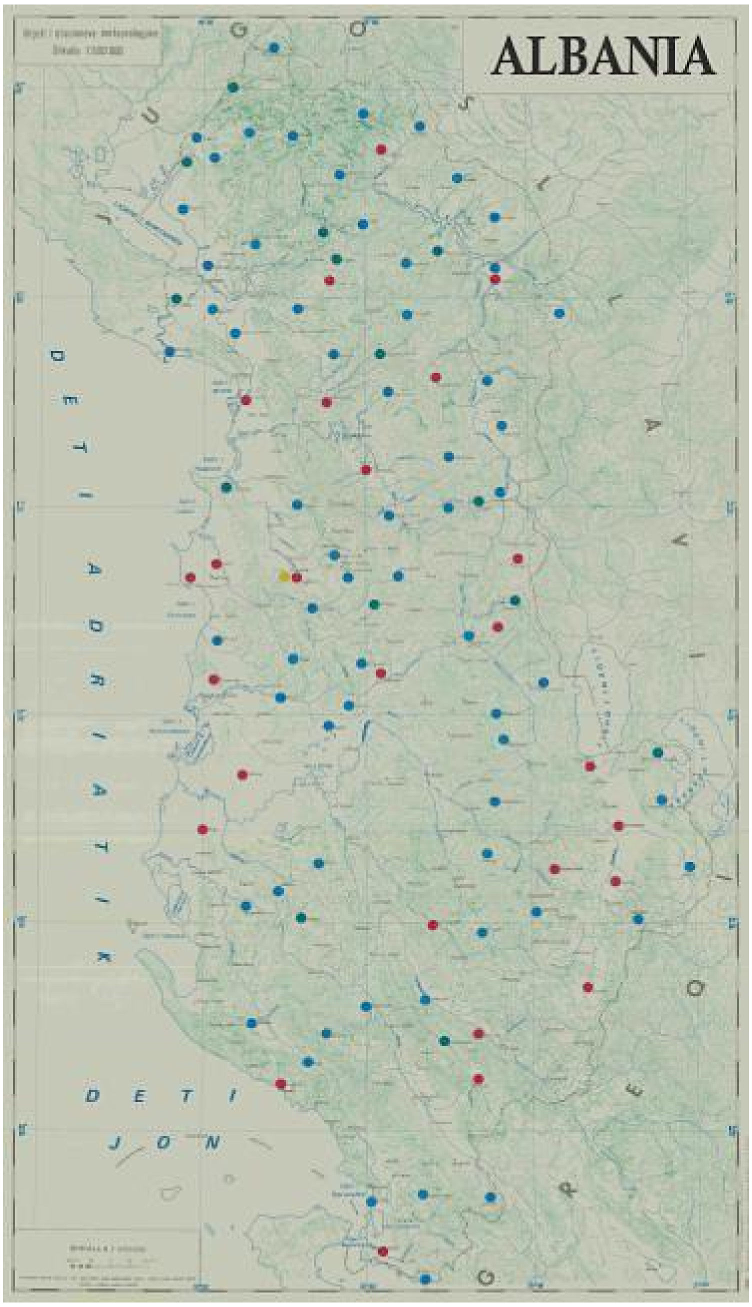

Figure 8.3: Existing meteorological stations (Source: national expert)

Details about the type and operational status of the stations is given in Annex A 6.3. The stations are mainly thermometric stations (65), seven of them are climatic stations and nine are pure pluviometric stations. Online transmission of data does not exist. The data are written into booklets and picked up by personnel or transmitted to the headquarters via post. The stations are generally in an adequate to poor condition.

The available data series were checked for gaps. The results are given in Annex A 6.4. Histograms are created for all meteorological stations until the year 2000. From 2001 up to now histogram data were not provided. According to the results of the questionnaire, this period is characterised with gaps on data series of observations that finally will be available and evaluated at the end of the digitalisation process.

8.3 Data management in IGJEUM – Department of Climate and Environment

For both hydrological and meteorological data, the present data management is on a poor level. Most of the long-term data series up to 1990 seem to be archived in paper format (Table 8.2).

Types of data base	Period	Comments from national expert (e.g. availability, utilization, etc.)
Atmospheric domain		
Access data base	--	
Excel data base		"This is a small data base not really secure for few short time period of some automatic meteorological station"
WISKI data base	--	
Paper documents		"All the data are in papers. Only the last 10 years period is in process of digitalization"
Other	--	
Hydrological / hydraulic domain		
Access data base	No information	
Excel data base		"All the data are in papers. Only the last 20 years period is in process of digitalization"
WISKI data base	No information	
Paper documents	No information	
Other	No information	

Table 8.2: Past and existing data base (Source: national expert)

Due to lack of quality control of data and lack of proper data management the hydrometeorological data base is presently not sufficient for watershed planning and forecast purposes.

8.4 Models, Flood Forecast and Warning System

Regarding models, flood forecasting and warning in Albania, two sources of information are available and, to some extent, contradictory. One source is WMO (2012), the other source is a Geophysical Research Abstract (Marku et al., 2012) obtained from an internet enquiry. From a visit of **the National Centre for Forecast and Monitoring of Natural Risks,** which has been recently established under the IGJEUM, and at the workshop hold in February, 2013, the international experts gained more information (CIMA, 2012)**.**

8.4.1 Information taken from WMO (2012):

Based on talks with WMO representatives at the GIZ-DEWS workshop hold on 12/13 February, 2013, in Tirana, the WMO experts being in charge of the WMO report (2012) were not aware about the new “National Centre for Forecast and Monitoring of Natural Risks” which was assigned to the IGJEUM. So the following information taken from WMO (2012) does not include the new centre, but realistically presents the situation at the hydrometeorological services within IGJEUM. According to WMO (2012), the national weather forecast is produced by three different organizations:

“Most weather forecasts disseminated by the media are produced by the Military Meteorological Service (MMS.) The Institute of GeoSciences, Energy, Water and Environment (IGJEUM) produces a general forecast for 24 hours, and a 3-, 5- and 10 day outlook. IGJEUM`s operational forecasting is based on use of printed analysis and forecast products from international forecasting centers and from the Montenegrin National Meteorological and Hydrological Service (NMHS).

The IGJEUM forecasters do not have access to any real-time data. Lack of national observation data is a severe obstacle especially for short term forecasting. Currently IGJEUM has only 2 duty forecasters and it does not have the capacity to operate 24/7 weather forecasting services. Currently there is no capacity to download numerical weather prediction model products to be used for national weather forecasts, or to run any numerical weather prediction models. MMS cooperates with the Italian meteorological service and gets their Numerical Weather Prediction (NWP) products to be used for MMS weather forecasting.

Numerical hydrological-hydraulic models, wave models or dispersion models for airborne or waterborne pollutants are presently not in operational use. IGJEUM produces by contract special forecasts for agricultural and aviation sectors. However, a hydrological and a hydraulic model (HECRAS) had been implemented at the Department.”

According to WMO (2012), the Directorate General for Civil Emergencies (DGCE) is responsible of the national “Disaster Risk Assessment” and coordinates sectoral line ministries/institutions that have responsibility for the respective sectoral risk analysis, development strategies and integrated plans. At local level, Prefectures and Municipalities are responsible for their own risk assessment and planning. The DGCE coordinates the interministerial committee in case of disaster and collects from line ministries, from its own local teams and from local authorities all relevant information about the disasters (mainly impact data). Twice a year a synthesis of this information is prepared for the Prime Minister. Twice a year DGCE organizes meetings with the Prefects for planning the Emergency management on the next 6 months. Then the DGCE prepares the national plan for the areas exposed to higher risk. All the geographical analyses and maps supporting the plans are prepared by the Ministry of Defense.

IGJEUM participates in the National Committee for Disaster Risk Reduction (DRR). Up to now the role of IGJEUM has been to produce some basic statistics and analyses of extremes and climate variability from the national hydrometeorological data to be used for strategic planning of DRR, but it is not actively included into the planning procedure of the DRR system in the country.

The mandate to produce different warnings related to the hydrometeorological phenomena is not clearly defined. Currently IGJEUM does not produce any public warnings. However, IGJEUM has a governmental role to produce up-dated maps and forecasts to the authorities. Hydrological studies for flood warnings have been done for different basins, but no mathematical model was used, only correlations with rainfall. Flood forecasting is given on the different river basins using the simple relationship between the meteorological forecasts and the water levels. MMS gives occasionally warnings in connection to its daily TV weather forecasts. Warnings to the aviation sector only are produced by the Meteorological Service under National Air Traffic Agency (MSNATA).

Regarding products and warning dissemination, IGJEUM disseminates hazard monitoring data, forecasts and early warning to the Head of the National Committee for Disaster Reduction and other partners of Disaster Risk Reduction (DRR). The limited weather warnings produced up to now are disseminated to the public via media. Military Meteorological Service (MMS) gives warnings in the TV presentations and by disseminating advisories to the media, who then edit their own weather forecasts and warnings. Currently there is no mandate to interrupt TV or radio programs, or to have a continuous warning stripe on the TV screen in the case of the emergency. Method to send warnings directly as SMSs to mobile phones located at, or going to, site of danger is not in use in Albania.

Sectors like Ministry of Health or NGOs like Red Cross are not on the direct contact list of warnings of hydrological or meteorological hazards."

Albania is not a member of the EUMETNET METEOALARM systems.

8.4.2. Information obtained from Marku et al. (2012) about the National Centre for Forecast and Monitoring of Natural Risks

The following information is taken from Marku et al. (2012) and coincides with information obtained during the workshop hold in Tirana from 12-13 February, 2013:

"In the framework of the International cooperation between the Civil Protection of Italy and Albania, the ***National Centre for Forecast and Monitoring of Natural Risks*** has been established at the ***Institute of Geosciences, Energy, Water and Environment (IGJEUM / IGEWE)***. The Centre is supported by expertise of CIMA Research Foundation - International Centre on Environmental Monitoring. The Centre issues (every morning) on a daily basis a Meteorological Warning Bulletin (the first bulletin was issued on the 20th of December 2011). It is mostly dedicated to the precipitation forecast, the most important hazard in Albania. It covers 36 hours, starting for the noon of the current day till the end of the next day. It offers a detailed precipitation forecast for each prefecture of Albania (12 in total). The prefectures that have to do with the most problematic river (Drini) are divided in a few warning areas each homogenous with respect to climatologic and hydrologic conditions.

The meteo-warning is synthetically evaluated for each prefecture; it contains the assessment of the experts about the severity of the forecasted storm in terms of average precipitations, and maximum possible storms (if rainfall intensity exceed 90 mm in 3 hours). The reference meteorological model is COSMO LAMI7 (managed by ARPA Bologna, Italy), its spatial resolution is 7 km and temporal resolution for the outputs is 3 hours. Also ECMWF model is available. After the pure meteorological evaluation, possible adverse ground effects are assessed with a second level of variable rainfall thresholds, whose estimated recurrence interval is compared to soil moisture dependent values. The soil moisture conditions are computed by the operational probabilistic forecasting model Flood Proofs, implemented by CIMA for the Drin and lake of Shkodra basins. Flood Proof is also used to forecast river discharge at the mains hydraulic cross-section of the basins; the third level of assessment is based on discharge thresholds.

All the meteorological and hydrological forecast models are available in the open source web-based platform DEWETRA (DEWETRA has been developed by CIMA on behalf of the Italian department of Civil Protection who uses it routinely for its activities of forecast, monitor and surveillance of Natural Risks) Meteo-Warning classification is chosen to be similar to MeteoAlarm; in the future the Center wishes to participate in this European activity. Hydrological warnings are expressed in terms of risk scenarios."

8.4.3 Information gained by the International Experts

During the mission of the international experts, the National Centre for Forecast and Monitoring of Natural Risks embedded in the IGJEUM was visited. As described in Chapter 4, the centre has been established recently, some working units are still in the process of initiation. The rough information which was available coincides with the information published by Marku et al. (2012) and CIMA (2012). A quantitative flood forecast for the lower Drin basin is not yet feasible, because of missing online hydrometeorological data from Albania and the other riparian countries. Furthermore the implemented modelling systems needs to be calibrated for the whole Drin river basin with long-term historical data series, extended by a functioning hydraulic model for the simulation of inundated areas, then adapted and fine-tuned to deal with future data input from various sources.

8.5 Overall Evaluation of Existing Data Acquisition, Data Management and Flood Warning System

The present level of the acquisition and management of hydrometeorological data is poor despite of the relatively dense station network. Main reasons are the extremely limited or reduced budget and organisational deficiencies. In particular, the hydrometric/hydrological service requires organisational improvement. Despite of the present poor conditions, the Department of Climate and Environment (Meteorology) is trying to keep its stations running best possibly. Enormous investment in measuring equipment and data management (technical components) as well as in staff training is required.

From a first view, the staff working in the meteorological, hydrological and IT sections of the new National Centre for Forecast and Monitoring at IGJEUM is well qualified and highly motivated. But further training in the field of modeling will be essential. The operational centre looks well equipped with IT components. The implemented software Flood-PROOFS (Flood-Probabilistic Operational Forecasting System) stems from Italia. The software consists of a fully distributed hydrological model which covers the whole Drin basin of about 17.000 km^2. A calibration of the model with long-term series of hydrometeorological data for the whole basin was not presented. Obviously, precise hydraulic modeling of inundation areas using the hydrological output is not yet included. According to the staff, a hydraulic model is going to be built up in the close future.

For the time being, Flood-PROOFS suffers on missing online meteorological and hydrological data. Presently, only very few online station data are transmitted to the centre. The numerical meteorological forecast required as an input into the hydrological model seems to stem purely from international forecast models. An adaption of the international meteo forecast data to the region with the help of regional online ground stations and radar is not yet part of the data processing for flood forecast.

In total, the international experts recommend to use this centre as an operational basis for the DEWS of this project. Hardware for an extended data base, transmission systems to the regional partners as well as modeling software (in particular calibration procedures, hydraulic model) need to be installed, extended or improved to interact with all riparian countries, and to deal with the complex Drin-Buna water system. In Table 8.3 the international experts' evaluation about the present HMS system with regard to the DEWS is summarized.

Albania: Present Conditions with Regard to EWS

Country	Meteo-Data / Transmission	Hydrological Data / Hydraulic Data / Transmission	Database (Met&Hyd)	Num. Meteo – Forecast (focus on quant. precip.	Modeling Hydrological / Hydraulical	Flood Forecast	Flood Warning Procedure
Albania	About 76 meteo stations: 65 climatic / ther-mometric stations, 9 pluviometric, etc. (diff. types) Presently no online transmission, data are written into booklets; manual data transfer	Historical: 52 stations – in paper format; Presently only 1 online station, Uncomplete information about the status of stations and data trans-mission; Histogram for 1991 ff not available	Since '50 – presently no database Archived data in paper format Digitalization of period 1991 – now in process (completed) No information about rating curves	Based on intern. models – own data not in use	Hydrol. Model covering the whole Drin basin is presently built up; Hydraulic model: WB model for Lower Drin available (HECRas), own model is presently built up based on WB model	Not based on modeling, but on historical and actual data and experience	Alert levels are existing (also from experience) – Warning procedure via transmission of bulletins to ministry (2-3 times a day – in case of emergency more often)
Evaluation	1 – 2	1	2 – 3	1 – 2	1	1 -2	3

0	1	2	3	4
not available / not adequate	poor	fair	good	very good

Table 8.3: Overall evaluation of present conditions at HMS Albania with focus on the DEWS

9 Concept of an Integrated Drin-Buna EWS (DEWS) and Interaction with National Hydrometeorological Services (HMS)

9.1 Overall Structure

The international experts recommend to structure the Drin-Buna EWS (DEWS) as an integrated system. It will consist of a DEWS operational centre and its data links to the national HMS of Macedonia, Kosovo, Montenegro and Albania (Fig. 9.1), to the EFAS and to the international meteorological forecast centres, and from the national HMS to EFAS.

The DEWS operational centre should be located at the National Centre for Forecast and Monitoring at IGJEUM, Tirana.

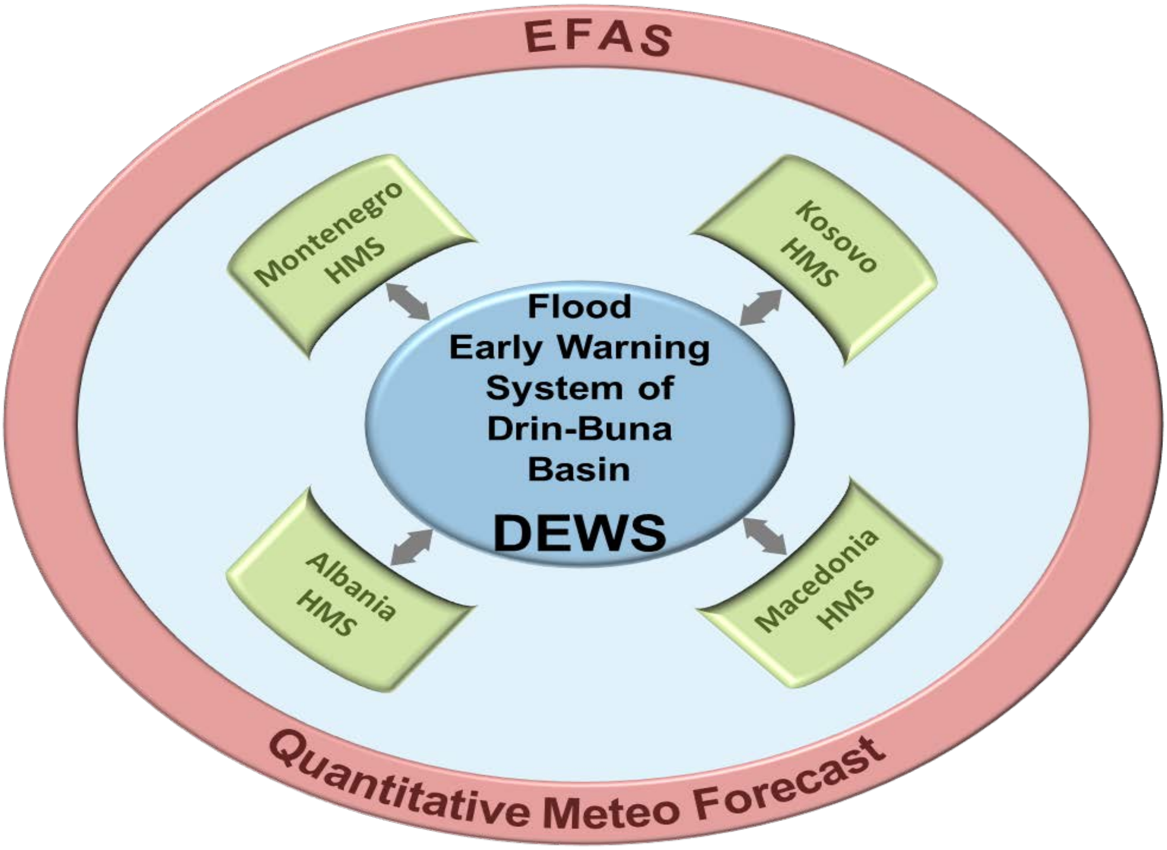

Fig. 9.1: DEWS and links to national hydrometeorological services (HMS), to EFAS and international quantitative meteorological forecast (including numerical precipitation forecast)

The general duties are illustrated in Figure 9.2. It shows all interconnected components of a comprehensive warning system with focus on the Drin river basin:

- Hydrometeorological data: monitoring and online transmission of hydrometeorological data to the national HMS data bases.
- Data base management: data processing, plausibility check, filing up of data gaps.

– Quantitative meteo forecast: combination of internationally available meteo forecast with regional meteo data obtained from ground stations and radar.

– Quantitative flood forecast: combined hydrological (water quantities) and hydraulic (water levels) modeling of whole basin based on hydrometeorological data input (online data and forecast data); prior to the use for flood forecast, the models need first to be calibrated with long term series of historic data.

– Flood early warning: decision making and dissemination of flood early warning to crisis management groups etc.

– Communication with actors and concerned public, with external institutions like EFAS; review and optimize DEWS after floods.

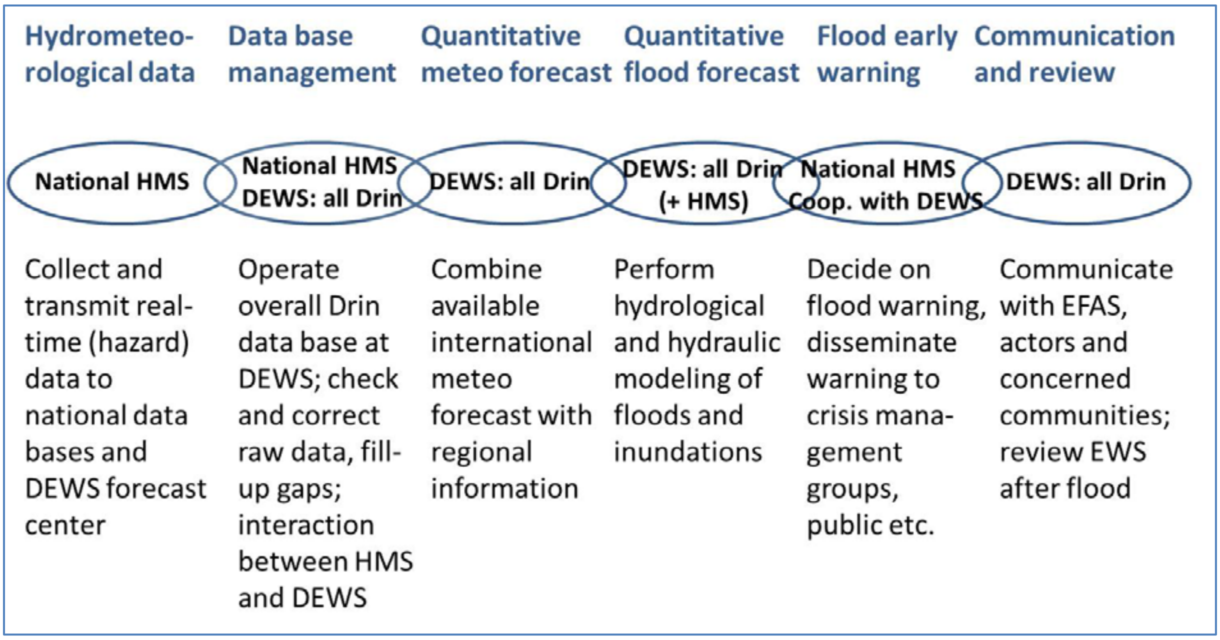

Fig. 9.2: Interconnected components and duties of the DEWS and national HMS

Some tasks are purely related to the HMS or to the DEWS operational centre, others should be performed in close collaboration between DEWS (regional) and national institutions.

In particular, well-functioning and robust data base systems need to be established to guarantee a smooth and reliable data transmission from the national HMS to the DEWS and reversely. Standardization of data base software, data storing, data quality checks, data transmission filters is considered essential. Details about the existing equipment are given in Chapters 5 to 8 and Annexes 3 to 6.

Elaboration of a regional quantitative meteorological forecast based on the international numerical forecasts requires special qualification and should be performed in the DEWS centre only.

Hydrologic and hydraulic modeling for flood forecast including ensemble forecasting requires large experience and continuous training in modeling. The experts knowledge may disappear if severe floods and flood forecasting do not occur for several years. Consequently it is recommended that the modeling tasks are concentrated in the DEWS operational centre, which may profit from the highly qualified personnel of the existing Albanian National Forecast Centre. Once if the DEWS is well established and has proved its functioning during floods, submodels taken from the complete river basin model and covering the subbasins of the riparians may also be forwarded to the national HMS. In doing so, some riparians – Macedonia, Kosovo, Montenegro - can develop their own local flood forecast in addition to the DEWS forecast in order to account in more detail for local conditions and to improve the accuracy of the local forecast. A submodel can also be used for variant analysis and prediction of local floods if reservoir releases will be modified. But such a transfer of submodel systems (software) requires continuous assignment of highly qualified modeling experts at place.

The construction and dissemination of flood warnings is the responsibility of the national institutions; for this issue, the DEWS may communicate with the HMS but should not interfere into any national decision making.

In Figure 9.3 the process for the creation of a flood early warning in the Drin-Buna basin by the DEWS centre is proposed. Dotted-line arrows indicate options, full-line arrows indicate necessities of interaction between the involved groups. The role of EFAS is explained in detail in Chapter 11.

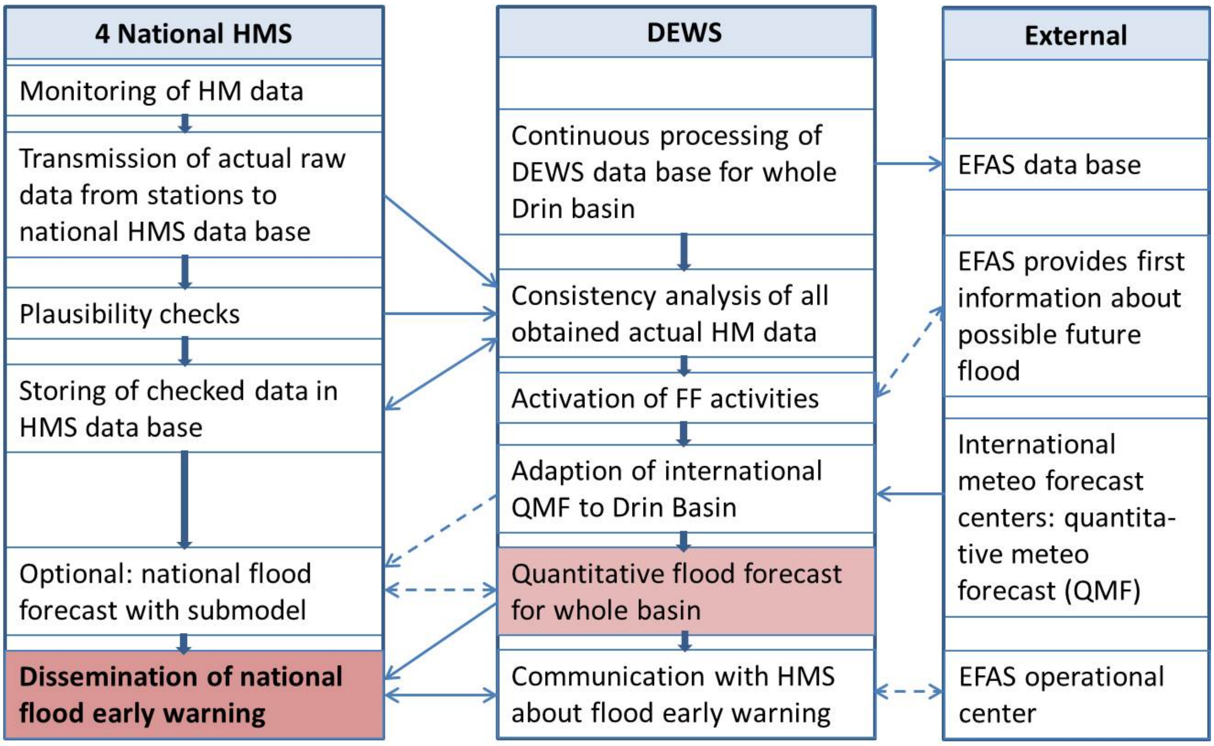

Fig. 9.3: Optimum sequence of interactions between DEWS operational centre, national HMS and external institutions for the operation of a flood early warning system

Figure 9.3 shows the sequence of actions within each HMS and the DEWS centre as well as the interaction between the parties involved. This figure shows an **optimum structure of operation with**

the DEWS centre as the main institution for data processing and modeling provided that the collaboration between the riparians is well organized and all required online data and the quantitative weather forecast will be available to the DEWS centre. If such a stage is reached, the DEWS operational center will be continuously linked with EFAS regarding the transmission of the processed and checked online data to EFAS as well as the receipt of a first information about upcoming floods from EFAS. According to Figure 9.3, the national HMS perform an immediate first plausibility check of the arriving hydrometeorological online data of their national station networks. The checked data will then be transmitted to the DEWS centre. The time interval for the transmission of online data will depend on the actual situation and can vary between about 1 day (dry season) and 1 hour (rainy season). The centre immediately performs a consistency analysis and - if necessary - adjustments under consideration of all data obtained. The data which the DEWS centre judges to be most representative will serve as an input into the forecast model chain. Forecast will be performed by DEWS only if given thresholds of rainfall and water levels are exceeded. The representative data will also be transmitted to EFAS as an input into their forecast tools which are continuously running on a daily time step and on a relatively rough spatial resolution for large parts of Europe. EFAS can provide a first information to the DEWS operational centre about an upcoming flood at an early stage. Such an information will initiate flood forecast activities at the DEWS operational centre. The flood forecast produced at the centre for given time intervals (often: 6 hours) will then be delivered to the national HMS for the elaboration and dissemination of early flood warnings.

Apart from the interaction between the DEWS centre and EFAS as described above it is recommended that the riparian countries directly share hydrometeorological online data via their HMS with EFAS. In doing so, EFAS will provide the riparian countries with EFAS' products free of charge, in particular with first information (warnings) about upcoming floods at an early stage.

9.2 Existing Hydrometeorological Station Network in the Drin Basin as a Basis for the DEWS

Chapters 5 to 8 contain inventories of existing and previous, functioning and non-functioning hydrological and meteorological stations in the Drin basin of the riparian countries. Details are given in the Annexes 3 to 6. All above stations for which the coordinates were handed over to the international experts, are plotted into the river basin maps of Figures 9.4 and 9.5, which were processed from the international experts' digital terrain model (see also Figure 3.1).

The digital **station maps** of Figures 9.4 ff are the first ones which had ever been developed and harmonized for the whole Drin-Buna basin. With the help of these digital maps, the station network for the DEWS could be pre-designed within this Assessment Study.

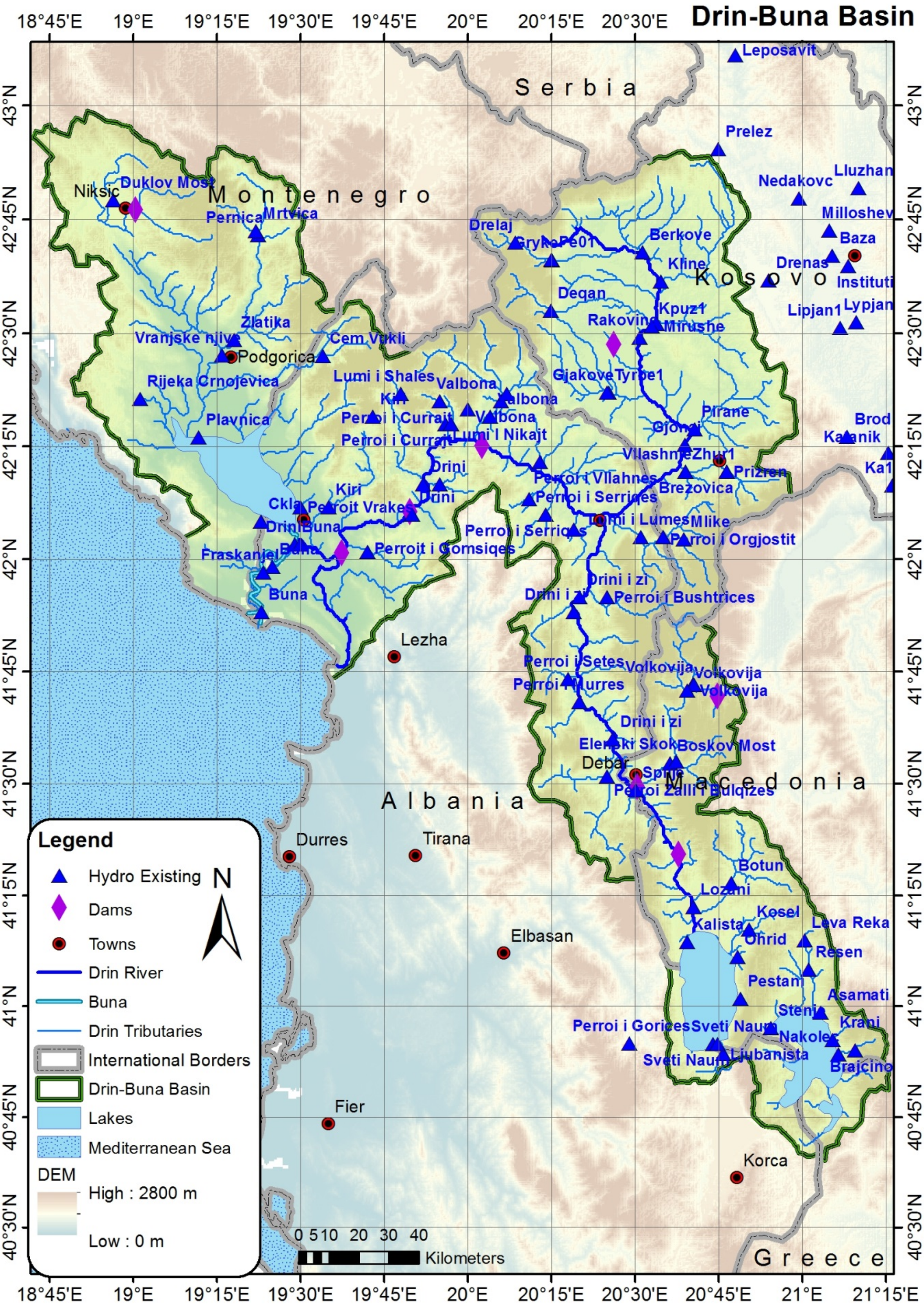

Figure 9.4: Existing (functioning and non-functioning) hydrological stations of the Drin-Buna river basin (Source: Meon)

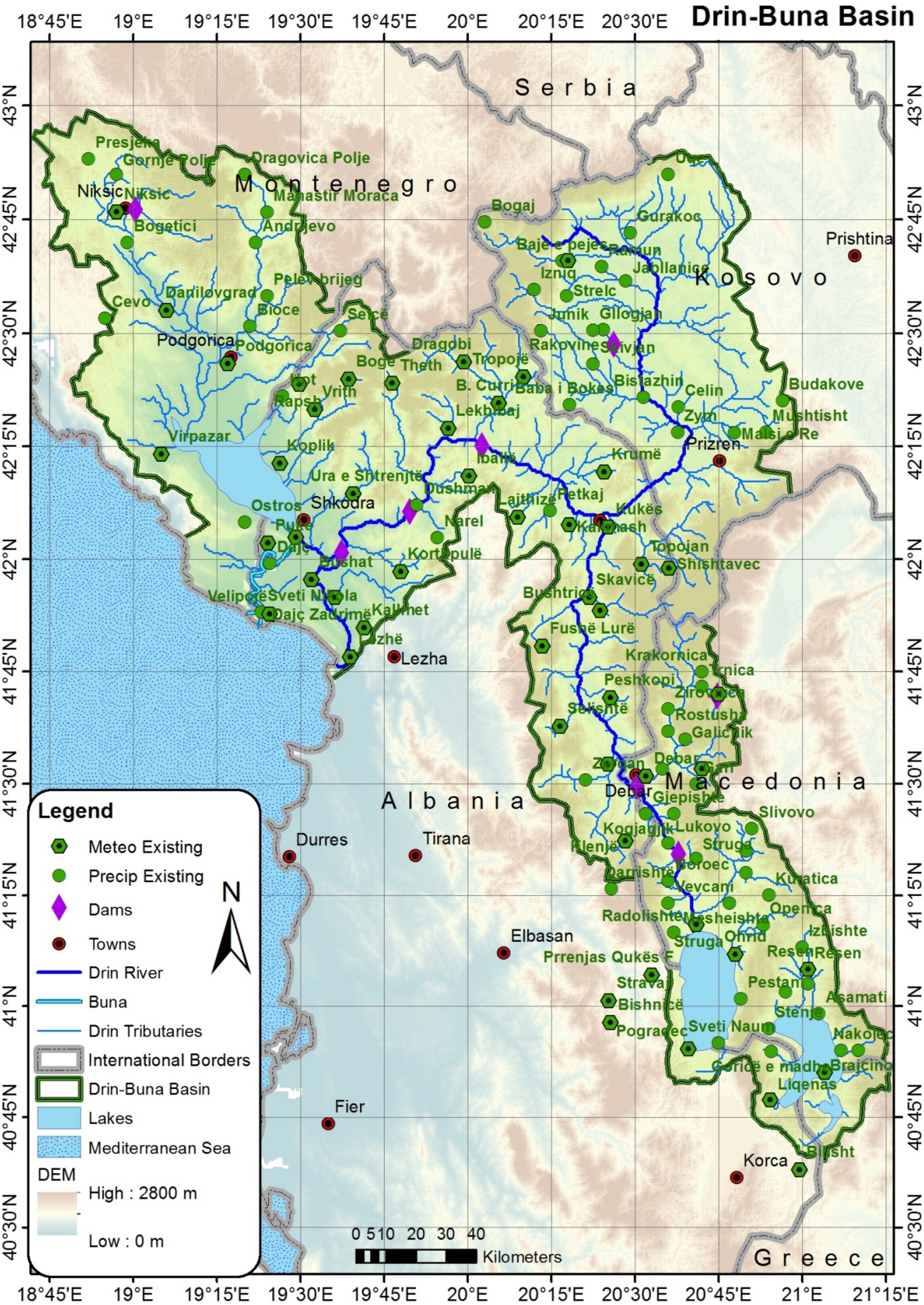

Fig. 9.5: Existing (functioning and non-functioning) meteorological stations (climatological, precipitation) of the Drin-Buna river basin (Source: Meon)

9.3 Required Hydrometeorological Station Network for the DEWS

Based on above information and on elaborations of working groups for each country consisting of national experts from the respective country during the workshop in February, 2013, the international experts selected key stations which are considered essential for the operation of a basic DEWS. These stations are defined as "**Level 1 (L1) stations**". In a first step, these stations should be preferably put into function as soon as possible. Such a basic DEWS will, first of all, allow a technical functioning of the DEWS system and deliver first flood predictions at any location of the Drin basin. The L1 stations will enable a somewhat reasonable short-term calibration of the combined hydrological and hydraulic models at the key gauging stations with the help of a relatively rough meteorological online data network. Such a short-term calibration covering about one month of input data from the past 30 days to present is part of the operation of the DEWS and will be repeated prior to each simulation of the flood forecast. Because of the low density of the meteorological online station network the flood forecast of the basic system will involve medium to high uncertainties. L1 hydrometric stations are usually located at the main river, at reservoir inflows and outflows, at the water bodies of the reservoirs or lakes (surface water level) and at major tributaries upstream of the junction with the main river. About one third of the L1 online meteorological stations should be automatic climatological stations (well equipped), two thirds can be pure automatic rainfall stations including snow pack measuring instruments if located in snow regions. The L1 meteorological stations should be distributed in such a way that the regions providing the largest amounts of rainfall and snow should be monitored with a denser station network than the other (lower) regions. Therefore, a higher density of stations in certain (higher) regions can be justified, if these regions have considerable annual rainfall and snowfall.

On request by GIZ, the international experts selected 20 stations from the L1 stations. Reason is the limited project budget being available for equipment. These **20 L1-A stations** are recommended for an immediate installation respectively upgrade as online stations by GIZ funding. Details are given in Chapter 9.4 (Table 9.3, Figures 9.9 and 9.10).

In a second step, **Level 2 (L2) stations** should be brought into operation and included in the online station network. L2 hydrometric stations are preferably located at tributaries of the Drin river. L2 meteorological stations are preferably automatic precipitation stations, some of them being located in mountainous regions with high amounts of annual rainfall and snow. Integration of L2 stations will significantly improve the performance of the DEWS to reach a standard level of accuracy.

In a third step, **Level 3 (L3) stations** may be added. These stations are located at minor tributaries and in remote areas. Final locations should be selected only after a longer period of modeling experience under Level 2 stage. L3 stations will raise the density of the hydrometeorological network and further improve the accuracy towards a higher standard DEWS.

The option of adding automatic online precipitation stations to selected hydrometric stations could not yet been investigated in detail. This option should be considered for appropriate locations because of control, maintenance and economic reasons. Installation may become interesting, if additional precipitation stations will become necessary in order to improve the modeling accuracy.

The international experts' recommendations for L1 and L2 stations are summarized in Table 9.1. L3 stations were not nominated. In total, 37 hydrological stations and 38 meteorological stations including climatological and precipitation stations are recommended for as Level 1 stations.

For comparison, the recommendations of the national experts are also listed in Table 9.1. The total numbers of L1 and L2 stations of the national recommendations coincide widely with the recommendations given by the international experts. The locations of the stations, however, differ to some extent. For example, the Albanian recommendations for L1 meteo stations did not include the stations which are going to be implemented by a World Bank funding in the close future. The Montenegrin recommendations of hydrological stations did not include several automatic online stations, which are definitely required as L1 stations.

National HMS	Hydrological Stations				Meteorological Stations		
	L1	L2	L3		L1	L2	L3
Macedonia	11 (14)	2 (4)	(4)		10 (10)	5 (4)	(9)
Kosovo	4 (4)	0 (0)	(0)		8 (3)	3 (7)	(0)
Montenegro (*)	7 (6)	0 (2)	(0)		6 (10)	3 (1)	(0)
Albania (**)	15 (14)	2 (3)	(4)		8+6 (8)	7 (6)	(4)
Total	**37 (38)**	**4 (9)**	**(4)**		**32+6 (31)**	**18 (18)**	**(13)**

Table 9.1: International experts' recommendation for hydrological (hydrometric) and meteorological stations (climatology and precipitation) of priority levels L1, L2 and L3 for the DEWS project. In addition, the national experts' recommendations are listed as red numbers.
Level 1: Key stations essentially required for a basic DEWS
Level 2: Important stations in addition to L1 stations for a standard DEWS
Level 3: Useful stations in addition to L1 and L2 stations for a higher-standard DEWS
Remarks:
(*) for Montenegro: 5 existing online stations are included; station Fraskanjel at the Buna river is assigned to HMS Montenegro but should be operated together with HMS Albania after upgrade to online
(**) for Albania: Experts' L1 meteorological stations include 6 planned stations to be funded by World Bank; these stations are not included in L1 number of national expert

For the stations selected by the experts, the station density in units of stations per 1000 km^2 was calculated. The values are listed in Table 9.2 and compared with average, minimum and maximum station densities from existing flood forecast systems in Germany. The German values are taken from a study which was performed under Prof. Meon's participation (DWA, 2009). It becomes obvious that the density of hydrological stations recommended by the international experts for the Drin-Buna DEWS is clearly below the average density occurring in Germany. For the meteorological stations, the density will be in a similar range, if both L1 and L2 stations will be included in the station network. It is emphasized that the comparatively low densities assigned to the Drin basin are – to some extent – also representing the financial conditions of the project.

Density of online station network in river basins with flood forecast modeling	**Hydrological stations**	**Meteorological (climatologic and precipitation) stations**
Recommended L1 stations for Drin basin (average)	2.2 per 1000 km^2	2.2 per 1000 km^2
Recommended L1 + L2 stations for Drin basin (average)	2.4 per 1000 km^2	3.3 per 1000 km^2
Germany (average)	about 5 per 1000 km^2	about 3 per 1000 km^2
Germany (maximum)	about 10 per 1000 km^2	about 11 per 1000 km^2
Germany (minimum)	not available	about 2 per 1000 km^2

Table 9.2: Density of station network recommended by international experts to be used for online data acquisition for the DEWS; for this, a relevant Drin-Buna catchment size of about 17.200 km^2 (without subcatchment of lake Prespa) was assumed; comparison with station densities occurring in German flood forecast basins covering catchments of up to about 15.000 km^2 (DWA, 2009).

The international experts' selection of L1 and L2 hydrological stations are displayed in the system sketch of Figure 9.6 and in the basin map of Figure 9.7. The international experts' selection of L1 and L2 meteorological stations are displayed in the basin map of Figure 9.8.

It is emphasized that flow measurement at outflow or inflow locations $H_{4,7}$, $H_{4,9}$ and $H_{4,13}$ of the Albanian reservoirs is critical with regard to backwater effects during floods. Water level gauges, however, are not sufficient for the hydrological modeling of the cascade reach. Consequently, cooperation with the KESH dam authority is required in order to integrate KESH's (calculated) reservoir outflow data in the future DEWS.

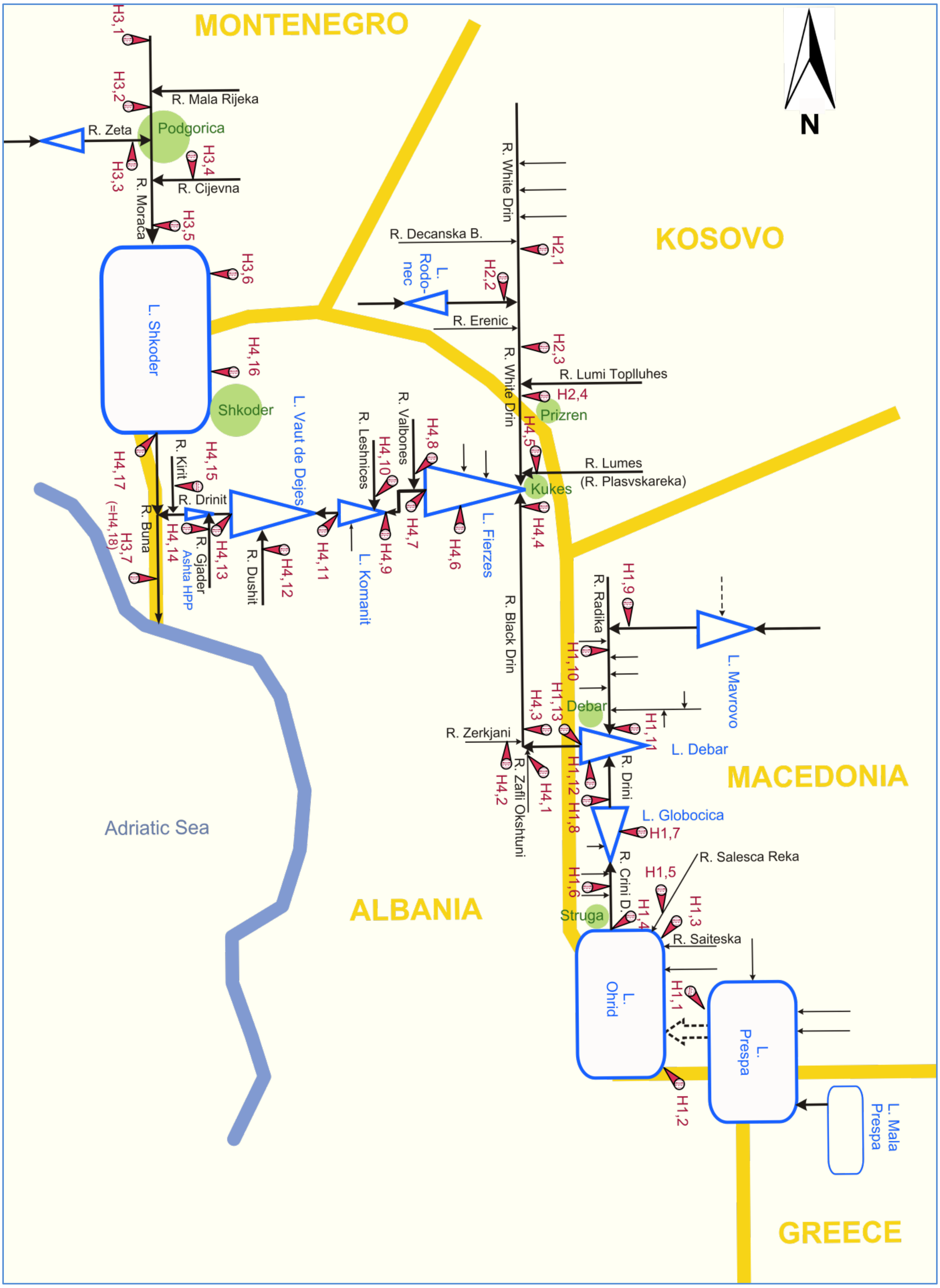

Fig. 9.6: Scheme of Drin-Buna river basin including L1 and L2 hydrological stations recommended by international experts (Source: Meon)

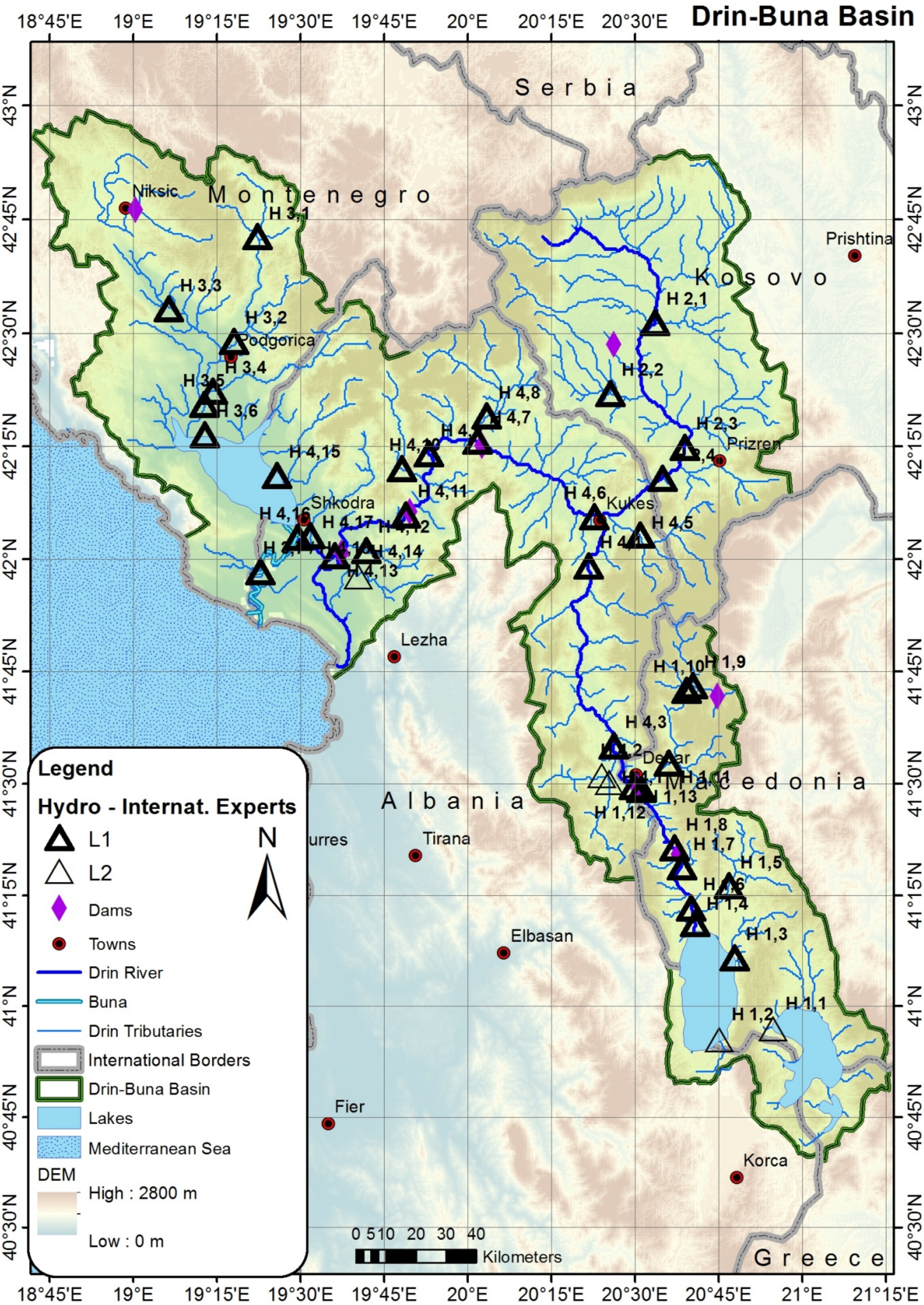

Fig. 9.7: International experts' selection of L1 and L2 hydrological stations

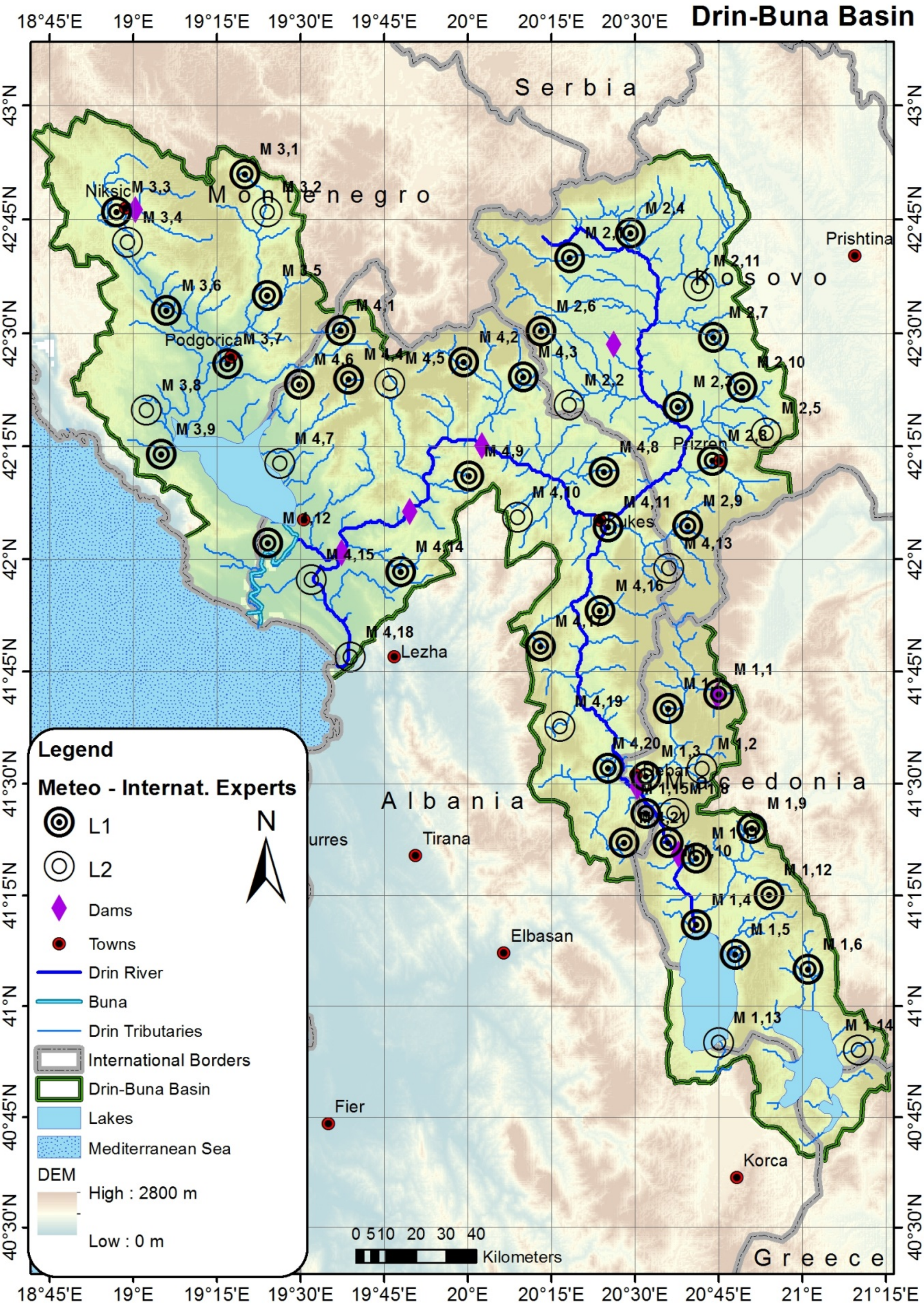

Fig. 9.8: International experts' selection of L1 and L2 meteorological stations

In Annex 7, the hydrological stations recommended by the international experts are plotted for each country. In addition, the national wishes are plotted in separate maps. In Annex 8, the recommended meteorological stations and the national wishes of meteorological stations are plotted.

The selected hydrological stations and details about the required upgrades are summarized for each country in tabular form in Annex 9 and for the meteorological stations in Annex 10.

9.4 Recommendation for an Immediate Setup of L1-A Online Stations by GIZ Funding

As indicated in Chapter 9.3, the international experts selected 20 stations from the group of L1 stations for immediate action. These 20 **"L1-A" stations** (plus one hydrological station L1,11 as additional option) are recommended to be installed respectively upgraded and put into online operation by GIZ funding as soon as possible. Together with existing online stations from Montenegro, with planned (or already partially installed) online meteorological stations in Albania financed by the World Bank and (online) outflow data information from the Albanian reservoir cascade obtainable from the KESH dam authority, a first transnational data network can be made available for the DEWS.

Selection of the L1-A stations is based on the information which was available up to the workshop in February, 2013. Criteria for the selection were in detail:

- Location at most relevant points of the catchment and river system with focus on a first rough hydrological modeling of the whole Drin-Buna basin. Such a preliminary model can be used to successively identify further essential stations out from the L1 and L2 group for the integration into the DEWS.
- Integration of several planned meteorological online stations in Albania to be financed by the World Bank into the online data network of the DEWS, and into the first rough modeling.
- Integration of several planned hydrological online stations in Albania, which are financed by the World Bank, into the online data network of the DEWS and into the first rough modeling. Some of the World Bank stations may even replace recommended L1-A stations if location and equipment meets the demands of the DEWS.
- Integration of online outflow data from the Albanian reservoir cascade being operated by KESH company into the online data network of the DEWS, and into the first rough modeling. The international experts do not have any detailed information about Kesh's data monitoring, but according to international practice, the dam authorities continuously measure or calculate the reservoir outflow. These data will essentially contribute to a reasonable performance of a DEWS.
- Integration of online data from existing online meteorological and online hydrometric stations from Montenegro.

Table 9.3 shows the L1-A stations in combination with planned (or already operating) online meteorological stations financed by the World Bank and locations downstream of the Albanian reservoirs, where calculated or observed online outflows should be made available from the KESH dam authority. In Figures 9.9 and 9.10 these stations and locations are placed in maps.

	Hydrometry		Meteorology	
Organisation / Country	GIZ	Kesh	GIZ	World Bank
Macedonia	H 1,4 H 1,13 (H 1,11)		M 1,1 M 1,4 M 1,9	
Kosovo	H 2,4		M 2,1 M 2,8 M 2,6	
Montenegro	H 3,5 H 3,7		M 3,3 M 3,5 M 3,9	
Albania	H 4,4 H 4,8 H 4,10 H 4,17	H 4,7 H 4,11 H 4,13	M 4,2 M 4,9	M 4,4 M 4,6 M 4,11 M 4,12 M 4,17 M 4,20

Table 9.3: International experts' recommendation of **L1-A stations** to be put into online operation by GIZ funding as soon as possible; in addition other planned or most recently operating online meteorological stations (funded by the World Bank), which coincide with L1 or L2 stations and other online data sources (Albanian reservoir outflows calculated or measured by KESH) are listed. Station H 1,11 can be added if online hydrological stations financed by the World Bank will replace one or more of the recommended L1-A stations.

The table does **not** include:

- Several meteorological and hydrological online stations being presently operated in Montenegro.
- Several planned or most recently operating online hydrological stations financed by the World Bank; status of these stations is unclear to international experts; locations are displayed in station map of Figure 9.9 .

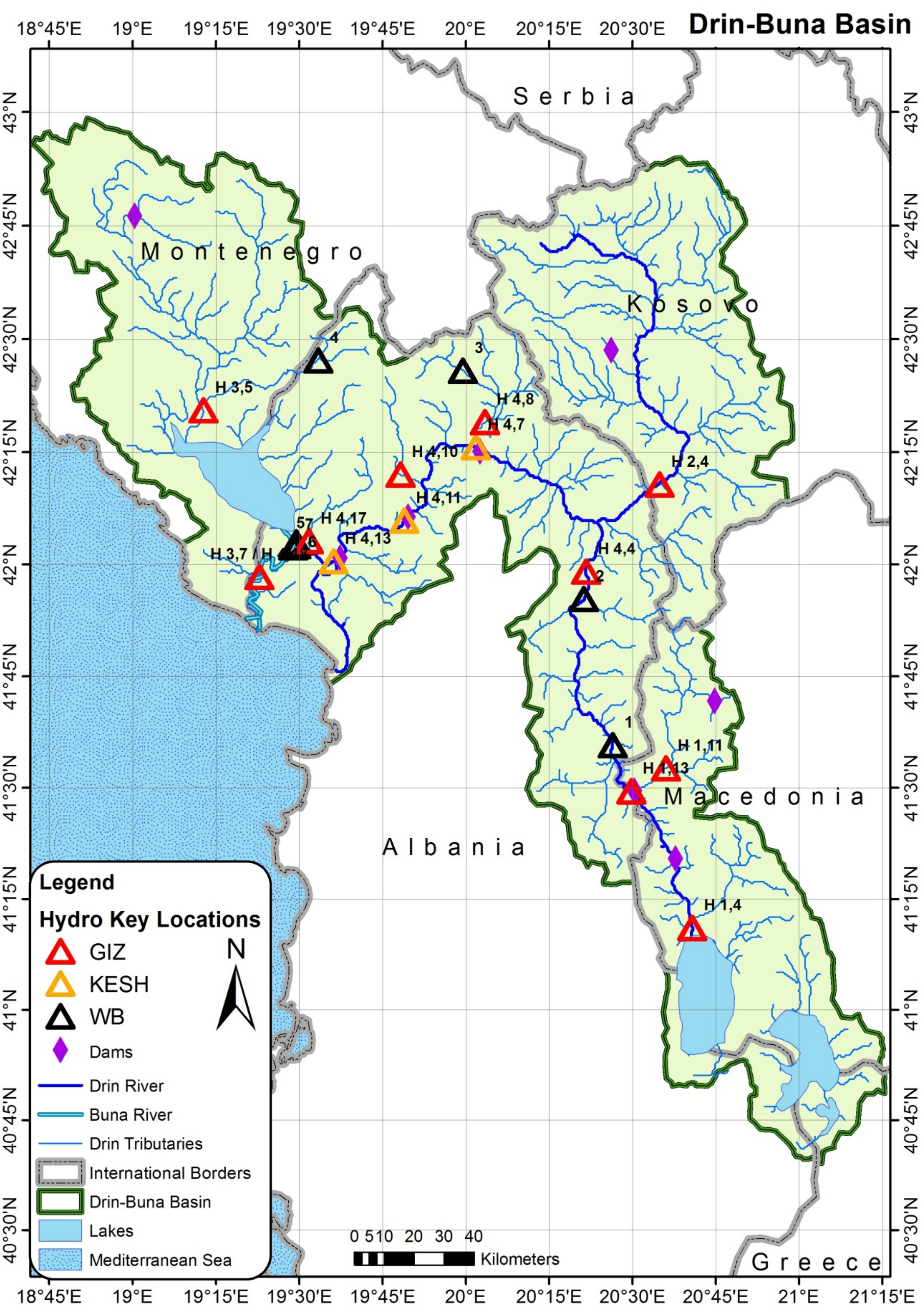

Fig. 9.9: International experts' recommendation of **L1-A hydrological** stations to be immediately put into online operation by GIZ funding (red symbol). In addition, planned online stations (uncertain information) financed by World Bank and locations of online outflow data available from KESH are included and should supplement or replace L1-A stations.

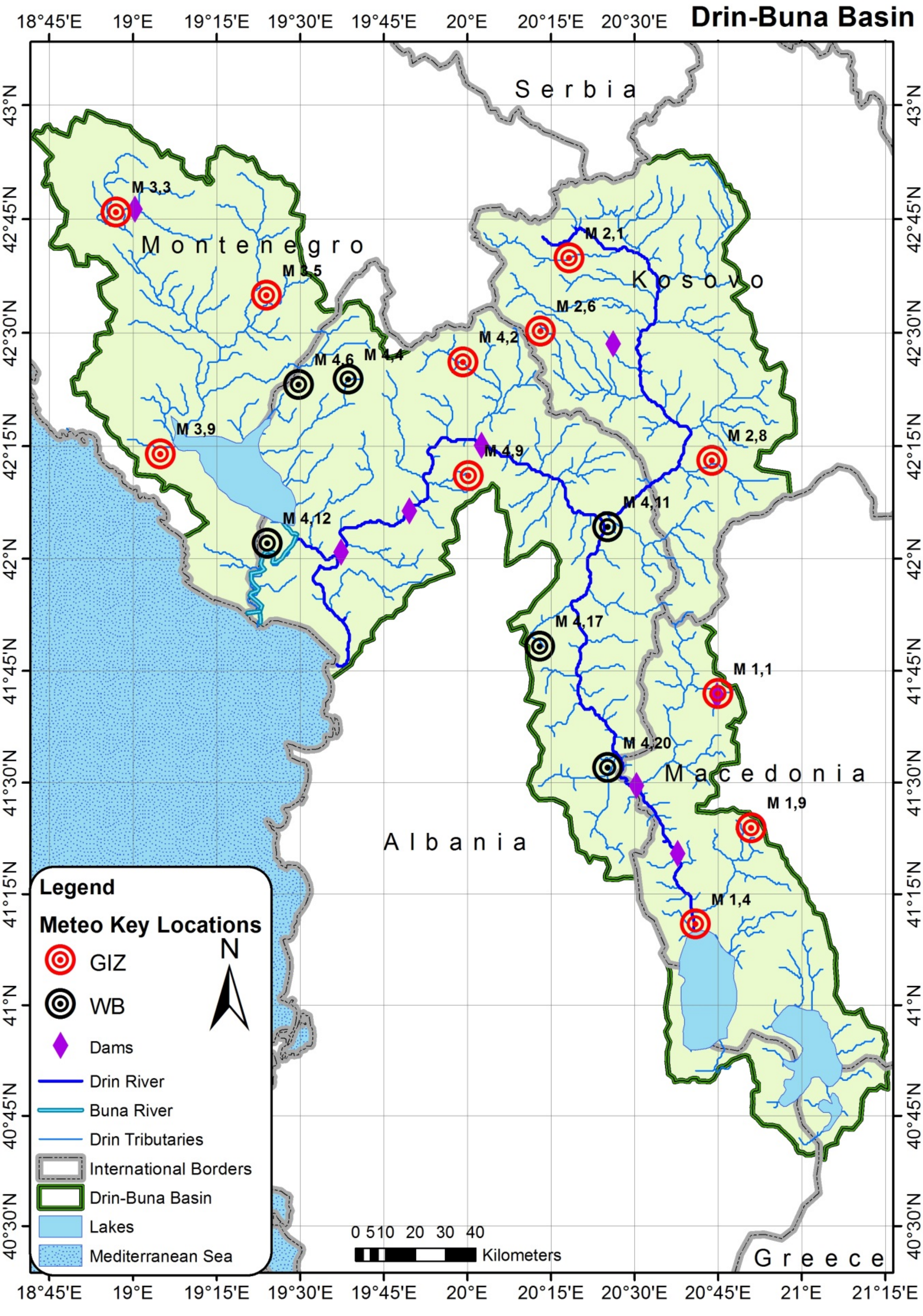

Fig. 9.10: International experts' recommendation of **L1-A meteorological** stations to be immediately put into online operation by GIZ funding(red symbol); planned online stations financed by World Bank (black symbol) should also be included in the initial online data network.

10 Recommended Investigation about Required Equipment and Future IT Structure at Four National HMS and DEWS Operational Centre, Collaboration with Dam Authorities

The inventory of the existing hydrological and meteorological networks and data series in the Drin-Buna basin for all four riparians including the development of catchment maps, several iterations for identification and specification of the stations, the graphical displays, the development of the DEWS concept with focus on the selection of stations under consideration of the findings obtained at the workshop in February, 2013, required all time being available for the Assessment Study.

From the field trip, only basic information on the existing information technology (IT) equipment could be collected. This information was, to some extent, supplemented with the help of questionnaires developed by the international experts and filled out by the national experts. Results of the IT inventory are given in the Chapters 5 to 8 and Annexes 3 to 6. These results, however, are not yet sufficient to develop detailed recommendations for the IT equipment tailored for each national HMS and for the DEWS operational centre. Furthermore it was not feasible to specify the required equipment and construction work for each recommended L1-A station in detail within the given working frame.

At least a more general recommendation about the structure and required equipment for functioning HMS units as well as for the DEWS operational centre and the IT system was worked out. The structure and lists of required equipment are composed in Annex 11.

The international experts recommend to perform a supplementary study which focusses on the specification of the required information technology as well as on the required collaboration of DEWS operational centre with the Macedonian and Albanian dam authorities. The following aspects need to be investigated in detail:

- Required hardware and software at the four national HMS
- Required hardware and software at the DEWS operational center
- Synchronizing of IT equipment (software of data bases, etc.) between HMS and DEWS operational centre with regard to robust and reliable data exchange
- Optimum share of hardware and software components between the DEWS operational centre and the new forecast centre in Tirana
- Hydrometeorological data transmission between national ground stations and national HMS
- Hydrometeorological data exchange between national HMS and DEWS operational centre
- Transmission of flood forecast from DEWS operational centre to national HMS and national crisis management groups
- Exchange of hydrometeorological data between DEWS centre and EFAS
- Cooperation with international numerical meteo forecast centres
- Sharing of hydrometeorological data within the riparian countries
- Detailed analysis of organizational and operational structures of dam authorities with regard to the Dam Safety Project (KESH) and data sharing; initiation of agreements of collaboration

11 Collaboration between DEWS and the European Flood Alert System (EFAS)

According to http://www.efas.eu/, the "European Flood Awareness System (EFAS), developed to produce European overviews on ongoing and forecasted floods up to 10 days in advance, contributes to better protection of the European Citizen, the environment, property and cultural heritage. It has been developed at the European Commission's in house science service, the Joint Research Centre since 2002 in close collaboration with the National hydrological and meteorological services, European Civil Protection through the Monitoring and Information Centre (MIC) and other research institutes. Since 2011, EFAS is part of the Copernicus emergency management service and has now been transferred to operational service in 2012. EFAS also represents the 1st operational hydrological network in Europe."

"The Operational EFAS consists of several centres executed by different consortia:

- EFAS Computational centre - European Centre for Medium-Range Weather Forecasts (UK) executes forecasts and hosts the EFAS-Information System platform
- EFAS Dissemination centre - Swedish Meteorological and Hydrological Institute, Rijkswaterstaat (NL) and Slovak Hydro-Meteorological Institute analyse EFAS on a daily basis and disseminate information to the partners and the MIC
- EFAS Hydrological data collection centre - REDIAM (ES) and ELIMCO (ES) collect historic and realtime discharge and water level data across Europe
- EFAS Meteorological data collection centre – not yet fully operationally and still managed by JRC. Collects historic and real-time meteorological data across Europe."

Already in the preparation phase of the DEWS project, information exchange between GIZ and the riparian countries with EFAS took place with the aim of collaboration regarding exchange of data, flood forecast and training.

In Figure 9.3, a recommendation about the sequence of interactions between DEWS operational centre, national HMS and external institutions for the creation of a flood early warning is given. This figure shows an optimum structure of operation with the DEWS centre as the main institution for data processing and modeling provided that the collaboration between the riparians is well organized and all required online data and the quantitative weather forecast will be available to the DEWS centre. If such a stage is reached, the DEWS operational center will be continuously linked with EFAS regarding the transmission of the processed and checked online data to EFAS as well as the receipt of a first information about upcoming floods from EFAS.

According to this Figure, EFAS may deliver a very early warning or information about a coming flood to the DEWS center on a more qualitative basis. This is one of the products of EFAS whose meteorological data base covers also neighbouring countries of the region.

At present the international experts highly recommend that the riparian countries directly share hydrometeorological online data via their HMS with EFAS. In doing so, EFAS will provide the riparian countries with EFAS' products" free of charge, in particular with first information (warnings) about upcoming floods at an early stage.

The international experts recommend the following first steps of realization of the cooperation between the riparian countries and EFAS:

- Agreement of cooperation between riparian countries (via HMS) and EFAS for sharing of hydrometeorological data
- National HMS continuously deliver checked data from relevant online hydrometeorological stations to EFAS
- EFAS delivers information on flood warning at an early stage to national HMS

In a similar way, an agreement of cooperation between the DEWS operational centre and EFAS should be initiated after implementation of the DEWS operational centre. The international experts recommend that the DEWS operational centre will – in addition to the data transmission to EFAS via the national HMS - transmit relevant hydrometeorological data series to EFAS directly after completion of the consistency checks. These data series can be finally used by EFAS as most representative online data for the Drin-Buna basin with regard to flood forecast. Depending on the models to be applied, training of DEWS personnel and further information exchange can be realized.

12 Conclusions and Next Steps

With the help of the national experts and logistic support by GIZ, the international expert team elaborated an assessment study for gaps and needs in establishing a flood early warning system in the Drin-Buna river basin. The national experts are associated with the hydrometeorological services of the riparian countries Albania, Kosovo, Macedonia and Montenegro. Information was also exchanged between representatives of the World Meteorological Organization (WMO) and the European Commission Joint Research Center (JCR) being in charge for the European Flood Awareness System (EFAS).

The international experts highly appreciate the close and cordial collaboration with the national experts, the national HMS and other institutions during the project phase and the workshop.

The international expert team coordinated and elaborated the following tasks:

- Visit of relevant institutional providers of hydro-meteorological information in Albania, Macedonia, Kosovo and Montenegro.
- First inventory of the existing hydrometeorological, flood forecast and warning conditions (gaps and needs) with regard to a functioning DEWS.
- Pre-design of the (overall) DEWS for the lower Drin Basin as well as of the upgrade of the national HMSS to contribute to the overall DEWS.
- Identification of steps to be taken for the integration of the DEWS in the European Flood Awareness System (EFAS).
- Workshop in Tirana from 12-13 February, 2013

- Final report including additional knowledge gained at the workshop.

The report is based on the information gathered and processed until end of the workshop. For details, results and recommendations it is referred to the Chapters 5 to 11. **Essential findings and conclusions** are summarized as follows:

- Collection and analysis of any kind of data (hydrological and meteorological stations and corresponding historical series) required – by far – more working effort than originally planned. This is because of the heterogeneous organisational and financial situation, of the differing personnel structures of the national HMS and of partially adverse political conditions in the close past. In order to provide a common base for the data inventory, questionnaires had to be created, filled out by the national experts and iteratively be completed. The data inventory as well as the findings of gaps and needs had to be integrated from four information sources: field trip, questionnaires, data processing by the national experts as recommended by the international experts, reports. Still up to now, there exist some contradictions in data information.
- Further homogenizing of data information required development of a highly resoluted digital topographical map of the river catchment. Into this map all existing (functioning and non-functioning stations) from the four riparian countries were drawn. This additional work was – in combination with the processed station histograms - necessary for the recommendation and graphical display of required online stations for the DEWS.
- The international experts selected 69 key stations – so-called Level 1 (L1) stations - (37 hydrological stations and 32 meteorological stations) which are considered essential for the operation of a basic DEWS. These stations should be preferably installed or – if already existing - upgraded and put into online function. Some of the selected stations coincide with planned online stations which are going to be built with World Bank funds (about 6 hydrological and 6 meteorological stations all being located in Albania). In further steps, the online data network should be extended by selected Level 2 and Level 3 stations to improve the performance of the DEWS to reach a standard level of accuracy in flood forecast.
- With regard to the limited financial GIZ budget for equipment, the international experts chose 20 so called L1-A stations from the group of L1 stations. The L1-A stations should be immediately installed or – if already existing - upgraded to online data transmission and put into operation. The online data should be transmitted to the national HMS which need to be equipped with suitable IT systems and data base software.
- Further development of the online station network towards a complete L1 network will require considerable efforts by the riparian countries with regard to financing of equipment and increased personnel at the national HMS. Institutional, economical and legal aspects of involved HMS could not be studied in detail.
- The extended scope of work and the incomplete information gathered during the visits of the national HMS did not yet allow to develop accurate recommendations about the future IT structure fitted to each national HMS and to the DEWS Operational Centre as well as a detailed recommendation for the collaboration with dam authorities. This task should be performed in the next project steps as listed below. At least, a more general recommendation for the required equipment of a well-functioning national data base and the regional forecasting centre was worked out.

- Regarding the operation accuracy of the DEWS, a close cooperation between the DEWS operational centre, the Albanian KESH and the Macedonian Dam authority is necessary. Hydrometeorological data collected by the national HMS (and checked on consistency by DEWS operational centre) and above authorities need to be shared in order to reach a "win-win" situation with regard to flood forecast and protection and economic benefits from hydroenergy production. A well-functioning flood forecast model system can be extended to provide accurate flow forecasts of reservoir inflow all over the year including low flow seasons. Furthermore such a model system can be extended for support of the real-time reservoir operation. Aim for the dam authorities could be to optimize hydroenergy production in combination with flood protection and downstream flood damage minimization.
- Contractual collaboration between the national HMS and EFAS with regard to online data provision to EFAS is recommended and should be realized as soon as possible. The riparian countries will receive – free of charge – products from EFAS like information about upcoming floods at a very early stage. At beginning of operation, the DEWS operational centre should also directly exchange information with EFAS.

The next steps should be (see also further steps listed in Chapter 10):

- Specification of the work to put a maximum number of the recommended L1-A level stations into online operation:
    - Detailed inventory of required equipment and structural work for each selected L1-A location.
    - If necessary, modification of station location and equipment.
    - Detailed determination of required IT at four national HMS and DEWS operational centre
    - Detailed cost estimates etc.
    - Preparation of ToR for the installation, data transmission and data management
    - Bidding, evaluation of proposals, award of contract(s) to manufacturers and (construction) companies.
- Installation and upgrade of L1-A stations and transmission facilities.
- Upgrade of national HMS units for online data handling for the DEWS; training in data base management with international partners.
- Development of organizational structures and agreements between riparian countries for the implementation of the DEWS – located at the National Centre for Forecast and Monitoring of Natural Risk, IGJEUM, Tirana.
- Development of a first hydrological model (planning stage) covering the whole Drin-Buna basin: calibration and validation with historical data, training with international partners.
- Start of online data sharing between the national HMS and the DEWS operational centre.
- Extension of the hydrological modeling tools towards rough forecasting.
- Extension of the online data network.
- Extension of the rough hydrological forecast model towards detailed hydrological modeling and combination with hydraulic modeling in flood prone areas.

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ANNEX

Annex 1:

Mission Report about Field trip

(26th of November – 6th of December 2012)

Gaps & needs assessment study 26.11.2012-06.12.2012

Prof. G. Meon Dr. M. Pätsch , Jakob Doetsch , Nikoleta Bogatinovska, Jelena Perunicic, Merita Mansaku - Meksi

Day 1	26.November , Monday	Details	Logistics
xxxxx	Arrival experts		(suggested Hotel Theranda or Hotel Tirana http://www.therandahotel.com/) http://tiranainternational.com/portal/
	AL GIZ climate change project,	Mission program, expectations, tips	Jakob Doetsch (JD) Merita Meksi (MM) +355(0) 694030510 Merita.meksi@giz.de
	27.November, Tuesday		
07:00	Travel to Skopje / Macedonia	A.Cango driver, trip is 5 hrs	suggested Hotel xxxxxxx
12:15	Meeting with national expert	Nat expert / details of the missions, clarifications	Nikoleta Bogatinovska
13:00 – 14:00	Lunch break		
14:00			NB & national expert
15:30			NB & national expert
	28 November Wednesday		
09:00			NB & national expert
11:00			NB & national expert
13:00			NB & national expert
14:30 – 16:00	Lunch break & Mission debriefing		
	A field visit will scheduled during the day		
	29 November ,Thursday,		
06:00	Travel to Prishtina/ Kosova	A.Cango driver, trip is 3 hrs	suggested Hotel xxxxxxx
09:00	Meeting with national expert	Nat expert / details of the missions, clarifications	
10:00			national expert
12:00			national expert
14:00 – 15:00	Lunch break		
15:00			national expert
16:30			national expert
	30 November Friday		
09:00			national expert
11:00			national expert
13:00			national expert

Gaps & needs assessment study 26.11.2012-06.12.2012

Prof. G. Meon Dr. M. Pätsch , Jakob Doetsch , Nikoleta Bogatinovska, Jelena Perunicic, Merita Mansaku - Meksi

15:30			Mission debriefing
	01.December, Saturday		
9:00	Field Visit		
13:00	Travel to Podgorica		
	02.December, Sunday		
	Field visit Montenegro		
	03. December, Monday		
09:00	Meeting with national expert	Nat expert / details of the missions, clarifications	Ivana Pavicevic
10:00			IP & national expert
12:00			
14:00 – 15:00	Lunch break		
15:00			IP & national expert
16:30			IP & national expert
	04 December, Tuesday		
09:00			IP & national expert
11:00			IP & national expert
13:00 – 15:00	Lunch break & Mission debriefing		
15:30	Travel to Tirana/ Albania	A.Cango driver, trip is 3 hrs	suggested Hotel Theranda or Hotel Tirana
	On the way back a field visit will be done in Shkodra (Petrit Zorba will join here)		
	05 December, Wednesday		
09:00	Meeting with Prof Petrit Zorba	Nat expert / details of the missions, clarifications	
11:00			Petrit Zorba & MM & JD
13:00 – 14:00	Lunch break		
14:00			Petrit Zorba & MM & JD
15:30			Petrit Zorba & MM & JD
17:00			Petrit Zorba
	06 December, Thursday ,		
09:00			MM & JD & Petrit Zorba
11:00			MM & JD & Petrit Zorba
12:30	Mission debriefing + next steps and milestones		
	Departure		

TABLE OF CONTENTS

Abbreviations

BC	Beneficiary Country
MS	Member State
PL	Project Leader
PM	Project Manager
STNE	Short-Term National Expert
GIZ	Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH
IE	International Experts
EWS	Early Warning System
EFAS	European Flood Alert System
KHMI	Institute for Hydrometeorology – Kosovo
HMS	Hydrometeorological Service of Macedonia
IHMS	Institute of Hydrometeorology and Seismology - Montenegro

Foreword

This document describes the course and the matter of subject of the working visits carried out by the international experts in Albania, Kosovo, Macedonia and Montenegro during the period from 26. November to 6. December 2012.

Acknowledgements

The authors want to thank the following persons, for their support and help before, during and/or after the visit:

- Mr. Jakob Doetsch, Project Manager, Climate Change Adaptation, Western Balkan
- Ms. Merita Mansaku- Meksi, Regional Coordinator Albania – Kosovo, Climate Change Adaptation, Western Balkans

Narrative Summary of Working Visit – GIZ / Albania

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Duration: 26.11.2012 – 26.11.2012

Locations of the mission: City of Tirana, GIZ Office

Mission team: The team that completed this mission, consisted of 2 GIZ Managers and 2 international experts namely:

GIZ

- Mr. Jakob Doetsch, GIZ
- Ms. Merita Mansaku- Meksi, GIZ

International Experts

- Prof. Günter Meon,
  Institut für Wassermanagement IfW gmbH, Braunschweig,
  g.meon@tu-bs.de
- Dr. Matthias Päetsch,
  Specialist for data modeling and analysis,
  Braunschweig,
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Course of the mission:

Day ONE - Monday, November 26, 2012

Primary Focus: Introductions, Mission program, expectations
Day Lead Facilitator: Jakob Doeetsch
Day contents & agenda focal point:

Who	Activity
Jakob Doetsch	Introduction of the Mission - an overview of the project and introduction of its goals and objectives, main components of the project cycle and expected outcomes and indicators of success
Prof Günter Meon	Introduction of the International Experts & Tasks

Narrative Summary of Working Visit - MACEDONIA

Short-term national experts:

Counterpart:
Vasko Stojov MSc, Hydrologist

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Hydrometeorological Service
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Duration: 27.11.2012 – 28.11.2012

Locations of the mission: City of Struga, Crn Drim River Basin, City of Skopje, Republic of Macedonia

Mission team: The team that completed this mission, consisted of 2 GIZ Managers, 2 international experts and the local experts. Namely:

- Mr. Jakob Doetsch, GIZ
- Ms. Merita Mansaku- Meksi, GIZ
- Prof. Günter Meon, team leader International Experts
- Dr. Matthias Pätsch, specialist for data modeling and analysis, International Expert
- Vasko Stojov **,** Hydrometeorological Service of Macedonia (HMS)
- Toni Markoski, Director of this subsidiary , JSC Macedonian Power Plants Subsidiary HPP “Globochica”,
- Mr. Slavko Milevski, Technical monitoring and maintenance at dams and other civil objects Section Manager
- Mrs. Rada Avramovska, Head of sector for weather forecast (HMS)
- Mr. Josif Milevski, Head of sector of Hydrology (HMS)
- Mrs. Nina Aleksovska, Head of sector for meteorology (HMS)
- Mr. Dushko Petrovski, the Head of Sector for Operation and Coordination (CMC)
- Prof. Blinkov, Faculty of Forestry

Course of the mission:

Day TWO - Tuesday, November 27, 2012

Primary Focus: Introductions, National Experiences, existing devices, gaps and needs
Day Lead Facilitator: Vasko Stojov
Day contents & agenda focal point:

Who	Activity
Jakob Doetsch	Introduction of the Mission - an overview of the project and introduction of its goals and objectives, main components of the project cycle and expected outcomes and indicators of success
Prof Günter Meon	Introduction of the International Experts & Tasks
Vasko Stojov	Introduction of the Hydrometeorological Service of Macedonia
	Introduction to the hydrology, geology, meteorology of the Drin Basin in Macedonia
	comprehensive overview of the service and the general functions and problems related to gain data in Macedonia
Mr. Slavko Milevski, Toni Markoski	Mr. Slavko Milevski made an overview of the basic activities for monitoring dam in the catchment of Crn Drim River. He also explained that there are two major dams in the basin, dam Globocica and dam Spilje, both connected in the system that includes natural Ohrid Lake too.
Vasko Stojov	Visit of Ohrid Lake: output water of the lake enters into the channel of the Crn Drim River. Introduction with basic characteristics of the and Crn Drim catchment.
Vasko Stojov	Hydrological station Lozani on Crn Drim River - information about the situation and the problems of this station.
Vasko Stojov	Visit of dam Globocica and the road near Lukovo village, where due to overflow waters from the dam in 2010 a flood occurred
Vasko Stojov	HPP Globochica; artificial lake Spilje (Debarsko Lake); crown of the Spilje dam; HPP Spilje; HS Spilje equipped with limnigraph and automatic station which is provided by the project RIMSYS; Online data from this HS is available on the HMS web site.
Vasko Stojov	Visit of a couple of existing hydrometric stations (HS Boskov Most, HS Zirovnica, HS Volkovija-Ribnichka, HS Volkovija-Mavrovska) and existing meteorological stations (MS Mavrovo, at dam Mavrovo)

Day Three - Wednesday, November 28, 2012

Primary Focus: Field Visit existing devices, gaps and needs
Day Lead Facilitator: Vasko Stojov
Day contents & agenda focal point:

Who	Activity
Vasko Stojov, Rada Avramovska	Visit and Introduction of the Hydrometeorological Service of Macedonia, insight of the forecasters' activities and the equipment they use
Mr. Josif Milevski	Visit of the office with the system for automatic data collection (DEMAS) and its Internetmodule for automatic publishing on-line (www.meteo.gov.mk), as a main outcome of the RIMSYS project.
Mrs. Nina Aleksovska	meteorological monitoring
Mr. Dushko Petrovski	Presentation of the scope of the work and functioning of the CMC,
Prof. Blinkov	Presentation of RIMA DIMA project, and certain situations related to floods and risks; shared experiences among the team members and the professor

Pictures (all Vlasko Stojov):

wooden bulkhead gate at lake Ohrid, where output water of the lake enters into the channel of the Crn Drim River

Artificial lake Spilje (Debarsko Lake), lake and its surroundings

HS Volkovija-Ribnichka is located on the right side of the Radika river, close to the place where river Ribnichka joins river Nichpurska – not in operation due to war impacts

MS Mavrovo, meteorological station

The Black Drin at Debar

Narrative Summary of Working Visit - KOSOVO

Short-term national experts:

Counterpart:
Ministry of Environment and Spatial Planning
Institute for Hydrometeorology -Kosovo
Director: Prof Sylë Tahirsylaj, stahirsylaj@yahoo.com
Hydrogeologist: Hasan Hasani, hasan.hasani@rks-gov.net
Geographer: Bashkim Kastrati, bashkimkastrati@gmail.com

Zyrtar i lartë për monitorimin e Ujërave sipërfaqsor dhe nëntokësor
Ministria e Mjedisit dhe Planifikimit Hapësinor
Instituti Hidrometeorologjik i Kosovës (KHMI)
Tel: 044-477-726

Duration: 29.11.2012 – 30.11.2012

Locations of the mission: City of Pristina, White Drin River Basin, Kosovo

Mission team: The team that completed this mission, consisted of 2 GIZ Managers, 2 international experts and the 3 local experts. Namely:

- Mr. Jakob Doetsch, GIZ
- Ms. Merita Mansaku- Meksi, GIZ
- Prof. Günter Meon, team leader International Experts
- Dr. Matthias Päetsch, specialist for data modeling and analysis, International Expert
- Prof Sylë Tahirsylaj, Director of KHMI
- Hasan Hasani, KHMI
- Bashkim Kastrati, KHMI

Course of the mission:

Day Four - Thursday, November 29, 2012

Primary Focus: Introductions, National Experiences, existing devices, gaps and needs
Day Lead Facilitator: Prof Sylë Tahirsylaj
Day contents & agenda focal point:

Who	Activity
Jakob Doetsch	Introduction of the Mission - an overview of the project and introduction of its goals and objectives, main components of the project cycle and expected outcomes and indicators of success
Prof Günter Meon	Introduction of the International Experts & Tasks
Prof Sylë Tahirsylaj	Introduction of the KHMI (Tasks & Responsibilities)
	Introduction to the hydrology, geology, meteorology of the Drin Basin in Kosovo
	comprehensive overview of the service and the general functions and problems related to gain data in Kosovo
	overview of the basic activities for monitoring in the catchment
	presentation of the local weather station and the new air and water chemistry laboratories

Prof Sylë Tahirsylaj, Hasan Hasani, Bashkim Kastrati, KHMI	handed over documents with all exsisting hydrometric and meteorological stations in Kosovo, discussed the functionality of hydrometric & meteorological stations, identified those which are not working properly
Prof Günter Meon, Dr Matthias Pätsch	handed over forms to fill in by KHMI with all data from existing h&m stations for river Drin Basin in Kosovo – gap form of h&m data –
Prof Günter Meon, Dr Matthias Pätsch	answered different questions from the participants most part of which where about possibility to improve the existing - but malfunctioning equipement (hydrometric and meteorologic)
	Discussion about Country-Specific Outstanding Issues – like the propability of new dams in the Drin Basin; lack of historical data as effects of war; lack of staff for numerical hydrological model application; lack of financial resources for technical personnel and appropriate hydro-meteorological equipement

Day FIVE - Friday, November 30, 2012

Primary Focus: Field Visit existing devices, gaps and needs
Day Lead Facilitator: Prof Sylë Tahirsylaj
Day contents & agenda focal point:

Who	Activity
Mission Team	Tour into the river basin of the white Drin. We have got a very good oversight over the catchment, were introduced to some basic characteristics and visited different locations and gained impressions of several monitoring stations. Unfortunately most of them showed demolition some from former flood events others from effects of war or wanon destruction. Details regarding this situation will be published in the main report of the mission.
	Tour from Pristina – dir. Zaijm – dir. Kralan – dir.Rakovine (station Rakovine) – dir. Gjonaj (Station Gjonaj) – dir. Pluviometric weather station – dir. Pristina
Dr Pätsch & Hasan Hasani & Bashkim Kastrati, KHMI	Discussions about used hydrological and hydraulic numerical models;
Prof Meon & Hasan Hasani & Prof Tahirsylaj	Discussions about meteorological issues & numerical forecast models

Pictures:

River Drin : Bridge near Zajm

Destroyed hydrometric station at river Drin (near Kralan)

White Drin Gorge

River Drin at Bridge Gjonaj – Hydrometric Station (function ok, but no data since 2006)

(Foto: Kastrati)

River Drin at Gjonaj

Trip from Pristina to Podgorica

Day SIX - Saturday, December 1, 2012

Primary Focus: Trip to Montenegro
Track: Pristina – Kukes – Lezhe – Vau I Dejes – Podgorica

Pristina: Prizrenska Bistrica, a tributary of White Drin

Vermica: at the Drin Basin

Kukes:


Torrent from the mountains


River Drin

Vau Dejes dam & lake

Movable Weir at Spathar, Drin

Narrative Summary of Working Visit - MONTENEGRO

Short-term national experts:

Counterpart:

Ms Ivana Pavicevic
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Hydro-meteorological Institute of Montenegro
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Montenegro
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Duration: 02.12.2012 – 04.12.2012

Locations of the mission: City of Podgorica, Moraca River Basin and Lake Shkodra

Mission team: The team that completed this mission, consisted of 2 GIZ Managers, 2 international experts and the local experts. Namely:

- Mr. Jakob Doetsch, GIZ
- Ms. Merita Mansaku- Meksi, GIZ
- Prof. Günter Meon, team leader International Experts
- Dr. Matthias Päetsch, specialist for data modeling and analysis, International Expert
- Ms. Ivana Pavicevic (IHMS)
- Mr. Novak Darmanovic (IHMS)
- Zoran Jankovic – governement of Meontenegro - Directorate of Water
- Zoran Begovic – Deputy Minister – Ministry of Interior, Sector for Civil Protection and Emergency Management
- Luka Mitrovic – Director of Institute of Hydrometeorology and Seismology
- Mirjana Ivanov – Head of applied Meteorology

Course of the mission:

Day SEVEN - Sunday, December 2, 2012

Primary Focus: Introductions, National Experiences, existing devices, gaps and needs
Day Lead Facilitator: Ivana Pavicevic
Day contents & agenda focal point:

Who	Activity
Doetsch, Meon, Pätsch, Pavicevic, Darmanovic	First inspection of main tributaires to Lake Shkodra: River Moraca . Visit of the hydrometric station MOR-1; visit of the lake Shkodra

Day EIGHT - Monday, December 3, 2012

Primary Focus: Field Visit existing devices, gaps and needs
Day Lead Facilitator: Ivana Pavicevic
Day contents & agenda focal point:

Who	Activity
Jakob Doetsch	Visit of the office in Podgorica : Introduction of the Mission - an overview of the project and introduction of its goals and objectives, main components of the project cycle and expected outcomes and indicators of success
Prof Günter Meon	Introduction of the International Experts & Tasks
Ivana Pavicevic, Luka Mitrovic	Introduction of the IHMS (Tasks & Responsibilities)
Ivana Pavicevic, Zoran Jankovic	Visit in the office of Zoran Jankovic – Governement of Montenegro - Directorate of Water. **Duties of the Directorate of Water:** Governmantal Institution for Water Management for whole Montenegro; Preparation of experts basis for river management plans – by themselves or consultants → procedure is in the water dirctorate and due to lack of personnel they have to install consulting companies. Basically problem with communication, although they are trying to overcome. Cooperation with the albanian part : using the absolute from Napoli (Montenegro) Difference to Albanian Zero is 40 cm…. Same problem with Serbia. Emphasize on solving the problem with the same Zero Point – in case of working on one joint project. **There are DAMs planned in the Moraca Basin** : Stage of the Project (is in the idea process) : 4 Hydro Power plants (1 big dam 3 small ones) at the Moraca. They will be multipurpose: not only but also for low flow increasing and high flow decreasing – could be quite quick that they will be realised.
Zoran Begovic	Visit in the office of Zoran Begovic – Deputy Minister – Ministry of Interior, Sector for Civil Protection and Emergency Management
Ivana Pavicevic	Visit in the office of IHMS – Mission Debriefing

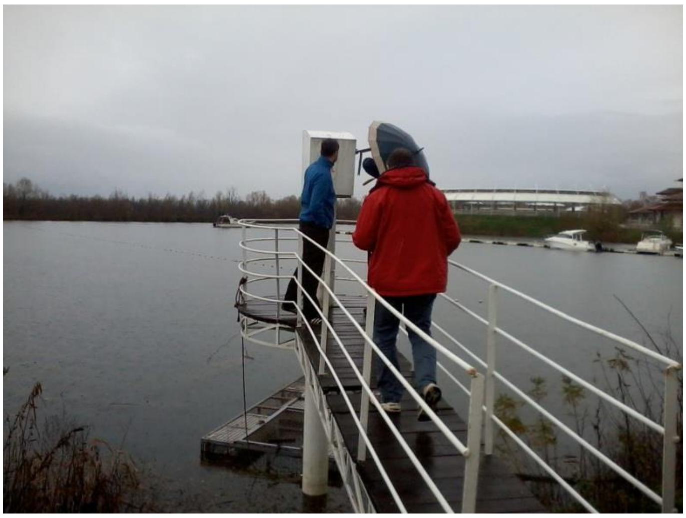
Day NINE - Tuesday, December 4, 2012

Primary Focus: Debriefing
Day Lead Facilitator: Ivana Pavicevic
Day contents & agenda focal point:

Who	Activity
Ivana Pavicevic & Mission Team	Discussion about the database issues (WISKI, EXCEL, HYDRAS, CliData); Issues about bathymetry data for the rivers Moraca & Bojana; Issues about numericalmodeling – snow melt inclusion; elevation data; enlarging of project area – inclusion of Moraca and Bojana River
Ivana Pavicevic	Visit in the office of IHMS – Mission Debriefing

Pictures:

Hydrometric Station at River Moraca MOR-1



Hydrometric Station at Lake Shkoder

Narrative Summary of Working Visit - ALBANIA

Short-term national experts:

Counterpart:

Prof. Petrit ZORBA
Head of the Department of Climate and Environment
IGJEUM
Tirana
ALBANIA
Mob Phone: 00355682151684

Duration: 04.12.2012 – 06.12.2012

Locations of the mission: Lake Shkoder area, Shkodra, Tirana

Mission team: The team that completed this mission, consisted of 2 GIZ Managers, 2 international experts and the local experts. Namely:

- Mr. Jakob Doetsch, GIZ
- Ms. Merita Mansaku- Meksi, GIZ
- Prof. Günter Meon, team leader International Experts
- Dr. Matthias Päetsch, specialist for data modeling and analysis, International Expert
- Prof Petrit Zorba, IGJEUM
- Elona Abazi , IGJEUM
- Goran Sekulic, IGJEUM

Course of the mission:

Day NINE - Tuesday, December 4, 2012

Primary Focus: Field Visit existing devices, gaps and needs
Day Lead Facilitator: Prof Petrit Zorba
Day contents & agenda focal point:

Who	Activity
Petrit Zorba	Meeting with Prof Zorba in Shkodra, clarification of special situation in the environment Lake Shkoder, Drin River, Bojana River
	Visit of Lake Shkoder environment, former hydrometric stations (destroyed by flood in 2010)
	Visit of meteorological station Shkoder / mountain station & Meteorological Station in Shkoder

Day TEN - Wednesday, December 5, 2012

Primary Focus: Introductions, National Experiences, existing devices, gaps and needs
Day Lead Facilitator: Prof Petrit Zorba
Day contents & agenda focal point:

Who	Activity
Petrit Zorba	1st Introduction of the Department of Climate and Environment
Jakob Doetsch	Introduction of the Mission - an overview of the project and introduction of its goals and objectives, main components of the project cycle and expected outcomes and indicators of success
Prof Günter Meon	Introduction of the International Experts & Tasks
	Introduction to the hydrology, geology, meteorology of the Drin Basin in Albania
	comprehensive overview of the service and the general functions and problems related to gain data in Albania
	overview of the basic activities for monitoring in the catchment
	Discussion about Country-Specific Outstanding Issues – like the propability of new dams / management of existing dams in the Drin Basin; lack of financial resources for technical personnel and appropriate hydro-meteorological equipement
Petrit Zorba	Visit of the National Centre for Forecast and Monitoring of National Risks
Dr Pätsch & Elona Abazi & Goran Sekulic	Discussions about used hydrological and hydraulic numerical models;
Prof Meon & Prof Zorba	Discussions about meteorological issues & numerical forecast models

Pictures:

Meteorologic Station at Lake Shkoder

Meteorologic Station, Vicinity of Lake Shkoder

Narrative Summary of Working Visit – ALBANIA / GIZ

Short-term national experts:

Counterpart:

GIZ

Duration: 06.12.2012 – 06.12.2012

Locations of the mission: Tirana, Office GIZ

Mission team: The team that completed this mission, consisted of 4 GIZ Managers, 2 international experts Namely:

- Mr. Hermann Plumm, GIZ
- Mr. Jakob Doetsch, GIZ
- Ms. Merita Mansaku- Meksi, GIZ
- Ms. Kocu, GIZ
- Prof. Günter Meon, team leader International Experts
- Dr. Matthias Päetsch, specialist for data modeling and analysis, International Expert

Day ELEVEN - Thursday, December 6, 2012

Primary Focus: Mission Debriefing
Day Lead Facilitator: Prof Günter Meon
Day contents & agenda focal point:

Who	Activity
Mr Plumm / Mr Doetsch	Introduction to the mission regarding the importance of flood protection
Prof Günter Meon	Introduction of the International Experts & Tasks
Meon / Pätsch	Presentation of the the up to date evaluation of the specific issues in the 4 countries regarding Meteo-Data & Transmission, hydraulic & hydrological data & transmission, database, nzmerical meteo-forecast, modeling (hydrological & hydraulic), flood forecast & flood warnings
Team	Discussion about specific issues in the 4 countries & about further action and appointments
Meon / Pätsch	Flight back to Germany

ANNEX

Annex 2:

Main questionnaire developed by International Experts for

National Experets

21 Dec. 2012

Prof. Dr.-Ing. Günter Meon and Dr.-Ing. Matthias Pätsch

Final questionaire to the national Consultants of EWS „Drin river basin“

Dear collegues, thanks for the answers we already got from the interviews and from documents or presentations delivered to us via Email. We noticed that some of the information is not sufficient or contradictionary. In order to systematically structure our report, we prepared the following questionnaire. Please answer the questions in detail and assign – once more – exact information, graphs or data. We apologize for occasional double work.

1. Please make a list of available relevant documents, reports and presentations on the Drin river basin and vicinities; if not yet done, please transmit these documents to GIZ and us via Email; Please include information about historical floods.

2. Please deliver an organizational chart of your organization and other involved institutions of your country; please include number of staff, branch and education as follows:

Number of staff

Branch / responsibility	**Field and education**					**TOTAL**
	Technicians	**Meteorologists**	**Hydrologists**	**Engineers**	**Others**	
Observation network						
Data management						
Weather modeling & forecasting						
Hydrological modeling & forecasting						
Hydraulic modeling & forecasting						
R & D (Research & Development)						
IT personnel						
Others						
TOTAL						

3. Inventory of hydrometeorological stations, data series, data transmission, data bases, data quality with regard to DRIN RIVER BASIN

3.1 Existing **hydrological** (=hydrometric) stations in the Drin river basin and vicinity:

3.1.1 Inventory of all types of existing hydrological stations **(please fill in table given in annex 1)**

3.1.2 Histogram according to given example for discharge and water level data **(please create a table according to the example file which we sent you some time ago; if not yet done, please use the Excel format given in annex 2)**

3.2 Existing meteorological stations in the Drin river basin and vicinity:

3.2.1 Inventory of all types of existing meteorological stations **(please fill in table given in annex 3)**

3.2.2 Histogram according to given example for meteorological data **(please create a table according to the example file which we sent you some time ago; if not yet done, please use the Excel format given in annex 4)**

3.3 Storing and transmission of data (data acquisition and communication): please fill out the following tables:

Computer capacity in use for data storing & management

Server/Workstation/PC	Characteristics	Disk space	Security

Equipment in use for data communication and warnings

Telecommunication Equipment	**To receive data**	**To send data**	**To send warnings**	**To send products**
Telephone / Mobile Phone / Telefax				
Data Collection Platforms used				
Global Telecommunication system (WMO-GTS)				
Internet				
Email				
Post/mail				
Print media				
TV				
Radio				
Bulletins				
Other: (name and description)				

3.4 Past and existing data bases

Types of data base	Period	Comments (e.g. availability, utilization, etc.)
Atmospheric domain		
e.g. access data base	From dd.mm.yyyy until dd.mm.yyyy	
Excel data base	From dd.mm.yyyy until dd.mm.yyyy	
WISKI data base	From dd.mm.yyyy until dd.mm.yyyy	
Paper documents	From dd.mm.yyyy until dd.mm.yyyy	
Other (please name & specify)	From dd.mm.yyyy until dd.mm.yyyy	
Hydrological / hydraulic domain		
e.g. access data base	From dd.mm.yyyy until dd.mm.yyyy	
Excel data base	From dd.mm.yyyy until dd.mm.yyyy	
WISKI data base	From dd.mm.yyyy until dd.mm.yyyy	
Paper documents	From From dd.mm.yyyy until dd.mm.yyyy	
Other (please name & specify) specify)	From dd.mm.yyyy until dd.mm.yyyy	

3.5 Data quality – overall assessment (qualitatively):

- please send us 2 series of meteo data (key stations, daily values) and 2 series of hydrological data (key stations, daily values) for a first check by the Consultant
- Please make a clear statement
  - Whether the existing data quality is, in total, suitable to be used instantly in an existing forecast model (like EFAS)
  - whether the historic data quality it is suitable for a historical calibration of a planning model for the Drin River Basin
  - whether a comprehensive data quality check of all past data is required

4. Gaps and needs with regard to the Drin Basin located in your country

4.1 Overall evaluation of existing situation: number and equipment of stations

4.2 Overall evaluation of data transmission, data bases and available data series (data quantity and quality)

4.3 Specification of needs for a local **Drin data base system** as a prerequisite for the comprehensive Drin EWS:

- Meteorological stations
- Hydrological stations
- Other measuring equipment (for rating curves, bathymetry, etc)
- Hardware including transmission facilities
- Software

The answer of question 4.3 should be put into a list as follows:

Ranked needs for a local Drin water information system: Please answer according to the the following example table:

Priority	Description
1	*Meteorological station at location a, equipment, online station, data transmission via….*
2	*Hydrometric station at location b; equipment: ….; including rainfall recorder; online station, data transmission via …*
3	*Hydrometric station at location c, equipment: …., online station, data transmission via….*
4	*ADCP for ….*
5	*Hardware: xyz PCs, monitors, printer…. backup system*
6	*Meteorological station at location d, equipment, online station, data transmission via….*
7	*Rainfall station at location e; equipment; including snowpack measurement facilities, online, data transmission via*
8	*Software xyz for data base system*
…	*Etc.*

5. Inventory of existing modeling components

Existing meteorological, hydrological and hydraulic modeling at the hydrometeorological services of your country:

- Numerical precipitation forecast
- Hydrological modeling (for design/planning purposes or for flow forecast?)
- Hydraulic modeling (for design/planning purposes or for water level forecast?)

In case of available models: are these models continuously used by trained experts?

Models already in use for operational purposes (not for design/planning purposes)

Type of existing forecast	**Name of the model**	Covered area	Spatial resolution	Temporal resolution	**Data Assimilation**	**Times/day**
Meteorological						
Weather						
Numerical precipitation						
Hydrological (for water quantities)						
Continuous operation						
Operation for floods						
Operation for flash floods						
Hydraulic (for water levels, inundation areas)						
Continuous operation						
Operation for floods						
Operation for flash floods						

6. Specifications of needs related to modeling

- Hardware
- Software

Needs with regard to modeling (example)

Priority	
1	*High performance computer: 2*
2	*hydrologic modeling software:….*
3	*hydraulic modeling software: ….*
…	…

7. Work flow and channels for warnings

Please describe very precisely and explicitely the work flow and channels for warnings with regard to flooding and weather forecast. What is the status regarding to:

- Equipment
- Procedure
- Data and exchange format with local and regional institutions

8. Flood vulnerability of river basins outside Drin Basin

Information on historical flood events in the Drin Basin and other regions of the country, see example table.

If available: attach a map showing relevant flood areas in your country

Impacts of major floods

Event	River basin / Location	Impacts
Flood of		EXAMPLE: xx ha agricultural land flooded Huge damages in flood infrastructure, road infrastructure,
Flood of		
Flood of		

ANNEX

Annex 3:

Contributions from Macedonia

Annex A 3.1 – Hydrometric Stations Macedonia 1 / 2

Hydro stations	Location	Location	Type	Operational period(s)	Rating curve available	No. of parameters measured	Which parameters	Transmission of data	Actual State of station	Suggested improvement with regard to EWS
	Latitude ° ' "	Longitude ° ' "					use flag *		use flag **	use flag ***
Brajcino	40° 54' 04"	21° 09' 30"	WL	Since 1964 - now	yes, but need update	3	1, 2 ,3	manual lists (via post)	+	3,4,5
Krani	40° 56' 43"	21° 07' 02"	WL	no exact info	no RC	1	2,	no observer	-	1,3,5
Resen	41° 05' 00"	21° 01' 06"	WL	since 1947 - now	old, need update	3	1,2,3	manual lists (via post)	0	4,
Leva Reka	41° 09' 55"	21° 00' 50"	WL	no exact info,1995-now	yes, but need update	3	1,2,3	manual lists (via post)	+	1,3,
Nakolec	40° 53' 28"	21° 06' 28"	WL	since 1954 - now	lake	2	1,3	manual lists (via post)	+	1,
Asamati	40° 59' 08"	21° 03' 15"	WL	since 1948-2003	lake			no observer	--	0,
Stenje	40° 57' 02"	20° 54' 24"	WL	since 1935 - now	lake	2	1,3	manual lists (via post)	+	1,3,4,5
Sveti Naum(Izvor)	40° 54' 54"	20° 44' 01"	WL	since 1950-2003	no RC	1	2,	no observer	0	1,3,4,5
Ljubanista	40° 53' 35"	20° 45' 47"	WL	no exact info	no RC	1	2,	no observer	-	1,3
Kosel	41° 10' 24"	20° 50' 29"	WL	since 1961 - now	yes	2	1,2	manual lists (via post)	+	3,4
Botun	41° 16' 39"	20° 47' 13"	WL	since 1948 - now	yes	4	1,2,3,6	manual lists (via post)	+	3,4,5
Sveti Naum(Ohrid Lake)	40° 54' 54"	20° 44' 45"	WL	since 1946-2006	lake			no observer	--	1,3,
Pestani	41° 01' 03'	20° 48' 55"	WL	since1945-2003	lake			no observer	-	0,
Ohrid	41° 06' 42"	20° 48' 21"	WL	since 1924 - now	lake	2	1,3	manual lists (via post)	+	3,4,5
Kalista	41° 08' 40"	20° 39' 22"	WL	no exact info	lake			no observer	--	0,

LEGEND

Flags

*

1	water level
2	discharge
3	water temperature
4	water quality data
5	rainfall (in addition)
6	
7	
8	
9	

**

-- / - / 0 / + / ++

***

1	renew at same location
2	renew at different location
3	upgrade to automatically working station - data logger
4	uprade to online station
5	add online rainfall recorder

WL = Water Level

Q = Discharge

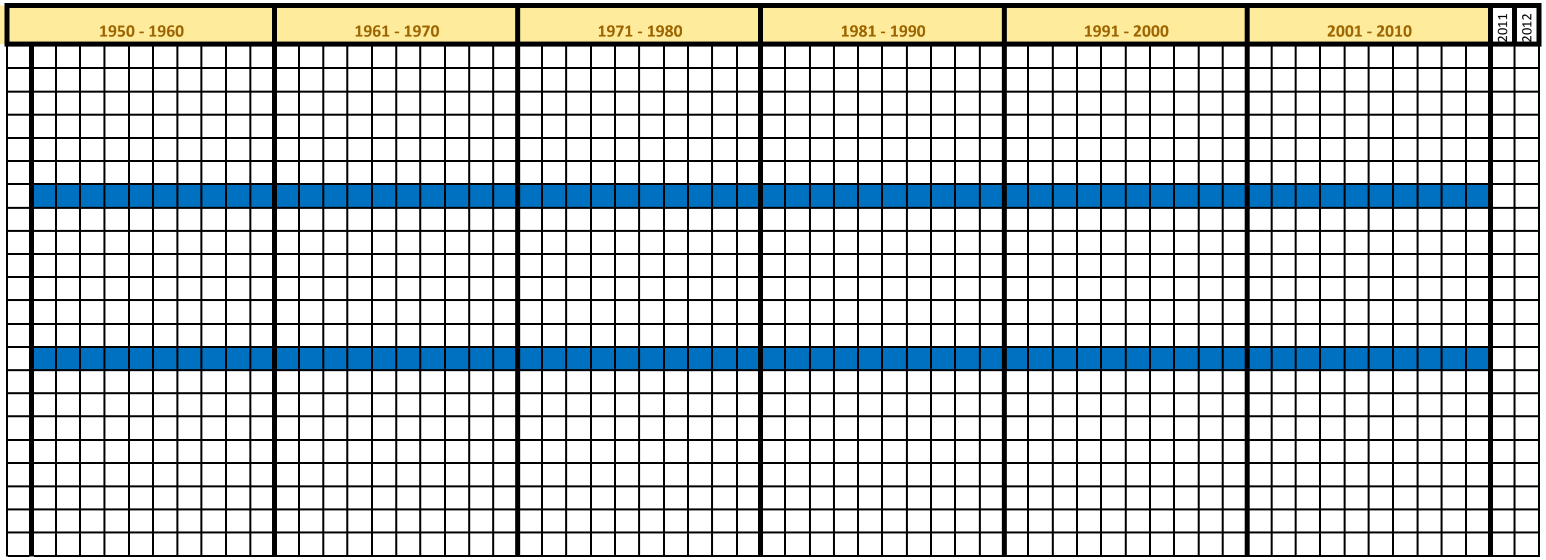
Annex A 3.1 – Hydrometric Stations Macedonia 2 / 2

Hydro stations	Location	Location	Type	Operational period(s)	Rating curve available	No. of parameters measured	Which parameters	Transmission of data	Actual State of station	Suggested improvement with regard to EWS
	Latitude ° ' "	**Longitude** ° ' "					**use flag** *		**use flag** **	**use flag** ***
Lozani	41° 13' 24"	20° 40' 26"	WL	no exact info,1978-now	yes, but need update	2	1,2	manual lists (via post)	-	1,3,4,5
HE Spilje	41° 29' 06"	20° 30' 05"	WL	since 1953 - now	yes, but need update	2	1,3	no observer	0	1,5
Boskov Most	41° 32' 46"	20° 36' 15"	WL	since 1958-2010	yes, but it is old	4	1,2,3,6	manual lists (via post)	--	2,3,4,5
Volkovija(Nicpurska)	41° 43' 19"	20° 40' 23"	WL	since 1946-1987	no RC			no observer	-	1,3,4,5
Volkovija(Mavrovska)	41° 43' 15"	20° 40' 38"	WL	since 1947-1987	no RC			no observer	-	1,3
Volkovija(Ribnicka)	41° 42' 30"	20° 39' 19"	WL	since 1952-2003	yes, but need update			no observer	-	1,3,4,5
Elenskok	41° 32' 59"	20° 37' 23"	WL	since 1960 - now	yes, but need update	2	1,2	no observer	0	2,3,4,5
Zirovnica	41° 39' 52"	25° 35' 58"	WL	not operational	no RC			no observer	-	2,3,4,5

AVAILABLE ON DATABASE - PC

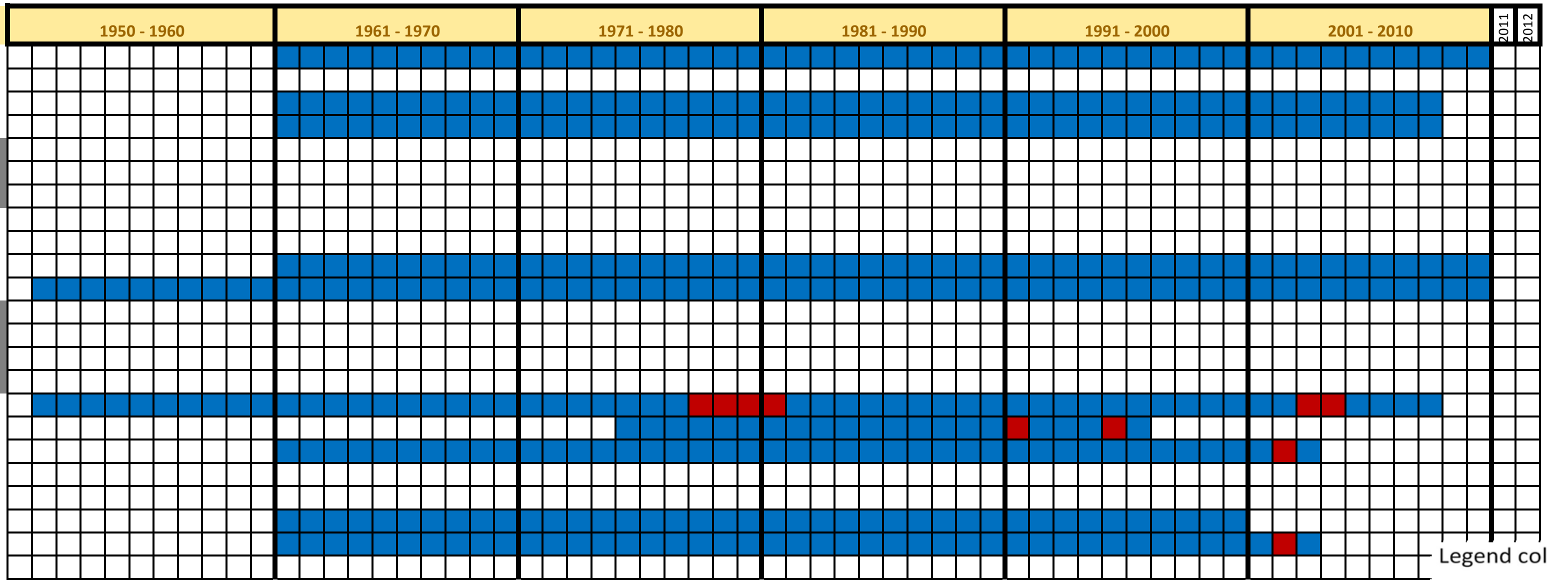
HISTOGRAM WATER LEVEL

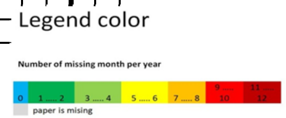
Code	Station
60555	Brajcino
60565	Krani
60575	Resen
60578	Leva Reka
60512	Nakolec
60514	Asamati
60516	Stenje
60010	Sveti Naum
60605	Ljubanista
60705	Kosel
60805	Botun
60012	Sveti Naum
60014	Pestani
60016	Ohrid
60018	Kalista
60020	Lozani
60030	Spilje
60909	Boskov Most
60905	Volkovija
60925	Volkovija
60965	Volkovija
60945	Elenskok
60955	Zarnica



HISTOGRAM DISCHARGE

Code	Station
60555	Brajcino
60565	Krani
60575	Resen
60578	Leva Reka
60512	Nakolec
60514	Asamati
60516	Stenje
60010	Sveti Naum
60605	Ljubanista
60705	Kosel
60805	Botun
60012	Sveti Naum
60014	Pestani
60016	Ohrid
60018	Kalista
60020	Lozani
60030	Spilje
60909	Boskov Most
60905	Volkovija
60925	Volkovija
60965	Volkovija
60945	Elenskok
60955	Zarnica



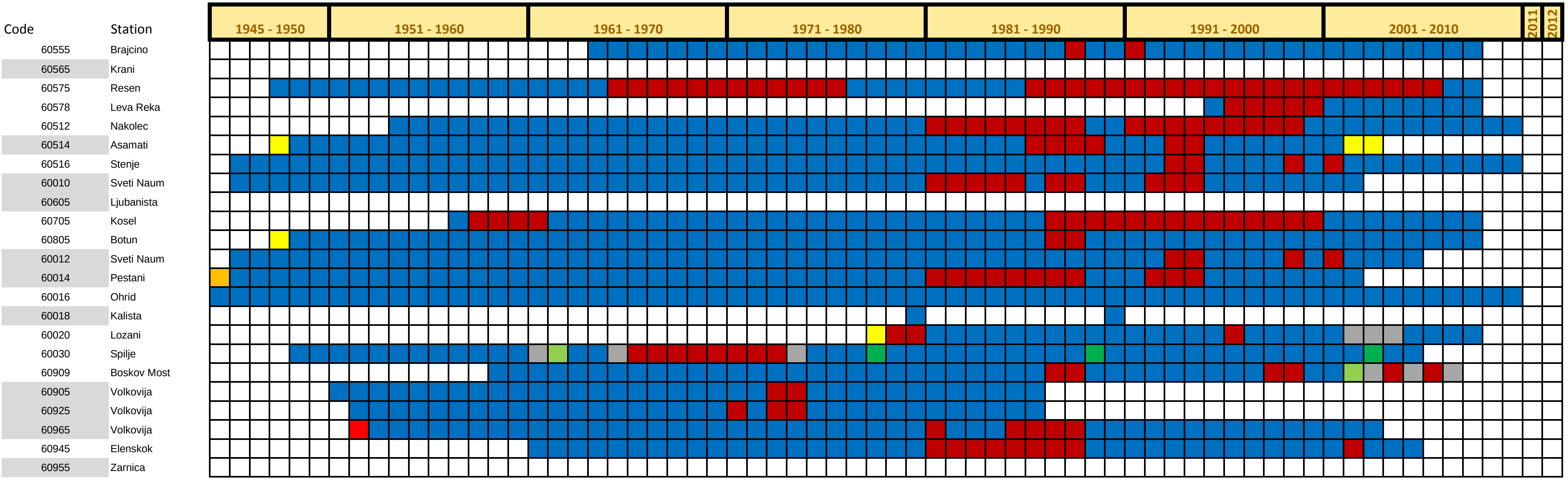


not operational

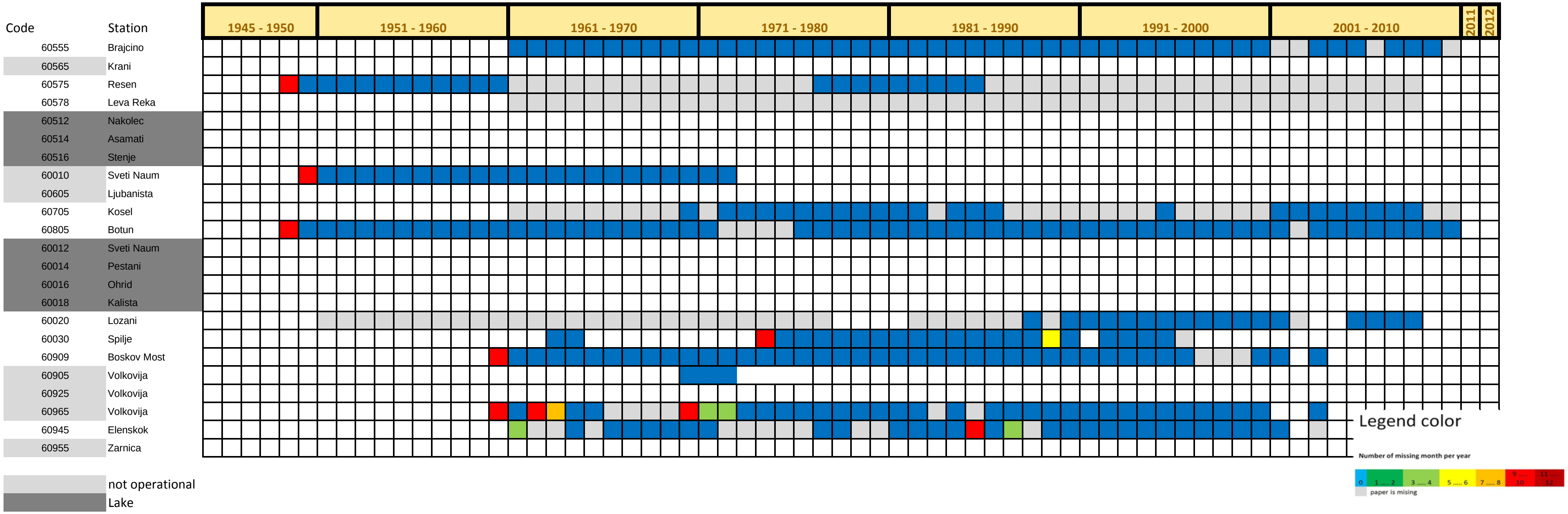
Lake

AVAILABLE ON DATABASE - PAPER

HISTOGRAM WATER LEVEL



HISTOGRAM DISCHARGE



Annex A 3.3 – Meteorologic Stations Macedonia 1 / 2

Meteo stations	Location	Location	Type	Operational period(s)	No. of parameters measured	Which parameters	Transmission of data	Actual State of station	Suggested improvement with regard to EWS
	Latitude ° ' "	Longitude ° ' "				use flag *		use flag **	use flag ***
Nakolec	40.900	21.117	P	1945-now	1	3	post	+	3
Brajcino	40.900	21.167	P	1951-now	1	3	post	+	3,4
Sveti Naum	40.917	20.750	P	1946-now	1	3	post	-	3
Stenje	40.950	20.900	P	1953-now	1	3	post	+	3
Asamati	40.983	21.050	P	1948-now	1	3	post	+	3
Pestani	41.017	20.817	P	1951-now	1	3	post	+	3
Pokrvenik	41.033	20.950	P	1951-now	1	3	post	+	3
Carev Dvor	41.050	21.017	P	1948-now	1	3	post	+	3
Resen	41.083	21.017	P	1946-1993	1	3	post	+	3
Izbishte	41.133	21.000	P	1947-now	1	3	post	+	3
Radolishte	41.167	20.617	P	1952-now	1	3	post	+	3
Openica	41.183	20.883	P	1947-now	1	3	post	+	3
Mesheishta	41.233	20.783	P	1955-now	1	3	post	+	3
Vevcani	41.233	20.600	P	1947-now	1	3	post	+	3,4
Kuratica	41.250	20.900	P	1953-now	1	3	post	+	3
Boroec	41.283	20.600	P	1947-now	1	3	post	+	3
Belcishte	41.300	20.833	P	1946-now	1	3	post	+	3
Struga	41.333	20.683	P	1945-2012	1	3	post	-	3
Izvor Kicevski	41.350	20.833	P	1952-now	1	3	post	+	3
Lukovo	41.367	20.600	P	1964-now	1	3	post	+	3
Slivovo	41.400	20.850	P	1949-now	1	3	post	+	3
Kogjagjik	41.433	20.617	P	1956-now	1	3	post	+	3

LEGEND

Flags

*

1	wind
2	temperature
3	precipitation
4	snow depth
5	radiation
6	sunshine duration
7	relative humidity
8	evaporation
9	ground Temperature

**

-- / - / 0 / + / ++

***

1	renew at same location
2	renew at different location
3	upgrade to automatically working station - data logger
4	uprade to online station
5	etc...

T - thermometric

P - pluviometric

C- climatic

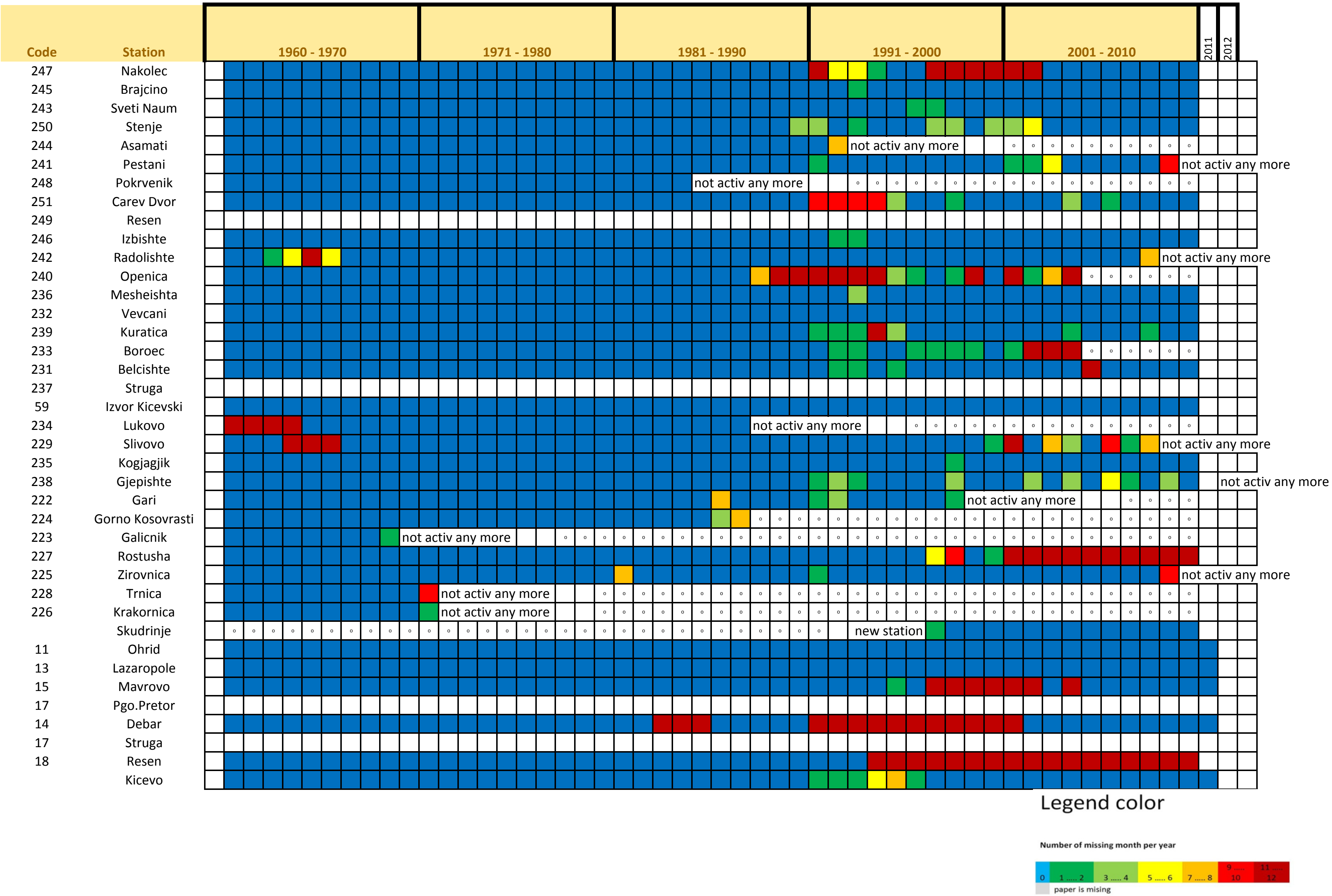
M - main automatic

Annex A 3.3 – Meteorologic Stations Macedonia 2 / 2

Meteo stations	Location	Location	Type	Operational period(s)	No. of parameters measured	Which parameters	Transmission of data	Actual State of station	Suggested improvement with regard to EWS
	Latitude ° ' "	Longitude ° ' "				use flag *		use flag **	use flag ***
Gjepishte	41.433	20.533	P	1945-now	1	3	post	+	3
Gari	41.500	20.683	P	1947-now	1	3	post	+	3
Gor.Kosovrasti	41.533	20.583	P	1951-now	1	3	post	+	3
Galicnik	41.600	20.650	P	1947-now	1	3	post	+	3,4
Rostusha	41.617	20.600	P	1946-now	1	3	post	+	3
Zirovnica	41.667	20.600	P	1951-now	1	3	post	+	3
Trnica	41.717	20.700	P	1946-now	1	3	post	+	3
Krakornica	41.750	20.700	P	1952-now	1	3	post	+	3
Skudrinje	n/a	n/a	P	1997-now	3	3	post	+	3
Ohrid	41°07'	20°48'	C	1945-now	7	1,2,3,4, 5,6,7	internet/post	++ (AS ++)	Automatic Since 2011
Lazaropole	41°32'	20°42'	C	1948-now	7	1,2,3,4, 5,6,7	internet/post	++	3,4
Mavrovo	41°42'	20°45'	C	1946-now	8	1,2,3,4, 5,6,7,8	internet/post	++	3,4
Pgo.Pretor	40°51'	21°04'	C	1981-now	8	1,2,3,4, 5,6,7,8	internet/post	+	3,4
Debar	41°31'	20°32'	C	1946-now	3	1,2,3	telephone/post	+	3,4
Struga	41°11'	20°41'	C	1945-2012	3	1,2,3	-	--	3,4
Resen	41°05'	21°01'	C	1946-1993	3	1,2,3	-	-- (AS ++)	Automatic Since 2010

Meteorologic Stations

Histogram Rainfall



ANNEX

Annex 4:

Contributions from Kosovo

Annex A 4.1 – Hydrometric Stations Kosovo 1 / 2

Hydro stations	Location	Location	Type	Operational period(s)	Rating curve available	No. of parameters measured	Which parameters	Transmission of data	Actual State of station	Suggested improve-ment with regard to EWS
	Latitude ° ' "	Longitude ° ' "					use flag *		use flag **	use flag ***
Drelaj	x	y	WL	1961-1986: 2003-2011	yes, developed	3	1,2 ,4	logger (once/month)	+	1
Gryk e Rugoves	x	y	WL	1963-1997:2003-2012 now	yes, developed	2	1,2,4	logger (once/month)	+	--
Deqan	x	y	WL	1952-1997	likely	3	1,2,4	logger (once/month)	+	2
Gjonaj	x	y	WL	1967-1997:2004-2006	likely	4	1,2,3,4	logger (once/month)	0	1
Kepuz	x	y	WL	1952-1997	likely	3	1,2,4	logger (once/month)	-	2
Krajk			WL	1980-1997	no	2	1,3	no active	0	-
Verbnic			WL	1949-1986	likely	3	1,2,4	no active	-	-
Gjakove	x	y	WL	1957-1998: 2006-2012 now	likely	2	1,4	logger (once/month)	+	1
Kline	x	y	WL	1957-1998:2006-2008	likely	2	1,4	logger (once/month)	0	1
Mirushe	x	y	WL	1969-1997:2006-2010	no	3	1,2	logger (once/month)	0	1
Orqush			WL	1963-1997	no	1	1	no active	-	-
Piran	x	y	WL	1966-1987:2006-2008	no	1	1	logger (once/month)	0	2
Vllashnje	x	y	WL	1985-1986:2003-2011	no	2	1,4	logger (once/month)	+	1
Mlikë	x	y	WL	1962-1999:2003-2012 now	no	2	1,2	logger (once/month)	+	--
Radavc			WL	1952-1979	yes, developed	1	1	no active	-	-

LEGEND

Flags

*

1	WL
2	discharge
3	water temperature
4	water quality data
5	rainfall (in addition)
6	
7	
8	
9	

**

-- / - / 0 / + / ++

***

1	renew at same location
2	renew at different location
3	upgrade to automatically working station - data logger
4	uprade to online station
5	add online rainfall recorder

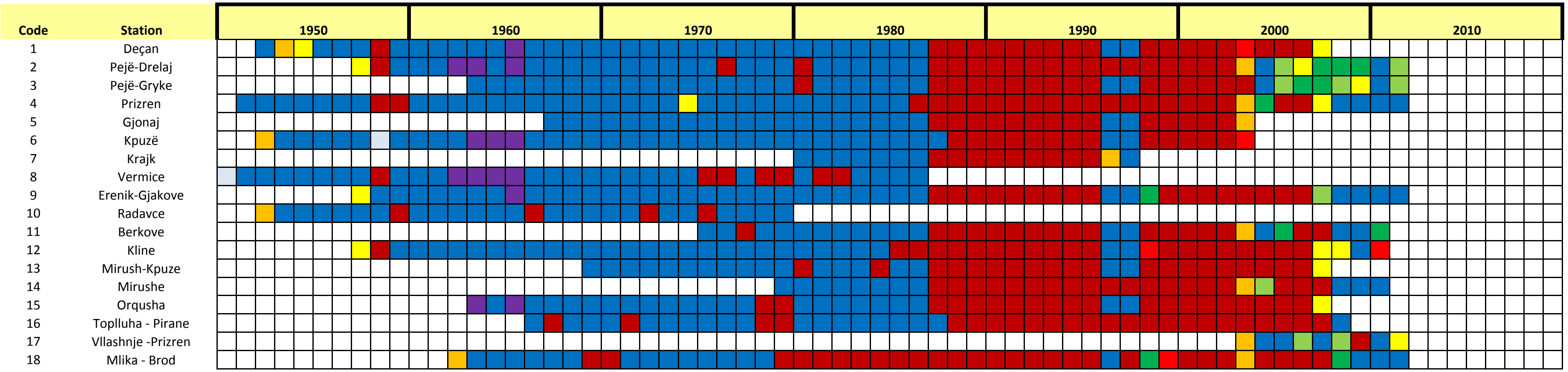
WL = WL

Q = Discharge

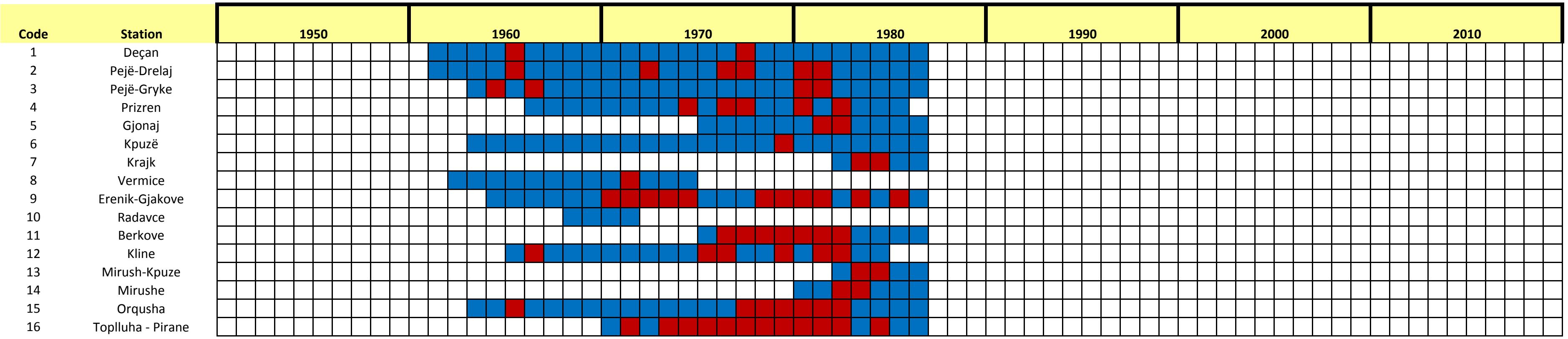
Annex A 4.1 – Hydrometric Stations Kosovo 2 / 2

Hydro stations	Location	Location	Type	Operational period(s)	Rating curve available	No. of parameters measured	Which parameters	Transmission of data	Actual State of station	Suggested improvement with regard to EWS
	Latitude ° ' "	**Longitude ° ' "**					**use flag ***		**use flag ****	**use flag *****
Bërkov	x	y	WL	1975-1997: 2006-2007	no	1	1	logger (once/month)	0	2
Prizren	x	y	WL	1951-1985:2003-2012 now	yes, developed	3	1,2,4	logger (once/month)	++	1
Ura Terezive			WL	1954-1960	no	2	1,4	no active	-	

HISTOGRAM WATER LEVEL



HISTOGRAM DISCHARGE



Annex A 4.3 – Meteorological Stations Kosovo 1 / 1

Hydro stations	Location	Location	Type	Operational period(s)	No. of parameters measured	Which parameters	Transmission of data	Actual State of station	Suggested improvement with regard to EWS
	Latitude ° ' "	Longitude ° ' "				use flag *		use flag **	use flag ***
Pejë	42.66.56	20.30.5	C	2002	6	1,2,3,4,5,6	manual reading	1	4

LEGEND

Flags

*

1	wind
2	temperature
3	precipitation
4	snow depth
5	radiation
6	sunshine duration
7	relative humidity
8	evaporation
9	ground Temperature

**

-- / - / 0 / + / ++

***

1	renew at same location
2	renew at different location
3	upgrade to automatically working station - data logger
4	uprade to online station
5	etc...

T - thermometric

P - pluviometric

C- climatic

M - main automatic

Code	Station	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
	Pejë										

Legend color

Number of missing month per year

0	1 2	3 4	5 6	7 8	9 10	11 12

paper is mising

ANNEX

Annex 5:

Contributions from Montenegro

Annex A 5.1 – Hydrometric Stations Montenegro 1 / 1

Hydro stations	Location	Location	Type	Operational period(s)	Rating curve available	No. of parameters measured	Which parameters	Transmission of data	Actual State of station	Suggested improvement with regard to EWS
	Latitude ° ' "	Longitude ° ' "					use flag *		use flag **	use flag ***
Plavnica	42 16 17	19 11 45	WL	1948 - 2012		1	1	on line	+	add online rainfall recorder
Ckla	42 05 05	19 22 54	WL	1950 - 2002, 2008-2012	no	1	1	on line	+	add water temperature
Podgorica	42 27 05	19 15 58	WL	1948 - 2012	yes, developed	3	1,2,3	on line	+	---
			Q	1948 - 2012	in 1948 to 2012					
Zlatica	42 29 07	19 18 04	WL	1983 - 2012	yes, developed	2	1,2	on line	+	
			Q	1983-2002	in 1983 to 2002					
Pernica	42 42 58	19 22 27	WL	1956 - 2012	yes, developed	2	1,2	on line	+	
			Q	1956 - 2012	in 1956 to 2012					
Fraskanjel	41 58 15	19 23 17	WL	1960 - 2012	no	2	1,3	on line	+	Acoustic Doppler Current profiler (ADCP)
Brodska Njiva	42 21 21	19 01 15	WL	1987 - 2004	yes, developed	2	1,2	on line	+	
			Q	1987 - 2004	in 1987 to 2004					
Duklov most	42 47 35	18 56 26	WL	1955 - 2012	yes, developed	2	1,2	on line	+	
			Q	1955 - 2012	in 1955 to 2012					
Medjurjecje / Mrtvica	42 43 32	19 22 02	WL	1948 - 2012	yes, developed	2	1,2	on line	+	
			Q	1948 - 2012	in 1948 to 2012					

LEGEND

Flags

*

1	water level
2	discharge
3	water temperature
4	water quality data
5	rainfall (in addition)
6	
7	
8	
9	

**

-- / - / 0 / + / ++

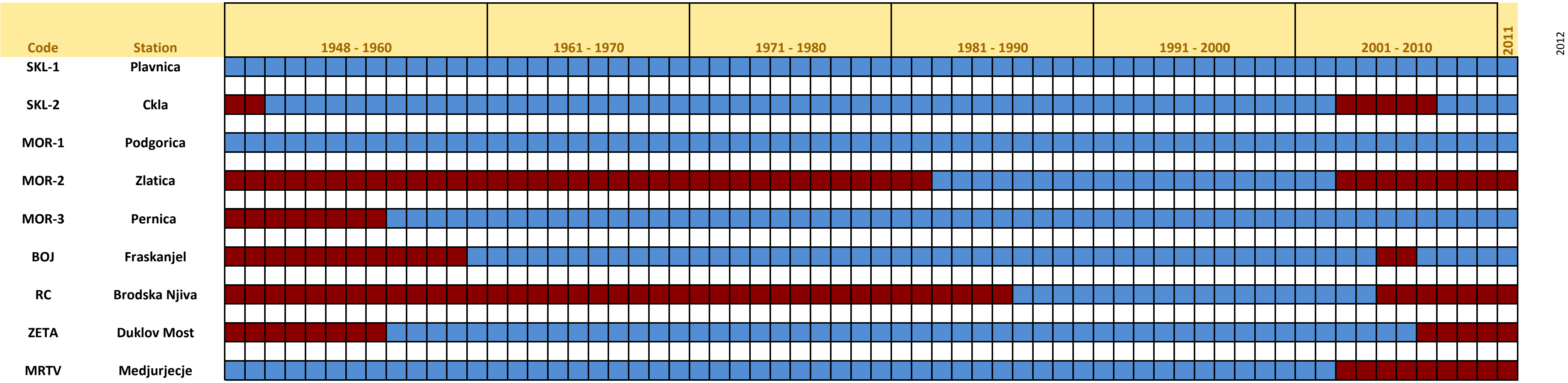
***

1	renew at same location
2	renew at different location
3	upgrade to automatically working station - data logger
4	uprade to online station
5	etc…

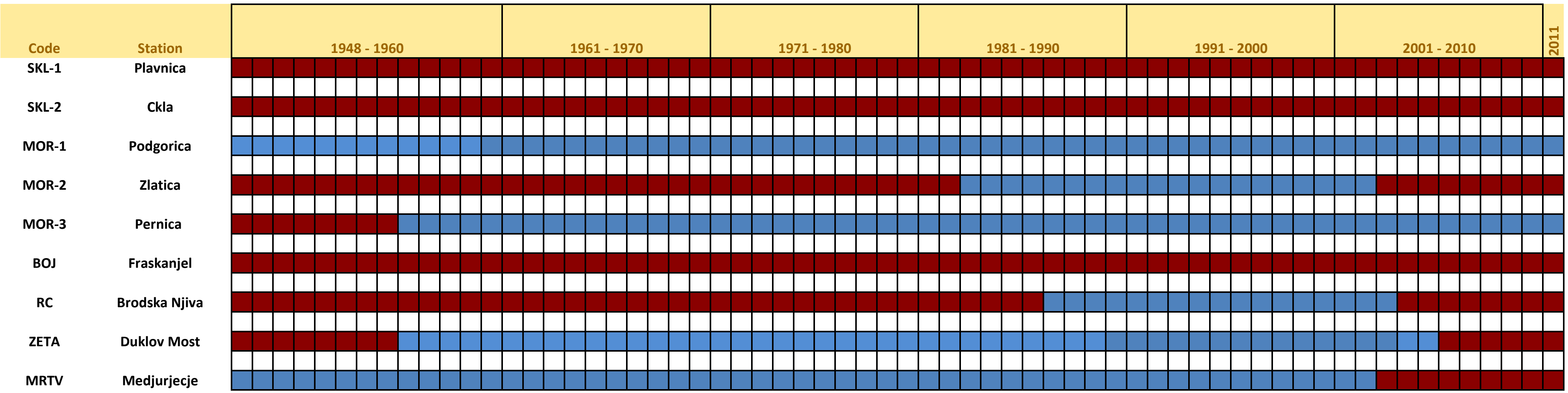
WL = Water Level

Q = Discharge

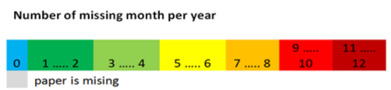
HISTOGRAM WATER LEVEL



HISTOGRAM DISCHARGE



Legend color



Annex A 5.3 – Meteorological Stations Montenegro 1 / 1

Hydro stations	Location	Location	Type	Operational period(s)	No. of parameters measured	Which parameters	Transmission of data	Actual State of station	Suggested improvement with regard to EWS
	Latitude ° ' "	Longitude ° ' "				use flag *		use flag **	use flag ***
Virpazar	42 14	19 05	C	1951 -	3	2,3,4,	data logger (every 4 h. read out)	0	1
Ostros	42 05	19 20	P	1948 -	2	3,4	manual	--	3
Sveti Nikola	41 53	19 23	P	1948 -	2	3,4	manual	--	3
Bioce	42 31	19 21	P	1956 -	2	3,4	manual	--	3
Pelev brijeg	42 35	19 24	P	1946 -	2	3,4	manual	--	3
Andrijevo	42 42	19 22	P	1951 -	2	3,4	manual	--	3
Manastir Moraca	42 46	19 24	P	1934 -	2	3,4	manual	--	3
Dragovica Polje	42 51	19 20	P	1946 -	2	3,4	manual	--	3
Podgorica	42 26	19 17	M	1917 -	8	1,2,3,4,5 ,6,7,9	online station (2005)	0	1
Danilovgrad	42 33	19 06	C	1955 -	3	2,3,4,	data logger (every 4 h. read out)	0	1
Cevo	42 32	18 55	P	1952 -	2	3,4	manual	--	3
Bogetici	42 42	18 59	P	1948 -	2	3,4	manual	--	3
Kunak			P	1954 -	2	3,4	manual	--	3
Niksic	42 46	18 57	M	1917 -	8	1,2,3,4,5 ,6,7,9	online station (2005)	0	1
Gornje Polje	42 51	18 57	P	1946 -	2	3,4	manual	--	3
Presjeka	42 53	18 52	P	1954 -	2	3,4	manual	--	3
Donja Trepca			P	1954 -	2	3,4	manual	--	3

LEGEND

Flags

*

1 wind
2 temperature
3 precipitation
4 snow depth
5 radiation
6 sunshine duration
7 relative humidity
8 evaporation
9 ground Temperature

**

-- / - / 0 / + / ++

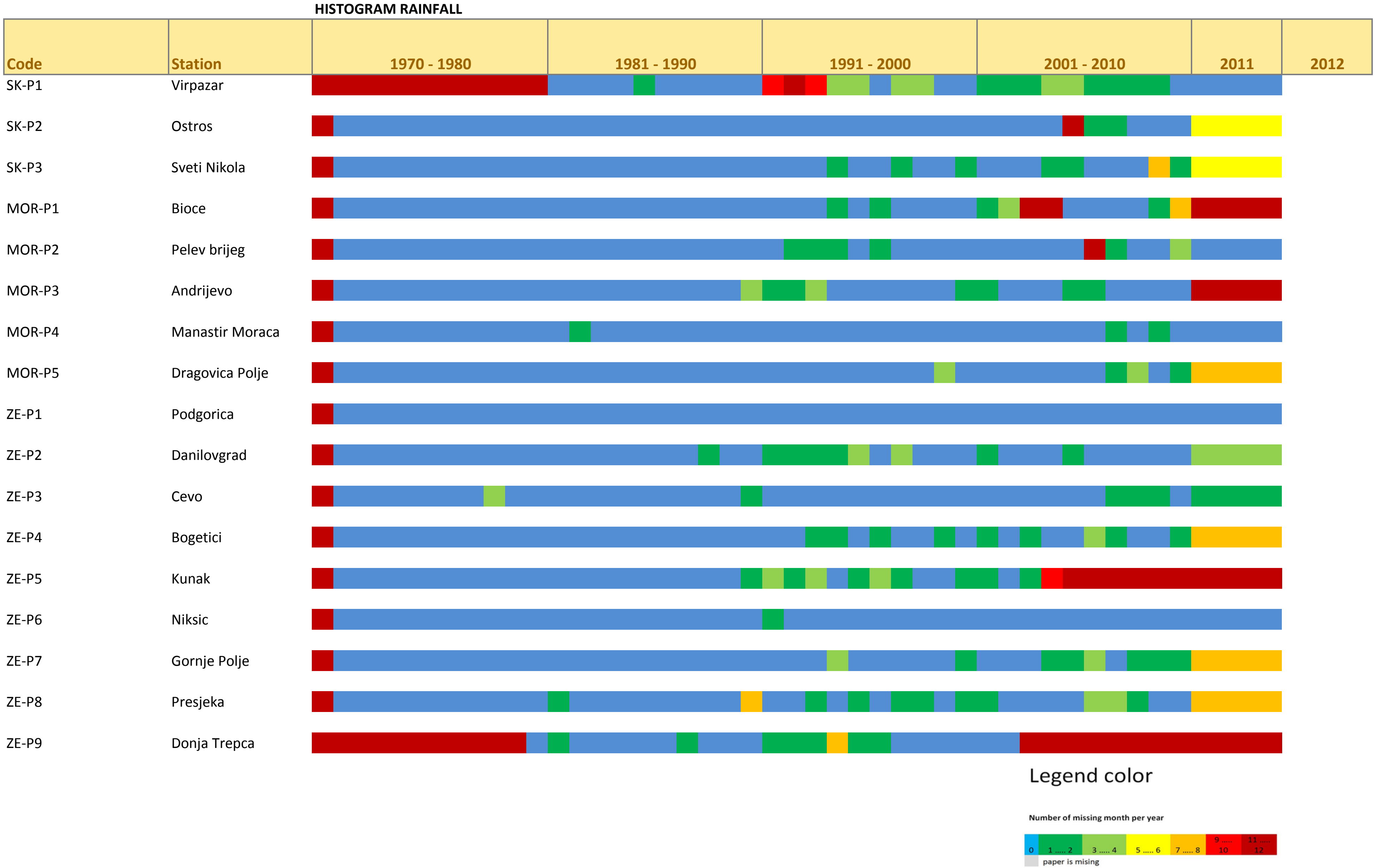
***

1 renew at same location
2 renew at different location
3 upgrade to automatically working station - data logger
4 uprade to online station
5 etc...

T - thermometric
P - pluviometric
C- climatic
M - main automatic

data digitized since 1960 for P station, and since 1949 for C and M station

M- main stations are fully automatic and connected with the center in Podgorica
C - observations and measurements are done in three terms 7h, 14h and 21h
P - precipitation quantity is observed in 24h sample, at 7h a.m.


HISTOGRAM RAINFALL
Code
Station
1970 - 1980
1981 - 1990
1991 - 2000
2001 - 2010
2011
2012
SK-P1 Virpazar
SK-P2 Ostros
SK-P3 Sveti Nikola
MOR-P1 Bioce
MOR-P2 Pelev brijeg
MOR-P3 Andrijevo
MOR-P4 Manastir Moraca
MOR-P5 Dragovica Polje
ZE-P1 Podgorica
ZE-P2 Danilovgrad
ZE-P3 Cevo
ZE-P4 Bogetici
ZE-P5 Kunak
ZE-P6 Niksic
ZE-P7 Gornje Polje
ZE-P8 Presjeka
ZE-P9 Donja Trepca
Legend color
Number of missing month per year
0
1 2
3 4
5 6
7 8
9 10
11 12
paper is mising

ANNEX

Annex 6:

Contributions from Albania

Annex A 6.1 – Hydrometric Stations Albania 1 / 3

Hydro stations		Location	Location	Type	Operational period(s)		Rating curve available	No. of parameters measured	Which parameters	Transmission of data	Actual State of station	Suggested improvement with regard to EWS
		Latitude ° ' "	Longitude ° ' "						use flag *		use flag **	use flag ***
Buna	Shkoder	42° 03'	19° 30'	H V	1928	1984						
Buna	Shkoder Fab Cim	42° 02'	19° 29'	H V	1964	1990						
Buna	Dajc	41° 59'	19° 25'	H	1958	1990						
Buna	Pulaj	41° 53'	19° 23'	H V	1965	1990						
Cem Bashkuar	Tamar	x	x	H	1981	1990						
Cem Vukli	Kozhenje	x	x	H	1984	1990						
Cem Vukli	Tamare	42° 27'	19° 34'	H	1977	1990						
Perroi Kozhnjes	Kozhnje	x	x	H	1984	1990						
Perroit Vrakes	Vrake	42° 07'	19° 30'	H	1971	1990						
Drini	Skavice	42° 10'	19° 52'	H	1950	1990						
Drini	Koman	42° 06'	19° 50'	H V	1968	1990						
Drini	Spathare Dige	42° 01'	19° 37'	H V	1972	1984						
Drini	Bahcallek	42° 02'	19° 30'	H V	1926	1990						
Drini i zi	Kovashice	41° 36'	20° 26'	H V	1967	1990						
Drini i zi	Ura Dodes	41° 53'	20° 19'	H V	1953	1990						
Drini i zi	Skavice	41° 55'	20° 20'	H V	1975	1990						
Perroi i Gorices	Pogradec	40° 55'	20° 29'	H	1974	1990						
Perroi Zalli i Bulqizes	Sofracan	41° 31'	20° 25'	H	1975	1990						
Perroi i Murres	Fush Muhur	41° 41'	20° 20'	H	1973	1990						

Observations from 1990 until 2012 are currently digitalized

LEGEND

Flags

*

1	water level
2	discharge
3	water temperature
4	water quality data
5	rainfall (in addition)
6	
7	
8	
9	

**

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***

1	renew at same location
2	renew at different location
3	upgrade to automatically working station - data logger
4	uprade to online station
5	etc…

WL = Water Level
Q = Discharge
H = Hydrometer
V = Autorecorder

Annex A 6.1 – Hydrometric Stations Albania 2 / 3

Hydro stations		Location	Location	Type	Operational period(s)		Rating curve available	No. of parameters measured	Which parameters	Transmission of data	Actual State of station	Suggested improvement with regard to EWS
		Latitude ° ‘ “	Longitude ° ‘ “						use flag *		use flag **	use flag ***
Perroi i Murres	Fush Muhur	41° 41'	20° 20'	H V	1928	1984						
Perroi i Setes	Arrez	41° 44'	20° 18'	H	1970	1990						
Perroi Molla e Lures	Ura Dodes	41° 53'	20° 19'	H	1950	1984						
Perroi i Bushtrices	Bushtrice	41° 55'	20° 25'	H V	1971	1990						
Perroi i Orgjostit	Orgjost	42° 03'	20° 35'	H	1975	1990						
Lumi i Lumes	Belaj	42° 03'	20° 31'	H	1979	1990						
Perroi i Kalimashit	Kalimash	42° 04'	20° 19'	H	1975	1990						
Perroi i Serriqes	Ngull I	42° 06'	20° 14'	H	1972	1990						
Perroi i Serriqes	Ngull II	42° 06'	20° 14'	H	1979	1990						
Perroi i Krumes	Gecaj	x	x	H	1983	1990						
Perroi i Vllahnes	Golaj	42° 13'	20° 13'	H	1981	1990						
Perroi i Vllahnes	Zarhishte	x	x	H	1984	1990						
Perroi Goska e Madhe	Xath	42° 08'	20° 11'	H	1978	1990						
Perroi i Skatines	Kam	x	x	H	1981	1990						
Valbona	Dragobi	42° 20'	20° 00'	H	1958	1990						
Valbona	Bajram Curri	42° 21'	20° 06'	H V	1974	1990						

Annex A 6.1 – Hydrometric Stations Albania 3 / 3

Hydro stations		Location	Location	Type	Operational period(s)		Rating curve available	No. of parameters measured	Which parameters	Transmission of data	Actual State of station	Suggested improvement with regard to EWS
		Latitude ° ' "	Longitude ° ' "						use flag *		use flag **	use flag ***
Valbona	Gri	42° 19'	20° 04'	H V	1958	1990						
Lumi I Gashit	Begaj	x	x	H	1984	1990						
Bushtrica	Sopot	42° 22'	20° 07'	H	1973	1990						
Lumi I Nikajt	Lekbibaj	42° 18'	19° 56'	H	1969	1990						
Perroi i Currajt	Curraj i Eperm	42° 21'	19° 55'	H V	1980	1990						
Perroi i Currajt	Curraj i Poshtem	42° 18'	19° 57'	H	1977	1990						
Lumi i Thethit	Okoll	x	x	H	1983	1990						
Lumi i Shales	Breg Lum	42° 22'	19° 48'	H	1972	1990						
Lumi i Shales	Molla Shoshit	x	x	H	1983	1990						
Lumi Lesniqes	Lesniqe	42° 11'	19° 52'	H	1956	1984						
Perroi i Berishes	Berish e Vogel	42° 10'	19° 55'	H	1970	1990						
Perroit i Gomsiqes	Gomsiqe (ure)	42° 01'	19° 42'	H	1961	1990						
Gjadri	Mnelle (Diga)	41° 59'	19° 30'	H	1963	1984						
Kiri	Kasnec	x	x	H	1984	1990						
Kiri	Prekal	42° 19'	19° 43'	H	1981	1990						
Kiri	Rasek	42° 07'	19° 35'	H	1961	1990						
Perroi I Rasekut	Boks	x	x	H	1984	1990						
Perroi I Manatis	Lezhe	x	x	H	1981	1990						

HISTOGRAM WATER LAEVEL BUNA CATCHMENT

Nr.	Station	Station place	1928-1950	1951-1960	1961-1970	1971-1980	1981-1990
1	Buna	Shkoder					
2	Buna	Shkoder Fab Cim					
3	Buna	Dajc					
4	Buna	Pulaj					
5	Cem Bashkuar	Tamar					
6	Cem Vukli	Kozhenje					
7	Cem Vukli	Tamare					
8	Perroi Kozhnjes	Kozhnje					
9	Perroit Vrakes	Vrake					

HISTOGRAM WATER LAEVEL DRIN CATCHMENT

Nr.	Station	Station place	1926-1950	1951-1960	1961-1970	1971-1980	1981-1990
12	Drini	Skavice					
13	Drini	Koman					
14	Drini	Spathare Dige					
15	Drini	Bahcallek					
16	Drini i zi	Kovashice					
17	Drini i zi	Ura Dodes					
18	Drini i zi	Skavice					
19	Perroi i Gorices	Pogradec					
20	Perroi Zalli i Bulqizes	Sofracan					
21	Perroi i Murres	Fush Muhur					
22	Perroi i Setes	Arrez					
23	Perroi Molla e Lures	Ura Dodes					
24	Perroi i Bushtrices	Bushtrice					
25	Perroi i Orgjostit	Orgjost					
26	Lumi i Lumes	Belaj					
27	Perroi i Kalimashit	Kalimash					
28	Perroi i Serriqes	Ngull I					
29	Perroi i Serriqes	Ngull II					
30	Perroi i Krumes	Gecaj					
31	Perroi i Vllahnes	Golaj					
32	Perroi i Vllahnes	Zarhishte					
33	Perroi Goska e Madhe	Xath					
34	Perroi i Skatines	Kam					
35	Valbona	Dragobi					
36	Valbona	Bajram Curri					
37	Valbona	Gri					
38	Lumi I Gashit	Begaj					
39	Bushtrica	Sopot					
40	Lumi I Nikajt	Lekbibaj					
41	Perroi i Currajt	Curraj i Eperm					
42	Perroi i Currajt	Curraj i Poshtem					
43	Lumi i Thethit	Okoll					
44	Lumi i Shales	Breg Lum					
45	Lumi i Shales	Molla Shoshit					
46	Lumi Lesniqes	Lesniqe					
47	Perroi i Berishes	Berish e Vogel					
48	Perroit i Gomsiqes	Gomsiqe (ure)					
49	Gjadri	Mnelle (Diga)					
50	Kiri	Kasnec					
51	Kiri	Prekal					
52	Kiri	Rasek					
53	Perroi I Rasekut	Boks					
54	Perroi I Manatis	Lezhe					

Digitalisation process by WB project ends January 2013 (about 50% of data base)

Annex A 6.3 – Meteorological Stations Albania 1 / 4

existing stations in the drin basin Nr.	Location	Location	Category	no of parameters measured	which parameters	state of station	suggested improvement	automatically
							with regard to EWS	
	Φ - Latitude	λ –Longitude		*	**	***		
Alarup	40 52.515	20 48.024	T	2	235	0	3	
B. Curri	42 20.761	20 05.562	C	2	235	0	4	
Bicaj	41 59.682	20 24.199	T	2	235	0	3	
Bilisht	40 37.751	20 59.467	T	2	235	0	3	
Bishnicë	40 57.786	20 25.636	T	2	235	0	3	
Bogë	42 23.899	19 38.678	T	2	235	-	4	
Boks	42 07.273	19 34.579	T	2	235	0	3	
Bushat	41 57.277	19 31.931	T	2	235	-	3	
Bushtricë	41 53.111	20 23.780	T	2	235	0	3	
Çëravë	40 51.305	20 43.827	T	2	235	0	**4**	
Dajç	41 59.502	19 24.593	P	2	35	0	**4**	
Dajç Zadrimë	41 54.888	19 36.216	T	2	235	0	3	
Degë	42 16.010	20 07.895	T	2	235	0	3	
Dragobi	42 26.191	19 59.271	T	2	235	-	**4**	
Dushman	42 07.259	19 50,868	P	2	35	0	3	
F. Paqes *Shkoder*	42 02.932	19 29.182	T	2	235	0	4	
Fierzë	42 15.794	20 02.222	T	2	235	0	3	
Fshat	41 54.259	20 26.865	T	2	235	0	3	

LEGEND

*

1 wind
2 temperature
3 precepetation
4 radiation
5 snow depth
6 sunshine duration
7
8
9

**

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***

1 renew at same location
2 renew at different location
3 improve to automatically working station - data logger
4 improve to online station

SUGGESTED IMPROVEMENTS

1 - All the renew has to be done at the same locations
4 - Improve to online station (WB project)
4 - Improve to online station (GIZ project)

T = thermometric P = pluviometric C = climatic

Annex A 6.3 – Meteorological Stations Albania 2 / 4

existing stations in the drin basin Nr.	Location	Location	Category	no of parameters measured	which parameters	state of station	suggested improvement	automatically
Fushë Lurë	41 48.372	20 13.034	**C**	2	235	0	4	
Goricë e madhe	40 53.911	20 54.503	**P**	2	35	0	3	
Gri+A82	42 18.082	20 04.259	**T**	2	235	0	3	
Hot	42 21.757	19 26.827	**P**	2	35	0	4	
Iballë	42 11.107	20 00.232	**T**	2	235	0	3	
Kalimash	42 04.620	20 18.229	**T**	2	235	0	3	
Kalivaç	41 54.872	19 45.568	**T**	2	235	0	3	
Kallmet	41 50.814	19 41.392	**T**	2	235	0	3	
Kam	42 15.387	20 15.012	**T**	2	235	0	3	
Kastriot	41 44.257	20 22.839	**T**	2	235	0	3	
Klenjë	41 22.025	20 28.030	**C**	2	235	0	**4**	
Koman	42 05.535	19 48.585	**T**	2	235	0	3	
Koplik	42 12.768	19 26.276	**T**	2	235	0	3	
Korthpulë	41 58.311	19 47.936	**T**	2	235	0	**4**	
Kostenjë	41 20.501	20 17.426	**T**	2	235	0	3	
Krumë	42 11.612	20 24.478	**T**	2	235	0	3	
Kryezi	42 06.506	20 03.063	**T**	2	235	0	3	
Kukës	42 04.268	20 25.213	**C**	5	23456	0	4	
Lajthizë	42 05.579	20 08.912	**T**	2	235	0	3	
Lekbibaj	42 17.385	19 56.047	**T**	2	235	0	3	
Lenë	41 23.802	20 13.471	**T**	2	235	0	3	
Lepush	42 31.634	19 43.940	**T**	2	235	0	3	

T = thermometric   P = pluviometric   C = climatic

existing stations in the drin basin Nr.	Location	Location	Category	no of parameters measured	which parameters	state of station	suggested improvement	automatically
Lezhë	41 46.911	19 38.971	C	2	235	0	4	
Librazhd	41 11.085	20 19.639	T	2	235	0	3	
Liqenas	40 47.262	20 54.264	T	2	235	0	3	
Narel	42 02.935	19 54.605	P	2	35	0	3	
Ostren i Vogël	41 25.750	20 29.295	T	2	235	0	3	
Peshkopi	41 41.054	20 25.616	C	5	23456	0	4	
Petkaj	42 06.544	20 14.827	P	2	35	0	3	
Pogradec	40 54.163	20 39.584	T	5	23456	+	4	
Prrenjas Qukës F	41 04.196	20 32.098	T	2	235	0	4	
Puke	42 02.129	19 24.121	T	2	23	-	4	
Qarrishtë	41 15.866	20 25.841	P	2	35	0	3	
Radomirë	41 48.933	20 28.874	T	2	235	0	3	
Rapsh	42 23.229	19 29.770	T	2	235	0	4	
Rragam	42 24.327	19 50.330	T	2	235	0	3	
Selcë	42 30.367	19 37.219	P	2	35	0	**4**	
Selishtë	41 37.670	20 16.499	T	2	235	0	3	
Shëngjin	41 48.646	19 35.951	T	2	235	0	4	
Shirokë	42 03.485	19 26.734	T	2	235	0	3	
Shishtavec	41 58.831	20 36.115	T	2	235	0	**4**	
Shupenzë	41 32.062	20 25.203	T	2	235	0	4	
Skavicë	41 54.897	20 21.737	T	2	235	0	3	
Stravaj	41 00.073	20 25.313	T	2	235	0	3	

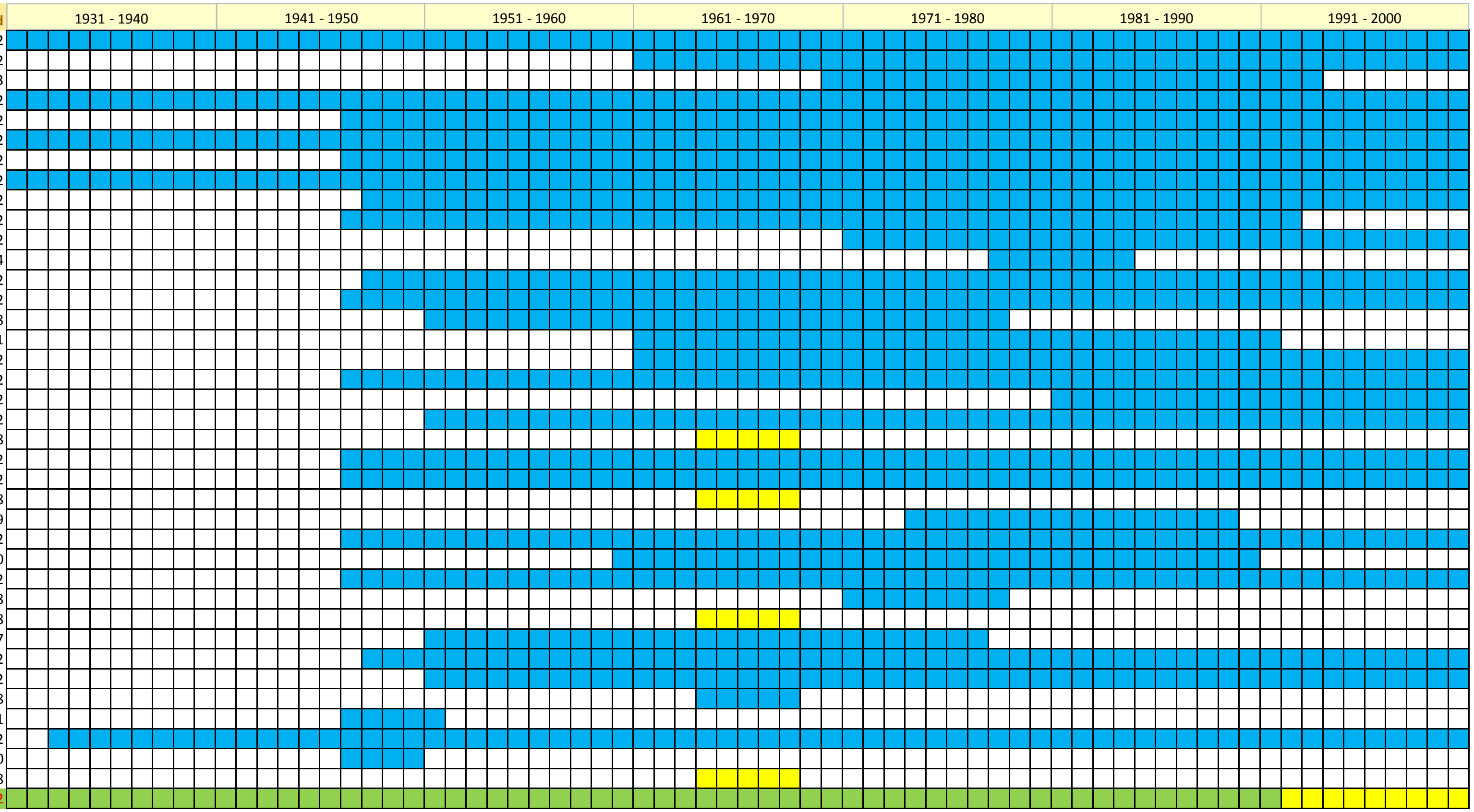
T = thermometric P = pluviometric C = climatic

Annex A 6.3 – Meteorological Stations Albania 4 / 4

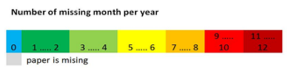
existing stations in the drin basin Nr.	**Location**	**Location**	**Category**	**no of parameters measured**	**which parameters**	**state of station**	**suggested improvement**	**automatically**
Tamarë	42 27.795	19 33.384	**T**	2	235	0	3	
Theth	42 23.420	19 46.049	**T**	2	235	-	**4**	
Topojan	41 59.332	20 31.171	**T**	2	235	0	3	
Torovicë	41 53.513	19 31.777	**T**	2	235	0	3	
Tregtan	42 08.151	20 10.380	**T**	2	235	0	3	
Tropojë	42 24.234	20 09.940	**T**	2	235	0	3	
Ura Dodës	41 53.501	20 18.905	**T**	2	235	0	3	
Ura e Shtrenjtë	42 08.748	19 39.423	**T**	2	235	0	3	
Valbonë	42 26.994	19 53.503	**T**	2	235	0	3	
Vau Dejës	42 00.941	19 38.398	**T**	2	235	0	3	
Vau Spas	42 09.505	20 15.002	**T**	2	235	0	3	
Velipojë	41 52.689	19 24.433	**T**	2	235	-	3	
Vrith	42 19.918	19 32.625	**T**	2	235	0	3	
Ylli Kuq Ish.Lezhë	41 45.922	19 38.523	**T**	2	235	0	3	
Zall i Kalisë	41 48.608	20 22.151	**T**	2	235	0	3	
Zerqan	41 30.049	20 21.181	**P**	2	35	0	3	
Zogaj *Shkoder*	42 04.178	19 23.645	**T**	2	235	0	**4**	
Zogaj *Tropojë*	42 17.694	20 17.675	**T**	2	235	0	3	

T = thermometric P = pluviometric C = climatic

Station	Start	End
Liqenas	1931	2012
Narel	1961	2012
Ostren i Vogë	1970	1993
Peshkopi	1931	2012
Petkaj	1947	2012
Pogradec	1931	2012
Prrenjas Qukë	1947	2012
Puke	1931	2012
Qarrishtë	1948	2012
Radomirë	1947	1992
Rapsh	1971	2012
Rragam	1978	1984
Selcë	1948	2012
Selishtë	1947	2012
Shëngjin	1951	1978
Shirokë	1961	1991
Shishtavec	1961	2012
Shupenzë	1947	2012
Skavicë	1981	2012
Stravaj	1951	2012
Tamarë	1964	1968
Theth	1947	2012
Topojan	1947	2012
Torovicë	1964	1968
Tregtan	1974	1989
Tropojë	1947	2012
Ura Dodës	1960	1990
Ura e Shtrenjt	1947	2012
Valbonë	1971	1978
Vau Dejës	1964	1968
Vau Spas	1951	1977
Velipojë	1948	2012
Vrith	1951	2012
Ylli Kuq Ish.Le	1964	1968
Zall i Kalisë	1947	1951
Zerqan	1933	2012
Zogaj Shkoder	1947	1950
Zogaj Tropojë	1964	1968
SHKODER	1868	2012



Legend color



ANNEX

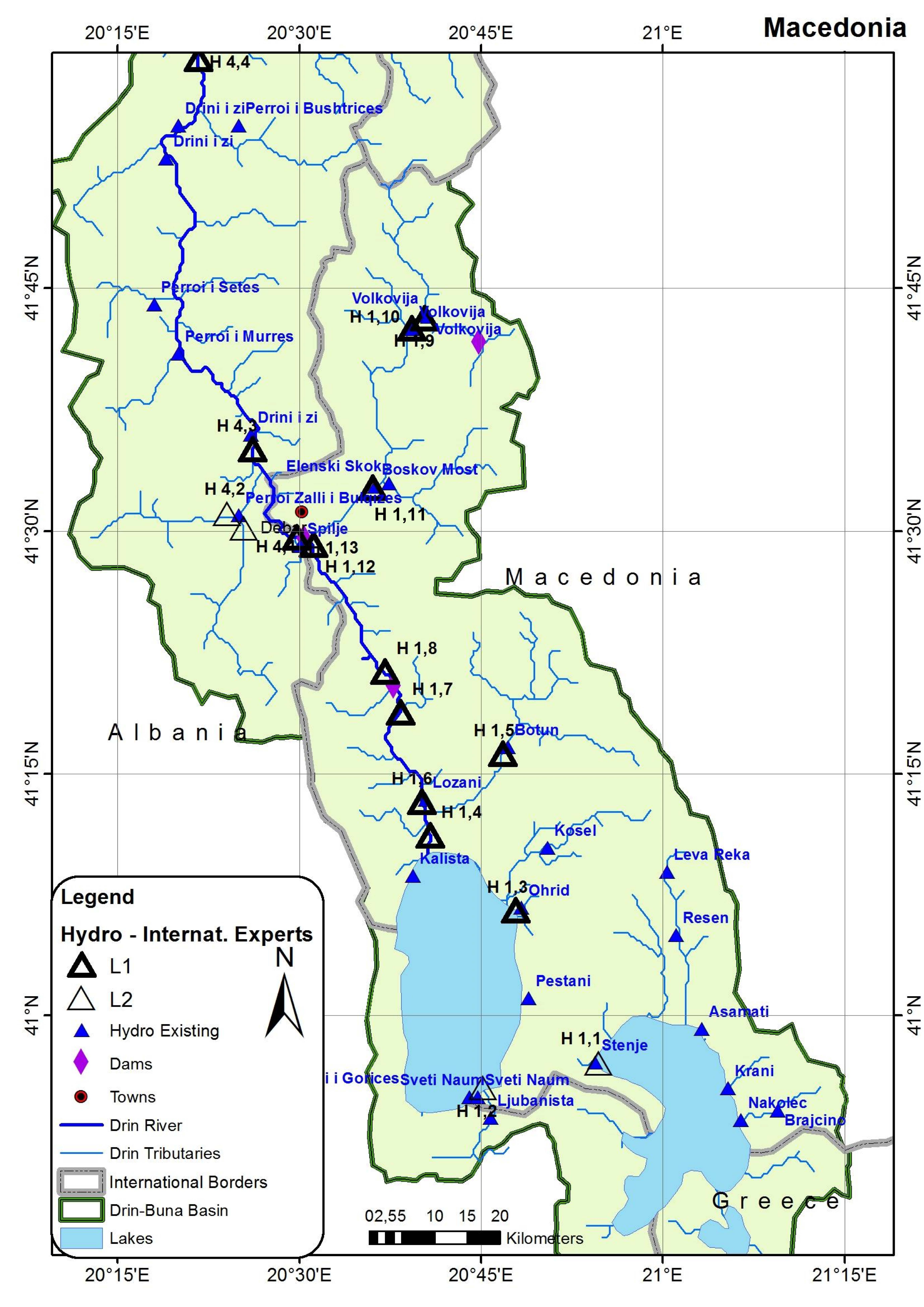
Annex 7:

Maps with recommended hydrological stations

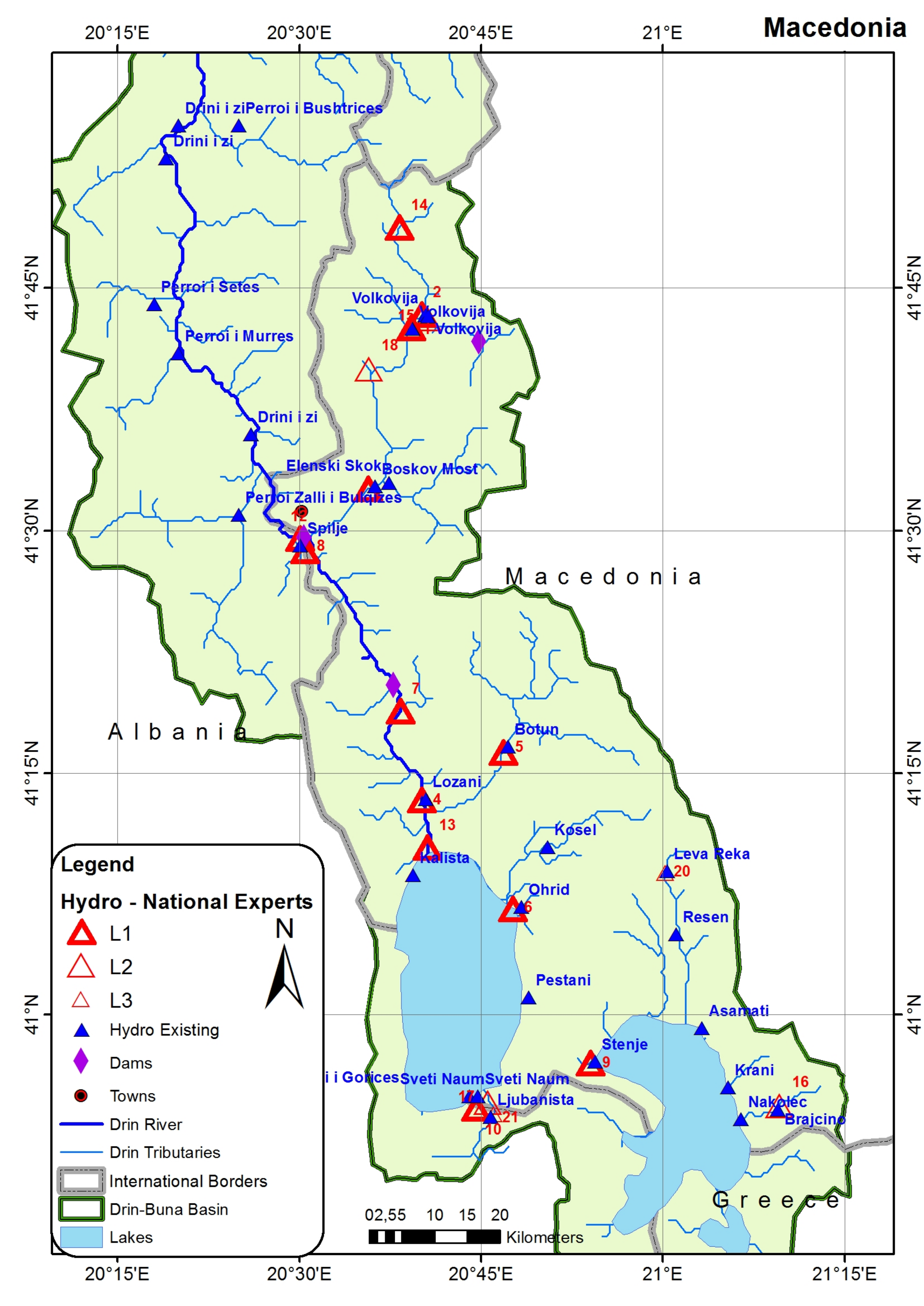
(international experts, national experts)

Remarks:

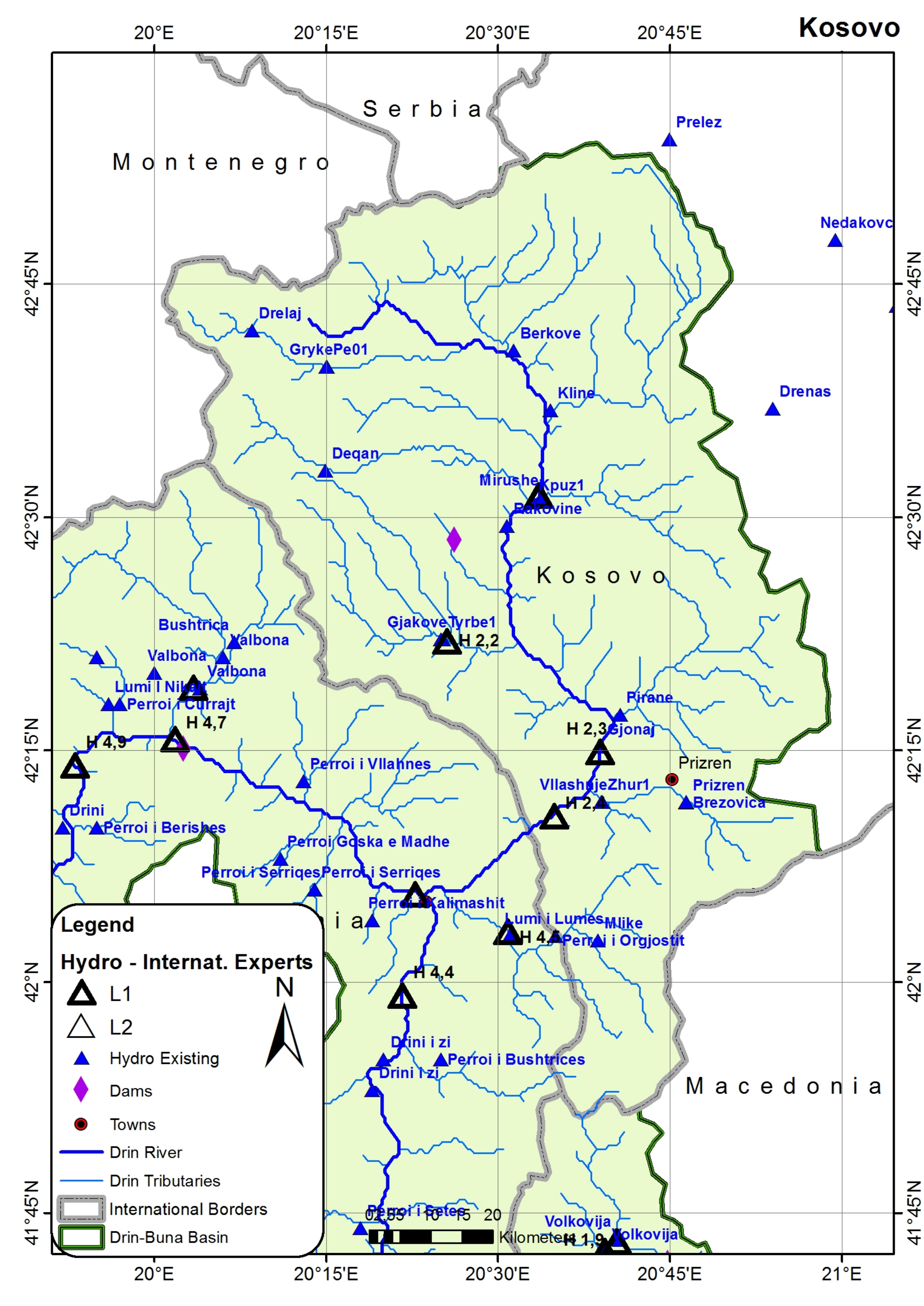
1) Red numbers assigned to the hydrological stations (national wishes) are used for internal purpose only.
2) The black nominations assigned to the hydrological stations recommended by the international experts are related to the Tables of Annex 9 and to the system sketch of Figure 9.6.



Macedonia
20°15'E
20°30'E
20°45'E
21°E
21°15'E
41°45'N
41°30'N
41°15'N
41°N
H 4,4
Drini i zi
Perroi i Bushtrices
Drini i zi
Perroi i Setes
Perroi i Murres
Volkovija
H 1,10
Volkovija
Volkovija
H 1,9
H 4,3
Drini i zi
Elenski Skok
Boskov Most
H 4,2
Perroi Zalli i Bulqizes
H 1,11
Debar
Spilje
H 1,13
H 1,12
M a c e d o n i a
H 1,8
H 1,7
A l b a n i a
H 1,5
Botun
H 1,6
Lozani
H 1,4
Kosel
Kalista
Leva Reka
H 1,3
Ohrid
Resen
Pestani
Asamati
H 1,1
Stenje
Krani
i i Gorices
Sveti Naum
Sveti Naum
Ljubanista
H 1,2
Nakolec
Brajcino
G r e e c e
Legend
Hydro - Internat. Experts
L1
L2
Hydro Existing
Dams
Towns
Drin River
Drin Tributaries
International Borders
Drin-Buna Basin
Lakes
N
02,55 10 15 20
Kilometers

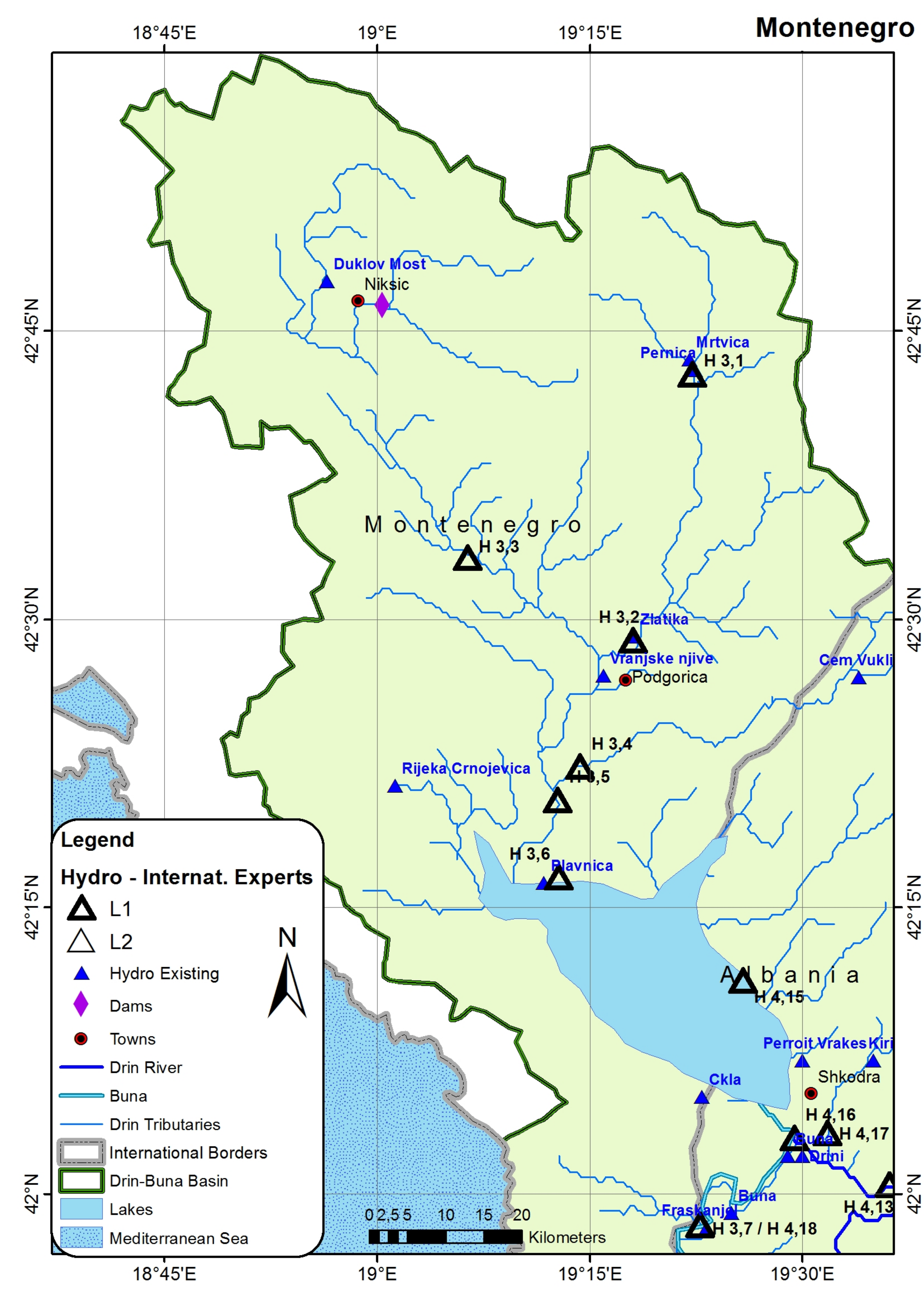


Macedonia
20°15'E
20°30'E
20°45'E
21°E
21°15'E
41°45'N
41°30'N
41°15'N
41°N
Drini i zi
Perroi i Bushtrices
Perroi i Setes
Perroi i Murres
Volkovija
Elenski Skok
Boskov Most
Perroi Zalli i Bulqizes
Spilje
Macedonia
Albania
Botun
Lozani
Kalista
Kosel
Leva Reka
Ohrid
Resen
Pestani
Asamati
Stenje
Krani
Nakolec
Brajcino
Sveti Naum
Ljubanista
Greece
Legend
Hydro - National Experts
L1
L2
L3
Hydro Existing
Dams
Towns
Drin River
Drin Tributaries
International Borders
Drin-Buna Basin
Lakes
N
0 2,5 5 10 15 20
Kilometers

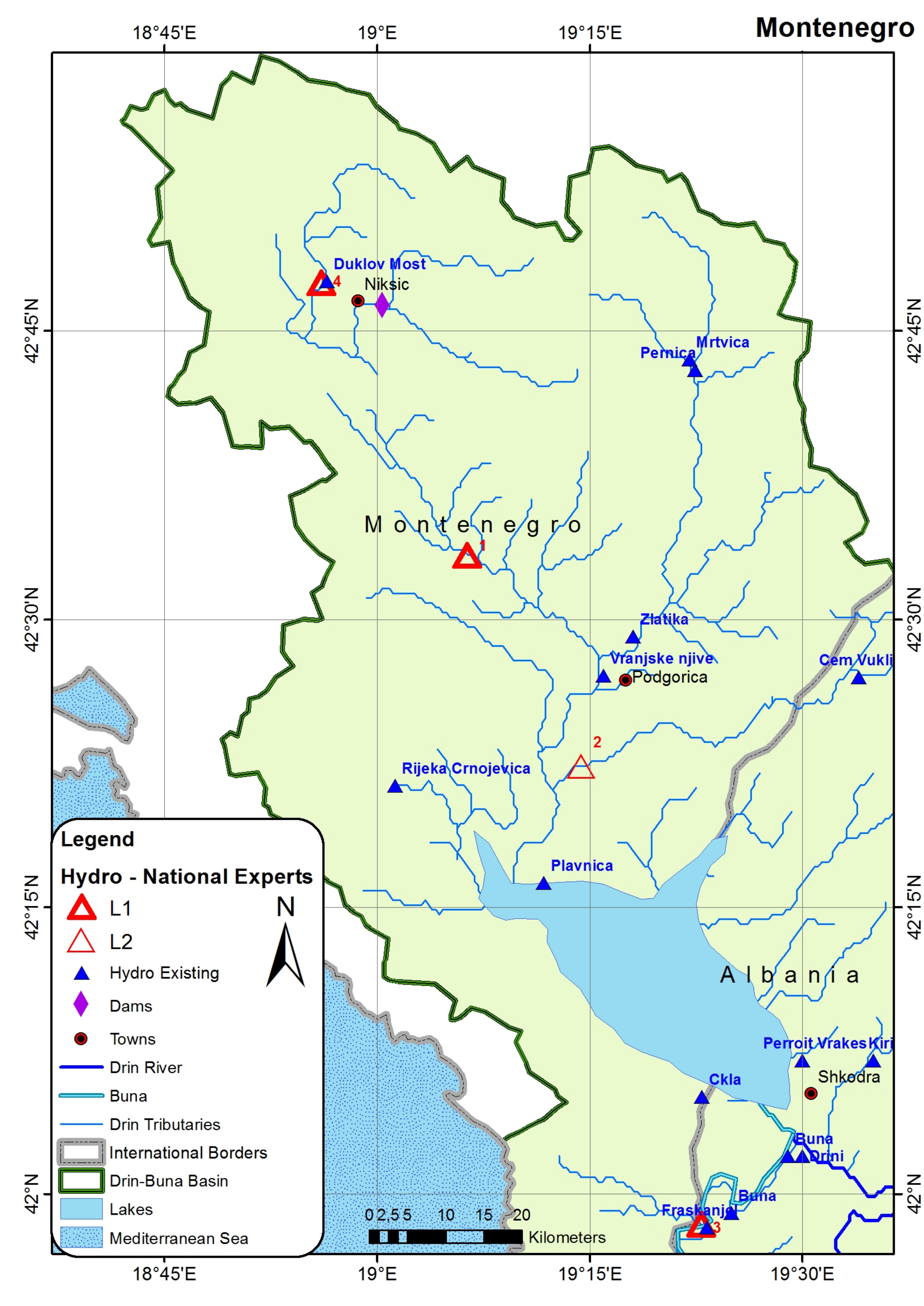


Kosovo
Serbia
Montenegro
Kosovo
Macedonia
Prizren
Prelez
Nedakovc
Drenas
Drelaj
GrykePe01
Berkove
Kline
Deqan
MirusheKpuz1
Rakovine
GjakoveTyrbe1
H 2,2
Bushtrica
Valbona
Valbona
Valbona
Lumi I Nikajt
Perroi i Currajt
H 4,7
H 4,9
Pirane
H 2,3
Gjonaj
Perroi i Vllahnes
VllashnjeZhur1
H 2,4
Prizren
Brezovica
Drini
Perroi i Berishes
Perroi Goska e Madhe
Perroi i Serriqes
Perroi i Serriqes
Perroi i Kalimashit
Lumi i Lumes
H 4,5
Mlike
Perroi i Orgjostit
H 4,4
Drini i zi
Perroi i Bushtrices
Drini i zi
Perroi i Setes
Volkovija
Volkovija
H 1,9
0 2.5 5 10 15 20
Kilometers
Legend
Hydro - Internat. Experts
L1
L2
Hydro Existing
Dams
Towns
Drin River
Drin Tributaries
International Borders
Drin-Buna Basin
N
20°E
20°15'E
20°30'E
20°45'E
21°E
42°45'N
42°30'N
42°15'N
42°N
41°45'N

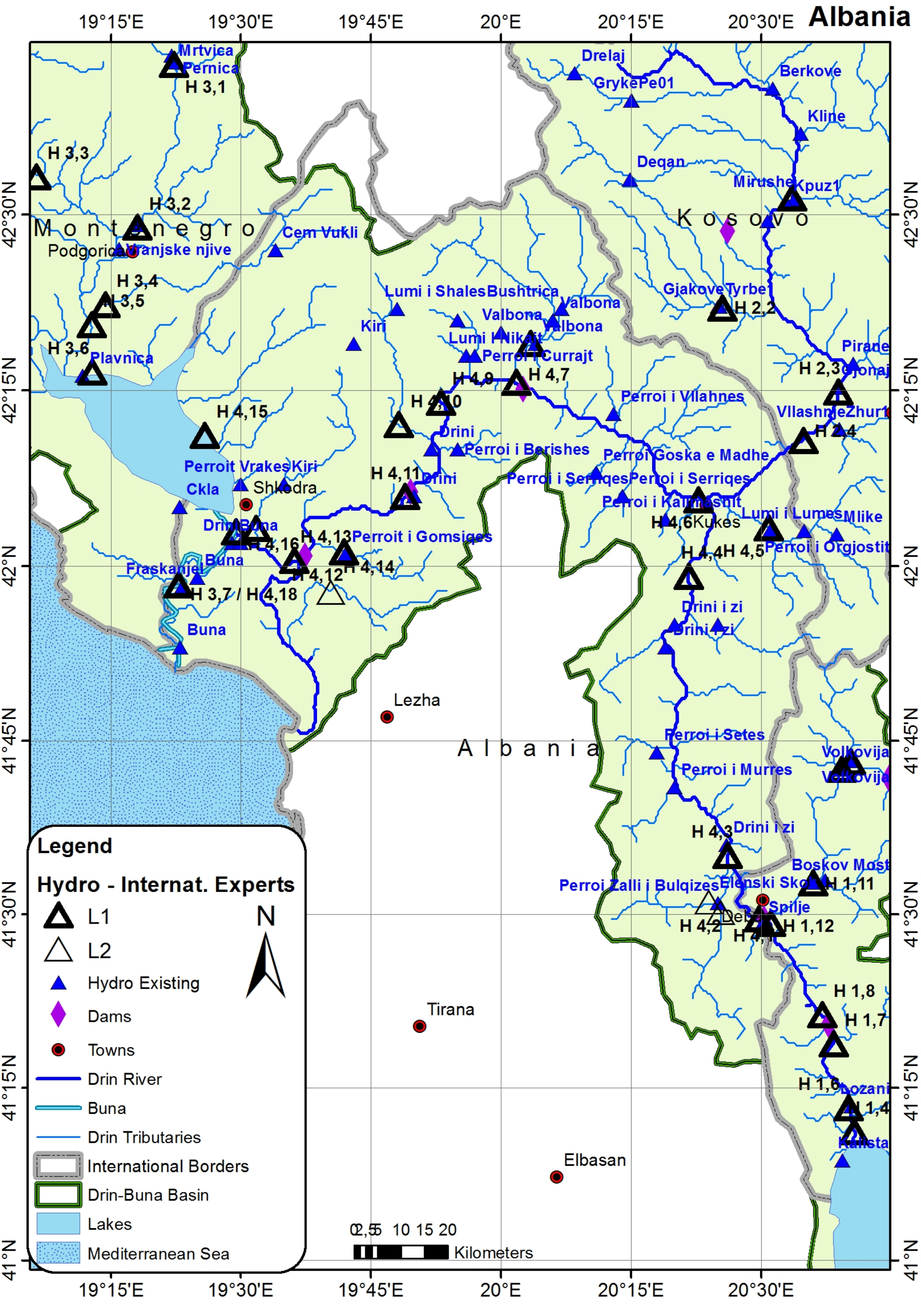

Kosovo
20°E
20°15'E
20°30'E
20°45'E
21°E
42°45'N
42°30'N
42°15'N
42°N
41°45'N
Serbia
Montenegro
Kosovo
Albania
Macedonia
Prelez
Nedakovc
Drenas
Drelaj
GrykePe01
Berkove
Kline
Deqan
Mirushe
Kpuz1
Rakovine
GjakoveTyrbe1
Bushtrica
Valbona
Valbona
Valbona
Lumi I Nikaj
Perroi i Currajt
Pirane
Gjonaj
Prizren
VllashnjeZhur1
Prizren
Brezovica
Perroi i Vllahnes
Drini
Perroi i Berishes
Perroi Goska e Madhe
Perroi i SerriqesPerroi i Serriqes
Perroi i Kalimashit
Lumi i Lumes
Mlike
Perroi i Orgjostit
Drini i zi
Perroi i Bushtrices
Drini I zi
Perroi i Setes
Volkovija
Volkovija
Legend
Hydro - National Experts
L1
Hydro Existing
Dams
Towns
Drin River
Drin Tributaries
International Borders
Drin-Buna Basin
N
0 2.5 5 10 15 20
Kilometers



Montenegro
18°45'E
19°E
19°15'E
19°30'E
42°45'N
42°30'N
42°15'N
42°N
Duklov Most
Niksic
Pernica
Mrtvica
H 3,1
Montenegro
H 3,3
H 3,2
Zlatika
Vranjske njive
Podgorica
Cem Vukli
H 3,4
Rijeka Crnojevica
H 3,5
H 3,6
Plavnica
Albania
H 4,15
Perroit Vrakes
Kiri
Shkodra
Ckla
H 4,16
H 4,17
Buna
Drini
Buna
Fraskanjel
H 3,7 / H 4,18
H 4,13
0 2,5 5 10 15 20
Kilometers
N
Legend
Hydro - Internat. Experts
L1
L2
Hydro Existing
Dams
Towns
Drin River
Buna
Drin Tributaries
International Borders
Drin-Buna Basin
Lakes
Mediterranean Sea



Montenegro
18°45'E
19°E
19°15'E
19°30'E
42°45'N
42°30'N
42°15'N
42°N
Duklov Most
4
Niksic
Pernica
Mrtvica
M o n t e n e g r o
1
Zlatika
Vranjske njive
Podgorica
Cem Vukli
2
Rijeka Crnojevica
Plavnica
A l b a n i a
Perroit Vrakes
Kiri
Shkodra
Ckla
Buna
Drini
Buna
Fraskanjel
3
0 2,5 5 10 15 20
Kilometers
N
Legend
Hydro - National Experts
L1
L2
Hydro Existing
Dams
Towns
Drin River
Buna
Drin Tributaries
International Borders
Drin-Buna Basin
Lakes
Mediterranean Sea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20°E
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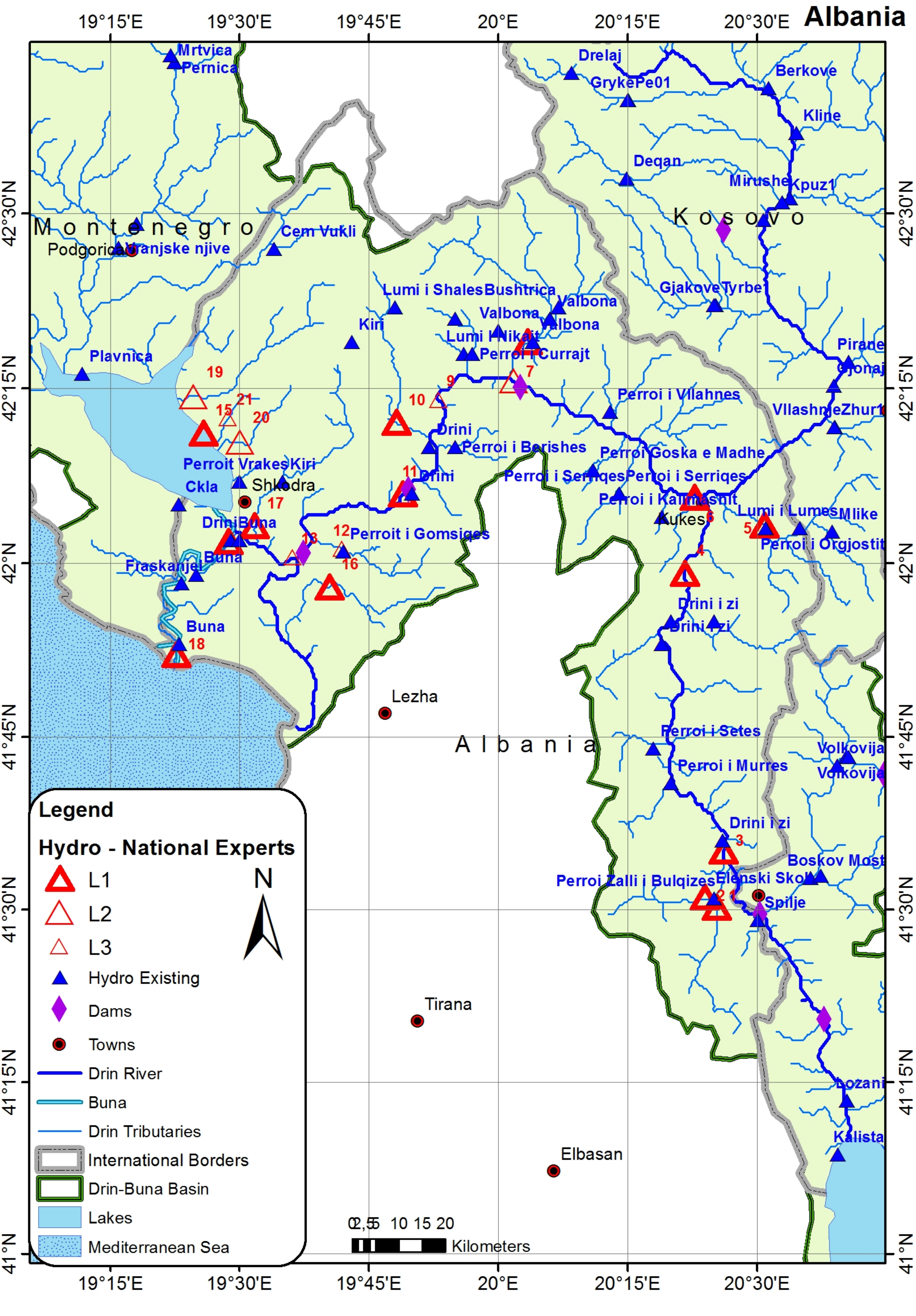
42°15'N
42°N
41°45'N
41°30'N
41°15'N
41°N
Montenegro
Kosovo
Albania
Podgorica
Shkodra
Lezha
Tirana
Elbasan
Kukes
Mrtvica
Pernica
H 3,1
H 3,3
H 3,2
Cem Vukli
Vranjske njive
H 3,4
H 3,5
H 3,6
Plavnica
H 4,15
Perroit Vrakes
Kiri
Ckla
Drin
Buna
H 4,16
H 4,13
Perroit i Gomsiqes
H 4,12
H 4,14
Fraskanjel
H 3,7 / H 4,18
Drelaj
GrykePe01
Berkove
Kline
Deqan
Mirushe
Kpuz1
Gjakove
Tyrbe
H 2,2
Lumi i Shales
Bushtrica
Valbona
Kiri
Lumi i Nikajt
Perroi i Currajt
H 4,9
H 4,7
H 4,10
Drini
Perroi i Berishes
H 4,11
Perroi i Vlahnes
Perroi Goska e Madhe
Perroi i Serriqes
Perroi i Kalimasnit
H 4,6
Pirane
H 2,3
Gjonaj
Vlashnje
Zhur1
H 2,4
Lumi i Lumes
Mlike
H 4,4
H 4,5
Perroi i Orgjostit
Drini i zi
Perroi i Setes
Volkovija
Perroi i Murres
H 4,3
Boskov Most
Perroi Zalli i Bulqizes
Elenski Skok
H 1,11
Spilje
H 4,2
Debar
H 1,12
H 1,8
H 1,7
H 1,6
Lozani
H 1,4
Kalista
Legend
Hydro - Internat. Experts
L1
L2
Hydro Existing
Dams
Towns
Drin River
Buna
Drin Tributaries
International Borders
Drin-Buna Basin
Lakes
Mediterranean Sea
N
0 2,5 5 10 15 20
Kilometers



Albania
19°15'E
19°30'E
19°45'E
20°E
20°15'E
20°30'E
42°30'N
42°15'N
42°N
41°45'N
41°30'N
41°15'N
41°N
Montenegro
Kosovo
Albania
Podgorica
Shkodra
Lezha
Tirana
Elbasan
Kukes
Mrtvica
Pernica
Vranjske njive
Cem Vukli
Plavnica
Drelaj
GrykePe01
Berkove
Kline
Deqan
Mirushe
Kpuz1
Lumi i Shales
Bushtrica
Valbona
Kiri
Lumi i Nikaj
Perroi i Currajt
GjakoveTyrbe
Pirane
Gjonaj
Perroi i Vlahnes
VllashnjeZhur1
Drini
Perroi i Berishes
Perroi Goska e Madhe
Perroi i Serriqes
Perroi i Kalimasnit
Lumi i Lumes
Mlike
Perroi i Orgjostit
Perroit Vrakes
Kiri
Ckla
DriniBuna
Buna
Fraskanjel
Perroit i Gomsiqes
Drini i zi
Perroi i Setes
Perroi i Murres
Volkovija
Boskov Most
Perroi Zalli i Bulqizes
Elenski Skok
Spilje
Lozani
Kalista
Legend
Hydro - National Experts
L1
L2
L3
Hydro Existing
Dams
Towns
Drin River
Buna
Drin Tributaries
International Borders
Drin-Buna Basin
Lakes
Mediterranean Sea
N
0 2,5 5 10 15 20
Kilometers

ANNEX

Annex 8:

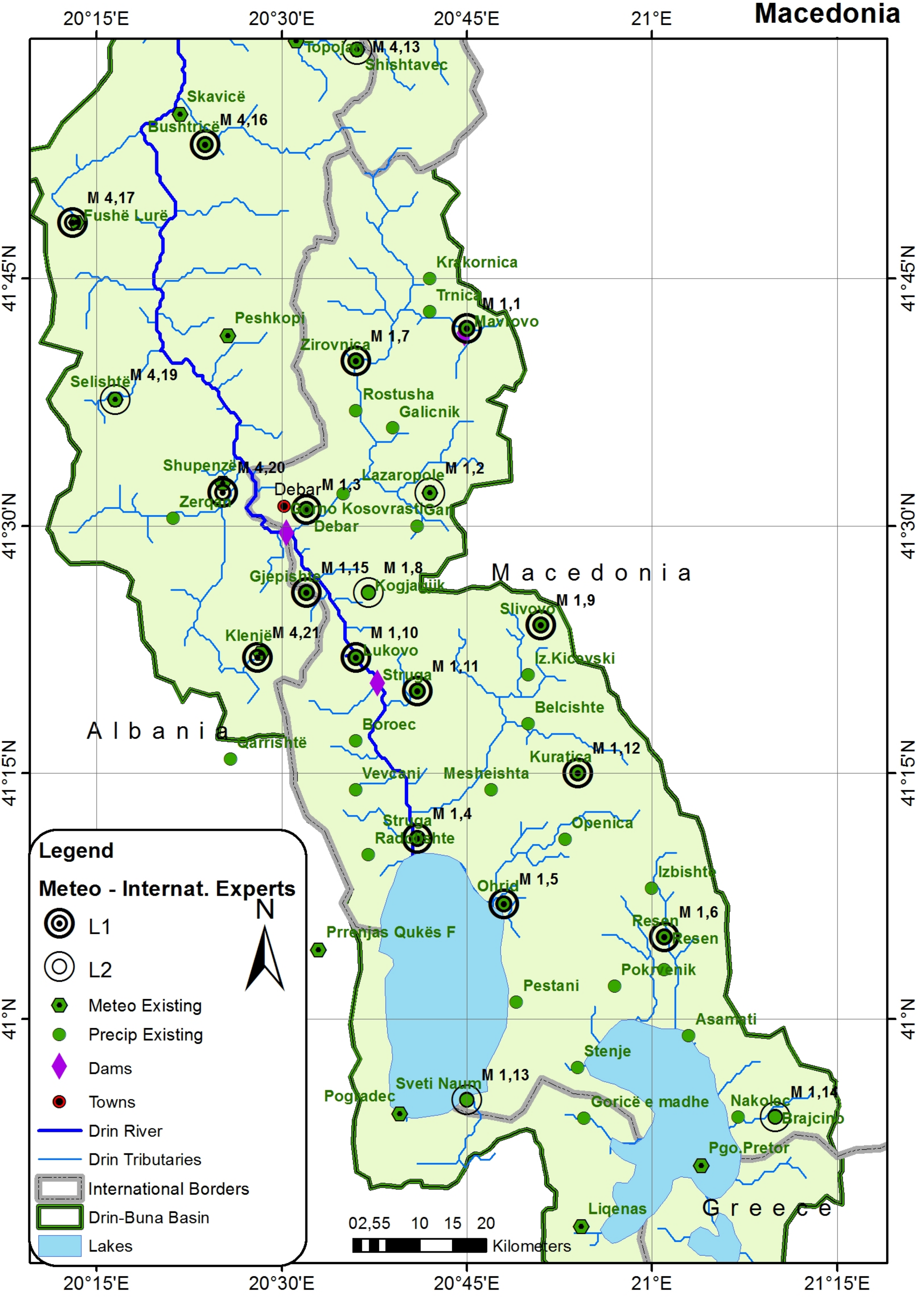
Maps with recommended meteorological stations

(international experts, national experts)

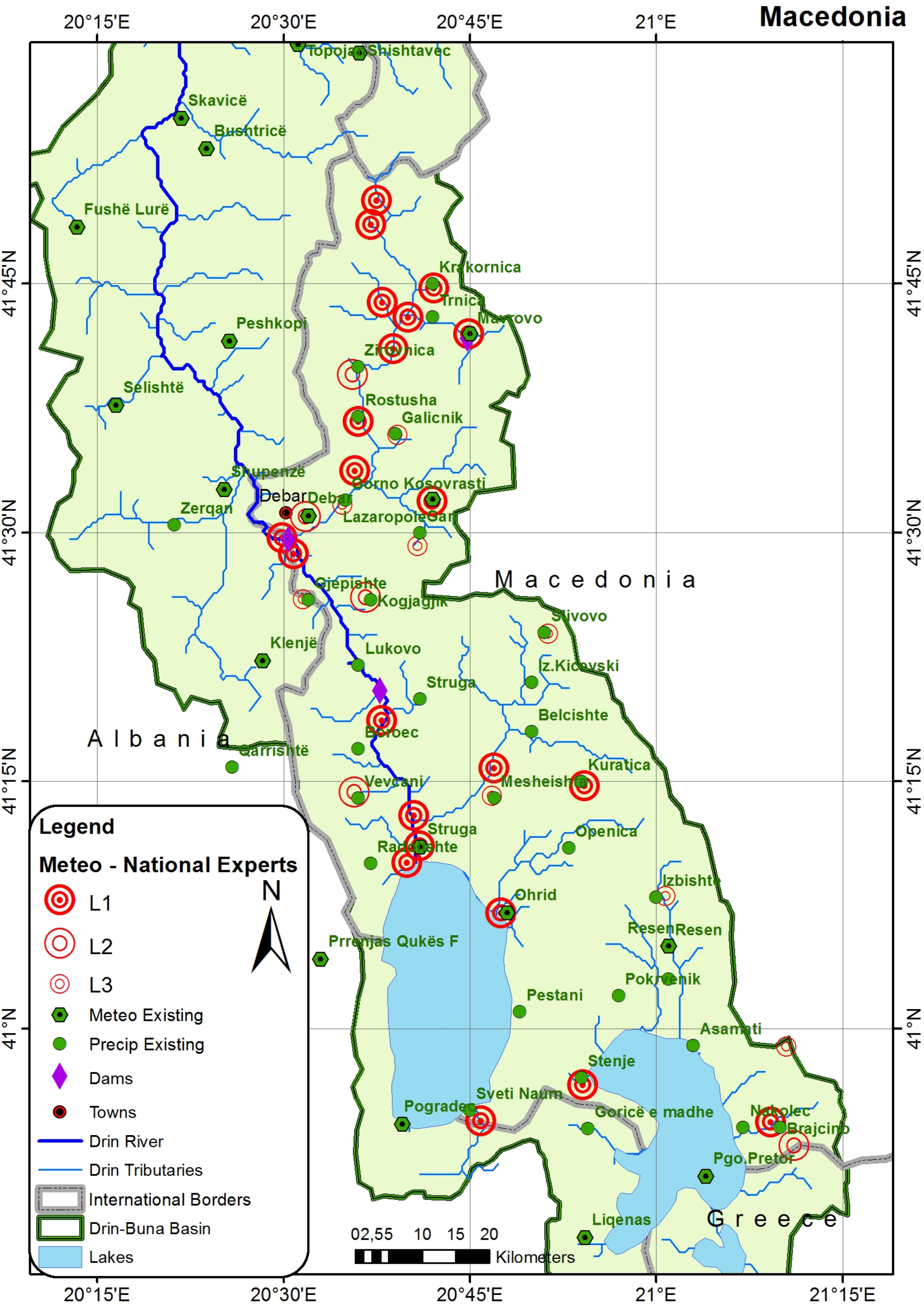
Remarks:

1) The black nominations assigned to the meteorological stations recommended by the international experts are related to the Tables of Annex 10.

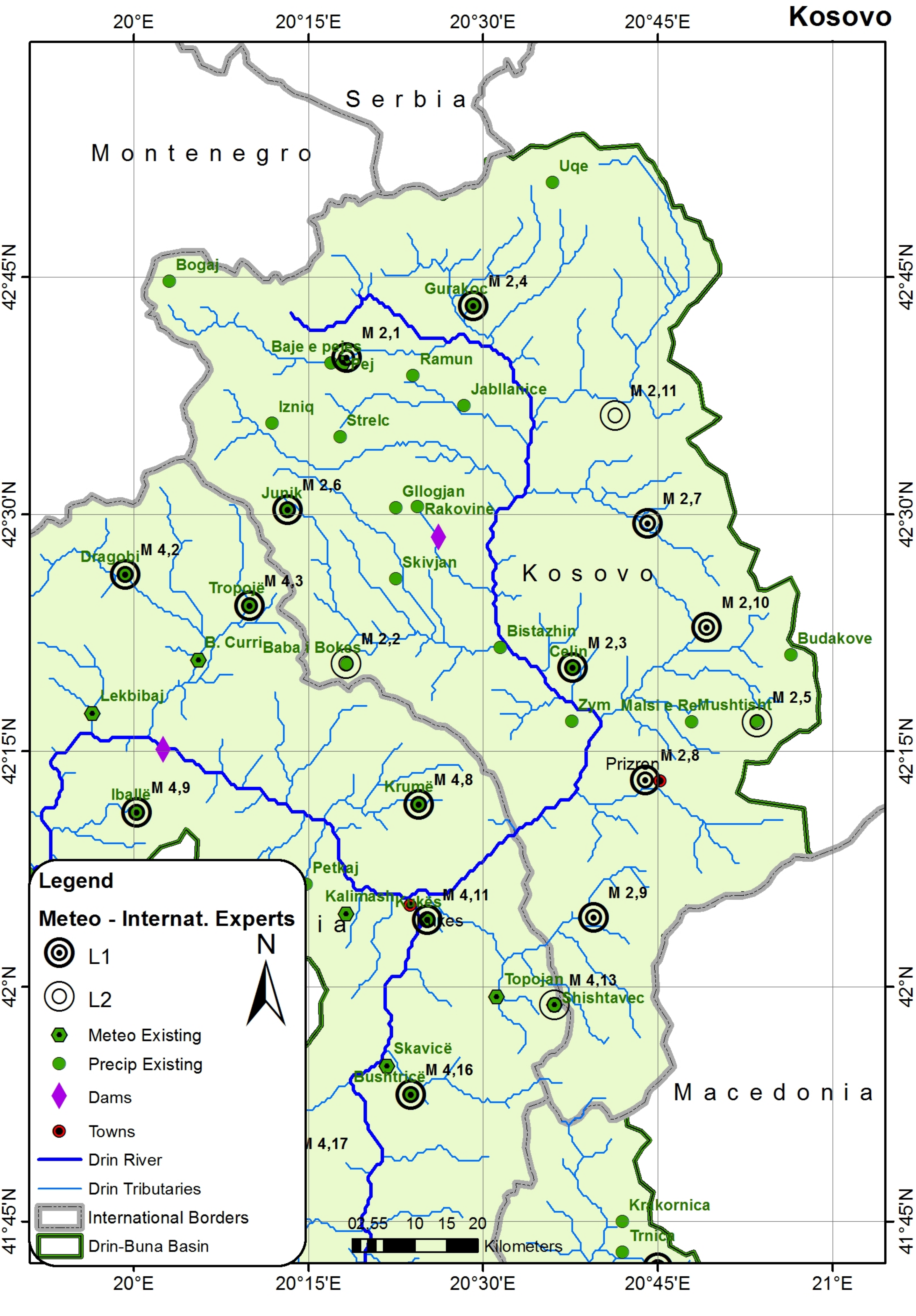
Macedonia



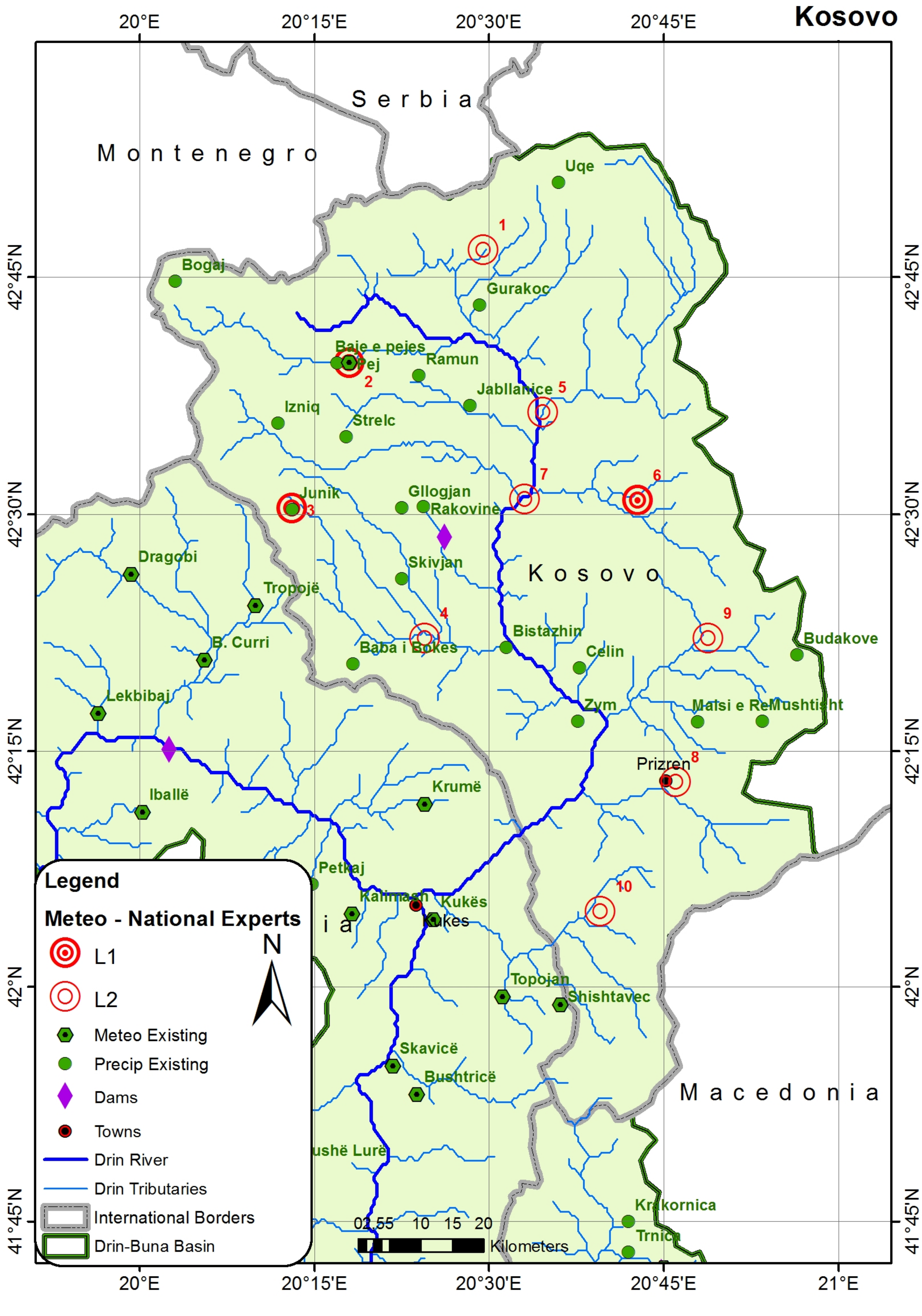
20°15'E
20°30'E
20°45'E
21°E
21°15'E
41°45'N
41°30'N
41°15'N
41°N
Shishtavec
M 4,13
Skavicë
Bushtricë
M 4,16
M 4,17
Fushë Lurë
Trnica
M 1,1
Peshkopi
Zirovnica
M 1,7
Selishtë
M 4,19
Rostusha
Galicnik
Shupenzë
M 4,20
Lazaropole
M 1,2
Debar
M 1,3
Zerqan
Debar
Macedonia
Gjepishte
M 1,15
M 1,8
Kogjajjik
Slivovo
M 1,9
Klenjë
M 4,21
M 1,10
Lukovo
Iz.Kicevski
Struga
M 1,11
Belcishte
Boroec
Albania
Qarrishtë
Kuratica
M 1,12
Vevcani
Mesheishta
Struga
M 1,4
Openica
Izbishte
Ohrid
M 1,5
Resen
M 1,6
Resen
Prrenjas Qukës F
Pokrvenik
Pestani
Asamati
Stenje
Sveti Naum
M 1,13
Pogradec
Goricë e madhe
Nakolec
M 1,14
Brajcino
Pgo.Pretor
Liqenas
Greece
N
02,55 10 15 20
Kilometers
Legend
Meteo - Internat. Experts
L1
L2
Meteo Existing
Precip Existing
Dams
Towns
Drin River
Drin Tributaries
International Borders
Drin-Buna Basin
Lakes



Macedonia
20°15'E
20°30'E
20°45'E
21°E
21°15'E
41°45'N
41°30'N
41°15'N
41°N
Topojan
Shishtavec
Skavicë
Bushtricë
Fushë Lurë
Krakornica
Trnica
Mavrovo
Peshkopi
Zirovnica
Selishtë
Rostusha
Galicnik
Shupenzë
Gorno Kosovrasti
Debar
Zerqan
Lazaropole
Gjepishte
Kogjagjik
Macedonia
Slivovo
Klenjë
Lukovo
Iz.Kicevski
Struga
Belcishte
Albania
Boroec
Qarrishtë
Kuratica
Vevcani
Mesheishta
Struga
Openica
Radolishte
Izbishte
Ohrid
Resen
Resen
Prrenjas Qukës F
Pokrvenik
Pestani
Asamati
Stenje
Sveti Naum
Pogradec
Goricë e madhe
Nakolec
Brajcino
Pgo.Pretor
Liqenas
Greece
Legend
Meteo - National Experts
L1
L2
L3
Meteo Existing
Precip Existing
Dams
Towns
Drin River
Drin Tributaries
International Borders
Drin-Buna Basin
Lakes
N
0 2,5 5 10 15 20
Kilometers



Kosovo
Serbia
Montenegro
Kosovo
Macedonia
Uqe
Bogaj
Gurakoc
M 2,4
M 2,1
Baje e pejes
Pej
Ramun
Jabllanice
M 2,11
Izniq
Strelc
Junik
M 2,6
Gllogjan
Rakovine
M 2,7
Dragobi
M 4,2
Skivjan
Tropojë
M 4,3
M 2,10
Budakove
Bistazhin
B. Curri
Baba i Bokes
M 2,2
Celin
M 2,3
Lekbibaj
Zym
M 2,5
Prizren
M 2,8
Ibballë
M 4,9
Krumë
M 4,8
Petkaj
Kalimash
M 4,11
Kukes
M 2,9
Topojan
M 4,13
Shishtavec
Skavicë
Bushtricë
M 4,16
M 4,17
Trnica
Legend
Meteo - Internat. Experts
L1
L2
Meteo Existing
Precip Existing
Dams
Towns
Drin River
Drin Tributaries
International Borders
Drin-Buna Basin
N
Kilometers
20°E
20°15'E
20°30'E
20°45'E
21°E
42°45'N
42°30'N
42°15'N
42°N
41°45'N


Kosovo
20°E
20°15'E
20°30'E
20°45'E
21°E
42°45'N
42°30'N
42°15'N
42°N
41°45'N
Serbia
Montenegro
Kosovo
Macedonia
Uqe
Bogaj
Gurakoc
Baje e pejes
Pej
Ramun
Jabllavice
Izniq
Strelc
Junik
Gllogjan
Rakovine
Skivjan
Dragobi
Tropojë
B. Curri
Baba i Bokes
Bistazhin
Celin
Budakove
Lekbibaj
Zym
Malsi e Re
Mushtisht
Prizren
Iballë
Krumë
Petkaj
Kalimash
Kukës
Kukes
Topojan
Shishtavec
Skavicë
Bushtricë
Krakornica
Trnica
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6
7
8
9
10
Legend
Meteo - National Experts
L1
L2
Meteo Existing
Precip Existing
Dams
Towns
Drin River
Drin Tributaries
International Borders
Drin-Buna Basin
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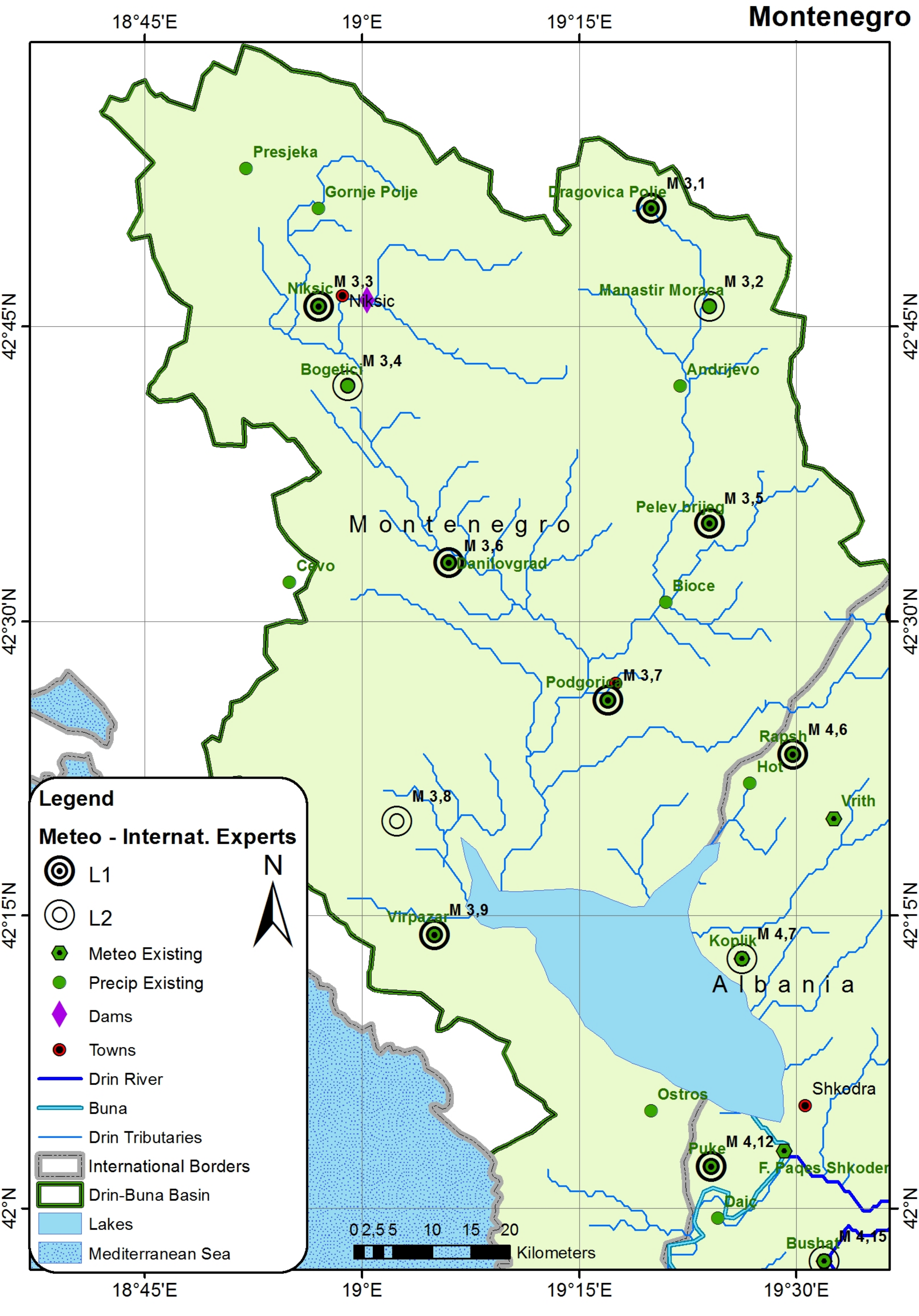
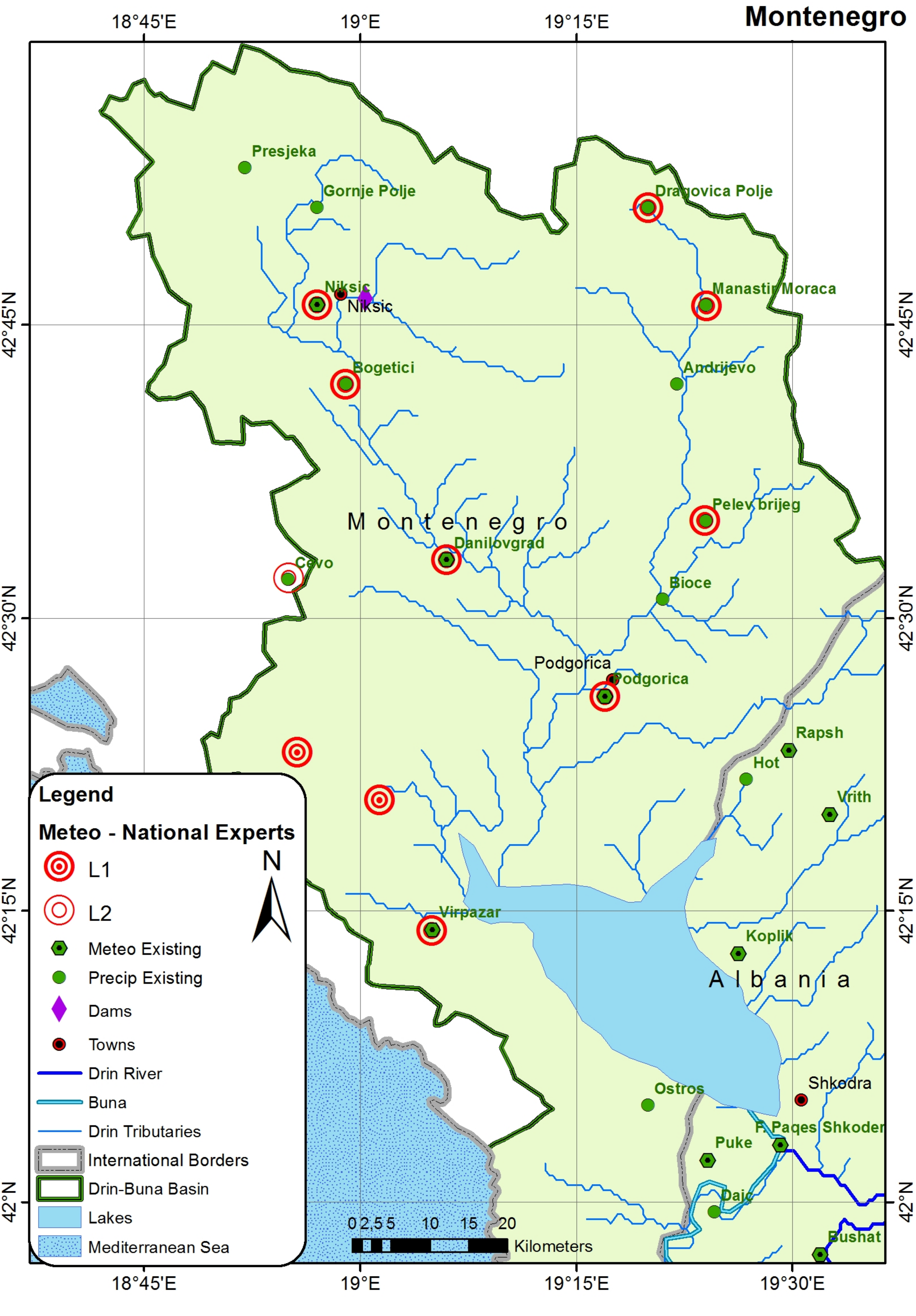
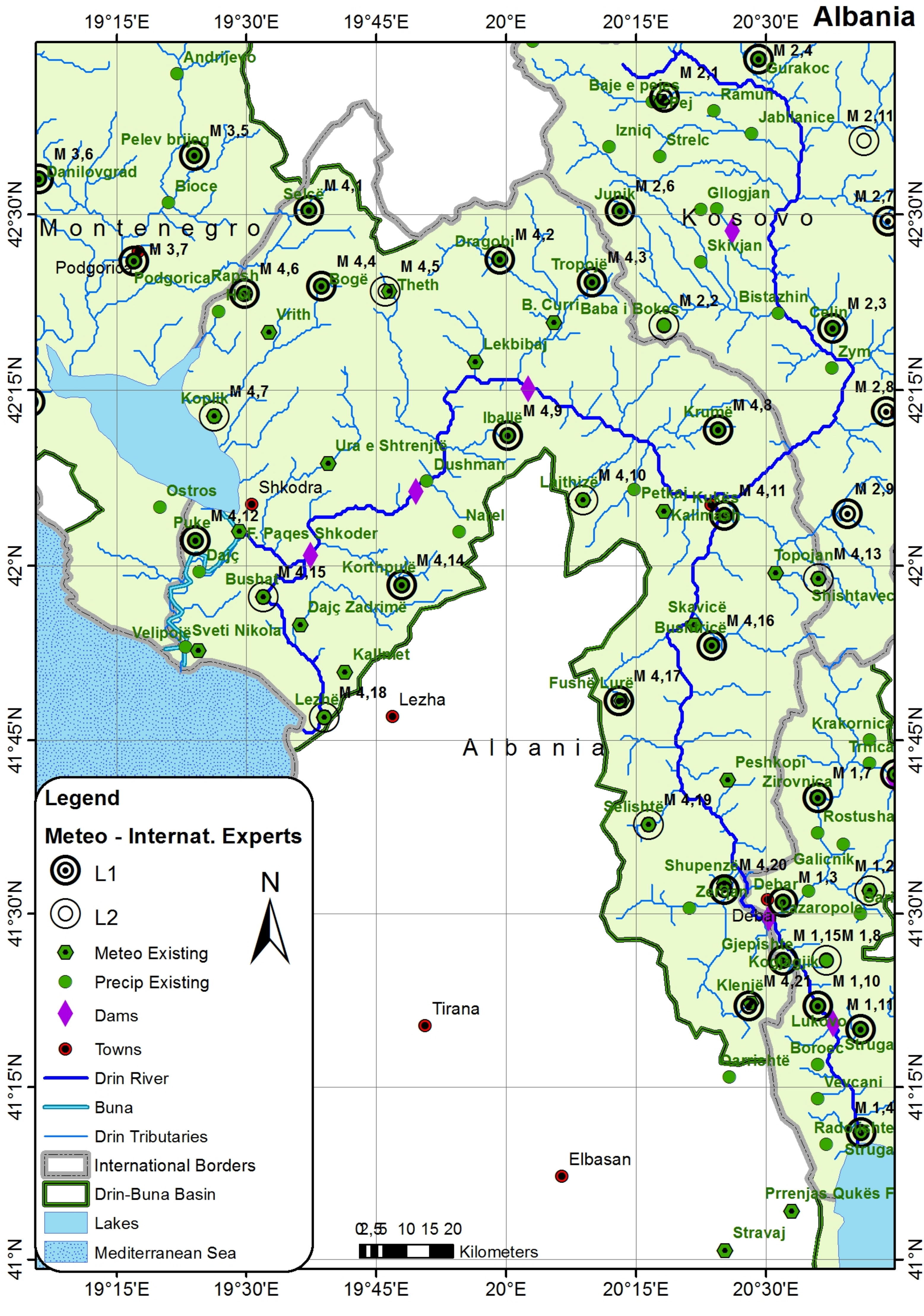
0 2.5 5 10 15 20
Kilometers



Montenegro
18°45'E
19°E
19°15'E
19°30'E
42°45'N
42°30'N
42°15'N
42°N
Presjeka
Gornje Polje
Dragovica Polje
M 3,1
Niksic
M 3,3
Niksic
Manastir Moraca
M 3,2
Bogetici
M 3,4
Andrijevo
Pelev brijeg
M 3,5
Montenegro
M 3,6
Danilovgrad
Cevo
Bioce
Podgorica
M 3,7
Rapsh
M 4,6
Hot
Vrith
M 3,8
Virpazar
M 3,9
Koplik
M 4,7
Albania
Ostros
Shkodra
Puke
M 4,12
F. Paqes Shkoder
Dajc
Bushat
M 4,15
N
0 2,5 5 10 15 20
Kilometers
Legend
Meteo - Internat. Experts
L1
L2
Meteo Existing
Precip Existing
Dams
Towns
Drin River
Buna
Drin Tributaries
International Borders
Drin-Buna Basin
Lakes
Mediterranean Sea



Montenegro
18°45'E
19°E
19°15'E
19°30'E
42°45'N
42°30'N
42°15'N
42°N
Presjeka
Gornje Polje
Dragovica Polje
Niksic
Niksic
Manastir Moraca
Bogetici
Andrijevo
Montenegro
Pelev brijeg
Danilovgrad
Cevo
Bioce
Podgorica
Podgorica
Rapsh
Hot
Vrith
Virpazar
Koplik
Albania
Ostros
Shkodra
F. Paqes Shkoder
Puke
Dajc
Bushat
Legend
Meteo - National Experts
L1
L2
Meteo Existing
Precip Existing
Dams
Towns
Drin River
Buna
Drin Tributaries
International Borders
Drin-Buna Basin
Lakes
Mediterranean Sea
N
0 2,5 5 10 15 20
Kilometers


Albania
19°15'E
19°30'E
19°45'E
20°E
20°15'E
20°30'E
42°30'N
42°15'N
42°N
41°45'N
41°30'N
41°15'N
41°N
Montenegro
Kosovo
Albania
Andrijevo
Pelev brijeg
M 3,5
M 3,6
Danilovgrad
Bioce
Podgorica
M 3,7
Ranch
M 4,6
Hot
Selcë
M 4,1
M 4,4
Bogë
M 4,5
Theth
Vrith
Dragobi
M 4,2
Tropojë
M 4,3
B. Curri
Baba i Bokes
M 2,2
Lekbibaj
Koplik
M 4,7
Iballë
M 4,9
Ura e Shtrenjtë
Dushman
Shkodra
Ostros
Nanel
Puke
M 4,12
F. Paqes
Shkoder
Dajç
Bushat
M 4,15
Korthpulë
M 4,14
Dajç Zadrimë
Velipojë
Sveti Nikola
Kallmet
Lezhë
M 4,18
Lezha
Baje e pejes
Pej
M 2,1
M 2,4
Gurakoc
Ramun
Jablanice
M 2,11
Izniq
Strelc
Junik
M 2,6
Gllogjan
M 2,7
Skivjan
Bistazhin
Celin
M 2,3
Zym
M 2,8
Krumë
M 4,8
Lajthizë
M 4,10
Petkaj
Kukës
M 4,11
Kalimash
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Topojan
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Shishtavec
Skavicë
Bushticë
M 4,16
Fushë Lurë
M 4,17
Krakornica
Trnica
Peshkopi
Zirovnica
M 1,7
Selishtë
M 4,19
Rostusha
Shupenzë
M 4,20
Galicnik
M 1,2
Zerqan
Debar
M 1,3
Debar
Lazaropole
Gjepishte
M 1,15
M 1,8
Kodragjik
Klenjë
M 4,21
M 1,10
M 1,11
Lukovo
Struga
Boroec
Qarrishtë
Vevcani
M 1,4
Radozhte
Struga
Tirana
Elbasan
Prrenjas
Qukës F
Stravaj
0 2,5 5 10 15 20
Kilometers
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Legend
Meteo - Internat. Experts
L1
L2
Meteo Existing
Precip Existing
Dams
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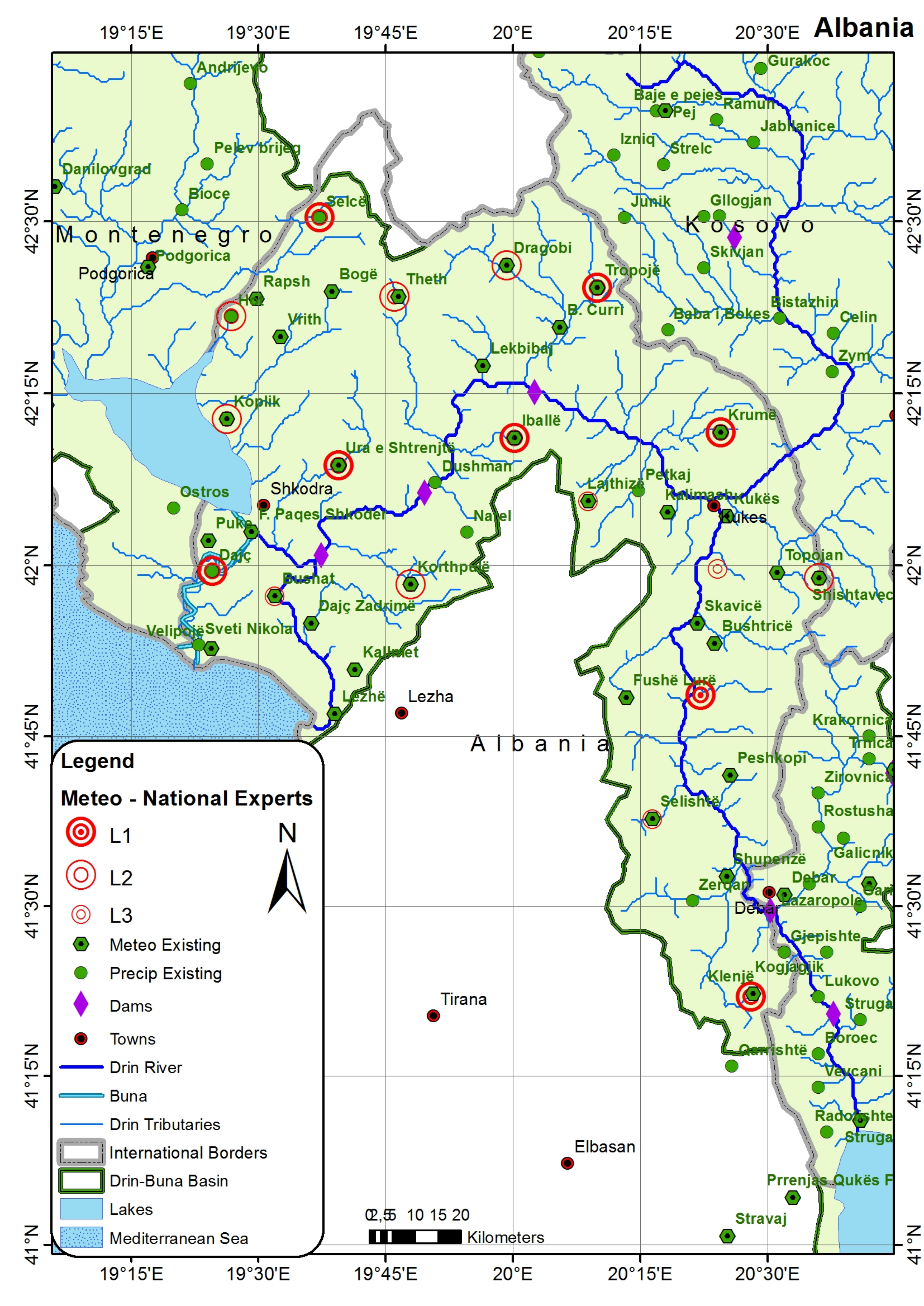
Drin River
Buna
Drin Tributaries
International Borders
Drin-Buna Basin
Lakes
Mediterranean Sea



Albania
19°15'E
19°30'E
19°45'E
20°E
20°15'E
20°30'E
42°30'N
42°15'N
42°N
41°45'N
41°30'N
41°15'N
41°N
Montenegro
Kosovo
Albania
Andrijevo
Pelev brijeg
Danilovgrad
Bioce
Selcë
Podgorica
Rapsh
Bogë
Theth
Dragobi
Tropojë
B. Curri
Vrith
Lekbibaj
Koplik
Iballë
Ura e Shtrenjtë
Dushman
Ostros
Shkodra
F. Paqes Shkodër
Nanel
Puke
Dajç
Bushat
Korthpulë
Dajç Zadrimë
Velipojë
Sveti Nikola
Kallmet
Lezhë
Lezha
Gurakoc
Baje e pejes
Pej
Ramun
Jablanice
Izniq
Strelc
Junik
Gllogjan
Skivjan
Bistazhin
Baba i Bokes
Celin
Zym
Krumë
Petkaj
Lajthizë
Kalimash
Kukës
Kukes
Topojan
Shishtavec
Skavicë
Bushtricë
Fushë Lurë
Krakornica
Trnica
Peshkopi
Zirovnica
Selishtë
Rostusha
Galicnik
Shupenzë
Debar
Zerqan
Debar
Lazaropole
Gjepishte
Klenjë
Kogjajik
Lukovo
Struga
Boroec
Qarrishtë
Vevcani
Radozhte
Struga
Prrenjas Qukës F
Stravaj
Tirana
Elbasan
Legend
Meteo - National Experts
L1
L2
L3
Meteo Existing
Precip Existing
Dams
Towns
Drin River
Buna
Drin Tributaries
International Borders
Drin-Buna Basin
Lakes
Mediterranean Sea
N
0 2,5 5 10 15 20
Kilometers

ANNEX

Annex 9:

Tables of selected hydrological stations and required upgrades

Hydrological stations for EWS recommended by international experts						Characteristics			
Stations Name	Type use flag *	Location	Waterbody	Level	according to the Macedonia system	Type use flag *	Improve-ment use flag ***	Comments
H 1,1	1 – OL	Lake Prespa	Lake	2	HS Stenje	1,3	1,3,4,7	Existing station – has to be renewed
H 1,3	1 - OL	Lake Ohrid	Lake	2	HS Sveti Naum (Ohrid Lake	1,3	1,3,4	Existing station (not operating) – has to be renewed
H 1,3	1 - OL	Lake Ohrid	Lake	1	HS Ohrid	1,3	3,4,7	Existing station – has to be upgraded
H 1,4	1,2-OL	Upstream Belciska (near M. Station Struga)	Drim	1	HS/MS Struga	1,2	--	Existing Station: HS/MS Struga: Station with Permanent ADCP (Complete Automatic Weather Station included)
H 1,5	1,2-OL	Botun	Saleska Reka	1	HS Botun	1,2,3,6	3,4,7	Existing station – has to be upgraded
H 1,6	1,2-OL	Lozani	Drim	1	Lozani	1,2	1,3,4,7	Existing station (not maintained) – has to be renewed
H 1,7	1-OL	Lake Globocicca	Lake	1	--	1,3	--	New station on the lake
H 1,8	1,2-OL	downstream Lake Globocicca	Drim	1	--	1,2	4,5,6,7	New station
H 1,9	1,2 – OL	Upstream Junction Mavrovska Reka / Radika	Radika	1	--	1,2	4,5,6,7	New station
H 1,10	1,2 – OL	Downstream junction Ribnicka Reka / Radika	Radika	1	HS Volkovija(Ribnicka):		1,3,4,5,6, 7	Existing station (not maintained) – has to be renewed

LEGEND

MACEDONIA STATIONS H 1, …

Flags

*

1	water level
2	discharge
3	water temperature
4	water quality data
5	rainfall (in addition)
6	suspended sediment
7	
8	
9	

**

-- / - / 0 / + / ++

***

1	renew at same location
2	renew at different location
3	upgrade to automatically working station - data logger
4	uprade to online station
5	Cross section survey
6	develop Rating Curve
7	add online rainfall recorder
8	
9	etc…
10	

OL	=	Online Station
H	=	Hydrometer
V	=	Autorecorder

H 1,11	1,2 – OL	Upstream Dam Debar	Radika	1		HS Boskov Most	1,2,3	2,3,4,5,6, 7	destroyed station – has to be renewed
H 1,12	1 – OL	Lake Debar	Lake	1		HS HE Spilje	1,3	1,4,7	Existing station – has to be renewed
H 1,13	1,2 – OL	Downstream dam Debar (boarder Macedonia-Albania)	Drim	1		--	1,2	3,4,5,6	New station

Hydrological stations for EWS recommended by international experts						Characteristics			
Stations Name	Type use flag *	Location	Waterbody	Level		according to the Kosovo system	Type use flag *	Improve-ment use flag ***	Comments
H 2,1	1,2 – OL	Kepuz	White Drin	1		Kepuz	1,2,4	1,3,4,5,6	Existing station – has to be renewed
H 2,2	1,2 - OL	Gjakove	Rodonec	1		Gjakove	1,4	1,3,4,5,6	Existing station – has to be renewed
H 2,3	1,2 - OL	Gjonaj	White Drin	1		Gjonaj	1,2,3,4	1,3,4,5,6	Existing station – has to be renewed
H 2,4	1,2-OL	Upstream boarder Kosovo-Albania	White Drin	1		--	1,2	1,3,4,5,6	New at this location

LEGEND

KOSOVO STATIONS H 2, …

Flags

*

1	water level
2	discharge
3	water temperature
4	water quality data
5	rainfall (in addition)
6	suspended sediment
7	
8	
9	

**

-- / - / 0 / + / ++

***

1	renew at same location
2	renew at different location
3	upgrade to automatically working station - data logger
4	uprade to online station
5	Cross section survey
6	develop Rating Curve
7	add online rainfall recorder
8	
9	etc…
10	

OL	=	Online Station
H	=	Hydrometer
V	=	Autorecorder

Hydrological stations for EWS recommended by international experts						Characteristics			
Stations Name	Type use flag *	Location	Waterbody	Level		according to the Montenegro system	Type use flag *	Improve-ment use flag ***	Comments
H 3,1	1,2 – OL	Pernica	Moraca	1		Pernica	1,2 – OL		Existing station – no improvement necessary
H 3,2	1,2-OL	Zlatica	Zalli Bulqizes	1		Zlatica	1,2 - OL		Existing station – no improvement necessary
H 3,3	1,2-OL	Danilovgrad	Zeta	1		HS Danilov-grad	1,2,3	1,3,4,5,6	At this location a meteo station exists-renew at this location
H 3,4	1,2-OL	Trgaj	Cijevna	1		HS Cijevna - Trgaj	1,2,3	1,3,4,5,6	new at this location
H 3,5	1,2-OL	Downstream junction Moraca – Cijevna	Moraca	1		--	1,2,3	1,3,4,5,6	new at this location
H 3,6	1-OL	Lake Shkoder	Lake	1		Plavnica	1 – OL	7	Renew at this location
H 3,7 [1)] H 4,18	2,3 -OL	Fraskanjel	Bojana	1		Fraskanjel	2 – OL	1, 3,4,5,6	For measuring of discharge on this station is crucial to obtain Dopler and to have common understanding with Albanian colleagues for measuring the whole cross section

[1)] Station No. 3,7 is identical to station H 4,18, and is operated by Montenegro HMS. In Future this station should be commonly operated by Montenegro & Albanian HMS

LEGEND

MONTENEGRO STATIONS H 3, …

Flags

*

1	water level
2	discharge
3	water temperature
4	water quality data
5	rainfall (in addition)
6	
7	
8	
9	

**

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***

1	renew at same location
2	renew at different location
3	upgrade to automatically working station - data logger
4	uprade to online station
5	Cross section survey
6	develop Rating Curve
7	add online rainfall recorder
8	
9	etc…
10	

OL	=	Online Station
H	=	Hydrometer
V	=	Autorecorder

Hydrological stations for EWS recommended by international experts						Characteristics			
Stations Name	Type use flag *	Location	Water-body	Level		according to the Albania system	Type use flag *	Improve-ment use flag ***	Comments (flag *)
H 4,1	1,2 – OL	River Zafli Okshtuni	Zalli Bulqizes	2		--	1,2,3	3,4,5,6	New station : 1,2,3
H 4,2	1,2-OL	River Zerkjani	Zalli Bulqizes	2		--	1,2,3	3,4,5,6	New station : 1,2,3
H 4,3	1,2-OL	River Black Drin / Rugae Arberit, right after junction of Zafli-Zerkjani-Drin	Black Drin	1		**16: Drini I zi, Kovashice**	1	3,4,5,6	Existing station – has to be upgraded
H 4,4	1,2-OL	upstream Kukes	Black Drin	1		--	1,2,3	3,4,5,6	New station : 1,2,3
H 4,5	1,2-OL	River Lumes upstream junction with Drin; Belaj	Lumes	1		**26: Lumi I Lumes:Belaj**	H	3,4,5,6	Existing station – has to be upgraded
H 4,6	1-OL	Lake Fierzes	Drin / Lake	1		--	1,3	3,4,	New station : 1,4 2)
H 4,7	1,2-OL	Downstream Dam Fierzes	Drin	1		--	1,2,3	3,4,5,6	New station : 1,2,3 2)
H 4,8	1,2-OL	River Valbones / upstream junction Drin; Gri	Valbones	1		37: Valbona Gri	H, V	3,4,5,6	Existing station – has to be upgraded

LEGEND

ALBANIA STATIONS H 4, …

Flags

*

1	water level
2	discharge
3	water temperature
4	water quality data
5	rainfall (in addition)
6	
7	
8	
9	

**

-- / - / 0 / + / ++

***

1	renew at same location
2	renew at different location
3	upgrade to automatically working station - data logger
4	uprade to online station
5	Cross section survey
6	develop Rating Curve
7	
8	
9	etc…
10	

OL = Online Station
H = Hydrometer
V = Autorecorder

Hydrological stations for EWS recommended by international experts						Characteristics			
Stations Name	Type use flag *	Location	Waterbody	Level		according to the Albania system	Type use flag *	Improve-ment use flag ***	Comments (flag *)
H 4,9	1,2-OL	Upstream junction Leshnices – Drin	Drin	1		--	1,3	3,4,	New station : 1,4 [2)]
H 4,10	1,2-OL	River Leshnices, upstream junction with Drin	Leshnices	1		--	1,2,3	3,4,5,6	New station : 1,2,3 [2)]
H 4,11	1,2-OL	Downstream Dam Komanit	Drin	1		--	1,3	3,4,	New station : 1,4 [2)]
H 4,12	1,2-OL	River Dushit, upstream junction with Drin	Gomsiqe	1		**48: Perroit I Gomisques**	H	3,4,5,6	Existing station – has to be upgraded
H 4,13	1,2-OL	downstreamstream Dam Vaut te Dejes	Drin	1		--	1,2,3	3,4,5,6	New station : 1,2,3 [2)]
H 4,14	1,2-OL	Gjader	River Buna	2		--	1,2,3	3,4,5,6	New station : 1,2,3 [2)]
H 4,15	1-OL	Lake Shkoder Shiroke	Lake	1		--	1,3	3,4,	New station : 1,4
H 4,16	1,2-OL	Outlet Lake Shkoder	River Buna	1		--	1,2,3	3,4,5,6	New station : 1,2,3
H 4,17	1,2-OL	River Kirit, upstream Junction to river Drin Rasek	Kiri	1		--	1,2,3	3,4,5,6	New station : 1,2,3
H 4,18[1)] H 3,7	1,2-OL	River Buna, downstream Junction with Drin	River Buna	1		--	1,2,3	3,4,5,6	New station : 1,2,3

Remarks:

[1] Station No. 4,18 is identical to station H 3,7, which is operated by Montenegro HMS. In Future this station should be commonly operated by Montenegro & Albanian HMS.

[2] Present knowledge about existing stations along the Albanian reservoir cascade is poor; it is expected that some of the recommended new stations are already existing (non-automatic) or will be installed by KESH company.

ANNEX

Annex 10:

Tables of selected meteorological stations and required upgrades

Meteorological stations for EWS recommended by intern. experts					Characteristics			
Stations Name	Type	Location	Level		according to the Macedonia system	Type use flag *	Improve-ment use flag ***	Comments (flag *) (national expert delivered detailed lists for upgrading)
M 1,1	C	Mavrovo	1		Mavrovo	1,2,3,4,5,6,7,8	3,4	
M 1,2	C	Lazaropole	2		Lazaropole	1,2,3,4,5,6,7	3,4	
M 1,3	C	Debar	1		Debar	1,2,3	3,4	
M 1,4	C	Struga	1		Struga	1,2,3	3,4	
M 1,5	C	Ohrid	1		Ohrid	1,2,3,4,5,6,7	4	Automatic Since 2011
M 1,6	C	Resen	1		Resen	1,2,3	4	Automatic Since 2010
M 1,7	P	Zirovnica	1		Zirovnica	3	3,4	
M 1,8	P	Kogjagjik	2		Kogjagjik	3	3,4	

LEGEND

MACEDONIA STATIONS M1, ...

Flags
*****

1	wind
2	temperature
3	precipitation
4	snow depth
5	radiation
6	sunshine duration
7	relaive humidity
8	evaporation
9	etc

******

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****

1	renew at same location
2	renew at different location
3	upgrade to automatically working station - data logger
4	upgrade to online station

T - termometric

P - pluviometric

C- climatic

Meteorological stations for EWS recommended by intern. experts					Characteristics			
Stations Name	Type	Location	Level		No. according to the albanian no system	Type use flag *	Improve-ment use flag ***	Comments (flag *)
M 1,9	P	Slivovo	1		Slivovo	3	3,4	
M 1,10	P	Lukovo	1		Lukovo	3	3,4	)
M 1,11	P	Struga	1		Struga	3	3,4	
M 1,12	P	Kuratica	1		Kuratica	3	3,4	
M 1,13	P	Sveti Naum	2		Sveti Naum	3	3,4	
M 1,14	P	Brajcino	2		Brajcino	3	3,4	
M 1,15	C	Gjepishte	1		Gjepishte	1,2,3, 4,5,6, 7,8	3,4	New station.

annex_10_2_kosovo

Meteorological stations for EWS recommended by intern. experts			Level	Characteristics			
Stations Name	**Type**	**Location**	**Level**	**according to the Kosovo system**	**Type** **use flag** *	**Improve-ment** **use flag** ***	**Comments (flag *)**
M 2,1	C	Pejë	1	Pejë	1,2,3, 4,5,6	4	Existing station has to be upgraded.
M 2,2	P	Baba i Bokes	2	Baba i Bokes	3	1,3,4	Existing station has to be renewed.
M 2,3	P	Celin	1	Celin	3	1,3,4	Existing station has to be renewed.
M 2,4	P	Gurakoc	1	Gurakoc	3	1,3,4	3,4 - Existing station has to be renewed.
M 2,5	P	Mushtisht	2	Mushtisht	3	1,3,4	3,4 - Existing station has to be renewed.
M 2,6	C	Junik	1	Junik	3	1,3,4	1,2,3,4,5,6 - Existing station has to be renewed.
M 2,7	C	Malishev	1	Malishev	3	1,3,4	1,2,3,4,5,6 - Existing station has to be renewed.
M 2,8	C	Prizren	1	Prizren	3	1,3,4	1,2,3,4,5,6 - Existing station has to be renewed.

LEGEND

KOSOVO STATIONS M2, ...

Flags
*

1	wind
2	temperature
3	precipitation
4	snow depth
5	radiation
6	sunshine duration
7	relaive humidity
8	evaporation
9	etc

**

-- / - / 0 / + / ++

***

1	renew at same location
2	renew at different location
3	upgrade to automatically working station - data logger
4	upgrade to online station

T - termometric

P - pluviometric

C- climatic

Meteorological stations for EWS recommended by intern. experts					Characteristics			
Stations Name	Type	Location	Level		No. according to the albanian no system	Type use flag *	Improve-ment use flag ***	Comments (flag *)
M 2,9	P	Shaii	1		Shaii	3	1,3,4	3,4 – New station
M 2,10	P	Therandee	1		Therandee	3	1,3,4	3,4 – New station
M 2,11	P	Ujemir	2		Ujemir	3	1,3,4	3,4 – New station

annex_10_3_montenegro

Meteorological stations for EWS recommended by intern. experts				Characteristics			
Stations Name	Type	Location	Level	No. according to the Montenegro system	Type use flag *	Improve-ment use flag ***	Comments (flag *)
M 3,1	P	Dragovica Polje	1	Dragovica Polje	3,4	1,3,4	Existing station has to be renewed.
M 3,2	P	Manastir Moraca	2	Manastir Moraca	3,4	1,3,4	Existing station has to be renewed.
M 3,3	M	Niksic	1	Niksic	1,2,3, 4,5,6, 7,9	1,3,4	Existing station as online station – station has to be renewed
M 3,4	P	Bogetici	2	Bogetici	3,4	1,3,4	Existing station has to be renewed.
M 3,5	P	Pelev brijeg	1	Pelev brijeg	3,4	1,3,4	Existing station has to be renewed.
M 3,6	C	Danilovgrad	1	Danilovgrad	2,3,4,	1,3,4	Existing station: Upgrade with additional sensors: 5,6,7,8,9
M 3,7	M	Podgorica	1	Podgorica	1,2,3, 4,5,6, 7,9		Existing station: Upgrade with additional sensors
M 3,8	C	Rijeka Crnojevica	2	Rijeka Crnojevica	1,2,3, 4,5,6, 7,9	1	NEW Station at an existing Hydrometric station

LEGEND

MONTENEGRO STATIONS M 3, ...

Flags
*

1	wind
2	temperature
3	precipitation
4	snow depth
5	radiation
6	sunshine duration
7	relaive humidity
8	evaporation
9	ground temperature

******

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****

1	renew at same location
2	renew at different location
3	upgrade to automatically working sta logger
4	upgrade to online station

T – termometric
P – pluviometric
C – climatic
M – meteorologic

Meteorological stations for EWS recommended by intern. experts					Characteristics			
Stations Name	Type	Location	Level		No. according to the albanian no system	Type use flag *	Improve-ment use flag ***	Comments (flag *)
M 3,9	C	Virpazar	1		Virpazar	2,3,4,	1,3,4	Existing station has to be renewed, and upgraded with: 7

annex_10_4_albania

Meteorological stations for EWS recommended by intern. experts				Characteristics			
Stations Name	Type	Location	Level	No. according to the Albanian no system	Type use flag *	Improve-ment use flag ***	Comments (flag *)
M 4,1	P	Selcë	1	Selcë	3,5	4	
M 4,2	T	Dragobi	1	Dragobi	2,3,5	4	
M 4,3	T	Tropojë	1	Tropojë	2,3,5	4	
M 4,4	T	Bogë	1	Bogë	2,3,5	4	World Bank funding for upgrade
M 4,5	T	Theth	2	Theth	2,3,5	4	
M 4,6	T	Rapsh	1	Rapsh	2,3,5	4	World Bank funding for upgrade
M 4,7	T	Koplik	2	Koplik	2,3,5	4	
M 4,8	T	Krumë	1	Krumë	2,3,5	4	

LEGEND

ALBANIA STATIONS M 4, ...

Flags

*****

1	wind
2	temperature
3	precipitation
4	snow depth
5	radiation
6	sunshine duration
7	relaive humidity
8	evaporation
9	etc

******

-- / - / 0 / + / ++

****

1	renew at same location
2	renew at different location
3	upgrade to automatically working station - data logger
4	upgrade to online station

T - termometric

P - pluviometric

C- climatic

Meteorological stations for EWS recommended by intern. experts					Characteristics			
Stations Name	Type	Location	Level		according to the Albania system	Type use flag *	Improve-ment use flag ***	Comments (flag *)
M 4,9	T	Iballë	1		Iballë	235	**4**	
M 4,10	T	Lajthizë	2		Lajthizë	235	**4**	
M 4,11	C	Kukës	1		Kukës	23456	4	World Bank funding for upgrade
M 4,12	T	Puke	1		Puke	23	4	World Bank funding for upgrade
M 4,13	T	Shishtavec	2		Shishtavec	235	**4**	
M 4,14	T	Korthpulë	1		Korthpulë	235	**4**	
M 4,15	T	Bushat	2		Bushat	235	**4**	
M 4,16	T	Bushtricë	1		Bushtricë	235	3,4	
M 4,17	C	Fushë Lurë	1		Fushë Lurë	235	4	World Bank funding for upgrade
M 4,18	C	Lezhë	2		Lezhë	235	4	
M 4,19	T	Selishtë	2		Selishtë	235	**4**	

M 4,20	T	Shupenzë	1		Shupenzë	235	4	World Bank funding for upgrade
M 4,21	C	Klenjë	1		Klenjë	235	**4**	

ANNEX

Annex 11:

Required Equipement and IT Structure

Equipment: Minimum requirements for each country and for the DEWS operational centre

As displayed in the above system sketch, the observation – transmission - storing – transmission system in general consists of seven basic system components which are related to each other:

Observation station and transmission – the rainfall stations, the water level gauging stations, the climate stations; with transmission standard GSM, UMTS, GPRS sending and receiving data via the Internet Protocol.

Data logger – all measured data are being stored to the data logger and will be transferred via any mobile communication standard (GSM, UMTS, GPRS) to a specific telemetry unit (e.g. SODA by Kisters).

Telemetry – (e.g. SODA) It consists of hardware and software designed specifically for handling a broad range of communication tasks. The software directs and monitors all the activities carried out by the Telemetry Unit (TU). This means that the TU user is able to configure the TU, view raw data and protocols on screen, manage and edit basic data, as well as creating and triggering jobs.

Netconnection – via internet

Data Server – Computer software and hardware (a database platform) which delivers database services.

Terminal PC – A computer terminal that is used for entering data into, and displaying data from a computer or a computing system and the data server. The function of a terminal PC is confined to display and input of data.

Compute Server – A computer to provide high computational performance i.e. for intensive tasks like simulation runs etc.

Equipment: Minimum requirements for each country and for the DEWS operational centre

Standard equipment for a national hydrometeorological department being responsible for acquisition and management of online data and the transmission to the forecasting centre

	Number	**Specification**	**Explanation**
Terminal PC	3	Industrial PC (1)	To be used as a terminal PC.
Data Server	2	Server Express Seller System (1)	Transmission, data access, data management (2 server: 1 server for data back-up – system mirroring)
Compute Server	1	Industrial PC (1)	Data computation of processed data
Hard-Drive-Disk	3	2 TB HDD for PC and MAC	Data security
Printer	2	Laser Jet	Print Bulletins
Security software	1		Data security
Internet – Router	1		Data Communication
Data Management - Software	1		Data Management (e.g. WISKI by KISTERS)
Hardware	1		Data Telemetry System (e.g. SODA by KISTERS)
Operatings Systems, data bank software	1		Windows, Oracle, MSSQL

Standard equipment for the DEWS operational centre (Minimum Equipment)

	Number	**Specification**	**Explanation**
Terminal PC	3	Industrial PC (1)	To be used as a terminal PC.
Data Server	2	IBM Server Express Seller System (1)	Transmission, data access, data management (2 server: 1 server for data back-up – mirroring)
Compute Server	1	Industrial PC (1)	Data computation of processed data
Hard-Drive-Disk	3	2 TB HDD for PC and MAC	Data security
Printer	2	Laser Jet	Print Bulletins
Security software	1		Data security
Internet – Router	1		Data Communication
Data Management - Software	1		Data Management (e.g. WISKI by KISTERS)
Hardware	1		Data Telemetry System (e.g. SODA by KISTERS)
Operatings Systems, data bank software	1		Windows, Oracle, MSSQL

Equipment: Minimum requirements for each country and for the DEWS operational centre

Remark [(1)]: Recommended Specifications (denominated manufacturers are just options)

Server/Workstation/PC	Characteristics	Disk space
Data Server	IBM SERVER, 8 GB DDR3; TFT Full HD Monitor (19");	2 TB HDD
Terminal PC (Industrial PC)	Atom-Duo, 2,13 GHz, 4GB RAM,320 GB HDD, TFT Full HD Monitor (19");	300GB
Hard Disk Drive (Backup)	Seagate GoFlex Desk 2TB	2 TB
Compute PC (Industrial PC)	Intel® Core™ i7-3770 Quad-Core-Processor 3rd Generation (3,4 GHz + Turbo Boost, 8 MB, HD-Grafic 4000) **Operating System** Windows 7 Professional (64Bit OS) **RAM** 8 GB DDR3 SDRAM at 1600 MHz **HDD** 3,5-Inch SATA, 500 GB at 7.200 rpm **Video** NVIDIA® Quadro® K600, 1 GB (1 x DP, 1 x DVI-I), DP-DVI- DVI-VGA-Adapter + TFT Monitor (19")	500 GB

Standard equipment for a national meteorological station

	Number	Specification	Explanation
Rain gauge recorder	1		Precipitation in high temporal resolution is the most important meteorological input for flood forecast
Standard rain gauge	1		The standard rain and snow gauge is an aluminium rain gauge with a total capacity of 20" of rainfall. The upper portion of the funnel is cylindrical in shape and is turned to a sharp edge. Rainwater falling into the funnel is delivered into the receiver.
Temperature and humidity sensor	1		Combined measurement of temperature and humidity in a ventilated and radiation protected cabin 2 m above ground.
Pyranometer	1		Measurement of the global radiation 2 m above ground.
Barometer	1		Measurement of the air pressure.
Wind sensor	1		Measurement of wind speed and wind direction 10 m above ground.
Telescopic mast	1		Mast with 10 m height to arrange the meteorological sensors.
Datalogger	1		Data logger to collect all measured values of the meteorological sensors.
Transmitter	1		e.g. GSM modem
Steel case			Water-Protection of the data logger and transmitter.

Equipment: Minimum requirements for each country and for the DEWS operational centre

Standard Equipment for a national Rainfall-Station

	Number	Specification	Misc.
Rainfall Station	1	Complete precipitation station for measuring, storing and transmitting precipitation data.	– Tipping bucket – Rain gauge – In-built data logger – In-built GSM modem – Stainless steel enclosure – Access and download of rainfall data remotely – 12VDC-Low power consumption 5 Watt solar panel
Standard rain gauge	1		The Standard rain and snow gauge is an all aluminium rain gauge with a total capacity of 20" of rainfall. The upper portion of the funnel is cylindrical in shape and is turned to a sharp edge. Rainwater falling into the funnel is delivered into the receiver.

Standard Equipment for a national Water-Level-Gauging Station

	Number	Specification	Misc.
Water Level Sensor & Data Logger	1	Water level & temperature & multilogger for storage of analogue and digital measuring values.	Measurement of water level can also be realised by Radar Level Sensor Technique – if bridges, walkways or pipelines across the river exists. In this case it wouldn't be necessary to construct expensive structures (water gauge housing)
Transmission System	1	The GSM / GPRS online measuring system with integrated data logger and modem. Battery or solar powered. SMS alarms when reaching free programmable alarm levels.	
Software	1	Data management	

Equipment: Minimum requirements for each country and for the DEWS operational centre

Standard Equipment for a national measurement of rating curves (denominated manufacturers are just options)

	Number	Specification	Explanation
ADCP (Acoustic Doppler Current Profiler)	1	Measurement of flow velocity, discharge determination, e.g. “River Ray” from SEBA	Modern and comfortable **discharge measurements**. For water depths from 0.6m - 40m and flow velocities up to max. 5m/s. The combination of latest technology and easy handling will make your next measurement an innovative experience. **ADCP Sensor** **Number of cells**: automatic, 25 typical, 200 maximum **Cell size**: automatic, 10 - 80cm **Min. depth**: 0.6m **Max. depth**: 40m **Bottom Tracking:** 70m **Accuracy**: ±0.25cm/s or ±0.25% of velocity (water and boat) **Resolution**: 0.1cm/s **Measurement range**: ±5m/s **Configuration**: phased array **Frequency:** 600kHz **Geometry**: 4 beams **Angle of beam**: 30°
Data Management	1	Handheld & Software	
Rubber Boat	1	Rubber Boat with 5 PS engine	
Propeller Type Current Meter	1	Measurement of flow (low velocity, low water level)	Portable device for point-by-point measuring for accessing the current speeds in running waters. The current meter consists of a hydro-metric vane at the lower end of a telescopic rod and a splash-proof hand terminal. **Technical Data** Measuring range : 0.100 ... 9.999 m/s Resolution : 0,001 m/s Accuracy : ± 5% (0.100 ... 0.499 m/s) : ± 1% (0.500 ... 9.999 m/s) Memory : 4000 measuring values Ambient temperature:: 0 - 50°C Protection type Hand Terminal : IP 65 EC-Conformity (CE) : EN 50081-1, EN 50082-1

Standard Equipment for surveying the bathymetry (rivers, lakes, reservoirs)

	Number	Specification	Explanation
Echo-sounder	1		With GPS supported echo sounding measurements the depths of the riverbed can be surveyed
GPS/GNSS-Satellite measurement equipment	1		

Additional costs

Additional costs not mentioned in the above tables are:

1. An autonomous, third-party housing / fencing of the different observation locations
2. Security measures against unauthorized access
3. Any necessary construction costs
4. Any training costs of staff (e.g. software, measuring equipment)