General Overview of the Transboundary Waters of Rivers, Lakes, Groundwater and Trend of them, in Albania

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Abstract

Albania - Land of the Eagles. The Republic of Albania is located in Southeastern Europe, in the western part of Balkan Peninsula facing the Adriatic Sea (sandy shore) and the Ionian Sea (rocky shore). Its coordinates are 39º 38' (Konispol) and 42º 39' (Vermosh) north latitude, and 19º 16' (Sazan Island) and 21º 40' (Vermik village, Korça). Albania has a surface area of 28748 km^2 and a population of 3, 6 million inhabitants. It is administratively divided in 12 prefectures, 36 districts, 61 municipalities with 2900 villages. Albania is rich in water resources like lakes, rivers, springs, lagoons, with a high quantity of available water. The Albanian territory covers about 65% of a total watershed (basin) area of 43,905 km^2. Water by Transboundary Rivers, Lakes and Groundwater's constitutes an important resource for Albania, and in comparison to other European countries is indeed considered to be one of the richest, as far as this resource is concerned. Albania is crossed by several rivers, which flow from mountainous regions to plains, generally from east to west. The most important ones are the Rivers, as well Buna, Drini, Mati, Ishmi, Erzeni, Shkumbini, Semani, Vjosa and Bistrica. All the rivers mentioned above flow (discharge) into the Adriatic Sea, except Bistrica, which flows (discharge) into the Ionian Sea, forming a number of coastal lagoons and swamps, while Vermoshi river is located in the northern tip of Albania, and it is the only river that flows into the Danube, therefore, the Vermoshi River is only tributary of Danube River in Albania. Additionally Albania shares lakes with its neighboring countries. Lakes Ohrid and Prespa are shared with the Former Yugoslav Republic FYR of Macedonia, Lake Shkodra with Montenegro, and Lake Prespa with Greece. In this paper are presented some characteristics of most important rivers and lakes in Albania, through the collection of data from existing networks of meteorology, hydrology & environment; harmonized surveys, sampling, assessment, monitoring and analysis of their by conducting several studies simultaneously by means of several long-term projects, but annual and short-term. The Groundwater in Albania is present in different sort of rocks of different ages, from Paleozoic to Quaternary, and has a great importance for being the only source of drinking water supply. Yet not much is known about its real availability and extraction capacity. This presently leads to some problems: well fields located near the Adriatic coast, near Laçi and Durresi is now affected by the intrusion of saline water, probably due to over exploitation. According to local conditions groundwater is exploited through wells, mainly in the plains and valleys, or through springs, most frequently in the hills and mountain areas. But its presence and use are fairly common throughout the country. As frequently the case, and particularly where large karstic areas affect the movement of groundwater, river basins do not coincide with groundwater units; in this report, however, groundwater resources will be presented sorted by river basin unit to enable a comparison of availability and use.

KEYWORLDS*:* monitoring, waters of rivers, lakes, groundwater

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1 Introduction

Albania is noted for a high change in the altitude above sea level (2751 m), a feature that is associated with deep changes in geology and the relief, as well as with substantial vertical changes of the climate, hydrographic, land and vegetation. It is mainly a mountainous country: 13,3 % of the territory is 0 up to 300 m high, 25,5 % between 300 and 600 m, and 61,2% over 600 m of altitude above sea level (Agim Selencia 2001/1; Bashkim Lushaj *et* al. 2015).

As we know, the first assessment of Transboundary Rivers, Lakes and Groundwater's was prepared for the Sixth Ministerial Conference "Environment for Europe" (Belgrade, 10-12 October 2007) by the Convention's Working Group on Monitoring and Assessment (WGMA). The Belgrade Ministerial Conference expressed its appreciation regarding the preparation of the First Assessment and invited the Meeting of the Parties to the Convention to prepare the Second Assessment of transboundary waters for the next Ministerial Conference tentatively scheduled to take place in Albania in 2011 (Agim Selenica 2008; Bashkim Lushaj *et* al. 2015).

For the 2-3 last decades the Albania has been in a state of economic transition and has adopted a democratic form of government and a free market economy. Albania had in the past an undeveloped economy, and continues to have severe environmental problems. Damage to forests, loss of wetlands, the use of out of date technology and lack of waste treatment plants for urban areas are among the many consequences of the past neglect of natural resources and environmental degradation. On the other hand, the increase in foreign investments has emphasized the need to address environmental protection issues and the rational utilization of natural resources (Agim Selenica 2001/1)

Albania is rich in water resources like lakes, rivers, springs, lagoons, with a high quantity of available water. The Albanian territory covers about 65% of a total watershed (basin) area of 43,905 km^2. More than 152 torrents and small rivers finally form the eight large rivers: Buna (41 km), Drini (285 km), Mati (115 km), Ishmi (74 km), Erzeni (109 km), Shkumbini (181 km), Semani (281 km), and Vjosa (272 km), which run southeast to northwest towards the Adriatic coast (Kabo 1990-1991, Agim Selenica 2008; Bashkim Lushaj *et* al. 2015).

Water resources by Rivers, Lakes and Groundwater's in Albania are abundant, almost in all the regions of the country, with an uneven seasonal distribution. The available quantity of surface water and to a less extent of groundwater also, strongly decreases during the months of summer. Thus, only about 6-9 % of the annual runoff is observed during the dry season (July-September). The average annual precipitation in Albania is approximately 1485 mm, the mean annual run off is 891 and the mean volume of water, discharged by all the rivers in the sea, is 41 km^3 of water. It corresponds to a mean discharge of 1300 m^3/s, approximate with those of the Po River in Italy (Agim Selenica 2001/1).

Water hazards are: Floods; Droughts; Pollution; Erosion; Dam and levee breaching; Impact of hydro-hazards on economy; Impact of hydro-hazards on society etc. (Bashkim Lushaj *et* al. 2015). Flooding is a frequent problem in Albania. The main causes of the extreme floods are the morphometric and climatic conditions. Degradation of the quality of transboundary water resources, caused mainly by pollution from land based activities (nutrients, pathogens, and oxygen-demanding wastes) is an important problem for Albania. The water sector is one of the priorities of the National Government. Several lending operations from international financial institutions are supporting the rehabilitation of the water and wastewater systems in the country (Agim Selenica 2001/2).

The water resources by Rivers, Lakes and Groundwater's in Albania are mainly used for: Energy, as hydropower development for energy security, hydropower generation - low, medium, and high head, alternative sources of energy, environment and energy and hydrological design aids; Other uses, as well irrigation, rural development, ecosystem and forestry, industry etc.; Society, as well drinking water demand management etc. Ago until now, the use of water resources from rivers, lakes and groundwater was not in the required level, then there's left to be desired, because we had use not clever of these water resources, let's look at the hopefully in the future! (Bashkim Lushaj *et* al. 2008; Bashkim Lushaj *et* al. 2015).

2 Climate

The Republic of Albania lies to the Western part of Balkan Peninsula at the coast of Adriatic and Ionian Seas. It is situated between 39° 38 - 42°39 N and 19°16 -21°04 E. Albania extends over an area of 28748 km^2, with 76, 6 % mountain and hills. The country combines a coastal plain in the West with fairly high mountains at the eastern part. The orography of the country is very broken. The highest point reaches 2751 m at the triple border with Kosovo Republic and Former Yugoslav Republic of Macedonia, while many ridges exceed 2000 m in the northern, central and southern parts of the country (Agim Selenica 2001/1).

Albania is included in the belt of subtropical Mediterranean climate, which significantly affects the elements of nature, such as the hydrographic network, vegetation and relief. The climate of Albania is very suitable for the economic-social life and activity of people. Even though Albania is a small country, the climatic changes are big, due to the very broken mountainous relief. In the regional division of the climate of Albania, the basic factors are sun radiation, geographical latitude, general atmospheric circulation and local factors (Agim Selenica 2001/1).

The country is characterized by typical Mediterranean weather, by hot dry summer, with long days of sunshine, mild winters and abundant rainfall. The rain comes mainly with southwest winds and is affected by the relief. This gives a variety of climates and rainfall patterns in the different regions of the country. The maximum temperature recorded is 44° C, in the central part of the country and the absolute minimum temperature recorded is –25.8° C, in the east. Average annual rainfall in Albania is about 1485 mm. In the Alps, the northern-northereneast part of Albania, the average rainfall is 2700-3000 mm and 650-700 mm in valleys of the interior. Annual distribution of rainfall has a maximum in winter months (40 %) and a minimum in summer months (10%). At the interior part of the country a secondary maximum appears during the spring months. Summer droughts are more pronounced towards the southwest. This phenomenon is typical over the Albanian coast, which is the most important and economically valuable part of the country from the development and environmental viewpoints (Agim Selenica 2001/2).

Albania is located at the northern part of the Mediterranean zone. In addition, the country combines a coastal plain in the West with fairly high mountains: the highest point reaches 2751 m at the triple border with Kosovo and FYROM, while many ridges exceed 2000 m in the northern, central and southern parts of the country. The rain comes mainly with south-west winds and is affected by the relief. This gives a variety of climates and rainfall patterns in the different regions of the country, as show the values extracted for stations with 30 years of continuous observation, as given to us (Agim Selenica 2001/1; Klodian Zaimi *et* al. 2015).

With its coastline facing the Adriatic and Ionian seas, its highlands backed upon the elevated Balkan landmass, and the entire country lying at a latitude subject to a variety of weather patterns during the winter and summer seasons. Inland temperatures are affected more by differences in elevation than by latitude or any other factor. Low winter temperatures in the mountains are caused by the continental air mass that dominates the weather in Eastern Europe and the Balkans. Average precipitation is heavy, a result of the convergence of the prevailing airflow from the Mediterranean Sea and the continental air mass. Because they usually meet at the point where the terrain rises, the heaviest rain falls in the central uplands. Vertical currents initiated when the Mediterranean air is uplifted also cause frequent thunderstorms. Many of these storms are accompanied by high local winds and torrential downpours. When the continental air mass is weak, Mediterranean winds drop their moisture farther inland. When there is a dominant continental air mass, cold air spills onto the lowland areas, which occurs most frequently in the winter. The rivers have deep valleys with steep sides and arable valley floors. Generally unavailable, the rivers obstruct rather than encourage movement within the alpine region. All of the precipitation that falls on Albania drains into the rivers and reaches the Albanian coast of Adriatic and Ionian Sea. In the north, only small stream (Lumi Vermoshit) drains to the Danube Catchment. Flood waters may occupy the floodplain for a matter of hours, as in case of flash floods, or for several weeks, as sometimes occurs during the winter period, when the period of rainfall is longer or during the floods of spring period caused by snowmelt. Flash floods are characterized by the occurrence of the peak of the flood within 3-6 hours of the onset of rainfall. The flood conditions develop rapidly because the rainfall is so heavy that the ground is incapable of absorbing the water quickly enough, resulting in a very high runoff rate. Flooding is a frequent phenomenon, particularly during November-March. The most endangered zone by flooding is the western low land, as a result of the rivers flows from the east to the west of the country. The existing infrastructure of drainage and protection against flooding has been designed for ensuring drainage and irrigation to 280 000 ha agriculture land, and reduction of the risk against rivers and sea flooding to a potentially of 130 000 ha from this surface (Klodian Zaimi *et* al. 2015).

Albania can be considered a water-abundant country. Its renewable water resources amount to 41.7 Km^3 per year out of which about 65% are generated within Albania and the remaining from upstream neighboring countries. Most of the rivers have highly irregular seasonal flow patterns. River flows are the highest in winter or early spring. Nearly all carry less than 10% (and sometime zero) of their winter averages during the summer season. Lakes cover about 4% of the country's territory. There are 3 large lakes and 247 smaller lakes. 630 reservoirs totaling 5.60 km^3 in a year of storage capacity have been built, mostly along the rivers for flood protection, irrigation and production of hydropower. For the purpose of water management, Albania is divided into six main hydrographical basins (Klodian Zaimi *et* al. 2015).

4 Material and methods

4.1 Hydrological observation networks

The Department of Water Economy and Renewable Energy (IGEWE) is responsible for monitoring all waters resources (Klodian Zaimi *et* al. 2015). The manual of the hydrological network is taking measurements 2 times in 24 hours, in the 07 am and 07 pm. This data are registered in a book from the observers and every month the all information's is sent to IGEWE with regular mail. This information's are archived and not controlled or digitalized. The archived information are controlled for the quality or digitalized only if there a request for having this data. A World Bank supported with investment for the digitalization and quality control of the data from 2001-2011. These data are available by request. The number of stations has decreased from a maximum of around 150 in the 1980s, and now there are 105 manual stations in all of the Albanian territory. Most of the stations have been operational from around 1948. However, it should be mentioned that the rating curves are in general old and not updated from the year 2008 (Klodian Zaimi *et* al. 2015).

The manual for the stations are usually kept when upgrading to automatic stations and in the same location there can be both manual and automatic equipment. The World Bank also supported 20 new automatic stations. The GIZ project supported 5 new automatic station located only in Drin-Buna catchment. The stations are transmitting data every 2 hours, but the system is remotely reconfigurable. Some of the measured parameters from the hydrological network are (Water level, Water Temperature, Suspended Sediments), by Klodian Zaimi *et* al. (2015).

Traditionally, the river discharge in Albania is measured by the method of flow velocities, using current meters. Recently IGEWE acquired two Acoustic Doppler current profilers (ADCP) and the staff is trained to use the new technology. Out of the measurements a rating curve linking the discharge to the water level at the gauge is established, and updated if some changes in the river cross-section or profile occurs. The recommendations from WMO are that a station needs to have 6 to 8 discharge measurement per year to update the rating curve. The rating curve is considered as valid for the range of discharges that have been measured; it is then extrapolated for higher flows by the Chezy formula. The most difficult problem in the activities of the IGEWE remains the lack of financial support and human resources from the government for this activity (Klodian Zaimi *et* al. 2015).

5.2 Determination of the quality of surface water of Rivers and Lakes

5.2.1 Determination of the quality of surface water of Rivers

The Albanian parliament has approved a Law on "Environmental Protection" on 2011, whose purpose is the prevention and reduction of pollution, the conservation of biodiversity, the rational management of natural resources, and the ecological restoration of areas damaged by human activities or natural phenomena. The law contains special sections on environmental licenses, environmental impact assessment and monitoring. A National Environmental Action Plan (NEAP) identifies priorities for environmental problems, in response to the new economic and social challenges Albania is now facing. In particular, NEAP sets environmental goals for relevant ministries. Albania is a signatory country to certain environmental conventions, such as the framework conventions on climate change, biodiversity protection, Barcelona, Bon and Ramsar conventions etc. In 1992 the Albanian government adopted the Helsinki Convention on the Protection and Use of Transboundary Water courses and International Lakes (M. Deliana, M. Sanxhaku, V. Puka, L. Selfo 2000; Bashkim Mal Lushaj *et* al. 2015).

Study of water quality in continuously way is started on 1992, according to the Decision of Government for "Monitoring of Environment", where the former Hydrometereologic Institute was mainly responsible for the monitoring of surface water in Albania (M. Deliana, M. Sanxhaku, V. Puka, and L. Selfo 2000). Its tasks were & are, as: Assessment of surface water quality in Albanian territory; Studies over water pollution range in surface and underground water; Model of pollution dispread in rivers, lakes and seas; Evaluation of risk of water pollution at emergency cases; Increasing of quality of information according to ISO standard (M. Deliana, M. Sanxhaku, V. Puka, and L. Selfo 2000).

For assessment of water quality of rivers and lakes are used two sources:

(i) Directive of European Community BMZ (Ed), Environmental Handbook: Documentation on monitoring and evaluation impacts, CEE/CEEA/ CE 78/659 "Quality of fresh waters supporting fish life", Vieweg, Leverkusen (1995) & (ii) Environmental quality criteria of the Institute for Water Research, Norway and Pollution Control Authority Norway, 1997 (Bratli L.J. (2000).

Working group of the former Institute of Hydrometeorology (former Institute of Energy, Water and Environment) now the Institute of Geosciences, Energy, Water and Environment has led for the realization of annual project: "Study of the state of surface water quality in Albania- (every year) and determination of the trend" for pollution levels in them and at the same time has implemented accurately reports. This study is based on manual prepared by working group (Working group 1995; E. Kuusisto 1996; Bashkim

Lushaj et al. 2008). This study is offering the survey, sampling, assessment of the real situation of the quality of surface water and control the level of pollution of these waters, and continuously monitoring the quality of surface waters of Albania, in accordance with the National Environment Strategy, National Program of Environmental Monitoring, legal basis, as: DCM No. 103, dated 31.3.2002 "On environmental monitoring in the Republic of Albania"; DCM No. 1189, dated 18.11.2009 "On rules and procedures for compilation and implementation of National Environmental Monitoring Program" & Improved Water Monitoring and Assessment Programme in Albania (IP no. 610), Final Report, January 2010 (Republic of Albania, Council of Ministers, DCM No. 103, dated 31.3.2002; Working group (1995); Republic of Albania, Ministry of Environment, Forestry and Water Administration 2006; Bashkim Lushaj *et* al. 2008; Republic of Albania, DCM No. 1189, dated 18.11.2009; Julia Obrovac, Arben Pambuku, Bashkim Mal Lushaj 2010 & Bashkim Lushaj 2015).

Based on what we have mentioned above, was proceeded step by step for each parameter, concretely for: Determination of alkalinity. Determination of alkalinity is carried out in the relevant working method, according to ISO 9963-2 (ISO 9963-2:1994); The method of determining the pH. Determination of pH achieved by the relevant working method based on ISO 10523 standards (ISO 10523:2008); Temperature. Temperature is measured based on a simple working method. The water temperature is measured by the meter sensor element immersed in the water and waiting achieving thermal equilibrium before done reading. The method is usable for natural waters and discharges with relevant features for special situations (Working group 1995); Conductivity. Conductivity is defined in the corresponding method of measuring the conductivity by Secchi disk. The method is carried out by technical report No. 163 UNEP/MAP (2005) UNEP/MAP 2005); Determination of ammonia. Determination of ammonia is carried out in the respective method, according to ISO 7150/1 (ISO 7150-1:1984); Determination of nitrite. The method is carried out by technical report No. 163 of UNEP/MAP (2005), by UNEP/MAP (2005); Determination of nitrates. The method is implemented by the APHA American standard (page 4-114), by APHA, AWWA, WPCF (1998); UNEP/MAP (2005); Determination of phosphates. The method is implemented by the American standard APHA (page 4-143), by APHA, AWWA, WPCF (1998); Determination of total phosphorus. The method is implemented by the American standard APHA (page 4-143), and according to the technical report No. 163 of UNEP/MAP (2005), by APHA, AWWA, WPCF (1998); UNEP/MAP (2005); Chemical oxygen demand. The method is implemented by the American standard APHA (page 4-133), by APHA, AWWA, WPCF (1998); Biochemical oxygen need. The method is implemented by the American standard APHA (page 4-133), by APHA, AWWA, WPCF (1998); Determination of dissolved oxygen. The method is implemented by the American standard APHA (page 4-131), and according to EN 25813:1992 (1992); WMO, UNESCO 1991; E. Kuusisto 1996; APHA, AWWA, WPCF (1998).

5.2.2 Determination of sampling site in rivers

Determination of sampling site in rivers is based on manual, mentioned above for the hydrodynamic theory of aquatic environments. Practically, the sampling site is selected in parts of the aquatic environment, where mixing of waters is better and the movement of water is almost laminar. In these conditions it can be only one champion and deals almost exactly in the middle of the water flow. Occasionally samples are taken at different points, according to the transverse profile and at different depths and respective comparisons are necessary.

As a rule, measurement places for determining the parameters and indicators of the quality of surface water flow and pollution level of installed (up) and work in or near their hydrological measurement places (Working group 1995; Bashkim Lushaj *et* al. 2008).

5.2.3 Determining the frequency of sampling

Determining the frequency of sampling is done on the basis of data obtained before and on the basis of climate characteristics, each watershed hydrology and human impact on the area where these rivers stretching. For the selection of stations is taken into consideration to reflect the change of water quality of rivers from source to discharge them into the sea, located stations upstream, middle and bottom of the trunk of the river, as well as branches with the greatest impact on water quality of the river. Conceretely, the frequency of sampling is: 6 times per year for river stations; 4 times per year for lakes stations; 2 times per year for seas stations (Working group 1995; Bashkim Lushaj *et* al. 2008).

Based on what we have mentioned above, we have proceeded step by step for each parameter, taking into account the Water Framework Directive (Directive 2000/60/EC of the European Parliament and of the Council of 23 October 2000 establishing a framework for Community action in the field of water policy) is a European Union directive which commits European Union member states to achieve good qualitative and quantitative status of all water bodies (including marine waters up to one nautical mile from shore) by 2015. It is a framework in the sense that it prescribes steps to reach the common goal rather than adopting the more traditional limit value approach. The Directive's aim for 'good status' for all water bodies will not be achieved, with 47% of EU water bodies covered by the Directive failing to achieve the aim (Directive 2000/60/EC 2000) .

5.3 Determination of the quality of surface water of Lakes

It is evident that the influence of atmospheric phenomena and processes in the water quality of lakes and wetlands is quite significant compared to other water bodies. This fact is taken into account in determining the minimum necessary number of measurement places for providing information representative, reliable low cost. This number will be determined by a simple formula N = log S, where S-surface water body in km^2.

Experience gained from the implementation of various projects has enabled the formulation of a minimum of necessary network for monitoring of water quality of lakes of Ohrid, Prespa, Shkodra and Butrinti.

For the selection of stations in lakes it is given that in lakes or wetlands with not very large surface the measurement installed almost in the center of the water body or in the deepest part of him (Working group 1995; Bashkim Lushaj et al. 2008).

5.4 Determination of the quality of groundwater

5.4.1 Parameters to be monitored

The following quality parameters have been proposed by the StEMA project to be analyzed in groundwater samples. The same idea will be followed by the CEMSA, although the monitoring network were discussed with AGS and representative drilled wells and springs were included into a national groundwater monitoring network: Descriptive parameters - temperature, pH, DO, electrical conductivity (EC); Major ions - Ca, Mg, Na, K, HCO_3, Cl, SO^4, PO_4, NH_4, NO_3, NO_2; TOC, ionic balance, TDS, Total mineralization and total hardness; Heavy metals: As, Hg, Cd, Pb, Zn, Cu, and Cr. More precise choice depends on local pollution sources; Organic substances - aromatic hydrocarbons, halogenated hydrocarbons, phenols, chlorophenols. More precise choice depends on local pollution sources; & Pesticides-choice depends in part on local usage, land-use framework and existing observed occurrences in groundwater (Arben Pambuku *et* al. 2001-2012; Arben Pambuku *et* al. 2012).

5.4.2 Monitoring frequency

The frequency of monitoring is not specified by the WFD, but it was adapted to the local hydro geological conditions. As a minimum surveillance monitoring was carried out once per planning period (6 years). Operational monitoring frequency generally was based on the characteristics of the aquifer and human impact. In reference monitoring wells it is advised to collect groundwater samples and measure water levels at least 4 times a year in order to determine seasonal fluctuations of groundwater levels and chemistry. Later the sampling frequency was reduced, but not less than 2 sampling rounds a year were undertaken.

The following groundwater monitoring frequency was proposed for Albanian groundwater's: Main anions and cations (Na, K, Ca, Mg, Fetot, NH_4, HCO_3, Cl, SO_4, NO_3, NO_2) with frequency twice a year by ACR, as a responsible institution; Physical properties (pH, specific conductivity, permanganate index, or TOC) with frequency twice a year by AGS, as a responsible institution; Trace elements (Fe, As, Hg, Cd, Pb, Zn, Cu, Cr etc.) with frequency once a year by AGS, as a responsible institution; Pesticides with frequency once per six years by AGS, as a responsible institution; PAH, BTEX, petroleum hydrocarbons, Phenols with frequency once per 2 years by AGS, as a responsible institution; Groundwater levels in monitoring wells, boreholes and natural springs. Automated monitoring wells-once a week, old monitoring wells & springs-during the sampling programme (with frequency 2 times/year) by AGS, as a responsible institution (Arben Pambuku *et* al. 2001-2012; Arben Pambuku *et* al. 2012-2014).

5.5 Effects of Climate Change on the rivers, lake and Groundwater

With the aim indication that works is being followed by other consecutive studies, in addition to monitoring and Evaluation of the Effects of Climate Change on the rivers, lake and Groundwater, namely the river Vjosa. To evaluate the effects of Climate Change on the Vjosa Basin, Drini Basin, Mati Basin, Erzeni-Ishmi Basin, Shkumbini Basin & Osumi Basin a hydrological rainfall-runoff model was applied. The precipitation and temperature input into the model was spatially averaged over the basin using Thisean method for precipitation and arithmetic mean for temperature. The model was calibrated with data for standard period 1961-2000. By the analysis results that the most important climate changes effects in the Vjosa Basin is a change in the timing of stream flow through the year. In the study is investigated the trends in annual maximum river flow for the station of the Vjosa River basin using the peak-over-threshold (POT) method. Trends in POT magnitude and in number of POT's per year are estimated. Studding the number of POT's per year will reveal if floods are becoming more frequent or not (Eglantina Bruçi 2007; Ndini, M., Bruci, E., Lushaj, B 2009; Miriam Ndini-Bogdani & Eglantina Demiraj 2011; Matilda Merkohasanaj *et* al. 2013; Arben Petto *et* al. 2014).

6 Results

6.1 Surface water

6.1.1 General

The hydrographical basin of Albania has a total area of 43,305 km^2 from which only 28,748 km^2 are situated within the state territory of Albania (see the Figures 1/1 & 1/2. The rest, which belongs to the Report 1.1.b 42 catchments of the rivers Drini and Vjosa, is situated in Greece, Montenegro, Kosovo and Former Yugoslav Republic of Macedonia (Agim Selenica 2001/2).

Albania is crossed by several rivers, in general East-West direction: Drini, Buna, Mati, Ishmi, Erzeni, Shkumbini, Semani, Vjosa & Bistrica are the most important ones. The mean annual discharge of all rivers of Albania is about 1300 m^3/s, which corresponds to a specific discharge of 29 l/s.km^2, one of the highest in Europe. Surface water include also the natural lakes of Ohrid, Prespa and Shkodra, a multitude of minor lakes, and reservoirs built along the main rivers: at Fierza, Koman and Vau Deja along Drin River, Ulza and Shkopeti on the Mat River, and Banja on the Devolli River. Some lagoons are situated along the sea coast, the main ones being the Karavasta, Narta and Butrinti lagoons (Agim Selenica 2001/2).

An important problem linked to the assessment of surface water resources is the lack of updated information, due to deficient data collection over the last years. Difficulties seem to arise mainly from lack of budget, inadequate maintenance and re-calibration of instruments, irregular payment to observers, and limitation of field trips and so on. Part of the solution to this problem may come from a reduction of the monitoring network to those stations most essential to water resources management or scientific investigations, by Agim Selenica (2001/1).

6.1.2 Drini-Buna Rivers

The Drini-Buna basin (watershed) unit is composed of the catchments of the Drini River and the Buna River and other minor ones (Agim Selenica 2001/2).

6.1.2.1 Drini River

Drini River is the largest river of our country with a watershed of 19.582 km^2, of which 14.173 km^2 belong to the Buna River Drin. Drin River consists of two main branches: the Black Drin, which stretches from Lake Ohrid to Kukes, in union with the White Drin and White Drin. Drin waters merge with the waters of the river mainly Buna and together poured into the Adriatic Sea (Agim Selenica 2001/1; Agim Selenica 2008).

Selection of monitoring stations is made taking into account: geographical characteristics of its life, the position of the watershed (basin), as well as the cascade of hydropower plants, which were built in the watershed, which affects the flow directed his in geological basin, the hydrological characteristics and the impact of human activity in this pond. To have a view as realistic as the situation in this pond is necessary to apply a monitoring program to include the entire watershed, but it is thought that this pond is represented by two stations: one Topojan, which gives the state of water Drini River, coming from Yugoslav Republic FYR of Macedonia and the Drini united in Bahçallek, it can be said that is the station before its flow into the Adriatic Sea (or joining the Bojana River), by Agim Selenica (2001/1).

The Basin of Drini is situated at southwestern part of Balkan Peninsula and concerns to the Adriatic Sea Catchment. It is the third biggest European river which discharges its water in the Mediterranean Sea, after Rone (France) and Po (Italy). Drini is a transboundary river shared between Greece, Former Yugoslav Republic of Macedonia, Albania and Kosovo. In the Drini Basin are situated Ohrid Lake and Prespa Lake (both under the patrimony of UNESCO) and Shkodra (Skadarski) Lake, the biggest lake in Balkan Peninsula. The hydrographic catchment of the Drini River has a total area of 19.582 km² from which 14.173 km² belong to the Drini itself and 5.187 km² to the Buna. The Drini is formed by two main tributaries: the Drini Zi, with a catchment area of 5.885 km², flowing from Former Yugoslav Republic FYR of Macedonia and the Drini Bardhë, flowing from Kosovo. The Buna River drains Lake of Shkoder, which is fed by rivers originating from Montenegro and Albania; its larger tributary is the Moraça River. In the past, the exits of Buna and Drin rivers have been separated. At present the old bed of the Drin, leading south to the city of Lezha, carries only a minor part of the discharge; the rest meets the Buna near Shkoder and follows its river bed along the border with Black Mountain, by Agim Selenica (2001/1, 2008).

The Drini River for the period 1951-1985 has a mean annual discharge of 680 m³/s, of which 360 m³/s come from Drin itself and 320 m³/s from Buna. The resulting specific discharge is about 35 l/s.km² and the runoff coefficient 0.74. These high values are mainly due to the very high yield of the Buna, which cannot be much exploited-except for navigation. Keeping in mind the water use in Albania, the most important river is the Drin, with the following characteristics: • Annual discharge volume: 11, 1 km³; • Specific discharge: 24.8 l/s.km²; • Ratio wettest month (December) to driest month (August): 5.7; • One in 10 year high flow: about 13 times the river module; • Storage capacity of Fierza reservoir: 2,700 million m³ (about 25 % of annual flow), by Agim Selenica (2001/2, 2008).

Chemical analyses of samples taken from the Drini River showed good quality water, with stable mineral composition along the river course. Metallic ions are present in small amounts except for iron in some cases. It appears that no restriction for the present uses (hydropower, irrigation) could arise from the water quality in the Drini River. A more difficult situation arises from the quality of the Kiri water, affected and possibly contaminating the local groundwater resources also. Its effects on the lake of Shkodra have not been clearly assessed
(Bashkim Lushaj *et* al. 2008- 2010; Çomo *et* al. 2013).

In Drini River have been constructed three hydropower plants with a total water storage volume of 3730 106 m^3, from which is produced 93 % of country's generation capacity until now (Agim Selenica 2008).

6.1.2.2 Buna River

Buna River flows from Lake Skadar. At the exit from the Shkodra Lake area Buna River watershed is 5179 km^2, of which 1025.2 km^2 in the territory of Albania, and the rest is in the territory of Montenegro. Buna River, the village Samrish until his discharge in the

Adriatic Sea, at a distance of 24 km separates the state border between Albania and Montenegro (Agim Selenica 2001/2).

By the geographical location of the river and the size of its watershed this river represented in the monitoring network from two monitoring stations, one near the former Cement Factory, which is closer to the point of exiting from Lake Skadar and station near the spill in the sea (in the village Dajç) (Agim Selenica 2001/2).

6.1.3 Mati River

Mat River lies in the northern part of the Central Highlands province of Albania. It consists of two main branches, that Mat and Fan. Its basin covers an area of 2441km^2. Its main branch is Fani surface 957 km^2 watershed. This branch of Mat consists of two branches of his Small Fan and Big Fan. Big Fan is a length of 76.9 km and the basin area of 542 km^2, while the Small Fanny has a length of 54.5 km and a basin area of 415 km^2. Starting from this stretch of the watershed, the river is represented by four stations in the network monitoring its water quality (Agim Selenica 2001/1, 2008).

The Mati basin coincides broadly with the catchment of the Mati River, which has an area of 2.441 km². The main tributary of the Mati River is the Fani River that flows from the north-east, while the Mati itself flows from the south-east down to the confluence with the Fani River, and then to the West. The Fani River has a catchment area of 1.076 km² and is formed by two tributaries: Big Fani and Small Fani rivers (Agim Selenica 2008).

The Mati has a mean annual discharge of 103 m³/s, of which 60 m³/s come from the Mati itself and 42 m³/s from the Fani River. The resulting specific discharge is about 40 l/s.km² and the runoff coefficient 0.75; these values apply for both the Fani and the Mati.

Chemical analyses of samples taken from the Mati River before 1990 showed a high content of metallic ions (iron, manganese and copper), which is not surprising in an important mining area. It appears that for some uses (hydropower, industry) these characteristics should not cause problems, while the impact on irrigated agriculture is not yet fully assessed and the implications for marine coastal waters are also not clear by Working group 1996-2008; Bashkim Lushaj *et* al. 2008-2011; Arben Pambuku *et* al. 2012, 2014; Çomo *et* al. 2013).

6.1.4 Erzeni-Ishmi Rivers

The Erzeni-Ishmi basin unit is composed of the catchments of the Erzeni River and the Ishmi River and other minor ones, with a global surface area of 1.439 km². This basin is characterized by a mean altitude lower than the adjacent catchments; indeed springs are not at high altitude and the part of the water courses in the plain is long (Agim Selenica 2008; Bashkim Lushaj *et* al. 2008-2011).

6.1.4.1 Erzeni River

Erzeni River lies in the central part of Albania and has a catchment area of 760 km^2. The length of this river is 109 km. This river has as main branch Stream of sand, Peza and Zhullimës. Given the size of the basin and extending its area of dense population in this river monitoring network is represented by three stations (Agim Selenica 2001/1, 2008).

6.1.4.2 Ishmi River

Even Ishmi River lies in the central part of Albania and has a catchment basin with an area of 673km^2. The length of the river is 75 km. It lies in the most densely population urban and has a significant impact. The river formed by the Ishmi River & Terkuze, Tirana River and the stream of black away. For self exstension and composition of its waters this river is represented by five network monitoring stations (Agim Selenica 2008).

Chemical analyses of samples taken from the Ishmi River before 1990 showed high values for many parameters (iron, manganese, nitrates, suspended solids, BOD_5 (Five-day biochemical oxygen demand) and so on. This is not surprising since urban and industrial waste water from Tirana is released in it, which limits the use of the water. The situation has somewhat improved now, but is still critical. This does not apply to the Erzeni River in which water quality is quite acceptable for the present main use: irrigation (Working group 1996-2008; Bashkim Lushaj *et* al. 2008-2011, 2009/2, Çomo *et* al. 2013).

6.1.5 Shkumbini River

Shkumbin River lies in the central part of Albania, with a watershed of 2445 km^2. The length of this river is 181 km. This river collects the waters mainly mountainous territory. Bearing in mind that the river passes in Elbasan is supposed to be represented in the networks we monitor from three stations (Agim Selenica 2001/2).

The Shkumbini basin unit broadly coincides with the catchment of the Shkumbini River, with an area of 2.445 km². The Shkumbini River receives along its long course tributaries of secondary importance, for example, Rapuni, Gostima and Zaranika. Basic characteristics include an annual discharge volume of 1,900 million m^3 (Agim Selenica 2008).

Chemical analyses of samples taken from the Shkumbini River showed high values for some parameters (iron, nitrites, ammonium, suspended solids and so forth). This was probably due to the mining areas upstream and to the metallurgic industry in Elbasani city; biodiversity in the estuary area is reported to have been seriously affected. Since the drastic reduction of activities of the industry, no complete analyses were made available, but the quality of the water has probably largely improved; this will need to be confirmed to ensure the suitability of the river water to agricultural uses. Another potential problem linked to bad water quality in the Shkumbini is the quality of drinking water, extracted from its alluvial banks for Lushnja and Rrogozhina (Working group 1996-2008; Bashkim Lushaj *et* al. 2008- 2011; Çomo *et* al. 2013).

6.1.6 Semani River

Semani River is one of the main rivers. It is formed by two main branches of his Devolli River and Osumi River, who have a large stretch of their catchment basins. The total area of Seman River basin is 5649 km^2 and its length is 281Km. Semani River as its two branches collect their water from a mountainous and hilly terrain, while its bottom part lies in the valley area. For his own expansion and its major branches of the river is represented by six stations in the monitoring network (Agim Selenica 2008).

The Semani basin coincides with the corresponding hydrographical catchment of the Semani River spreading over 5,649 km^2. It is formed by two main tributaries: Devolli River (3,130 km^2) and Osumi River (2,073 km^2), which meet near the city of Kuçove. The basic characteristics are an annual discharge volume of 2,700 million m^3 (Agim Selenica 2001/1).

Chemical analyses of samples taken from the Semani River in the past showed high values for some parameters (BOD5, ammonium, suspended solids, manganese, iron and so on). The last left bank tributary, the Gjanica River, drains oil fields and shows very high contents of oil and phenols, to name but a few; it is possibly the most polluted river in the country. This has already had disastrous effects on the biodiversity in the lower reach of Semani River and the nearby coastal areas. But it may also affect other uses, such as drinking water supply, by contaminating the groundwater. The water for irrigation purpose is taken upstream of the main pollution sources and should be safe. More recent analyses showed an improvement of the water quality in the lower reaches of the Semani River, linked to the strong decrease in oil extraction and the slowdown of chemical industry activities in Fier, but the quality is still far from good (Bashkim Lushaj *et* al. 2008-2011; Çomo *e*t al. 2013; Arben Pambuku *et* al. 2012, 2014).

6.1.7 The Vjosa River

Vjosa River is one of the biggest rivers and important country. This river has its source outside the territory of Albania and the bulk of its watershed pellut located in the territory of Albania. Watershed has an area of 6710 km^2. Majors Rivers are Drino River and Shushica River, Vjosa River (Agim Selenica 2001/1)..

For mountain nature of this river waters also appear with a good water quality. But large catchment basin and its extension make this stream is represented by six monitoring stations in the national network for monitoring surface water quality (Working groupn 1995, 2003; Klodian Zaimi *et* al. 2015)

Vjosa River is one of the biggest rivers in Albania. The total area of basin is 6710 km^2. The Albanian catchment of the Vjosa River has an area of 4365 km^2 or about 2/3 of the entire catchment; the rest is situated in Greece. The largest tributary of Vjosa River is the Drino River; it has a catchment area of 1320 km^2, of which 256 km^2 are situated in Greece. A characteristic feature of the catchment of the Vjosa River is the presence of deep karst, which measures an abundant underground supply during the dry season (see the figure 7) by Agim Selenica (2001/2)

Basic characteristics are as follows: • Annual discharge volume: 5,550 million m^3, • Specific discharge: 26 $l/s.km^2$; • Ratio wettest month (April) to driest month (August): 10.8; • One in 10 year high flow: about 24 times the river module; • Storage capacity on either river: none (Agim Selenica 2001/1; 2008).

Chemical analyses of samples taken from the Vjosa showed that water quality is generally good; some high values have been observed for iron or hardness in the mainstream of Vjosa River, for the contents of chlorine in the torrent of Langarica, but from the global point of view this river has the best water quality of the country, adequate for all uses. Based on the biotic indices the water quality appeared to be excellent except two points near a bitumen mine and an oil reservoir (Working group 1996-2008; Bashkim Lushaj *e*t al. 2008-2011; Çomo *et* al. 2013).

Vjosa Valley ecosystem confronts many phenomena as erosion, pollution of the soil and water, loss of the land and water habitats, land fragmentations, severing of the biodiversity etc, which have caused the degradation. This degradation has attained stability and productivity of the agricultural ecosystems. In the Vjosa catchment area high precipitation takes place. Last years the human activities as abusive deforestations opening of new agricultural lands and their intensive cultivation, exploitation of the gravel and sand in the riverbed are intensified (Agim Selenica 2001/1).

6.1.8 The Shkodra Lake

Shkodra Lake (Lacus Labeatus) is the largest lake in the Balkan Peninsula. It is situated in south-eastern Montenegro, in the Zeta-Shkodra Valley, and in Albania in the karsts terrain of the south-east Dinaric Alps (19°0' and 19°30' east longitude and 42°0' and 42°30' north latitude). In Albania, on the lake's eastern shore, lies the Shkoder lowland. The northern coast is flat, gradually descending towards the lake's bottom, and covered with lush vegetation. The southern coast is steep and rugged (see the figure 9). Through Tables no. 11 give the geographical data of the stations and network monitoring code for Shkodra lake (Lushshaj *et* al. 2008; 2009/1; 2010).

The surface of the lake is 368 km^2 of which 149 km^2 are located inside the jurisdiction of

Albania. Its line length is 48 km, its width 26 km and depth 7-10 m. The lake origin is tectonic and karstic. The lake is situated at an average height 4.5 m above the sea level. The surface of the water collecting basin is 5176 km^2, with an average water-body volume of 2.6 billion m^3. It is a relatively shallow lake with a maximum depth of 9 meters'.

The Shkodra Lake fed by: Dried River, the River of Vraka, Rrjolli and the underground

resource of Shegani.The Lake's coast length is 150 km. The western coasts are rocky with a gradual lowering on the northeastern side. The basin is situated on carstic rocks: the rainfall quantity is about 2170 mm and their flow velocity is 355 m^3/sec. The level of the Shkoder Lake fluctuates between 4.39-9.4 m due to the discharge capacities of the Buna River. It's so called mirror is 368-542 km^2. the lakebed is the soil surface covered by water at the highest level in 25 years (Agim Selenica 2001/1).

It falls into the category of open lakes. It drains into the Adriatic Sea at the Bojana River with an average discharge of 332 cubic meters' per second resulting in a total water volume exchange occurring 2-2.5 times per year. The water level of Shkoder Lake varies widely. Extreme observed values are Hmin=4.97 meters and Hmax=9.84 meters, and the surface varies between a minimum water level of 395 km^2, and a maximum of 530 km^2. Respective water volumes are Vmin=1.8 x109 m^3, and Vmax=4.25 x 109 m^3. The lake's surface under the mean water level of 6.59 m is 475 km^2. In the total inflow of water into the lake, the Moraca River is the most significant tributary. Its watershed area is estimated at 3,200 km^2, and the river brings 200 m^3 per second on average into the lake. The estimated outflow is 330 m^3 per second (Agim Selenica 2001/2; 2008).

Shkodra Lake and its watershed are of important economic value, with huge potential for the economic development of the northern regions of Albania, in terms of fishery, ecotourism, agriculture, hydro energy etc. The ecological value of Lake Shkoder and its watershed are of international importance. The main concerns for Lake Shkoder and its watershed are linked with pollution from human activities, wastewater, urban and industrial wastes, the use of chemicals in agriculture etc. (Agim Selenca 2008).

Urban wastewater is one of the main concerns for Shkodra Lake.

A project is being prepared by institutions in Albania and Montenegro and concerns the conservation of Shkodra Lake (Working group 1996-2008; Agim Selenica 2008; Bashkim Lushaj *et* al. 2008, 2009/1, 2009/2, 2010, 2011; Çomo 2013).

6.1.9 The Ohrid-Prespa Lakes

The surface area of Ohrid Lake is 358 km^2, of which 249 km^2 belongs to Macedonia and 109 km^2 to Albania (see the figure 10).). The coastline of Lake Ohrid is 87.5 km long, of which 56 km belongs to Macedonia and 31.5 km to Albania. The lake itself has a maximum length of about 30 km and a width that varies from 11.2 km to 14.5 km. The maximum depth is 289 m and average depth is 164 m. The current surface area of the Prespa Lakes (Big and Small) is about 301 km^2. The surface area of the Prespa Lakes has been declining for the about 15 years. The surface area reported in 1984 was about 329 km^2 (Agim Selenica 2001/2; 2008).

The water system of Ohrid Lake is rather complex because of the underground links with Lake Prespa. Lake Prespa sits southeast of Lake Ohrid, at an elevation of 845 m, about 150 m higher than Lake Ohrid. About 50 % of the water in the Saint Naum and Tushemisht springs on the south coast of Lake Ohrid Lake is from Lake Prespa. The karstic mountains of Dried Mountain (Mali i Thate) in Albania and of Galicica in Macedonia are highly porous, with a high capacity for water transport (Bashkim Lushaj *et* al. 2008- 2011; Çomo 2013).Because of this high porosity and water content, the rocks of the Prespa-Ohrid Lakes area are classified as porous aquifers, karstic and fissured aquifers.

Characteristic of the surface karst is a high concentration of swallow holes, dolinas, karst poljes, dead valleys and karst plateaus. The karst plateaus spread over the limestone massifs of the area are the most distinctive form of surface erosion. They generally indicate advanced karstification in the rock formation itself. Examples include the high plateau of Petrinska Mountain (1600 m), Mali i Thate (1700-1800 m), and the Samri Dea Valley in the northeastern part of Galicica Mountain, at elevations of about 1300-1400 m (Agim Selenica 2001/1, 2008; Bashkim Lushaj *et* al. 2008).

The swallow holes are considered as the most prominent karst phenomenon that connects the surface and underground water. The most important swallow hole is that of Zaveri, situated in the western periphery of Prespa Lake, near village Gollomboch (Agim Selenica 2001/1).

The loss of the lake water into the karst massif can be observed at different levels of Lake Prespa.

As the topographic length from Zaveri swallow hole to Saint Naum is 16.2 Km and the height difference is 143-155 m, the average hydraulic gradient in the karst is about 0.009.

Therefore, Lake Ohrid receives its water from both orographic surface water flow, and underground flow from the Lake Prespa system. The two Prespa lakes, Big Prespa and Small Prespa, which are linked together by an isthmus, compound the system of Prespa Lake. Because of these unique links, the Prespa-Ohrid water system is unique in the world.

The major water masses flowing into Lake Ohrid on the Macedonian side of the lake are

the springs arising from Galicica Mountain, and the surface water flowing in from its tributaries.
The only watercourse flowing out of Lake Ohrid is the Crn Drim River with an average discharge of 22 m^3/s. In this case, it is easy to calculate the amount of water flowing out of Lake Ohrid, which corresponds to 693.8 * 106 m^3 per year. Urban wastewater is one of the main concerns for Lake Ohrid (Agim Selenica 2001/2; Working group 1996-2008; Bashkim Lushaj *et* al. 2008, 2009/1, 2009/2, 2010, 2011; Çomo 2013).

In 1996, both countries agreed to carry out the Lake Ohrid Conservation Project-financed by the Global Environment Facility (GEF) and executed by the World Bank-with the goal of conserving and protecting its unique biodiversity and watershed through a joint management arrangement. A Lake Ohrid Management Board was set up and a bi-national monitoring task force has produced a State of the Environment Report. The project has facilitated cooperation between local authorities on both sides of the lake and has helped mobilize substantial investment assistance, including for the funding for sewage treatment, solid waste management, and water supply system improvements (Agim Selenica 2001/2, 2008). Devolli River used for irrigations purposes (Agim Selenica 2008; Bashkim Lushaj *et* al. 2008).

6.2 About the National network of monitoring of water surface of rivers and lakes in Albania

More difficulties are set up and put in function two networks monitoring for surface water quality of river and lakes, the sheep by means. The present National network of monitoring of water surface of rivers and lakes in Albania. We ask staff to the National Environment Agency, which already has full legal responsibility to carry out this monitoring, that these monitoring networks maintained to continue its work of monitoring, where our staff has made it over 20 years old. Thank you for your understanding! (Bashkim Lushaj *et* al. 2015).

6.2 Groundwater in Albania

6.2.1 General

Groundwater in Albania is present in different sort of rocks of different ages, from Paleozoic to Quaternary, and is of a great importance due to it being the only source of drinking water supply. Yet not much is known about its real availability and extraction capacity, due to the lack of studies beyond the amount of water table level observations. This has already led to some problems: well fields located near the Adriatic coast near Laçi and Durres is now affected by the intrusion of saline water, probably due to over exploitation (Agim Selenica 2001/2).

According to local conditions groundwater is exploited through wells, mainly in the plains and valleys, or through springs, most frequently in the hills and mountain areas. But its presence and use are fairly common throughout the country. As is frequently the case, and particularly where large karstic areas affect the movement of groundwater, river basins do not coincide with groundwater units. In this report however, groundwater resources will be presented sorted by river basin unit to enable a comparison of availability and use. Law No 8093, dated 23.03.1996 “On Water Reserves”, serves as a guide on the way of treatment of superficial and underground waters. Also, at the decision no 1 of the National Water Committee, dated 19.07.2002 “On establishment of the Basin Councils", and at the decision no 3, dated 19.07.2002 "On the Approval of Functioning of the Technical Secretariat of the Water National Council, Council of Water-collection Basins and Water Agency", which defines the rights and responsibilities of these institutions, the territory of the Republic of Albania is divided in six basic river basins (Agim Selenica 2001/2, 2008; NOVIWAM 2011; Arben Pambuku, 2001-2012; CEMSA 2012).

Through Tables no. 12 give the geographical data stations and network monitoring code for groundwater of the Drini-Buna Basin (Watershed); Mati Basin (Watershed); Erzeni-Ishmi Basin (Watershed); Shkumbini Basin (Watershed); Semani Basin (Watershed) & Vjosa Basin (Watershed), by Bashkim Lushaj *et* al. (2015).

6.2.2 The Drini-Buna Basin (Watershed)

In the Drini basin unit, three main aquifers can be defined: • One north from Shkodra along the Shkodra Lake, in the districts of Shkodra and Malesia e Madhe. It includes the wells of Dobraç, which supply water for the city of Shkoder with wells yielding 80 l/s of good quality water. No quantitative data was obtained for the rest of this aquifer, but qualitative information shows that, in quantity and quality, the supply obtained from this aquifer is not satisfactory for the drinking water supply for Koplik and its region; other sources of supply are presently being investigated;

• One on the left side of the Drini downstream of Shkodra; no information, either qualitative or quantitative, has been obtained for this aquifer; • In the district of Has, water is obtained mainly from wells, but no data has been found out about the resources (Agim Selenica 2001/2, 2008).

Most of the groundwater in the Drini basin is taken from springs, 65 of which have a wet season discharge above 100 l/s, mainly in the districts of Malesia e Madhe, Tropoje, Kukes, Diber and Bulqize. The quality of these springs is generally good; they yield a fairly stable amount of water with low hardness (5 to 8 German degrees in most cases) (Agim Selenica 2001/2, 2008; NOVIWAM 2011; Arben Pambuku, 2001-2012; CEMSA 2012).

6.2.3 The Mati Basin (Watershed)

In the Mati basin, only one significant aquifer is found around the river mouth, extending from Lezha in the North to Mamurras in the South, in the lands reclaimed in the last 50 years from the swamps. Extraction from the wells varies from 0.1 l/s to more than 80 l/s, but quantity and quality vary greatly depending on the location: • Wells in the north, near Lezha, have fairly high yields and a water quality ranging from good to bad (excess of chloride and high pH indicating brackish water); it can be inferred that an excessive drawdown of the water table caused an advance of the saline sea water into the aquifer. This is a very serious issue, and the exploitation of this aquifer should be minimized until more precise studies (probably using modern modeling techniques) define the safe extraction capacity in each point; • Wells located on the South of the Mati, near Laçi, show very low yields and mostly brackish or salty water; here studies should also be carried out as soon as possible to assess the real extraction capacity (Agim Selenica 2001/2).

In the rest of the basin, groundwater appears in springs, with 13 of them yielding more than 100 l/s in winter, mainly in the district of Mati. The source of the Uraka is one of the biggest in Albania, with a discharge reaching up to 20 m^3/s. Most springs give good quality soft water, but their yields vary heavily throughout the year or even cease in summer (Agim Selenica 2001/2, 2008; NOVIWAM 2011; Arben Pambuku, 2001-2012; CEMSA 2012).

6.2.4 The Erzeni-Ishmi Basin (Watershed)

This basin presents two main aquifers: one along the Erzeni and one along the Ishmi. The aquifer following the course of the Ishmi and its main tributaries is intensively exploited: • Downstream near Fushe Kruja wells give discharges from 0.5 l/s to 20 l/s with an acceptable water quality; cases of excessive iron or nitrites contents or high hardness have appeared; • Upstream around Tirana many wells were dug with discharges sometimes exceeding 100 l/s and their quality is highly variable; frequent cases of excessive iron, nitrates and sulphates have been observed, together with acceptable quality in those wells used for drinking water supply; • The Erzeni aquifer is not used on a large scale; no information was obtained about its quality or water availability (Agim Selenica 2001/2).

Few important springs are found in the Erzeni-Ishmi basin; some near Kruja give hard water, while those near Tirana give high yield of excellent quality water, and are used for drinking water supply to the capital (Agim Selenica 2001/2, 2008; NOVIWAM 2011; Arben Pambuku, 2001-2012; CEMSA 2012).

6.2.5 The Shkumbini Basin (Watershed)

Three main aquifers are defined in the Shkumbini basin: • On the right bank of the river near Rrogozhina and Kavaja lies an aquifer of local interest, for which no concrete data were obtained; • On the left bank, from the river to Lushnja, an aquifer supplies water to this city; the traditional source of Konjat gives water of good quality, but new developments in Cerma (near the bed of the Shkumbini) are not as good, with some odor problems. Water availability is good with a supply to the city of 160 l/s at the source. This aquifer extends over reclaimed areas, as the ones near Laçi and Lezha, and may require particular studies for further use; • Around Elbasani groundwater is very abundant on both banks of the river with several wells yielding more than 100 l/s; their quality is generally good, with some cases of high sulphate contents (compared to other aquifers) which should not hamper their use for human, industrial or agricultural use (Agim Selenica 2001/2).

Eighteen main springs are identified in the Shkumbini basin, in its upper mountain part but also near Elbasan, often with variable discharges and medium hardness (Agim Selenica 2001/1, 2008; NOVIWAM 2011; Arben Pambuku, 2001-2012; CEMSA 2012).

6.2.6 The Semani Basin (Watershed)

The Semani basin is known to be rather poor in groundwater resources; yet it includes two main aquifers: • One covering most of the plain of Korça; the wells in that area have medium yields (a few litters per second) and their quality is often good (they supply drinking water to the city of Korçe) although in some cases excessive amounts of iron, nitrites and nitrates have been found, possibly due to the intensive agricultural activity of the region; • One in the Osumi valley near Berati and Kuçova; its yield is sufficient for the local water supply, but the water quality is poor and hardly meets the national water standards (Agim Selenica 2001/2).

Eighteen main springs are identified in the Semani basin, from the upper part to the river mouth; in most cases they have variable discharges, and their hardness varies from low to fairly high (this mainly in Korça and Berati) (Agim Selenica 2001/2, 2008; NOVIWAM 2011; Arben Pambuku, 2001-2012; CEMSA 2012).

6.2.7 The Vjosa Basin (Watershed)

The Vjosa basin is rich in groundwater resources, but mainly as springs; yet it includes three main aquifers: • Along the lower valley of the Vjosa. It supplies the city of Fieri with more than one m3/s of good quality water from the wells of Kafaraj, unaffected by the polluted water carried by the nearby Semani. The well fields of Novosele near Vlore, on the other bank, have also high yields (up to 80 l/s) and good quality water, although sometimes nitrites and nitrates have been found in fairly high amounts around Saranda and Butrinit. It supplies part of the drinking water to Saranda. The water is reported to be very of good quality, and extraction is around 100 l/s for Sarande only in the Drino valley around Gjirokastra. It supplies part of the drinking water to Gjirokastra. The water is reported to be of very good quality, and extraction is around 40-90 l/s for Gjirokastra only (Agim Selenica 2001/2).

Forty-seven main springs are identified in the Vjosa basin. In most cases the discharge is fairly stable, twelve springs yield more than one m^3/s and some of the biggest springs of the country are found there, such as the Syri Kalter source of the Bistrica or the Kelcyre spring in the district of Permeti. Water is of good quality, and the hardness varies from low to medium, except near the Ionian coast where it reaches 20-30 German degrees (Agim Selenica 2001/2, 2008; NOVIWAM 2011; Arben Pambuku, 2001-2012; CEMSA 2012).

The EU Directive 2006/118/EC on the Protection of Groundwater against Pollution and Deterioration (further referred to as "Groundwater Directive") sets out criteria for assessing the chemical status of groundwater, as required by Article 17 of the Water Framework Directive. Groundwater Directive has been developed for establishment of specific measures to prevent and control groundwater pollution. These measures include criteria for assessing good chemical status, criteria for identifying significant and sustained upward trends in the concentration of pollutants in groundwater and criteria for defining the starting points for trend reversals.

Criteria for the assessment of good chemical status of groundwater include: • Quality standards; • Threshold values for those pollutants that put groundwater at risk and that take into account the natural variability of national groundwater's (Directive 2006/118/EC of the European Parliament and of the Council (2006); CEMSA 2012).

7 Conclusions

Albania is crossed by several rivers, which flow from mountainous regions to plains, in general from east to west. The most important ones are the rivers of Buna, Drini, Mati, Ishmi, Erzeni, Shkumbini, Semani and Vjosa. All the rivers discharge into the Adriatic Sea, except Bistrica, which flows (discharge) into the Ionian Sea, forming a number of coastal lagoons and swamps, while Vermoshi River is located in the northern tip of Albania, and it is the only river that flows into the Danube, therefore, the Vermoshi River is only tributary of Danube River, in Albania.

Based on preliminary data, comparatived with them described above for all rivers studied have these interim conclusions, for the period from 2005 to 2015, concretely: In general the temperature of the water in the rivers has an annual distribution of their values according to the season and with the same performance as well as air temperature. Compared with a year ago we did not have changes in annual performance river water temperature; General performance alkalinity river water to Albania in 2015 shows that the high content of this parameter have stations of the Ishëm river basins, as well as polluted branch of the Gjanica, Semani River. The values of this parameter have fluctuated annually, almost the same for all stations of the Drina, Buna, Matt, Erzeni & Vjosa, while rivers of the Seman & Ishmi the fluctuations alkalinity in years is dependent on the amount of their waters and the season, when carry out the expeditions; The annual performance of electrical conductivity of river water in 2015 shows that the highest content of electrolytes have water on stations of the Gjanica, Sallmone, Kozarë and Ishmi River stations. This indicator from 2005 to 2015 is growing series in series for these stations, which indicates that they are under constant impact of liquid urban and industrial; The average annual values of Biological Oxygen Demand (BOD5), from 2005 to 2015 are growing and highest content of NBO5 have the water stations of the Seman basin and river stations of the Ishmi River; The annual average values of Ammonia (NH4), from 2005 to 2015 are growing and highest content of NH4 have the water stations of the Seman basin and river stations of the Ishëm; The average annual values of total phosphorus (Ptotal), from 2005 to 2015 are growing and highest content of total phosphorus (Ptotal) have the water stations of the Seman basin and river stations of the Ishmi; The average annual values of nitrate (NO_3) from 2005 to 2015 are growing and highest content of nitrate (NO_3) have the water stations of the Seman basin and river stations of the Ishëm; The average annual values of nitrites (NO_2) from 2005 to 2015 are growing and highest content of nitrites (NO_2) have the water stations of the Seman basin and river stations of the Ishmi (Bashkim Lushaj *et* al. 2008, 2011, 2015).

These rivers should be studied taking into account the physical and geographical conditions, morphometric and hydrodynamic they have. Of course, to carry out a thorough study of it, in any case required continuing the cooperation with the Montenegro, FYR Macedonia and Greece on the exchange of data on water quality of lakes, as well as for a more thorough study of each ecosystem.

The rainfall is a real potential for flooding in Albania especially for Drini and Vjosa Rivers. The types of rainfall that cause floods in Albania are cyclonic rains, which are preceded by frontal storms. The floods in Albania are classified like "flash flood" (Bashkim Lushaj *et* al. 2008, 2015).

Albania shares lakes with its neighboring countries. Lakes Ohrid and Prespa are shared with the Former Yugoslav Republic of Macedonia, Lake Shkoder with Montenegro, and Lake Prespa with Greece. The sediment deposition from Devolli River to Small Prespa has caused a 20 % damages in the ecosystem of the lake.

There are changes at the hydrological regime for Ohrid and Prespa lakes.

Material collected in 2014 during the monitoring of water quality of lakes shows that the frequency monitoring is reduced to 1 times per year, giving an assessment of incorrect state of water quality to them, as there are insufficient funds for get them from time to time. This frequency is not enough to provide accurate conclusions on the trend of the content of polluting elements in the waters of small lakes of the country, where already there are changes to their trophic status.

For lakes of Shkodra, Ohrid and Prespa we can highlight these features: the relatively waters are saturated with oxygen; The content of phosphorus values result in lower levels, but with an increase in the bottom of the lake; electrical conductivity of water tends increase as a result of different discharges into the lake.

These lakes should be studied taking into account the physical and geographical conditions, morphometric and hydrodynamic they have. Of course, to carry out a thorough study of it, in any case required continuing the cooperation with the Montenegro, Macedonia and Greece on the exchange of data on water quality of lakes, as well as for a more thorough study of each ecosystem.

The rising of building sector and quick uncontrolled industrial development in Albania is connected with gravel / sand extractions and dams, abstraction of water for irrigations purposes, which are intense at certain locations and form an extremely difficult problem to be solved.

No concrete actions on the Basis of Transboundary water monitoring, and this is a necessity, as the first steps have been cast in Prespa.

By establishing a basis of joint management of their watersheds, the projects which are implemented or are waiting to be, will promote a cost-effective solution to transboundary natural resources management and pollution problems, and provide a basis for the sustainable economic development of the watersheds in Albania (Bashkim Lushaj *et* al. 2008; 2009/1; 2009/2; 2010; 2011; 2015).

Flood risk assessment in Albania

Main features of floods in Albania

Flooding is a natural phenomenon in Albania. In general, the precipitation regime is Mediterranean, characterized by intensive showers in winter and droughts in summer. In the highest part of the basin, the precipitation mainly comes down as snow. The floods, in general, have a pluvial origin, so they are observed during the period of November-March (generally months totaling around 80-85% of the annual runoff).

In the mountainous rivers of Albania the floods are flashy; flood – waters occupy the floodplain for a matter of hours. On the contrary, in the biggest rivers, close to the river-mouth area, these waters inundate the floodplain for several weeks, particularly during the most severe floods resulting from the compounding influences of a heavy rainfall together with the spring snowmelt runoff.

Paradoxically, flooding is both feared and valued. Floods have been considered destructive, taking lives and leaving a trail of damage. Yet for our ecosystem, flooding is vital in many respects. It serves to recharge coastal wetlands including lagoons, to maintain the ecological balance of both terrestrial and aquatic ecosystems, and to disperse nutrients throughout the ecosystem.

Governments have attempted to alleviate flood situation in Albania by building protective dykes and creating upstream storage. Although many of these measures have been beneficial, they also served to encourage further encroachment upon river floodplains, thereby raising the potential for flood damage and leading to request for greater levels of protection. Actually, more than half of the Albanian population lives very close to the river-mouth areas, where the risk of flooding is higher. In other words the structural solution is only a partial one; the only long-term solution consists of keeping flood-vulnerable development and uses out of the floodplain.

The purpose of floodplain mapping was to delineate the area affected by a 100-year flood. For this study the maps of 1:5 000 scale has been used and the contours of the inundations zones were delineated.

Applying special software, the corresponding digitizing maps were established for each river and the number of houses and habitants affected by floods were calculated.

Albania shares lakes with its neighboring countries. Lakes Ohrid and Prespa are shared with the Former Yugoslav Republic of Macedonia, Lake Shkoder with Montenegro, and Lake Prespa with Greece. The sediment deposition from Devolli River to Small Prespa has caused a 20 % damages in the ecosystem of the lake.

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The rising of building sector and quick uncontrolled industrial development in Albania is connected with gravel / sand extractions and dams, abstraction of water for irrigations purposes, which are intense at certain locations and form an extremely difficult problem to be solved.

By establishing a basis of joint management of their watersheds, the projects which are implemented or are waiting to be , will promote a cost-effective solution to transboundary natural resources management and pollution problems, and provide a basis for the sustainable economic development of the watersheds in Albania.

8 Recommendations

Almost half the world is situated in transboundary river basins. From time to time actions in a broader interest require cooperation from the countries sharing those basins. Typical examples are the protection of downstream ecosystems from upstream pollution. But cooperation is not always easy to obtain.

Land and water resources of transboundary river basins should be managed in an integrated way at the catchment level, just as is the case for national rivers. This means making the most of social, economic, and environmental benefits related to the water, and sharing the benefits equitably among all parties. This requires establishing institutions-agreements, laws, organized procedures, and joint commissions and administrations. And it requires the cooperation of national organizations and administrative bodies.

New cooperation arrangements for transboundary water systems are emerging, thanks largely to the broker role played by international organizations. The trend is to reduce the risk for conflicts and improve the capacity to reach shared solutions through training and better access to negotiation methods. Ecosystem protection and risk management are new drivers for transboundary cooperation.

There is a clear move from a mono-sectoral approach towards a more multi-purpose one.

Non-state actors are also gradually becoming more involved. And integrated water resources

management should be viewed as only one element of broader cooperation in regions that are connected by water systems.

Some Measures for flood mitigation

As it is mentioned in the above paragraphs, flooding is a natural phenomenon in Albania. In these conditions only flooding mitigation measures could be taken in order to reduce the damages caused by flooding. These measures can be classified into two types:

short-term measures and long-term measures.

Short – term measures

These measures consist of local works, generally of low cost, that could be undertaken in one season or year. They include maintenance works and organizational measures, aiming to warn as soon as possible the state institutions and population. These measures could be summarized as follows: • Measures for the improvement of the drainage systems and the channels of high water, especially the work of the pumping stations; • Organization of the Flood Warning Service in the Institute of Geosciences, Energy, Water & Environment (former Institute of Hydrometeorology), which will have the responsibility of warning the emergency institutions and populations on the situation of the rainfall regime and stages of the rivers, on a regular basis.

Long-term measures

The establishment of a National Flood Damage Reduction Program is a priority. This program will be based on the actual Law on Emergencies, which charges the institutions to establish national or regional Flooding Mitigation Planes.

Some measures of technical character are mentioned as follows: • Identification of the state of dykes and necessary measures for rehabilitation and eventually, building of new structures on both riverbanks (partly in Drini and Buna, Shkumbini, Semani and Vjosa); • Analyzing the current standards of the hydro-module of drainage of agricultural fields aiming for the re-computation of these standards and increasing the pumping station's capacity; • Rehabilitation of existing dams in small irrigation reservoirs and eventually building new reservoirs, which could increase the capacity of the flood control; • Reducing the high erosion rates by means of reforestation, building of small dams in areas such as the upper part of mountain torrents, especially in the rivers Devolli, Erzeni, Osumi, and Drino; • It is time to have a clear idea about concrete actions on the Basis of Transboundary water monitoring, and this is a necessity, as the first steps have been cast in Prespa.

More difficulties are set up and put in function two networks monitoring for surface water quality of river and lakes, the sheep by means of Fig. 13. The present National network of monitoring of water surface of rivers and lakes in Albania. We ask staff to the National Environment Agency, which already has full legal responsibility to carry out this monitoring, that these monitoring networks maintained to continue its work of monitoring, where our staff has made it over 20 years old. Thank you for your understanding! (Bashkim Lushaj *et* al. 2015).

At the same time, exactly the same thing the networks we ask also for monitoring of the Groundwater! (Bashkim Lushaj *et* al. 2015).

Let's hope...!

9 References

Agim Selenica (2001/1): "Water resources of Albania" (2001/1): In: Hydrometereological Institute; Hydrotechnics Department, Faculty of Civil Engineering, Polytechnic University of Tirana; INWEB (International Network of Water Environment Centers for the Balkans)/MED-HYCOS MED-HYCOS (Mediterranean Hydrological Cycle Observing System) joint meeting-Belgrade 25-28 April 2001, Report n° 16, pp. 1-11.

Agim Selenica (2001/2): "Water resources of Albania" (2001/2): In: MED-

HYCOS MED-HYCOS (Mediterranean Hydrological Cycle Observing System) joint meeting in Montpellier, June 2001, MED-HYCOS Phase 2, period 2002-2005. Project Proposal Montpellier, June 1, 2001, Report n° 17, pp. 1-9.

Agim Selenica (2008): Water resources of Albania (2008): In: Department of Technologies of Energy, Department of Climate and Environment & Department of Water Economy, Institute of Geosciences, Energy, Water and Environment, pp. 1-11.

APHA, AWWA, WPCF (1998): APHA, AWWA, WPCF (ed), Standard Methods for the Examination of Water and Wastewater, 18 Ed. American Public Health Ass., Washington D. C. 20005 (1998).

Arben Pambuku, Adrian Dhimitri, Marenglen Gjoka, Aranit Gelaj, Sokol Olli, Brunilda Brushulli *et*. al. (2014): Annual Report on “The study of the state of surface water quality in Albania-2013 and determining of the trend for pollution levels in them”. In: the Albanian Geological Survey and National Environment Agency, supported by Ministry of Environment, pp. 1-63 (in Albanian language).

Arben Pambuku, Xhume Kumanova, Emirjeta Adhami, Marenglen Gjoka (2012-2014): “Conservation and sustainable use of biodiversity at Lakes of Prespa, Ohrid and Shkodra / Skadar (CSBL) Project”, pp. 1-34.

Arben Pambuku, Adrian Dhimitri, Marenglen Gjoka, Aranit Gelaj (2012/2) “Consolidation of the Environmental Monitoring System in Albania" (CEMSA Project), pp.

Arben Pambuku, Adrian Dhimitri, Marenglen Gjoka, Aranit Gelaj, Sokol Olli, Brunilda Brushulli *et* al. (2012/2): Annual Report on “The study of the state of surface water quality in Albania - 2011 and determining of the trend for pollution levels in them”. In: Albanian Geological Survey and Environment and Forestry Agency, supported by Ministry of Environment, Forests and Water Administration, pp. 1-69 (in Albanian language).

Arben Pambuku, Nazmie Puca, Sonila Marku, Aranit Gelaj *et* al. (2001-2012): The study of the state of groundwater quality in Albania In: Albanian Geological Survey and Environment and Forestry Agency, supported by Ministry of Environment, Forests and Water Administration, pp … (in Albanian language).

Arben Petto, Matilda Merkohasanaj, Arvjen Lushaj , Miriam Bogdani-Ndini, Arnisa Lushaj, Bashkim Mal Lushaj, Eneida Isufaj, Spahi Isufaj, Elma Kodra, Enkelejda Sopaj, Eglantina Demiraj-Bruçig, Adesa Boja, Sotiraq Pandazi, Klodian Sina, Admir Seci (2014): The Expected Impacts of Climate Changes to the Transboundary Water Resources in Vjosa River Catchment, Albania. Online International Interdisciplinary Research Journal, {Bi-Monthly}, ISSN 2249-9598, Vol-IV, Jan 2014 Special Issue, pp. 96-103. ISSN 2249-9598. Available online at www. oiirj.org

Bashkim Lushaj, Agim Selenica, Miriam Ndini & Spahi Isufaj (2015): Present state of the transboundary waters of rivers, lakes, groundwater and trend of them, in Albania, pp. 1-41. In: Department of Climate and Environment & Department of Water Economy, Institute of Geosciences, Energy, Water and Environment; Faculty of Architecture and Engineering, Department of Civil Engineering, Epoka University Tirana & Faculty of Engineering, Metropolitan University of Tirana, pp. 1-41.

Bashkim Lushaj, Elvin Çomo, Bledar Myrtaj (2011): Annual Report on “The study of the state of surface water quality in Albania - 2010 and determining of the trend for pollution levels in them”. In: Department of Climate and Environment, Institute of

Energy, Water and Environment and Environment and Forestry Agency, supported by Ministry of Environment, Forests and Water Administration, pp. 1-67 (in Albanian language).

Bashkim Lushaj, Elvin Çomo, Bledar Myrtaj (2010): Annual Report on "The study of the state of surface water quality in Albania - 2009 and determining of the trend for pollution levels in them". In: Department of Climate and Environment, Institute of Energy, Water and Environment and Environment and Forestry Agency, supported by Ministry of Environment, Forests and Water Administration, pp. 1-61 (in Albanian language).

Bashkim Lushaj, Petrit Zorba, Emirjeta Adhami, Bledar Murtaj & Elvin Çomo (2009/2): The work presented during our qualification in Stockholm, Sweden, on May 2009, supported and led by the Swedish Environmental Protection Agency, Stockholm, Sweden, in the framework of the project "Improved Water Monitoring and Assessment Programme in Albania (IP no. 610)", pp. 1-19.

Bashkim Lushaj, Emirjeta Adhami, Elvin Çomo, Bledar Myrtaj (2009/1): Annual Report on "The study of the state of surface water quality in Albania - 2008 and determining of the trend for pollution levels in them". In: Department of Climate and Environment, Institute of Energy, Water and Environment and Environment and Forestry Agency, supported by Ministry of Environment, Forests and Water Administration, pp. 1-34 (in Albanian language).

Bashkim Lushaj, Emirjeta Adhami, Bledar Myrtaj & Elvin Çomo (2008): "Manual methods to water quality monitoring in Albania" and analyzes to the study, pp. 3-31.

Bratli L.J. (2000): Classification of the Environmental Quality of Freshwater in Norway. In Hydrological and limnological aspects of lake monitoring. Ed. Heinonen *et.* al., John Wiley & Sons Ltd., 2000, pp. 331-343.

CEMSA (2012): Groundwater monitoring in Albania, CEMSA Project. May 2012, "Consolidating the Environmental Monitoring System in Albania". A project funded by the European Union and managed by the Delegation of the European Commission to Albania. Project Europe Aid/128449/C/SER/AL – IPA 2008, pp. 1-14.

Directive 2006/118/EC (2006): Directive 2006/118/EC of the European Parliament and of the Council of 12 December 2006 on the protection of groundwater against pollution and deterioration. Official Journal of the European Union L 372/19- L 372/31.

Directive 2000/60/EC (2000): Directive 2000/60/EC of the European Parliament and of the Council of 23 October 2000 establishing a framework for Community action in the field of water policy. Official Journal of the European Communities L 327/1-l 327/71.

Directive 1995/46/EC (1995): Documentation on monitoring and evaluation impacts. Environmental Handbook: Documentation on monitoring and evaluating environmental impacts - Volume I: Introduction, Cross-sectoral Planning, Infrastructures (Vol 1) 1996th Edition by Eds. (Author), Bundesministerium für wirtschaftlic (Editor) and Environmental Handbook. Volume II: Documentation on monitoring and evaluating environmental impacts. Agriculture, Mining/Energy, Trade/Industry. Authors: Eds.) Editors: Bundesministerium für wirtschaftlic (Ed.)

CEE/CEEA/ CE 78/659 "Quality of fresh waters supporting fish life", (Vol. I-III), Vieweg, Leverkusen (1995).

Eglantina Bruçi (2007): Climate Change Projection for South Eastern Europe, pp. 1-65

Elvin Çomo, Albana Hasimi, Bashkim Lushaj (2013): Annual Report on "The study of the study of the state of surface water quality in Albania-2012 and determining of the trend for pollution levels in them". In: Department of Climate and Environment, Institute of Geosciences, Energy, Water and Environment and Environment and Forestry Agency, supported by Ministry of Environment, Forests and Water Administration, pp. 1-57 (in Albanian language).

E. Kuusisto (1996): Water Quality Monitoring - A Practical Guide to the Design and Implementation of Freshwater Quality Studies and Monitoring Programmes. Edited by Jamie Bartram and Richard Ballance Published on behalf of United Nations Environment Programme and the World Health Organization © 1996 UNEP/WHO ISBN 0 419 22320 7 (Hbk) 0 419 21730 4 (Pbk).

EN 25813:1992 (1992): Water Quality-Determination of Dissolved Oxygen, pp. 1-9.

Gjoka L. (1990): Ground temperature features in Albania; Ph.D. Thesis, (In Albanian); Hydrometeorological Institute of Academy of Sciences, Tirana, Albania.

ISO 10523:2008 (2008): Water quality-Determination of pH, pp. 1-13. This standard was last reviewed in 2012.

ISO 9963-2:1994 (1994): Water quality-Determination of alkalinity-Part 2: Determination of carbonate alkalinity, pp. 1-7. This standard was last reviewed in 2015**.**

ISO 7150-1:1984 (1984): Water quality-Determination of ammonium-Part 1: Manual spectrometric method, pp. 1-7. This standard was last reviewed in 2012.

Julia Obrovac, Arben Pambuku, Bashkim Mal Lushaj (2010): "Improved Water Monitoring and Assessment Programme in Albania (IP no. 610)". Final Report, January 2010, pp. 1-8, supported and led by Swedish Environmental Protection Agency, Sweden (Swedish project leader). A bilateral cooperation program for the period 2006-2009, in the field of environment between the Ministry of Environment, Forest and Water Administration (MoEFWA) and Swedish Environmental Protection Agency (Swedish EPA).

Kabo M, editor (1990-1991): Physical Geography of Albania, vols. I and II. Academy of Sciences, Geographic Center; Tirana, 1990-91. (In Albanian language).

Klodian Zaimi, Metodi Marku & Bashkim Lushaj (2015): Hydrological observation networks in Albania. In: Department of Climate and Environment & Department of Water Economy, Institute of Geosciences, Energy, Water and Environment, pp. 1-5.

M. Deliana, M. Sanxhaku, V. Puka, L. Selfo (2000): Part III: "The Status of Water Resources Monitoring in the Balkans", J. Ganoulis *et* al. (eds.), SI-S5. @ 2000 Kluwer Academic Publishers, pp. 81-84.

Matilda Merkohasanaj, Miriam Bogdani-Ndini, Eglantina Demiraj-Bruçi, Bashkim Mal Lushaj, Arvjen Lushaj, Arnisa Lushaj, Eneida Isufaj, Klodian Sina, Spahi Isufaj, Elma Kodra, Enkelejda Sopaj (2013): Climate Changes and the Expected Impact to the Transboundary Water Resources in Vjosa River Catchment, Albania. Research Article, published at JECET; June – August 2013; Vol.2. No.3, pp. 501-505. An International Peer Review E-3 Journal of Sciences and Technology. E-ISSN: 2278–179X.

Miriam Ndini-Bogdani & Eglantina Demiraj (2011): Assessment of Climate

Change Impacts on Water Resources in the Vjosa Basin, In: Institute of Energy, Water and Environment, pp. 1-4.

Ndini, M., Bruci, E., Lushaj, B (2009): “Climate changes and the expected impact to the water resources in Albania”, Water Policy 2009 – Water as a Vulnerable and Exhaustible Resource, Prague, June 22nd – 26th, pp. 131.

NOVIWAM – Report 1.1.b. (2011): “Report on socio-political framework affecting or being affected by water catchment management and the European Union Water Framework Directive (WFD)”, 24th January 2011, pp. 36-53, 136-141.

Republic of Albania, Council of Ministers, DCM No. 103, dated 31.3.2002 (2002): On environmental monitoring in the Republic of Albania.

Republic of Albania, Ministry of Environment (MoE, 2004): Compendium on Environmental Legislation of Albania, laws from 1991 to 2003, pp. 3-577.

Republic of Albania, Council of Ministers, DCM No. 1189, dated 18.11.2009 (2009): “On rules and procedures for compilation and implementation of National Environmental Monitoring Program”.

Republic of Albania, Ministry of Environment, Forestry and Water Administration (MoEFWA, 2006)): National Environmental Strategy of Albania (NES), November 2006.

United Nations Environment Programme/Mediterranean Action Plan (UNEP/MAP 2005): Sampling and analysis techniques for the eutrophication monitoring Strategy of MED POL. MAP Technical Reports Series No. 163, pp. 1-46.

WMO, UNESCO (1991): *Scientific and Cultural Organization, Progress in the Implementation of the Mar del Plata Action Plan and a Strategy for the 1990s. Report on Water Resources Assessment*, 1991.
http://docs.watsan.net/Scanned_PDF_Files/Class_Code_2_Water/210-91WM-9429.pdf (accessed March 10, 2013).

Working group (1996-2008): “Water quality monitoring in Albania”, Technical Reports, 1996-2007 HIDMET, Tirana

Working group (1995): “Manual methods to water quality monitoring in Albania", pp. 3-21.

10 Figures

Fig. 1 Water Surface and Transboundary Water of Albania