UNIVERSITETI I PRISHTINËS
UNIVERSITY OF PRISTINA
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EVALUATION REPORT OF THE MANUSCRIPT OF THE MASTER THESIS

FACULTY OF CIVIL ENGINEERING		
Department/ Programme	HYDROTECHNICS	IWRM
Project proposal	**Urban Impact on the Pollution of the Prishtina River and a Future Perspective**	
Candidate	BSc Anita Hajredini	
Mentor	Prof. Asoc. Dr. Lavdim Osmani	
Approval of the project proposal in the Faculty Council	Date:18.12.2025	
	Decision no.:2961/1	

For the Master Thesis **"**Urban Impact on the Pollution of the Prishtina River and a Future Perspective**"**, submitted by the candidate Anita Hajredini, the Evaluation Committee appointed by the Department of Hydrotechnics and approved by the Faculty Council of the Civil Engineering Faculty submits the following report.

REPORT OF THE EVALUATION COMMITTEE

I. Master thesis analyses

Master thesis "*Urban Impact on the Pollution of the Prishtina River and a Future Perspective*", by candidate BSc Anita Hajredini, Hydrotechnical Department, IWRM program has a total 72 pages, including figures, tables, recommendations and literature references.

This Master Thesis provides a comprehensive academic investigation into the severe environmental degradation of the Prishtina River resulting from rapid urbanization and inadequate infrastructure. It utilizes a **mixed-method approach**, combining longitudinal climate data analysis, GIS mapping of urban expansion, and original field sampling to document the river's transition from a clean resource into a heavily polluted conduit.

The thesis systematically addresses the environmental degradation of the Prishtina River through three primary inquiries, supported by rigorous data and field research.

Severe environmental degradation of the Prishtina River is documented resulting from rapid urbanization and inadequate wastewater infrastructure. It effectively addresses its primary research questions by systematically identifying anthropogenic pressures, from traditional disposal practices to modern industrial impacts. A thorough evaluation of the current sewer and stormwater network highlighted the critical need for the separate systems currently under development by RWC Prishtina.

Further, it draws on successful international case studies like the Saw Mill River and River Sheaf, and provides a feasible, spatially explicit proposal for river restoration in the Kalabria and Uglar sections

and the daylighting of the river corridor, which offer multi-dimensional benefits and by achieving compliance with the EU Water Framework Directive and Urban Wastewater Treatment Directive.

The evaluation committee notes the following academic and technical strengths of the work: *Methodological Rigor:* The candidate employed a comprehensive mixed-method approach, combining GIS mapping, hydraulic modeling (SCS-TR 55), and specialized biological sampling processed in the Laboratory of the Biology Department.

A central component of the study is a biological assessment using macroinvertebrates, which revealed a "Heavily Polluted" status at the city's outlet where no living macroinvertebrates were found, contrasting sharply with the relatively clean upstream branches in Grashtica,. Complementary physical-chemical analyses further proved that pollutant levels for BOD, COD, and TSS significantly exceed the limit values established by both the National Administrative Directive 02/2022 and EU standards. Furthermore, the thesis includes a critical hydrological evaluation showing that the existing covered river segments—which serve as combined collectors—are critically undersized and incapable of safely conveying water during 50- or 100-year flood events. Beyond documenting these challenges, the thesis offers a visionary yet technically grounded proposal for urban renewal through "daylighting". By reopening the river corridor in the Kalabria and Uglar sections, the research proposes a transition from traditional "gray" engineering toward multifunctional blue-green infrastructure. This approach aims to align Kosovo with the EU Water Framework Directive and Urban Wastewater Treatment Directive, transforming an environmental liability into a vital urban asset that provides flood mitigation, recreational spaces, and improved public health for the citizens of Prishtina. *Alignment with Regulatory Standards:* The research demonstrates a deep understanding of the EU Acquis on Water Protection, specifically the Water Framework Directive (WFD) and the Urban Wastewater Treatment Directive (UWWTD), positioning the findings within the context of Kosovo's path toward EU integration. *Social and Historical Context:* The inclusion of the "Social Aspect" chapter provides valuable insight into the traditional relationship between Prishtina's citizens and their rivers, adding a layer of cultural significance to the technical restoration proposal

Problem-Solving Potential

The research raises three questions identifies and offers solutions for several urgent problems documented in the study:

Ecological Degradation: The thesis highlights a severe environmental crisis; biological monitoring found no living macroinvertebrates at the Prishtina outlet, indicating a total ecosystem collapse, and proposes daylighting, combined with the new Wastewater Treatment Plant (WWTP), which would provide the "necessary precondition" for aquatic life to return.

Hydraulic Capacity and Flooding: A critical finding is that the city's current covered collectors are critically undersized. For a 100-year flood event, no segment of the current infrastructure can safely convey the water. The proposed daylighted channel uses a trapezoidal form designed to handle both dry-season baseflow and high-volume storm events, reducing urban flood risk.

Legal Non-Compliance: The study proves that current effluents significantly exceed the limit values of the National Administrative Directive 02/2022 and EU standards and the intended interventions that provide a roadmap for Kosovo to align with the EU Water Framework Directive and Urban

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Wastewater Treatment Directive. *Urban Livability:* The project addresses social and climatic issues like the urban heat island effect and the lack of accessible green space in rapidly developing neighborhoods like Kalabria

In summary, the thesis moves beyond simple pollution documentation to provide a feasible, evidence-based vision that transforms a hidden environmental liability into a visible structuring element for a sustainable and resilient city. Given the high quality of the research, the depth of the data analysis, and the practical relevance of the proposed solutions for the Municipality of Prishtina, the committee finds that thesis meets all academic requirements for a Master's degree in Integrated Water Resource Management (IWRM). The candidate has successfully bridged the gap between engineering (sewer infrastructure) and environmental science (biological indicators). The results provide a comprehensive strategy that can serve as a baseline for future municipal planning and international investment projects.

II. Proposal of the Evaluation Committee

The Evaluation Committee for the Master Thesis "Urban Impact on the Pollution of the Prishtina River and a Future Perspective" submitted by the candidate for Bsc. Anita Hajredini concludes that the submitted manuscript fulfills the requirements established by the Law on Higher Education and the Regulations for Master Studies of the University of Prishtina.

Therefore, the Master thesis evaluation Committee note that the submitted work meets the requirements set by the Law on Higher Education and the Regulations for Master Studies of the Faculty of Civil Engineering. Therefore, the committee proposes to the Council of the Faculty of Civil Engineering in Prishtina to approve this report and to continue the procedure for the public defense of the work.

Pristina, 14/07/2026

Evaluation Committee:

1. _____
Prof.asoc. Dr. Lavdim Osmanaj – Mentor

2. _____
Prof. Dr. Laura Kusari – Head of Committee

3. _____
Prof. Dr. Halil Ibrahimi– Member

P.S. The number of pages is added as needed. Place, date and signatures come at the bottom.

ABSTRACT

The degradation of water bodies is a growing problem in Kosovo. Effective management is essential to improve ecological conditions and ensure a healthy environment. Human activities and the lack of wastewater treatment contribute to problems in water bodies, causing changes in water quality that lead to eutrophication. Sources of pollution and proposed solutions will be presented with a focus on the degradation of Prishtina River, aiming to improve water quality, protect the ecosystem, and safeguard human health.

This thesis will analyze and study the importance of water and its evaluation by stakeholders regarding the quality of water resources and sanitation, population trends, awareness of the situation, changes in precipitation, and pollution. Special focus will be placed on the catchment area of Prishtina River, considering water quality and major sources of pollution as one of the greatest risks, which ultimately flows into the Sitnica River and joins the Iber River in Mitrovica, then continues northward toward the Morava River and eventually the Danube, creating transboundary environmental impacts.

This topic has scientific significance and responds to current needs for urban environmental sustainability, aligning with Kosovo's national policies and EU standards. It also addresses practical requirements for improving infrastructure to protect river ecosystem of Prishtina.

Impact of measures and investments in wastewater treatment will be analyzed by the implementation of the Prishtina Wastewater Treatment Project which focuses on the management of wastewater and stormwater in Prishtina, addressing significant environmental and public health challenges caused by pollution from untreated

wastewater.

This research aims to systematically investigate environmental and anthropogenic pressures on the Prishtina River, explore the impacts of urbanization on water quality, assess current wastewater and stormwater infrastructure interventions, and propose improvements to support sustainable urban water management and pollution reduction strategies.

According to recent United Nations studies, since 2016, approximately 54.6% of the world's population lives in cities. The same report also highlights floods as the most widespread natural disaster affecting cities, both in terms of loss of life and economic losses (21).

In recent years, many countries have seen an increase in the number and intensity of heavy rainfall events due to the effects of climate change. The consequences of urban flooding are causing concerns ranging from mild to extraordinary devastation. Preparing cities that can withstand floods is becoming increasingly important in development plans worldwide. Regarding climate change, Kosovo belongs to the most vulnerable part of Europe. The study on climate change in the Western Balkans (22) points out that the climate in Kosovo during the middle and end of this century will impact many parameters. This will result in an increase in the frequency and duration of heatwaves and droughts and increase in the risk of floods.

ABSTRAKT

Degradimi i trupave ujorë përfaqëson një nga sfidat më të rëndësishme mjedisore në Republikën e Kosovës. Menaxhimi i qëndrueshëm dhe efektiv i burimeve ujore është thelbësor për përmirësimin e gjendjes ekologjike, ruajtjen e biodiversitetit dhe garantimin e një mjedisi të shëndetshëm për popullsinë. Aktivitetet antropogjene, të kombinuara me mungesën ose pamjaftueshmërinë e sistemeve për trajtimin e ujërave të ndotura, kanë ndikuar drejtpërdrejt në përkeqësimin e cilësisë së ujërave sipërfaqësore, duke nxitur procese të eutrofikimit dhe degradim të vazhdueshëm të ekosistemeve ujore. Në këtë kontekst, punimi trajton burimet kryesore të ndotjes dhe masat e propozuara për përmirësimin e gjendjes mjedisore, me fokus të veçantë në lumin Prishtina, me synim përmirësimin e cilësisë së ujit, mbrojtjen e ekosistemit lumor dhe ruajtjen e shëndetit publik.

Ky hulumtim synon të analizojë rëndësinë e burimeve ujore dhe perceptimin e palëve të interesit lidhur me cilësinë e ujit dhe shërbimet e sanitacionit, duke marrë në konsideratë trendet demografike, nivelin e ndërgjegjësimit publik, ndikimin e ndryshimeve klimatike në regjimin e reshjeve dhe faktorët kryesorë të ndotjes së ujërave. Vëmendje e veçantë i kushtohet pellgut ujëmbledhës të lumit Prishtina, ku cilësia e ujit dhe burimet e ndotjes përbëjnë një ndër sfidat më serioze mjedisore. Lumi Prishtina derdhet në lumin Sitnica, më pas bashkohet me lumin Ibër në Mitrovicë dhe vazhdon rrjedhën drejt lumit Morava e më tej në lumin Danub, duke e shndërruar ndotjen e tij në një çështje me ndikim ndërkufitar dhe rajonal.

Rëndësia shkencore e këtij punimi qëndron në trajtimin e një problematike aktuale që lidhet me menaxhimin e qëndrueshëm të mjedisit urban dhe të burimeve ujore, në përputhje me objektivat strategjikë të Republikës së Kosovës dhe standardet e Bashkimit Evropian në fushën e mbrojtjes së mjedisit dhe menaxhimit të ujërave. Përveç kontributit teorik, ky hulumtim ofron edhe një dimension praktik, duke identifikuar nevojat për avancimin e infrastrukturës ujore dhe zbatimin e masave efektive për mbrojtjen dhe restaurimin e ekosistemit të lumit Prishtina.

Në kuadër të këtij punimi do të analizohet ndikimi i masave dhe investimeve në trajtimin e ujërave të ndotura përmes zbatimit të Projektit për Trajtimin e Ujërave të Ndotura të Prishtinës. Ky projekt paraqet një ndër investimet më të rëndësishme infrastrukturore në sektorin e ujërave në Kosovë, duke synuar menaxhimin e integruar të ujërave të ndotura dhe ujërave atmosferike, si dhe adresimin e sfidave mjedisore dhe të shëndetit publik që burojnë nga shkarkimi i ujërave të patrajtuara në trupat ujorë.

Qëllimi i këtij hulumtimi është të analizojë në mënyrë sistematike presionet mjedisore dhe antropogjene që ndikojnë në lumin Prishtina, të vlerësojë efektet e urbanizimit mbi cilësinë e ujit, të shqyrtojë gjendjen aktuale të infrastrukturës për menaxhimin e ujërave të ndotura dhe ujërave atmosferike, si dhe të propozojë masa konkrete për përmirësimin e menaxhimit të qëndrueshëm të burimeve ujore urbane dhe

reduktimin e ndotjes, në përputhje me parimet e zhvillimit të qëndrueshëm dhe legjislacionin evropian në fushën e ujërave.

Sipas studimeve të Kombeve të Bashkuara, që nga viti 2016 rreth 54,6% e popullsisë së botës jeton në zona urbane. I njëjti raport evidenton se përmbytjet përfaqësojnë fatkeqësinë natyrore më të përhapur në qytete, si për nga humbjet në jetë njerëzore, ashtu edhe për nga dëmet ekonomike që shkaktojnë (21).

Gjatë viteve të fundit, shumë vende kanë shënuar rritje të shpeshtësisë dhe intensitetit të reshjeve të dendura si pasojë e ndryshimeve klimatike. Përmbytjet urbane po shkaktojnë pasoja që variojnë nga dëme të moderuara deri te shkatërrime me përmasa të mëdha, duke krijuar sfida serioze për planifikimin dhe zhvillimin urban. Për këtë arsye, ndërtimi i qyteteve rezistente ndaj përmbytjeve është shndërruar në një prioritet të rëndësishëm të politikave zhvillimore në nivel global.

Në aspektin e ndryshimeve klimatike, Kosova konsiderohet ndër rajonet më të cenueshme në Evropë. Studimi mbi ndryshimet klimatike në Ballkanin Perëndimor (22) thekson se, gjatë mesit dhe fundit të këtij shekulli, ndryshimet klimatike do të ndikojnë ndjeshëm në parametrat klimatikë të vendit. Si rezultat, pritet rritje e frekuencës dhe kohëzgjatjes së valëve të të nxehtit dhe periudhave të thatësirës, si dhe rritje e konsiderueshme e rrezikut nga përmbytjet, me pasoja të rëndësishme për burimet ujore, mjedisin dhe zhvillimin socio-ekonomik.

UNIVERSITY OF PRISHTINA

"HASAN PRISHTINA"

FACULTY OF CIVIL ENGINEERING

INTEGRATED WATER RESORCE MANAGEMENT DEPARTMENT

MASTER THESIS

Urban Impact on the Pollution of the Prishtina River and a Future Perspective

Professors:

Lavdim Osmani – Mentor, IWRM

Candidate:

Anita Hajredini

Prishtina, 2026

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List of Abbreviations:

UN- *United Nations;*

SDG - *Sustainable Development Goal;*

RWCP- *Regional Water Company "Prishtina" j.s.c.;*

WTP-*Water Treatment Plant;*

KAS *– Kosovo Statistics Agency*

KEPA *– Kosovo Environmental Protection Agency*

MESP *- Ministry of Environment and Spatial Planning*

EU *– European Union*

WSRA *– Water Supply Regulatory Authority*

WWTP *– Wastewater Treatment Plant*

ESIA *– Environmental and Social Impact Assessment*

KfW*- German Development Bank*

1. INTRODUCTION

The degradation of water bodies is a growing problem in Kosovo. Effective management is essential to improve ecological conditions and ensure a healthy environment. Human activities and the lack of wastewater treatment contribute to problems in water bodies, causing changes in water quality that lead to eutrophication. Sources of pollution and proposed solutions will be presented with a focus on the degradation of Prishtina River, aiming to improve water quality, protect the ecosystem, and safeguard human health.

This thesis will analyze and study the importance of water and its evaluation by stakeholders regarding the quality of water resources and sanitation, population trends, awareness of the situation, changes in precipitation, and pollution. Special focus will be placed on the catchment area of Prishtina River, considering water quality and major sources of pollution as one of the greatest risks, which ultimately flows into the Sitnica River and joins the Iber River in Mitrovica, then continues northward toward the Morava River and eventually the Danube, creating transboundary environmental impacts.

This topic has scientific significance and responds to current needs for urban environmental sustainability, aligning with Kosovo's national policies and EU standards. It also addresses practical requirements for improving infrastructure to protect river ecosystem of Prishtina.

Impact of measures and investments in wastewater treatment will be analyzed by the implementation of the Prishtina Wastewater Treatment Project which focuses on the management of wastewater and stormwater in Prishtina, addressing significant environmental and public health challenges caused by pollution from untreated wastewater.

This research aims to systematically investigate environmental and anthropogenic pressures on the Prishtina River, explore the impacts of urbanization on water quality, assess current wastewater and stormwater infrastructure interventions, and propose improvements to support sustainable urban water management and pollution reduction strategies.

According to recent United Nations studies, since 2016, approximately 54.6% of the world's population lives in cities. The same report also highlights floods as the most widespread natural disaster affecting cities, both in terms of loss of life and economic losses (21).

In recent years, many countries have seen an increase in the number and intensity of heavy rainfall events due to the effects of climate change. The consequences of urban flooding are causing concerns ranging from mild to extraordinary devastation. Preparing cities that can withstand floods is becoming increasingly important in development plans worldwide. Regarding climate change, Kosovo belongs to the most vulnerable part of Europe. The study on climate change in the Western Balkans (22) points out that the climate in Kosovo during the middle and end of this century will impact many parameters. This will result in an increase in the frequency and duration of heatwaves and droughts and increase in the risk of floods.

1.1 Organization of the Diploma Thesis

This Diploma Thesis is organized and contains the following chapters:

***Chapter 1**: Introduction*

***Chapter 2**: Literature Review*

***Chapter 3**: Baseline of Prishtina River Catchment Area*

***Chapter 4:** Urban Development in Prishtina*

***Chapter 5**: Legal framework and Requirements*

***Chapter 6**: Social Aspect*

***Chapter 7:** Research Work and Discussion*

***Chapter 8**: Interventions for improvement*

***Chapter 9**: Case Studies*

***Chapter 10:** A Future Perspective – Proposal*

1.2 Questions of the Diploma Thesis

The purpose of the research is to investigate, identify and assess the sources of pollution in Kosovo, particularly the contribution of raw untreated wastewater from wastewater into Prishtina River, to analyze its impact in the water quality and what can be done for the improvement in the future.
By addressing these objectives, the research seeks to contribute valuable insights and recommendations for policymakers, stakeholders, and communities to enhance water resource

management and promote sustainable development by identifying the challenges posed by pollution in a country with water stress.

The main research questions are:

1. What are the existing environmental challenges and urban pollution pressures affecting the Prishtina River?
2. The hypotheses assume that improvements in wastewater infrastructure will reduce pollution loads and improve water quality in accordance with national and local laws and standards.
3. What are the benefits of the interventions, and how can they be utilized for the benefit of citizens?

2. METHODOLOGY

The thesis will use and analyze various data describing the current situation of water supply and wastewater systems within the study area, provided by the responsible utilities. Additional data will be collected from various studies, responsible companies, and official reports from relevant institutions managing water resources and wastewater. Mixed-method approach, including desk research of reports and studies, field observations, water quality monitoring, meetings with stakeholders, and data analysis will be conducted and utilized.

The thesis will include qualitative assessments derived from stakeholder engagement, quantitative measurements of water quality, and evaluation of infrastructure interventions in the Prishtina region.

For a deeper development of the research, site visits to several locations were conducted to observe and identify sources of wastewater pollution. In cases where data are lacking, research papers, studies and reports will be used for comparison and assessment of impacts within the defined period.

To understand the existing situation of water resources and to identify existing and potential pollution points, a qualitative research methodology has been followed for source selection. For physical verification, visits to pollution hotspots were conducted, and wastewater samples and analyses were carried out. Special emphasis was placed on the most recent studies and reports from 2022–2025 related to Kosovo projects and European best practices, highlighting ongoing gaps in systematic pollution control and infrastructure coverage.

Data describing the actual situation of the water supply and wastewater systems within the study

area from responsible utilities, was collected from various studies responsible companies, official reports from relevant institutions responsible for the management of water resources, wastewater. Comprehensive identification of relevant literature from government reports, study reports, feasibility studies, analyses, interviews, and webpages was done by utilizing existing data, reputable online research, and official websites to identify key sources. Inclusion and Exclusion Criteria was applied in the respective literature based on relevance, reliability, and recency.

The methodology applied in the theses includes:

- Data collection and analysis of the existing situation and requirements,
- Sampling at four locations macroinvertebrates, and laboratory work to sort macroinvertebrates, their identification and quantification according to relevant literature.
- Water Sampling for physical and chemical analyses conducted at water laboratory.
- Comparison of streams and causes of pollution downstream
- Alternatives for ecosystem improvement

3. LITERATURE REVIEW

3.1 Baseline of Prishtina Catchment Area

The city of Prishtina is located in the northeastern part of Kosovo and covers an area of 7,768.8 hectares. Prishtina spans geographical latitudes from 42°40'00" and longitudes from 21°20'15", with a central position in the Balkan Peninsula. Currently it is populated with 227.000 inhabitants divided in 39 settlements. About 84% of the population within this municipality are living in Prishtina town and 16% are living in rural part. (32)

The relief of Prishtina consists of elevated terrains with elevations ranging from 535-730 m above sea level. The city is surrounded by slopes on three sides, creating an amphitheatrical topographic situation. In the north and east, the Germia forest reaches an elevation of 1,100 m.
In the north, the city is bordered by the cadastral zones of Upper Bernica, Lower Bërnica, and Llukar; In the east, by the cadastral zone of Makoc, Mramor, Novosella; In the south, by the cadastral zone of Çagllavicë; In the west, by the municipality of Fusha Kosova and the village of Shkabaj.

Water supply and sewer services is provided by the Regional Water Company “Prishtina” j.s.c.

the only shareholder of which is the Government of Kosovo. Prishtina is supplied from surface water the artificial Lake Batllava with a total installed capacity of 1000 l/s; Badovc Lake located about 7 km from Prishtina in the east with a total installed capacity of 520 l/; the surface water, artificial Lake Ujman with a total capacity of 700 l/s.

Figure 1: Map of service area, covered by RWCP

3.2 Hydrological data

Kosovo belongs to the most sensitive areas regarding climate change in Europe. The study on climate change in the Western Balkans region 30 (2018) revealed that the climate in Kosovo is forecast to be, toward the mid and the end of this century, hotter and drier than today.

This will result in:

- Increased duration and frequency of heat waves and droughts;
- Increased risk of flooding;
- Forest degradation related to increased fire frequency and its spreading, defoliation and the death of trees;
- Early growing season start and high risk of late spring frost, decrease in yield quality during the years with warmer and/or drier growing period;
- Decreased average river discharge and problem with drinking water quality and supply

especially during summer season;

- Increased energy consumption during summer;
- Increased health and safety risks *(23)*.

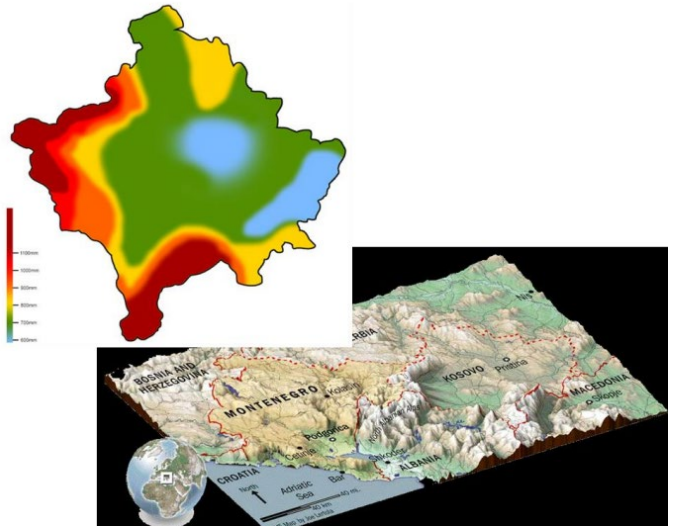

Figure 2: Presentation of Rainfall variation in Kosovo between mountainous areas with in average more than 1.100 mm and the lower part [16]

Table 1 General information for river basins [14]

River	Surface (km^2)	Flow (m^3/s)	Flow coef. ($l/sek/km^2$)	Annual flow **x** $\mathbf{10^6}$ (m3)	Basin	Discharge
Drini i Bardhë	4340.14	61.7		1946	Drini i Bardhe and Plava	Adriatik Sea
Sushica	49.4					
Lumbardh of Peja	464,8	10.21	24.13	200.66		
Lumbardh of Deçan	259,3	7.84	42.46	152.46		
Ereniku	519.3	12.16	26.73	383.04		
Istogu	405.3	6.98				
Klina	458.7	2.8	4.92	65.52		
Mirusha	336,7	1.661				
Toplluha	495	3.44				
Lumbardh of Prizren	247,8	6.49	29.68	147.74		
Plava, Restelice	341.86	5.25	20.79	165.06		
Ibri	**4044.21**	**36.4**	**6.39**	**1148**	**Ibri**	**Black Sea**
Sitnica	2912	13.94	5.38	439.11		
M.Binçes	1564	8.7	5.99	330	Morava	
Kriva Reka	640.7	4.43	7.27	139.55		
Lepenci	653	8.4	14.91	190	Lepenci	Aegan Sea
Nerodime	209.4					
Total	10 907.00	121.2		$3.8*10^6$		

Water is very important for both economic and social development. Kosovo, in its five river basins, is estimated to have 1,600 m³ of water per capita per year. Kosovo's basins are: Iber, White Drin, Binçë Morava, Lepenc, and Plava Basin. [14]

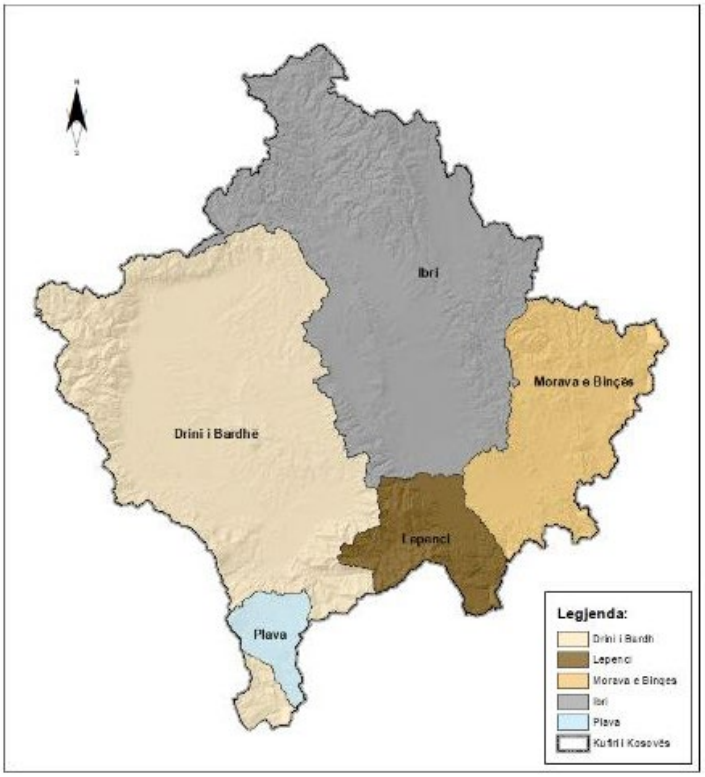

Figure 3 River basins in the Republic of Kosovo (Gis Software)

The Iber River Basin, the Drenica region, and the Kosovo Valley have a number of smaller rivers and streams, most of which are polluted and carry much less water than the Drin Basin. The majority of the Kosovo Valley, through the Sitnica River, flows into the Iber River, which drains wastewater from the northern part, but also the northeastern part of Kosovo, covering an area of 4,369 km². The longest and most important rivers are the Iber (172 km) and Sitnica (94 km). The population living along this basin is approximately 725,000. The main artificial lakes are Ujman, Batllava, and Badovc.

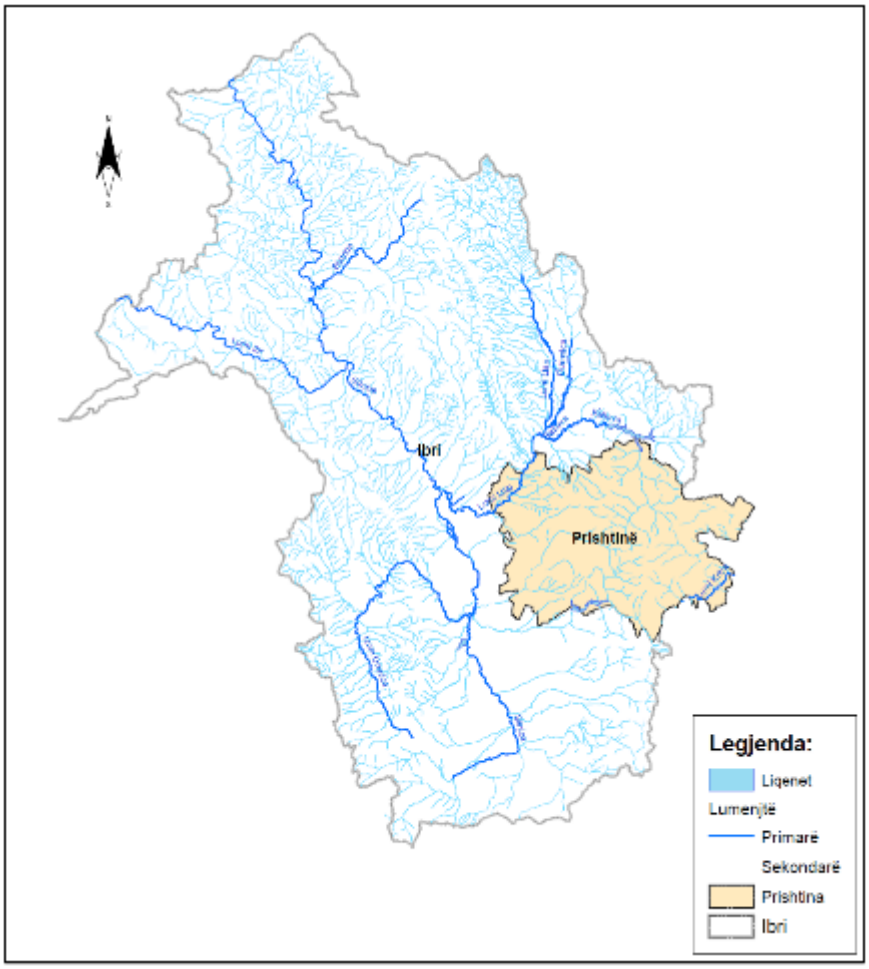

Figure 4. Catchment Area and hydrographic network of Prishtina Municipality

3.2.1 Climate Conditions in Prishtina Region

The general climatic features of the Kosovo plain and the Prishtina region are determined by geographical position, relief (elevation and exposure), position relative to air and land masses, as well as local site conditions. Located at mid-geographical latitudes, between 42°05'25.08" and 43°16'1.57", it is characterized by a mid-latitude climate. As a continental region, with an air distance not too great from the Adriatic Sea (150 km) and the Aegean Sea (250 km), the barriers of mountainous relief reduce the influence of air masses from the coast.

The climate in the service area is mainly continental. [34] Prishtina region is poor from a hydrographic perspective. The water flows of the wider city area consist of the Prishtina and Vellusha rivers, which together flow into the Sitnica with several permanent and periodic tributaries. [16]

3.2.2 Temperature, Air Humidity and Solar Radiation

The average temperature is around 10.04°C. Monthly temperature and average humidity range from 1°C (December) to 22°C (August) and from 78% (December) to 52% (August). Wind speed ranges from 1.0 m/s (September) to 2.3 m/s (February), while sunshine duration ranges from 1.3 hours/day (December) to 11.0 hours/day (August). [12]

Table 2 Average Temperatures 2001-2020 [12]

Tav_e.°C -Prishtinë	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	Annual
2001	2.7	2.8	10.3	9.3	16.5	18.2	21.9	22.6	8.1	13.2	4.4	-5.7	18.1
2002	-2.8	4.7	7.1	9.5	16	20	21.9	20.3	14.8	11	6.9	1.5	10.9
2003	0.2	-3	4.7	8.8	19	21.9	22.2	23.7	15.1	10.3	6.8	0.5	10.9
2004	-1.6	2.2	6.2	11.9	13.2	19.4	22.4	20.7	16.6	14	4.8	1.8	11
2005	0	-2.2	4.6	10.1	15.8	17.8	21.1	19.6	16.8	11	4.2	1.8	10.1
2006	-3.5	-8	5.1	11.7	15.4	18.8	21.5	20.2	16.7	12.4	5.2	0.9	9.7
2007	3.9	4.9	8.2	12	16.2	21	24	22.9	14.8	10.5	2.3	-0.6	11.7
2008	0	3.4	7	11.3	15.3	20	21.1	22.5	15.3	12.5	7.4	3.2	11.6
2009	-0.6	1.1	5.2	12.7	16.8	19.1	21.6	22.2	17.1	10.7	7.7	3.7	11.4
2010	0.5	2.9	6.6	11.5	16	19.5	21.8	23	17	9.5	10.3	2.1	11.7
2011	-0.3	0.2	6.1	10.9	14.7	19.8	22	22.9	20.1	9.5	3.2	1.5	10.9
2012	-1.9	-4.9	7	11.3	14.8	21.6	24.4	24	19.8	13.4	9	-1.1	11.5
2013	2.5	3.7	6.8	12.7	16	19	21.6	23.4	16.5	12.5	8.1	0	11.9
2014	2.9	6.6	8.2	10.5	14.5	18.6	20.7	21.9	15.5	10.9	8.1	1.8	11.7
2015	-0.7	2.5	4.6	10.4		16.9	24.4	23.8	19.1	11.9	7.6	1.6	10.2
2016	0.1	8	7.1	13.7	14.6	20.8	21.9	20.5	16.7	11	5.6	-0.5	11.6
2017	-4.9	4.7	9.5	10.9	15.7	21.4	23.4	22.2	17.8	11.1	6	2.8	11.7
2018	1.3	2	6.3	15.6	17.9	19.4	20.7	21.7	17.2	13.1	6.5	0.1	11.8
2019	-2.2	2.7	8.6	12	13.5	21.4	22	23.2	17.6	13.5	10.3	2.7	12.1
2020	0.2	4.5	6.5	10.9	14.8	18.5	21.4	21.2	18	12	6	4.5	11.6
Average	-0.2	1.9	11.4	11.4	15.6	19.7	22.1	22.1	16.5	11.7	6.5	1.1	11.6

Air temperature is one of the fundamental climatological elements. The air temperature regime is expressed: daily, monthly, and annual, with extreme values and the frequency of certain air temperature values.

Humidity is the concentration of water vapor present in the air. Humidity indicates the possibility of precipitation, dew, or fog. Humidity depends on the temperature and pressure of the system of interest. The same amount of water vapor results in higher relative humidity in cold air than in warm air.

Three main measurements of humidity are widely used: absolute, relative, and specific. Absolute humidity is expressed either as the mass of water vapor per volume of moist air (in grams per cubic meter) or as the mass of water vapor per mass of dry air (usually in grams per kilogram). Relative humidity, often expressed as a percentage, indicates the current state of absolute humidity in relation to a given maximum humidity at the same temperature. Specific humidity is the ratio of the mass of water vapor to the total mass of the moist air parcel.[12]

Table 3 Humidity in Prishtina 2001-2020 [12]

Humidity %	I	II	III	IV	v	VI	VII	VIII	IX	X	XI	XII	Annual
2001-2020	84.2	78.0	72.1	69.4	71.6	69.9	64.9	63.9	70.2	77.1	81.1	84.6	73.6

Weather and climate conditions in a location depend on the direction of the winds that blow and the properties of the air they bring. The Western Balkans are dominated by winds from the northwest and northeast, which are also influenced by the topography. In the weather and climate conditions of the Republic of Kosovo, particular importance is given to the Morava and Iber valleys, through which air masses penetrate from the northern quadrants, as well as the Lepenc and Vardar valleys for flows coming from the southern quadrant.

The flow of air masses is created due to large fluctuations in air temperature in the high mountains and plains. Mainly, during winter, northwest, north, and northeast winds dominate, while during summer, southeast and southwest winds prevail. In the Kosovo Plain, winds blow from all quadrants, but their frequency varies, also depending on local conditions. Throughout the year, there are on average 50-60 windy days, of which 59% occur in the Kosovo Plain, compared to 45% in the Dukagjin Plain.

Table 4 Wind through 2001-2020 [12]

Wind m/s	I	II	III	IV	v	VI	VII	VIII	IX	X	XI	XII	Annual
2001-2020	1.60	2.21	2.37	2.08	1.78	1.41	1.51	1.49	1.63	1.52	1.69	1.80	1.74

3.2.3 Analysis of Precipitation

Atmospheric precipitation is an important indicator of climate and represents the meteorological element with the most pronounced temporal and territorial variations. The characteristics of precipitation include their forms of presentation such as rain, snow, hail, dew, drizzle, etc. Precipitation in the form of rain and snow, the time of fall, as well as their quantity have great climatic and practical importance. The amount of rainfall is measured in millimeters (mm), where 1 mm of precipitation means 1 liter per square meter. Not all rain falls to the ground, as a portion of it evaporates during the fall due to dry air. In our country, about 70-75% of precipitation falls during the period October–May, while the rest occurs during the summer period, June–September. The largest amounts of precipitation occur in the months of April and May, where, in addition to rainfall, there is also snowmelt. In order to examine the impact of precipitation on the city of Prishtina, we have considered two monitoring periods for precipitation: 1948-1998 and the latest data from the Kosovo Hydrometeorological Institute 2001-2020. The data are from Kosovo's main meteorological station, location Prishtina.

The analyzed data from meteorological stations in Prishtina for the two periods 1948-1978 and 2001-2020 indicate an increase in precipitation. Thus, for the first period, average precipitation was 578.9 mm, while for the last 20 years (2001-2020), it was 650 mm (Tables 5 and 6).

Table 5 Average monthly and annual precipitation in Prishtina 1948-1998 [38]

Precipitation (mm) -	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	Annual
1948-1998	31.9	37.1	38	50.9	55.3	53	46.4	44.1	62.3	49.6	57.8	52.5	578.9

Table 6 Precipitation mm from Hydrometeorological Institute, Prishtina,2001-2020 [12]

Precipitation (mm)	I	II	III	IV	v	VI	VII	VIII	IX	X	XI	XII	Annual
2001	76.8	41.1	15.1	127.5	48.4	49.1	42.2	33.9	91.0	19.5	24.8	55.3	624.7
2002	3.0	11.6	50.3	51.4	97.8	37.1	88.6	18.3	137.4	69.2	47.0	65.6	677.3
2003	116.1	13.5	0.9	42.3	41.5	20.3	41.6	23.2	54.0	119.9	49.6	19.1	542.0
2004	72.7	52.9	55.6	51.1	46.4	46.3	67.7	56.3	53.8	34.6	110.1	33.3	680.8
2005	30.7	34.7	51.3	54.1	98.2	55.4	55.7	76.8	21.1	35.9	41.3	87.6	642.8
2006	35.5	67.6	67.6	75.5	42.5	55.5	34.3	90.4	30.0	43.1	27.3	32.1	601.4
2007	49.6	19.7	53.3	25.2	83.1	21.2	6.1	24.2	56.8	110.4	141.9	30.2	621.7
2008	19.0	4.5	93.5	16.4	34.9	113.4	68.6	20.4	44.0	44.4	46.9	105.8	611.8
2009	58.8	45.0	76.0	26.7	58.6	90.4	29.7	46.8	16.4	89.6	72.3	79.6	689.9
2010	70.7	83.0	50.1	78.5	77.2	67.8	67.8	27.6	26.2	84.7	95.6	111.1	840.3
2011	19.5	20.3	25.1	33.8	66.0	23.9	50.4	31.0	34.1	48.1	4.5	73.7	430.4
2012	105.7	36.1	12.8	51.5	102.0	6.2	53.3	3.9	13.7	60.4	29.6	60.8	536.0
2013	21.4	31.3	25.7	18.9	56.2	37.5	32.6	5.6	56.6	64.8	42.6	15.9	409.1
2014	10.9	2.1	50.1	218.8	71.0	88.7	76.8	9.0	152.8	63.7	82.4	58.6	884.9
2015	63.7	78.5	90.3	38.3	63.2	45.9	3.1	56.2	42.1	136.0	41.4	0.8	659.5
2016	93.8	38.1	101.5	24.3	100.0	46.5	106.9	115.2	40.9	100.1	120.4	2.3	890.0
2017	57.6	41.8	12.8	48.4	81.4	42.8	47.5	48.5	33.4	104.1	40.9	144.3	703.5
2018	42.1	62.0	111.4	16.6	67.9	150.2	90.0	22.0	2.9	11.7	32.9	57.8	667.5
2019	68.5	12.1	13.5	92.6	72.0	77.5	87.9	12.3	45.4	9.5	68.7	47.7	607.7
2020	11.7	68.6	61.6	49.4	82.2	86.1	25.3	138.1	44.0	60.1	0.9	50.2	678.2
2001-2020	51.4	38.2	50.9	57.1	69.5	58.1	53.8	43.0	49.8	65.5	56.1	56.6	650.0

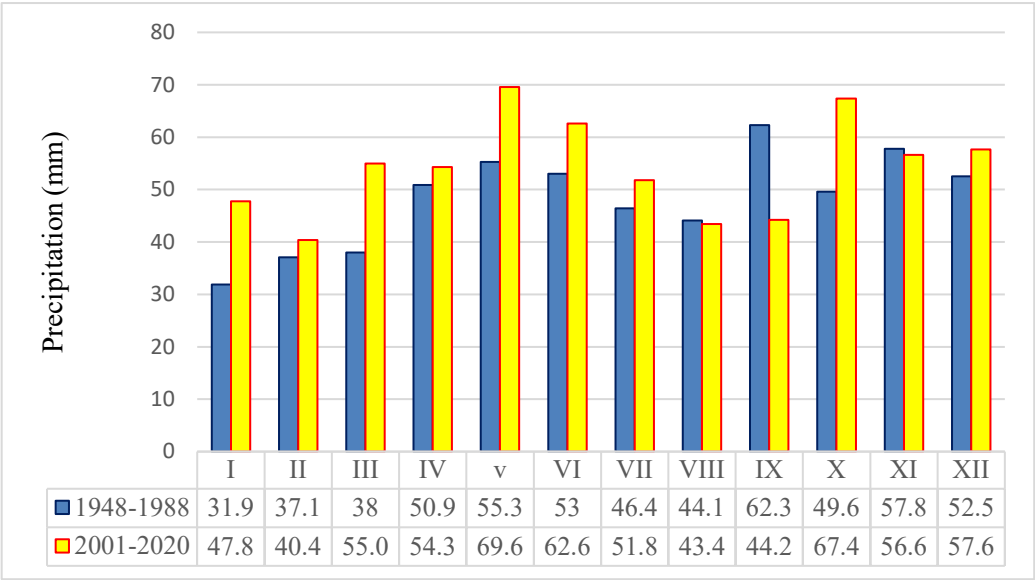

Figure 4 Average annual precipitation 1948-1998 and 2001-2020

From comparing these two graphs, we see that from 2001-2020, there has been an increase in the amount of precipitation in the first seven months and in the tenth month; in the eighth, ninth, and eleventh months, there has been a decrease in precipitation, while in the twelfth month, the level is almost equal.

3.2.4 Analysis of Precipitation in the Municipality of Prishtina Territory

To analyze precipitation in the territory of the Prishtina municipality, official data from the Kosovo Hydrometeorological Institute were used for daily and annual data, while short-duration precipitation data came from a personal meteorological station located in Kalabria. Data from the Prishtina Hydrometeorological Institute show that precipitation for the period 1948-1998 was 606.3 mm, while for the period 2000-2020 it was 675.2 mm at the Prishtina station (Table 7, Figure 5). It is assessed that there are much more frequent occurrences of short-duration rain with very high intensity. Collected data indicate that in 2019, over a 10-minute duration, precipitation reached 19.8 mm, while in 2021 it was 11.94 mm. It can be concluded that there is a high probability that precipitation exceeding 15 mm in 10 minutes will recur in less than 20 years.

Table 7 Precipitation in Prishtina for the period 1948-1998 and 2001-2020 [12]

Month	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	Total (mm)
1948-1998	31.9	37.1	38	50.9	55.3	53	46.4	44.1	62.3	49.6	57.8	52.5	578.9
2001-2020	51.4	38.2	50.9	57.1	69.5	58.1	53.8	43.0	49.8	65.5	56.1	56.6	650.0

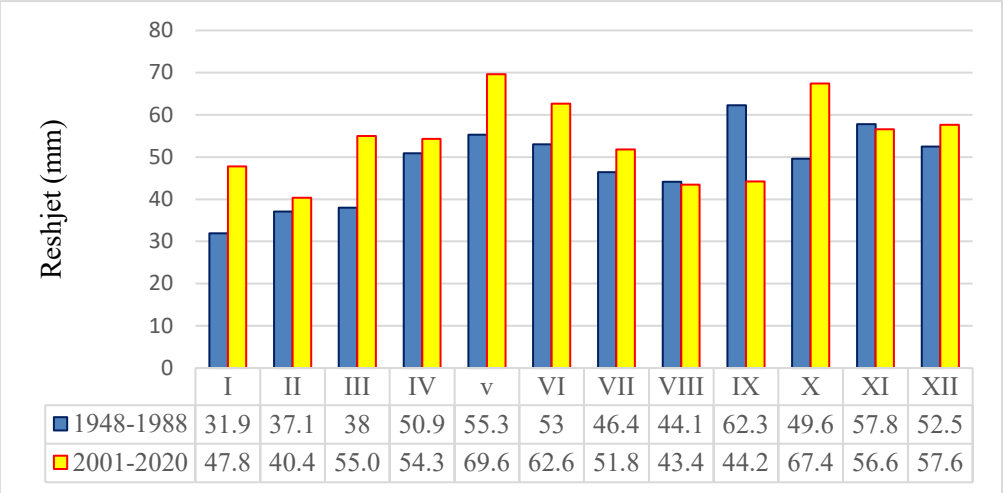

Figure 5 Precipitation in Prishtina for period 1948-1998 and 2001-2020

3.3 Hydrography, Topography, and Physical Characteristics of Prishtina's Catchment Area

Prishtina and Vellusha rivers, in most of the urban areas, are covered and serve to collect rainwater from all urban parts of Prishtina. The main sources of drinking water remain the accumulation lakes of Ujmani, Batllava, and Badovci. [17].

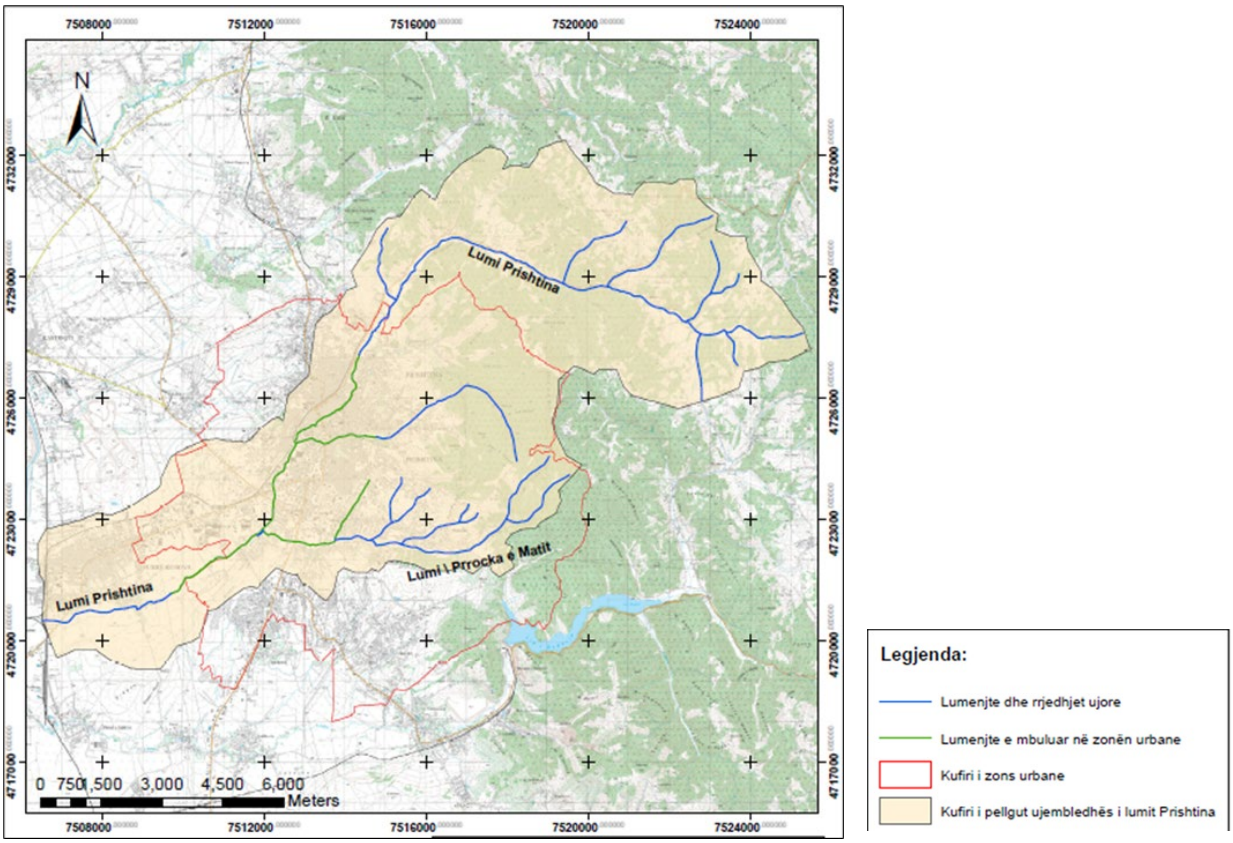

Figure 6 Border of catchment area, Hydrographic network and closed rivers in the urban area, GIS Software

The topography of the Prishtina River's catchment area is characterized by elevations ranging from 490 m above sea level to 1,000 m above sea level. The urban area extends from 540 m above sea level to an elevation of 700 m above sea level.

The main physical characteristics of the catchment area and the Prishtina River have been analyzed using topographic maps and GIS processing.

Catchment area – is a land zone defined by an imaginary line where all precipitation converges to a common point through secondary flows or valleys that drain into a main river. Based on

measurements taken, the catchment area of the Prishtina River basin, which includes the Vellusha River and Mat River branches, is approximately 105.85 km² (Table 8).

Prishtina's catchment area is divided into seven zones that separate the areas from the maximum elevation of 1,000 m.a.s.l. down to the outflow into the Sitnica River at 490 m.a.s.l. (Figure 7 and Table 8) and river slope is given in Figure 8)

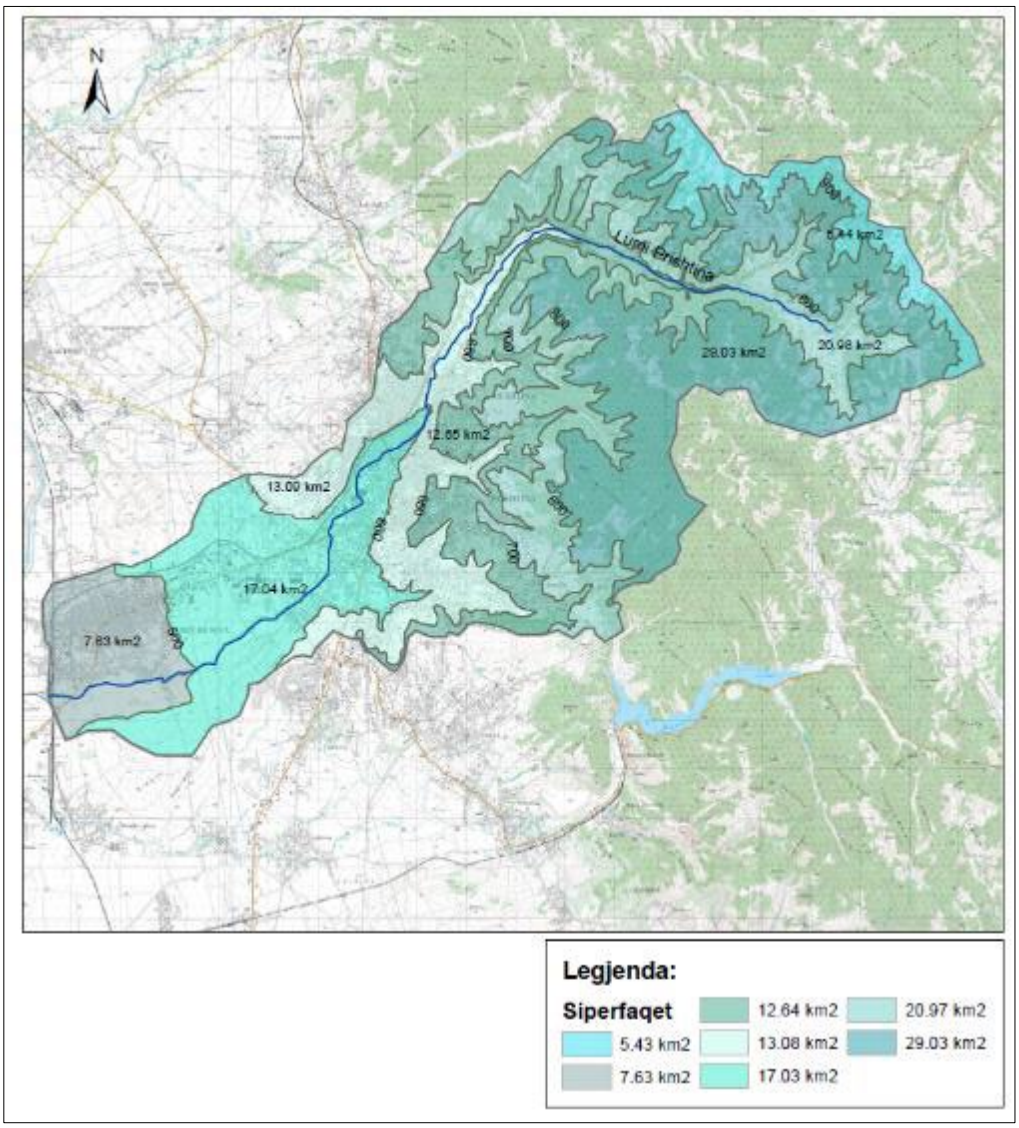

Figure 7 Catchment areas as per level, GIS

Table 8 Data for surface according to sea level, GIS

Hight (m.n.d)	Surface (km^2)	%	River length (km)
490-500	7.63	7.21	3.2
500-600	17.04	16.10	8.1
600-650	13.09	12.37	5.2
650-700	12.65	11.95	3.2
700-800	20.98	19.82	4
800-900	29.03	27.43	1.1
900-1000	5.43	5.13	1
Total	105.85	100	25.8

The slope of the Prishtina River – The longitudinal slope of the watercourse is be determined based on the geodetic survey of the river's longitudinal profile.

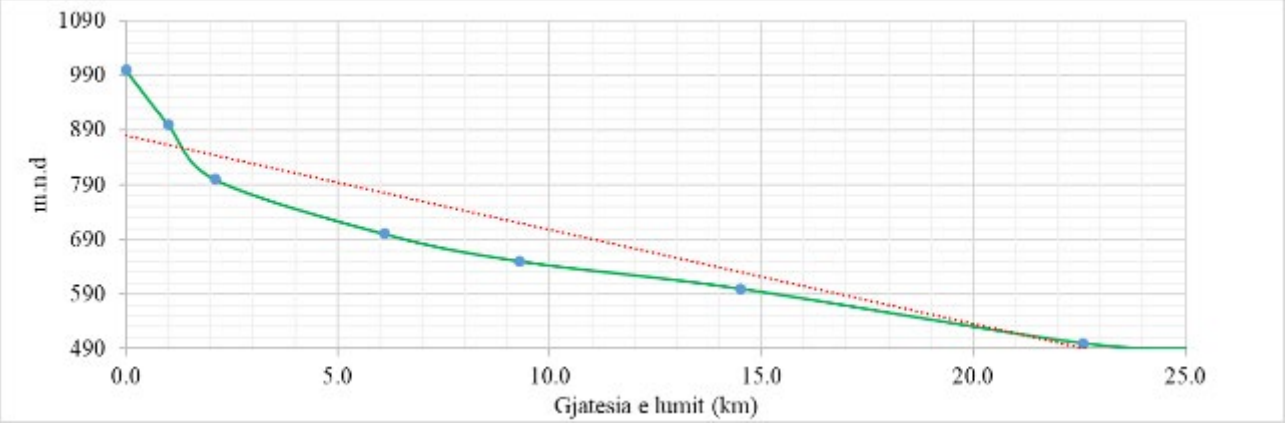

Figure 8 Slope of the River Prishtina

3.4 Urban Development in Prishtina

3.4.1 Analysis of Prishtina's Urban Developments Over Time Periods

Prishtina is the capital of the Republic of Kosovo, as well as the administrative center of the Prishtina district and region. As the capital, Prishtina functions as the country's political, economic, cultural, logistical, and scientific center.

In 1486/87, Prishtina had 392 houses in 10 neighborhoods. In 1569/70, it had 629 houses in 29 neighborhoods. In 1660, Prishtina had 2,060 houses. In 1689, it had 4,000 houses. In 1811, Prishtina had 12,000 inhabitants. In 1991, Prishtina was estimated to have 150,000 inhabitants, while according to the 2011 census, the Prishtina municipality had 198,897 resident inhabitants,

of which 164,296 in the urban zone. [32] According to projections from the Kosovo Agency of Statistics at the end of 2021, the Prishtina municipality has 219,017 inhabitants. [33]

With the growth and development of the capital, the urban area has also increased over the years. Prishtina initially had an urban area of 17.99 km² and a perimeter of 19.3 km. Now, according to the Urban Development Plan (2012-2022), it has an area of 77.67 km² and a perimeter of 54.09 km. For the researched maps on the existing state of buildings, roads, and green areas, we refer to maps produced for the existing conditions in 1989, 2002, and ortho-photos or maps from Google Earth in 2003 and 2022 (Figure 9 and Figure 10).

Prishtina -1989

Prishtina -2002

Figure 9 Layout of Prishtina 1989-2002, Geodesic and Photogrammetric Entity

Prishtina -2003

Prishtina -2022

Figure 10 Layout of Prishtina 2003-2022 [38]

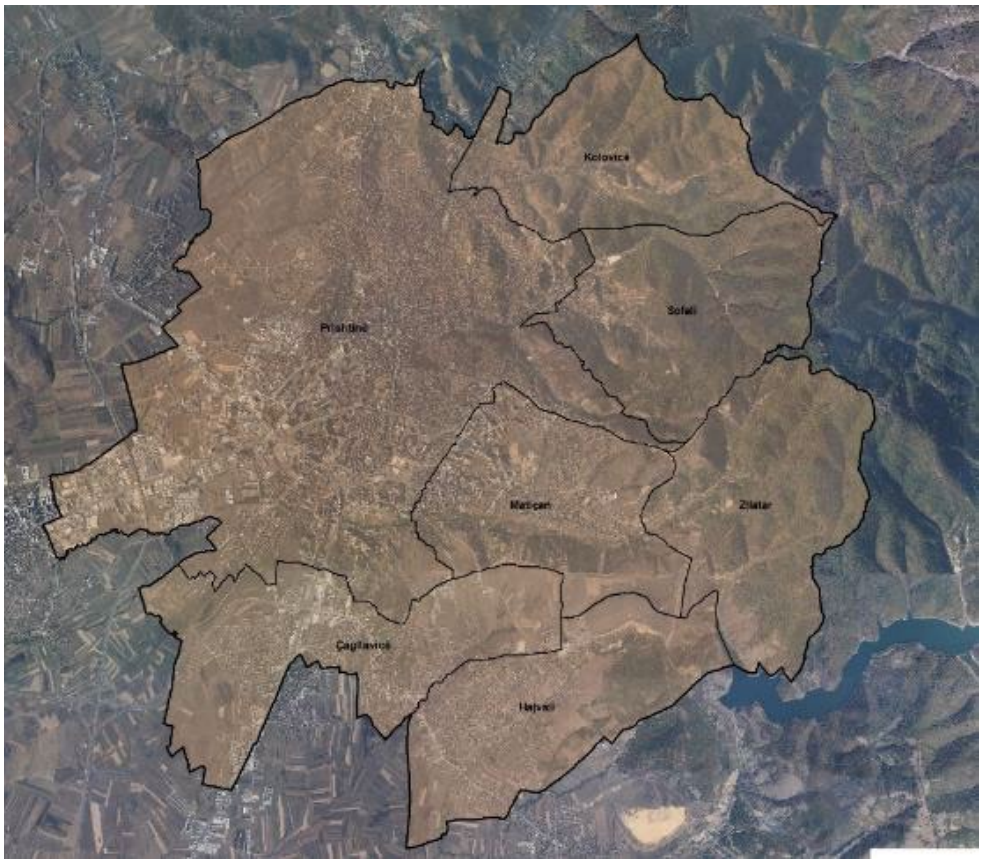

Figure 11 Urban Zone of Prishtina in 2022 [34]

Within the current urban zone, several areas that were considered rural until 2012 have been incorporated, and these villages are: Kolovica, Sofali, Matiçan, Zllatar, Çagllavicë, Hajvali.

3.4.2 Comparisons of Urban Development 2003–2022

Prishtina in the urban zone has undergone major transformations, especially after 1999, where in many neighborhoods that were barren land, arable fields, or shrublands, have been converted into construction land populated with residential buildings, businesses, or construction zones. All these have influenced changes in ratios across zones, with the potential to increase surface water runoff toward manholes, collectors, and rivers.

The development of development plans and the urban plan (2012-2022) envisages the expansion of urban areas toward New Prishtina and Bernica (Figure 12).

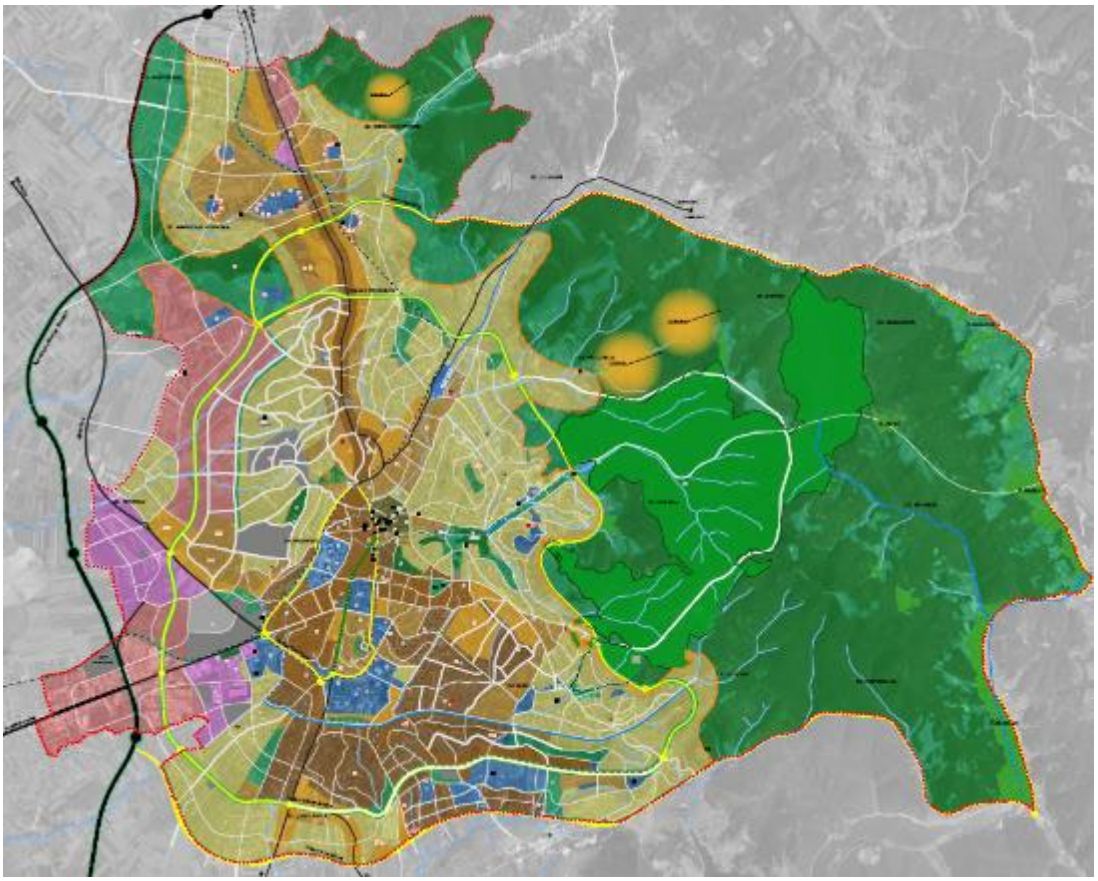

Figure 12 Land use allocations according to Prishtina's Urban Development Plan 2012-2022 [34]

Figures below shows entire zones with new constructions, roads, parking lots, and sidewalks. These changes are particularly evident in neighborhoods such as Mati-1, Prishtina e Re, Arberia, Kalabria, and the economic zone. Obvious comparisons are noticeable from 2003 to 2025 through images from Google Earth.

Neighborhood Kalabri, Mati 1,2003

Neighborhood Kalabri, Mati-1,2025

Figure 13 Google earth images for Neighborhoods Kalabri and Mat 2003 and 2025 [38]

Neighborhood Arberia 2003

Neighborhood Arberia 2025

Figure 14 Google earth images for Neighborhood Arberia 2003 and 2025 [38]

Neighborhood New Prishtina 2003

Neighborhood New Prishtina 2003 and 2025

Figure 15 Google earth images for Neighborhood New Prishtina 2003 and 2025 [38]

Neighborhoods Arberia and Pejtoni 2003

Neighborhoods Arberia and Pejtoni 2025

Figure 16 Google earth images for Neighborhoods Arberia and Pejtoni 2003 and 2025 [38]

Satellite images over different periods show rapid development, especially in the urban area of Prishtina city. However, such development often disregards environmental criteria related to the creation of extensive surfaces with structures that generate surface water runoff and reduce infiltration rates.

3.5 Sewer and Storm water infrastructure

Considering the situation of water resources and Kosovo being a country with limited water resources and with water stress, the purpose of the research is to identify the most significant aspects of pollution of the water resources with the main focus in wastewater management.

Most of the sewerage network is almost more than 40 years older, except of some investments made by Municipality of Prishtina in the last 10 years mainly in new neighborhoods such as the extension of the main collectors parallel to the river Prishtina in the direction of Fushe Kosova and the

construction of the main collectors on the road B and C. A relatively new investment was also made in 2012/2013 in the change of the sewerage network in the Dodona neighborhood. The existing sewerage infrastructure of the City of Prishtina is designed as separate system, but in absence a stormwater system, the main part of the city is operated as a combined system.

Out of 38 settlements/Villages located within this service area, only 18 settlements (47%) having a piped sewerage system with service coverage of in average 83%. The remaining 20 settlements are relying on onsite sanitation facilities or dispose their wastewater directly in streams. [17]

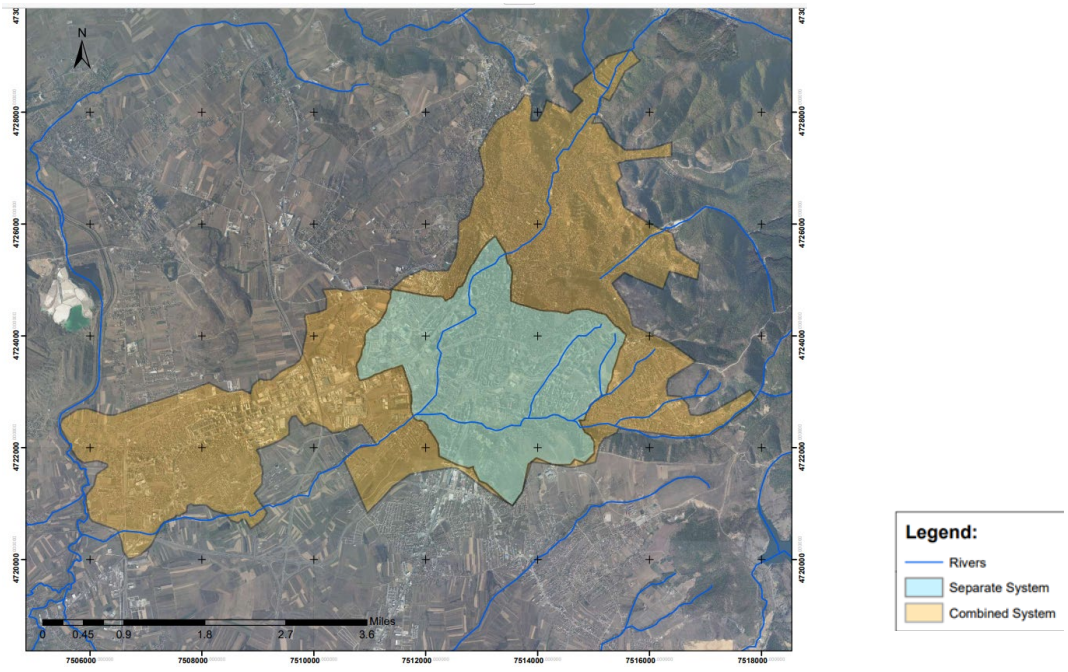

Figure 17 Sewer Network Area of Combined and Separate System, Prishtina region [17]

Although having requested, no significant/reliable data exist regarding sewerage network in the rural area. The sewer system was installed by the Municipality and based on interviews and experience the system is operated as a combined system with having various outlets to the rivers/streams. In addition, in the Municipality of Prishtina there are four major industrial dischargers from which the Hospital is the biggest with an estimated discharge to the sewer network of about 690.000 m^3/year. Due to the specifics of the discharged water from the hospital, Administrative Instruction 30/2014 should be applied, which means that the hospital should have a pre-treatment system.

There are also non-served areas which are in general located on the periphery of the settlement and consequently they are relying on onsite sanitation (Septic Tanks) facilities or dispose their wastewater directly in streams. As such Septic Tanks are made privately, they do not fulfil any requirements, and emptying is done by farmers on private initiative. [16]

3.5.1 Current State of Existing Stormwater Drainage Infrastructure

The infrastructure for stormwater drainage has been constructed over different periods. Thus, the first structures were built around the 1970s-1980s, when the two main rivers in the central city area, Prishtina and Vellusha, were covered, and parallel to them, the sanitary water collectors were also built (Figure 18). The covered collectors of the Prishtina (Prishtina) and Vellusha rivers still constitute the main drainage system of Prishtina's urban area, but at the same time, they also receive stormwater from the Prishtina and Vellusha rivers starting from the beginning of the catchment area.

Figure 18 River Prishtina and Vellusha as Collectors [17] [38]

With the expansion of construction after 1999, additional works were carried out on the main collectors, extending the construction of the Prishtina River covering the collector to the north and west, respectively from the bus station to the end of the Kalabria neighborhood which is the main part of this Diploma Thesis. Additionally, in 2012-2015, the manhole that is now Road B was covered, and currently, the construction of the collector—respectively the covering of the Mat River—from the hospital neighborhood to the junction with the Prishtina collector is underway.

The starting and ending points for the existing state of the collectors are shown in Figure 19. Additionally, we have taken photos at each point of the collectors-rivers (Figure 20).

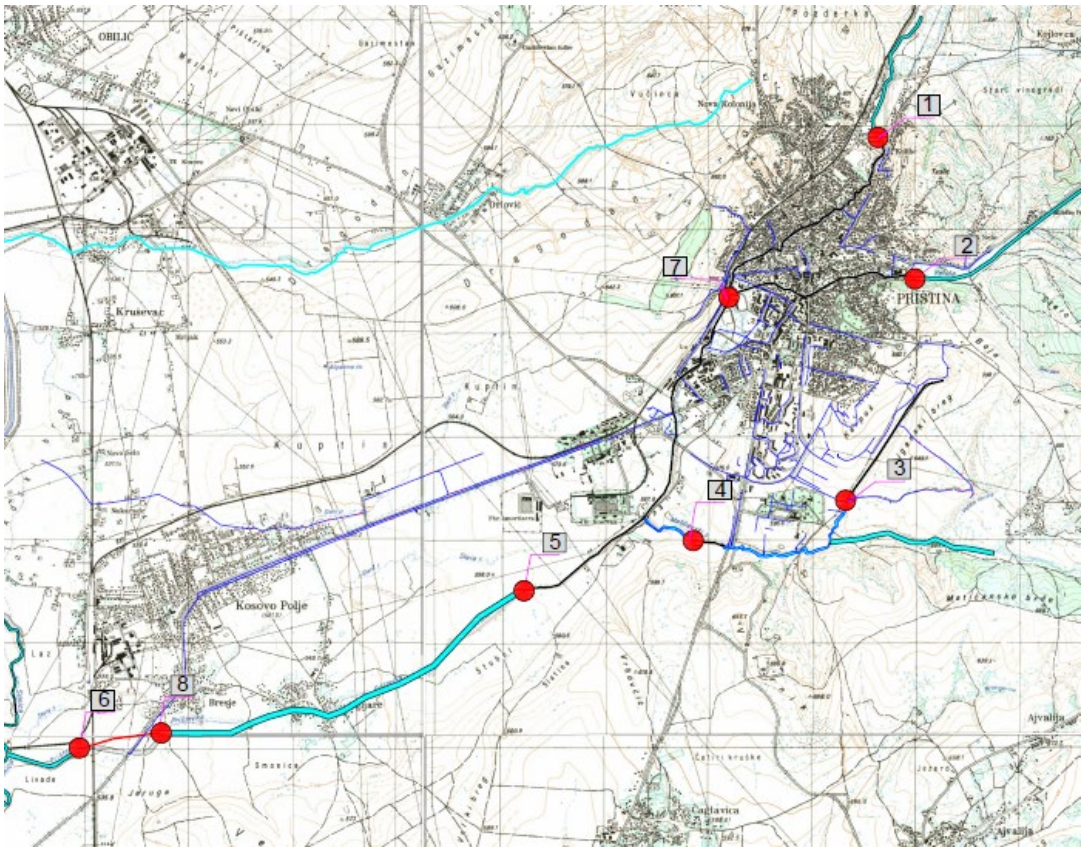

Figure 19 Drainage network and points of covered collectors – FS SRP

Below pictures of covered points are given:

River Prishtina in North entry-1

Vellusha River in Tokbashqe Park -2

Street B-3

Street A-Kalabri River Mat-4

River Prishtina Kalabri-5

River Prishtina -Fushe Kosove -6

Figure 20 Profiles of covered rivers Prishtina, Vellusha, street B and Street A

Due to topographical reasons, wastewater and stormwater from Prishtina's urban area flow westward, towards Fushë Kosovë. This topography enables the entire volume of water to be conveyed by gravity in that direction.

3.5.2 Network Details and Recent Developments

Based on data from RWC Prishtina and field interviews, the total length of the stormwater sewer network in urban areas reaches 40-60 km, with pipe diameters ranging from 300 to 1200 mm, and about 30% having diameters of 300-500 mm .

The primary stormwater system consists mainly of small rivers such as the Prishtina River, Vellusha, and Mati; the Prishtina (7 km long) and Vellusha (2 km long) have been converted into closed collectors. These two collectors join in central Prishtina (Figure 18) and continue towards Fushe Kosova, transforming most of the rivers into collectors for wastewater and stormwater.[17]

In recent years, Prishtina Municipality has continued building the Prishtina collector in the western part of the city towards Fushë Kosovës; due to city expansion, it also constructed similar 1.4 km

collector in the southwest, in the Mati neighborhood (figure 20). These two segments are still under construction.

3.5.3 Collector Network and Issues

Prishtina as a city has a characteristic that the two rivers (Stream) Prishtina with 7 km length and and Vellusha with 2 km have been built as a closed collector that collected stormwater in the initial project. Both of these collectors join in the center of the city of Prishtina and continue in the direction of Fushe Kosova. Majority of the river's length has been transformed into a collector for both stormwater and wastewater.

Various stormwater collectors, mainly along main roads, discharge into three rivers. Although parallel wastewater collectors exist on both sides of the small rivers, cross-connections still occur, polluting the rivers. Sewer network for Prishtina and Fushe Kosova is shown in figure 21.[17]

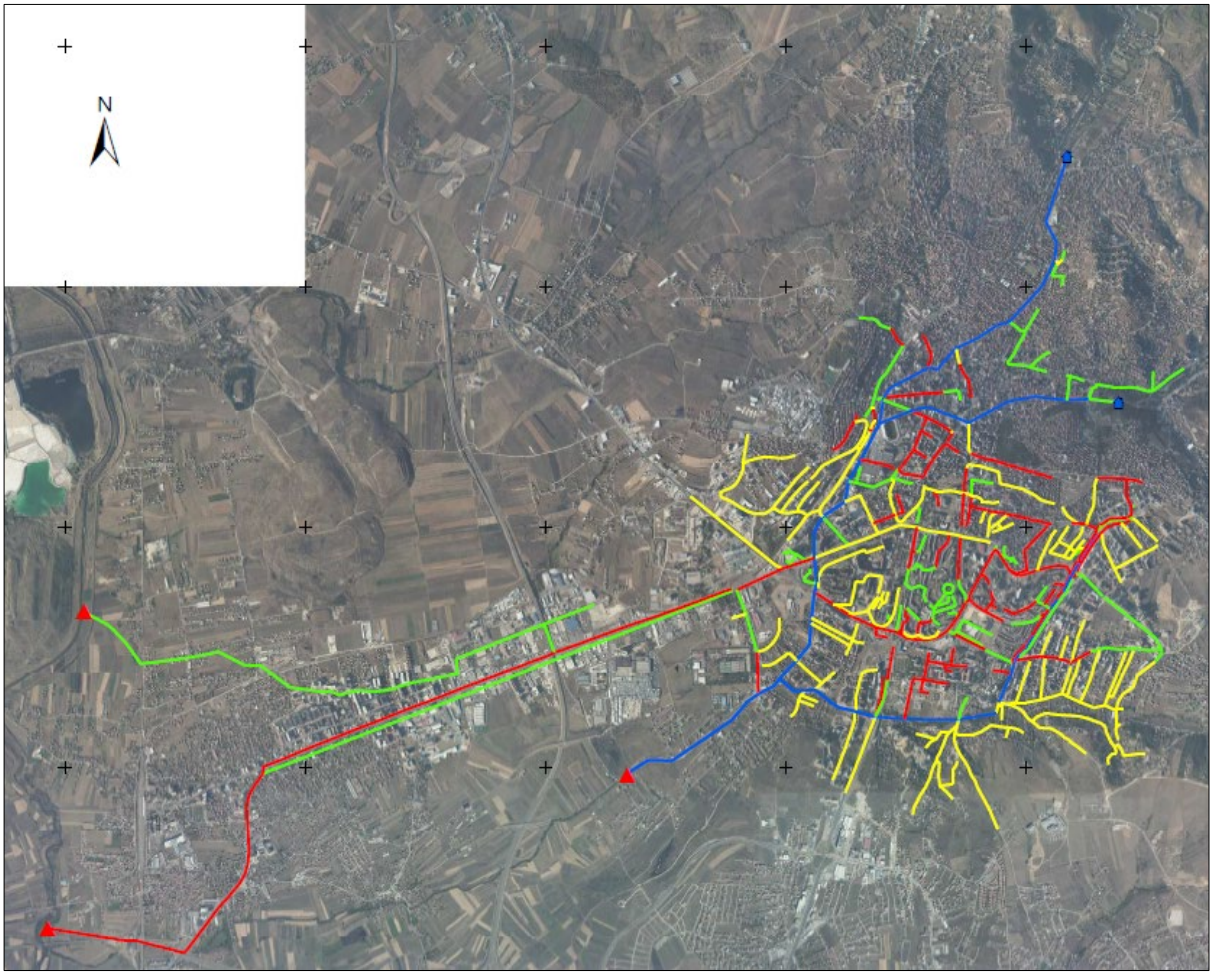

Figure 21 Layout of main storm water network for Prishtina and Fushe Kosova [17]

3.6 Results of Maximum Inflows for 2, 10, 50, and 100-Year Periods for the Urban Area

The calculation of maximum inflows includes the entire urban area and non-urban areas where water flow passes through the urban zone. For this purpose, this area has been divided into 8 catchment zones, where the drainage selection aligns with the inlets and outlets of covered or to-e-covered rivers (Prishtina, Vellusha, Road B, Road A, Figure 6).

For the calculation of the maximum quantities for the urban area and the areas that the non-urban areas that drain water towards the urban areas were calculated by combining the two methods, Rational and SCS-TR 55. The area included in the calculation is of 85 km2 divided into 8 watersheds, to more easily calculate each segment Table 9.

Type C of soil hydrology includes soils that have a low infiltration rate when fully wetted and a low rate of water transmission. Examples are soils with a layer that prevents the movement of water downward or soils with a medium fine to fine structure. This type of soil is considered for the non-urban part of Prishtina and CN=70 by calculating zones 1,2 and 3 while the rest of the urban part of Prishtina with low permeability CN=80, Table 9. [39]

Table 9 Surface and number of curve CN [39]

No Catchment	Name of catchment	Surface (km^2)	Nr of flow curve (CN)
1	River Prishtina	50.4	70
2	River Vellusha,Vellusha	9.8	70
3	River Mat	9.8	70
4	Tophane, Medrese	3.8	80
5	Centre	2.4	80
6	Street B	1.7	80
7	Center, Dradania, Ulpiana, Arberia	4.5	80
8	New Prishtina, Kalabria	2.6	80
Total (km2)		85.0	Equivalent CN=(72)

Maximum quantities for the urban area and non-urban zones draining water towards urban areas were calculated by combining the Rational Method and SCS-TR 55. The included area spans 85 km^2, divided into 8 catchments to simplify calculations for each segment (Table 9).

Soil hydrology Type C includes lands with low infiltration rates when fully saturated and low transmission rates. Examples are soils with a restrictive layer impeding downward water movement or those with moderately fine to fine texture. This type was applied to Prishtina's non-

urban part with CN=70 for zones 1, 2, and 3, while the rest of the urban area used low permeability CN=80 (Table 20).

Precipitation and runoff for the urban area, divided into 5 sub-catchment zones covering a total area of 15 km² out of the overall catchment area of 85 km², along with the calculation of comparative inflows, shows results for calculated return periods of 2, 10, 50, and 100 years. The importance of accurately determining the volume of runoff cannot be overstated. Estimates of peak runoff rates, runoff volumes, and the temporal distribution of runoff provide the foundation for all planning, design, and construction of drainage facilities. Incorrect hydrology leads to infrastructure that is undersized, oversized, or hydraulically unbalanced. At the same time, it is important to understand that the result of the runoff analysis is an approximate value. [39]

The hydraulic analysis results for the existing infrastructure of the Prishtina and Vellusha rivers—covering the covered sections at points 1 to 10 for Prishtina and 2 to 7 for Vellusha, which include 8 sub-catchments—indicate a risk, particularly in the lower part of Prishtina city from the stadium through Pejton to Dardania, of flooding and inundation, as shown in Table 10. For 50-year return periods, the covered segments of the Prishtina River do not meet the conditions for handling the water, while for 100-year return period inflows, no segment meets the criteria for conveying the inflows. These calculations are based on the assumption that the existing condition of the collector-covered river channels is good and that the profile is nearly complete (95%). In practice, this situation is even more problematic due to documented waste accumulation and poor maintenance.

Table 10 Comparing results of covered sections of rivers Prishtina and Vellusha for the repeating period T=2,10,50 and 100 years [39]

Covered segments	Catchment	Surface (km^2)	Flow as per current condition (m^3/s)	Flow as per calculations (m^3/s)			
			X	2	10	50	100
Prishtina 1-7	1+4	54.2	74.1	12.38	31.86	66.29	116.51
Vellusha 2-7	2+5	12.2	38	6.07	13.82	27.48	46.46
Prishtina 7-9-10	1+2+4+5+7	70.9	67.54	27.68	60.30	115.06	189.13
Prishtina 10-5	1+2+3+4+5+6+7+8	85	92.22	37.51	79.06	148.17	239.91

4 LEGAL FRAMEWORK AND REQUIREMENTS

In Kosovo, the legal framework for wastewater management is still developing, and gaps in enforcement, infrastructure, and coordination between stakeholders exacerbate the issue. There is a critical need to strengthen regulatory mechanisms, implement financial incentives, and align national laws with international standards—particularly the EU Acquis—to safeguard water quality and protect ecosystems.

The EU Acquis on water protection, particularly the Water Framework Directive (WFD) and the Urban Wastewater Treatment Directive (UWWTD), sets clear guidelines for wastewater treatment and water quality management. As Kosovo aims to align its legislation with EU standards, it faces the dual challenge of improving its regulatory and enforcement mechanisms while investing in the infrastructure necessary to reduce untreated wastewater discharge.

Currently, a lack of wastewater treatment plants in many municipalities contributes to significant pollution in Kosovo's rivers, threatening ecosystems and local communities alike. Kosovo has made commitments to improve water management through national strategies and environmental laws, but more must be done to ensure proper implementation and to bridge the gaps between policy and practice.

According to the annual report on the state of the environment in 2021 published by KEPA, the quality of surface water in our country continues to be affected by pollution. Water pollution comes from various sources and factors, but mainly, our rivers are polluted due to contamination resulting from urban and industrial wastewater discharges, uncontrolled dumping of waste into rivers, the use of pesticides and fertilizers in agriculture, the degradation of riverbeds due to the extraction of inert materials, as well as illegal construction.

According to this report, in 2021, the monitoring of surface water quality was conducted at 54 monitoring points in rivers, revealing the presence of organic pollutants in the river waters at all monitored locations but to varying degrees. Kosovo still does not have regular monitoring of the water quality of lakes and groundwater, but some steps have been taken within various projects to improve monitoring. Kosovo does not even have biological monitoring of surface waters, and the wastewater treatment system is not fully developed, although there was progress in this field during 2021. However, the treatment still remains at a low level, with only 11% of the all wastewater being treated. [28]

Urban wastewater pollution has emerged as a pressing environmental challenge in Kosovo, particularly raising concerns about its detrimental effects on the country's rivers [16]. The UWWTD requires that the escalating issue demands immediate attention and effective

management strategies to ensure the restoration and maintenance of sound ecological conditions. Human activities, coupled with inadequate wastewater treatment, contribute significantly to severe eutrophication problems in water bodies, leading to alarming changes in water quality. [3]

4.1 Kosovo's Regulatory Framework on Wastewater

Kosovo has been in pace to adopt the EU Directives. In regard to national laws regulating the sector there are the following laws: Law No. 04/L 147 on the Waters of Kosovo to ensure the sustainable development and use of water resources, which are essential to public health, environmental protection and social-economic development of Kosovo, establish procedures and guidelines for optimal allocation of water resources based on use and purpose, ensure protection of water resources from pollution, overuse and misuse and to determine the institutional framework for administration of water resources; Law no. 05 / L - 042 on the regulation of water services that establishes the Water and Wastewater Regulatory Office and constitutes the legal framework for the economic regulation of public companies providing water and wastewater services. It represents the Primary Legislation which provides the authorizations, responsibilities, and mandate for the regulation of water services in Kosovo of WSRA. Also, the responsibilities and mandate of the Director, the Head of the Review Committee, punitive provisions etc. are foreseen by this law; Law No. 02/L-78 on Public Health that determines institutions responsible for enforcing health policies and stipulates duties of the National Institute of Public Health, which, among others, include drinking water quality monitoring; Law No. 02 /l-79 on Hydro-meteorological activities aiming to regulate hydro-meteorological activities and how they are conducted. [17]

As Secondary Legislation there is the Administrative Directive no. 2/2022 which regulates manners, parameters and limit values of wastewater discharge into public sewage network and in the water body. It considers all kinds of wastewaters (urban and industrial) and its release into surface water, ground water and sensitive areas, to protect environment and human health from negative aspects of wastewater. It determines the conditions, methods, parameters and limit values of the wastewater discharge to the public sewerage, WWTP and water body; The Administrative Instruction N° 03/2018 on Procedures for Water Permit which refers to the process of obtaining a water permit, which also includes obtaining a discharge permit for the used water. According to this instruction, three authorities issue a water permit: The Ministry of Environment and Spatial Planning (MESP), River District Basin Authority (RDBA), and the Municipalities; Administrative

Instruction No. 28/2014 for the Sanitary Protected Zones which defines the sanitary protected areas, criteria and measures for the protection of water resources that are used and can be used in the future for the water supply; Administrative Instruction 02/2016 on Water Payment Structure which defines level of compensation for the use of water, waste water discharge and compensation for the extraction of gravel from river beds and banks of water flows. [17]

The Environmental legislation regulating the environmental protection in Kosovo is currently regulated through the following application main laws: on Environmental Protection" approved by the Assembly of Kosovo on 26.02.2009 and promulgated by the President Decree on 19.03.2009, it repealed the AI No.02/2004 and the Regulation No. 9/2003; Law No. 04/L-175 "on the inspectorate of environment, waters, nature, spatial planning and construction", approved on 2.10.2013 and promulgated by Presidential Decree No. DL-053-2013, dated 21.10.2013; Law No.05/L-044 "on the environmentally endangered zone of Obiliq and its surroundings" approved by the Assembly of Kosovo. [17]

4.2 Role of Government Institutions for regulating and monitoring water sector

The role of government institutions responsible for regulating and monitoring the water sector and for wastewater discharge in Kosovo in this regard comprises of two sub-sectors: water resources and water services, in which the Ministry of Environment, Spatial Planning and Infrastructure (MESPI) is the responsible authority for the management of water resources, policy drafting and the strategy for water management, while 7 public Regional Water Companies licensed and regulated by the Water Services Regulatory Authority (WSRA) are responsible towards water services (comprising water supply services and wastewater services). [17]
An overview of the actors in the water sector and its relationship is shown in the Figure below:

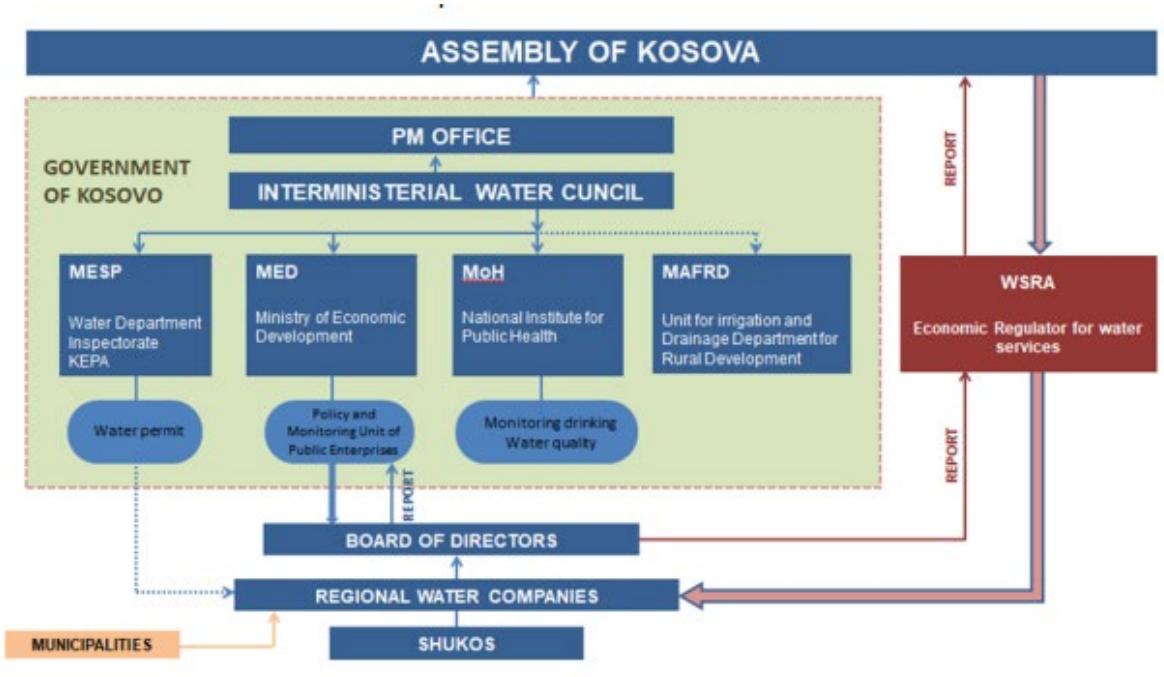

Figure 22 Institutional framework of water sector in Kosovo [17]

4.3 EU Acquis on Water Protection

The key EU Directives related to water protection are the Water Framework Directive (WFD) and the Urban Wastewater Treatment Directive (UWWTD).

The EU's Water Framework Directive (WFD) (Directive 2000/60/EC) establishes a comprehensive framework for the protection of all water bodies within the EU. Its objectives are to prevent deterioration of water quality, protect aquatic ecosystems, promote sustainable water use, and improve the aquatic environment overall. The directive sets ambitious targets for achieving "good status" for all surface and groundwater by implementing river basin management plans. The said Directive (2000/60/EC) requires all Member States to protect and improve water quality in all waters so that we achieve good ecological status by 2015 or, at the latest, by 2027.

Key elements of the WFD include River Basin Management Plans (RBMPs): Member States must develop RBMPs that include measures to protect and restore water bodies to good status, public participation by involving stakeholders in the planning and implementation of water management strategies to ensure transparency and effectiveness, and systematic monitoring of water quality and the impact of human activities on water bodies to guide policy and action plans.

In the environmental, economic, and public health aspect, untreated wastewater negatively affects

water quality, biodiversity, and community health. It depletes aquatic oxygen, introduces toxins, and contributes to eutrophication. For Kosovo, economic impacts include degraded agricultural land and higher costs for water treatment. The Drinking Water Directive emphasizes the need for clean drinking water free from contaminants, underscoring the health risks of polluted sources.

In Kosovo's legal framework for wastewater, Kosovo aligns with EU standards through the Law on Waters and administrative directives like AI 2/2022. However, gaps persist in enforcement and infrastructure. Article 4 of the Drinking Water Directive mandates safe drinking water sources and can guide improvements in source water protection.

EU Acquis on water protection: The Drinking Water Directive complements the Water Framework Directive by setting standards for safe human consumption, focusing on chemical, microbiological, and indicator parameters (Annex I). Kosovo must meet these thresholds while addressing untreated wastewater sources that could lead to non-compliance.

Whereas the Urban Wastewater Treatment Directive (Directive 91/271/EEC) focuses specifically on the collection, treatment, and discharge of urban wastewater to protect the environment. It mandates that Agglomerations with populations above certain thresholds must have collecting systems and appropriate treatment plants. Sensitive areas require even more stringent treatment measures to prevent eutrophication and protect vulnerable ecosystems. Industrial wastewater entering urban systems must comply with prior regulations to prevent contamination and overloading of treatment plants.

The EU’s Urban Wastewater Treatment Directive currently in force is more than 30 years old. Since its adoption in 1991, the quality of European rivers, lakes and seas has dramatically improved. EU countries have set up collecting systems and wastewater treatment plants with the help of EU funding. Yet there is still pollution that needs to be addressed and is not covered by the current rules. To address this, the Commission has proposed an update to the Directive. [3]

Urban wastewater is one of the main sources of water pollution if it is not collected and treated according to EU rules. It contains organic matter, nitrogen and phosphorous. These are all removed when properly treated, otherwise they can lead to eutrophication. It also can be contaminated with harmful chemicals, bacteria and viruses which, when untreated and discharged into the environment, affect our health and damages our rivers, lakes and coastal water.

The national Administrative Directive no. 2/2022 on conditions, methods, parameters and limited values of wastewater discharge into public sewer network and water bodies gives the following limited values which are fully in line with the EU's Urban Wastewater Treatment Directive for effluents into water bodies presented on the table below.

Table 11 Parameters and limited values of wastewater discharge into water bodies, National Administrative Directive on Wastewater Discharge 2022. [13]

Limited values of Wastewater effluents in a water body								
Parameters - Unit mg/L	TSS	COD	BOD	Total-P	Total N	NH4-N	NO3-N	NO2-N
Effluents into surface water	35	125	25	1	15	10	2	1

However, in practice there is still a lot to be invested in infrastructure. Based on conducted analysis of freshwater ecosystems in one of the most polluted rivers in the capital of Prishtina by the influence of human activities in their intermediate and lower segments. Pollution arises from the discharge of wastewater into rivers and streams, industrial discharges, and polluted waters in rivers and streams.

As an indicator there were analysis conducted of wastewater discharged into the water body, with which we can ascertain that the water discharge does not comply firstly with limited values of the National Administrative Directive, see tables 18, 19 and 20.

In order to integrate the Drinking Water Directive, Articles like 8.1 and 8.2 mandate swift corrective actions when water fails quality standards, emphasizing the elimination of pollution sources such as untreated wastewater. Parameters for compliance: Annex I parameters (e.g., nitrate, pesticides) underscore the interconnectedness of wastewater management and drinking water quality. Mismanagement of wastewater could lead to violations, endangering public health.

For Kosovo, aligning with these EU directives means adopting stricter regulations on wastewater treatment and investing in infrastructure to meet the compliance requirements. This is essential as Kosovo aims for EU integration, necessitating harmonization of its national laws with the EU Acquis. In order to align with EU integration Process it remains to be discussed because even though the Kosovo Law is fully transposed, it still remains a lot of efforts in regard to financing and implementation to cover wastewater treatment in the entire state. Some progress has been made in some cities like Prizren and Peja having constructed and operating with WWTP, and some are in the process of constructing WWTPs such as Prishtina, Gjilan and Ferizaj.

Based on the EU's Urban Wastewater Treatment Directive industrial wastewater entering collecting systems as well as the discharge of wastewater and disposal of sludge from urban wastewater treatment plants should be subject to general rules or regulations and/or specific authorizations, yet it remains for Kosovo to develop Sludge Strategies since it is not yet in place.

4.4 Regulatory Mechanisms for Ecosystem Protection

To enhance ecosystem protection, Kosovo could introduce stricter permitting systems for wastewater discharge. This system would ensure compliance with environmental standards and impose penalties for violations. Financial incentives, such as subsidies for wastewater treatment infrastructure or tax benefits, could encourage investment in sustainable practices. Additionally, enforcing discharge permits aligned with EU standards could strengthen regulatory compliance.
To address the issue of untreated wastewater discharge, Kosovo could benefit from adopting regulatory measures similar to those outlined in the EU directives. Here are key mechanisms that could be effective:
Permitting System: Establishing a robust permitting system for wastewater discharge can control pollution levels. Permits should include conditions that align with water quality standards and require periodic reviews to ensure compliance.
Polluter Pays Principle: Implementing and monitoring financial penalties for non-compliance could incentivize industries to adopt better waste management practices. Fines for illegal discharges and non-compliance with permit conditions would help enforce the regulations.
Financial Incentives: Kosovo can introduce subsidies or tax breaks for industries investing in wastewater treatment technology. This could encourage the adoption of cleaner technologies and infrastructure development.
Safeguard Zones: Establishing and extending protected zones around critical water bodies can prevent direct discharge of pollutants and safeguard sensitive ecosystems.

These regulatory mechanisms must be complemented by capacity-building initiatives to strengthen enforcement capabilities among local authorities.

4.5 Challenges and Solutions

Kosovo faces notable challenges in achieving specific environmental goals and adhering to

European Environmental Directives (Urban Waste Water Treatment Directive (91/271/EEC), Water Framework Directive (2000/60/EC), Industrial Emissions Directive (2010/75/EU), Nitrates Directive (91/676/EEC), Directive on Environmental Liability (2004/35/EC)) with a particular emphasis on the Water Framework Directive and Urban Wastewater Treatment Directive. Notably, various studies have been conducted to address wastewater treatment, aiming to meet national and European standards before discharge into receiving waters.

5 SOCIAL ASPECT

The traditional use of water resources among Albanians is deeply connected to cultural practices and the natural environment. In this paper traditional use will be explored of water resources among Albanians, focusing on its cultural, economic, and spiritual significance. By examining historical practices and their evolution, this paper aims to highlight the importance of water in shaping Albanian society and provide recommendations for sustainable water management in modern contexts. Historically, the presence of water sources has been a decisive factor in the selection of settlements, where cultural development has bloomed reflecting the vital role of water in daily life and spiritual practices.

5.1 Traditional and Historical Practices

In traditional Albanian society, water was revered as a source of life, cleanliness, and spiritual purification. A common belief and statement among the eldest is that water that flows through six levels of stones is drinkable, illustrating the intuitive, albeit limited, understanding of natural filtration. Water was not only a practical necessity but also a symbol of purity and resilience.
Communities living near rivers developed unique lifestyles, harmonizing economic needs with respect for nature.
Historically, Kosova has had many challenges especially during the occupation of Serbia. The population was taken the right for many things, including the infrastructure improvement and provision of elementary household services. Traditionally, in the water resource aspect Kosovo Albanians appreciated the water as a resource of life, purification, and cleanliness. Nature was a source of providing goods and serving to the people. Traditional water use included essential daily activities such as drinking, washing, and waste disposal. Without being aware of the negative effect, they used rivers not only for washing, but also for disposing of the waste and wastewater into the nearest stream, or river. Nonetheless it is to be considered that due to less industrial

development, back then there was more organic waste and less industrial and inorganic waste.
Water has always been central to Albanian life, shaping settlements, traditions, and cultural identity. The presence of water sources was a decisive factor in the establishment of communities, reflecting its essential role in daily life and spiritual practices. [40]

5.2 Economic Significance

As mentioned several times in the previous chapters about its catchment area, Prishtina river is a good example that was a factor for Prishtina to develop as an economic center, now the Capital of Prishtina.
Based on interviews from inhabitants, in the 5070's settlements were developing around the river Prishtina as Tophane neighborhood in the upper part of Prishtina. This neighborhood became a trade center for the surroundings because the green market, the animal market and a butcher were located near the river and people from different areas would come to trade. Two water mills (Gerdovc and Bankoviq) were situated on the river as the main source providing flour and wheat not only for the people nearby, but for the entire surrounding. Interviewees state that there was also the Pakashtica Inn serving the traders [46]. At that time Prishtina was a clean river home to fish and wild ducks, but also a place of leisure for the kids for bathing. The river was used for irrigation for the surrounding settlements. [46], [47]
Gradually Prishtina became the main trade center for Kosovo and continued to grow not only as an economic center, but also with settlements. As explained in Chapter 4 and very similar to other countries in transition, internal migration in Kosovo is obvious and mostly synonymous of urbanization. Even though the internal movements are multidimensional it is obvious that the majority of internal flows seems to be focused on Prishtina as economic center. It became an economic center for the population attracting inflow of people and infrastructure development. Rural-urban migrations have marked a significant progress especially after 2000s (Chapter 4). Among the most appropriate theories to explain the reasons or motives of rural-urban migration in that influence population to migrate within the region is the Push-Pull factor. Push factors are considered to be worse living conditions, unemployment, lack of infrastructure (roads, water and sewage systems, electrical energy), poverty, environmental factors, etc, and pull factors such as better living conditions, better education, better health system, employment, family reunification, etc. [16]

5.3 Wastewater Disposal

Traditionally in the water resource aspect Kosovo Albanians appreciated the water as a resource of purification and cleaning. However, rivers were also used for disposing the waste and wastewater into the nearest stream.

Using the historical point of Prishtina from the 70's, the remaining waste of the green market, the animal market, the butcher was all disposing the waste into the river. Moreover, all the wastewater of the surrounding houses was discharged into the river contributing into the water quality of the river. Gradually Prishtina was developing with infrastructure when the wastewater collector was constructed in at the beginning of the 70's to collect the wastewater from the settlements to end up in the river again. [48]

5.4 Challenges in Modern Water Use

Nowadays challenges, including environmental degradation and limited infrastructure, threaten this vital resource. Addressing these issues through sustainable management and increased awareness, is essential to preserve both the environmental integrity and cultural heritage surrounding water in Albanian society.

The transition from traditional to up-to-date practices has its own significant challenges:

- Environmental Degradation: Rivers suffer from waste and wastewater discharge due to industrial development, inadequate infrastructure and poor management.

- Limited Public Awareness: Despite historical reference for water, in modern practices environmental consequences should not be disregarded. Community awareness from traditional to modern practices should be given special focus.

- Infrastructure Deficiencies: The governance level should prioritize water issues and environmental degradation by investing in infrastructure to prevent pollution and restore river ecosystems.

6 RESEARCH ASSESSMENT AND DISCUSSIONS

6.1 Impact of Urbanization

As presented in Chapter 4, Degradation of the river continues up to date either with the lack of infrastructure, awareness or poor management which are the challenges to be addressed. Waste and wastewater are still being discharged into water bodies, and the environmental situation is worsening year after year.

The aim of this Chapter is to unveil the current situation using macroinvertebrates as bioindicators for assessing water quality in the Prishtina River ecosystem, and measurement of physical and chemical parameters was conducted parallel. Sampling was performed at the upper branches of the Prishtina River in the village of Grashtica, and at location where Vellusha River and the Matiqani stream join each other at the outlet of Prishtina. To ensure a comprehensive representation of the ecosystem the results of such analysis will be discussed.

This part of the research is based on macroinvertebrate samples focusing on analyzing four key indices: the EPT index (Ephemeroptera, Plecoptera, Trichoptera), the Functional Biotic Index (FBI) according to Hilsenhoff, the Biological Monitoring Working Party (BMWP), the Average Score per Taxon (ASPT) and Stround Water Research Center – Biotic Index (SWRC) data, to assess water quality.

The research focuses on habitat structure, physical and chemical analyses indicating the impact of inhabited pollution issues from urban wastewater discharges and human-induced waste contributing to the degradation of the Prishtina River in the Municipality of Prishtina, exacerbating eutrophication problems. This alarming situation emphasizes the need for effective management to improve ecological and environmental condition areas on the river ecosystem.
An analysis of freshwater ecosystems in the Municipality of Prishtina is conducted, their pollution and influence by human activities in their intermediate and lower segments. Pollution arises from the discharge of wastewater into rivers and streams, industrial discharges, and polluted waters in rivers and streams.

As mentioned in previous chapters, quality of surface water in our country continues to be affected by pollution. As a result of urban water discharges and industrial, uncontrolled dumping of waste in

rivers, use of pesticides and chemical fertilizers/fertilizers in agriculture, damage to the river beds from the use of inerts as well as from illegal constructions. In particular in this case study the contribution of raw untreated wastewater from the Vellusha, Prishtina, and Matiqan rivers, as well as industries such as Kosovo Energy Corporation (KEK), producers of milk and meat products, dyes, etc. [28]

There are many discharge points for sewage directly into the streams and rivers. Sewage starts to be added to the upstream sections of Prishtina, before it reaches Prishtina, in the villages of Llukar and Makovc to the east of the city via numerous unauthorized private connections, and this pattern continues all the way to the Sitnica River. Many of these unauthorized connections were installed by private householders or developers. *[16]*

6.2 Biological Assessment Using Macroinvertebrates

Based on the inspections in field aiming to analyze the existing situation, to identify the pollution points, their cause and effect, samples were taken for macroinvertebrates as bioindicators for assessing water quality.

Sampling was done quantitatively with a Surber net of size 30 x 20 cm. The net was placed on the bottom, every stone in its frame was lifted and washed away in the current of water, and the sand and leaves were left in the net, which then was checked for macroinvertebrates. Samples were taken in a field trip in 5 locations. After sorting, the material was transferred to cuvettes with 75% alcohol in the laboratory. Processing and sorting of benthic material was done at the Laboratory of the Department of Biology, Faculty of Mathematics and Natural Sciences, University of Prishtina, Prishtina with supervision of Faculty professors. Material was analyzed with the help of a binocular stereomicroscope. For the determination of groups of macroinvertebrates, different keys were used, as in other literature.

6.2.1 Sample Location

Samples were taken at a total of five localities on the longitudinal profile of the Prishtina River from the village of Grashtica east of the city of Prishtina to Prishtina outlet towards Fushe Kosova. Locations are marked with P1, P2, P3, P4 and P5.

Sample P1, is located in the village of Grashtica east of the city of Prishtina closer to the sources

of the streams – main branch of river Prishtina. In the relative vicinity of the locality, there are several houses of the resident population that discharge sewer water directly into the stream. The riverbed is sand and gravel, mud in places and with a lot of waste (paper, plastic, household garbage and others). The stream bed in this locality is about 3 meters wide.

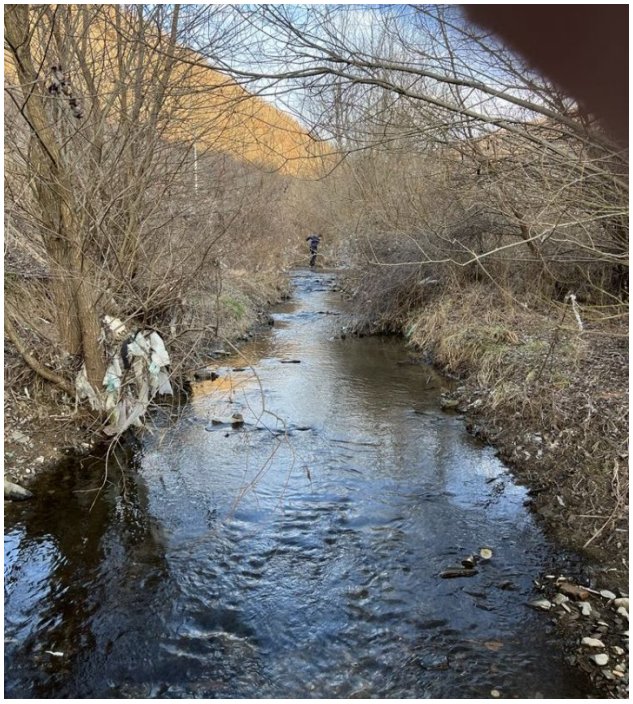

Figure 23 Sample P1, main branch of river Prishtina in Grashtica

Sample P2, located in the village of Grashtica east of the city of Prishtina, branch from Grashtica, The riverbed is sand and gravel, and mud in places. The stream bed in this locality is about 1 meter wide.

Figure 24 Sample P2, branch from Grashtica

Sample P3, located in the village of Grashtica east of the city of Prishtina, branch alongside the road from Grashtica. The riverbed is sand and gravel, mud in places and concrete alongside the

road. The stream bed in this locality is less than 1 meter wide.

Figure 25 Sample P3, branch alongside the road of Grashtica

Sample P4, located in the village of Grashtica east of the city of Prishtina, joining of the two streams in Grashtica In the relative vicinity of the locality, there are several houses of the resident population that discharge sewer water directly into the stream. The riverbed is sand and gravel, mud in places, and waste, paper, plastic, household garbage and others. The stream bed in this locality is about 3 meters wide.

Figure 26 Sample P4 joining of two streams in Grashtica

Sample P5, located outside the city of Prishtina, towards Fushe Kosova at Prishtina outlet, which also collects streams of Vellusha and Matiqani in Prishtina. where along the river there is a discharge to the sewage waters directly into the stream. The riverbed is muddy and in places gravel and sand with a lot of waste (paper, plastic, household garbage and others). The stream bed in this locality is about 3 meters wide.

Figure 27 Sample P5, Prishtina outlet towards Fushe Kosova, Kalabria

6.2.2 Index results

In the following a map is given which shows location and number of samples: 2 samples at branch from Grashtica, 1 sample the stream alongside the road in location Grashtica, 1 sample at the main branch of Grashtica, 1 sample at location where these two streams join towards River Prishtina, and 1 sample at the outlet of Prishtina in Prishtina River which also collects streams of Vellusha and Matiqani in Prishtina.

Figure 28. Map of Catchment area in Prishtina with sampling locations

EPT Index: The EPT index focuses on the presence of Ephemeroptera, Plecoptera, and Trichoptera taxa within macroinvertebrate communities. These orders are often considered sensitive to environmental disturbances, with their abundance indicating good water quality. The EPT index is calculated as the proportion of EPT taxa relative to the total number of macroinvertebrates sampled, providing a qualitative measure of ecosystem health. [1]

Table 12 Values of EPT Index

Value of EPT index	<2	2-5	6-10	>10
Water Quality Category	Polluted	Clean	Good	Very Good

FBI (Functional Biotic Index): The Functional Biotic Index assesses macroinvertebrates based on their functional feeding groups, offering insights into ecosystem processes. It categorizes taxa into groups such as shredders, collectors, and predators, allowing for an evaluation of how well the ecosystem performs essential functions. The FBI is calculated by assigning scores to each functional group, providing a quantitative measure of functional diversity.[7]

Table 13 FBI Assessment on water quality

Family Biotic Index	**Water Quality**	**Extent of Organic Pollution**
< 3.75	Excellent	Pollution Unlikely
3.76 – 4.25	Very Good	Possible Slight Pollution
4.26 – 5	Good	Some Pollution Probable
5.01 – 5.75	Fair	Fairly Substantial Pollution
5.76 – 6.50	Fairly Poor	Substantial Pollution Likely
6.51 – 7.25	Poor	Very Substantial Pollution
7.26 – 10	Very Poor	Sever Pollution Likely

BMWP (Biological Monitoring Working Party) Score: The BMWP score is a widely used index in biomonitoring studies, particularly in Europe. It assigns sensitivity scores to different macroinvertebrate taxa based on their tolerance to pollution. The sum of these scores for all taxa present at a site provides a numerical value that correlates with water quality, with higher scores indicating better ecological conditions.[8]

Table 14 Scoring of BMWP

BMWP score	**Category**	**Interpretation**
0 – 10	Very Poor	Heavily Polluted
11 – 40	Poor	Polluted or Impacted
41 – 70	Moderate	Moderately Impacted

71 – 100	Good	Clean but slightly impacted
> 100	Very Good	Unpolluted, unimpacted

ASPT (Average Score per Taxon) Score: is calculated as the ratio of the score obtained in the BMWP index to the number of families scored in the sample. A high ASPT score is considered indicative of a clean site containing large numbers of high scoring taxa. The index is suitable for assessing the impact of organic pollution.[8]

Table 15 Scoring of ASPT

ASTP value	**Water Quality Assessment**
> 6	Clear Water
5-6	Doubtful quality
4-5	Probable moderate pollution
< 4	Probable severe pollution

SWRC (Stroud Water Research Centre - Biotic index) Score: The SWRC biotic index is used to monitor river water quality taking into account two variables, species abundance and their values of pollution tolerance.[8]

Table 16 Scoring of SWRC

S.W.R.C. – Biotic Index	0 - 3.75	3.76 – 5.0	5.10 – 6.50	6.60 – 10.0
Water Quality Category	Excellent	Good	Fair	Poor

The following results were achieved from the macroinvertebrate samples focusing on analyzing the four above key indices: the EPT index (Ephemeroptera, Plecoptera, Trichoptera), the Functional Biotic Index (FBI) according to Hilsenhoff, the Biological Monitoring Working Party (BMWP) result, and the Average Score per Taxon (ASPT) and SWRC to assess water quality. Assessment was conducted at the Laboratory of the Biology Department, University of Prishtina, with the supervision of Department Professors.

Table 17 Results of the samples taken in each sample point, Laboratory of Biology Department, UP

Location	EPT	FBI	BWMP	ASPT	SWRC
P1 / Main branch river Prishtina - location Grashtica	5.00	4.09	55.00	6.11	5.04
Coordinates: N: 4727392.00; E: 519493.00	**Clean**	**Very good**	**Moderate**	**Clean water**	**Good**
P2 /River branch from Grashtica, River Prishtina	5.00	3.70	53.00	6.63	4.95
Coordinates: N: 4727129.00; E: 519549.00	**Clean**	**Excellent**	**Moderate**	**Clean water**	**Good**
P3/ River branch from Grashtica alongside the road	2.00	3.95	17.00	5.67	5.53
Coordinates: N: 4727120.00; E: 519441.00	**Clean**	**Very Good**	**Poor**	**Doubtful quality**	**Fair**
P4 / Joining of the two streams, location Grashtica	3.00	4.00	32.00	7.25	3.79
Coordinates: N: 4727359.00; E: 519363.00	**Clean**	**Very Good**	**Poor**	**Clean water**	**Good**
P5/Lower part of the river at Prishtina outlet	0	0	0	0	0
Coordinates: N: 4720622.00; E: 510864.00	**Very Poor/Sever Pollution Likely**	**Very Poor/Heavily Polluted**	**Very Poor/Heavily Polluted**	**Poor/Probable moderate pollution**	**Poor**

Based on the results we can see that at Grashtica locations the water quality is in average good. However with the river flow through Prishtina urban part up at the outlet of Prishtina we can see the deteoriation of the water quality. At the outlet of Prishtina river, based on the sampling there were no living macroinvertebrates found.

6.2.3 Physical and chemical parameters for water quality

Physio-chemical and biochemical parameters at the upper branch of the Prishtina River in the village of Makovc where Vellusha River and the Matiqani stream join each other at the outlet of Prishtina.

Measurement of physical and chemical parameters was conducted for sampling was taken at the upper branch of the Prishtina River in the village of Grashtica and where Vellusha River and the Matiqani stream join each other at the outlet of Prishtina.

To ensure a comprehensive representation of the ecosystem the results of such analysis will be discussed.

Figure 29. Prishtina outlet where samples were taken

Figure 30. Autosampler Equipment

Figure 31 Sampling Equipment

6.2.4 Results from Physical-Chemical Analyses

For research purposes several sites at different locations were visited and samples were taken to be analyzed were taken within 24 hours in dry weather season and in rainy season.

The table below presents values from results during the dry season:

Table 18 Results from analysis during dry season at the Laboratory of RWCP, 2023

	Values from results							
	Parameters - Unit mg/L							
Sample Points	**TSS**	**COD**	**BOD**	**PO4-P**	**Total N**	**NH4-N**	**NO3-N**	**NO2-N**
1. Gracanice	76	469	184	3.17	>16	18.67	<5	<0.6
2. Prishtina star	81	505	330	3.03	>16	18.77	<5	<0.6
3. Lizmir, Fushe Kosova	196	237	167	2.89	>16	13.45	<5	<0.6
4. Termokos	113	291	283	<2	>16	25.19	<5	<0.6
5. Dardani	153	434	364	5.74	>16	27.88	<5	<0.6
6. Prishtina outlet	97	240	158	4.54	>16	22.02	<5	<0.6

The table below presents values from results during the wet season:

Table 19. Results from analysis during wet season RWCP, 2023

	Values from sampling after rain					
	Parameters - Unit mg/L					
Sample Points	**TSS**	**COD**	**Total N**	**NH4-N**	**NO3-N**	**NO2-N**
1. Lizmir, Fushe Kosova	152	487	>16	31.79	<5	<0.6
2. Prishtina outlet	367	562	>16	17.76	<5	<0.6

For research purposes, further analyses were conducted for some additional parameters at the Laboratory of Regional Water Company Prishtina. The table below presents values from results in year February 2024, conducted at the laboratory of Water Treatment Plant. Samples from the main branch of Prishtina river, Secondary branch of Prishtina River and the stream at the outlet of Prishtina were analyzed.

Table 20. Results from chemical analysis RWCP, 2024

Parameters	Unit	Main branch of Prishtina river	Secondary branch of Prishtina River	Prishtina Outlet
BOD_5	mg/l	21	7	133
COD_{Cr}	mg/l	42	15	222
TSS	mg/l	150	105	470
TN	mg/l	11.5	0.4	35.42

N-NH4-	mg/l	0.498	0	0.52
N-NO3-	mg/l	7.95	0.3	34.8
N-NO2-	mg/l	0.095	0.003	0.105
pH		7.15	8.29	7.52
P_{tot}	mg/l	0.28	0.05	0.755
PO4-P	mg/l	0.386	0.79	3.03
PO^{3-}_4	mg/l	0.317	0.7	7.58
P_2O_5	mg/l	0.289	0.56	7.55
S^{2-}	mg/l	0.057	0.03	0.16
SO_4^{3-}	mg/l	35	17	58
Chlorides Cl^-	mg/l	29	11	46
Conductivity	µS/cm	456	398	516

With the given analysis of wastewater discharged into the water body, we can ascertain that the water discharge does not comply firstly with limited values of the National Administrative Directive no. 2/2022 on conditions, methods, parameters and limited values of waste water discharge into public sewer network and water bodies gives the following limited values for effluents into public sewer network and effluents into water bodies (Table 11)

According to the EU's Urban Wastewater Treatment Directive the quality of the treated water will also respect temperature is lower than 30°C and pH to be between 5.5 and 8.5.

If we analyze the situation in the above points effluents comply are discharged directly into the water bodies without prior treatment, subsequently not fulfilling the National Directive for surface water. This occurs due to lack of a Wastewater Treatment Plant in the region in order to fulfill the required criteria. Consequently, all raw untreated wastewater eventually drains into the Sitnica River, which joins the Iber at Mitrovica and thus flows north to the Morava and eventually into the Danube with transborder effect.

7 INTERVENTIONS FOR IMPROVEMENT

In Kosovo, all rivers are classified as being polluted and having unacceptable levels of biological oxygen demand as well as lack of dissolved oxygen due to the lack of operating wastewater treatment systems. Monitored water pollution comes mainly from bacteriological contamination due to the absence of operational wastewater treatment plants [25].

7.1 Interventions with Ongoing Projects

In this respect, there is an ongoing Project to be implemented by RWC Prishtina with the aim of the overall project to contribute to environmentally friendly, hygienically safe, and sustainable wastewater and stormwater management, in line with the national wastewater and resource protection strategy, while fostering alignment with European Union (EU) Standards, there-by contributing to sustainable urban development and climate adaptation. The project is composed of two Components:

Component 1: Construction of a wastewater treatment plant for the region to collect the wastewater of Municipalities of Prishtina, Fushe Kosova, Obiliq and Graqanica. The said project will be financed by the French Treasury and the French Development Agency (AFD) through a loan by the Ministry of Finance, and a combination of grants from WBIF.

Component 2: Upgrade and construction of wastewater network and backbone collectors of these municipalities in order to collect urban wastewater. This component will be financed through a grant by KfW (German Bank for Development) and EU.

The following key investment measures are being handled as part of the project:

- Construction of main collectors to convey wastewater from main settlements to the planned Wastewater Treatment Plant (WWTP) Prishtina and hence to avoid discharge of untreated wastewater to the rivers with respectively environmental hazards.
- Rehabilitation of the existing sewer networks in urban core areas of Prishtina (separate system) and Fushe Kosova (combined system) to improve the functionality of the sewer networks.
- Construction of a new stormwater system in urban core areas of Prishtina to improve the functionality of the entire system / infrastructure and to prevent flooding of concerned areas.

- Complete rehabilitation of the (existing) sewer network in Lismir village and connection to the new WWTP Prishtina.

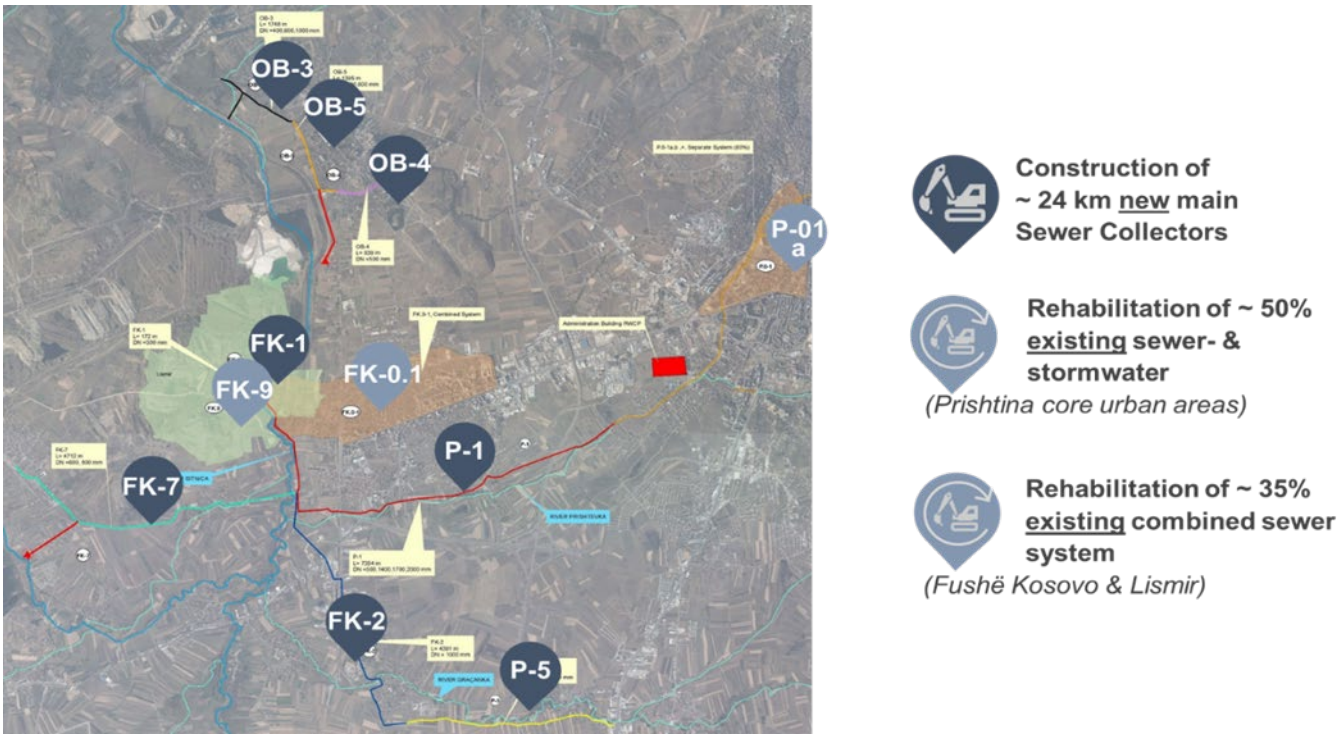

Figure 32 Overview on project measures on spatial scale [48]

The strategy for the construction of new main sewer collectors and rehabilitation of the existing sewage and stormwater networks in the city centers of Prishtina and Fushe Kosove took into consideration the following key aspects and underlying principles:

- Rehabilitation and construction of the backbone of entire wastewater and stormwater system for Prishtina Greater area.
- To collect as much as possible wastewater and to bring it to the future WWTP on short term – after implementation of all measures of this phase, taking into account that further phases will follow and will enlarge the quantity and quality of the wastewater, which will be treated at the future WWTP serving for the Prishtina greater area.
- The WWTP foreseen to be constructed next to the village Lismir (belonging to the Municipality of Fushe Kosova), is co-financed by France and EU (through WBIF) and is currently in the design stage. It is the intention, that all the sewer collected inside the Prishtina greater area will be treated at this plant and that the quality of the water of the related rivers in the project area (Prishtina, Gracanica and Sitnica river as well as other smaller streams) will be considerably improved. The cooperation between these two

Consultants is already established and will be an important factor for the success of both projects (collection system and treatment of the wastewater).

- Elimination of wrong connections of wastewater into the stormwater (underground rivers) inside of the city center of Prishtina wherever it is possible. On the other side it shall be eliminated as much as possible stormwater from the sewage network to reduce the dilution rate of the wastewater. [48]

Figure 33 Sewer system at Prishtina, project area [48]

The main aim of the project in the network are the re-organization of city-internal collectors / backbones, reduce flooding as well as to start mitigation of structural deficits through exchange of existing pipes. According to studies under the project, it seems that the existing system is overloaded (existing pipelines are undersized and often overloaded) and a new "skeleton" structure for the city-internal collection network seems useful. As the available budget will not be enough to cover rehabilitation of entire city area, prioritization of measures will be necessary. [48]

7.2 Significant Environmental and Socio-Economic Impacts

The project will significantly improve the situation for the citizens and for the water bodies and will bring Kosovo closer to complying with the EU Urban Wastewater Treatment Directive and with the EU Water Framework Directive.

Significant positive impact is expected after the implementation of the Project measures that will reflect from regulated collection and discharge of wastewater and stormwater. According to the Environmental and Social Impact Assessment (ESIA) of RWCP the following results will be expected:

- Improvement of the biological water quality of the waters, in our case specifically Prishtina River, that have received previously untreated wastewater
- Improving people's living conditions, particularly health
- Environmental discharge effect with regard to flora, fauna and habitats.
- Improvement of the conditions for local and regional economic development
- Risk of flood in the urban areas is minimized that such will improve the living condition
- Living conditions are improved due to improved collection of wastewater and stormwater in urban area (no smell)
- Risk of flood is minimized which will have a positive impact on reduction of damages caused by this [48]

8 CASE STUDIES

Considering the Baseline of Prishtina Catchment Area given in Chapter 3 and the interventions for improvement elaborated and described in Chapter 8, we can come to conclusions that the situation will undergo significant improvement and that are able to think and plan development of Prishtina city, and specifically for River Prishtina.

There are different experiences in the world that demonstrate that even small and heavily modified urban streams can be successfully restored through daylighting and nature-based solutions. Cities such as Zürich and Paris have reintroduced previously buried rivers into the urban landscape, transforming them into ecological and recreational corridors. Similarly, large-scale interventions such as the Emscher River Restoration highlight the importance of combining wastewater infrastructure improvements with river restoration. These cases provide strong evidence that the proposed intervention for the Prishtina River is both feasible and aligned with contemporary

European practices. In the following two study cases will be presented that are quite similar to the situation of Prishtina River that combine blue and gray approach.

8.1 Saw Mill River Daylight, New York

The term daylighting is used to describe the restoration of rivers that have been covered up with concrete, usually as a result of past public works in urban areas.
For more than a decade the Saw Mill River Coalition led the effort to bring the Saw Mill River to daylight. Part of the revitalization of downtown Yonkers, this project has enormous ecological, economic and cultural significance. In November of 2011, after many years of organizing, waters began to flow above ground in downtown Yonkers for the first time in 90 years – a major achievement for both the Coalition and the City of Yonkers.
With the aboveground riverbed we have recreated 1,279 m² of aquatic habitat, including a tidal pool and two freshwater pools. The natural river now flows parallel to the preexisting underground flume, which now serves as an overflow channel to protect the integrity of the new park and the downtown area from floods.

The Grand Opening occurred in 2012. The Saw Mill River Coalition worked with local partners and community stakeholders – including the City of Yonkers, the Project for Public Spaces, the Public Library, the Beczak Environmental Education Center, the Friends of Philipse Manor Hall, and area businesses – to develop the interpretive elements for this new space. Through educational exhibits, residents and visitors can investigate the river's history and the various ways in which human activity has affected its ecology over the past 400 years. Groundwork has used the work on the park and river as a catalyst to engage area youth and residents in stewardship. In 2014, the US Fish & Wildlife Service designated Van der Donck Park as a National Fish and Wildlife Urban Refuge, to foster a new generation of urban river stewards. [49]

Before

After

Figure 34 Before and after river implementation of Saw Mill River Daylight, New York [49]

Figure 34 shows the former condition of the river and the actual implementation of river restauration. A small, buried urban river completely hidden under the city before restoration was daylighted in a short section (~120 m), there was creation of a public park achieved, naturalized channel added, creating a revitalized city center, improving the ecology and creating a public attraction area.

8.2 River Sheaf, United Kingdom

The restoration of the River Sheaf in Sheffield demonstrates how small-scale daylighting interventions can successfully reintroduce hidden watercourses into the urban landscape. By uncovering sections of the river alongside historical features such as a medieval moat and gatehouse structures, the project highlights the potential to combine river restoration with cultural heritage and public space development. This approach is particularly relevant for the Prishtina River, where spatial constraints may limit large-scale interventions but still allow for targeted and impactful restoration.

Connecting Limbs is developing an ambitious program that looks at the whole water catchment of the River Sheaf, from where it first arises within the Peak District National Park as a series of streams, on a ridge of gritstone between 6 and 7 miles to the south west of Sheffield. Old Hay Brook and Totley Brook join to become the River Sheaf, which then flows for around 10km, picking up further contributions from other tributaries such as the Limb Brook and Meers Brook, before joining the River Don at Castlegate Market, which has recently been ‘daylighted’ to help restore natural processes. uncovered sections of the moat, the western and eastern tower of the gatehouse and part of the drawbridge.

The River Sheaf flows through Sheffield and, like many urban rivers, was heavily modified during industrialization. Large sections of the river were culverted, built over and incorporated into urban infrastructure. As a result, the river became largely invisible within the city center. [44]

Figure 35 Picture under construction and the first image/plan of the daylighted River Sheaf , England [44]

Rather than a full restoration, the project implemented a targeted daylighting and heritage-led intervention, including partial uncovering of the River Sheaf, exposure of historical structures (moat, towers, drawbridge), integration of water features into public space and urban design focused on visibility and identity. The key characteristics are that it was a small-scale intervention, focusing on a limited section and designed as part of urban redevelopment.
The benefits of the citizens are that opened the area for public interaction and created recreational space, which reconnected citizens with a previously hidden river and with urban identity and heritage value, increased attractiveness of the area, and demonstration that even minimal daylighting can have impact

The river channel is also transformed by the removal of the two-meter-high Castle Orchard Weir to create a series of gently rising pools which will allow fish and wildlife to traverse this reach of the Sheaf to and from the Don, as well as creating opportunities to revegetate the formerly sterile concrete banks and providing habitat for birds, insects, fish and mammals. [43] [44]

9 RESULTS AND DISCUSSIONS

Aligning Kosovo's wastewater management with the EU Water Acquis is a critical precondition for sustainable urban development and the ecological restoration of the Prishtina River corridor. In this context, the proposed daylighting and restoration of the Prishtina River selected for the Thesis are urban sections that are feasible and conceived as a multifunctional blue-green infrastructure project that builds directly on the planned wastewater collection network and treatment plant for Prishtina.

By ensuring that municipal effluents are adequately treated prior to discharge, the planned wastewater infrastructure for Prishtina creates the necessary precondition for in-stream ecological restoration and for safe public access to the river corridor. The present diploma thesis therefore concludes with a forward-looking project proposal that links regulatory compliance (Chapters 7 and 9) with a spatially explicit river rehabilitation strategy for the Prishtina River within the urban area of Prishtina.

9.1 Project Provision and Environmental Rationale

Following completion of the wastewater collection system and the central wastewater treatment plant, a selected section of the Prishtina River corridor is proposed to be reopened (daylighted) and transformed into a continuous green-blue urban space. River daylighting—understood as the deculverting and resurfacing of previously buried channels—has been shown to improve hydrological functioning, enhance biodiversity, and reduce polluted runoff in cities.

The proposed intervention combines pollution source control (through upstream wastewater treatment), river daylighting, bank naturalization, and recreational landscape design, with the overarching objective of improving water quality, microclimate, and ecological connectivity while simultaneously enhancing urban livability and equitable public access to water. In line with contemporary blue-green infrastructure concepts, the corridor is conceived as a multifunctional system that delivers ecosystem services such as flood mitigation, urban cooling, habitat provision, and recreation.

Figure 36 Area of proposal, river section from bus station in Kalabria up to Uglar in Fushe Kosova, GIS

9.2 Spatial scope and river corridor concept

The project is divided into two sections. The primary project area (Figure 37) encompasses the Prishtina River section from the roundabout at the bus station in Kalabria downstream to the roundabout at Hazir Shala Street, which allows for a modest lateral shift of the riverbed to the left bank, as this area is characterized by low existing constructions density and is largely designated as public space in the Geoportal.

The proposal aims for a clear stream corridor with visible water, improved microclimate, and ecological habitat value, while still respecting the urban setting and flood safety requirements.

The restored and daylighted river corridor is envisaged as a linear recreational zone with a clear and visible stream channel, vegetated banks, and continuous public access on both sides. One traffic lane would be maintained along each bank, while surplus road space and degraded infrastructure strips would be reallocated to active mobility and green space.

River Layout, GIS

River daylight in GIS layout, AI generated

Figure 37 Existing layout of proposed area and river section and daylight proposal bus station roundabout up to Hazir Shala roundabout, Kalabria

The second section (Figure 38) downstream from roundabout in Hazir Shala street towards Uglar the river flows predominantly through open public land with sufficient lateral space, making this stretch particularly suitable for phased implementation of river restoration and daylighting measures.

These spatial conditions favor the creation of a linear river park that can be integrated into the urban fabric with limited need for costly land acquisition or major relocation of built structures.

Figure 38 River section proposed for restauration, roundabout at Hazir Shala street, Kalabri to Uglar towards Fushe Kosova, GIS

This section can include walking and cycling paths, small rest areas, lighting, native planting, and simple public furniture. The space should connect nearby neighborhoods and turn an existing degraded infrastructure corridor into a public urban asset.

Current condition in Kalabria, Prishtina

Proposal AI generated

Figure 39 Current condition, section of proposed river restauration in GIS and Proposal generated through AI

For both sections (Figure 38 and Figure 39) the smooth trapezoid form is well suited to both dry-season baseflow and wet-season flood conditions. In dry periods, the low, narrow channel at the bottom concentrates the limited flow, maintaining water depth and velocity sufficient to avoid stagnant pools and excessive sediment deposition, while the gently sloping, grassed banks remain dry and stable. During storm events or floods, rising water levels progressively flowthrough the wider cross-section between the embankments, providing additional conveyance capacity without overflowing.

9.3 Design principles and functional elements

The design must comply with hydraulic and flood safety requirements, ensuring sufficient conveyance capacity during design flood events and maintaining or improving current levels of flood protection. At the same time, the corridor should remain legible as public space, with clear sightlines, accessible entrances, and integration into the wider open-space network of Prishtina

- Trapezoidal shape that provides a good balance between wetted perimeter and cross-sectional area, maximizing flow efficiency at both high and low flows.
- Bank stability: Sloped sides are more stable than vertical walls, preventing collapse during wet season floods while remaining intact during dry season low flows.
- Adaptability: As water levels rise from dry to wet season, the sloped banks allow the channel to expand gradually in width, accommodating increasing volume without sudden pressure on banks.
- Continuous walking and cycling paths along both banks, ensuring barrier-free connectivity between adjacent neighborhoods and transport nodes.
- Small rest areas and viewing points, integrated lighting, and simple public furniture to support everyday use and social interaction.
- Native riparian planting and bank naturalization (e.g. gentle slopes, benches of emergent vegetation, woody debris where appropriate) to enhance habitat complexity and ecological value.
- Opportunities for small wetlands, bioswales, or retention pockets in wider sections of the corridor, improving stormwater retention and water quality through natural filtration.

9.4 Anticipated environmental and climatic benefits

Evidence from urban river daylighting projects in Europe and globally indicates that reopening buried watercourses can substantially improve local environmental conditions. First, the restoration of a naturalized channel, in combination with upstream wastewater treatment, contributes to improved physio-chemical status and habitat conditions, supporting the recolonization of aquatic and riparian biota and thereby increasing local biodiversity.

Second, a vegetated river corridor can mitigate the urban heat island effect by increasing evapotranspiration, shading hard surfaces, and enhancing air circulation along the river valley.

Third, re-establishing floodplains, creating multi-stage channels, and slowing flow velocities can help attenuate peak discharges during intense rainfall events, thus contributing to urban flood risk reduction. Finally, enhanced soil–water interactions along permeable banks and vegetated overbank areas can promote groundwater recharge where hydrogeological conditions are favorable.

9.5 Social and economic co-benefits

Beyond the biophysical improvements, blue-green river corridors offer significant social and economic co-benefits. Providing accessible, high-quality open space along the Prishtina River would increase opportunities for everyday recreation, active mobility, and informal social encounter, thereby contributing to public health and well-being. Furthermore, direct contact with a restored river landscape can strengthen citizens' connection to local ecosystems and raise awareness of water as a shared resource that requires collective stewardship.

From an economic perspective, numerous studies and practical examples indicate that riverfront restoration can increase adjacent property values, attract private investment, and reinforce the attractiveness of the city for visitors and tourism-related activities. The proposed project for Prishtina can thus be understood as a strategic investment in urban resilience and competitiveness, rather than as a purely environmental cost.

9.6 Implementation requirements and constraints

Successful implementation will depend on a series of technical, institutional, and socio-economic conditions. Technically, the project must be coordinated with the final configuration of the wastewater collection and treatment system to ensure that in-river water quality meets minimum standards for ecological restoration and safe public use. Additional requirements include detailed hydraulic modelling for flood management, geotechnical assessments of bank stability, and design of a robust maintenance regime covering vegetation management, litter removal, and monitoring of flow, odour, sediment, and pollutant levels.

Institutionally, coordinated governance is required between the Ministry of Environment and Spatial Planning (as the authority for rivers and water resources), the Municipality of Prishtina (urban development and public space), and the Municipality of Fushe Kosova, as well as utilities and other infrastructure operators.

Financially, the project entails excavation, riverbed reconstruction, bank stabilization, and public-space investments, which may necessitate a combination of municipal budgeting, national funds, and international or EU financing instruments.

Public acceptance and awareness will also be decisive: participatory planning, communication of benefits, and careful consideration of land-use changes are needed to ensure that local communities perceive the corridor as an inclusive public asset rather than a top-down imposition.

10. CONCLUSION

This research has documented the severe environmental degradation of the Prishtina River resulting from rapid urbanization and inadequate wastewater infrastructure.

The thesis effectively addresses its primary research questions by systematically identifying anthropogenic pressures, from traditional disposal practices to modern industrial impacts. A thorough evaluation of the current sewer and stormwater network highlighted the critical need for the separate systems currently under development by RWC Prishtina.

Further, it draws on successful international case studies like the Saw Mill River and River Sheaf, and provides a feasible, spatially explicit proposal for river restoration in the Kalabria and

Uglar sections and the daylighting of the river corridor, which offer multi-dimensional benefits and by achieving compliance with the EU Water Framework Directive and Urban Wastewater Treatment Directive.

While currently a degraded and hidden conduit for wastewater, the planned investments in wastewater treatment provide a unique opportunity for ecological and urban renewal. By adopting the blue-green infrastructure approach proposed in this thesis, Prishtina can transform this environmental liability into a vital urban asset, fostering a resilient, sustainable, and livable capital for the future. Ultimately, the source serves as a comprehensive strategy for restoring the river corridor to enhance both ecological health and urban livability.

In summary, the proposed daylighting and restoration of the Prishtina River, from the Kalabria bus station roundabout to Uglar in Fushe Kosova, illustrates how integrated water management and blue-green infrastructure can generate concurrent environmental, social, and economic benefits for Prishtina. By linking EU-driven improvements in wastewater treatment with river rehabilitation and high-quality public space design, the project has the potential to transform the Prishtina River from a hidden, polluted conduit into a visible, structuring element of sustainable urban development and resilience.

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