

Онлајн издание / Online publication: ISSN 1857-9507  
УРЛ / URL: [http://www.sf.ukim.edu.mk/sumarski\\_pregled.htm](http://www.sf.ukim.edu.mk/sumarski_pregled.htm)

УДК / UDC 630  
УДК / UDC 635.9  
УДК / UDC 674

# ШУМАРСКИ ПРЕГЛЕД (ŠUMARSKI PREGLED) FOREST REVIEW

МЕЃУНАРОДНО НАУЧНО СПИСАНИЕ  
INTERNATIONAL SCIENTIFIC JOURNAL

Шум. преглед (Šum. pregled)  
For. Review

Год. 49  
Vol. 49

Бр. 2  
No. 2

Стр. 27–60  
Pag. 27–60

Скопје, 2018  
Skopje, 2018

**ШУМАРСКИ ПРЕГЛЕД**

Меѓународно научно списание

Год. 49, бр. 2, стр. 27–60

Скопје, 2018 година

**Онлајн издание:** ISSN 1857-9507

УДК: 630

УДК: 635.9

УДК: 674

**Фреквенција на издавање**

Се објавува двапати годишно

**Издавач**

Универзитет „Св. Кирил и Методиј“ во Скопје

Шумарски факултет во Скопје

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Универзитет „Св. Кирил и Методиј“ во Скопје

Шумарски факултет во Скопје

Редакција на „Шумарски преглед“

ул. „16 Македонска бригада“ бр. 1

(поштенски фах 235)

1000 Скопје

Република Македонија

Адреса на е-пошта: [sumpregled@sf.ukim.edu.mk](mailto:sumpregled@sf.ukim.edu.mk)Веб-локација: [www.sf.ukim.edu.mk](http://www.sf.ukim.edu.mk)**FOREST REVIEW**

International scientific journal

Vol. 49, No. 2, Pag. 27–60

Skopje, 2018

**Online publication:** ISSN 1857-9507

UDC 630

UDC 635.9

UDC 674

**Frequency (issues per year)**

Semi-annual (2)

**Publisher**

Ss. Cyril and Methodius University in Skopje

Faculty of Forestry in Skopje

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Ss. Cyril and Methodius University in Skopje

Faculty of Forestry in Skopje

Editorial Board of the Forest Review

Ul. 16 Makedonska brigada br. 1

(P.O. Box 235)

MK-1000 Skopje

Republic of Macedonia

Email address: [sumpregled@sf.ukim.edu.mk](mailto:sumpregled@sf.ukim.edu.mk)Website: [www.sf.ukim.edu.mk](http://www.sf.ukim.edu.mk)

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**Фреквенција на издавање      Frequency (issues per year)**

Се објавува двапати годишно      Semi-annual (2)

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Editorial Board of the Forest Review

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## Challenges of Skopje Green City – Establishing green corridors upon the rivers Lepenec and Serava

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**ABSTRACT:** For years, the City of Skopje has been facing the problem of increasing pollution, congestion, uneven construction, but also the problem of losing free public spaces, especially green. Unfavourable environmental conditions and the diminished quality of life, is mostly reflected in health of residents, but also in their satisfaction of living in the city. The city is becoming an inconvenient and undesirable place to live not only from an environmental point of view, but also from a sociological and economic point of view. Within the last ten years, the City of Skopje has intensified its efforts to attain the status of Green City by adopting the United Nations recommendations for achieving the goals of sustainable development. This article presents the urban aspects that are part of the research and results of the Study on the development of green corridors along the rivers Lepenec and Serava. Green corridors have been recognized as important elements for the enrichment of the green infrastructure of the city, whose basic functions and goals are related to improving the quality of life, mitigating the effects of climate change, preserving biodiversity, increasing the diversity of opportunities in urban areas and establishing sustainable transport corridors.

**Keywords:** sustainable development, green city, green corridor

### 1 INTRODUCTION

Since the second half of the twentieth century, the basis of the system of green areas within the urban structure of the City of Skopje is comprised of the riverbanks of Vardar, Treska and Lepenec, with the Kale fortress, Gazi Baba Park-Forest and the slopes of Vodno Forest-Park. These areas present the most important landscape aspect and visual landmarks of the City. They represent important urban and peri-urban green areas, embedded in the urban documentation for the development of the City since 1965, and accepted in all subsequent plans (1985, 2002, 2012) [1].

The city development policy, so far, has been mainly focused on providing land for green surfaces and design thereof. There is not enough analysis with regard to the multifaceted importance of public and open green spaces, and especially of their impact on environmental quality and biodiversity. The possibilities for establishing green corridors along the rivers Lepenec and Serava have been researched for creating modern policies for improving green infrastructure and the quality of life in the City of Skopje [2]. Green corridors along riverbeds are especially important given the valley character of Skopje and the need to improve climatic and general environmental conditions. So far green areas have only been established along the rivers of Vardar and Treska - parks, sport fields, tree lines. But, they are not categorised as ecological multifunctional corridors, but only have their protective and recreational purpose being emphasized.

The study on establishing of green/ecological corridors along the rivers Lepenec and Serava, also investigates the aspects of urban development of the City [2]. The research indicates several important aspects of this domain, which should be properly analysed during the process of preparation of urban documentation at all levels, to be incorporated in the policies for the future development of the City. This paper presents activities that should be undertaken by the City and the municipalities, and then incorporated in the analysis and concepts for future urban development. This is in line with the visions and accepted policies towards the development of Skopje-Green City.

### 2 URBAN GREEN CORRIDORS

The development and improvement of open green surfaces in urban areas implies their structural and functional connection within a single network. Important component of open green spaces in urban areas are the green corridors, which interconnect the green open spaces within an integral system and thus create the so-called green infrastructure.

#### 2.1 Definition of green corridors

According to environmentalists Jongman and Pungetti [3], the primary purpose of green corridors is to provide opportunities for wildlife survival and migration, as well as opportunities for a variety of recreational functions. Five key aspects of environmental corridors have been identified: (1) they have a linear configuration, (2) provide connections, (3) are multifunctional, (4) are most closely related to the concept of sustainability, and (5) enable integration.

Green corridors provide a range of benefits to city life, they mitigate the damage of construction and urban development, and contribute to improving the quality of the environment. They are particularly important for sustaining ecological processes, for connecting and sustaining biodiversity and for maintaining a healthy environment. Their most important feature is the multifunctionality, and in their function within the urban environment is ecological, social and aesthetic.

Natural, coastal corridors and waterways include high-quality habitats and ecosystems [4]. They prevent soil erosion and absorb rainwater, thereby improving drainage, and protect against the urban heat islands [5].

The social benefits of the corridors are reflected in providing opportunities for recreation. They give people the sense of identity and of belonging, and allow users to feel free in a more structured environment such as the urban one [5].

Green corridors provide a high quality life through integrating nature into the urban environment. They play an important role in reshaping the urban spatial pattern and establishing connectivity for a wide variety context across the city [5].

## 2.2 Rivers as green corridors in urban areas

Rivers are special landscape structures, and modern ecology acknowledges them as complex ecosystems. As natural green corridors, linear and connecting systems in the network of urban green areas, they have important ecological functions in urban areas.

Green corridors along rivers and their riverside areas, called “riparian areas”, cover the areas around the river, the riverbed, the surrounding land through which the river meanders, the river banks, the land that can be flooded by the seasonal influx of river waters and forests around river banks [6].

A group of authors [7] estimate that the riparian corridors have a great variety of species and ecological processes, which is related to the diversity of climatic conditions, biochemical cycles and more. The authors believe that “efficient management of riparian corridors can improve many environmental problems related to land use and environmental quality”, which can play an essential role in water management, aquatic systems regeneration and spatial planning. Therefore, rivers areas are given the status of green corridors, and the support for the restoration and sustainable management of rivers as presented in the European Water Directive continues to grow [8]. In recent decades, efforts have been made to restore the natural appearance and functioning of river systems, precisely because of their ecological significance. River restoration involves a number of environmental, physical, spatial actions and management measures. River restoration is an integral part of sustainable water management and is directly supported by national and regional water management policies in European countries [9].

## 2.3 Establishing of green corridors

In multifunctional urban areas, very important for green open spaces is: (a) to enable the fulfilment of their ecological function, (b) to reduce the impact caused by human activities – construction, traffic, industrial production, etc., and (c) to provide conditions for recreational activities.

Securing and preserving green corridors in urban areas is even more important due to the specific function of the corridors.

In order for green corridors to be established in urban areas, their biological values and ecological meanings are perceived and the possibilities for achieving a number of goals are defined. Thus, in Barcelona [10], for the design of green corridors a matrix of criteria has been used, whose identification is required so that an environmental corridor can be formed and goals that should be achieved through their implementation, such as: providing ecological connections, creating rich vegetation, introducing nature in the city, providing diversity of plant and animal species, reflecting the evolution of natural cycles, creating landscape identity, generating interest in nature, creating therapeutic areas, adapting social diversity of the urban environment, and increasing the values of natural and cultural heritage.

The above stated clearly states the multifunctionality, significance and complexity of green corridors. The establishing and shaping requires careful study of the conditions of each urban environment, it further requires political readiness and will to provide land and territory that can be used for undisrupted functioning of nature, and thus the quality of the environment. Cities around the

world are increasingly engaged in creating green network, using green corridors as an important category.

## 2.4 Guidelines for determining the width of the ecological corridor in urban/rural area

The development of green corridors, both in urban and rural environments, generally strives for maximum protection of the natural state of the corridor. Labaree [6] indicates several guidelines for determining the width of the corridor and the shaping thereof. They refer to the hydrological and hydrographic features, the functions of providing habitats, the functions of biochemical and physicochemical processes, etc., so that rivers can perform their complex ecological functions.

These guidelines lead to a different perception of the riparian areas and observance of the acquired knowledge about the necessity for perseverance of natural landscapes along rivers. They should and must be incorporated in the concept of urban development as natural spaces of vital interest for the environment and as open, construction-free, publicly available spaces. The scope and the boundaries of these areas must be incorporated and respected in determining the purpose and future use of the land.

## 3 CASE STUDY

The spatial development of cities is focused on urban planning. Very often is the significance of environmental systems and processes that take place in cities and their relationship with the environment are neglected or insufficiently considered. In the urban plans in our country, the elements of green infrastructure (parks, park-forests, shoreline, tree lines, sports fields, etc.) are considered as type of land use in the city, for which the position and surface need to be determined.

The City of Skopje has always developed along the river. The Skopje valley has a developed river network, water canals, natural swamps, ponds, and several artificial lakes, which constitute the blue infrastructure. In the past, they played a major role in the persistence of the city. Nowadays they are interesting for the formation of comprehensive green infrastructure, because they are rich in lush greenery and they represent habitats of numerous flora and fauna, as well as “connectors” or “corridors” of the “green network”. The utilisation of this potential means creating new urban development policies aligned with the global trends of creating sustainable cities, a path chosen by the City of Skopje.

Although, for more than fifty years, through the urban documentation of Skopje the river corridors that are located in the city and gravitate towards it, have been planned as part of the system of green areas, the activities for their protection are modest and the measures undertaken for the design and utilisation thereof are even scarcer. Almost nothing has been done towards educating the population to recognize the values of rivers and their riparian belts and there have been very modest investments in more detailed professional and scientific research.

There is potential for activating the riparian areas of the rivers Lepenec and Serava, but has not exploited. Current conditions and trends indicate processes that threaten their values. Both rivers are located in the northern part of the city, on the left bank of the river Vardar, where future development has been planned. By acknowledging the values of the rivers Lepenec and

Serava, the river corridors can be preserved, and guide future utilisation as well as land use.

Exploring the values of the rivers Lepenec and Serava is of great importance for preserving and improving the quality of the environment and it represents a way of withstanding the pressure for construction and improper utilisation of riparian areas. If the local self-government and the citizens of Skopje are to recognize the values and the importance of the rivers and their shores, policies can be designed that will provide permanent protection and improvement of the river corridors. This is certainly an important step towards supporting the concept of sustainable urban development and the creation of Skopje - Green City.

In the race between creating policies, measures and guidelines for the protection of environmental corridors and the constant pressure to utilise the shores for other purposes and construction, it is necessary to point out the activities and guidelines that need to be incorporated in the urban development planning process. The purpose of which is to find a balance between different and often conflicting interests of the community. Therefore, by relying on and accepting the knowledge of environmentalists and biologists with regard to the values of ecological corridors along the rivers Lepenec and Serava, the paper presents: (a) knowledge of existing problems and critical areas arising from the state that was created and the weaknesses in the applicable urban documentation; (b) the guidelines to be followed in the process of preparing urban documentation; and (c) the activities of the city and local administration in order to achieve the set objectives: healthy environment and Skopje - Green City.

### 3.1 Methodology

The study for the establishing of ecological corridors along river flows was prepared with an inter and multidisciplinary approach, through expert observation of key aspects (hydrographic and hydrological characteristics of rivers, the characteristics of flora and vegetation communities, research of fauna and habitats of different animal groups, analysis of the planned urban development of the area where the rivers pass, the quality of the environment and the analysis of land ownership in the riparian zones) [2]. The key findings of the expertise are summarized in two important chapters. The first chapter refers to the values of the natural environment of river flows and determining opinions regarding the functions and purposes of green corridors. The second key chapter refers to detecting the requirements for implementation of the concept, with emphasis on the expected and possible problems, conflicting interests and collisions. These findings should serve the city and local administrations in taking concrete steps and activities toward the implementation of the corridors developing concept in order to achieve mutual benefit - preservation of rivers and their nature and development of society.

For the purposes of the Study, an expert report has been prepared which refers to the urban aspects, covering the topics:

- Urban development of the city of Skopje, historical overview;
- Current situation and planned development, regarding (1) the land use and (2) the green infrastructure;
- Critical points along the corridors;

- Conditions and guidelines for the establishing Green Corridors (borders, elements, etc.) within urban development planning.

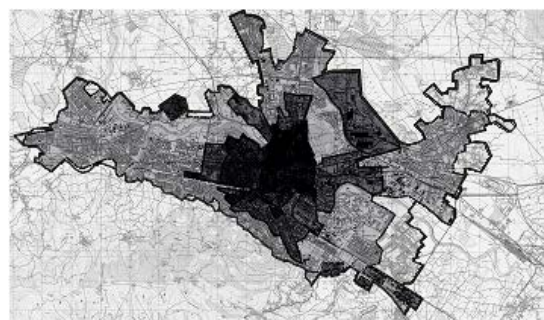
Publicly available data, cadastral data, GIS tools and field research were used for the research.

The important goal of this expert report was to determine guidelines that should be accepted and observed during the process of urban planning in order to achieve the goals of preservation and/or renewal of the natural character of rivers in urban areas, without thereby excluding the human and the society. Hereafter we provide a short overview of these aspects.

### 3.2 Urban development of the City of Skopje

The fertile land of the Skopje valley, with its spread river network, has been considered as a suitable place for living since ancient times, so the urban development of Skopje can be traced back at least for two millennia. Several stages of spatial development are characteristic and several key periods in the disposition and growth of the city can be distinguished (Penchikj [11]). Over a long period, the city has been developing and relying first on the course of the river Lepenec, later on the course of the river Serava and then on the riverbanks of Vardar.

Since the second half of the 20th century, the riparian area of the river Vardar and the area near the confluence of the river Lepenec into the river Vardar have been part of the city recreational zones. After the earthquake (1963), until today, the city has had an expansive spatial development and the riparian areas of the rivers Vardar, Treska and Lepenec have been developing or kept as park and sports areas and main recreational areas. The river Serava is regulated, at some points it is induced into a deep canal and only on some sections, it has local significance as a recreational area. There is recreational potential only in the lower river flow, in the areas around the Aqueduct, but this part is deserted and still not activated.



**Figure 1:** The growth of the City of Skopje [11]

The development policies of the City of Skopje and the current General Urban Plan 2012-2022 [12], follow the principles of sustainable development, by accepting and supporting the commitments for creating green network, in which the riparian areas are seen as important green corridors. However, their ecological function has not been sufficiently studied and substantiated. Hence the changes in the land use of riparian areas (along the river Vardar in the centre of the city and the municipality of Karpos), some sections remain unregulated, and on some sections the regulation is not in accordance with their environmental specifications and functions. The reason for such conditions, beside the ignorance of the ecological significance of rivers and riverside, is the fact that the

urban planning documentation does not clearly define and incorporate binding requirements and guidelines for designing open spaces. A specific problem is that the existing practice of regulating riverbeds for protection against floods permanently changes and reduces the potentials for fulfilling the ecological functions of the river corridors (until now the riverbeds of the rivers Vardar, Lepenec and Serava have been partially regulated). This issue, however, requires very careful expert analysis and study that lead to the adopting of more modern policies for achieving balance between the needs for protection against high water and the protection of biodiversity and natural ecosystems, as a way of creating sustainable concepts of water management and urban development.

The City of Skopje has opted for the platform for creating Green City and strengthening the resistance to the expected climate change. Therefore, research on the importance and values of ecological riparian corridors can guide and significantly improve urban development policies and create conditions for a quality environment.

### 3.3 Current situation and expected future development

The conducted research shows that the two rivers, Lepenec and Serava, have different characteristics and their own specifics. However, both corridors are interesting due to their natural conditions, the manner of land use within the considered area, the critical points, the population and the settlements that gravitate towards the rivers as well as the planning solutions for the future development of the surroundings. In fact, the situation with the population and the construction (planned and spontaneous), as well as the planned solutions for urban development can significantly affect the prospects for establishing and preservation of the ecological corridor. Therefore, this paper presents the conditions, tendencies and guidelines for planning the future urban development.

#### 3.3.1 Lepenec River

##### Conditions

The subject matter of research is the corridor of the river Lepenec, from the village Orman up to the inflow into the river Vardar, with a length of about 6.0 km.

The river is formed in the Shara region and it enters the state territory near Kachanik. From here up to the inflow into the river Vardar, with a length of 6-7 km, the river Lepenec flows through the plain area of the Skopje Valley. In this area the river meanders distinctly, and river ridges, sandbars and wet meadows are formed along the river. In the lower flow, before the inflow into the river Vardar, the riverbed of Lepenec is regulated along a length of 800 meters. The river is distinguished by large alterations for water after certain years, which affects the occurrence of floods.

When catastrophic flood waves occur, the overflow most often occurs from the entrance of the river Lepenec at the Macedonian border, up to the village of Orman and downstream, but mostly along the right bank. There is groundwater along the river and it is used for irrigation and water supply for the City of Skopje (from two well systems - Lepenec and Nerezi). The water quality of the river Lepenec is measured at several measuring points. In many places, the water quality is fifth class (much polluted water, which cannot be used for any purpose) [13].



**Figure 2:** River Lepenec, from Kachanik up to the inflow into the Vardar River

The width of the riverbed, with meanders, sand bars and vegetation, ranges from 400 meters, under the junction near the village of Orman and the ring road, up to 70-40 meters near the confluence with the river Vardar. Downstream, in the industrial zone, the river turns into a wastewater canal from production facilities, it is undistinguishable, and its landscape values are marginalized.

Both sides of the surroundings of the river are confined. On the west there is a railway and on the east the highway to Kosovo. Several settlements are developing in the area and then there is the industrial zone in Gjorce Petrov, all of which have access to the river. In recent years there has been great interest in construction, so agricultural land is converted into construction land. Until recently, the construction was without proper planning regulations and therefore, the landscape looks unregulated and chaotic, but there are also regulated settlements, which do not have a proper connection to the city and the natural environment.



**Figure 3:** Lepenec River, conditions

The surrounding area consists of valuable architectural and cultural heritage, archaeological sites and numerous monasteries and churches, as well as places for recreation (the archaeological site Skupi, the cultural and historical monument Hamdi Pashini Konaci, picnic site above the village Kuckovo, several churches and monasteries).



**Figure 4:** Lepenec River, significant contents: Skupi and Hamzi Pashini Konaci

Several critical activities and sites appear along the river that even today they endanger the survival and quality of the ecological corridor:

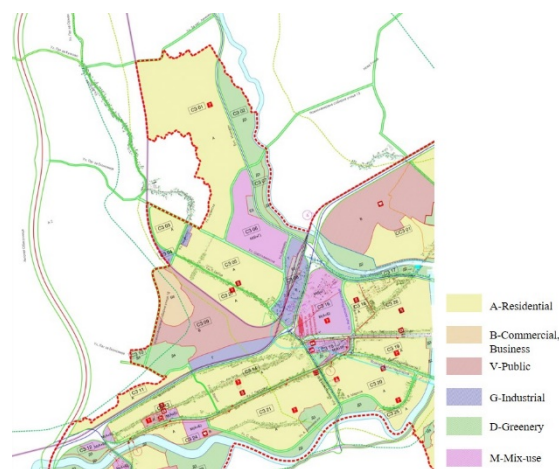
- In the urban part, near the industrial zone (West), the facilities, warehouses and services are located next to the river, which greatly narrows the corridor. This creates obstacles for the entire ecological functioning of the corridor. The riparian area is not used, because it is almost blocked and inaccessible. This makes the river marginalized as a landscape element in the urban matrix;
- There is a large sand separation located near the village of Orman, which exploits the riverbed for sand extraction;
- There is a large number of illegal landfills, practically all over the riverbed, and the largest ones are in the area east of the village of Novo Selo and in the industrial zone;
- The access to the inflow of Lepenec into the river Vardar is hindered, due to the busy road “Aco Shopov”, which passes over the river and due to the fenced area of the wellhead protection area;
- The riverside is not maintained and the access to the river is difficult for both pedestrians and cyclists;
- The available, construction-free space is used for agricultural activities, so the river is exposed to pollution from fertilization, depletion of irrigation water and disruption of the riparian corridor;
- The population does not know and does not recognize the values of the river and the corridor. The habits of using the riverside for recreation have been lost.

#### *Planned urban development*

Upon inspection of the available planning documentation, it can be concluded that the area around the river Lepenec is of special interest for the local self-government. Both in close and extended proximity to the corridor, in conversion of agricultural land into construction land, for housing, but also for production, distribution and services and mostly light industry is planned. According to the General Urban Plan of Skopje 2012-2022 [12], a green belt with different width is planned along the river.



**Figure 5:** Lepenec River, unfavourable conditions



**Figure 6:** Excerpt from the GUP of Skopje 2012-2022 – land use along the Lepenec River

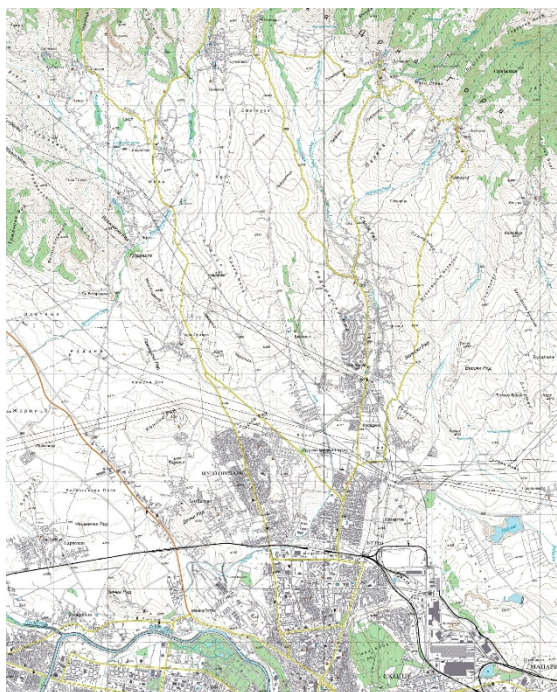
The planned urban development, determined with GUP 2012-2020 and the detailed urban plans for the urban quarters, which refer to the corridor of the river Lepenec, indicate several aspects that may affect the protection of the course of river and the riparian areas. Namely:

- The planned land use, such as housing, mixed use and industry, which are right next to the river, do not leave enough space for the ecological corridor, and the intensive construction and utilization thereof is expected to further create unfavourable conditions;
- The planned extension of the route of the boulevard Ilinden comes to close to the river in some places and it enters the existing riverbed;
- No measures have been provided in order to protect the villages from the expansion of the river, nor have any other natural barriers been established;
- The planned areas intended for greenery, sports and recreation have not been properly defined neither with regard to the scope nor with regard to the well-established conditions for landscaping;
- The planned housing along the river, towards the inflow into the river Vardar, is set to close to the river and allows for a very narrow corridor. A special problem is that it is located in the immediate vicinity of the first wellhead protection zone;

- The existing urban documentation does not provide for the development of green belts between the settlements, i.e. the development of green network within the wider area and its connection to the green corridor of the river Lepenec;
- The urban documentation does not pay enough attention to the value and importance of natural environment.

### 3.3.2 Serava River

The river Serava, formed by several smaller rivers in Skopska Crna Gora, has a length of 21.0 km up to the confluence with the river Vardar. It is an important corridor for the supply of fresh air masses to the urban area of Skopje. Therefore, it is of particular interest to determine the possibilities for the development of a green corridor along its course.



**Figure 7:** Serava River, from the springs up to the inflow into the Vardar River

#### Conditions

The basin of the river Serava in the upper part extends through the hilly-mountainous terrain, and in the lower part through the Skopje Valley and it has the characteristics of a plain. In the upper part, the waters have the character of rapids, and in the lower part, the flow is uniform. The steep falls cause erosion and undermining of the natural riverbed, which is of variable width (from several to 20 meters).

The riverbed of Serava is regulated in two sections - in the settlement Butel 1, in order to protect the settlement against floods, in a length of about 2.0 km and up to the inflow into the river Vardar in a length of 5.0 km. The Serava riverbed was diverted to the west to avoid the collapsing of the existing natural, closed riverbed, which used to pass through the central city area to the south. The regulation has different width.

Along the upper river course, in the highest mountainous areas and springs, the river can be difficultly accessed, with natural vegetation and fauna and with pronounced landscape values. The middle course of the river has been utilised for a long period of time for agriculture and there are vineyards and orchards, as well as pastures. The villages here are compact, located in sunny positions, on flat lake terraces, often separated from each other by deep river valleys. Starting from the settlement Butel all the way to the city, the river has no natural riverbed since the riverbed is regulated, and the shores are covered with stone slabs or with concrete. The Serava canal is available only through the settlements Butel 1 and 2, and at the Aqueduct. Further down, the regulated Serava riverbed is inaccessible due to the service and industrial zone, bridged by street infrastructure, and serves as a canal and recipient for wastewater. The most impressive is the section that passes through the area of the Aqueduct. Here, too, the river is regulated, flowing through interesting but neglected area. The space is constantly under pressure from various users, who appropriate it and often usurp it (improvised warehouses and waste materials), which strongly distorts the visual effect on the Aqueduct and the overall value of the landscape.

In the past, the river Serava used to provide Skopje (the core of the old town) with drinking water. Once the riverbed was regulated, the river Serava was a neglected and forgotten. Debris is dumped in many places and illegal landfills are created. Houses and production facilities, several makeshift passages and smaller bridges have been built along the canal. When there are large volumes of water, the water overflows the riverbed and endangers the infrastructure facilities. The river Serava is the main recipient of wastewater in the municipality of Butel, from Radisani to the confluence with the river Vardar, in a length of 12 km. The water quality of the river-canal Serava is not controlled.

Upstream, the streams and rivers that form the river Serava pass through or near several villages and several vacation settlements. In the area covered with hills, it passes through the village Radishani and close to the settlement Radishani, and enters the territory of the city after crossing the ring road. Near Krivi Dol, it flows into the river Vardar.



**Figure 8:** Serava River, conditions

There is an extremely valuable architectural and cultural heritage in the surrounding area, archaeological sites and numerous monasteries and churches, as well as places for recreation, and because of that the mountain is called “Skopje Holy Mountain”.



**Figure 9:** Serava River, values of the area: Aqueduct; Monastery St. Elijah

Due to the length of the river and the diverse land use of the surrounding area, diverse problems arise. Especially in several critical sites and sections, due to which the river/canal cannot fulfil its function of green and ecological corridor that can be used for fresh air supply to the city:

- In the hilly areas and when passing through villages, the riparian area has deep and narrow cuts, it is not regulated and there is a lot of garbage;
- Throughout the villages, the riparian areas are private and inaccessible, and often end directly on the river (especially in the villages of Ljubanci, Ljuboten and Radisani). There is partial accessibility in places where local roads and village streets run parallel along the river, but access is difficult due to untidy and neglected riverbeds;
- In the industrial zone around the Railway Station Skopje-North, the river/canal is inaccessible, has no function. Illegal landfills have been created along the bridges and polluted wastewater from the surrounding industrial plants, warehouses and car washes is being uncontrollably dumped;
- The area where the canal/river Serava passes through the Ilinden barracks, towards the Aqueduct, has the greatest potential to be an open green space. This archaeological site, which is of great importance, was once an important picnic place for the city of Skopje, but today it is very neglected. The area is available to the public, but the negligence and the lack of regulation of its status (there is an on-going process for it to be declared as “cultural landscape”), has left it at the mercy of the weather, human negligence and inappropriate activities;
- The section that passes through the warehouse zone of Momin Potok and the settlement Krivi Dol is almost inaccessible and the local population uses the canal as a landfill and wastewater recipient. Some plots lay directly at

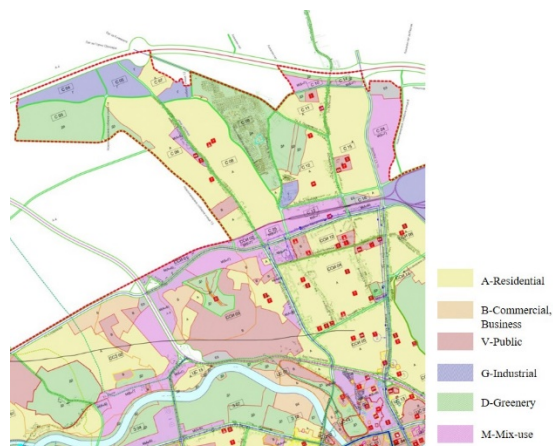
the canal, which makes it difficult to move continuously along it. The riverbanks themselves are partly streets, but neglect and waste make them unattractive.



**Figure 10:** Serava River, unfavourable conditions

#### *Planned urban development*

The area around the upper course of the river Serava, is not a priority of the local self-government and there is no available planning documentation based on which the planned future development of the rural area could be assessed (in the Municipality of Chucher-Sandevo).



**Figure 11:** Excerpt from the GUP of Skopje 2012-2022 – land use along the river Serava

The planned urban development of the City, determined with GUP 2012-2020 [12] and the detailed urban plans for the urban quarters, which lay on the path of the river Serava, indicate several aspects that may affect the protection of the course of river and the riparian areas:

- The river Serava has not been drawn into the General Urban Plan of Skopje 2012-2022 at all and the planning solutions do not anticipate the existence of this watercourse;
- The treatment of the Serava canal is different in the detailed urban plans. In some instances, the Serava canal is not acknowledged as a course of river, and in others, it is not being mentioned, because it is treated as a sewage canal. In some plans, the canal has a width of 18-25 m;
- In most cases, local streets and access roads are directly aligned to the riverbed or canal, which

makes the belt around the river particularly narrow;

- In urban plans referring to the area of the Ilinden barracks, the canal is not acknowledged and is not drawn, except for the part around the aqueduct;
- The planned land uses, such as housing, mixed use and industry, which are right next to the river do not leave enough space for the ecological corridor, nor do they provide free access, and the intensive construction and utilization thereof itself will create further unfavourable conditions;
- No measures have been provided in order to protect the villages from the expansion of the river, nor have any other natural/green barriers been established;
- The planned land use for greenery, recreation has not been properly defined neither with regard to the scope nor with regard to the well-established conditions for landscaping;
- In particular, it should be noted that the surface area around the Aqueduct that is planned to be protected as a cultural landscape does not correspond to the guidelines given in the document Strategic Plan for Rehabilitation of the Aqueduct and its surroundings [14].

### 3.4 Establishing green corridors along the rivers Lepenec and Serava

The establishing of green corridors to the rivers Lepenec and Serava have been determined in accordance with the expert investigations of the natural values [2], the above stated Labaree guidelines [6] and past experiences of cities that have dealt with this issue [10], as well as other relevant globally acknowledged directives and guidelines. The mentioned Study [2], sets out proposals for:

- The scope of the green corridor as well as the width of the green belt.
- Future land use, expected users and possible activities;
- Key activities to be undertaken for the implementation of the concept of establishing of river ecological corridors.

The paper presents the activities that need to be undertaken in the process of urban planning. According to the legislation for urbanism, “The system of spatial and urban planning is in the service of design and humanization of space, the protection and promotion of the environment and nature, as well as of the social, economic and ecological sustainability of human settlements. This is to be achieved through the continuous process of preparation, adopting, implementation and monitoring of the implementation of the plans.” Urban plans serve to protect the public interest, recognized as “the design and humanization of space, the protection and promotion of the environment and nature, as well as the preservation of natural and cultural values of space.” Urban plans regulate the boundaries of settlements and the boundaries of planned construction outside settlements, the organization, purpose, manner of space and land use and the manner and requirements for construction of planned construction inside and outside of settlements, as well as traffic and any other infrastructure, protection and regulation of the environment, immovable cultural heritage and other aspects of social, economic and ecological sustainability

of human settlements [15]. Hence, the urban planning and the urban plans themselves have a key role in creating conditions for the establishing and implementation of the identified green corridors.

#### 3.4.1 Ecological/green corridor of the river Lepenec

It has been proposed for the green corridor along the river Lepenec to be treated as a river park. The function of this park should predominantly have ecological, protective and educational functions.

The green corridor needs to be preserved and restored in order to preserve the ecological functions of the river valley. It is therefore proposed for the natural course and morphology of the riverbed to be preserved, for the indigenous characteristics thereof to be promoted and the indigenous flora and fauna, as well as their communities and habitats to be preserved. The riparian vegetation is typical of the plain river areas of the Balkan Peninsula. Although fragmented, discontinued, and at places destroyed, its potentials need to be fully exploited to ensure the habitat and survival of many animal species. The fauna has autochthonous characteristics that should and can be preserved and fostered (rare species have been registered, species protected on European and national level, species of international interest for protection of several groups of fauna and plethora of birds, some of which are sensitive at global and European level, some protected by the Berne and Bonn Conventions) [2]. Thus, the green corridor can contribute to improving the ecological function of the river and the riparian area in order to ensure the development of ecological connections with the environment.

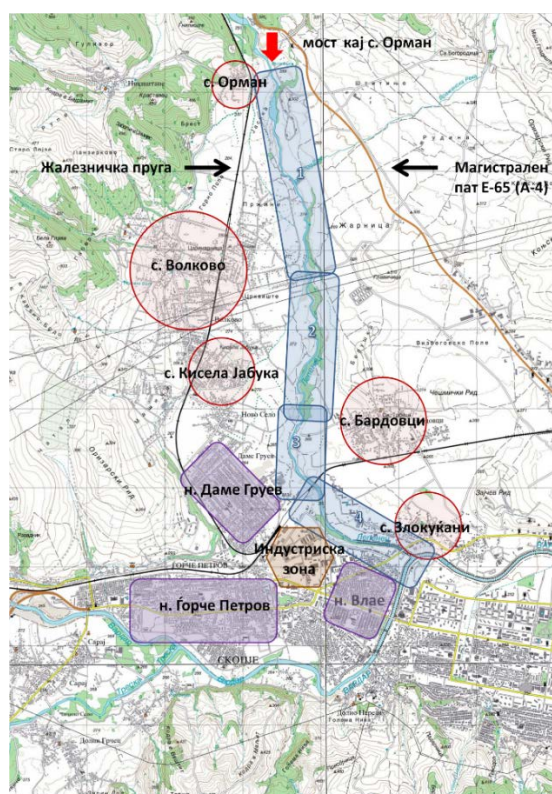
The green corridor is suitable for sports and recreation, fishing and organic farming, but also educational and nature observation activities. The potential for recreation has already been determined with the urban documentation, which sees the riparian area as a green protection zone. The green corridor should also be used as an alternative connection for a green pathway (pedestrian and bicycle). The corridor represents an important landscape and spatial element that defines the urban structure, one that separates land with different land use and connects the green spaces of the city in a green network/infrastructure.

The scope that is being proposed for the Green Corridor-Lepenec stretches from the bridge near the village of Orman to the mouth of the river Vardar, with a length of 6 km. The width of the green belt is determined by the natural characteristics of the river, i.e. its meanders and the changing riverbed. According to the land cadastre, wider belts belong to the river, and in the upper belt the local pathways that go along the entire riverbank, are suitable for creating the border of the corridor. Along the upper segments, the width is larger and easier to secure. For those segments where the corridor passes through the urban area, it is proposed that a belt of at least 100 m from the regulated riverbed on both sides should be provided. At some places, a wider belt can be established.

Most of the riparian area is state land. With regard to private land, it is pointed out that the activities must not disturb the corridor (fencing, construction, etc.) or affect the water quality. Interventions, considered as natural, are allowed in these areas, with the purpose of stabilizing the riverside and preventing erosion: planting appropriate vegetation, use of natural construction materials for stabilization, etc.

It is crucial that the corridor is open and accessible along its entire length on both sides. A bottleneck occurs only at the railway track, i.e. the arch of the Railway Station Skopje-West and where the ring road crosses the river. The current belt with service and warehouse contents on the left bank and at the confluence with the river Vardar should be used for greenery, protection and park.

Four segments with different characteristics have been identified along the corridor, which can accommodate different main land uses as green areas, but the absolute priority in establishing a continuous ecological belt is the rehabilitation of natural habitats and the provision of biodiversity.



**Figure 12:** Proposed ecological/green corridor of the Lepenec River

Bicycle tracks can be created along the entire length of the riparian area, and at several key points, sports and recreational contents on small terrains, picnic points, etc. can also be established.

Access and movement along the corridor should be predominantly planned as pedestrian, by bicycle or by public transport, and only in some places by car (for which sufficient parking space should be provided). It is important to ensure the connection between the river banks, the improvement of the connections between the settlements and the easy access to natural landscapes.

It is expected that the green corridor of Lepenec will be attractive to the inhabitants of the surrounding settlements, but also to the entire city. It is estimated that a population of about 30,000 inhabitants gravitates toward this corridor, but given the intensive development and construction, it is expected that this number will rise.

In order to ensure the establishing of a green corridor on the river Lepenec, as well as continuity and

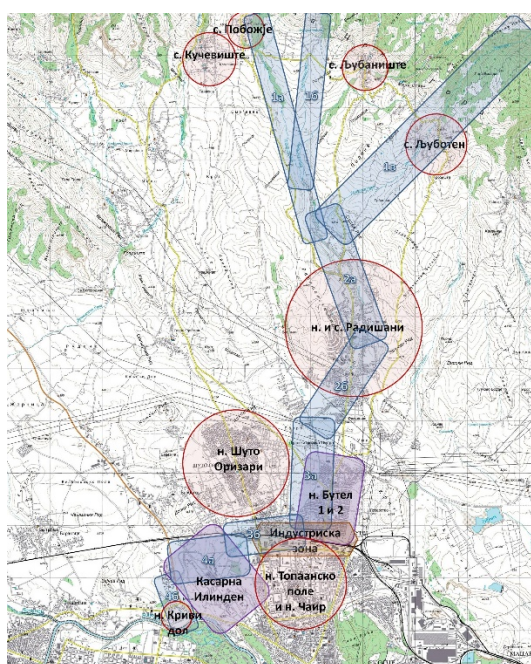
functionality, in the process of defining the concepts for future urban development, and the preparation of the urban documentation, the following recommendations and guidelines should be respected and included:

- For urban development of the city, the settlement Gjorce Petrov and the other settlements, the river Lepenec are to be a central open green zone;
- To include the opinions and determinations for securing the green river corridor in the new urban plans and the revisions of the urban plans, which encompass or touch upon the riparian area;
- To develop a concept and plan for regulating the ecological corridor as an easily accessible multifunctional zone;
- The planned land use of the construction land to be harmonized with the character of the landscape and the corridor;
- To check and revise the recommendations of the environmental assessment studies in the project documentation;
- The space at the confluence of the river with the river Vardar to be converted into a new urban park that will mark the beginning of the green corridor;
- Reconsideration of the possibilities for establishing green corridor at the railway station and the railway bridge;
- Identifying the capacity of the corridor and the riparian area for recreational activities and introduction of modern forms that will coexist with the ecological functions of the green corridor;
- Reconsideration and/or finding an alternative route for the boulevard Ilinden and the connection with the village of Orman;
- Creating green protective belts to prevent the spread of settlements toward the corridor and development of a green network in the wider area, connected to the corridor;
- In urban quarters, the lands that touch upon the corridor should be treated as park greenery;
- Pedestrian and bicycle tracks to be located on the outline between the proposed green corridor and construction or agricultural land;
- Determining the sites where natural pools should be made to retain the water that spills over, which in dry periods represent beautiful natural places;
- Detecting places where content for socialization, sports and recreation can be located;
- In the urban part, the plots that are next to the river, should be arranged so as to enable continuity of the corridor (with subdivision of parcels and purchase of state-owned parts; with allowed passage through them). The parcels in the parts towards the river should be designed as landscape with natural and porous materials and greenery.

#### 3.4.2 Ecological/green corridor – Serava

In the upper basin of the river Serava, the fauna and flora habitats are in a natural state with a diversity of species, especially of some groups of fauna, some of which

are of international and national interest for conservation [2]. The regulated riverbed of the river Serava in the urban area of Skopje has lost the attributes of a natural riverbed and due to the strong anthropogenic pressure; the wildlife in urban areas is extremely devastated and cannot fully function as an ecological corridor. The diversity and richness of the fauna in the upper basin should be protected and conditions for functional habitats, movement and connection with the surrounding nature and urban green spaces should be provided. The estimation is that if space is provided for a green belt along the canal in the urban area, two important goals will be achieved: space will be provided for the movement of some groups of fauna and air circulation from the mountainous areas to the city shall be enabled. Therefore, the basic commitment is to exploit the advantages to the maximum in order to form a linear park along the course of Serava, which will serve for the movement and communication of citizens and bringing the surrounding natural and recreational areas closer. Hence, the course of the river Serava can have a function of a green linear park, but also of an ecological corridor, with a length of more than 18 km. Five segments with different features and editing capabilities are identified: (1) creating a park area with several contents under the settlement Radishani, (2) arranging the green belt above the settlement Butel for walks and movement, (3) to provide a belt for movement and bridging through the service and industrial zone, (4) perceiving and planning the space of the archaeological site of the Aqueduct as a public green space with the status of “cultural landscape” [14, 16], (5) providing access and opportunity for movement of pedestrians and bicycles, erecting tree lines and thus developing green infrastructure for movement from the inflow of the Serava canal in Momin Potok to the inflow into Vardar. A very important determination is the planting of trees along the pedestrian and cycling trails, which will absorb air masses from the mountain and direct them towards the city. Only in this way will the green corridor be able to fulfil its primary function. At the same time, as a green linear structure to define the urban structure.



**Figure 13:** Ecological/green corridor – Serava

The green corridor of Serava is attractive to the inhabitants of the surrounding settlements, but also to the entire city. Access should preferably be on foot, by bicycle or public transport, and in exceptional parts by car (for which sufficient parking space should be provided). The population of about 50,000 now gravitates towards this corridor, but given the planned intensive development and construction of housing, this number is expected to grow. The green corridor in the upper part of the river course is suitable for sports and recreation, especially walking, hiking and fishing, and on the immediate agricultural areas, for organic farming. In the middle and lower part of the corridor, at several sites sports-recreational facilities, small picnic points, etc. can be established. Along the entire length of the linear park, both in the urban area and in the rural areas, a pedestrian and bicycle trails have been planned. In this way, the northern part of the city will be accessible by alternative traffic, pedestrian and bicycle traffic. It is important to connect both river banks, to improve the connections between the settlements and to provide easy access to natural landscapes.

In order to for the concept of linear park along Serava to be implemented, the following recommendations should be respected and appropriately incorporated in urban and other development documentation, in the process of preparation of the concepts for future urban development:

- Incorporating in the urban documentation knowledge about the values of the green corridor, i.e. the river/canal, continued treatment as a green belt with appropriate security and protection measures;
- Analysis of the strategic documents of the municipalities, for evaluating the opinions/or incorporating the opinions on the significance, suitability and threats to the river/canal of Serava;
- Re-evaluation of the urban documentation around the Ilinden barracks and the Aqueduct, so as not to jeopardize the possibility of forming a public green space, and the area to be perceived as a cultural heritage site;
- Regulating/planning the area around the Aqueduct as a public green area by taking special protective measures, shaping measures, etc.;
- Providing space for establishing a protective belt around Serava at the railway station and the railway bridge Skopje-Server;
- Arranging the area at the confluence of Momin Potok in Vardar as a park area to mark the inflow and to connect it with the greenery of the riparian area of Vardar;
- Review of the strategic development documents in order to emphasize the importance of the green corridor, determining of links between urban-peri-urban and rural areas, according to the recommendations of the Global Sustainable Development Goals (GDP 11) [17];
- A spatial plan is needed for the area of Skopska Crna Gora, which will provide the most suitable guidelines for all the different activities;
- Examining possible recreational activities in order to develop a concept for the use and

landscaping of open urban spaces along the corridor;

- The priority for the municipalities should be to create policies for harmonizing water conservation and management activities with biodiversity and urban development;
- Creation of green protection belts in order to prevent the spreading of the settlements toward the corridor;
- The urban documentation should provide for space for pedestrian and bicycle trails, more transverse connections across the river/canal, it should also make sure that streets and roads do not approach the corridor and to provide space for sidewalks and tree lines;
- Detecting places where content for socialization, sports and recreation can be located;
- When providing access to the green corridor, the natural features should be respected. Certain sites should be accessed with sustainable means of transport: by foot, bicycle or public transportation. For the sites where a larger number of visitors is expected, green solutions for car parking should be provided, but not on a large scale;
- In the urban part, the plots that are next to the river should be arranged to enable continuity of the corridor (with subdivision of parcels and securing land for general use with the means of expropriation or at least with allowed passage through them. The parcels in the parts towards the river should be designed as landscape, with natural and porous materials and greenery.

#### 4 CONCLUSIONS

The above stated observations, suggestions and guidelines clearly present the multifunctionality, significance and complexity of Green Corridors. The establishing and shaping thereof requires careful study of the conditions in each urban environment. Both political readiness and will are needed to secure and preserve land that functions as a green corridor.

Enabling the nature and natural process to function freely and safekeeping biodiversity should be the priority when defining future development and when determining land use.

The research investigated the possibilities for establishing green corridors along the rivers Lepenec and Serava, detected the characteristics, the critical points and showed that the establishing thereof and their future regulation demands strong determination, use of knowledge and investment in continuous research.

Creating a green network in urban and peri-urban environments should incorporate and use green corridors as an important category. This is of course directly related to urban planning at all levels. Thus, it was important for the Study on establishing ecological/green corridors to provide an overview of the existing urban documentation and to present which aspects need to be incorporated or revised in the future documentation.

By paving its way toward creating a vision and preparing a strategy for „Green City - Skopje”, the City of Skopje can incorporate the potentials of the two proposed green corridors on the rivers Lepenec and Serava, as significant elements in its platform and program for

achieving better quality of life for all citizens of the city, and for the entire population of the Skopje region as well.

Urban planning and preparation of urban plans for Skopje requires a revision of the planning solutions and incorporation of modern understanding of the city, of the needs of citizens and it needs to provide conditions for dealing with challenges in terms of climate change, protection of biodiversity, establishing of larger ecological/natural areas, pollution reduction etc.

#### 5 NOTES

This paper does not present the findings from other areas (hydrology, flora and vegetation, fauna, biodiversity, social aspects, ecology), which have been used in the analysis, evaluation and determinations for the establishing of ecological/green corridors.

#### 6 ACKNOWLEDGEMENT

The Authors are grateful to the entire team that participated in the preparation of the *Study for the establishment of green corridors - along the river Serava, from the source to the inflow into the river Vardar and on the river Lepenec from the junction near the village Orman to the inflow into the river Vardar*: Josif Milevski, B.Sc., expert in hydrology; Jane Acevski, PhD, expert on flora and vegetation habitats; Slavcho Hristovski, PhD, expert on fauna; Metodija Veleviski, PhD, expert in ornithology; Mila Stamenova, MSc, expert in social aspects; Menka Spirovska, B.Sc., expert in environmental impact assessment; Sofija Trajkovska, B.Sc., expert in ecology.

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