



GEOGRAPHICAL SUPPORT FOR PARTICIPATORY RIVER BASIN MANAGEMENT: THE CASE OF THE TEMENICA RIVER

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Abstract

Participatory river basin management, which requires the cooperation and active engagement of various stakeholders at different levels (local, sub-regional, national and international), is a key aspect of EU water management policy. In Slovenia, although participatory river basin management is formally advocated, it has not yet been effectively implemented in practise, especially in smaller sub-basins where various river initiatives tend to emerge from the bottom up. This paper examines a geographical approach to participatory management of the karst Temenica River basin. The geographical support focused on a comprehensive geographical analysis of the river basin, identification of key water management challenges, stakeholder analysis and empowerment process, and impact assessment of the participatory activities (2020–2023). The results indicate that significant progress has been made toward participatory management in the pilot area of the upper Temenica River basin. Beyond systemic support, the long-term success of participatory management and its extension to the entire Temenica River basin will depend on the ability of stakeholders to maintain and further develop the networks that have been established.

Keywords: hydrogeography, sustainable water management, integrated river basin management, stakeholder networks, stakeholder collaboration, LEADER/CLLD, Dinaric Karst, sinking karst river

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1 INTRODUCTION

Water management has emerged as an important topic in international political discourse and is acknowledged as one of the United Nations Sustainable Development Goals (United Nations, 2015). However, sustainable water management is becoming an increasingly pressing challenge, the importance of which is reinforced by the growing pressures of human activities (agriculture, industry, transport, urbanization, etc.), but also by climate change. Inadequate water management can lead to negative multiplier effects, potentially resulting in the loss of some fundamental functions of rivers, such as ecological, economic, social, recreational or cultural functions (Cerkvenik, 2017).

The need for a comprehensive approach to understanding and managing water resources was already emphasized by Radinja (1955). He described river basins as complete units that encompass the entire physical and socio-geographical inventory (Radinja, 1955) and which are the most fundamental units for water management. Unfortunately, river basin boundaries often do not coincide with existing administrative units, making the practical implementation of river basin management more challenging (Plut, 1999). On the other hand, this is precisely the reason why water management is an area where cross-sectoral and interdisciplinary approaches, as well as new policy models and governance concepts for state, society and natural resource management have traditionally been tested and implemented (Berardo, Lubell, 2019; Berardo, Scholz, 2010; Fischer, Ingold, 2020; Lubell, 2013; Pahl-Wostl et al., 2010).

Water management can be described as both a process and an outcome (Jiménez et al., 2020). In the 2020s, a key objective of European water management policy (Directive 2000/60/EC of the European Parliament..., 2000 and subsequent amendments) is to achieve better cooperation at the river basin level, also referred as bioregional approach (Huitema, Meijerink, 2017), and enhancing the involvement of lower territorial levels, diverse local actors and stakeholders (Fischer, Ingold, 2020). Achieving this requires combining top-down governance approaches with bottom-up management strategies. This multi-level governance is one of the key challenges in integrated water resources management (Watson, 2014). In Slovenia, for example, river basin management takes place at several levels: at the micro-local level (e.g. the spatial unit of a water mill or other economic activity near the river), at the local level (municipality, local community), at the sub-regional level (e.g. local action group, fishing association), at regional level (e.g. territorial projects of regional development agencies, cooperation projects, etc.), at national level (e.g. River Basin Management Plans), and at international level (e.g. the International Sava River Basin Commission, the International Commission for the Protection of the Danube River).

For multi-level governance in the water sector, various participatory management models are continuously being developed and put into practice (Berardo, Lubell, 2019; Jiménez et al., 2020). They are based on vertical and horizontal, formal and

informal networks of actors and stakeholders (Fischer, Ingold, 2020; Prell et al., 2016). The purpose of this type of networking is to share knowledge, skills and perspectives between experts and national authorities that traditionally monitor, manage and maintain river ecosystems (Johannes et al., 2002) on the one hand, and stakeholders and actors living and working in the river basin on the other. The stakeholders in the river basin can be divided into two groups (Johannes et al., 2002): 1) communities of place and 2) communities of interest, between which it is not always possible to draw a sharp line in practice, as their roles are often intertwined and complementary. Participatory management, also called co-management, integrative, inclusive or collaborative management, requires a high level of trust between the different stakeholders, an awareness of mutual benefit and interdependence, the ability to share knowledge and learn, critical self-reflection and mediation in cases of conflict (Mostert et al., 2008). A key element of participatory water management is the active involvement of diverse stakeholders not only in the planning and implementation of strategies or measures, but also in decision-making (Emerson, Gerlak, 2014). This also entails a certain degree of delegation of responsibility to lower decision-making levels (Emerson, Gerlak, 2014; Hill Clarvis, Engle, 2015; Pahl-Wostl et al., 2010).

The challenges of multi-level governance involving multiple stakeholders arise from conflicting objectives, approaches and the partial interests of stakeholders operating at different levels (Fischer, Ingold, 2020). In practice, this most often manifests itself in conflicting top-down and bottom-up initiatives as well as conflicts between different groups, such as formal stakeholders and voluntary, informal, self-organized groups or initiatives (Berardo, Scholz, 2010; Watson, 2014). The participatory approach is now mandatory in many water policies; however, the extent of collaboration and the impacts of participatory processes on local water communities as well as on water quality and ecosystem health remain poorly understood and require further research (Van der Heijden, Ten Heuvelhof, 2012).

Slovenia is characterized by a dense river network, where larger and smaller watercourses connect numerous municipalities. The management of waters, water and riparian land in Slovenia is formally regulated by the Water Act (ZV-1, 2002), which emphasizes three key aspects: water protection, water regulation and decision-making regarding water use. The aim of managing water bodies, water and riparian areas in Slovenia is to achieve good quality water bodies and other water-related ecosystems, to ensure protection against harmful water impacts, to maintain and regulate water quantities, and to promote the sustainable use of water. This approach enables various types of water use while considering the long-term protection of available water resources and their quality (ZV-1, 2002).

For the purposes of water management, Slovenia has adopted water management plans for the Danube and Adriatic basin districts for the period 2023–2027 (Načrt upravljanja voda na vodnem območju Donave..., 2023; Načrt upravljanja voda na vodnem območju Jadranskega morja..., 2023). However, these plans are too general

to meet the challenges of water management in smaller river sub-basins. The Regulation on the Detailed Content and Preparation of Water Management Plans (Uredba o podrobnejši vsebini..., 2006) envisions the preparation of detailed water management plans at the level of smaller sub-basins. However, this hierarchical approach to water management has not yet been put into practice. In response to inadequate, predominantly top-down water management, numerous local initiatives have emerged in smaller river basins that pursue a bottom-up approach (e.g. in the Temenica, Kamniška Bistrica, Reka, Sora, Kokra, Savinja and Sava Bohinjka and Sava Dolinka confluence river basins) (Varuhinje rek, 2023). These initiatives aim to influence river basin management. However, the functioning and scope of activities of such initiatives or movements have not yet been thoroughly researched.

Empowered stakeholders are the key to implementing a bottom-up river basin management approach. Their empowerment is a process (capacity building) that helps individuals, organizations or communities to develop greater capabilities, knowledge and skills to perform certain tasks, achieve goals or take responsibility (Simmons et al., 2011). An important group in river basin management are active and empowered (local) residents who are living with the river. Key factors that influence their engagement and thus improve the effectiveness of water management include formal and informal education on water-related topics at all educational levels, participation in research and the interpretation of new knowledge, and the transfer of this knowledge to the local environment (Mikolič et al., 2024). Particular attention should be paid to young people, who will be the key drivers of change and creators of new approaches and ideas in water management in the future. Universities or related research and educational institutions can play an important role in empowering stakeholders and promoting new approaches in water management. These institutions house experts in water-related fields who are holders of cutting-edge knowledge and have access to the latest available data.

Water management falls within the remit of various disciplines: geography, hydrology, geology, biology, forestry, law, sociology, political science, economics, etc., which makes it highly interdisciplinary (Grigg, 2016). Geography strives for a holistic approach in its research, based on a comprehensive analysis of the physical and sociogeographical characteristics of the landscape and the cause-and-effect processes taking place within it (Bobovnik et al., 2023). Such an approach, using a range of landscape diagnosis methods, enables the identification of the hydrogeographic constants of a river basin and the definition of the key water management challenges. Addressing these challenges has to be aligned with European, national, regional and local water management objectives (Brečko Grubar, 2007; Bricelj, 2007; Draksler, Kušar, 2018; Prah, 2012).

This paper presents the geographical support for water management in the karst Temenica River basin. This support was provided between 2019 and 2023, with more intensive efforts in the period 2021–2023, when it was financially supported by the

LEADER/CLLD project Rusalka (Reviving Life Along and Within the Temenica River). The project activities were mostly limited to the upper Temenica basin (the section between the river's source and its first sinkhole near Dolenje Ponikve in the Municipality of Trebnje), which was also studied in more detail. The upper Temenica reflects the trajectory of many Slovenian rivers, which have suffered from decades of unsustainable management, resulting in several water management challenges, most notably its poor ecological status (Ocena ekološkega stanja..., 2021). The geographical support for participatory management of the Temenica River basin is presented in three completed sections:

- a comprehensive geographical analysis of the basin, the identification of hydrogeographical constants and the definition of the key water management challenges in the upper Temenica River basin;
- a stakeholder analysis and a presentation of the stakeholder empowerment process (with a focus on young locals) in the upper Temenica River basin;
- evaluation of the impact of the participatory activities in the upper Temenica basin through a stakeholder interest and power matrix in two time periods (before and after the completion of the pilot project activities in the upper Temenica River basin).

2 METHODS

The study used a triangulation of research approaches (qualitative and quantitative research), methods, techniques and data sources.

2.1 Geographical analysis of the Temenica River basin

We conducted a detailed geographical study of the Temenica River basin using a variety of research methods. First, we collected and analysed various sources and literature (e.g. basic regional geographical and other literature, hydrological data on the discharge characteristics and water quality of the Temenica River and its subsurface flow, old and current cartographic and other data on the past and present use of water and riparian areas, the past course of the river, etc.), which provided us with basic data and information about the Temenica River and its basin. Subsequently, various spatial data layers were collected, converted, and analysed using GIS (e.g. geological, pedological, vegetative, climatic, and other thematic maps; population and settlement data; natural and cultural heritage data). These were used to supplement the findings from the literature. Additional information was obtained through fieldwork (e.g. mapping of water and riparian areas and anthropogenic interventions on watercourses, inventory of natural and cultural heritage and other hydrological elements in the landscape, own longitudinal water quality measurements at selected sections of the Temenica River, survey of local population and 12 semi-structured interviews with various

stakeholders in the basin). The research covered a longer period (2019–2023) and included contributions from three generations of students from the Department of Geography (Chair of Regional Analysis and Planning) at the Faculty of Arts, University of Ljubljana, who participated in the survey of the local population (in 2019, N=180) and in the mapping of the river and riparian areas. The results were finally evaluated and used to derive hydrogeographic landmarks of the upper Temenica River basin, which form the basis for river basin management. Based on these landmarks and the water management objectives, the main water management challenges were identified and priorities for action within the basin were set.

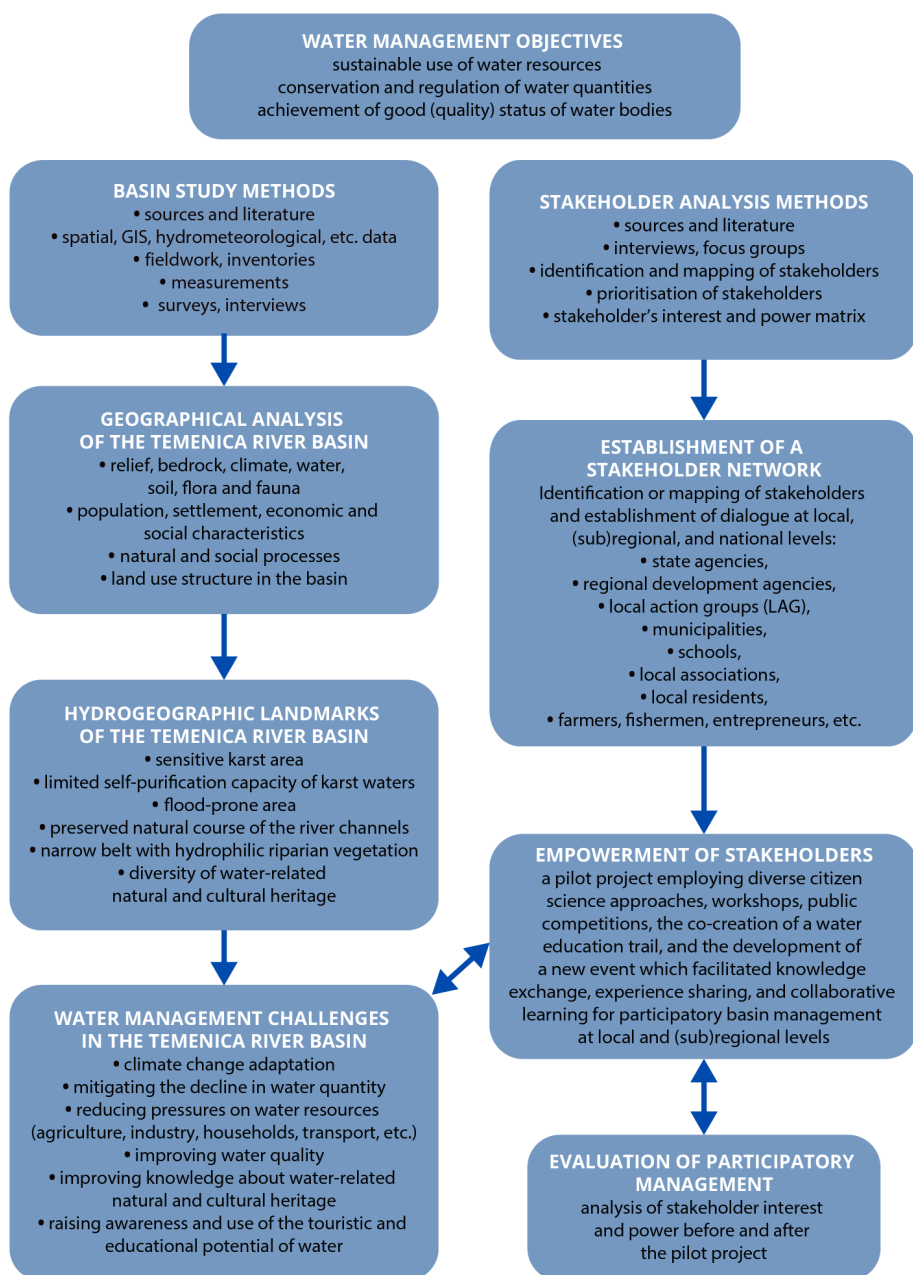
2.2 Stakeholder analysis

A stakeholder analysis was carried out in parallel to the analysis of the study area. The success of participatory river basin management depends largely on the methods of stakeholder engagement and the forms of cooperation. The stakeholder analysis was based on Mendelow’s Stakeholder Matrix (Mendelow, 1981), which was adapted to our needs. The analysis was carried out in three steps. The first and most important step was the identification and mapping of the stakeholders. Stakeholder mapping is a process that begins with the identification of stakeholders, followed by the assessment of the frequency and strength of relationships between them, using primarily qualitative methods (e.g. semi-structured interviews, workshops, focus groups) (Blázquez et al., 2021; Prell et al., 2016; Smrekar et al., 2023). To investigate stakeholder management (Freeman, McVea, 2000), 12 key stakeholder groups in the Temenica River basin were identified through informal discussions, literature, documents and online sources. In 2019, 12 semi-structured interviews were conducted with these

Figure 1: Stakeholder’s Interest and Power Matrix (adopted from Mendelow, 1981).

| | | | |
|-----------------------|------|---|--|
| P O W E R | high | II. high power/low interest – satisfy and stimulate interest | I. high power/high interest – active engagement |
| | low | III. low power/low interest – monitor activities | IV. low power/high interest – provide relevant information and updates |
| | | low | high |
| | | INTEREST | |

Figure 2: Conceptual-methodological framework of the research.



stakeholder groups. This was followed by three stakeholder workshops in 2020 and a series of project activities and workshops between 2021 and 2023. In addition to the national and (sub)regional stakeholders, local stakeholders from the central settlement of Trebnje in the upper Temenica River basin were also identified. Once the stakeholders and their interrelations were identified and understood, the next step was to prioritize the stakeholders. The role of individual stakeholders, their level of influence and interest in activities that contribute to the sustainable management of the upper Temenica basin were assessed by experts. Based on the results of the interviews and workshops, the power and interest of each stakeholder was assessed and they were categorized into one of four quadrants: 1) high power and high interest, 2) high power and low interest, 3) low power and low interest, or 4) high interest and low power (Figure 1). The third step was to determine the most effective way to engage and empower stakeholders from each quadrant and to identify the most appropriate methods of communicating with them (Mendelow, 1991).

Finally, the impact of the participatory activities was assessed by comparing the two stakeholder networks classified in the interest and power matrixes before the implementation of different project activities (2020) and after the completion of the project (2023). This approach allowed us to assess the contribution to stakeholder empowerment and strengthening participatory management in the upper Temenica River basin.

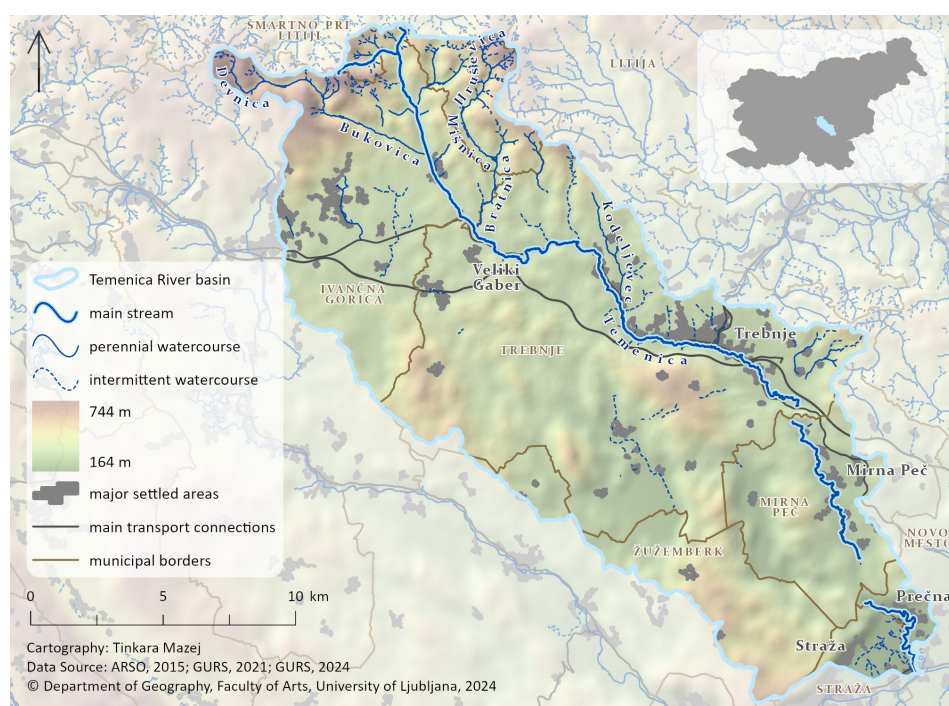
3 GEOGRAPHICAL PRESENTATION OF THE TEMENICA RIVER BASIN

The Temenica River is a karstic sinking stream that predominantly flows through the Low Dinaric Karst of the Dolenjska Elongated Lowland (Figure 3). Its surface stream is about 42 km long (GURS, 2018). It originates from two headwater branches on the southern slopes of the Posavje Hills, near the settlements of Javorje and Vrata. After 27 km of flow, it first sinks near the settlement of Dolenje Ponikve and emerges again at the nearby karst spring of Zijalo in the Mirna Peč Valley. It sinks again near Goriška Vas and reappears as the Prečna Spring in the Luknja Steep-Head Valley on the Zalog Field, from where it continues its course to the confluence with the Krka River.

The entire basin is about 35 km long and 10 km wide. Due to the uncertain course of the watershed divide in the southwestern part of the basin (Habič, 1989, p. 17; Novak, 1960, p. 19), its exact area is not precisely known but is estimated at just over 300 km² (ARSO, 2023b). The Temenica basin is characterised by elevations predominantly between 200 and 400 meters above sea level. In the northern part, Triassic dolomite is the most presented (GeoZS, 2023). Due to its low water permeability, a fluviokarst relief with a sparse surface water network has developed on it. The southern part of the basin is dominated by water-permeable Jurassic limestone, in which there are almost no surface waters. The most common soils are shallow rendzinas and

brown carbonate soils (MKGP, 2008), while deeper soils can be found on Pliocene and Pleistocene reddish-brown clays and silts, offering favourable natural conditions for agriculture along the entire valley. The climate in most of the basin is moderately continental (Ogrin et al., 2023). The Temenica has a (sub)Pannonian rain-snow discharge regime with a pronounced summer low and autumn high flow (Frantar, Hrvatín, 2005; Stojilković, Brečko Grubar, 2024). The mean annual discharge for the period 1991–2020 at the Rožni Vrh water gauging station near Trebnje is $0.72 \text{ m}^3/\text{s}$, while at the Prečna gauging station it raises to $4.03 \text{ m}^3/\text{s}$ due to the inflow of karst groundwater from eastern Suha Krajina (ARSO, 2023a).

Figure 3: The Temenica River basin.



The basin is administratively divided into seven municipalities, with the largest and central part belonging to the municipality of Trebnje. Around 23,000 people live in the basin (SURs, 2023), with a population density of $75 \text{ inhabitants}/\text{km}^2$. The larger settlements (Trebnje, Ivančna Gorica, Stična with Šentvid pri Stični and Mirna Peč) are located at the bottom of elongated lowland or along the Temenica river, while the rest of the basin is sparsely populated and dominated by smaller settlements. The proportion of built-up area is around 6% and the proportion of forest is 56% (MKGP, 2023). The economic and employment centres are the settlements of Trebnje and

Ivančna Gorica and, to a lesser extent, Mirna Peč, Straža and Prečna. Due to the highway and railroad connections to Ljubljana and Novo mesto, a large part of the population migrates daily to work outside the Temenica River basin. Agriculture is also an important economic sector, with livestock farming predominating, which is reflected in the relatively high proportion of meadows (23.6%) and arable land (11%). From a landscape perspective, permanent crops (orchards and vineyards) are also important, accounting for 1.3% of the area (MKGP, 2023).

In the present study, we focused primarily on the upper Temenica River basin, which stretches from the source near Javorje to Dolenje Ponikve and accounts for about one third of the entire basin and two thirds of the total surface flow of the Temenica. The study focused on the valley floor along the river, with an emphasis on the wider Trebnje area. In this area, the pressure on the water and the riparian zone is the greatest due to population concentration, transportation routes and various activities, which is also reflected in the poor ecological status of the Temenica (Ocena ekološkega stanja..., 2021).

4 HYDROGEOGRAPHICAL LANDMARKS OF THE UPPER TEMENICA RIVER BASIN

Due to the karst terrain with vertical drainage and a poorly developed river network dominated by shorter, less water-abundant, slower-flowing, intermittent (with the exception of the Temenica), non-sediment-bearing watercourses and losing streams, the upper Temenica River basin is very sensitive to anthropogenic pressures on the environment and thus on the water bodies.

The specific hydromorphological conditions of the valley floor make it a wetland and floodplain landscape, which in some places has been transformed by drainage channels into an intensive agricultural landscape, posing a considerable burden on the less water-rich watercourse. As the settlements are relatively well adapted to the frequent flooding and are mostly located outside the flood-prone areas, the natural course of the Temenica River has been largely preserved, with a slight gradient that allows the course of the river to meander strongly. Riparian vegetation is restricted to a narrow strip along the riverbed, which prevents it from providing its full ecosystem services and creating optimal conditions for the development of a rich biodiversity.

Most of the upper Temenica River basin is characterised by scattered settlement with smaller settlements, which is unfavourable for the provision of municipal infrastructure, especially sewage systems. Apart from the concentrated settlement in Trebnje (and its nearby surroundings) and Veliki Gaber with its wastewater collection and treatment system, the inhabitants of this area are forced to look for individual solutions. The area is development-oriented and economically relatively prosperous, with a well-developed industrial sector supported by its excellent transport links and accessibility. However, industry is also a significant consumer and polluter of water,

which affects water quality mainly through discharges in the Trebnje town area.

The fluviokarst relief, which combines elements of karst and fluvial landforms, the transitional nature of an area, the tradition of permanent settlement in the area, and the development of some water-dependent crafts, make the water-related natural and cultural heritage in the river basin extremely diverse. Along with the Ljubljanica River, the Temenica River is one of the most characteristic and picturesque sinking rivers in Slovenia, with a whole range of different river features (blind valleys, dry valleys, meanders, oxbow lakes and sloughs, a branched system of sinkholes and swallow holes, karst springs, caves, and more). It is protected as a hydrological, geomorphological and ecosystem value of national importance (Pravilnik o določitvi..., 2004). In addition, the upper Temenica Valley is the longest blind valley in Dolenjska region (Gams, 1983) and one of the longest in Slovenia (Gams, 1962). The cultural heritage includes the former mills and the traditional water management with dams and millraces, washing sites, a bathing area, Trebnje Castle, numerous archeological sites, and the unique cultural landscape along the Temenica River (MZK, 2023). Consequently, the upper Temenica River basin has at least moderate, if not significant, tourism and education potential related to water. If appropriately utilized through the implementation of soft tourism practices, this potential could provide an additional development impulse and sustainable jobs.

Figure 4: The floodplain of the Temenica River in Trebnje (photo: Department of Geography, Faculty of Arts, UL, 2022).



5 WATER MANAGEMENT CHALLENGES IN THE UPPER TEMENICA RIVER BASIN

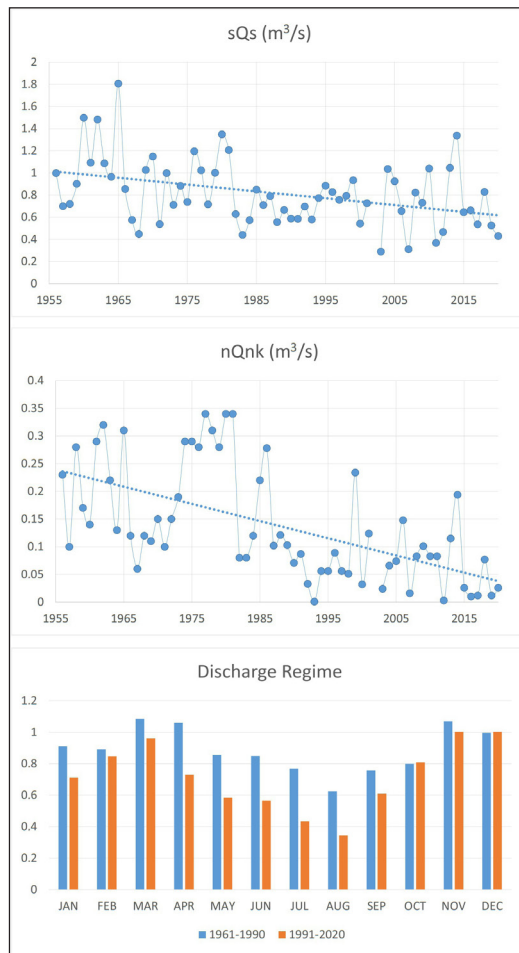
The biggest water management challenge is the pollution of the upper Temenica River, which has a poor ecological status according to the results of national monitoring of watercourses (Ocena ekološkega stanja..., 2021). Due to increasing pressures, the sensitive karst basin, and the river's limited self-purification capacity, water quality progressively deteriorates downstream (Dečman, 2025 – in press). Solutions must therefore be found in the future to reduce the degrading pressures and improve water quality.

In the context of climate change, the significant decline in the discharge of the Temenica river also poses a particular challenge. Its average discharge (Q_s) at Rožni Vrh has decreased by 40% in the period 1956–2020 (Figure 5a) and its low discharge (Q_{nk}) by as much as 80% (Figure 5b, ARSO, 2023b). The amount of water has decreased the most during the growing season between April and September (Figure 5c), when water demand is highest. In recent decades, the decline in runoff due to climate warming and increasing evaporation, as well as the overgrowth of agricultural land with forest, which is a large consumer of water, has been typical for most Slovenian watercourses, but few have experienced such a sharp decline as the Temenica River (Uлага, 2002). This pronounced decrease in discharge is probably also related to the collapse of mills and the associated abandonment of traditional water management practises, including the clogging of sinkholes in the riverbed. Another reason is probably the water abstraction in the headwaters (near Radanja Vas and in the Bratnica Valley) for the water supply of settlements and industry in Trebnje (Letno poročilo 2022, 2023; Oskrba s pitno vodo, 2023). The significantly lower volume of water during low flows and its poor quality are, in addition to high summer water temperatures and low oxygen content, the main causes of frequent fish kills in the upper Temenica River catchment. The reduction of average and low discharge and the unfavourable changes of the discharge regime make it necessary to find appropriate measures to mitigate and adapt to the effects of climate change on water resources.

We assessed the population's relationship with the river and their attachment to it by surveying the local community. The survey results revealed that people were significantly more attached to the river in the past than they are today. In the past, they swam in the Temenica River, fished, and socialized along its banks. Today, the river is mostly neglected, and residents no longer perceive the riverside area as a space for gathering, recreation, or leisure. They have become alienated from the river and do not know it as well as they did decades ago when their lives depended on it to a much greater extent. The same applies to the diverse natural and cultural heritage associated with water, which is poorly recognized, and its potential remains underutilized for both educational and tourism-recreational purposes. Based on conversations and interviews conducted with local stakeholders in water management (including municipal representatives, associations, civil initiatives, the fishing society, and the interested public), most expressed

a desire for the development and revitalization of the river and its surroundings. However, due to insufficient awareness of contemporary sustainable practices in sustainable river management, each group of stakeholders envisions the implementation differently. Additionally, they are not sufficiently interconnected. Thus, it is necessary to unify a sustainable, nature-based vision for managing the river and its surroundings, one that aligns with modern research guidelines. This vision should aim to enhance river ecosystem services (such as blue-green infrastructure, ecoremediation, and nature-based solutions) while preventing further degradation of water quality and biodiversity.

Figure 5: Trends in medium (sQs) and low flow ($nQnk$) during the period 1955–2020 and a comparison of river flow regimes for the periods 1961–1990 and 1991–2020 at the Rožni Vrh hydrological station.



6 STAKEHOLDERS IN THE UPPER TEMENICA RIVER BASIN AND THE EMPOWERMENT PROCESS

In participatory river basin management, it is important to involve a wide range of relevant stakeholders who can contribute to the co-management of the river ecosystem. At the same time, it is crucial to understand the roles of individuals and their relationships with each other. In the upper Temenica River basin, we identified 12 key stakeholder groups: three at the national level, two at the regional or sub-regional level and seven at the local level. These stakeholder groups form both formal networks (e.g. state–municipality, state–development agency, municipality–primary school) and informal networks (e.g. farmers–fishermen, municipality–entrepreneurs, municipality–local association, local association–local residents). The networks develop both horizontally (e.g., municipality–primary school, municipality–local association, state–national association) and vertically (e.g. municipality–state, state–development agency).

The upper Temenica River basin extends administratively over the territories of three municipalities. The middle and lower parts of the basin belong to the Municipality of Trebnje, while the upper reaches belong to the Municipality of Ivančna Gorica and, to a lesser extent, to the Municipality of Šmartno pri Litiji. While the Municipality of Trebnje has a strong interest in the management of the Temenica River, the development of water-related initiatives and the improvement of blue-green infrastructure along the river, the Municipality of Ivančna Gorica focuses primarily on its better-known central watercourse, the Krka River. Although the upper reaches of the Temenica originate in the Municipality of Šmartno pri Litiji, this municipality shows little interest in managing the river. This lack of interest is due to the fact that the headwaters of the Temenica are difficult to access and heavily forested, and the river quickly crosses the municipal border after its source. It is therefore no coincidence that the Municipality of Trebnje was the initiator and lead partner of the LEADER/CLLD project Rusalka, in the framework of which numerous activities promoting participatory river basin management were carried out (Figure 6). Although the Municipality of Ivančna Gorica was not a formal partner of the project, it was indirectly involved, as some project activities were also carried out on its territory.

The administrative fragmentation of the upper Temenica basin is exacerbated by the division between the territory of the Local Action Group (LAG) Suha Krajina, Temenica and Krka (LAG STIK) and the LAG Heart of Slovenia, which covers the upper reaches of the Temenica in the Municipality of Šmartno pri Litiji. Local Action Groups (LAGs) are partnerships that bring together public and private stakeholders at sub-regional level to implement development projects in specific areas and local communities. Both formal networks (e.g. with ministries) and informal networks (e.g. with various associations and individuals) are established within the LAGs (Potočnik Slavič et al., 2022). The LAG Suha Krajina, Temenica and Krka (STIK) has identified the Temenica River as one of its priority areas in two development documents

(for the periods 2014–2020 and 2021–2027) (SLR LAS STIK, 2014–2021; SLR LAS STIK, 2021–2027). So far, the Temenica has only been directly addressed once by a LEADER/CLLD project, namely by the above-mentioned project Rusalka (Reviving Life Along and Within the Temenica River, 2022–2023).

The upper Temenica basin is divided between two development regions: the Central Slovenia Development Region and the Southeast Slovenia Development Region. Consequently, it falls under the jurisdiction of two different development agencies: the Agency for Regional Development of the Ljubljana City Region and the Novo Mesto Development Centre, which serves as the regional development agency for South-east Slovenia. In the current programming period, neither agency has addressed the management of the Temenica River (RRA JV Slovenija, 2022; RRA LUR, 2022). Additionally, the upper Temenica basin is divided between two cohesion regions (Eastern and Western Slovenia), which further complicates the formation of partnerships and access to funding.

National authorities and agencies (e.g. the relevant ministry, directorates, agencies and inspectorates) are responsible for implementing European directives (e.g. the EU Water Framework Directive) and drafting national water, environmental and spatial planning legislation. They also oversee the management and monitoring of water resources (e.g. quality, use), with implementation often delegated to lower administrative levels or operational units. For example, municipalities may occasionally be tasked with cleaning smaller riverbeds. National institutions and authorities also act as “permitting authorities” for various interventions in water and riparian areas and guide sustainable development based on political decisions. These authorities form formal networks and work together both vertically (e.g. cooperation and delegation of tasks to municipalities) and horizontally (e.g. cross-sectoral cooperation between ministries and national authorities). The Temenica River basin falls within the jurisdiction of the Lower Sava sector of the Water Management Agency (Sektor..., 2024).

An informal form of networking at national level is various interest groups that aim to unite individuals around a common goal. Examples include raising public awareness, participating in media campaigns, pursuing legal action and pushing for social or political change. In the Temenica River basin, for example, the Association of Slovenian Geographers has been active together with its Hydrogeography Commission. In cooperation with the Slovenian Environment Agency (ARSO), they led an initiative to install high-water level markers to raise awareness of flood risks along Slovenian rivers (Frantar et al., 2018).

At the invitation of the Municipality of Trebnje (as part of the preparatory activities and later the Rusalka project), the Department of Geography at the Faculty of Arts, University of Ljubljana (Department of Geography, FA UL) was involved in research into the Temenica karst River and the management of its basin. The department established both vertical networks (e.g. with the municipality, primary schools, local associations and the local action group) and horizontal networks (e.g. with the

Association of Geographers of Slovenia and the Commission for Hydrogeography). During the project activities, stakeholders in the Temenica River basin were empowered with various methods and techniques, new insights and knowledge about the Temenica River and support in building networks for participatory basin management. The department contributed to the design of workshops for primary school students, conducted trainings for teachers and developed a manual for teachers (Mikolič et al., 2023b). They also created a digital representation of Temenica River online (Mikolič et al., 2023a) and organised several participatory and educational workshops for different stakeholders and the public (Figure 6).

Primary school can raise pupils' awareness of the importance of water conservation and sustainable use through regular lessons and additional activities (e.g. science days, elective courses), thus promoting a more responsible attitude of young people towards the environment. Primary schools can also serve as a hub for communities, local associations and residents by creating formal and informal networks that facilitate knowledge exchange and collaboration on local environmental projects. There are two main and four branch schools in the upper Temenica Basin. Trebnje Primary School, with around 1,100 students in the main school and the three branch schools, was directly involved in the participatory river basin management process. The Veliki Gaber Primary School and the Temenica Village Branch School were indirectly involved. In cooperation with the teachers of these schools, the staff of the Department of Geography at the Faculty of Arts, University of Ljubljana developed four thematic workshops on integrated water management: Responsible Water Use, Water Reuse, Water and Riparian Spaces, Water Quantity and Quality. The workshops were tailored to children aged 8 to 12 and were modular, allowing teachers to choose between one-hour and full-day activities. They were suitable for both classroom teaching and field work. Teaching materials were developed, including an illustrated map of the Temenica, various games, worksheets and more. Eight pilot workshops were held in four primary schools. A 65-page didactic manual (Mikolič et al., 2023b) was produced for teachers and friends of the Temenica River and other watercourses, containing all the necessary information for independent use. The schools also received water analysis kits and an electronic conductivity metre. In addition, teacher training courses were held in the LAG STIK to enable teachers to incorporate local water issues into the educational process. Students also created a short film showing how they are exploring the Temenica.

An important stakeholder in participatory river basin management are local associations (cultural, sports, environmental, art, tourism associations, etc.) that organize workshops, lectures and events to raise awareness among residents about the importance of protecting water resources and their sustainable use. These associations also build and strengthen informal networks with other local actors such as schools, municipalities, entrepreneurs, farmers, fishermen and residents by acting as a bridge between formal decision-makers and the community. In the upper Temenica basin, local associations played an active role in organizing events on the tangible and

Figure 6: Project activities implemented in the upper Temenica River basin between 2021 and 2023.



intangible heritage of the Temenica River, designing excursions along the river, organizing art and photography competitions and hosting annual clean-up campaigns. Their commitment to the interests of the local water community is also an important aspect of their contribution.

Farmers, fishermen, entrepreneurs and local residents are important stakeholders who can contribute to the sustainable management of the river through their activities. Farmers in particular use the land directly adjacent to the river for agricultural production. Most of the valley floor in the Temenica basin, including the sensitive wetlands, consists of farmland that extends almost to the riverbank. Despite the prescribed 5-meter buffer zone, which is supposed to protect the river's ecosystem, it is insufficient due to the karst features of the Temenica River. Agricultural activities, especially fertilization and pesticide use, have a direct impact on water quality. As part of the participatory management process in the upper Temenica basin, farmers were targeted through public awareness workshops. These workshops focused on educating attendees about sustainable agricultural practices that reduce the environmental impact on the sensitive karst river, such as the responsible use of crops and fertilizers and the establishment of vegetative buffer strips along the river. This initiative helped to empower farmers and improve their practices and is therefore directly in line with the objectives of participatory management, where local stakeholders take responsibility for the protection of natural resources and their sustainable use.

The fishermen were directly involved through consultations during the workshops, where they shared their extensive traditional knowledge of the river and fish habitats. This is in line with the theory of co-management, which emphasizes collaboration with local experts in identifying problems such as fish mortality due to pollution and low water. The fishermen also contributed by proposing technical solutions, including the restoration of fish habitats and the repair of cascade barriers, some of which they have already implemented as part of their regular activities on the Temenica River.

Entrepreneurs belong to a stakeholder group that can have a significant impact on water resources, as their activities often require water use. Through vertical and horizontal networking, socially and environmentally responsible entrepreneurs can contribute to efforts towards sustainable water use, both within their own industrial and business operations and by raising awareness among other stakeholders. An entrepreneur in the upper Temenica basin organized workshops on small wastewater treatment plants and educated the local population about technological solutions for wastewater treatment.

The local population participated in several activities, most notably Temenica Day, a newly established annual event aimed at raising awareness of the importance of the Temenica River for the local community and beyond. During this event, residents participated in educational workshops and activities led by local experts and researchers. In three public competitions (art, literature and photography competitions), the local population reflected on their relationship with Temenica. They were indirectly

involved through primary school students who participated in several educational workshops. This empowered the younger generations and their families to better understand and contribute to the protection of the river. Residents living near the river play a crucial role in the co-management of natural resources, as local knowledge is combined with modern sustainable practices, fostering mutual responsibility.

7 MATRIX OF STAKEHOLDER POWER AND INTEREST BEFORE AND AFTER THE PILOT PROJECT

In the participatory river basin management model, understanding the interests and power of different stakeholders is crucial for effective planning, collaboration, interaction and implementation of interventions. To support the participatory management of the upper Temenica River basin, we conducted a stakeholder mapping exercise. Based on the results of interviews and focus groups and their willingness to participate in various project activities in the Temenica basin, we developed an interest and power matrix for key stakeholders. Stakeholders were categorised into four quadrants according to the combination of two parameters: their power to influence river management (low or high) and their interest to participate in participatory management (low or high). In order to bring about change, improve collaboration and strengthen communication, it is important to aim for a strong group of stakeholders with high influence and interest.

Figure 7: Matrix of stakeholder power and interest in the upper Temenica River basin before project activities (in 2020).

| | | | |
|-----------------------|------|--|---|
| P O W E R | high | II. high power/low interest - satisfy and stimulate interest <ul style="list-style-type: none"> • national authorities and agencies • regional development agency | I. high power/high interest – active engagement <ul style="list-style-type: none"> • municipality • LAG |
| | low | III. low power/low interest – monitor activities <ul style="list-style-type: none"> • national interest groups • farmers • entrepreneurs • local residents • local associations • primary school | IV. low power/high interest – provide relevant information and updates <ul style="list-style-type: none"> • university (Department of Geography, FA UL) • fishermen |
| | | low | high |
| | | INTEREST | |

The first quadrant contains stakeholders with high power and high interest in participating. These stakeholders should be actively involved in the process of participatory management of the upper Temenica River basin in order to find sustainable solutions, and they should feel that their contributions are useful and satisfactory. The second quadrant contains stakeholders with high power but little interest. For these stakeholders, efforts should focus on ensuring their satisfaction and encouraging their interest in greater participation, but without exerting excessive pressure. The third quadrant consists of stakeholders with low power and low interest. Their position should be monitored in case their power or interest changes. The effort required to communicate with them is minimal, but it is important to maintain contact through regular updates. The fourth quadrant contains stakeholders with low power but high interest. Active collaboration with these stakeholders is necessary to provide them with relevant information and keep them informed about opportunities to participate. The stakeholders in this group often come up with innovative solutions.

Prior to the start of the pilot project (in 2020), a general lack of interest and power among local stakeholders for active participation in water management was observed. The results of the workshops and interviews showed that the stakeholders of the upper Temenica River basin were mainly divided into the following groups.

I. Stakeholders with High Power and High Interest – Active Engagement

The Municipality of Trebnje and the Local Action Group (LAG) were key actors with sufficient interest and power to contribute to the project initiative for sustainable management of the upper Temenica River basin. Although their role was not very active before the year 2020, they had the authority to influence decisions and implement changes. These are two stakeholder groups that need to be actively involved in the decision-making process and have a leading role in the implementation of measures. Consequently, they were also the main drivers of project activities between 2021 and 2023.

II. Stakeholders with High Power and Low Interest – Satisfy and Encourage Interest

The identified stakeholders with high power but low interest include the state with its associated institutions and authorities as well as the regional development agencies. The state has considerable power through its institutions due to its formal role in water management. However, it shows little interest in addressing water management at the level of smaller river sub-basins such as the Temenica basin. Its efforts are primarily focused on drafting laws and guidelines for the management of larger spatial units (river basins) and it shows a lack of interest in taking a proactive role in addressing local water management challenges. There is also little to no interest in the management of the Temenica catchment at the regional level (development agencies). From a stakeholder management perspective, these stakeholders were identified as those that need to be satisfied and only involved in the management process if this is necessary to achieve the project objectives. At the same time, efforts should be made to find ways to encourage their active participation.

III. Stakeholders with Low Power and Low Interest – Monitor and Address Potential Changes

Before the project started, low-power and low-interest stakeholders included local residents, farmers, entrepreneurs, local associations and primary schools. These stakeholders lacked both power and influence over the river basin management and showed no interest in participating in the management process. This can be partly attributed to a lack of information and partly to a lack of incentives and concrete opportunities for participation. Dealing with these stakeholders involves monitoring their activities and engaging them through awareness-raising campaigns and participatory activities to encourage their interest and involvement.

IV. Stakeholders with Low Power and High Interest – Provide Relevant Information and Continuous Updates

Although the fishermen expressed a strong interest in improving the condition of the river, particularly fish populations, and a desire to participate in the protection of the river's ecosystem, they were categorized as stakeholders with low decision-making power before the project began. Their influence was limited to local initiatives, which is why they had to be regularly informed about activities in the Temenica River basin and involved whenever possible. The Department of Geography at the Faculty of Arts, University of Ljubljana also focused primarily on research and educational activities, which limited its direct influence on management decisions. However, it showed great interest in the involvement and implementation of participative water management measures based on scientific findings. These stakeholders require consistent communication, access to relevant information and efforts to involve them in the process whenever possible.

Figure 8: Matrix of stakeholder power and interest in the upper Temenica River basin after project activities (in 2023).

| | | | |
|-----------------------|------|---|--|
| P O W E R | high | II. high power/low interest – satisfy and stimulate interest <ul style="list-style-type: none"> • national authorities and agencies • regional development agency | I. high power/high interest – active engagement <ul style="list-style-type: none"> • municipality • LAG • university (Department of Geography, FA UL) • primary school |
| | low | III. low power/low interest – monitor activities <ul style="list-style-type: none"> • national interest groups • local residents | IV. low power/high interest – provide relevant information and updates <ul style="list-style-type: none"> • local associations • fishermen • farmers • entrepreneurs |
| | | low | high |
| | | INTEREST | |

The implementation of the LEADER/CLLD pilot project, which included a series of workshops, training sessions, and stakeholder networking, has significantly changed the stakeholder interest and power matrix (as of 2023). The project activities helped to empower (local) stakeholders, increase their interest in participating and increase their influence on the process of managing the upper Temenica River basin. As a result, the number of stakeholders in Quadrant I (high power/high interests) and Quadrant IV (low power/high interests) increased.

I. Stakeholders with High Power and High Interest

In addition to the Municipality of Trebnje and LAG STIK, the stakeholder quadrant was expanded with high impact and interest to include the local elementary school and the university (Department of Geography, FA UL). These stakeholders became key actors in the sustainable management of the upper Temenica River basin. The municipality and LAG recognised the importance of involving broader stakeholders and supported local initiatives. The Department of Geography, FA UL played an important role in empowering local stakeholders through research and educational activities. The primary school increased its power and interest by involving students in educational and awareness-raising projects about the Temenica River. These stakeholders should continue to be encouraged to actively participate and guide local initiatives. The LEADER/CLLD approach and the associated funding mechanism have proven to be effective in addressing the specific environmental needs of a particular area or local community (in this case the upper Temenica River basin). However, due to its structure and relatively limited financial support, the scope of activities it can support is limited.

II. Stakeholders with High Power and Low Interest

There have been no changes in this quadrant. The state and its agencies and institutions retained their formal power, but showed no interest in direct involvement in the management of smaller sub-basins, despite nominal support at local level. Its role remains limited. The management of this actor in the Temenica River basin continues to focus on fulfilling formal requirements, with no significant activation to be expected. The situation is similar at the regional development level, where participation in the management of water catchment areas is not yet a priority.

III. Stakeholders with Low Power and Low Interest

After the project activities, the number of stakeholders in this quadrant decreased, as most stakeholders developed a greater interest and shifted to another quadrant. The national interest groups and local residents remain in this quadrant. Due to the large number of similar river basins in Slovenia, the national associations are only marginally involved in the management of smaller river basins. Despite efforts to raise awareness through the project, not all locals have managed to get involved or recognize the importance of participatory management. Their participation should continue to be monitored to identify potential opportunities to increase their interest.

IV. *Stakeholders with Low Power and High Interest*

After the project activities, several local associations, fishermen, farmers and entrepreneurs showed a greater interest in participating. The fishermen and farmers began to better understand the impact of their activities on the river's water quality and ecosystem and acquired new knowledge to mitigate this impact. At the same time, they made valuable contributions with their expertise and experience and enriched the knowledge about the Temenica River. A local entrepreneur organized educational workshops on small wastewater treatment plants and linked his product or service to the local environment. Local associations also became more active, participating in the organization of events and encouraging wider public participation. These stakeholders should continue to be informed about future activities, receive relevant information about the river and its ecosystem and be encouraged to participate in the management of the upper Temenica River basin.

The pilot project led to considerable shifts in the matrix of interests and power of those involved. Local stakeholders such as the municipality, primary schools and LAG as well as the university — especially the geographers — gained more power and interest in participating in river basin management after the activities carried out. Primary schools and local associations have become vital pillars for future sustainable management, while farmers and fishermen showed increased interest due to concrete activities, they were able to carry out themselves. In the future, it will be crucial to continue to serve the most important stakeholders, to keep those with high interest but limited resources (financial and otherwise) well informed and to monitor those whose role is currently still limited.

8 DISCUSSION AND CONCLUSIONS

The pilot project on participatory management of the upper Temenica River basin has demonstrated that the involvement of local stakeholders and the application of interdisciplinary approaches based on collaboration and knowledge exchange play an important role in enhancing the sustainable management of small karst basins. These basins are particularly vulnerable to various anthropogenic pressures and climate change. Although there is strong support in principle for participatory river basin management at the national level, cross-sectoral activities have not yet been established, leaving the management of smaller basins to local communities. These communities often lack the necessary knowledge, data and approaches, prompting them to engage various experts for assistance. A geographical approach that focuses on a holistic analysis of the river basin, identifying hydrogeographic constants and water management challenges, combined with stakeholder engagement in the Temenica basin, proved to be effective. Only a comprehensive approach tailored to the unique characteristics of each river basin can effectively address multiple challenges simultaneously. Partial or segmented solutions run the risk of creating conflict between

stakeholders, leading to dissatisfaction. It is therefore important to address all aspects comprehensively and involve all stakeholders in the management process. However, stakeholder management is a long-term endeavor.

The upper Temenica River is in a poor ecological condition due to numerous anthropogenic pressures, the sensitivity of the river basin and its limited self-purification capacity, which urgently needs to be improved. Poor water quality, decreasing water levels and frequent fish kills make it clear that immediate action is needed to solve these problems. This situation is exacerbated by the lack of support from local residents, who feel increasingly disconnected from the river and do not perceive it as their own. As a result, improving the condition of the river is becoming a particular challenge. Educated and attentive young residents, together with other stakeholders, could play a crucial role in the transition to more sustainable river management.

Water management serves as a platform for innovation and testing new approaches to collaboration and decision-making. River basin management is effective when it addresses key water management challenges through a combination of bottom-up and top-down approaches. This allows the specific needs of each area to be addressed and encourages constructive interaction between stakeholders at different levels of governance, including government and civil society. In the Temenica River basin, the LEADER/CLLD approach, implemented through the Local Action Group (LAG), proved to be a suitable model. LAGs operate as spatial units on a sub-regional level, which we consider suitable for the implementation of activities in smaller river basins. Within LAGs, it is possible to address the specific needs and challenges of particular areas and local communities. The LEADER/CLLD approach is inclusive, encouraging participation and cooperation between different stakeholders. However, a major limitation is the modest financial support available for LEADER/CLLD projects, which limits the scope of activities that can be carried out.

The Municipality of Trebnje was the initiator of the activities in the upper Temenica River basin, while the process of involving various stakeholders in the participatory management of the river basin was carried out with the expert support of the Department of Geography, Faculty of Arts, University of Ljubljana. Educational institutions and local associations have proven to be crucial pillars for sustainable river management. Meanwhile, the interest of various stakeholders (farmers, fishermen, entrepreneurs and local residents) in sustainable, nature-oriented management of the Temenica River has increased due to concrete activities they can carry out themselves. When local stakeholders and actors participate in the decision-making and management of the river basin management, a sense of ownership over decisions and actions is created. This sense of responsibility motivates active engagement and improves understanding of the environmental challenges. In this context, empowerment means that residents not only accept decisions, but also actively participate in the implementation of measures and the solution of problems. This reduces the feeling of detachment

from their environment and increases support for environmental initiatives. Local residents gain valuable information and knowledge about the processes and challenges in their river basin. This collaboration goes beyond education and includes knowledge exchange between residents and experts (Mikolič et al., 2024). Experts can integrate this local knowledge into their analyses and planning, thus increasing the relevance and effectiveness of environmental measures. Participation promotes the co-creation of solutions and increases the likelihood that measures will be accepted and implemented in the long term.

For the long-term success of the integrated management of the Temenica River basin, it is essential to continue participatory activities and maintain strong networks between stakeholders at different levels. In the future, it will be crucial to steer the identified key stakeholders, including the municipality, the Local Action Group, the primary school and the supporting professional group of geographers. At the same time, it will be important to inform and engage those who have a strong interest but limited resources or authority, such as local associations, fishermen, farmers and entrepreneurs, while monitoring and addressing the needs of stakeholders at the national and regional levels who have not yet developed a systematic approach to managing smaller river basins. These sustained efforts will ensure continued collaboration and coordination among stakeholders and promote a more effective and inclusive water management process.

Comprehensive initiatives for participatory river basin management are rare in Slovenia, which underlines the importance of the Temenica River project. It is expected that a similar approach will gradually be adopted in other small river basins in Slovenia, as bottom-up participatory river management is gaining recognition worldwide. Given Slovenia's headwaters character, numerous small watercourses and geographical diversity, this approach is very suitable for the country. However, the implementation of this approach faces certain obstacles due to the administrative fragmentation of water areas into several municipalities and local action groups, the lack of an active role of the regional level, and the division of responsibilities between municipalities and the state in water management and spatial planning. Overcoming these obstacles — possibly even through legislative changes — will be necessary to achieve a more efficient and integrated water management in Slovenia. Future river basin management efforts must include knowledge transfer, exchange of best practices and scaling up of local initiatives within river basins, supported by broader political and financial mechanisms at national and (sub)regional levels. The objectives of participatory river basin management, community empowerment and a more integrated approach to natural resource management should also be included in legislation, e.g. the Water Act.

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