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Toward Flood Resilience in Serbia: The Challenges of an (Un)Sustainable Policy

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Abstract: In May 2014, Serbia was hit by a catastrophic flooding event. The Municipality of Obrenovac suffered severe consequences due to a number of reasons, mainly the poor conditions of flood protection infrastructure and outdated land use management. These problems have been triggered and/or affected by the post-socialist transition of Serbia, initiated during the 1990s. The ongoing period of socio-economic turbulences, also detected in other countries with a similar development background, caused a shift in both the planning paradigm and the economy (from a planned/centralized model to a market-oriented model), creating numerous problems related to the synchronization of legislation, governance, implementation and management. Considering the specificities of local context, as well as its similarities to other post-socialist countries, the main aims of the article are to establish a relationship between planning, legislation and flood resilience, identify its (un)sustainable elements and provide an insight into the dynamic of their causal links whose effectiveness could be improved in given conditions. The main findings indicate an absence of a sustainable policy which would guarantee efficient implementation (regarding both planning documents and laws). Simultaneously, there were other challenges—from the lack of risk assessment to outdated regulations and general unpreparedness which led to severe damage of urban systems and local economy, while many lives were lost. Consequently, the article provides guidelines for new planning documents, suggesting measures that would increase the resilience of flood protection (applicable in both local and regional context), as well as the overall sustainability of the analyzed area and its ecosystem.

Keywords: flood protection; resilience; planning process; legislation; sustainable land use; Serbia

1. Introduction

When Cyclone Tamara struck in May 2014, Serbia demonstrated itself to be unprepared. Heavy rainfall caused vast floods in the Balkans and the amount of rainfall ranged from 120 mm to over 200 mm in a three-day period. The cyclone-like features of rainfall led to flooding of an area of 20,000 km^2, which was unprecedented. According to Dragovic [1], floods recorded before May 2014 covered areas of several hundred to several thousand square kilometers, revealing low resilience and general unpreparedness for emergency situations in Serbia. Consequently, many urban and rural settlements suffered great material damage (up to 1.7 billion euros [2,3]) and 57 people lost their lives [4]. After the dismemberment of Yugoslavia, the successive governments payed little attention to disaster risk reduction and resilience. Therefore, 2014 floods came as a reality check and a warning for Serbia that settlement resilience must be improved nationwide. Currently, the Serbian Law on Disaster Risk Reduction and Emergency Management [5] defines resilience as a capability of a community exposed to hazards to respond to those hazards, to recover timely and efficiently while maintaining basic

functions. This definition, although adopted from the recently developed theoretical background, still has to be applied and verified in Serbian practice.

The modern meaning of resilience is defined by C.S. Holling as a measure of the persistence of systems and of their ability to absorb change and disturbance while maintaining the same relations between population or state variables [6]. Holling differentiates engineering and ecological resilience, defining engineering resilience as the capability of a system to return to a previous state of equilibrium after a disturbance [6]. In that case, resistance to shock and the speed of recovery are measures of resilience. Ecological resilience is different, as there are multiple states of equilibrium in ecological systems. Therefore, it is characterized by the ability to endure and capability to adapt.

Evolutionary, or socio-ecological resilience, rejects the idea about the states of equilibrium and advocates the idea that the nature of systems is such that they can change over time with or without the influence of external factors [7]. Three main characteristics define resilience: (1) the amount of change a system can take and maintain same control over function and structure; (2) the degree to which a system is capable of self-organizing; (3) the ability to build and increase learning and adaptation capacity [8–10]. Yosif Jabareen [11] argues that the main challenge is developing a multidisciplinary theory that integrates the vast diversity of urban dimensions, such as social, economic, cultural, spatial, environmental and physical infrastructure in a singular conceptual framework for understanding urban resilience.

When considering social systems, it is necessary to take various factors into consideration. Intentional human actions can influence the mutual functioning of system components. Interventions in processes can increase or decrease their resilience. Therefore, it is considered that resilience is the capability of individuals, communities, institutions, enterprises and systems to survive, adapt and grow despite all the chronic stresses and/or acute shocks that influence them. Chronic stresses like unemployment, inefficient public transportation, high crime rates, etc. especially weaken cities on a daily or cyclic basis, while sudden, severe events, like earthquakes or floods are considered as acute shocks. Consequently, the quality of systems that compose any urban settlement increases its overall resilience [11,12].

When it comes to resilience in the context of urban planning, John Friedmann states three objectives targeting its philosophical task, adaptability of planning practices and interdisciplinary transfer of knowledge and concepts [13]. Adaptation and planning for the unpredictable are qualities of the resilient approach to planning. Urban planning is authorities' and institutions' main tool for achieving resilience, and after it comes urban management. These two instruments must operate in coordination.

Considering the current state of research on resilience in the challenging post-socialist context of Serbia [14,15], which has been characterized by socio-economic turbulences affecting legislation, governance, implementation and management, this article aims to establish a relationship between planning, legislation and flood resilience, identify its main (un)sustainable elements and provide an insight into the dynamic of their causal links whose effectiveness could be improved in given conditions, both on the local and regional level. The selected case study was conducted in a very specific context of the Municipality of Obrenovac and one of its settlements which suffered the most—Braće Jugović, resulting in a list of guidelines for improving the resilience of medium size settlements vulnerable to river flooding (e.g., Obrenovac).

The experiences of Romania [16] and the Czech Republic [17], post-socialist countries which also identified floods as one of their main hazards, were considered in order to identify further possibilities for the improvement of planning efficiency in dealing with the prevention of floods and increasing flood resilience. The analysis conducted in this article also represents an insight into specific regional problems which have not been studied extensively, especially within the framework of resilience. For example, the study by Pudjak [18], conducted in Bosnia and Herzegovina, Croatia and Serbia (all exposed to the 2014 floods) detected policy issues in the governance of climate change adaptation resulting in increased and destructive occurrences of floods. They demonstrate the lack of capacity to tackle negative impacts of climate change on both the national and local level. This problem is

especially visible in a domain of policy reforms and their implementation, as well as in organizational terms—sector management and institutional fragmentation. Although positive changes regarding the legal framework of disaster risk reduction in Serbia have been initiated, Pudjak argues that a successful adaptation to climate change cannot be addressed solely on this level, but should also include prevention and community resilience.

The article consists of eight parts. The applied methodology and sources are presented after the introduction, while the third part presents the case study. The next segment is focused on legal framework and followed by the part dealing with the relationship between planning and resilience. Part six presents results, which are elaborated and discussed in the following section. The conclusion takes into consideration all the findings, compares them with two examples from the similar, post-socialist background and provides applicable guidelines for new planning documents.

2. Materials and Methods

A combined methodology of document analysis, a case study and interviews was used in this article. The relevant documents, their relationship and spatial/environmental effects (or lack thereof) considered two key periods (before and after the flood of 2014), as well as three governing and spatial levels—national, regional and local. This structure (Figure 1) enabled the evaluation of policy implementation and its (un)sustainability in terms of resilience. The before and after comparison provided an insight into the effects of the catastrophe, especially regarding different stakeholders and experts dealing with planning policies and legislation which should have increased the resilience of Serbian settlements. Two national laws on emergency management were considered: the one from the period before the disaster—The Law on Emergency Situations [19], and the one adopted after it—The Law on Disaster Risk Reduction and Emergency Management [5]. Additionally, an important regional document was analyzed to provide an insight into the hydrological issues of flood risks—The Kolubara River Basin Study [20]. The Spatial Plan of Obrenovac Municipality (SP) [21], as the most important local document published before the disaster, was studied along with the local Risk Assessment [22], published after the catastrophe.

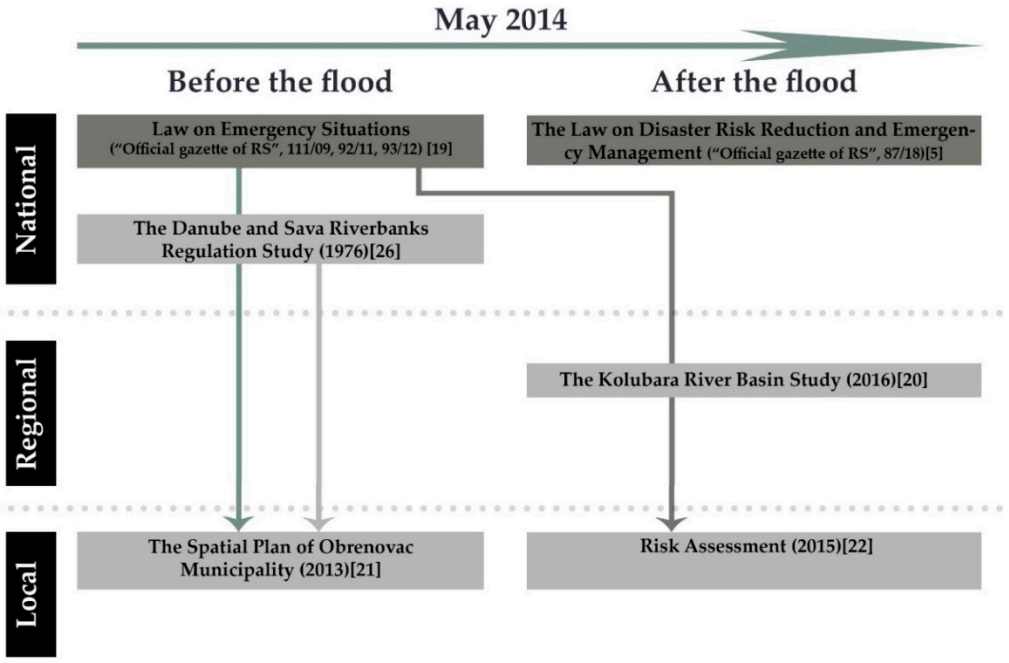

Figure 1. The diagram of the analyzed documents—spatial levels and time frames. Source: Authors.

The case study of Obrenovac is highlighted, focusing on its settlement which suffered the most—Braće Jugović. It illustrates the impact caused by inadequate land use management. The available

municipality budget reports (2014–2018) were analyzed in order to conclude how the resources were invested in improving flood resilience.

Further insight into the situation was provided by two interviews—with a local Civil Defense Department Inspector and a member of the Committee for Emergency Situations. They were conducted on 22 April, 2015, during the student workshop "Resilient Obrenovac" (personal data of both interviewees are available on request since only one of them approved to be listed with a full name in the final report [23]). They highlighted the decision-making problems which local agencies faced before the disaster (2009–2014), when many responsibilities were moved to the City of Belgrade, restricting the possible actions of the Municipality of Obrenovac. In 2017, the third interview was conducted with the president of the Citizens Association of Braće Jugović. During non-structured conversation, several questions relevant to the case study were answered, while also providing photographs, additional information and the Estimation of Damage and Repair Costs produced by the International Organization for Migrations (IOM) [24].

The data obtained for the case study included relevant information on all housing units (e.g., number of floors, floor area, age, quality, maximum water level during flood, degree of damage, photographs as well as an estimation of repair costs) [24] and the approximate data on the damage on the municipality level [2]. These data sets, gathered from freely available sources (e.g., the internet, IOM damage assessment conducted after the floods) enabled the analysis of the relationship between the housing stock age and the level of damage. The physical damage inflicted by flooding was identified by comparing the destroyed floor area and the total floor area, as well as the number of damaged housing units and total housing units. Furthermore, the flood impact in Braće Jugović and the Obrenovac Municipality were compared by highlighting the disaster impacts on both legal and illegal areas (Figure 2).

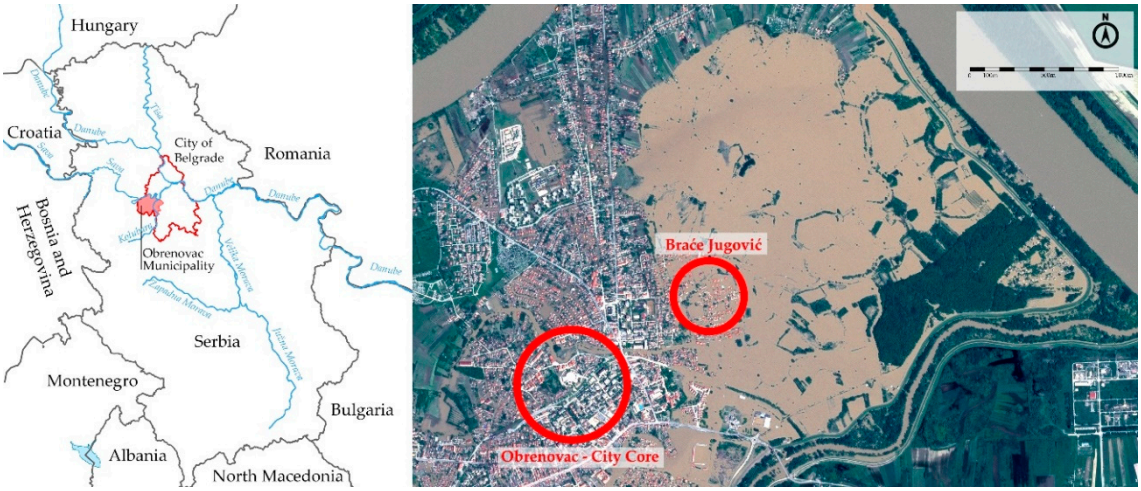

Figure 2. The position and aerial photo of the Municipality of Obrenovac and the settlement Braće Jugović (May 2014). Source: The Republic Geodetic Authority of Serbia, edited by the authors.

3. Case Study—Braće Jugović Settlement

Obrenovac is a town located on the confluence of the rivers Kolubara and Sava, representing a part of the larger Belgrade city area. Inhabited by approximately 25,000 people, it is located 35 km southwest of Belgrade. It belongs to the lower basin of the river Kolubara. The terrain configuration is mostly flat—about 76 m above sea level, with some areas declining to ≈72 m above sea level.

Braće Jugović represents a settlement built without legal permissions and plans, positioned in a close proximity to the urban center of Obrenovac. Its location was always considered problematic and inadequate, since it is positioned on low ground (ca. 72 m.a.s.l.), with high soil saturation due to high ground waters (circa 71 m.a.s.l.) (Figure 3). The first house was built in 1952 and its sprawl was

never regulated. Although vulnerable to all kinds of floods, it is now declared a residential zone by the Spatial Plan, because it was too costly and difficult to relocate it. Since it consists of good quality housing, it is currently in the process of obtaining formal legalization [21].

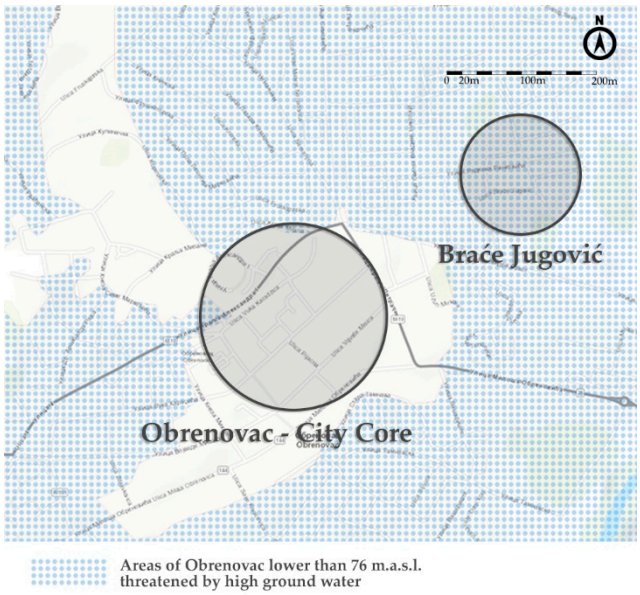

Figure 3. The areas of higher ground water. Source: The Republic Geodetic Authority of Serbia, edited by authors.

Positioned in the Kolubara basin, with many fast-flowing rivers converging in the Kolubara river on a relatively small area, Obrenovac is often exposed to flash floods (Figure 4). Furthermore, the Kolubara river flows into the river Sava just outside Obrenovac. This confluence is also in a plain, causing floods whenever the amount of water exceeds the flow capacity, while many anthropogenic factors reduce its receptive capacity—bridges, dumping, riverbanks, etc. Since the Kolubara basin is characterized by dense population and intense economic development, an adequate level of security in terms of flood protection was always needed. Due to frequent flooding events accompanied by significant damage, many infrastructural works have been undertaken during the last decades but the existing flood protection is not sufficient for the type of flooding that occurred in 2014 and is highly probable to occur in the future due to impacts of climate change.

Although some sections of the dike system protecting Obrenovac from the river Sava are not high enough, there are some with sufficient height, determined by the regulation study of the Danube and Sava riverbanks [26]. However, these flood protection structures were not designed to withstand the amount of water that occurred in 2014, and the consequences could be seen in the Kolubara flow chart (Figure 5). The chart compares the actual river flow (Q) in May 2014 (blue line), its hydrological calculation assuming that there was no overflow (red line) and hydrological calculation of the flow if all the water catchments planned by the Kolubara river basin study were built (green line) [20]. It could be noted that there is a significant drop in the amount of water at the 40th kilometer, which is the point where overflow started, mainly into the Kolubara coal basins.

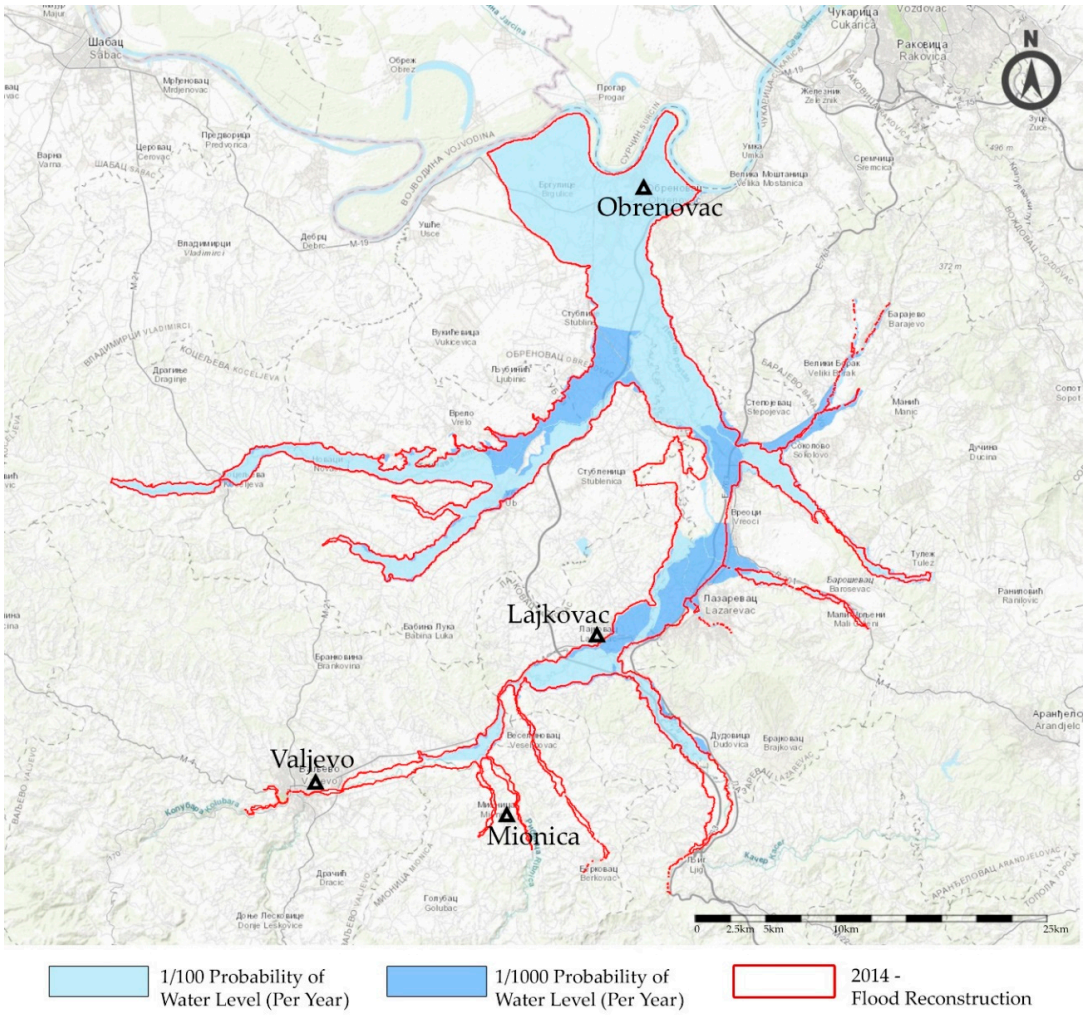

Figure 4. Kolubara basin—the areas of flood risk. Source: "SRBIJAVODE" Water Authority [25], edited by authors.

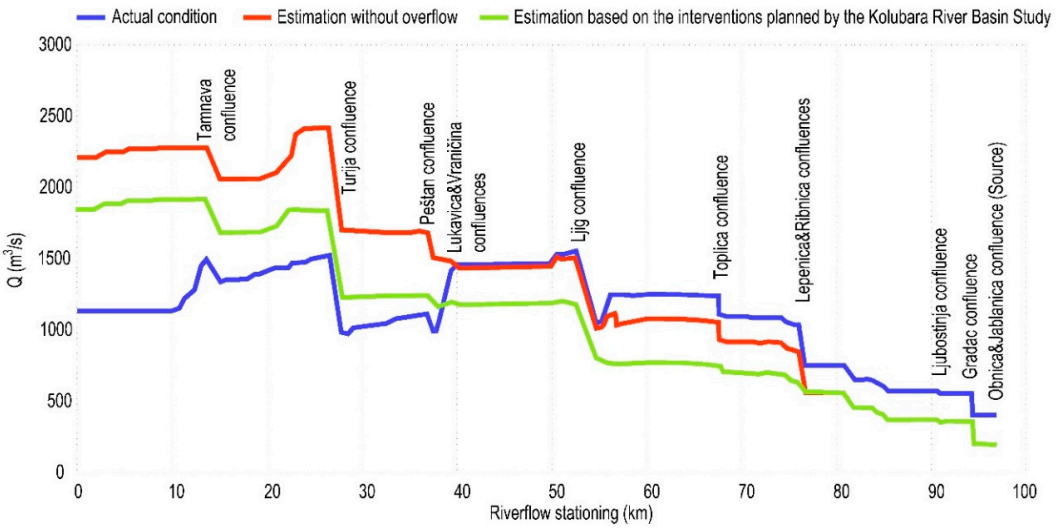

Figure 5. Kolubara flow chart (May 2014). Source: Institute for the Water Development "Jaroslav Černi", 2016 [20].

All watercourses of the Kolubara basin are flash flood prone. The threatened area measures around 17,000 ha, and is defended by 443 km of dikes and 89 km of riverbed regulations. Protection from flash floods on lesser watercourses is regulated by riverbed regulations and water canals. An important factor that increases the vulnerability of rural parts of Obrenovac is the Kolubara riverbed regulation located upstream, designed to protect the coal exploitation zones around the river. Since the downstream of the coal exploitation site is not regulated, and some areas, such as Poljane, Konatice, Draževac and Piroman (10,000 ha) are not protected at all, this zone represents the most vulnerable area which could be flooded in the case of an intense water discharge. The accumulation Stuborovni, located outside of the municipality, circa 15 km west from Valjevo, has special significance in flood protection, as it can efficiently lower the intensity of the flood wave. Also, nine lesser accumulations are planned in the Tamnava river basin (part of the Kolubara basin), but only one (Paljuvi Viš on the river Kladnica) was built when the Spatial plan [21] was approved. An external factor that also influences flood protection from the river Sava is the massive Djerdap hydropower plant, located on the Danube (the river Sava flows into the Danube). This hydropower plant is a dam and the speed of the flow of both the Danube and the Sava can be altered by the flow regulation of the hydropower plant itself.

The Obrenovac drainage system, consisting of nine drainage systems, covering 21,000 ha, with canal length totaling 267 km, requires complete reconstruction in order to increase its overall efficiency and sustainability—cleaning of canals, construction of lesser canals to complement the existing network, construction of pipe drainage where required, refurbishment of pumping stations, etc.

The first documented catastrophic flood occurred in 1926, when the flood spread across the entire valley, reaching 5 km around the riverbed in Obrenovac. In 1981, 20,000 hectares of agricultural land and 900 houses were flooded, while many communal and infrastructural object were damaged. In 2001 the upper basin was flooded, affecting Valjevo, Mionica and Lajkovac. In 2006, 3000 hectares and 280 houses were flooded in Obrenovac. A total of 1100 inhabitants were directly influenced. Four years later another flood occurred in Obrenovac, covering 2000 hectares and impacting 135 houses. Many rivers of the Kolubara basin have caused floods since 1999, including the rivers Tamnava, Ub and Gračica.

The severity of the problem was manifested in May 2014, when the catastrophic flood caused damage to the local population, livestock, agriculture, industry, infrastructure and environment. The assessed damage surpassed 1.7 billion euros, and many people and animals died [20]. The interviews conducted in 2015 also revealed that the proper understanding of roles and responsibilities regarding disaster preparedness and risk management was not evident at the municipal level prior to the 2014 flood. Also, after the flood, most decisions regarding flood relief were not made by the municipality itself, but rather by the higher levels of government and by people who did not have first-hand experience of the situation in Obrenovac, which presented a severe obstacle to improving the general sustainability of the whole system.

The impact of the 2014 flood was devastating, especially on the housing units in the settlement Braće Jugović (Table 1) [24]. All 126 housing units (100%) were affected by the flood. Furthermore, since they are mostly one or two stories high and water was exceptionally high in this part of Obrenovac, 96% of the total floor area was affected, while the rest of the municipality was affected on the ground floor level. The data also indicates that the settlement Braće Jugović has quality housing, as only 7% of total floor area was heavily damaged and 4% was destroyed.

Table 1. The impact level on housing stock, settlement Braće Jugović. Source: IOM [24].

	Floor Area	**Housing Units**	**% (Total Floor Area)**	**% (Housing Units)**
affected	17,182	126	96	100
heavily damaged	2035	15	7	12
destroyed	789	8	4	6

According to the data presented in Table 2, 60 out of 126 housing units were built before 1990, while 18 out of 23 heavily damaged or destroyed housing units are from this period. That means that 30% of all houses older than 1990 were severely affected. Out of the remaining number of more recent buildings (66), only 5 were severely affected, which is 8%.

Table 2. The flood impact on housing regarding the period of construction. Source: IOM [24].

	Housing Units	Heavily Damaged	Destroyed	% (Severely Affected)
older than 1990	60	13	5	30
younger than 1989	66	2	3	8

The flood impact in Braće Jugović and the Obrenovac municipality was also compared, indicating differences between unplanned/illegally built and planned areas. The approximate data on the damage on city level [2] was combined with data obtained from IOM sources [24]. In Obrenovac area (planned) 5292 housing units were affected. Out of those, 8% was heavily damaged (12% in the unplanned settlement Braće Jugović) and 2% was destroyed (6% in Braće Jugović). It is important to highlight that even when flooded houses did not suffer structural damage, their walls and floors got saturated, electrical installations of the flooded floors were permanently damaged, bathroom fixtures got clogged by mud and wooden doors in the flooded floors were destroyed. A similar situation was recorded in Braće Jugović settlement, including the damage of wooden windows, depending on the depth of floodwater. Furniture and home appliances were damaged or destroyed, too.

Data in Table 3 indicate the consequences of poor and unsustainable land use management since the higher share of damaged houses is located in Braće Jugović, the part of Obrenovac which was not developed in accordance with a spatial plan. Its unfavorable position with a low elevation significantly contributed to the devastating effect of the flood.

Table 3. The comparative data on the flood impact—housing, illegal vs. legal areas. Source: IOM [24].

Impact Level	Braće Jugović		Obrenovac	
	Housing Units (m^2)	%	Housing Units (m^2)	Housing Units %
affected	126 (17,182)	100	5292 (397,640)	100
heavily damaged	15 (2,035)	12	422 (34,060)	8
destroyed	8 (789)	6	120 (8,070)	2

4. Legal Framework

The Law on Emergency Situations [19], adopted in 2009, revised in 2011 and 2012, regulated the system for the protection and rescue of people, material, cultural goods and environment in the event of a natural disaster. It defined a set of preventive measures aimed at strengthening community resilience, the elimination of possible threats and disaster impact reduction. It introduced the principle of preventive protection, thus binding the national administration and local governments to implementation of preventive protection measures in accordance with their competencies. Preventive measures also included risk and vulnerability assessment measures for reducing different disaster risks. Regarding the implementation, this law remains largely focused on emergency response, while the concept of preparedness and risk reduction has still to be applied.

The main goals of the Law on Disaster Risk Reduction and Emergency Management [5], adopted in 2018, are: (1) comprehensive standardization of prevention measures and disaster risk reduction activities; and (2) efficient reaction in case of a disaster, as well as efficient elimination of disaster consequences in order to restore function as soon as possible. In accordance with these goals and with the Hyogo [27] and Sendai [28] frameworks, the focus is on the principles, planning documents, measures and activities which should contribute to an efficient disaster prevention, resilience and preparedness of communities and individuals.

There are not many differences between the 2009 Law on Emergency Situations and the 2018 Law on Disaster Risk Reduction and Emergency Management, but they do provide an insight into changed comprehension of disaster risks and the concept of resilience (Table 4). The solutions in the new Law are based on the ones from 2009, except for those that proved inefficient during the 2014 flood. The focus is shifted from protection and rescue activities to disaster risk reduction, prevention and preparedness, while the elements of climate monitoring and adaptation are introduced as a key element in this process. The rights and duties of all subjects in the system are now more precisely defined, local governments are identified as primary subjects supported by regional and national institutions and threatened communities have the right to take part in devising activities.

The relevant planning documents are better regulated, e.g., risk assessments and disaster risk reduction plans. For example, the Article 15 regulates the area of risk assessments, stating that they could be published by both national and local governments, as well as by special agencies dealing with rescue and protection operations, enterprises, vital facilities (schools and hospitals), universities, etc. They should be updated every three years or sooner, if required. The latest Risk Assessment on the national level was published in March 2019 [29], when it was adopted by the National Assembly of Serbia. The last Risk Assessment published by the Obrenovac local government is from 2015 [22].

The duties of local governments are regulated by the Article 29, which states that their most important role is the elaboration and publication of risk assessments, disaster risk reduction plans, protection and rescue plans on the local level. They are also obliged to plan and allocate funds for both disaster risk reduction and emergency management, as well as to establish local civil protection units and emergency management committees (required on all governing levels). The local committees are in charge of rescue and recovery operations, the evaluation of risk assessments and other relevant plans and reporting to the national level. Cooperation between local governments is highlighted, especially in the implementation phase.

The problems of resilience were considered in both laws [5,19], addressing the following issues:

1. Resilience to detected problems (i.e., identified threats)
2. Responsibility (institutions, levels of governance, etc.)
3. Approach / i.e., how are these threats tackled? (e.g., scale, intensity, prevention/reaction, modes of cooperation, etc.)
4. Modes of financing.

The basic definitions of threats, risks, catastrophes and risk assessment are similar in both laws, while more complex concepts are treated differently. For example, 2018 Law [5] defines disaster risk reduction as a policy established to prevent new and reduce existing risks by implementing integrated and inclusive measures that increase resilience and community preparedness and mitigate catastrophe consequences. Risk management is a way of dealing with identified risks by defining prevention measures, respectively increasing the preparedness of forces and subjects in charge for response and rescue operations. The Build Back Better (BBB) principle is also introduced as a part of disaster risk reduction and should be applied during the post-disaster reconstruction in order to make infrastructure and the community more resilient.

Table 4. Legal framework—the key differences between the Law on Emergency Situations [19] and the Law on Disaster Risk Reduction and Emergency Management [5].

Concept	Law on Emergency Situations, 2009, rev. 2011, 2012 [19]	Law on Disaster Risk Reduction and Emergency Management, 2018 [5]
Disaster Risk Reduction (DRR)	➢ DRR and RM are defined as one concept ➢ expert activities for risk reduction by systematic efforts to analyze factors that cause catastrophes and to handle them ➢ Civil protection citizen duties	➢ preventing new and reducing existing risks ➢ implementing integrated and inclusive measures that increase resilience and community preparedness ➢ mitigate catastrophe consequences ➢ Build Back Better (BBB) ➢ climate change monitoring and adaptation ➢ citizens take part in devising DRR policies
Risk Management (RM)	➢ Tackling threats identified by the local RA is a Local Government (LG) responsibility	➢ prevention measures and training forces for rescue and protection from risks identified by the Risk Assessment (RA) ➢ dealing with identified risks ➢ defining prevention measures for DRR ➢ increasing preparedness and response levels based on a relevant disaster risk assessment (RA) ➢ primary role in RM belongs to LGs, supported by regional and national institutions
Emergency management (EM)	➢ EM committee evaluates the RA	➢ EM committee evaluates and suggests improvements to the RA ➢ EM committee has the authority to suggest the proclamation of the state of emergency
DRR and EM funding	➢ LGs plan and determine sources of financing for rescue and protection activities and organizing civil protection units and their operation	➢ LGs plan and provide funds intended for DRR and EM
Focus	➢ Rescue and protection	➢ Risk reduction, prevention and preparedness

5. Planning (for) Resilience

5.1. The Spatial Plan of Obrenovac Municipality

The Spatial Plan of Obrenovac Municipality [21] was published one year before the 2014 flood, stating the integral management and a systematic control of natural conditions as one of its main goals which would create favorable conditions for the preservation of natural values, the environment, lives and material goods. Since floods and landslides are identified as the main threats, a large section of the plan is dedicated to the flooding hazard, while the absence of the municipal strategy for the defense from natural disasters is highlighted as one of the main weaknesses. In the same section, the plan states that the existence of irrigation and drainage canal network, as well as the flood protection infrastructure represent some of the main strengths, although their condition is described as having deteriorated due to the lack of maintenance. The Operational Plan for Flood Protection [30] is also mentioned as an overall national document on flood protection agencies, measures and infrastructure,

emphasizing that other documents for infrastructural development (e.g., urban regulation plans) were not created affecting the further implementation or lack thereof.

The Plan takes into consideration several problems: 1) the city territory is under threat from high water levels of both the Sava and the Kolubara rivers; 2) there are multiple lesser flood prone watercourses on the Obrenovac territory that often cause short term, but dangerous floods, jeopardizing the community, infrastructure, agriculture and dwellings; 3) due to low elevation and high ground waters, the drainage capacity of the soil is very low. Therefore, the Plan defines tasks required for the reduction of flood risk, such as the improvement of water canals, the construction of efficient drainage systems and anti-erosional works (e.g., forestation, anti-erosion grassing, terracing, riverbeds cleaning and others, as well as bans on deforestation, the exploitation of sand and gravel and harmful agricultural practices). Furthermore, it includes the introduction of water catchments and protected natural zones intended for flooding, as well as the construction of additional linear infrastructure (e.g., dikes and quays), new canals and pumping stations, covering an additional 4620 ha in the rural parts of the municipality.

The Plan does not consider the concept of resilience on a small scale (cadastral parcel level) and the flood protection measures prescribed in this plan are intended only for the city level. Although no urban water retention measures are suggested, it provides some building regulations addressing the construction in the proximity of flood protection structures, minimal distances (the position) allowed and prohibited functions of future buildings.

Addressing the disaster risk reduction, the Plan includes a goal related to the inclusion of integral management and the systematic control of natural conditions. Prevention, preparedness and response measures are emphasized as imperatives on all levels—the micro, local and national, as well as the enforcement of defense systems in terms of institutions, organizations and personnel. The establishment of a natural hazards' vulnerability cadaster is required in order to assess vulnerability levels correctly and define adequate mitigation measures. Finally, the Plan suggests an integral natural disaster protection strategy, as a necessary document for the further sustainable development and protection of the whole area.

5.2. Risk Assessment

After the 2014 catastrophic flood, the process of disaster risk assessment was initiated. As a result, a massive Risk Assessment document [22] was published in 2015 identifying all the hazards threatening the municipality. The document states that all settlements of the municipality are at risk of floods, due to its landscape and the number of rivers. The main threats represent the rivers Sava, Kolubara, Tamnava, and Peštan, where the latter three could also cause landslides. The chapter on hydrosphere hazards protection measures in urban plans and construction works refers to the Spatial Plan [21], providing only general guidelines to regulate the riverbeds in urbanized areas.

The Risk Assessment provides an explanation of the events that occurred in May 2014, stating that Obrenovac was flooded because many dikes were breached, especially those protecting from the rivers Kolubara and Tamnava and their tributaries. When evaluating the state of the flood protection system, the Risk Assessment (as well as the Spatial Plan) underlines its inability to fulfill the required protection criteria. Furthermore, the Risk Assessment explains possible threats caused by flooding events, emphasizing accidents in industrial facilities with dangerous materials which could cause fires and chemical spills. Landslides are also highly probable, while flood water retention in human settlements increase the possibility of an epidemic and epizootic. Considering this, the Risk Assessment includes data concerning risk management measures, human resources in charge of conducting the measures and required material resources and listing structures intended for flood protection, as well as protection and maintenance works.

According to this document, all water management issues, including flood protection infrastructure, are under the jurisdiction of the Republic of Serbia, being executed through the Ministry of Agriculture, Forestry and Water management, the regional secretariat, Local Governments and other state-owned agencies specialized for water management.

5.3. The Kolubara River Basin Study

The Kolubara River Basin Study [20] focuses on the concept of integral protection against floods providing measures related to settlements, agriculture, industry protection and their increased sustainability. The study deals with techno-economic, social and ecological perspectives and its goals are set to be implemented in a 20-year period, starting from 2015.

Obrenovac Municipality is situated in one of two sectors of the basin and the study indicates a significant decrease of maintenance regarding flood and erosion protection structures, especially during the last 30 years (coinciding with the dismemberment of SFR Yugoslavia). The document analyzes every structure, elaborating improvement guidelines and emphasizing the role of new accumulation and water catchment capacities in the Kolubara basin, which would respond to events similar to the 2014 flood (Figure 6). Consequently, the Study explores the possibilities for the construction of upper basin retentions, the application of anti-erosion measures and natural retention measures, as well as the reconstruction of dikes and embankments in order to obtain a necessary level of protection. The conditions for the construction of lower basin retentions were evaluated as being unfavorable, while 20 upper basin retentions on Kolubara tributaries, implemented in two phases (12 by 2025, and 8 by 2035), should reduce the maximum influx of water into the lower basin riverbed during extreme discharges. Apart from hydrological factors, the anthropogenic ones were also considered, suggesting alternative land use or new vegetation cover of the basin.

The Study also provides hydrographic simulations supposing that the proposed flood protection measures were constructed in 2014. These simulations show that the flood wave peak could have been lower by 10–15%. However, since during the flood when the Kolubara and Tamnava dikes were breached, it has been necessary to upgrade the dikes by increasing their height by approximately 2 m, which would withstand 1000-year waters ($Q_{0.1\%}$). Additionally, the crown width should be 6 m to allow access to mechanization during active flood defense. These dimensions would ensure protection from flows of 2300m^3/s which is more than the maximum flow of 1000-year waters (2250m^3/s). In order to increase the sustainability of proposed measures which would contribute to the wellbeing of the community and improve the ecosystem, a part of the study is dedicated to detailed cost/benefit and environmental analyses.

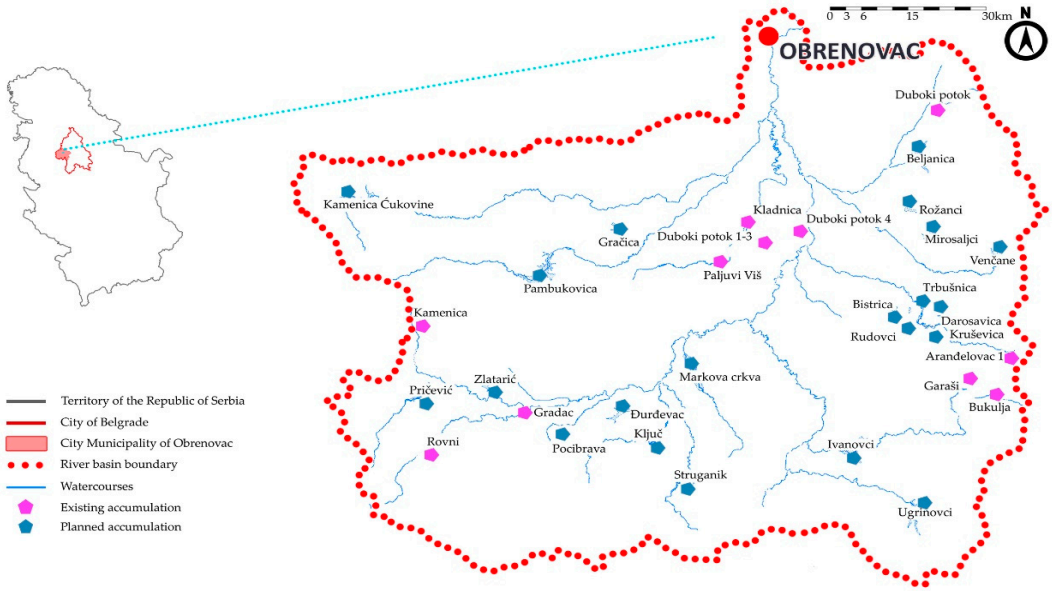

Figure 6. GIS visualization showing existing (magenta) and planned (blue) accumulations in the Kolubara river basin. Source: According to "SRBIJAVODE" Water Authority [25].

6. Results

The consequences of the 2014 flood had a significant impact on the shift of the legislative focus from the rescue and protection issues to risk reduction, prevention and preparedness, supported by the possibility of community participation. The introduction of the Build Back Better principle and climate change adaptation also presents an important (and highly necessary) step, although their implementation still has to be verified in practice. However, the refurbishment of the selected case area—the settlement Braće Jugović, which was conducted by the support of donations obtained before the 2018 Law on Disaster Risk Reduction and Emergency Management, did not respect this principle decreasing the overall quality of the settlement.

New legal framework also influenced establishment of Emergency Management Committee by the local government, in charge of both disaster risk reduction and emergency management. Before the flood, this body did not exist, and an ad hoc committee was set up when disaster struck. Nowadays, a permanent and institutionalized committee consists of 17 members selected among experts and public servant members of the municipal parliament which have the following responsibilities: (1) recommending the proclamation of a state of emergency; (2) managing and coordinating rescue operations, civil protection, recovery and reconstruction operations as well as rehabilitation operations following the principles of sustainable development and disaster risk reduction; (3) evaluation of risk assessments; (4) monitoring the condition and organization of the protection and rescue systems and proposing actions for their improvement; (5) informing and alarming the population about potential or impending threats and hazards; (6) organizing civil protection units; (7) delegating civil protection commissioners among the population; (8) cooperation with all governing levels and other municipalities; (9) informing the central Emergency Management Committee on local conditions; (10) commanding readiness in case of a potential emergency; (11) reporting to the Municipality annually; (12) other work in compliance with the Law.

The issue of financing was also reconsidered and remodeled after the flood. Apart from the recovery funds and the environmental protection funds (mainly intended for the remediation of the environmental effects of the Nikola Tesla power plant), the budget documents, available at the municipality's website, provide more information on the financing focused on resilience. Currently, Obrenovac has two sources: the municipality budget and external sources (e.g., donations) allocated in several categories: civil protection, emergency management, scientific conferences, projected capital expenditures in a 3-year period and urban planning projects focused on flood resilience.

In 2015 significant external sources (31 million dinars) were made available for urban planning projects focused on flood resilience. However, these funds are not detectable in the expenditures report. During the following years, circa 5 million dinars (0.3% of the municipality's budget) have been allocated for such projects—e.g., water canal and riverbed regulations (2015). In 2016, circa 16 million dinars, out of which 15.2 were external sources, were spent on further works on urban planning projects. In 2017, the level of municipal investments significantly increased, as circa 4.4 out of 4.7 million dinars intended were invested in water canals regulation, as well as the improvement and regulation of watersheds. In 2018 circa 400,000 dinars were spent on a hydrologic study for further watersheds regulation, while 100,000 dinars (less than 1000 €) were allocated for urban planning documents, possibly the preparation of the changes related to the General Plan of Regulation (as listed in the budget).

Before 2016, there were no funds intended for civil protection in the municipality budget. Since then, the annual finance plans have included them, but they cannot be always found in the final budget reports. Therefore, it is not possible to identify the outcome of planned costs. For example, in 2016 the financial plan allocated circa 1,600,000 Serbian dinars for civil protection, circa 17,192,000 in 2017 and circa 16,000,000 in 2018. In 2016 and 2017, the municipality of Obrenovac made circa 500,000 dinars available for emergency management, including delegation, training and equipment of subjects or Emergency Management Committee. The available data indicates that these funds were spent in 2017, as they appear in that year's expenditure report, which was not the case in 2016. Meanwhile, an annual international scientific conference has been organized in Obrenovac since 2015, focused on emergency

management (SeCMan: Security and crisis management—theory and practice) [31]. It has been funded yearly with circa 1 million dinars.

7. Discussion

The case of Obrenovac and its settlement Braće Jugović demonstrates all the weaknesses of a post-socialist transition reflected in a devastating situation of a natural disaster. The 2014 flood revealed all the consequences of poor maintenance, outdated planning, inefficient implementation and unsustainable management, while the upgrading of previous conditions and the improvement of flood resilience have become imperatives of future sustainability.

The 2013 Spatial Plan [21] included large-scale flood resilience measures, but it omitted elaborating the regulations on the level of a cadastral plot. Therefore, a new, updated plan should be produced integrating the knowledge from the Kolubara River Basin Study [20]. This document should also be considered during the development of new urban plans, even though many measures in the existing Spatial Plan coincide with the data from the Kolubara Study. For example, the criteria for the dikes to withstand the occurrence of $Q_{0.1\%}$ flows are in accordance with the Study, and these measures must be implemented. Also, the Spatial Plan suggests the construction of water catchments as parts of flood protection system, while the Kolubara Study further develops this idea.

In fact, the flooding of Poljane, Konatice, Draževac and Piroman (rural settlements in the Municipality of Obrenovac) was foreseen by the Spatial Plan. The amount of water discharged upstream, around the coal exploitation zones where the Kolubara riverbed is regulated, flooding villages downstream. After the break of the Tamnava dikes, the entire municipality area was flooded. The amount of rainfall was so high that the coal exploitation zone was flooded too. Therefore, it is not surprising that the Spatial Plan advocated for further progress of the regulation process of the Kolubara river and its tributary Peštan, which is currently in the process of implementation [32]. However, it should be noted that some flood protection measures were ignored by the Spatial Plan, such as urban water retention measures [33]. The Spatial Plan [21] also prescribes a minimum of 10 m^2 of public green space inside the settlement per inhabitant (circa 250,000 m^2) in the form of parks, squares, linear green surfaces along roads, woods, etc. Therefore, the further elaboration of documentation could introduce and integrate resilient principles of green spaces as water accumulations. Additionally, a new plan could provide better building codes and suggest mechanisms which would subsidize private home-owners and land developers to include small scale flood protection measures and urban water retention measures into future buildings and their gardens [33]. Also, future public spaces and vital facilities should be planned in a similar manner to increase flood resilience [34,35].

Although Braće Jugović does not have a high drainage potential in its soil and urban water retention measures are not very useful, they can help in reducing the level of water flow from the higher parts of Obrenovac. There are also other measures directly applicable in Braće Jugović, such as automatic barriers that are installed on gates, house and garage doors and windows. They would stop flood waters from intruding in homes to a certain degree, and in combination with all the other measures mentioned above, they would significantly reduce the impacts of a future flood similar to the one in May 2014. However, poor land use management remains one of major obstacles to a higher resilience in the Obrenovac municipality and the settlement Braće Jugović is not the only example. Poljane village also consists of houses built in an unprotected area with dikes and similar flood protection infrastructure and due to that, it was the first one to be flooded in 2014.

Considering this complex condition with low resilience, documents such as the Kolubara River Basin Study [20] and the Risk Assessment [22] should provide the input for the new Spatial plan. Before the Study was published, 10 small accumulations were implemented and Stubo-Rovni accumulation was completed shortly afterwards. It is significantly larger than others, with a capacity of 50,000,000 m^3. However, it should be emphasized that only four accumulations are integrated in the flood protection system, and their combined capacity is around 714,000 m^3. Curiously, only one of them was built for the purpose of flood protection, while others are intended for irrigation and recreation.

Out of the remaining seven, three were built with the flood protection purpose, but were not included in the protection system. The completion of the system of accumulations and water catchments defined in the study (Figure 6) is the absolute imperative in order to cope with future events similar to the 2014 rain surges. These structures should be built in accordance with the European Commission's initiative on natural water retention measures [34]. They are multi-functional and have multiple benefits such as flood risk reduction, water quality improvement, groundwater recharge and habitat improvement.

Meanwhile, the planning measures stated in the Risk Assessment [22] are general and apart from the guideline on the regulation of riverbeds, the document provides mostly recommendations. They are not directly applicable. As they require further elaboration by a third party (experts, institutions, planners and engineers). The document also includes local risk maps and identifies the lack of resilience regarding infrastructure, legislation and regulation. Its availability on the Obrenovac municipality website enables its wider dissemination, although its reach is rather questionable considering the fact that the large part of population is not digitally literate. However, this document is mostly intended for urban planners and other experts, as they should integrate it in all new plans and building regulations.

8. Conclusions

Since the 2014 disaster, there have been positive changes in flood risk management in Serbia. However, the general impression is that much more should have been done. The legal framework was adapted to comply with the Hyogo [27] and Sendai [28] frameworks, but there is an obvious lack of implementation. As explained earlier, bad land use management and a lack of citizen participation (local knowledge and timely information) in the planning and decision-making processes amplified disaster consequences. Incorporating local perceptions, interests, ideas and knowledge can be a meaningful and helpful step in future flood risk management. While Serbia was a part of the Socialist Federative Republic of Yugoslavia, planning was conceived as integrated planning, based on multi–disciplinarity and public participation [36]. After the dismemberment of Yugoslavia, transitional Serbia abandoned its good urban planning practices. Therefore, a "step back" would be beneficial in this case. Similar problems are identified in other post-socialist countries such as Romania [16] and the Czech Republic [17].

In Romania, the decisions on land-use regulations tend to be made by experts, usually from a remote workplace, and only occasionally the public is involved. Also, there is low level of implementation and the protection measures are scarce. Although a strategy that aims to improve the spatial planning and urban development was adopted, the results are not sufficient and visible. Meanwhile, the Czech Republic flood management is moving from flood protection to flood risk management by shifting hard structural to more natural solutions, resulting in a mix of technical and natural measures for flood control. Vávra et al. [17] argue that the top-down approach and difficult implementation of some regulations hinder this shift. In 2007 the Czech government adopted a plan for the main water catchments which financially favors natural over technical measures. In Serbia, a combination of hard structures and natural solutions is required in line with goals set in the Kolubara River Basin Study, aiming at the increased quality of local ecosystems.

In all three countries risk management is based on a top–down approach. This is a characteristic of post-socialist countries with a legacy of a centralized government, although the inclusion of community into decision making processes should be introduced as an imperative. However, the example of Braće Jugović settlement, also testifies that in some cases the role of authorities was not demonstrated in time, when illegal urban sprawl was initiated in a flood-prone area almost 70 years ago. The Czech Republic has identified a similar problem, which indicates that both countries need an update of a planning system able to adequately tackle the issue of flood risk and ensure the sustainability of proposed policies.

Considering the analysis presented in this article and the detected problems common for the countries from an ex-Yugoslav area and/or post-socialist background, it is possible to provide guidelines

which would increase the resilience of flood-sensitive areas both in the case of Obrenovac (Figure 7) and the post-socialist countries.

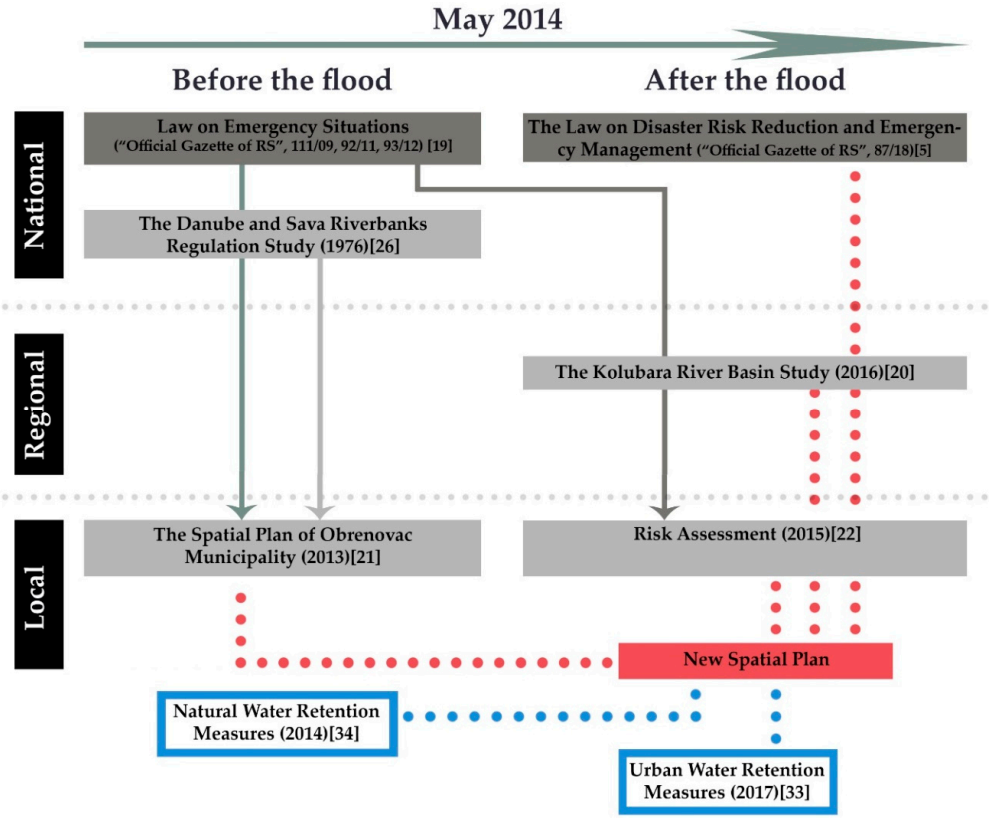

Figure 7. The diagram of recommended influences applied in the case of Obrenovac and its new spatial plan. Source: Authors.

These recommendations include following elements which contribute the overall sustainability of future policies, measures and their implementation, simultaneously targeting efficiency of land management and environmental protection:

- Inclusive planning, with a participative elaboration process;
- Focus on risk reduction, prevention and preparedness;
- Inclusion of climate change adaptation;
- Implementation of the Build Back Better principle;
- Introduction of natural water retention measures and urban water retention measures as integral features of new building codes and capital investments;
- Introduction of prevention and flood protection measures based on risk assessments and environmental studies;
- Flexibility and adjustability of a plan (regarding unexpected circumstances on all spatial levels affecting the implementation).

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