

POSSIBLE SPATIAL IMPACTS OF NATURAL AND OTHER DISASTERS ON THE DEVELOPMENT OF THE WIDER URBAN AREA OF THE GORENJSKA REGION

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Abstract: A wider urban area is a functionally connected gravitational zone encompassing one or more centers, characterized by daily population movements that generate significant traffic flows. It forms the core of functional urban areas, within which conurbations facilitate functional linkages between centers (SPRS 2050, 2023). In Slovenia, 11 wider urban areas have been officially defined. This paper examines the potential impacts of natural and other disasters on the development of the wider urban area of the Gorenjska region and the region as a whole. Some natural disasters stem from the effects of climate change, while others result from extreme weather events, earthquakes, or even potential terrorist activities. In certain cases, disasters may be triggered by a combination of factors, such as exceptional precipitation, pronounced temperature fluctuations, and seismic activity. To our knowledge, no comprehensive study has yet been developed to assess the vulnerability of the region's space and environment to natural and other disasters during peacetime. Additionally, there is a lack of a theoretical and methodological framework for integrating preventive spatial planning into disaster resilience strategies. This contribution serves as an initial step toward filling that gap.

Key words: wider urban area, natural and other disasters, (regional) spatial planning, Gorenjska region, Slovenia

MOGUĆI PROSTORNI UTIČAJI PRIRODNIH I DRUGIH KATASTROFA NA RAZVOJ ŠIREG URBANOG PODRUČJA GORENJSKE REGIJE

Apstrakt: Šire urbano područje je funkcionalno povezana gravitaciona zona koja obuhvata jedan ili više centara, a karakterišu je svakodnevna kretanja stanovništva koja generišu značajne saobraćajne tokove. Ono predstavlja jezgro funkcionalnih urbanih područja, unutar kojih konurbacije omogućavaju funkcionalne veze između centara (SPRS 2050, 2023). U Sloveniji je zvanično definisano 11 širih urbanih područja. Ovaj rad istražuje potencijalne uticaje prirodnih i drugih katastrofa na razvoj šireg urbanog područja Gorenjske regije, kao i regije u celini. Neke prirodne katastrofe proizlaze iz efekata klimatskih promena, dok su druge posledica ekstremnih vremenskih nepogoda, zemljotresa ili čak mogućih terorističkih aktivnosti. U pojedinim slučajevima, katastrofe mogu biti izazvane kombinacijom više faktora, kao što su obilne padavine, izražene temperaturne oscilacije i seizmička aktivnost. Koliko nam je poznato, još uvek nije razvijena sveobuhvatna studija koja bi procenila ranjivost prostora i životne sredine regije na prirodne i druge katastrofe u mirnodopskim uslovima. Takođe, nedostaje teorijski i metodološki okvir za integraciju preventivnog prostornog planiranja u strategije otpornosti na katastrofe. Ovaj doprinos predstavlja prvi korak ka popunjavanju te praznine.

Ključne reči: šire urbano područje, prirodne i druge nepogode, (regionalno) prostorno planiranje, Gorenjska regija, Slovenija

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1. INTRODUCTION

A wider urban area is a functionally connected gravitational zone encompassing one or more centers, characterized by daily population movements that generate significant traffic flows. It forms the core of functional urban areas, within which conurbations facilitate functional linkages between centers (SPRS 2050, 2023). In Slovenia, 11 wider urban areas have been officially defined, of these, 3 are of national and 8 are of regional importance. In this paper, we discuss the wider urban area of the Gorenjska region, which is a wider urban area of regional importance.

In this paper we would like to draw attention to another aspect that has not yet been given its due place in the field of spatial planning in general, as well as in the case of the preparation of expert documents and spatial planning acts in the Gorenjska region. This concerns the potential impact of natural and other disasters on the development of the wider urban area of the Gorenjska region and the Gorenjska region as a whole. To our knowledge, no project has been developed so far that would comprehensively address the vulnerability of the region's space and environment to potential natural and other disasters in peacetime, and which would at the same time propose a theoretical and methodological framework for the development of a so-called preventive spatial planning.

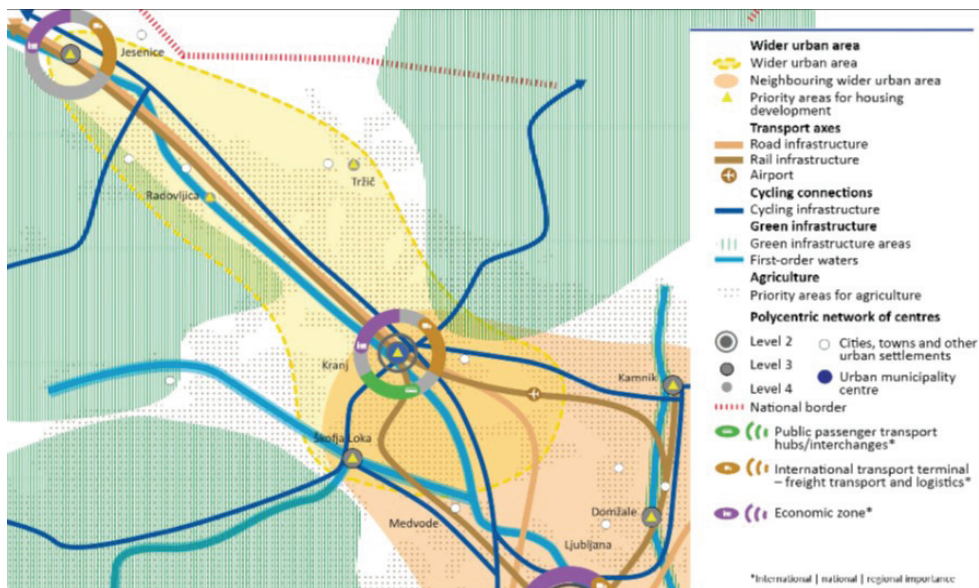


Figure 1. Wider urban area of the Gorenjska region (Source: SPRS 2050, 2023).

2. SITUATION ANALYSIS

Some of the potential natural disasters can be attributed to the impact of climate change, but others can also be attributed to extreme weather events, earthquakes and possible terrorist activities. However, it is also possible that two or more factors (e.g. extreme precipitation events, extreme temperature fluctuations and an earthquake) may have an impact on the occurrence of a potential disaster at the same time.

The Gorenjska region has a number of vulnerable areas which, in the event of extreme events (earthquake, flood, landslide, structural collapse and/or terrorist acts), can trigger a number of negative impacts on the space, environment, population and economy. Let us highlight just some of them in the context of the wider urban area of the Gorenjska region. In the field of transport infrastructure: motorway viaducts (Lešnica, Ljubno, Peračica, Moste, etc.) and tunnels (Karavanke, Ljubno, etc.); the Moste railway bridge and the Karavanke tunnel; Ljubljana International Airport, etc. In the field of energy infrastructure: Kavčke barrier (Moste hydroelectric power station), Završnica hydroelectric power station barrier. In the field of exceptional natural events: the Urbas landslide above Koroška Bela in Jesenice.

In this context, we would like to highlight the risk of terrorist acts, which could pose a serious threat to the above-mentioned infrastructure facilities as well as to the settlements in their vicinity. Although Slovenia is not particularly exposed to such acts, its situation may start to change rapidly in the light of current security developments in Europe and beyond. Potential transport of military equipment and troops could practically overnight tighten security conditions and increase the vulnerability of key infrastructure to potential terrorist/war acts, which could also cause significant damage to the local population, settlements and infrastructure.

In presenting the risk assessments for the collapse of the Kavčka barrier (Moste hydroelectric power station) and the Završnica barrier, we will draw on the findings of the task "Safety analysis of the Moste-Završnica barrier system" (Kete, 2015), which was based on the use of the record sheets prepared in the framework of the VODPREG project (Kryžanowski et al., 2012). In Tables 1 and 2, we present a tabular representation of the final risk assessment for both of these barriers.

"The Moste barrier, according to the subdivision used in the VODPREG project, represents a medium risk for the surrounding area, but due to the size of the reservoir and the barrier itself, we would expect the barrier to fall into the high risk area. Table 1 shows that the most significant risk is posed by the basic parameters of the barrier and the risk arising from the operation of the barrier. This is understandable as the Moste barrier is currently the largest in Slovenia with a height of 60 metres and the storage behind the barrier is also quite large. As it is located upstream of the Sava River, the characteristic flows are relatively low, although they pose a disproportionately higher risk to the population and infrastructure downstream than would be expected according to the methodology. The state of documentation poses a low risk: the state of documentation is relatively regulated and the documentation is maintained by the dam operator. The operator also carries out regular measurements and inspections of the barrier facility and compiles the findings in annual reports. These reports are used as a basis for the preparation of a maintenance programme for the facilities and equipment, which forms the basis for the works to be carried out. Maintenance is carried out on a regular basis and the condition of the facilities and equipment does not pose a significant risk" (Kete, 2015: 48).

A possible breach of the barrier would flood the settlements of Lancovo, Podnart, Gobovce and Zasip, while industrial facilities in Kranj on the left bank of the Sava would also be at risk. It would also destroy the road bridges over the Sava at Radovljica and Bled (Kete, 2015: 31).

Possible spatial impacts of natural and other disasters on the development of the wider urban area of the Gorenjska region

Table 1. Final risk assessment for the Kavčke barrier (Moste hydroelectric power station)
(Source: Kete, 2015: 48)

Evaluation criteria	Overall evaluation score	Low risk	Low to medium risk	Medium risk	Medium to high risk	High risk	
A) Basic barrier parameters	24	10 - 13	14 - 18	19 - 24	25 - 31	32 - 40	Medium risk
B) Status of project and operational documentation	12	10 - 13	14 - 18	19 - 24	25 - 31	32 - 40	Low to medium risk
C) Operation	16	14 - 17	18 - 23	24 - 31	32 - 42	43 - 56	Low risk
D) Risks	44	16 - 20	21 - 26	27 - 36	37 - 49	50 - 64	Medium to high risk
E) Condition of facilities and equipment	34	14 - 17	18 - 23	24 - 31	32 - 42	43 - 56	Medium to high risk
Overall assessment	130	64 - 79	80 - 105	105 - 140	141 - 191	192 - 256	Medium risk

Table 2. Final risk assessment for the Završnica barrier (Source: Kete, 2015: 49)

Evaluation criteria	Overall evaluation score	Low risk	Low to medium risk	Medium risk	Medium to high risk	High risk	
A) Basic barrier parameters	34	10 - 13	14 - 18	19 - 24	25 - 31	32 - 40	High risk
B) Status of project and operational documentation	26	10 - 13	14 - 18	19 - 24	25 - 31	32 - 40	Medium to high risk
C) Operation	26	14 - 17	18 - 23	24 - 31	32 - 42	43 - 56	Medium to high risk
D) Risks	42	16 - 20	21 - 26	27 - 36	37 - 49	50 - 64	Medium to high risk
E) Condition of facilities and equipment	18	14 - 17	18 - 23	24 - 31	32 - 42	43 - 56	Low to medium risk
Overall assessment	146	64 - 79	80 - 105	105 - 140	141 - 191	192 - 256	Medium risk

“The Završnica barrier poses a higher risk to the surrounding area than the Moste barrier, according to the VODPREG division, but mainly due to the fact that no demolition project has been carried out and due to the lack of some data. In addition, some documents do not exist or are outdated. For these parameters, we have assigned the lowest score because it is difficult to assess what risk they pose to the surroundings. From Table 2 we can see that the basic parameters represent a high risk, but the assessment can be improved by

obtaining the missing data. The state of the design and operational documentation represents a medium risk, but the development of a demolition project and an action programme for information and alerting would drastically reduce the score. The risk parameter could be reduced by establishing remote monitoring and a demolition project identifying the risk to downstream settlement areas. The operational parameter could be improved by setting up an alert and notification system and a system for measuring hydrological quantities. The condition of the facilities and equipment is on the borderline between low and medium risk, so the assessment is very realistic given the condition and role of the facility” (Kete, 2015: 49).

For the Završnica barrier, no demolition project has been carried out, so it is not precisely defined, what the risk is to settlements, infrastructure and other downstream facilities. For this reason, the risk assessment for the basic parameters factor of the barrier was given a high risk rating (Kete, 2015: 43).

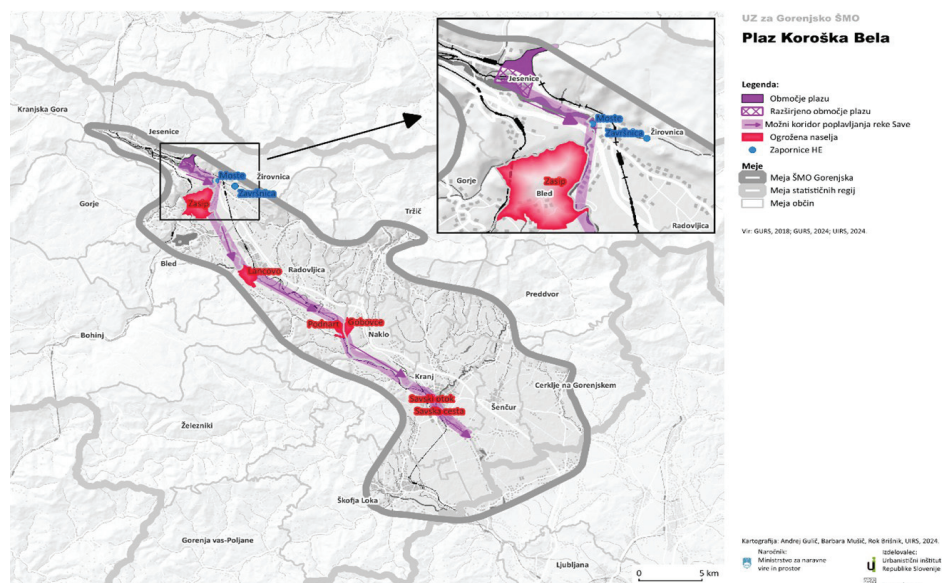


Figure 2. Schematised cartographic representation of the potential spatial impacts of the Urbas landslide triggered above Koroška Bela and of the potential breach of the Kavčke (HE Moste) and HE Završnica dams

The third of these factors, which could threaten human life, human settlements and infrastructure, is the active landslide Urbas above Koroška Bela. The threat to the settlement of Koroška Bela is real. Systematic monitoring of the avalanche is carried out on a regular basis. “The containment capacity of the currently existing facilities totals 6,500 to 7,000 cubic metres and is intended only for the containment of material in the event of minor torrential events. Based on the results of modelling and reconstruction of historical events, the estimated volume of material that can be mobilised is between 100,000 and 400,000 cubic metres (even more in extreme but less likely events), as the Bele stream channels alone contain between 25,000 and 170,000 cubic metres of active and potentially active material that can be mobilised as mass flow” (Peternel, 2023).

Possible spatial impacts of natural and other disasters on the development of the wider urban area of the Gorenjska region

However, construction and technical measures are needed to ensure greater safety for the inhabitants of the settlement. "Among the most important are the construction of a barrier or breaker of the gravel flow on the Bela stream, downstream of the tributary of the Čikla stream, and the arrangement of a system of catch net barriers in the Čikla stream bed, regulation of spring or surface water in the central and lower part of the Urbas landslide and at the Urbas springs and the spring on Olipa planina, drainage measures at the Urbas landslide, anchoring of the limestone block at the Čikla landslide" (Peternel, 2023).

The potential risks to the population, settlement and infrastructure considered (in this context, we deliberately do not include environmental aspects, which are very important) are presented in a schematised cartographic form in Figure 2.

3. CONCLUSIONS

In the introduction of the paper we already stated that to our knowledge no task has been developed so far that would comprehensively address the vulnerability of the region's space and environment to potential natural and other disasters in peacetime and that would at the same time propose a theoretical and methodological framework for the development of a team of preventive spatial planning.

Preventive spatial planning could make a significant contribution to reducing the vulnerability of the Gorenjska Region and the region as a whole to natural and other disasters. The most important features and usefulness of this type of planning include:

1. Risk anticipation and management

- Risk assessment and analysis: Preventive spatial planning involves a thorough assessment and analysis of various risks, such as natural disasters (floods, landslides, earthquakes) and man-made threats (industrial accidents, terrorism). This enables the identification of potentially dangerous areas and the preparation of appropriate protective measures.
- Exposure reduction: Carefully planned land use reduces the exposure of people and critical infrastructure to risks. For example, building in areas prone to flooding or landslides is avoided and development in safer areas is encouraged.

2. Sustainable development

- Alignment with environmental objectives: Preventive spatial planning supports sustainable development by taking into account environmental constraints and natural features. This includes the conservation of natural resources, the protection of ecosystems and the promotion of the use of renewable energy sources.
- Integration with spatial and environmental policies: Planning is coordinated with other spatial and environmental policies and legislation, contributing to the integrated and coordinated development of areas.

3. Increasing resilience and adaptability

- Building resilient settlements: Preventive spatial planning contributes to building settlements that are resilient to different hazards. This includes designing infrastructure that is adapted to extreme weather conditions and introducing green infrastructure such as water retention basins and urban forests.
- Adaptability to change: Planning allows for resilience to long-term changes such as climate change through appropriate land-use planning and urban design adaptations.

The development and application of preventive spatial planning would be most appropriately initiated at national and regional level, in the context of the update of the SPRS 2050 (MNVP, 2023) and the preparation of regional spatial plans. In this case, the preparation of a regional spatial plan for the Gorenjska region. This is a developing area of research and planning (King et al., 2016; Saunders et al., 2016; Australian Disaster Resilience Handbook Collection, 2020; Falasca et al., 2024; Junger et al., 2024) that would be useful to familiarise oneself with and to start using.

LITERATURE

Australian Disaster Resilience Handbook Collection (2020): Land Use Planning for Disaster Resilient Communities. Melbourne, AUS.

Falasca, F. idr. (2024): Addressing land use planning: A methodology for assessing pre- and post-landslide event urban configurations. *Science of the Total Environment* 921 (2024) 171152.

Junger, L., Seher, W. (2024): Mitigating the levee effect – Spatial planning approaches to address residual risk. *Progress in Disaster Science* 23 (2024) 100355.

Kete, A. (2015): Analiza varnosti sistema pregrad Moste-Završnica. Diplomaska naloga. Univerza v Ljubljani, Fakulteta za gradbeništvo in geodezijo. Ljubljana.

King, D. idr. (2016): Land use planning for disaster risk reduction and climate change adaptation: operationalizing policy and legislation at local levels”, *International Journal of Disaster Resilience in the Built Environment*, Vol. 7 Issu 2 pp.

Kryžanowski, A., Širca, A., Humar, N., Ravnikar Turk, M., Žvanut, P., Četina, M., Rajar, R., Detela, I., Polič, M. (2012): Zemeljske in betonske vodne pregrade strateškega pomena v RS – VODPREG. Razvojno raziskovalni projekt. Republika Slovenija, Ministrstvo za obrambo. Ljubljana.

MNVP - Ministrstvo za naravne vire in prostor (2023). Strategija prostorskega razvoja Slovenije 2050 / Spatial Development Strategy 2050. Uradni list Republike Slovenije, t. 72 / 3.7.2023. Ljubljana.

Peternel, U. (2023): Geologinja: Koroška Bela ostaja ogrožena. Intervju z dr. Tino Peternel. *Gorenjski Glas*, 12. september 2023. Dostopno na: <https://www.gorenjskiglas.si/article/20230912/C/230919960/1004/geologinja--koroska-bela-ostaja-ogrozena> (downloaded 03.08.2024).

Saunders, W.S.A. idr. (2016): Innovative land use planning for natural hazard risk: A consequence driven approach from New Zealand. *International Journal of Disaster Risk Reduction*, Vol. 18.