REPUBLIKA SLOVENIJA
MINISTRSTVO ZA OKOLJE IN PROSTOR
DIREKCIJA REPUBLIKE SLOVENIJE ZA VODE

Hajdrihova ulica 28c, 1000 Ljubljana

PROGRAM SODELOVANJA INTERREG V-A SLOVENIJA HRVAŠKA 2014-2020

PROJEKT: **FRISCO 1**
ČEZMEJNO USKLAJENO SI-HR ZMANJŠEVANJE POPLAVNE OGROŽENOSTI - NEGRADBENI UKREPI

NASLOV ŠTUDIJE: **CELOVITA ŠTUDIJA ZMANJŠEVANJA POPLAVNE OGROŽENOSTI ZA ČEZMEJNO POREČJE REKE SOTLE**

MEJNIK 2: **Analiza obstoječega stanja**
Oblikovanje in analiza alternativnih rešitev

AKTIVNOST: **Analiza alternativnih rešitev 1.faza**

FAZA POROČILA: **ZAKLJUČNO POROČILO**

ŠT. POGODBE: **2555-17-430013**

VODJA DELOVNE SKUPINE ZA SOTLO, PREDSTAVNIK VODSTVA PROJEKTA FRISCO1 PO PN ZA IZDELAVO ŠTUDIJE: **ALENKA ZUPANČIČ**

ZA DRSV ODGOVORNA PO POGODBI: **STANKA KOREN**

KRAJ IN DATUM IZDELAVE NALOGE: **Ljubljana, marec 2018**

NAROČNIK:	Republika Slovenija Ministrstvo za okolje in prostor **Direkcija Republike Slovenije za vode** Hajdrihova 28c 1000 Ljubljana
VSEBINA DOKUMENTACIJE:	**FRISCO 1** **Čezmejno usklajeno slovensko-hrvaško zmanjševanje poplavne ogroženosti za čezmejno porečje reke Sotle**
VRSTA PROJEKTNE DOKUMENTACIJE	**Elaborat**
ŠT. DOKUMENTA.:	**J36/17**
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DOKUMENTACIJO IZDELAL:	**IZVO-R , projektiranje in inženiring d.o.o.** Pot za Brdom 102, 1000 Ljubljana **DHD d.o.o.** Praprotnikova 37, 2000 Maribor
VODILNI PARTNER:	**HIDROSVET d.o.o.** Kidričeva 25, 3000 Celje, **Direktor:** **Branko SKUTNIK**, univ.dipl.inž.gradb.
KRAJ IN DATUM IZDELAVE NALOGE:	**Ljubljana, marec 2018**

2 IZDELOVALCI NALOGE

FRISCO 1
TEHNIČNA POMOČ V IZDELAVI CELOVITE ŠTUDIJE ZMANJŠEVANJA POPLAVNE OGROŽENOSTI ZA ČEZMEJNO POREČJE REKE SOTLE

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1. UVOD

Iz projektne naloge v poglavlju 2.2.2 **Analiza alternativnih rešitev** izhaja, da je v prvi fazi treba izdelati preliminarno analizo alternativnih rešitev na osnovi prve faze modeliranja in ocene poplavne ogroženosti, da bi lahko izdelali nadaljnji pregled potencialnih ukrepov in oceno izvedljivosti potencialnih kratkoročnih ukrepov, ocenjenih kot "no-regret" ukrepi.

Obstoječe stanje je bilo iz hidrotehničnega vidika obravnavano v poročilu »Hidravlična analiza, 1.faza« (DHD d.o.o., IZVO-R d.o.o., HIDROSVET d.o.o., št. projekta: 16/2017, 2017), ki je bilo izdelano v sklopu tega projekta. Kot podlaga za določitev dodatnih alternativnih rešitev je bil dne 14.11.2017 organiziran ogled terena, kjer so bila s strani hrvaških območnih strokovnjakov predstavljena poplavno ogrožena območja na levem bregu Sotle. Dodatne alternativne rešitve so tako bile izdelane na osnovi terenskega ogleda ter na podlagi hidravlične analize 1. faze, ki je bila izdelana na osnovi ekspertnega mnenja.

Partnerji v projektu so se odločili, da se prva faza hidravlične analize ne bo izvajala (ker preliminarni 1d model ni bil izdelan). Izvajalci tehnične pomoči ugotavljajo, da druge ustrezne metode za analizo poplavne ogroženosti in oceno izvedljivost možnih preverjenih kratkoročnih ukrepov ni.

Na osnovi obstoječih podatkov in obstoječih hidravličnih modelov (ki jih ni), v tej fazi zato ni možno izdelati analiz, ki so zahtevane v projektni nalogi.

V mapi Oblikovanje altenativnih rešitev 1. faza je tako podan nabor potrebnih ukrepov na porečju Sotle. S strani delovne skupine je bil ocenjen kot "no regret" ukrep - Sanacija pregrade Vonarje, ki ga predlagamo kot kratkoročni ukrep za nadaljne financiranje v okviru projekta FRISCO.

V nadaljevanju podajamo opis projekta Sanacija pregrade Vonarje v angleškem jeziku.

Frisco1
Cross – border cooperation for flood risk reduction

Interreg SLOVENIJA – HRVAŠKA SLOVENIJA – HRVATSKA
Evropska unija | Evropski sklad za regionalni razvoj
Europska unija | Europski fond za regionalni razvoj

Preliminary Project Description_

Vonarje/Sutlansko jezero

Contents

1 INTRODUCTION

The Sutla River in most of its flow forms the border between the Republic of Slovenia and the Republic of Croatia. The Sutla River is a left tributary to the Sava River near the settlement of Ključ Brdovečki (Croatia) i.e. Rigonce (Slovenia). It is 92 km long, and has a catchment area of 590 km^2.

In the north, the Sutla River basin borders with the Dravinja River basin, in the west with the Savinja River basin, and in the east with the Krapina River basin. Its catchment surface is very unsymmetrical; its right tributaries on the Slovenian side are very dominant, whereas its left tributaries on the Croatian side are very short with small catchment areas.

In the upper part of the river basin on the Slovenian side there are several smaller right tributaries, and the Mestinjščica Stream is a large right tributary near the settlement of Podčetrtek (Harina Zlaka in Croatia) Downstream towards Kumrovec there are larger tributaries: Tinski Stream that flows into Mestinjščica immediately prior to the Sutla estuary), Buča Stream and significant right tributary the Bistrica Stream. After Bistrica estuary, the Sutla River passes through Kumrovečko polje and the narrow Zelenjak valley between the Hills of Bizelj and Cesargradska Mountain, and it flows southward across the alluvial plan with larger tributaries: the Dramlja Stream and Bizeljsko Stream.

On the river basin's left side on the territory of Croatia, Sutla mostly flows along the foothills and cuts into smaller valleys only in certain places. All its left tributaries are short and characteristically torrential with expressed riverbed erosion. Larges tributaries on the Croatian side are the Škrnik, Kladnik and Razvor Streams in the area of Kumrovec, the Čemehovec Stream in the area of Kraljevec na Sutli and the Dubravica Stream.

In its upper course, the Sutla River has a large longitudinal slope and torrential flow, whereas in its middle part the longitudinal slope rapidly declines and transforms into lowland flow with large meanders.

The Sutla riverbed is characterized by thick vegetation (trees and brushwood) in most parts of its flow, which causes the formation of "clogs" that cause local flooding during high water levels in the Sutla River. Likewise, the riverfrequently erodes its banks in river bends, which causes significant meandering as well as damages to the surrounding lands.

The Sutla River overflows its banks during high water levels almost along its entire course and it floods surrounding areas both on the Croatian and on the Slovenian side. Certain hydraulic structures were constructed during the past few years in certain parts alongside settlements and roads in order to minimize flood damages.

The following locations are at risk of flooding on the Croatian side:

- Section from border crossing Harmica (Zaprešić-Dobova road) until railway track Zagreb-Ljubljana, where there is no constructed embankment. Several family houses in that part which are surrounded by railway embankments and the Sutla River are at risk in this part,
- The settlement of Gmajna in Kumrovec where several residential and commercial buildings are at risk during high water levels,
- The settlement of Plavić, where local road L22026 is closed during high water levels,

- The settlements of Bratkovec, Luka Poljanska and Harina Zlaka, where several residential and commercial buildings are at risk during high water levels,
- The section upstream and downstream from the border crossing Hum na Sutli where several residential and commercial buildings as well as a kindergarten are at risk during high water levels.

The following locations are at risk of flooding on the Slovenian side:

- Road to border crossing Orešje,
- Buildings in the settlements of Bračna Vas, Gregovce, Nova vas, Rigonce, Loče,
- The area of Rogatec in the part along the border crossing Hum na Sutli,
- Part of inhabited area in the municipality of Podčetrtek.

2 VONARJE DAM – description of current situation

Sutlansko Lake/Vonarje dam is located upstream from where Mestinjščica flows into the Sutla River, in the area of the municipality of Podčetrtek (Slovenia) and the municipality of Zagorska Sela (Croatia).

This structure was designed and performed as a multi-purpose storage reservoir (water supply, irrigation and retention of flood wave). However by the end of 1980s, after pollution caused by the non-existence of system for collecting wastewater from upstream settlements, it was no longer used for water supply, and in the past thirty years it has served as a retarding basin. Its basic purpose is to retain flood wave of the Sutla River for the purpose of flood protection of downstream settlements. The dam will serve this purpose in the future as well.

Sutlansko Lake storage reservoir/retarding basin is a joint Slovenian-Croatian project. It was constructed in 1980 as a joint project of Croatian and Slovenian water management authorities in agreed 50%:50% ratio.

Sutlansko Lake retention area stretches about 6 km in length, and has a surface of 195 ha and is located on the territory of Slovenia (municipalities of Rogaška Slatina and Podčetrtek) and Croatia (municipalities of Zagorska Sela and Hum na Sutli).

Vonarje dam was constructed as an earth-fill dam, 12.0 meters in height, with water volume in the reservoir at the overflow water level (207.50 m.a.s.l) of 8.7×10^6 m^3.

Basic information on the Sutlansko Lake (Vonarje) reservoir are:

- Dam crest level 211.45 m.a.s.l.
- Overflow level 207.50 m.a.s.l.
- Maximum level 209.35 m.a.s.l.
- Security freeboard 1.5 m
- Dam height above terrain 14.85 m
- Dam length 102.2 m
- Crest width up to 4.0 m

- Biological minimum of 120 l/s
- Reservoir volume at level 207.50 m.a.s.l. amounts to 8.7 x 10^6 m^3
- Reservoir volume at level 209.35 m.a.s.l. amounts to 12.4 x10^6 m^3

Dam management, maintenance and observation are conducted by the Slovenian concession-holder of public economic service.

In its present function of retarding basin during heavy rainfall and high water levels Sutlansko Lake retains almost the entire flood wave of the Sutla River generated upstream from the dam and is of extreme importance for flood protection of the area downstream.

The condition of Vonarje dam is very poor. Concrete parts are visibly damaged, reinforcements are visible on the surface, and hydro-mechanical equipment (metal parts) is corroded. Safe management of the retarding basin and its functionality are problematic due to the structure's old age. Concrete structures have to be rehabilitated, while hydro-mechanical equipment and equipment for observation of dam condition has to be replaced.

Given that Vonarje dam has the status of large dam, seismic observation system has to be established according to the Ordinance on seismic observation in large dam area (Official Gazette of the Republic of Slovenia, no. 92/99 and amendments), given that in its present condition the dam does not have such a system established.

Poor condition of the dam was discussed on several occasions during meetings of the Permanent Croatian-Slovenian Commission for Water Management, that has also established an expert group for improvement of this condition; however, the expert group has not held a single meeting.

3 Proposed intervention for improvement of Vonarje dam on Sutlansko Lake – description and purpose of planned intervention

Dam's structural elements will be reconstructed (concrete and metal constructions), dilapidated hydro-mechanical equipment as well as equipment for operating gates will be replaced, electrical installations and electric equipment will be replaced and upgraded, equipment for automatic gate operation and remote supervision of gate operation will be installed as well as equipment for monitoring dam condition (accelerograph, piezometer, inclinometer).

The existing structure will be reconstructed within its original boundaries. Neither the structure's purpose nor its basic requirements will be changed, nor the method how the retarding basin is managed. The proposed intervention will guarantee improved safety and functionality of Sutlansko Lake retarding basin.

The following interventions will be performed:

- Complete rehabilitation of damaged concrete surfaces of gate and outlet structure,

- Rehabilitation of RC support of communication bridge to gate and outlet structure,

- Rehabilitation of spillway structure due to damaged concrete (side spillway, spillway channel and stilling pool – absorption basin),

- Replacement of metal fence on spillway structure and fence on communication bridge and gate and outlet structure (fence length 126 m),

- Improvement of corrosion protection of load-bearing metal construction and communication bridge landing (bridge length 32.0 m and width 1.2 m),

- Replacement of entry element with doors on communication bridge,

- Replacement of shed over area for operating gates in outlet structure,

- Replacement of metal ladders (2 x 16 m) on outlet structure,

- Replacement of four metal covers with dimensions 1.30m x 1.30m on gate plates on outlet structure,

- Replacement of four lamp posts of Vonarje dam,

- Replacement and automatic operation of entire hydro mechanical equipment which is dilapidated and outdated (over 30 years old); this includes replacement of four gates 1m x 1 m, gates 1,6m x 1,8m, including drive, guides and latches,

- Introduction of remote monitoring and management of gates,

- Emergency electrical generator (diesel generator) for gate operation and other electro- and telecommunication equipment,

- Installation of two mutually connected accelerographs for seismic observation,

- establishment of communication connection between accelerographs with command control room in existing structure using low-tension supply and telecommunication connection for seismic observation (power line 65 meters long),

- Upgrade of monitoring system.

4 List and explanation of works on current (regular) maintenance of Vonarje /Sutlansko Lake Dam performed by current concession holders/licensed companies as part of their regular/contract activities, that indicate that proposed works are not regular maintenance works

4.1 Hrvatske vode

Works that will be performed within the framework of the Project FRISCO 2.1. *Improvement of safety and functionality of Vonarje /Sultansko Lake Dam,* as previously foreseen and described, are not works that would be conducted by licensed contractors for works on preventive flood defense, i.e. works on regular maintenance of water, water estate and water structures, as part of their annual contract with Hrvatske vode. Procurement procedure will be conducted for works that will be implemented as part of the FRISCO 2.1 Project Vonarje/Sutlansko Lake in accordance with the Public Procurement Act.

As part of annual plans for preventive protection against floods, i.e. regular maintenance of water, water estate and water structures on Vonarje/Sutlansko Lake, Hrvatske vode perform only works of manual mowing of thick grass and removal and disposal of cut grass on the left slope between the road and spillway channel.

Licensed contractor of works on preventive protection against floods (works on regular maintenance of water, water estate and water structures) for the area of the Krapina-Zagorje County where Vonarje/Sultansko Lake Dam is located is Vodoprivreda Zagorje d.o.o. Klanjec.

Hrvatske vode have concluded a contract with Vodoprivredq Zagorje d.o.o. entitled *Framework agreement for procurement of works of preventive, regular and emergency flood defense in defended area no. 12: area of small river basin Krapina-Sutla and northern part of area of small river basin »Zagrebačko prisavlje« which includes: Town of Zaprešić and the municipalities of Brdovec, Marija Gorica, Dubravica, Pušća, Luka, Jakovlje and Bistra for the period of four (4) years (2014 – 2018).* Cost Estimate with unit prices for types and scopes of works forms a constituent part of the stated Framework Agreement and annual contracts for preventive, regular and emergency flood defense in defended area no. 12 are concluded on the basis of this. List of works contracted on the basis of the Framework Agreement are enclosed to this Preliminary Project Description, and they indicate that works that will be implemented as part of the FRISCO 2.1 Project are not on the list of works performed as part of regular maintenance that might be performed by licensed contractor of works of regular maintenance as part of their contract.

Planned works would be performed as part of the rehabilitation of existing structures into the condition and with characteristics according to which they have been constructed with operative adjustment of the management part of mechanical equipment to timely monitoring and management (forecasting) system. Legal prerequisites on the Croatian side allow for the preparation of the stated project related to the rehabilitation of existing structures of Vonarje Dam, without having to obtain construction permit. Rehabilitation works that will be performed as part of the FRISCO 2.1 Project Vonarje/Sultansko Lake in the stated way are based on the provisions of the *Ordinance on Maintenance of Structures (Official Gazette no. 122/2014)* that defines the same nature of works as works of emergency maintenance, which also includes a set of measures that are implemented in order to remove consequences of emergency actions, but also circumstances that have reduced or endangered structure's usability, in order to restore the structure into its original technical and/or functional state or bring it into the state compliant with designed structure's state.

The stated works basically do not change structure's technical solution, or endanger the fulfilment of basic requirements for the structure and other conditions as well that the structure has to fulfil. The compliance of the structure with building permit based on which the building was constructed also does not change.

4.2 4.2 Slovenian Water Agency

Regular maintenance works performed on the dam are regular hydro mechanical equipment repairs, simple repairs and maintenance, removal of alluvial material and vegetation and mowing dam surface. This means that the works planned within this project does not fall under the scope of regular maintenance that the concession holder is obliged to perform, i.e. provider of public economic service of water regulation.

Concession contract indicates that water regulation works include management, maintenance and supervision of the condition of water infrastructure intended for the protection from adverse effects of water (Sutlansko Lake, Vonarje Dam are on the list of existing water infrastructure, published in the Official Gazette no. 63/2006; https://www.uradni-list.si/1/objava.jsp?sop=2006-01-2726).

Contract on the performance of tasks of public water regulation service in the Savinja river basin is based on concession contract and Regulation on the method of provision of mandatory state economic

public services in the area of water regulation (https://www.uradni-list.si/1/objava.jsp?sop=2014-01-3642https://www.uradni-list.si/1/objava.jsp?sop=2012-01-3943https://www.uradni-list.si/1/objava.jsp?sop=2011-01-4203(https://www.uradni-list.si/1/objava.jsp?sop=2010-01-5763, https://www.uradni-list.si/1/objava.jsp?sop=2011-01-4203, https://www.uradni-list.si/1/objava.jsp?sop=2012-01-3943, https://www.uradni-list.si/1/objava.jsp?sop=2014-01-3642)

5 Explanation of proposed works that will be the subject of FRISCO 2.1 Project – significance of proposed works for reduction of flood risks

Basic flood risk with retarding basins formed by a dam which is not in satisfactory technical condition is the risk of dam breach when retarding area is filled with water.

Vonarje Dam can break due to:

- Human factor on the subjective level (lack of maintenance of equipment and structures, gross negligence by responsible persons when water is released quickly into the retarding basin),
- As consequence of a terrorist attack (deliberate dam breach),
- Due to extreme natural phenomena (earthquakes, landslides).

Vonarje Dam is at a particularly high risk due to outdated condition of dam equipment and structures.

The following structures of Vonarje Dam are the most significant for its safe functioning:

- Bottom outlet – reinforced concrete structure for evacuating water through dam body,
- Gates and regulation using gates (mechanical) - metal constructions on reinforced concrete support, which enable regulation of the level of water spillway in 4 different levels as well as sudden evacuation of retained water in necessary,
- Spillway for high water – enables safe overflow of high water in order to prevent overflow across dam crest.

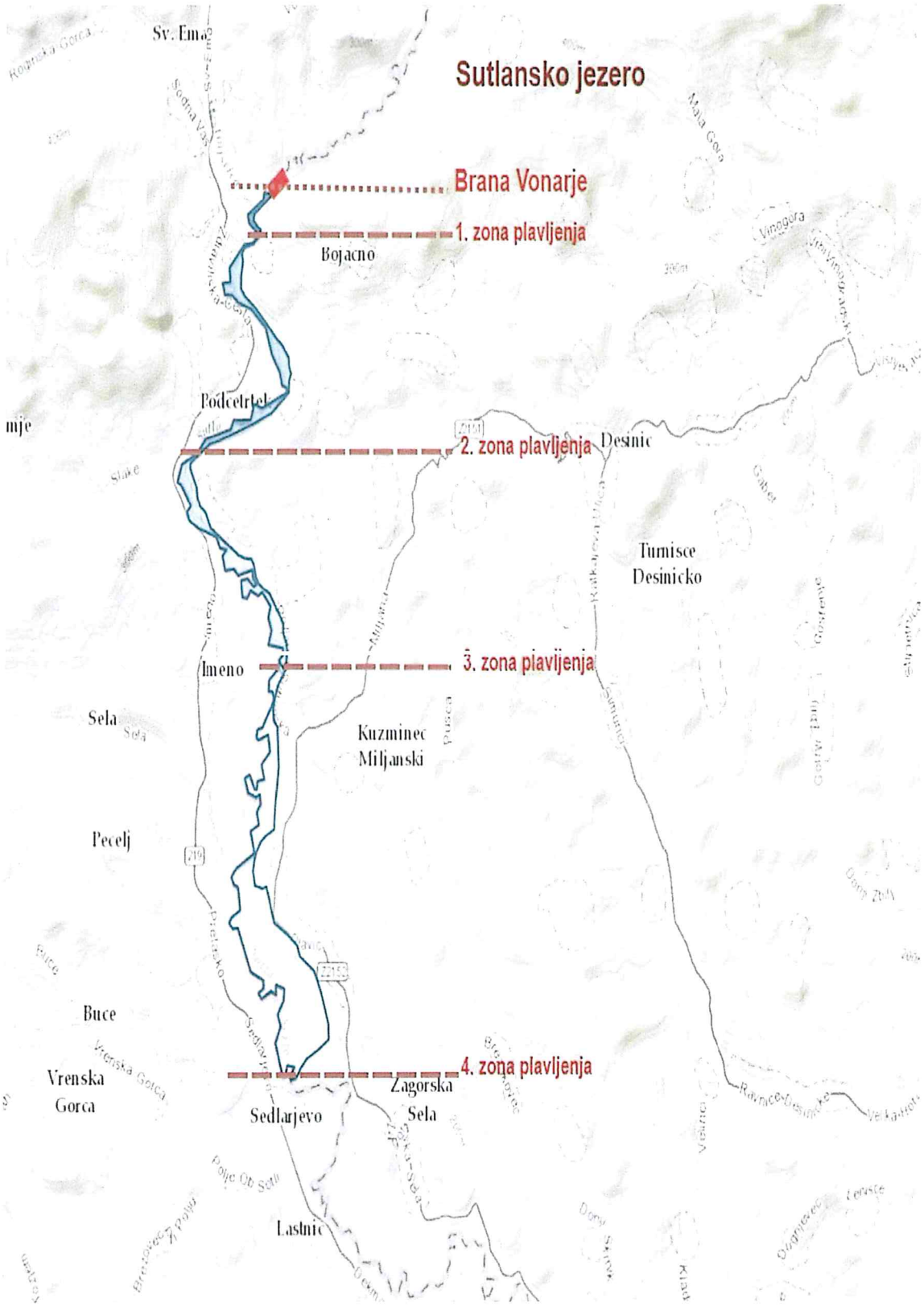
Stated structures are in a dilapidated condition and their rehabilitation is necessary for ensuring the dam's safety and functionality.

Hrvatske vode have prepared a Threat Assessment of Sultansko Lake/Vonarje retarding basin (enclosed) which has identified possible threat to civilians, material and cultural goods as well as environment in case of dam breach.

The collapse of this dam would cause a destructive flood wave with catastrophic consequences. Water wave height, regardless of dispersion when entering the valley, would amount to between 2 and 3 meters. The water wave would follow the direction of the river and water would also cover the railway track (Slovenian side). Water Park that is located less than 1000 m from the dam and has no natural protection, would be hit the hardest, especially people standing in open air. During bathing season, there are 25 employees working there and on average 300 guests who, if not warned and evacuated to higher levels, could get hurt. Outside bathing season there are about 70 people in that area on average. On the Croatian side (Harina Zlaka) there are some family houses with occupants, on average 15 people are in danger. Initial settlements on the Croatian side are under less danger because they have been constructed on higher levels, but also due to water wave's direction.

After further dispersion of water wave and water level drop, settlements on the Croatian side are not under more significant threat (behind Sutlanska poljana parts of settlements of Bijačno, Bratkovec, Miljana, Plavić, Risvica up to Zagorska Sela) even though material damage and certain casualties are possible in worst case scenario. Material damage would be (on the Croatian side) reasonably large on local road infrastructure, agricultural lands, distribution power lines and home gardens, it would be characterized as local accident, whereas in the initial Slovenian part it would be characterized as disaster.

Enclosed figures show four flood zones caused by dam breach.



Flood zones during Vonarje/Sultansko Lake dam breach

Below are photographs of the current condition of structures on the dam which indicate that their rehabilitation is required so that the dam is safe and functional in the forthcoming period.

Spillway sill

Spillway collecting channel

Side spillway

Spillway structure and entrance into bottom outlet

Damages to concrete and reinforcements

Damages to concrete and reinforcements

Damages to concrete

Damages to concrete elements

Access bridge to spillway structure

Necessary replacement of metal parts of fence on the bridge

Gates on spillway structure

6 Explanation of intervention on Vonarje dam as no regret measures

- Foreseen intervention will guarantee more safety and functionality of Sultansko Lake retarding basin with Vonarje Dam. Existing structure will be rehabilitated within its outline, and the structure's purpose and basic requirements, as well as method how the retarding basin is managed have not changed.

- Foreseen intervention significantly reduces flood risk of areas downstream from Sultansko Lake retarding basin and Vonarje Dam given that the entire retarding area has the purpose of retaining water wave volume of areas downstream from Vonarje Dam.

- Foreseen intervention is in accordance with the definition of no regret actions- Ecoystem based Adaptation: Building on No Regret Adaptation Measures (20th session of the Conference of the Parties to the UNFCCC and 10th session of the Conference of the Parties to the Kyoto Protocol, Lima Peru 1-12 December 2014):

The no-regret approach is an important part of EbA and focuses on maximizing positive and minimizing negative aspects of nature based adaptation strategies and options. No-regret actions include ... *measures taken by communities [and/or facilitated by organisations] which do not worsen vulnerabilities to climate change or which increase adaptive capacities and measures that will always have a positive impact on livelihoods and ecosystems regardless of how the climate changes2.*

In conclusion, the proposed project is necessary to reduce the risk of catastrophic flooding that would occur in the event of failure of the Vonarje Dam, which is becoming more and more likely due to the existing unsatisfactory conditions of the infrastructure, which are continuously further deteriorating. Without joint funding from the INTERREG Cooperation Programme Slovenia-Croatia 2014-2020 and subsequent joint implementation of the proposed measures, as required by the Programme, the

proposed interventions would not be performed (through maintenance activities by either Slovenian or Croatian side), and the risk of flooding would continue to increase. The cost of the proposed intervention is much smaller than the benefit of avoiding consequences of dam failure (economic damages and potential losses of life).