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Flood Risk Management for 'Morave e Binces'

Kosovo

Project Report - Volume III

Conceptual Design (Draft)

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1 INTRODUCTION

1.1 Project area

'Morava e Binces' (Morava e Binces) is a river that originates in Mountains of 'Crna Gora' in Macedonia north of Skopje (actually close to the border between Macedonia and Kosovo) and south of the Municipality of Viti. It flows in north-easterly direction through the Southeast of Kosovo, to join the Western Morava River in Serbia. The Western Morava River flows into the Danube which in turn flows into the Black Sea.

The length of the river in Kosovo is approximately 50 km. The river flows through complex topography changing from mountainous headwaters into flat areas near Viti, to hilly geographical configurations near the Serbian border, with moderate heights on the sides.

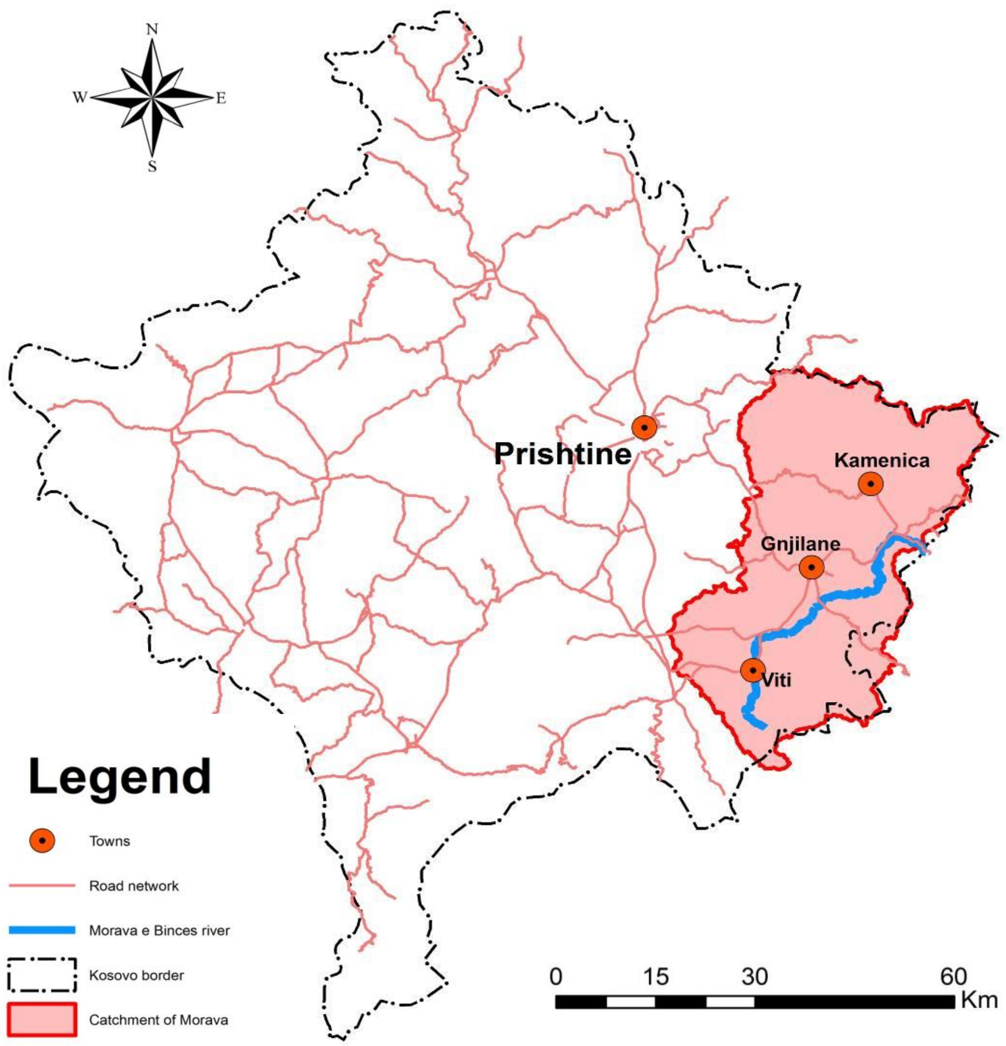

Figure 1: Location of the river basin of 'Morave e Binces'

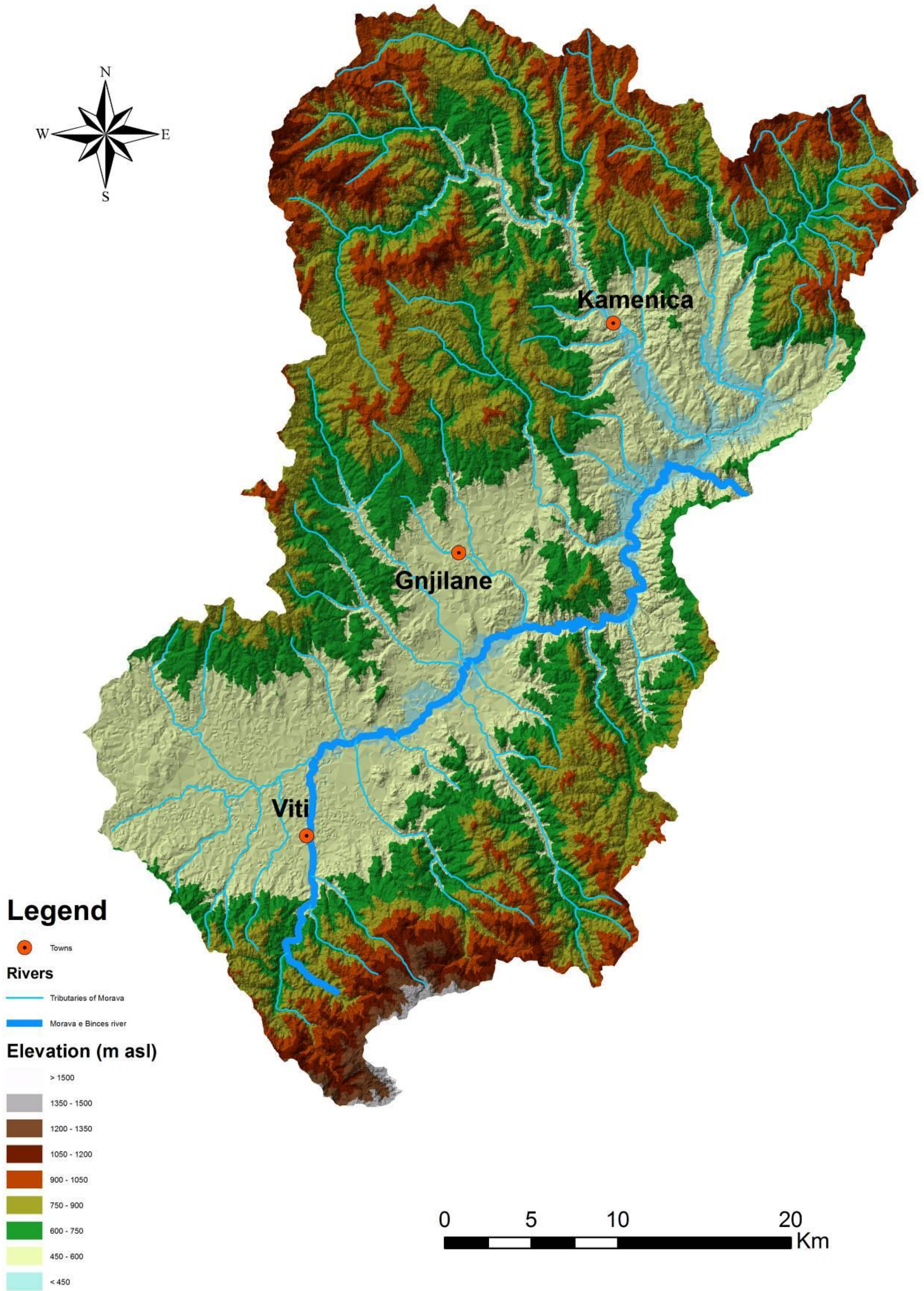

Figure 2: Elevation, main towns and rivers in the Morave e Binces river basin

The entire basin of the Morava Binces with its subsidiaries comprises approximately 1,624 km^2. Without the Kriva Reka basin in the north (at 607 km^2)[1] it is about 1,017 km^2 [2]. The flow is greater in February and March and lowest in August and September[3].

The area of interest is the Morave e Binces river basin within Kosovo.

Folowing the ToR requiments this Volume3 presents the conceptual design documents.

In this Volume the project setting in general is discussed in Chapter 2.

The four selected measures for which designs are made are discussed in separate Chapters:

Chapter 3: Clearing of the river bed and floodway (between the embankments)

Chapter 4: Normalisation of the river bed at confluences of Morava River and Kriva Reka

Chapter 5: Retention area at Nasale village

Chapter 6: Rehabilitation of river bed and embankments

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[1] Upstream from Domorovc hydrological station
[2] Upstream from the Korminjan hydrological station
[3] Source: ToR

2 PROJECT SETTINGS

2.1 Designing criteria

While defining the measures necessary for the improvement of the conditions of the Morava river corridor, the following design criteria have been considered:

- **River Alignment**

- *The alignment of the rehabilitated river bed should run through the lowest places of the river valley in order that the surface waters be drained naturally and effectively.*
- *The alignment of the rehabilitated river bed should follow the existing river bed to the maximum possible extent. This will enable minimization of the earth works and expropriation of the surrounding areas as well as increased cost-effectiveness of the works.*
- *The alignment of the rehabilitated river bed should be adapted to the built structures – bridges, roads, etc. to the best possible extent.*

- **Longitudinal slope**

In accordance with its regime of flow and transport of sediments, the river forms its alignment, its longitudinal section and cross-section. Therefore, for the purpose of preservation of the natural regime of the river, *the existing longitudinal slope of the river should, first of all, be observed in defining the designed level of the regulated river bed*.

- **Cross-sections**

The cross-section of the rehabilitated river bed should satisfy the following requirements:

- *It should safely let the referent flood waters through;*
- *It should enable concentration of low waters in the river bed;*
- *It should enable cost-effective performance of the construction works and maintenance of the river bed;*
- *It should not disturb the regime of underground waters and should enable natural drainage of surface waters;*
- *It should not disturb the established ecological regime of the river corridor.*

2.2 Used data

2.1.1 Topographic data

To be able to carry out a meaningful hydraulic modelling a, detailed topographic data of all relevant parts of the river system are needed. One source used of such data would be a detailed DEM or Digital Elevation Model. A DEM is available at the Kosovo Cadastral Agency4 (part of MESP) and has been purchased for the floodplain areas.

However, while the DEM is accurate enough to use for the floodplain it is not accurate enough for the dimensions of the streambed itself and the embankments. This area is mostly heavily overgrown, with fully grown trees obscuring the ground.

Detailed geodetic survey data of cross sections of the river, embankments and floodplain were available for about half the course of the Morave e Binces River. They were prepared for the (MESP-Basler 2007) project and by the Viti Municipality in preparation of the river restoration project proposal. Within this project a geodetic survey of cross sections for the remaining length of the river including detailed measurements for the bridges was arranged for and carried out in November 2013. With the results of the survey, the earlier detailed geodetic data and the DEM a TIN elevation model of the project area is prepared and from this the model schematisation has been created. This TIN was used to create the cross sections in HEC-RAS, the hydraulic model.

2.1.2 Geophysical data

Unfortunately, during the preparation of the conceptual design no information of the geological composition , physical and mechanical characteristics of the soil mass in the area of river Morava were availabl . Knowing the importance of this information for proper and safe design of structures in civil engineering, it is strongly recommended in the next phase of this project to be carried out detailed geophysical investigations of the area covered by the project activities.

2.1.3 Hydrological data

A detailed description of the hydrological analysis performed for the analized region is given in Volume 1 of this report. Here there will be given only major hydrological parameters used in the preparation of a conceptual design.

Hydrological analysis has been carried out by applying appropriate statistical analysis methods that has been used with the available dataset of probability of occurrence on the annual flood discharges (annual maximum flow): Gumbel, Pearson III type, Log Pearson III type.

Покрај споменатите статистички методи во хидролошката анализа се користени и неколку добро познати емпириски методи : For estimation of flood discharges numerous empirical methods exist. These methods take a set of areal parameters into account. They usually fit a certain region for which they have been developed. The following three locally known methods were used:

- Fuller
- Gavrillovic
- Srebrenovic

The results of the statistical and empirical methods were analysed and compared, and based on the result of the analysis the flood discharges for the various return periods have been determined.

Best fit analysis shows that the Log Pearson III analysis is the best way to represent the flow at both the Korminjan and the Domorivc hydrological stations. The total flow at Korminjan, for the main stream of the Morave e Binces River, can thus be estimated at about 435 m^3/s for a return period of 100 years. For river Kriva reka the estimated flow for a return period of 100 years is estimated at 295 m^3/s.

2.1.4 Peak discharge distribution along the river

As it is mentioned before, the peak discharges linked to specific return periods are calculated for specific points (hydrological stations) along the river: at Domorovcë on the Kriva Reka and at Korminjan on Morava river (Volume 1 , page 25).

Table gives the calculated discharges for the full length of the Morave e Binces River.

Table 1: Discharge distribution Morave e Binces River Basin - static flow, area adjusted

		Return Period T (year)					
	Watershed area	100	50	20	10	5	2
	km²	m³/s	m³/s	m³/s	m³/s	m³/s	m³/s
Morava Binac	75	54	45	34	27	20	11
Morava Viti	95	65	55	41	32	24	13
Morava d/s Gilbusha	275	153	128	97	76	56	30
Morava d/s Budriga	313	170	142	107	84	62	33
Morava u/s Zegra	445	225	189	142	111	83	44
Morava d/s Zegra	525	257	215	162	127	94	50
Morava d/s Livocka	650	305	256	193	151	112	60
Morava d/s Llastice	665	310	260	196	153	114	61
Morava d/s Pasjane	680	316	265	200	156	116	62
Morava Ugljare	744	339	285	214	168	125	66
Morava Podgrade	838	373	313	236	184	137	73
Morava Dobrcane	954	414	347	262	205	152	81
Morava at Korminjan	1015	435	365	275	215	160	85

In this table the discharge has been adjusted for lower discharges in relatively larger watersheds.

2.1.5 Return periods and flood protection norms

Flood protection *norms* give a guideline on the level of protection that should be attained, and are ideally set by the responsible national government authority. Such norms are important as they tell local citizens what level of protection they can expect, and outline the responsibility for the local and national authorities. The norms usually indicate the frequency of flooding that is acceptable given a certain land use; this approach minimises the overall flood risk (where risk is defined as the probability of flooding multiplied by the damage such flooding causes). It is strongly linked with 'zoning' or spatial planning.

Lacking national standards the consultants have proposed a set of norms and discussed these with the relevant stakeholders and the MESP during a workshop in December 2013. The table with the resulting approved set of norms (Table 2) can be used when analysing the produced flood risk maps, in combination with GIS maps of land use (detailed to crops) and objects at risk.

Table 2: Flooding norms

Land use	Flood frequency	Return period
	1/year	year
Nature, wetland	1	1
Grassland, meadows	0.20	5
Agricultural land	0.10	10
Orchards, horticulture	0.05	20
Roads, secondair	0.05	20
Isolated buildings, isolated businesses	0.05 - 0.02	20 - 50
Roads, main	0.02	50
Urban areas	0.01	100

On base of mentioned discussion with the stakeholders and considering the area at risk, a return period of 20 years was adopted for protection of the area from Viti to Ugljare and from Podgradje to Dobrcane as well . For the region from Dobrcane to Korminjane a return period of 50 yars was used in the analyzes, having in mind the density of the populated area, main road passing thru that area .

2.3 Hydraulic modeling

2.3.1 Model Concept

From hydraulic aspect, the flow of Morava e Binces river through the analyzed section can be defined as stationary non-uniform/variable one.The modeled section is complex due to the shape of the cross-sections, the inclination of the bottom and particularly for the structure/the bridge in the river bed which is part of the analized area. The hydraulic analysis was done by use of the HEC RAS River Analysis System software, which is based on a unidimensional concept of solving complex hydraulic phenomena in case of open flows.

The hydrodynamic characteristics of the flow can be defined by application of the energy equation, which is simplified for the unidimensional flow. Within the frames of this study, a hydraulic analysis was carried out by use of the HEC-RAS, River Analysis System, Steady Flow Water Surface Profiles software with a unidimensional concept, whereat the basic energy equation was used.

$$y_2 + z_2 + \frac{\alpha_2 V_2^2}{2g} = y_1 + z_1 + \frac{\alpha_1 V_1^2}{2g} + h_E \qquad 1$$

The energy loss is defined by the following relationship:

$$h_E = \overline{S_f}\, L + \mathbf{K} \left| \frac{\alpha_2 V_2^2}{2g} - \frac{\alpha_1 V_1^2}{2g} \right| \qquad 2$$

2.3.2 Scenarios

With the HEC-RAS model of the Morave e Binces river basin four model scenarios were calculated, to determine which level of intervention is needed to arrive at an acceptable flood return period.

The selected scenarios are:

1. Present situation
2. Cleaned river bed
3. Cleaned and widened river bed
4. Rehabilitated river bed and repair / raising of embankments

All of those Scenarios and achieved results are described in details in Volume 1 of this report.

3 CLEARING OF THE RIVER BED

Clearing of the river bed means removal of all hindrances for the water course as are fallen trees in the river, areas overgrown with dense grass and bushes, removal of solid waste from the river bed and the banks as well as clearing the existing inundations from trees, grass, bushes, waste, etc.

Clearing of the river is expected to extensively improve the hydrodynamic characteristics of the water course. The simulation of this state, namely "cleared river bed" has been modeled by reduction of the Manning's roughness coefficient. Hence, in the basic simulation of the water course in natural conditions, this coefficient has been adopted depending on the occurred resistances and is within the range of 0,045 – 0,060 for the river bed, while for the inundations and the wider river valley, this parameter ranges from 0,05 to 0,130. For the conditions of cleared river bed, the coefficient of roughness according to Manning has been adopted to be n = 0.030 – 0.035.

4 RETENTION AREA AT NASALE VILLAGE

During analyses of the valley of the Morava e Binces river, it was determined that a portion of the valley was flooded 1-2 times each year. It is a wetland area located in the vicinity of the village of Nasale. To protect the village from flooding, embankments were constructed from the side of the wetland. Obviously, constructed levees weren't sufficient to protect the village from the floods of River Morava which were a reason for villagers to broke them in several places in order to allow one part of water from the river diverting to the wetland area.

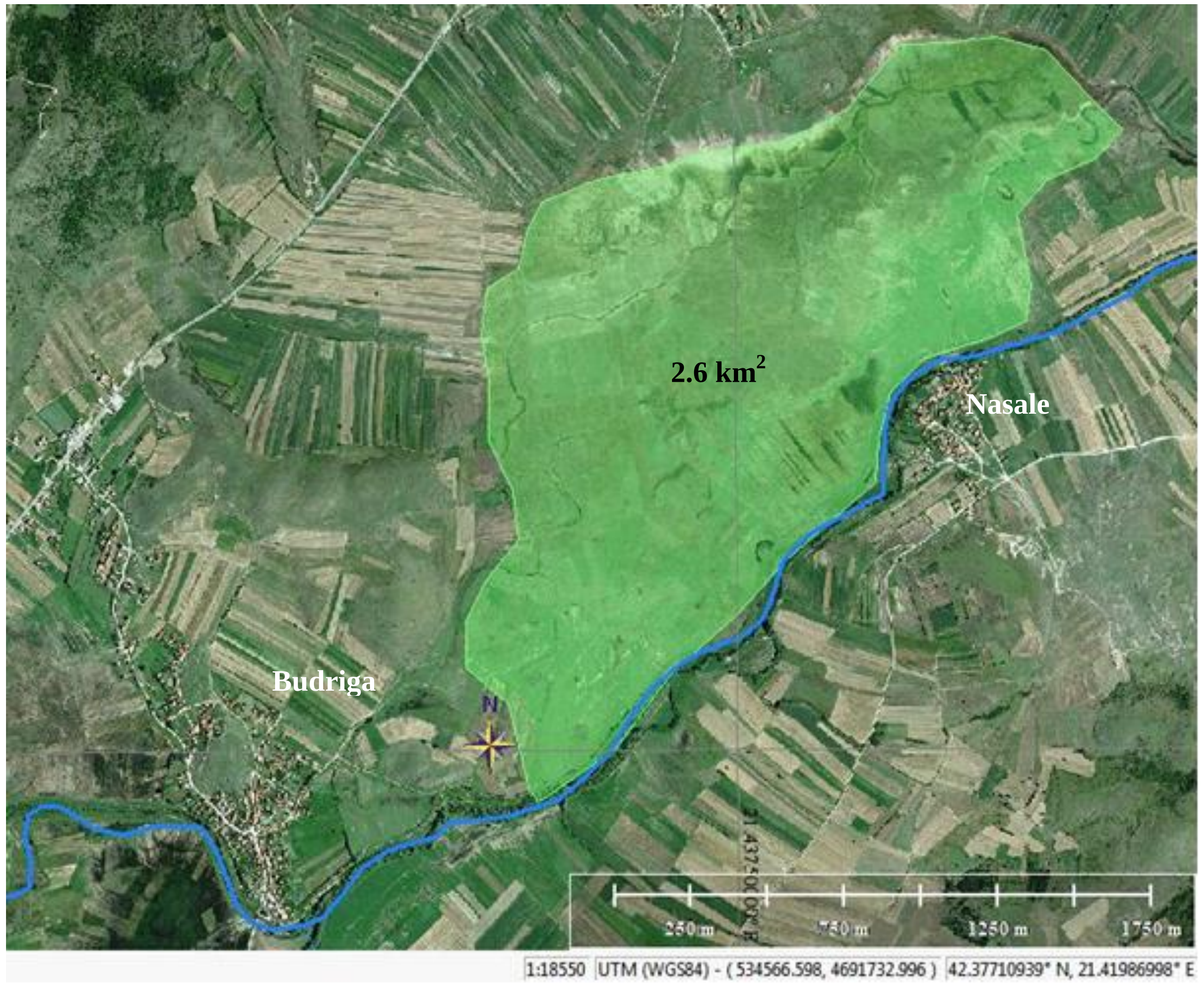

Figure 3 Wetland area near the village of Nasale

Following the same idea it is proposed in this conceptual design this wetland area to be used as a retention pool and thereby reducing flood wave impact downstream.

This means that the wetland can be used as a safety valve, by automatically filling over a wide concrete sill at a lowered part of the embankment. The level of the sill is designed to start operation at the indicated cut-off level for once in twenty years.

For practical reasons (flexibility of operation) a series of gates has been incorporated in the design; the gates will be very simple to operate and made of wood, to prevent pilfering of metal. Appendixes ???

5 NORMALISATION OF THE RIVER BED

At certain parts along Morava river course, its erosive effect upon the river banks and its passing in the immediate vicinity of residential houses is evident. Such an example has been observed in the populated place called Korminjane situated downstream the river, in the immediate vicinity of the place where the river leaves the territory of Kosovo. Korminjane is a larger settlement located in the area where Kriva Reka river empties into Morava river. The power of these two rivers as well as the irregular and insufficient maintenance of the river beds has caused pronounced erosion of the river banks with manifestations of meanders displacing the river course to the immediate vicinity of the residential houses on the outskirts of the Korminjane village. These structures are directly threatened by the effect of the river and necessitate technical measures for their protection.

As a solution to the previously described conditions, with this Conceptual Design, displacement of Morava river in the endangered zone and straightening of its alignment is proposed. At the same time, solution for the place of emptying of Kriva Reka river into Morava river is given. This place will be hydraulically favorably shaped whereat Kriva Reka river will empty into Morava river under an angle of .degrees, which enables good interaction of these two water courses along this section.

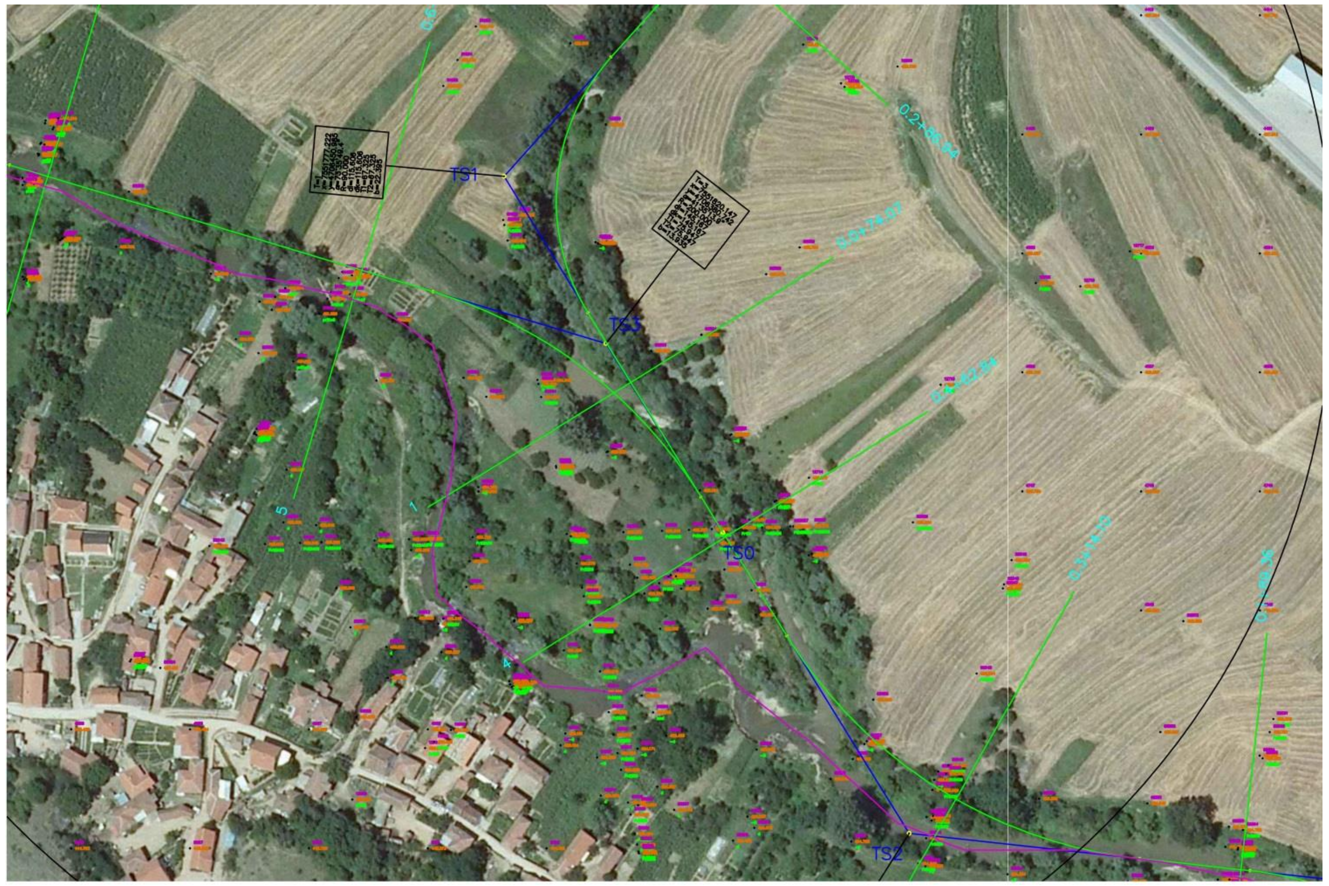

Figure 4 Normalized river bed and confluence of Kriva Reka near Korminjane village

Details of the proposed intervention are given in Maximal capacity of the spillway is calculated as follows:

$$Q = m * b * \sqrt{2g} * H^{1.5}$$

Where:

Q – spillway capacity (m3/s)

m – overflow coefficient (0.45 - 0.46)

b - spillway crest length (30 m)

g – earth acceleration (9.81 m/s^2)

H – overflow water height , difference between water flow elevation and spillway crest elevation

(H = 0.76 m)

Following previous procedure it is obtain maximum capacity of the spillway

Q = 40.0 m^3/s .

A proper way to drain the retention area efficiently also is incorporated. For this a gated culvert is deployed.

6 REHABILITATION OF RIVER BED AND EMBANKMENTS

The simulation of hydrodynamic characteristics after clearing of the river bed has shown a certain effectiveness and reduction of the water levels as well as reduction of the flooded areas in the river valley. However, due to the river being filled with deposit and considerable damage to existing embankments, floods along the river valley were still evident.

For the purpose of overcoming the stated conditions regarding the river bed as well as providing thorough protection of the river valley against floods, widening of the bottom of the river bed as well as shaping of the river banks is recommended in this phase. Based on the performed analysis of the shape of the Morava river bed, it has been decided that the river bottom be widened for 10 metres. Widening will be done mechanically, while part of the excavated material will be used for filling local depressions in the river bottom. Shaping of the river slopes is proposed to be done simultaneously with the widening of the river bottom. Due to lack of data on the composition and the geological characteristics of the terrain, it has been proposed that the slopes of the minor river bed be shaped with an inclination of 1:2. If the height of the river bed exceeds 2 m, horizontal berms with a width of 1-2 metres are anticipated to be constructed with continuation of the slope of the river bed down to its maximum depth. This shape of the river bed should guarantee stability of the newly formed slopes without application of special protective measures. Still, in the next phase of the project realization, detailed geophysical investigations will be necessary for the purpose of optimal proportioning of the river bed.

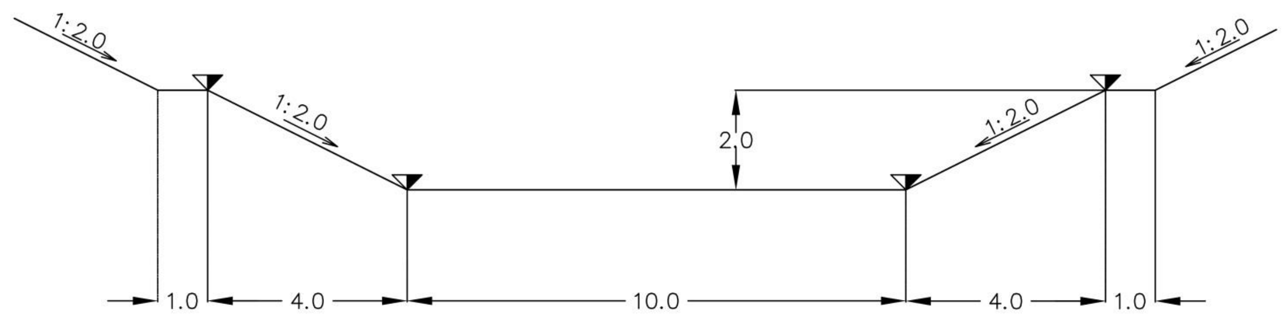

Figure 5 Proposed cross-section

In addition to widening and shaping of the river bed, it is proposed to rehabilitate and add excess height to the existing embankments as well as to construct new embankments at sections where such protective structures were not constructed in the past. Rehabilitation of the existing embankments will be done by banking up to the height that is necessary for the river profile to let the referent flood waters through. It is proposed that the width of the embankments at their crests be 3 m to enable their usage as a road for agricultural mechanization in future. The slopes of the embankments are anticipated to be constructed with different inclinations, namely 1: 2 on the inside and 1: 3 on the outside. The main design criterion for definition of the slope inclination of the embankments is their stability during serviceability. This means that the proposed dimensions of the embankments could be changed in the phase of design of the Main Project on base of stability analyzes when detailed data on the quality of the material to be built in them will be available.

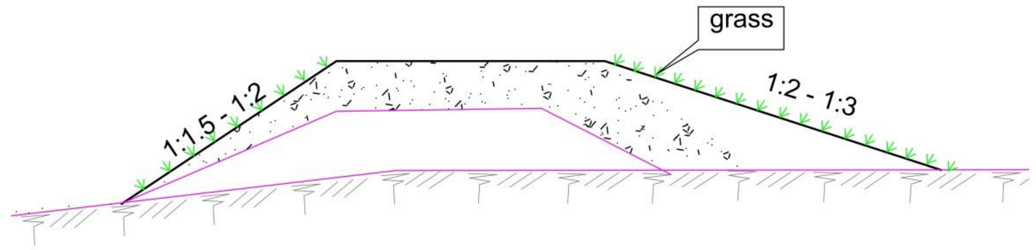

Figure6 Rehabilitation of existing embankment

The distance between the existing embankments is variable along the length of the regulated part of Morava river. These parameters are given in the subsequent table.

Table 3 Distance between embankments along different sections

Section	B (m)
Vitina - Budriga	30 – 60
Budriga – Velekince	70 – 90
Velekince – Ugljare	60 - 70

In order to minimize the total expenses, the existing position of the protective embankments has been maximum respected in the phase of elaboration of the Conceptual Design.

New embankments are anticipated to be constructed along Budriga – Velekintse section, namely from the bridge on Velekintse – Patresh road to the bridge on Donja Budriga – Nasale road. Embankments are designed for both sides of Morava river, with a distance of 60 – 70 m between them.

The design height is variable and, depending on the terrain, it ranges from 0.5 to 2.0. At cross-section, the embankments have a trapezoidal form. The width of the crest is 3 m, while the slopes are at an inclination of 1: 2 (the inner slope) and 1:3 (the outer slope).

In addition to this section, new embankments are anticipated to be constructed also along the section running from Dobrchane to Korminjane. Since the adopted return period for the flood waters in this area is 50 years, the protective embankments have a greater height ranging to 3.0 m. The distance between them is 60 m, while the remaining dimensions are the same as in the other sections of the river corridor.

7 BILL OF QUANTITIES

BoQ

Rehabilitation of the river bed of Morava e Binces : Part VITI - BUDRIGE

	Work Description	measure	quantity	unit price	Total EURO
1	**Geodetic works**				
1.1.	Marking of the designed alignments of the river bed and connection with the existing trigonometric network	m	9566.86	0.48	4,629.13
	TOTAL 1				**4,629.13**
2	**PREPARATION WORKS**				
2.1.	Complete cleaning of bush-like vegetation from the bed and the litoral part	m2	472404.50	1.05	495,262.78
2.2.	Mechanical wood cutting, cutting of branches and their sorting aside.				
	trunks ф 10-20cm	piece	250.00	3.23	806.5
	trunks ф 20-30cm	piece	100.00	8.06	806.5
	trunks ф 30-50cm	piece	50.00	16.13	806.5
	trunks ф greater than 50cm	piece	30.00	23.39	701.6
	TOTAL 2				**498,383.8**
3	**EARTH WORKS**				
3.1.	Mechanical excavation of earth of the III category in a wide excavation, in water and partially in dry conditions, for shaping of the designed cross-section of the river bed with transport of the excavated material to the embankmenst V=136803.82m3				
3.1.1.	Mechanical excavation 80%	m^3	109443.06	2.90	317,737.90
3.1.2	Additional manual excavation of earth (20%) for finalization of the bed shape.	m^3	27360.76	5.65	154,455.93
3.2.	Construction of the embankments by use of excavated material in layers of 30 cm with compaction up to the necessary compactness (according to table)	m^3	77472.35	7.26	562,299.31
3.3.	Loading, transport and unloading of the remaining excavated material to a spoil in the immediate vicinity of the treated section.	m^3	31970.71	1.61	51,565.65
	TOTAL 3				**1,086,058.80**
	GRAND TOTAL				**1,589,071.68**

Rehabilitation of the river bed of Morava e Binces : Part BUDRIGE - VELEKINCE

	Work Description	measure	quantity	unit price	Total EURO
1	**Geodetic works**				
1.1.	Marking of the designed alignments of the river bed and connection with the existing trigonometric network	m	8612.31	0.48	4,167.2
	TOTAL 1				**4,167.2**
2	**PREPARATION WORKS**				
2.1.	Complete cleaning of bush-like vegetation from the bed and the litoral part	m2	516738.60	1.05	541,742.1
2.2.	Mechanical wood cutting, cutting of branches and their sorting aside.				
	trunks ф 10-20cm	kom	220.00	3.23	709.7
	trunks ф 20-30cm	kom	92.00	8.06	741.9
	trunks ф 30-50cm	kom	45.00	16.13	725.8
	trunks ф greater than 50cm	kom	27.00	23.39	631.5
	TOTAL 2				**544,551.0**
3	**EARTH WORKS**				
3.1.	Mechanical excavation of earth of the III category in a wide excavation, in water and partially in dry conditions, for shaping of the designed cross-section of the river bed with transport of the excavated material to the embankmenst (V=117624.74)m3				
3.1.1.	Mechanical excavation 80%	m^3	96774.82	2.90	280,959.1
3.1.2	Additional manual excavation of earth (20%) for finalization of the bed shape.	m^3	24193.70	5.65	136,577.4
3.2.	Construction of the embankments by use of excavated material in layers of 30 cm with compaction up to the necessary compactness (according to table)	m^3	140378.48	7.26	1,018,876.1
3.3.	Loading, transport and unloading of the remaining excavated material to a spoil in the immediate vicinity of the treated section.	m^3	19409.96	3.23	62,612.8
	TOTAL 3				**1,499,025.3**
	GRAND TOTAL				**2,047,743.5**

Rehabilitation of the river bed of Morava e Binces : Part VELEKINCE - UGLJARE

	Work Description	measure	quantity	unit price	Total EURO
1	**Geodetic works**				
1.1.	Marking of the designed alignments of the river bed and connection with the existing trigonometric network	m^2	4819.43	0.48	2,332.0
	TOTAL 1				**2,332.0**
2	**PREPARATION WORKS**				
2.1.	Complete cleaning of bush-like vegetation from the bed and the litoral part	m2	4819.43	0.97	4,664.0
2.2.	Mechanical wood cutting, cutting of branches and their sorting aside.				
	trunks ф 10-20cm	kom	140.00	3.23	451.6
	trunks ф 20-30cm	kom	65.00	8.06	524.2
	trunks ф 30-50cm	kom	30.00	16.13	483.9
	trunks ф greater than 50cm	kom	21.00	23.39	491.1
	TOTAL 2				**6,614.8**
3	**EARTH WORKS**				
3.1.	Mechanical excavation of earth of the III category in a wide excavation, in water and partially in dry conditions, for shaping of the designed cross-section of the river bed with transport of the excavated material to the embankmenst (V=78357.28)m3				
3.1.1.	Mechanical excavation 80%	m^3	62685.82	2.90	181,991.1
3.1.2	Additional manual excavation of earth (20%) for finalization of the bed shape.	m^3	15671.46	5.65	88,467.9
3.2.	Construction of the embankments by use of excavated material in layers of 30 cm with compaction up to the necessary compactness (according to table)	m^3	54770.36	7.26	397,526.8
3.3.	Loading, transport and unloading of the remaining excavated material to a spoil in the immediate vicinity of the treated section.	m^3	23586.92	1.61	38,043.4
	TOTAL 3				**706,029.2**
	GRAND TOTAL				**714,976.0**

Rehabilitation of the river bed of Glibusha river

	Work Description	measure	quantity	unit price	Total EURO
1	**Geodetic works**				
2.1.	Marking of the designed alignments of the river bed and connection with the existing trigonometric network	m	2588.94	0.48	2,589.4
	TOTAL 1				**2,589.4**
2	**PREPARATION WORKS**				
2.1.	Complete cleaning of bush-like vegetation from the bed and the litoral part	m2	77668.20		0.0
2.2.	Mechanical wood cutting, cutting of branches and their sorting aside.				
	trunks ф 10-20cm	kom	100.00	3.23	
	trunks ф 20-30cm	kom	45.00	8.06	
	trunks ф 30-50cm	kom	19.00	16.13	306.5
	trunks ф greater than 50cm	kom	16.00	23.39	374.2
	TOTAL 2				**680.6**
3	**EARTH WORKS**				
3.1.	Mechanical excavation of earth of the III category in a wide excavation, in water and partially in dry conditions, for shaping of the designed cross-section of the river bed with transport of the excavated material to the embankmenst (V=23674.33)m3				
3.1.1.	Mechanical excavation 80%	m^3	19698.91	2.90	57,190.4
3.1.2	Additional manual excavation of earth (20%) for finalization of the bed shape.	m^3	4924.73	5.65	27,800.9
3.2.	Construction of the embankments by use of excavated material in layers of 30 cm with compaction up to the necessary compactness (according to table)	m^3	33501.52	7.26	243,156.2
3.3.	Loading, transport and unloading of the remaining excavated material to a spoil in the immediate vicinity of the treated section.	m^3	8877.88	1.61	14,319.2
	TOTAL 3				**342,466.6**
	GRAND TOTAL				**345,736.7**

CONFLUENCE OF GLIBUSHA AND MORAVA RIVER

	Work Description	measure	quantity	unit price	Total EURO
1	**EARTH WORKS**				
1.1.	Mechanical excavation of earth of the III category , in water and partially in dry conditions, for stabilization sills	m^3	78.30	2.90	227.3
1.3.	Construction of the embankments by use of excavated material in layers of 30 cm with compaction up to the necessary compactness	m^3	810.00	7.26	5,879.0
1.4.	Loading, transport and unloading of the remaining excavated material to a spoil in the immediate vicinity of the treated section.	m^3	731.70	3.23	2,360.3
	TOTAL 1				**8,466.7**
2	**MASONRY WORKS**				
2.1.	Purchase, transport and embedding of crushed stone into the stabilization sill and into the lining upstream and downstream of the sill for river Glibusha	m^3	28.40	100.00	2,840.0
2.2.	Purchase, transport and embedding of crushed stone into the stabilization sills (2) and into the lining upstream and downstream of the sills for river Morava	m^3	73.66	100.00	7,366.0
	TOTAL 2				**10,206.0**
	GRAND TOTAL				**18,672.7**

Rehabilitation of the river bed of Morava e Binces : Part PODGRADJE - DOBROCANE

	Work Description	measure	quantity	unit price	Total EURO
1	**Geodetic works**				
2.1.	Marking of the designed alignments of the river bed and connection with the existing trigonometric network	m	6851.00	0.48	3,315.0
	TOTAL 1				**3,315.0**
2	**PREPARATION WORKS**				
2.1.	Complete cleaning of bush-like vegetation from the bed and the litoral part	m2	205530.00	1.05	215,475.0
2.2.	Mechanical wood cutting, cutting of branches and their sorting aside.				
	trunks ф 10-20cm	kom	110.00	3.23	354.8
	trunks ф 20-30cm	kom	60.00	8.06	483.9
	trunks ф 30-50cm	kom	25.00	16.13	403.2
	trunks ф greater than 50cm	kom	10.00	23.39	233.9
	TOTAL 2				**216,950.8**
3	**EARTH WORKS**				
3.1.	Mechanical excavation of earth of the III category in a wide excavation, in water and partially in dry conditions, for shaping of the designed cross-section of the river bed with transport of the excavated material to the embankmenst (V=86584)m3				
3.1.1.	Mechanical excavation 80%	m^3	80634.40	2.90	234,099.9
3.1.2	Additional manual excavation of earth (20%) for finalization of the bed shape.	m^3	20158.60	5.65	113,798.5
	TOTAL 3				**347,898.4**
	GRAND TOTAL				**568,164.2**

Rehabilitation of the river bed of Morava e Binces : Part DOBROCANE - KORMINJANE

	Work Description	measure	quantity	unit price	Total EURO
1	**Geodetic works**				
2.1.	Marking of the designed alignments of the river bed and connection with the existing trigonometric network	m	9420.25	0.50	4,710.1
	TOTAL 1				**4,710.1**
2	**PREPARATION WORKS**				
2.1.	Complete cleaning of bush-like vegetation from the bed and the litoral part	m2	659417.50	1.00	659,417.5
2.2.	Mechanical wood cutting, cutting of branches and their sorting aside.				
	trunks ф 10-20cm	kom	250.00	3.20	800.0
	trunks ф 20-30cm	kom	100.00	8.00	800.0
	trunks ф 30-50cm	kom	50.00	16.00	800.0
	trunks ф greater than 50cm	kom	30.00	23.00	690.0
	TOTAL 2				**662,507.5**
3	**EARTH WORKS**				
3.1.	Mechanical excavation of earth of the III category in a wide excavation, in water and partially in dry conditions, for shaping of the designed cross-section of the river bed with transport of the excavated material to the embankmenst (V=23674.33)m3				
3.1.1.	Mechanical excavation 80%	m^3	172939.20	3.00	518,817.6
3.1.2	Additional manual excavation of earth (20%) for finalization of the bed shape.	m^3	43234.80	5.00	216,174.0
3.2.	Construction of the embankments by use of excavated material in layers of 30 cm with compaction up to the necessary compactness (according to table)	m^3	368831.00	7.50	2,766,232.5
3.3.	Loading, transport and unloading of the remaining excavated material to a spoil in the immediate vicinity of the treated section.	m^3	152657.00	3.50	534,299.5
	TOTAL 3				**4,035,523.6**
	GRAND TOTAL				**4,702,741.2**

CONFLUENCE OF KRIVA REKA AND MORAVA RIVER

	Work Description	measure	quantity	unit price	Total EURO
1	**EARTH WORKS**				
1.1.	Mechanical excavation of earth of the III category , in water and partially in dry conditions, for stabilization sills	m^3	44256.91	4.50	199,156.1
	Construction of the embankments by use of excavated material in layers of 30 cm with compaction up to the necessary compactness	m^3	148.75	3.00	446.3
1.4.	Loading, transport and unloading of the remaining excavated material to a spoil in the immediate vicinity of the treated section.	m^3	44405.66	3.20	142,098.1
	TOTAL 1				**341,700.5**
2	**MASONRY WORKS**				
2.1.	Purchase, transport and embedding of crushed stone into the stabilization sills and into the lining upstream and downstream of the sills	m^3	123.96	100.00	12,396.0
	TOTAL 2				**12,396.0**
	GRAND TOTAL				**354,096.5**

7 APPENDICES