

**GENERAL DESIGN WITH PRE-FEASIBILITY STUDY FOR THE REGULATION OF
THE JUŽNA MORAVA RIVER
FROM GRDELICA TO PREŠEVO**

TERMS OF REFERENCE

European PROGRES is a multi-donor Programme, financed by the European Union (EU), the Government of Switzerland and the Government of Serbia, designed to support sustainable development in the South East and South West Serbia. The Programme has been conceptualised jointly with the European Integration Office of the Government of the Republic of Serbia (SEIO), which has responsibility for monitoring implementation and providing assistance and facilitation. The United Nations Office for Project Services (UNOPS) has been granted with an initial budget of 17.46 million Euros and has the overall responsibility for the Programme implementation.

Through a multi-sector approach this Programme will contribute to sustainable development of underdeveloped areas and creation of more favourable environment for infrastructure and business growth by strengthening local governance, improving vertical coordination, planning and management capacities, improving business environment and development, as well as enhancing implementation of social inclusion and employment policies.

The Programme works towards achieving four main results, while good governance principles are interwoven as a cross cutting aspect of the entire intervention:

1. Strengthened local governance, planning and management capacities through introduction of new, or improvement/elimination of existing procedures and processes in line with the principles of good governance
2. Increased competitiveness of local economy through improved business environment and management/organizational capacities of small and medium enterprises/agricultural cooperatives
3. Improved access to employment, offering equal opportunities to both men and women, and social inclusion of most vulnerable and marginalised groups through development and implementation of local policies resulting in reduced migration from South East and South West Serbia
4. Effects of Serbia's European accession communicated to general public.

Final beneficiaries, but also the key stakeholders and financial contributors of this Programme are **34 municipalities** from the third and fourth group of development level , which have responsibility of taking ownership of activities implemented in their territory:

- Novi Pazar, Ivanjica, Nova Varoš, Priboj, Prijepolje, Raška, Sjenica and Tutin, in the South West Serbia
- Prokuplje, Blace, Žitorađa, Kuršumlija in the Toplica District
- Leskovac, Bojnik, Vlasotince, Lebane, Medveđa and Crna Trava in the Jablanica District
- Vranje, Bosilegrad, Bujanovac, Vladičin Han, Preševo, Surdulica and Trgovište in the Pčinja District
- Brus in Rasina District
- Aleksinac, Gadžin Han, Doljevac, Merošina and Svrlijig in Niš District
- Babušnica, Bela Palanka in Piroć District

- Knjaževac in Zaječar District.

Other beneficiaries include municipality-founded institutions and public utility companies, civil society organisations (CSO) and media in the participating municipalities. It is the inhabitants of the South East and South West Serbia who will feel the biggest benefits of the Programme.

1. PROBLEMS AND OBJECTIVES

The Južna Morava river, with a basin covering an area of about 15,000 km², is the most important watercourse of Southeast Serbia. It is formed from the Binačka Morava and the Preševo Moravica which join near Bujanovac, at an altitude of 392 m. It joins the Zapadna Morava downstream from the place called Stalać and that is how the Velika Morava is formed.

The valley of this river has a large agricultural potential and a prominent role in transport. Therefore, the regulation of the Južna Morava river is not only the interest of water management, but has a broader economic and social importance.

The main problem in the regulation of the Južna Morava river arises from the lack of spatial and temporal continuity of works. The hitherto practice of river engineering has been characterized by a fragmented approach to the problem. The works were carried out on the short river sections, without including natural functional entities. For that reason, the regulation works did not produce a satisfactory effect, both in terms of flood control, and from the standpoint of controlling morphological processes. A particular problem is posed by the sharp temporal discontinuity of works, because after a phase of more intensive interventions, very little was done on the extension or reconstruction of river structures and the flood defence system. Maintenance of completed structures was inadequate and performed on an *ad hoc* basis, which is particularly evident in the most recent period (due to lack of funds).

The current state of the Južna Morava from the standpoint of hydraulic engineering cannot be considered satisfactory, both in terms of stability and hydraulic functionality of the riverbed, and of protecting its riparian lands against floods. On several sections of the watercourse the river route has not been stabilized, because of the intensive fluvial erosion. Many riverine structures have been damaged or completely destroyed. Flood defence embankments have uneven properties, which is why the level of protection of the banks varies along the river. The problem should also be pointed out of insufficiently controlled exploitation of material from the river bed, which in places endangers the stability of the river route and calls into question the protection of riparian lands from flooding. After the construction of a stretch of E-75 highway, Belgrade - Nis - Tabanovce, the section Pečenjevce – Grabovnica, a dozen bridges have collapsed and the contractor has not removed them yet.

Based on the above considerations, it can be concluded that the state of hydraulic engineering on the Južna Morava is absolutely inadequate compared to the importance of the watercourse. It would therefore be necessary to start preparing technical documentation for the river engineering and protection of the riparian lands against flooding as soon as possible. Given the length of the watercourse and the severity of the problem, the preparation of the technical documentation would have to take place in several phases, in the following sequence:

- collation and analysis of the existing documentation and background material,
- detailed terrain reconnaissance along the entire course of the Južna Morava
- field investigations, in order to provide the necessary bases for the regulation projects,
- the development of the General Design with pre-feasibility study for the entire course of the Južna Morava, including the determination of priorities and sequence of regulation of individual sections,

- development of preliminary and construction designs for regulations by section of the watercourse.

The preparation of the technical documentation for the regulation of the Južna Morava River is a very comprehensive and responsible job. The importance of works on field investigations, which are essential for a comprehensive and accurate overview of the problem, should be specially emphasized as their results should form the basis for regulation projects.

It is particularly important for the Južna Morava to provide a reliable morphological base, because the systematic survey of the riverbed cross sections has not been carried out for several decades now. In doing so, it must be taken into account that the scope of geodetic surveys of the minor and major riverbed would be very extensive, given the length of the watercourse.

Bearing in mind the length of the watercourse and its geomorphological and morphological properties, the entire course of the Južna Morava River can be divided into three independent parts: from the junction with the Zapadna Morava to H. S. Grdelica (km 146), the Grdelička gorge itself, which constitutes a geomorphological discontinuity (about 28 km long), a sector upstream from the gorge to the junction of the Preševsko Moravica and the Binačka Morava (about 50 km long).

The sector of the watercourse downstream from H. S. Grdelica was the subject of the General Design with Pre-Feasibility Study for the Južna Morava regulation between Grdelica and its confluence with the Zapadna Morava River (Institute for the Development of Water Resources Jaroslav Cerni, 2005).

The program "General Design with Pre-Feasibility Study for the Južna Morava Regulation from Grdelica to Preševsko," which is described below, has been conceptualized in such a manner that it can provide responses to the following problems that exist or may be expected on the observed stretch of the watercourse:

- During the construction of highway E-75, Belgrade-Niš-border with the Republic of Macedonia, from the village of Mala Kopašnica (Grabovnica) to H. S. Grdelica, new regulation works have been performed under modified main designs. Within this General Design with Pre-Feasibility Study, on the basis of a new survey of cross sections (from km 140 to km 146), their impact should be examined, and differences in relation to the above General Design with Pre-Feasibility Study of 2005 identified, as it has already covered this section.
- In the sector upstream from the Grdelica gorge, in the period 1957-1965, the regulation works were performed and flood defence embankments were built on the Binačka Morava, the Moravica, the Južna Morava and its tributaries the Trnovačka and Krševička rivers, in the total length of about 60 km. Embankments included in the Operational Plan are:
 - Left bank embankment along the Južna Morava at a cellulose factory in Vladičin Han, L = 1.8 km;
 - Left bank embankment along the Južna Morava from the Vranje railway station to the mouth of the Vranje (City) river, L = 2.7 km;
 - Left bank embankment along the Južna Morava from Ribnica to Pavlovac, L = 4.2 km;
 - Left bank embankment along the Južna Morava from Pavlovac to the Davidovačka river, L = 2.3 km;
 - Right bank embankment along the Južna Morava from Zlatokop to the mouth of the Koštanička river, with bilateral backwater embankments along the Trebešinjska and Ratajska rivers 9.0 km, and a right bank embankment along the Koštanička river from the confluence with the Južna Morava, L = 1.7 km, 10.70 km in total;
 - Right bank embankment along the Južna Morava from the mouth of the Koštanička river to the mouth of the Krševička river 0.32 km with a right bank embankment along the Krševička river from the confluence with the Južna Morava, L = 3.5 km, 3.82 km in total;

- Right bank embankment along the Južna Morava from the Ristovac railway station to the mouth of the Žbevačka river 1.2 km with a left bank embankment along the Krševička river from the confluence with the Južna Morava L = 3.5 km, L = 4.7 km in total;
- Left bank embankment along the Južna Morava from Davidovac to the mouth of the Trnovačka river, L = 4.0 km with a left bank embankment along the Trnovačka river from the confluence with the Južna Morava, L = 2.5 km, L = 6.5 km in total;
- Left bank embankment along the Južna Morava and the Binačka Morava from the mouth of the Trnovačka river to the road Bujanovac - Gnjilane L = 4.3 km with a right bank embankment along the Trnovačka river from the confluence with the Južna Morava L = 2.5 km, L = 6.8 km in total;
- Right bank embankment along the Moravica from the confluence with the Južna Morava L = 5.16 km;
- Left bank embankment along the Moravica from the confluence with the Južna Morava, L = 5.16 km and a right bank embankment along the Binačka Morava from the confluence with the Južna Morava to the road Bujanovac - Gnjilane (Lučani village), L = 5.3 km.

Likewise, there are embankments which are not included in the Operational plan:

- Right bank embankment near Vladičin Han, L = 0.86 km;
- Right bank embankment Vrbovo-Gramađe across the village of Stubal, L = 1.5 km;
- Left bank embankment near Vranjski Priboj L = 1.0 km.

These embankments need to be surveyed in the context of the General Design with Pre-Feasibility Study in order to determine the existing level of protection against high waters, and propose measures to improve the current situation.

- During the construction of highway E-75, upstream of the Grdelica gorge, regulation works were carried out on certain sections, as needed (channels, stone masonry laid in cement mortar), several bridges with approach ramps were built, excess material from excavations and tunnels has been deposited on the water resources, gravel from the riverbed and floodplains was excavated along the entire section of the highway, and due to the transporting of the material the existing embankments were also partially damaged. The road foundation for the highway is near the watercourse on certain sections, so it plays the role of an embankment. Based on site visits after the high waters that occurred in the period 2010-2015, professional services of VPC "Morava" Nis concluded that the river was spilling over from the new regulated riverbed on certain sections, and that bridges were positioned low because they let high waters flow with minimal clearance.
- The construction of sections of E-75 highway through the Grdelica gorge as such is under way. The impact of these works (new bridges, narrowing of the major bed of the river due to the highway construction and relocation of the railroad, a landfill for excess material) on the river flow regime can be significant and should be examined in the context of General Design with Pre-Feasibility Study.
- On the observed section of the Južna Morava, there are many road and rail bridges, and the construction has begun of several new ones on the route of the new highway. Some of these bridges do not have adequate capacity and some are poorly positioned (at an angle in relation to the river, with hydraulically poorly positioned and shaped piers and abutments in the bed), so it is necessary to check the capacity, clearance and backwater by making a hydraulic calculation.

The General Design with Pre-Feasibility Study would aim at maximum streamlining of regulation works. This means that the task of the author of the plan would consist of determining as small-scale regulation works as possible but with optimal effects on the river flow regime, the stability of the river route and the protection of riparian lands against flooding.

Upon the completion of the General Design with Pre-Feasibility Study, which would identify priority sections for the regulation, one would proceed with more detailed surveys of the riverbed on these stretches, which would constitute a basis for the Preliminary and Main Designs of the regulation. It should be noted that such approach to preparing geodetic documents is very rational, given the dynamics of morphological processes on the Južna Morava.

2. SPATIAL COVERAGE OF THE DESIGN

The General Design with Pre-Feasibility Study should cover the following reference sections of the Južna Morava course and its tributaries:

- Južna Morava from Kopasnica (km 140) to H. S. Grdelica (km 146)
- Južna Morava from H. S. Grdelica (km 146) to H. S. Vladičin Han (km 177)
- Južna Morava from H. S. Vladičin Han (km 177) to the junction of the Preševo Moravica and Binačka Morava at Bujanovac (km 225)
- Preševo Moravica, the regulated riverbed at Levosoje (about 5 km)
- Binačka Morava from Bujanovac to Lučani (about 5 km).

The total length of the watercourse to be covered by geodetic surveying and analyses in the General Design with Pre-Feasibility Study is approximately 95 km.

2. SCHEDULE OF WORKS

A) SITE INVESTIGATIONS

1. Detailed terrain reconnaissance

In order to determine the condition of the riverbed, banks, river regulation structures, riparian areas, embankments, former and existing excavation sites, landfills for materials, etc., detailed terrain reconnaissance will be carried out along the Južna Morava and its tributaries, in the scope of the General Design with Pre-Feasibility Study (in the total length of about 95 km). The professional services of JVP "Srbijavode", VPC "Morava" Nis, should participate in the terrain reconnaissance, to indicate any problems encountered in the previous period.

After detailed terrain reconnaissance a report would be produced, providing an assessment of the current situation of the riverbed and riparian lands, as well as hydraulic structures on the section of the watercourse under consideration.

2. Geodetic survey of cross sections of the main riverbed

It is necessary to carry out geodetic surveying of the main riverbed cross sections at an average distance of 500 m, with additional surveys of the bed in zones of existing and planned bridges and other structures in the riverbed. Bearing in mind the length of the section under consideration, the total number of cross-sections is higher than 200. The position of cross sections will be determined during the reconnaissance, while respecting longitudinal changes in the river bottom (alternation of "rapids" and "dead water"), the confluences of major tributaries, bridges, excavation sites, etc.

The linking of cross sections for the national reference frame and the levelling should be done by using GPS technology. Part of the cross-section below the water table should be surveyed by probing from a vessel. It is necessary to materialize by permanent cairns all the points that will serve as reference (base) GPS stations. This will allow considerably simpler and faster geodetic surveying for the purposes of Preliminary and/or Main Designs for selected sections of the watercourses and riparian areas.

As part of geodetic surveying of the main riverbed, cross-sections should also be created of existing bridges

(upper and lower edges of the structure, the position and dimensions of bridge piers and abutments) with access roads that intersect the valley of the river.

All data from the surveying should be entered into ACAD, which is digitally delivered to the Contracting Authority.

3. Geodetic survey of existing embankments

In the preparation of the General Design with Pre-Feasibility Study geodetic surveys should be carried out of all embankments along the Južna Morava and the lower stream of the Moravica and Binačka Morava rivers. Embankments should be surveyed by making cross sections spaced apart by 500 m, or even less in places where the embankment profile (shape, height, etc.) is significantly changed. Between the cross sections of an embankment the crown with two detailed points should be surveyed at every 100 m. All survey data should be entered into ACAD, which is digitally delivered to the Contracting Authority.

4. Taking samples from the bottom of the riverbed and river bars, along the watercourse

On the observed stretch of the Južna Morava, about 100 samples from the river bottom and river bars should be taken, at the average distance of 1 km. The location of the sampling sites will be determined during the terrain reconnaissance. The grain-size distribution should be determined by means of sieve analyses on the ground for coarse fractions of the samples, and/or in the laboratory for the finer fractions.

B) PREPARATION OF TOPOGRAPHIC MAPS FOR THE GENERAL DESIGN WITH PRE-FEASIBILITY STUDY

In the preparation of the General Design with Pre-Feasibility Study, the preparation of topographic maps with a presentation of the vertical situation on the terrain is a specially significant activity.

The Južna Morava Valley is presented on 1:25000 topographic maps, whose content dates back to the period 1969-1971, as well as 1:10000 situational plans with presentations of the vertical situation, based on surveys carried out in 1960. Bearing in mind the dynamics of morphological changes of the riverbed, the construction of regulation structures and flood control structures, transport and other infrastructure facilities in the riparian lands of the Južna Morava in the previous period, it is clear that the said topographic maps in their original form are not adequate for developing the General Design with Pre-Feasibility Study.

Considering the above, it is necessary to update the topographic maps of the Južna Morava valley with new orthoimagery or by using satellite images, while utilizing the results of performed geodetic surveys.

Working topographic maps should be prepared in the ACAD software, by compiling all available maps and data from additional surveys of the riverbed and structures on the Južna Morava. For the purpose of preparing geodetic documents, the following should be used:

- Digital maps and a digital terrain model 1:25000
- More recent satellite images
- More recent orthoimagery of the area
- Data from surveys carried out in the context of the General Design with Pre-Feasibility Study (the riverbed and embankments)
- Data from main designs for E-75 highway (digital data on routes and elevations of facilities). The obtaining of these designs is the obligation of the Contracting Authority.

C) STUDY WORK

1. Collecting, collating and analyzing the existing documentation and background material

It is necessary to collect and analyze:

- Studies and designs for the regulation of the Južna Morava on the observed sector, which were made as part of the designs of E-75 highway and other infrastructure facilities,
- Plans for the spatial regulation and use of riparian areas,
- Morphological, geological and hydrological surveys of the watercourse.

2. Hydrological analysis of the observed sector of the Južna Morava

It is necessary to conduct a hydrological analysis of the regime of high, medium and low waters of the Južna Morava. In the analysis, data should be used of the Republic Hydro-Meteorological Institute from the H.S. Grdelica, Vladičin Han and Vranjski Priboj, up to 2015 inclusive. The results are to be submitted to RHMI and approval for further work is to be obtained.

On the basis of the results of the hydrological analysis, the design flows for watercourse regulation are to be determined, by sector/section.

3. Hydraulic analysis of the observed sector of the Južna Morava

As part of the hydraulic analysis of the Južna Morava, from Grdelica to the junction of the Binačka Morava and the Moravica, the following is to be done:

- on the basis of all collected and surveyed bases and data, make a hydro-morphological model of the riverbed, which comprises the full major bed up to the estimated reach of high waters with low probability of incidence, in the case of the destruction of the embankment,
- define the hydraulic resistance in the minor and major bed,
- by applying a 1-D flow hydraulic calculation model, define the capacity of the existing river bed and sediment transport capacity of the river course.

A report on hydraulic modelling in the study should include:

- A description of river sections that are hydraulically modelled;
- A description of hydraulic models of individual river sections (morphological bases, boundary and initial conditions and other input data);
- Results of the calculations with a reference to the issue of flood control in the valley of the Južna Morava and the impact of built or designed infrastructure facilities (including landfills for material).

4. Morphological and psamological analysis of the observed sector of the Južna Morava

It is necessary to provide an overview of properties of morphological and psamological processes of the Južna Morava, particularly of the river route changes and the deformation of the riverbed, and the process of fluvial erosion along the watercourse.

C) GENERAL DESIGN WITH PRE-FEASIBILITY STUDY

1. Categorization of the observed sector from the standpoint of its hydro engineering status and urgency of regulation interventions

Under this item of the General Design with Pre-Feasibility Study, it is necessary to determine the criteria for the categorization of the Južna Morava sections. Critical sections from the standpoint of fluvial erosion and stability of the river route, the capacity of the existing riverbed and the degree of protection of riparian lands against flooding, should be designated.

2. River engineering solutions

It is necessary to determine the river engineering variants for the minor and major bed of the Južna Morava, on the sector from Grdelica to the junction of the Moravica and Binačka Morava rivers.

For each variant, it is necessary to make a hydraulic analysis of the effects of the river regulation and provide an approximate priced bill of quantities.

The selection of an optimal variant should be made on the basis of the results of the hydraulic analysis of the effects of the river regulation and the priced bill of quantities.

3. Prioritization in the context of the watercourse regulation and recommendations for further actions

For the adopted river engineering concept and solution, priorities should be identified and the schedule of works on the regulation of the watercourse by section of the Južna Morava should be provided. Also, the program should be submitted for site investigations for the next phases of the designing (preliminary designs and designs necessary to obtain a building permit)

4. BACKGROUND MATERIAL

The background material for the development of the documents in question includes:

Publicly available documents:

- Regional spatial plans
- Spatial plans of municipalities on the upper segment of the Južna Morava basin

The documentation and data to be provided by the Contracting Authority:

- The existing design documents and studies related to the flood control facilities and measures in the basin of the Južna Morava river.
- The existing design documents related to the envisaged capital infrastructure facilities in the basin of the Južna Morava river
- Topographic maps of the basin area of scale 1:25.000
- Digital model of the terrain 1:25.000 (or a DTM of a better quality if it is available)
- Cross sections of river beds from various documentation
- Orthoimagery of the Južna Morava river basin

5. ORGANIZATION AND TIME TABLE FOR THE DEVELOPMENT OF THE GENERAL DESIGN WITH PRE-FEASIBILITY STUDY

The funding for the development of the General Design with Pre-Feasibility Study will be secured by UNOPS - Belgrade, which will set up, together with JVP „Srbijavode“ a Project Technical Council, which will monitor and verify on their behalf the results of the General Design with Pre-Feasibility Study in the course of its preparation.

The General Design with Pre-Feasibility Study is to be developed in phases, with periodical reporting on what has been achieved and with guidelines for further work. Three phases are planned for the submission of the documentation:

1. phase – a Report on the performed site investigations – 4 months after the commencement of the works
2. phase – a Report on the Situation Analyses Conducted– after 9 months
3. phase – General Design with Pre-Feasibility Study – after 12 months