FINAL CONFERENCE, 9.6.2020.

Bednja catchment and dynamic model tool

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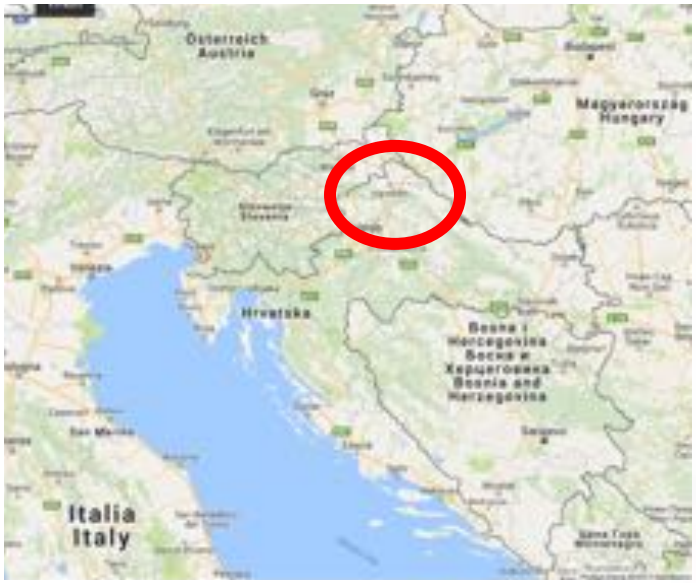
BEDNJA RIVER BASIN - OVERVIEW

BEDNJA RIVER BASIN – LOCATION



- The Bednja river basin covers little more than 600 km².
- The Bednja river basin can be divided into two main parts: upland and lowland.
- In terms of surface area, the major share (app.70%) of the Bednja basin belongs to the upland part, with the remaining share belonging to the lowland part. In the upland part, with a surface area of app. 480 km², there are 48 torrential basins with approximately 250 km of watercourses.

- The Bednja River basin largely lies in Varaždin County, with only a minor share of the upland part of the basin along the slopes of mountain Ivančica lying in Krapina-Zagorje County.
- Some 60,000 people or app. 34% of the population of Varaždin County live in the area of the Bednja River basin.
- The population is primarily concentrated in:
  5 towns (Lepoglava, Ivanec, Novi Marof, Varaždinske Toplice and Ludbreg)
  and 6 municipalities (Bednja, Donji Martijanec, Klenovnik, Donja Voća, Maruševec and Ljubešćica).

MAP OF THE BEDNJA RIVER BASIN

HYDROLOGICAL CHARACTERISTICS

- The backbone of the hydrographic network in the Bednja basin is the river Bednja and its tributaries, which are more numerous in the upland (upstream) part of the basin than in the lowland part of the basin.
- The course of the Bednja River from its source at the foot of Maceljska Hill to its confluence with the Drava River near the settlement of Mali Bukovec is 106 km long.
- Due to its pluvial regime, high water levels in the Bednja River form in the spring months (March- April), with the snow melt and spring rains occuring at the same time.

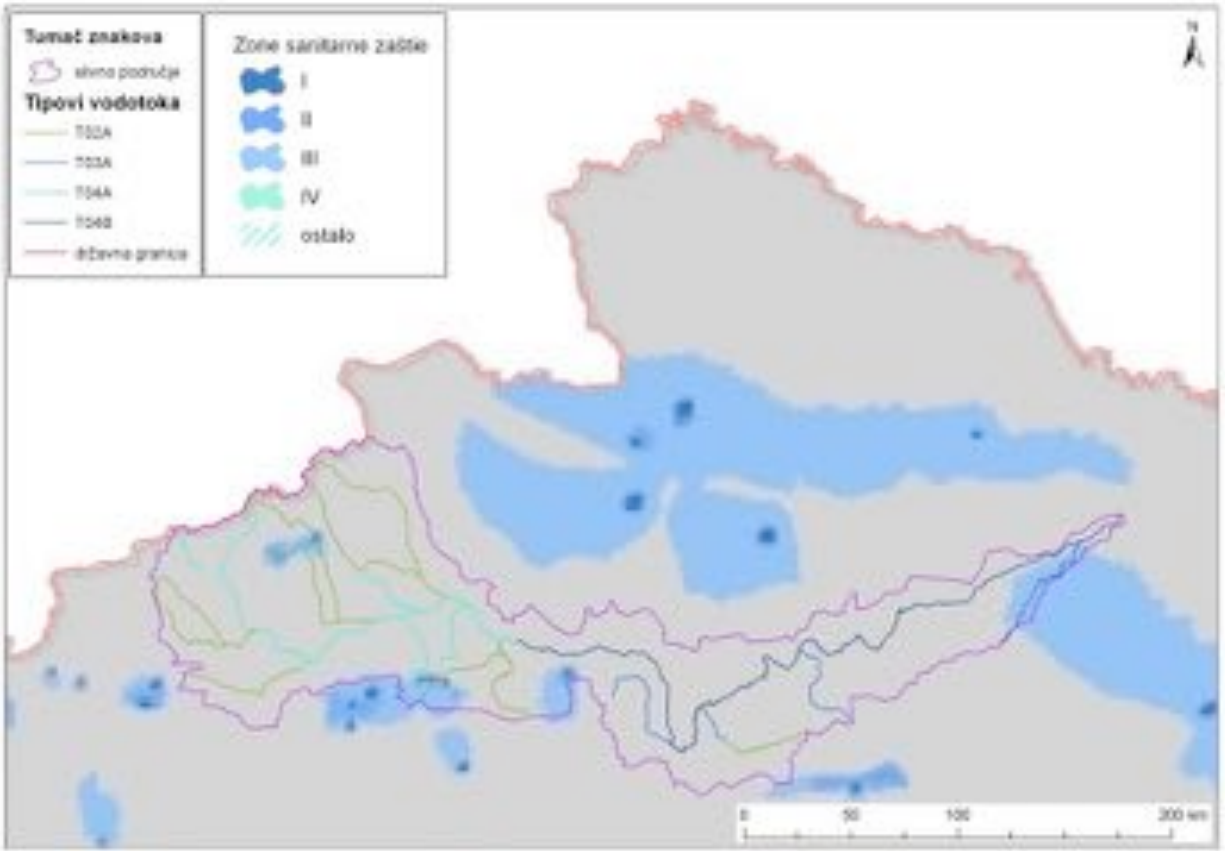
BEDNJA RIVER BASIN – BIO-ECOLOGICAL CHARACTERISTICS

The natural aquatic habitats lying on the sections of the Bednja River that haven't been modified by structural works and in the areas of alluvial and wet meadows are of key importance for the survival of rare and endangered species.

PROTECTED AREAS

According to Natura 2000, in the Bednja basin there are 14 sites important for the conservation of endangered species and a total of 12 sites with different levels of protection (1 regional park, 3 nature monuments, 1 significant landscape, 1 park forest and 6 monuments of park architecture).

AREAS OF SPECIAL WATER PROTECTION



The following protected areas lie in the Bednja basin:

- Areas designated for the abstraction of drinking water
- Areas suitable for the protection of economically significant aquatic species
- Areas subject to eutrophication and areas vulnerable to nitrates

ECOLOGICAL AND CHEMICAL STATUS OF WATER BODIES

Implementation of the Water Framework Directive:

- Assessment of ecological status at gauging stations and assessment of status according to quality elements.
- Assessment of surface water chemical status at surveillance monitoring stations.

Oznaka vodnog tijela	Mjerna postaja		Oznaka tipa	NM	OM	biološki elementi	prateći fizikalno-kemijski elementi kakvoće	specifične onečišćujuće tvari	EKOLOŠKO STANJE	stupanj pouzdanosti ocjene
	Šifra	Naziv				stanje	stanje	stanje		
CDRN0017_005	21083	Bednja, Stažnjevec	HR-R_1	DA	DA		UMJERENO	VRLO DOBRO/DOBRO	UMJERENO	SREDNJI
CDRN0017_005	21120	Voća, Ribić breg	HR-R_1		DA	UMJERENO	DOBRO		UMJERENO	SREDNJI
CDRN0017_001	21085	Bednja, Mali Bukovec	HR-R_4	DA	DA	UMJERENO	DOBRO	VRLO DOBRO/DOBRO	UMJERENO	SREDNJI
CDRN0177_001	21114	Ivanečka Železnica, na utoku	HR-R_1		DA	DOBRO	DOBRO		DOBRO	SREDNJI
CDRN0207_001	21116	Korušćak, Novi Marof	HR-R_2B		DA	LOŠE	UMJERENO		LOŠE	SREDNJI
CDRN0195_001	21117	Ljuba voda, Ljuba	HR-R_2B		DA	UMJERENO	DOBRO		UMJERENO	SREDNJI
CDRN0195_002	21118	Ljubelj, Ljubelj	HR-R_1		DA	UMJERENO	DOBRO		UMJERENO	SREDNJI
CDRN0140_001	21121	Žarovnica, Žarovnica	HR-R_1		DA	UMJERENO	DOBRO		UMJERENO	SREDNJI

Oznaka vodnog tijela	Mjerna postaja		Oznaka tipa	NM	OM	Kemijsko stanje	stupanj pouzdanosti ocjene
	Šifra	Naziv					
CDRN0017_005	21083	Bednja, Stažnjevec	HR-R_1	DA	DA	VRLO DOBRO/DOBRO	SREDNJI
CDRN0017_001	21085	Bednja, Mali Bukovec	HR-R_4	DA	DA	VRLO DOBRO/DOBRO	SREDNJI

FLOODS IN BEDNJA RIVER BASIN

- Floods sometimes occur several times a year, as the result of which the flooded area along the Bednja gradually attains swamp-like characteristics and cannot be used for agriculture. In such areas valuable wetlands have developed with endangered species on the county and even national level.

- There is a serious problem of flash floods that form after intensive rainfall in a significant number of the Bednja tributaries. A sudden increase in discharges causes the movement and transport of significant sediment quantities into the lowland parts of the watercourses and the Bednja recipient. It is not rare that flash floods are accompanied by landslides that put houses and commercial buildings at risk.

- Flash floods put at risk many settlements and facilities in this area: state roads, county roads and numerous local mountain roads, railroads with culverts and bridges, as well as minor industrial plants.

Croatian team - field trip to the Bednja river basin (October, 2018).

MATHEMATICAL MODELS

MATHEMATICAL MODELS IN THE BEDNJA RIVER BASIN

The mathematical models in the Bednja River basin were developed for the purpose of simulating flood events with selected measures for the present and planned state.

Used models:

- HEC-HMS 4.0 (Hydrologic Engineering Center – Hydrologic Modelling System) Hydrological runoff model; transformation of precipitation into runoff.

and

- MIKE 21 (DHI) - 2D model - Hydraulic analyses and flow modelling.

MEASURES USED FOR DYNAMIC MODELLING

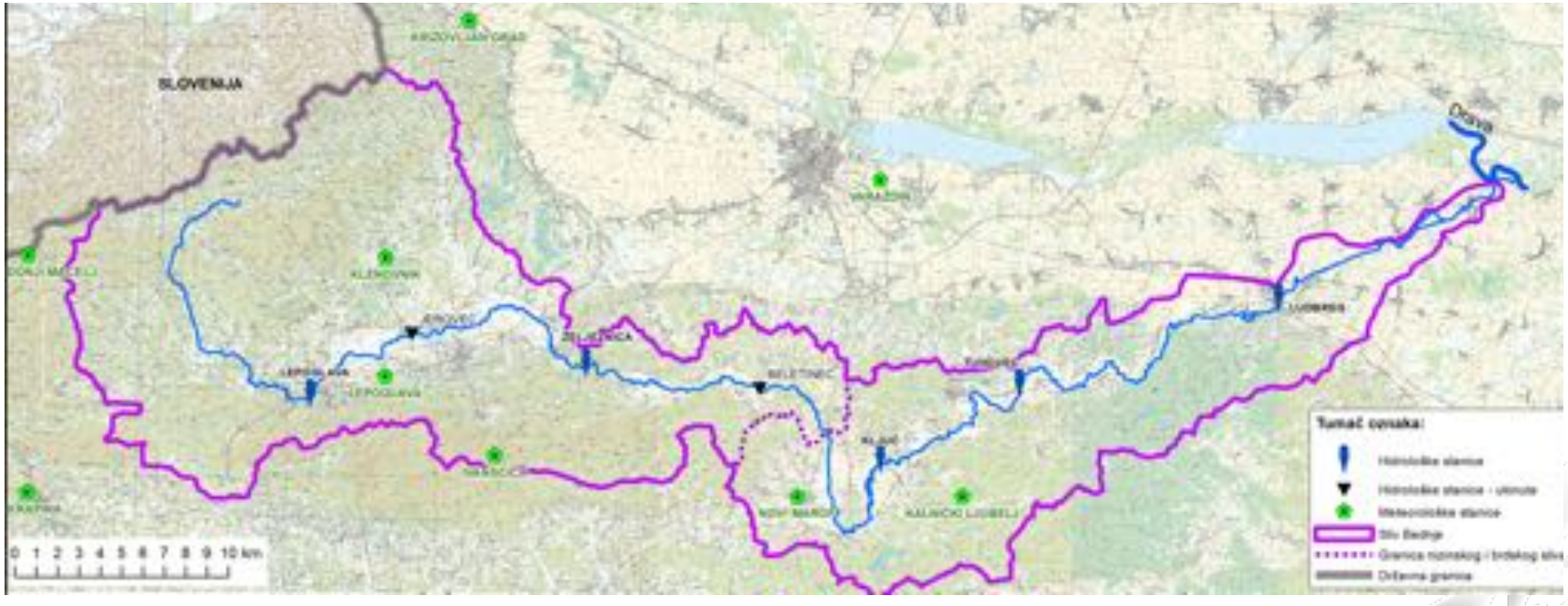
According to the catalogue of measures and based on the basin analysis, the following basin-wide measures have been selected on the Bednja river:

T01 - *Polders, dry flood protection reservoirs, sediment trapping dams*
Water retention basins for flood defense and control discharge into the downstream basin and to reduce erosion on the downstream river.

T02 - *Widening or removing of flood protection dikes*
By moving the dikes away from the river, riparian habitats are protected better, floods have a weaker impact, and maintenance requirements are lower.

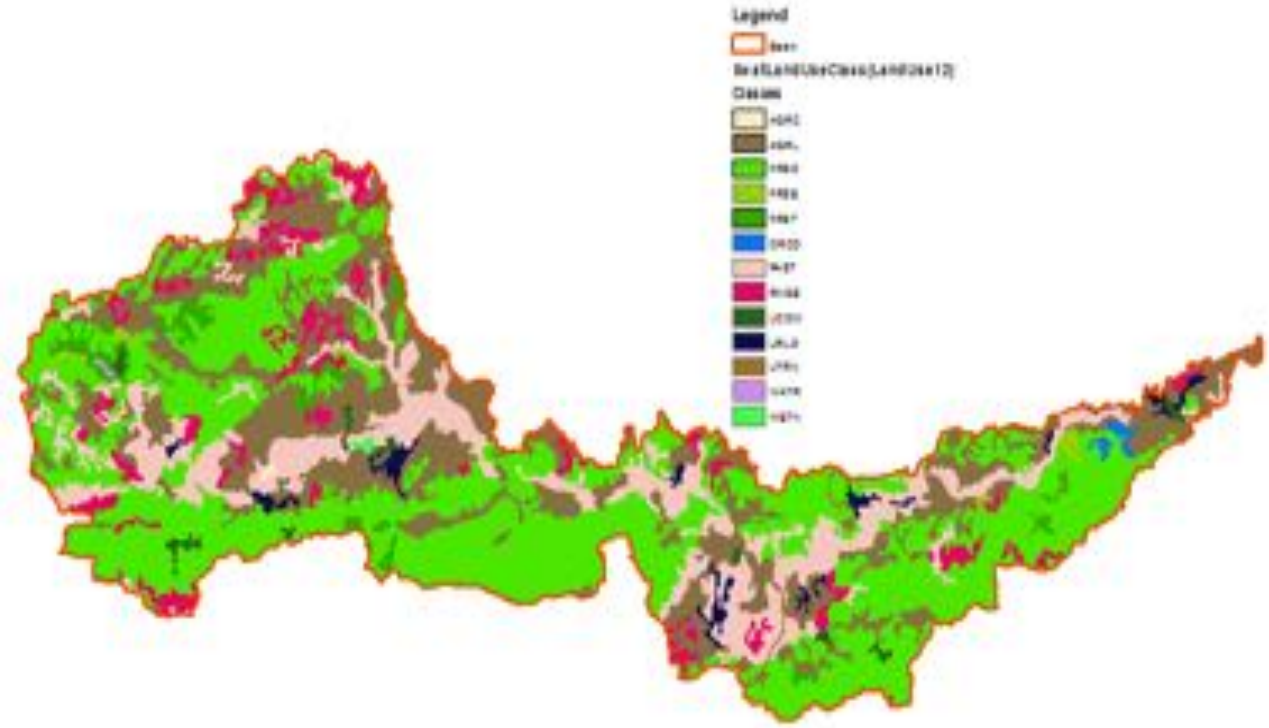
Statistical analyses of flows at the hydrological station and precipitation at the meteorological stations were made in order to obtain inputs for precipitation and flow information for hydrological model calibration.

Meteorological stations used for modelling and flow gauges used for calibration/validation.



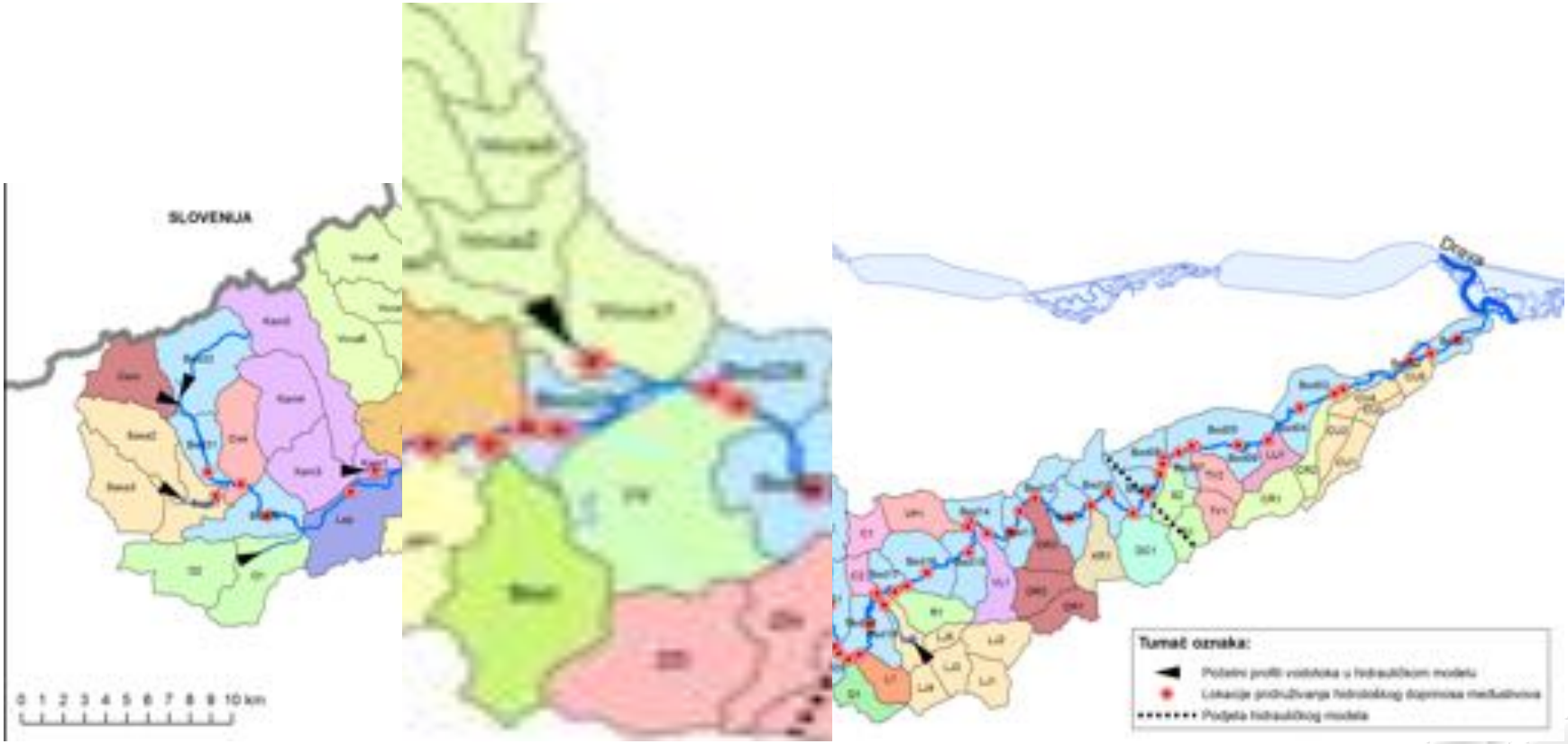
The hydrological model requires a land cover map reclassified into hydrological model's classes (HEC-HMS).

Input data source: Corine Land Cover

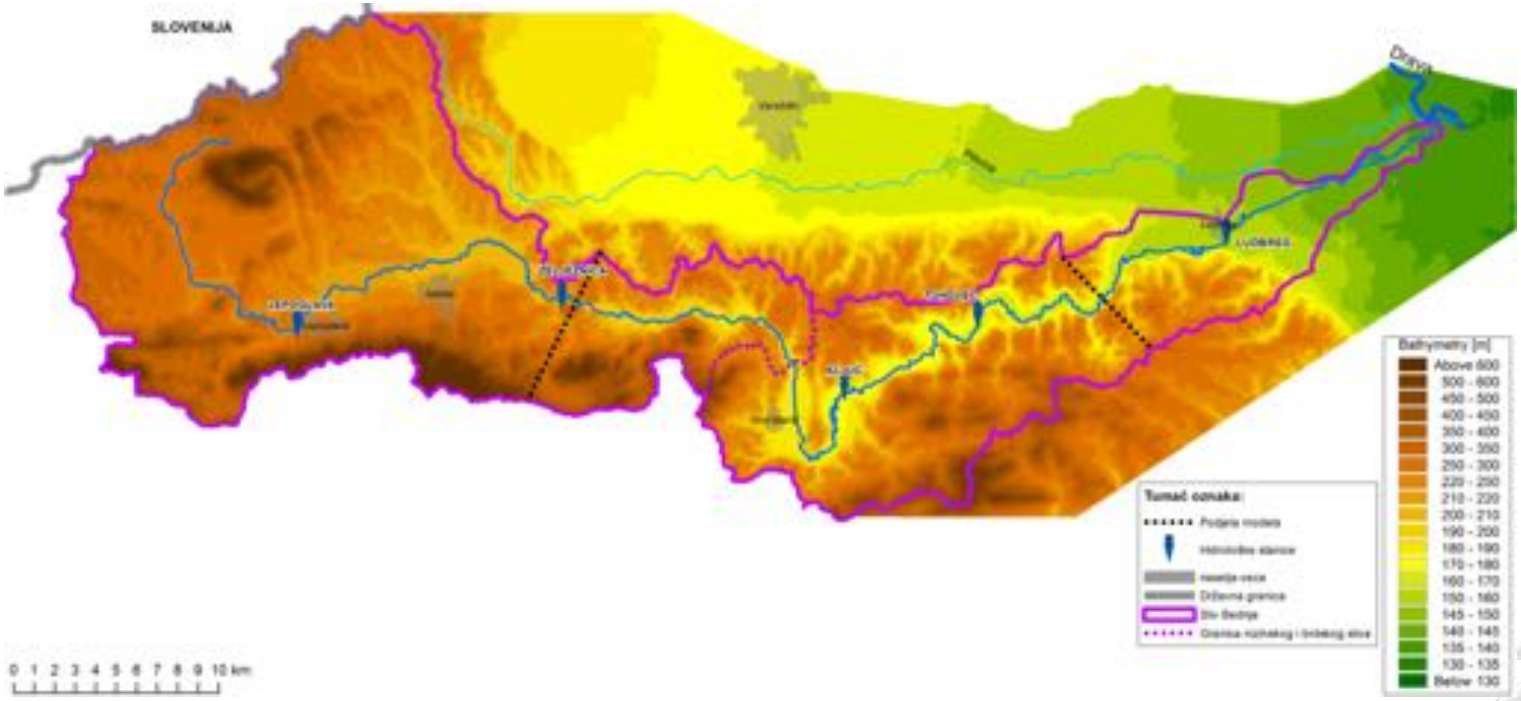


PROJECT AREA FOR 2D MODEL

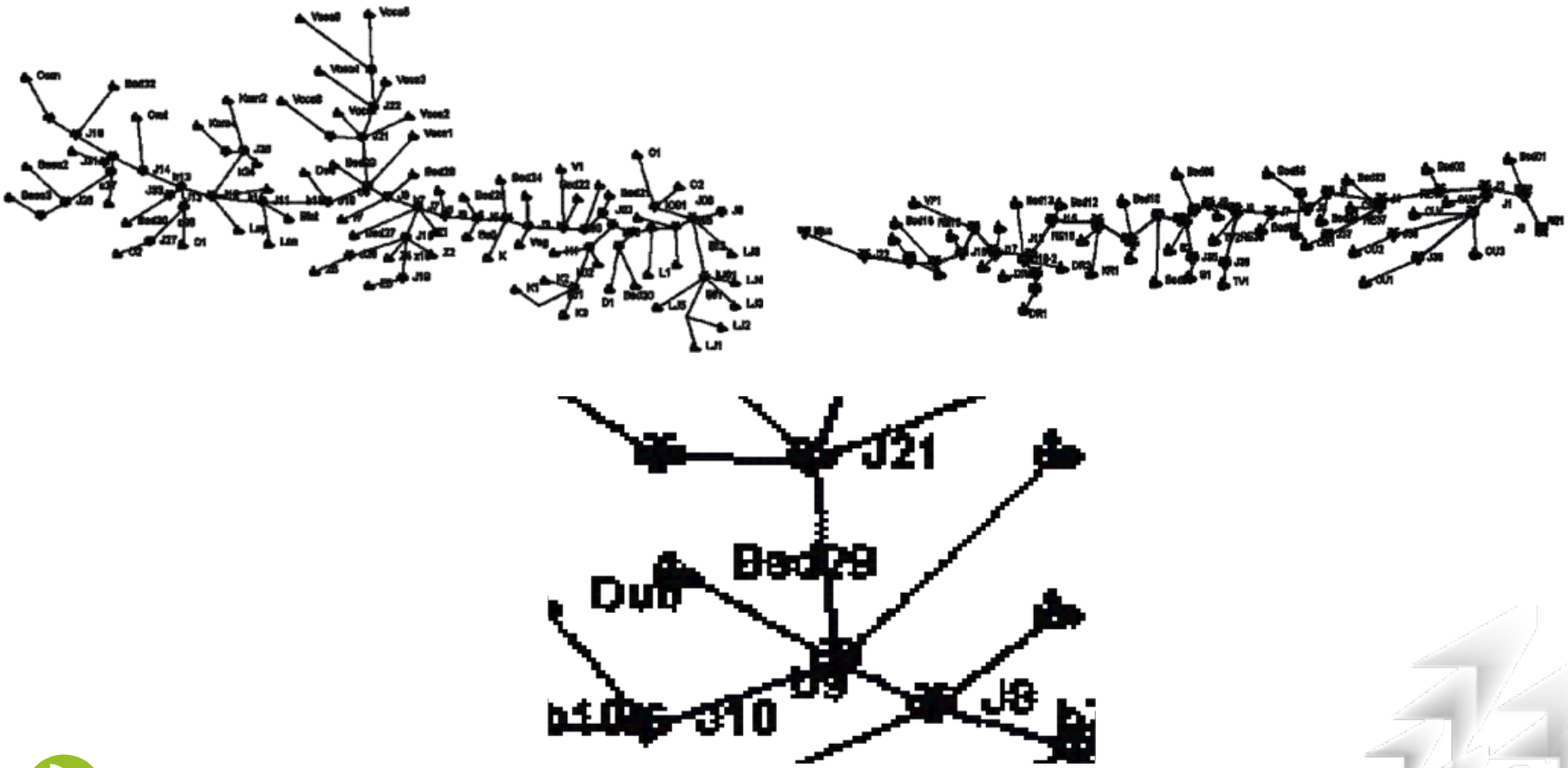
Running the HEC - HMS hydrological model requires the division into sub-basins which are shown schematically in the model. The model simulates the precipitation-runoff process at the design points. Division into subbasins (101):



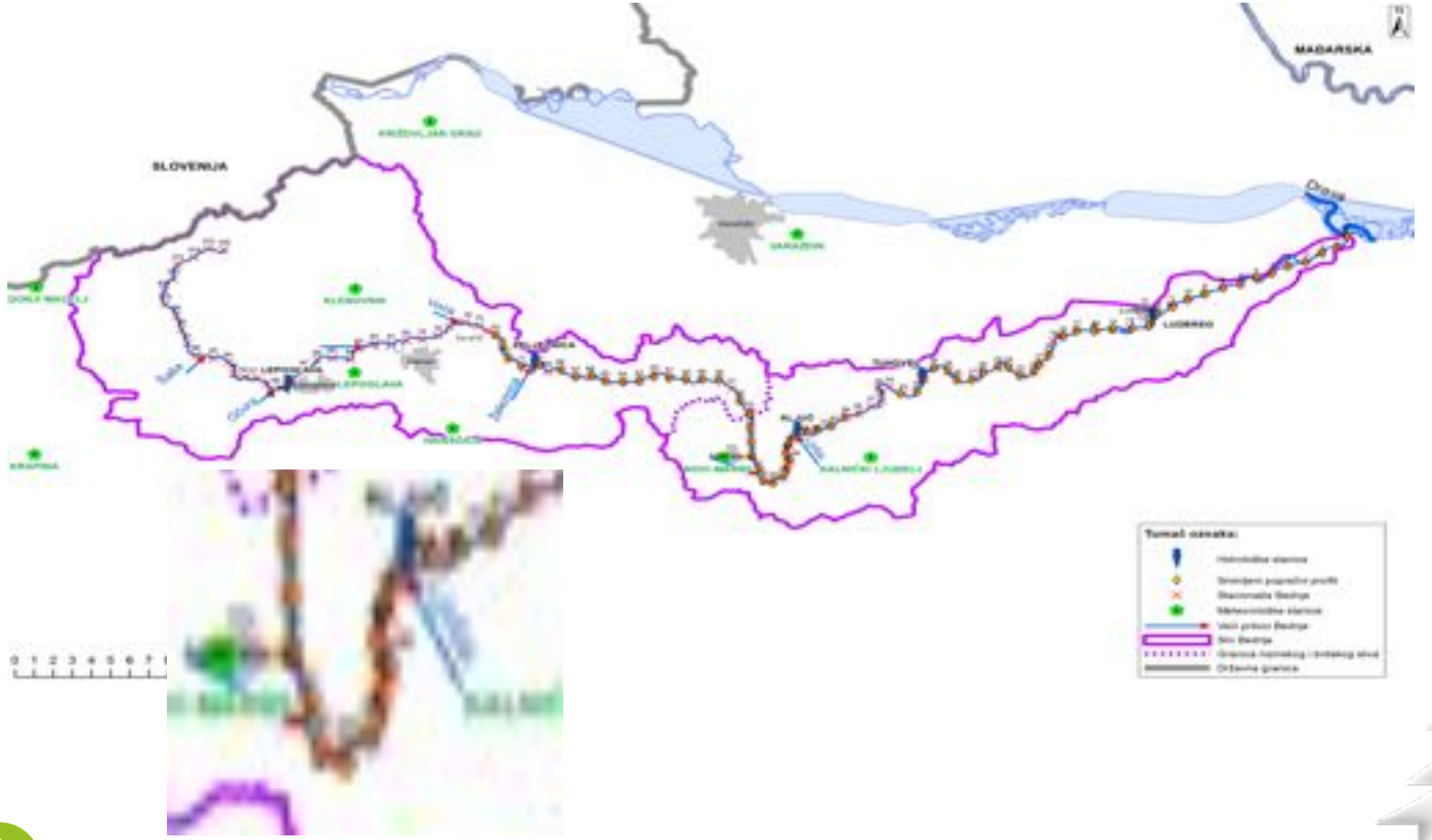
The 2D model is based on the Digital Elevation Model (DEM) that shows the configuration of the terrain.



River network as implemented in the model.



Profiles of the Bednja river and its major tributaries are inserted near the point where they enter the Bednja.

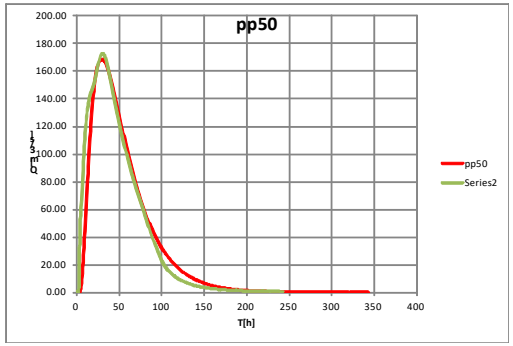


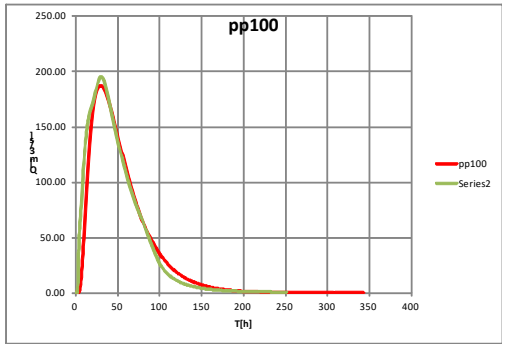
MODEL CALIBRATION AND VALIDATION

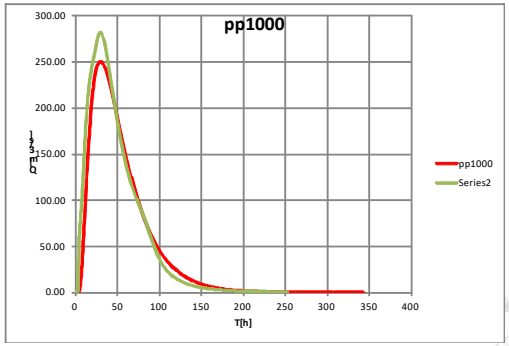
Results of hydrological model calibration and verification at the locations of hydrological stations.

- The model was used for the calculation of hydrographs at locations of hydrological stations and in the defined sub-basins.

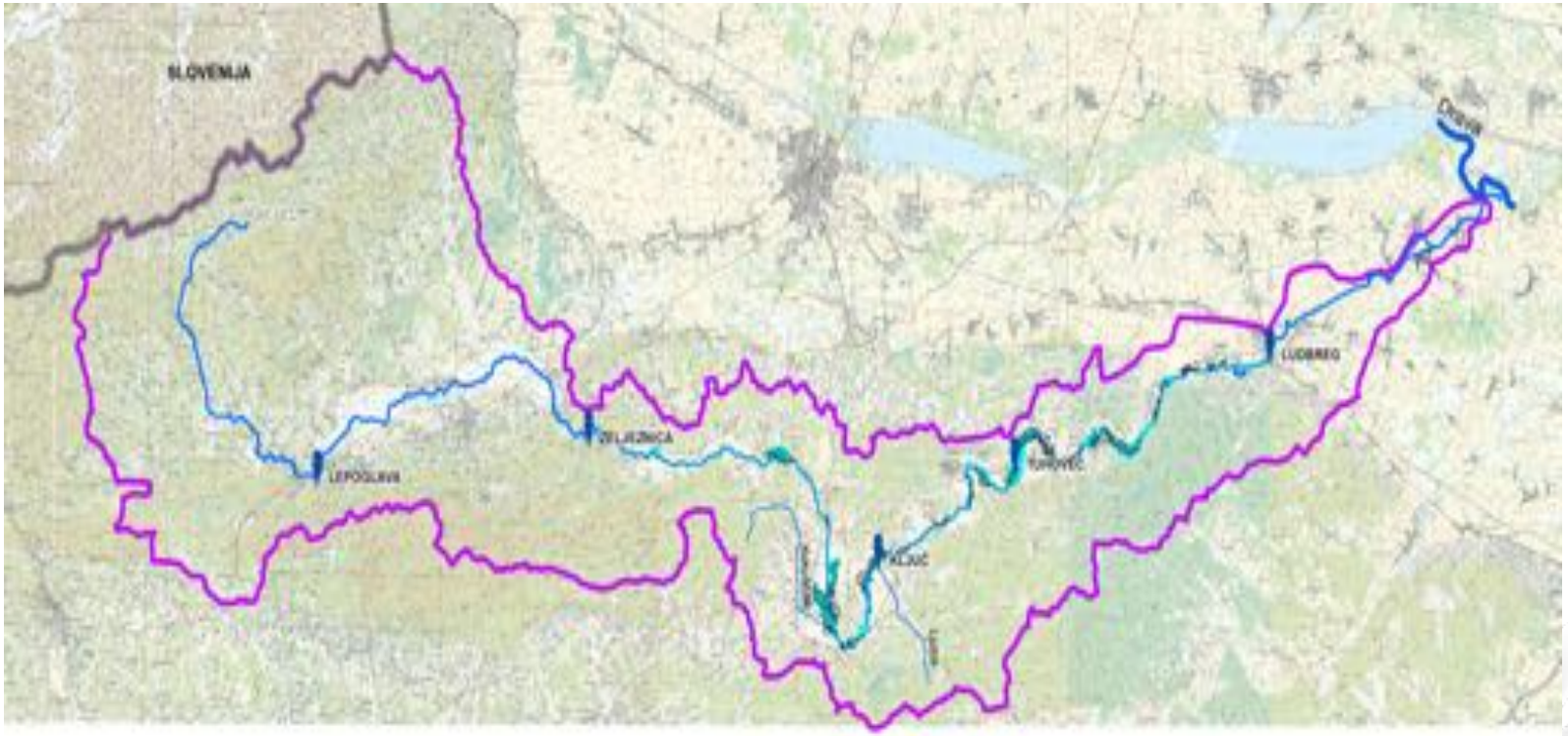
- Based on the design precipitation defined earlier and hyetographs of different return periods (RPs), the model calculated hydrographs at the locations of hydrological stations which were compared with the synthetic hydrographs of corresponding RPs calculated and construed based on the statistical analyses of the measured data.



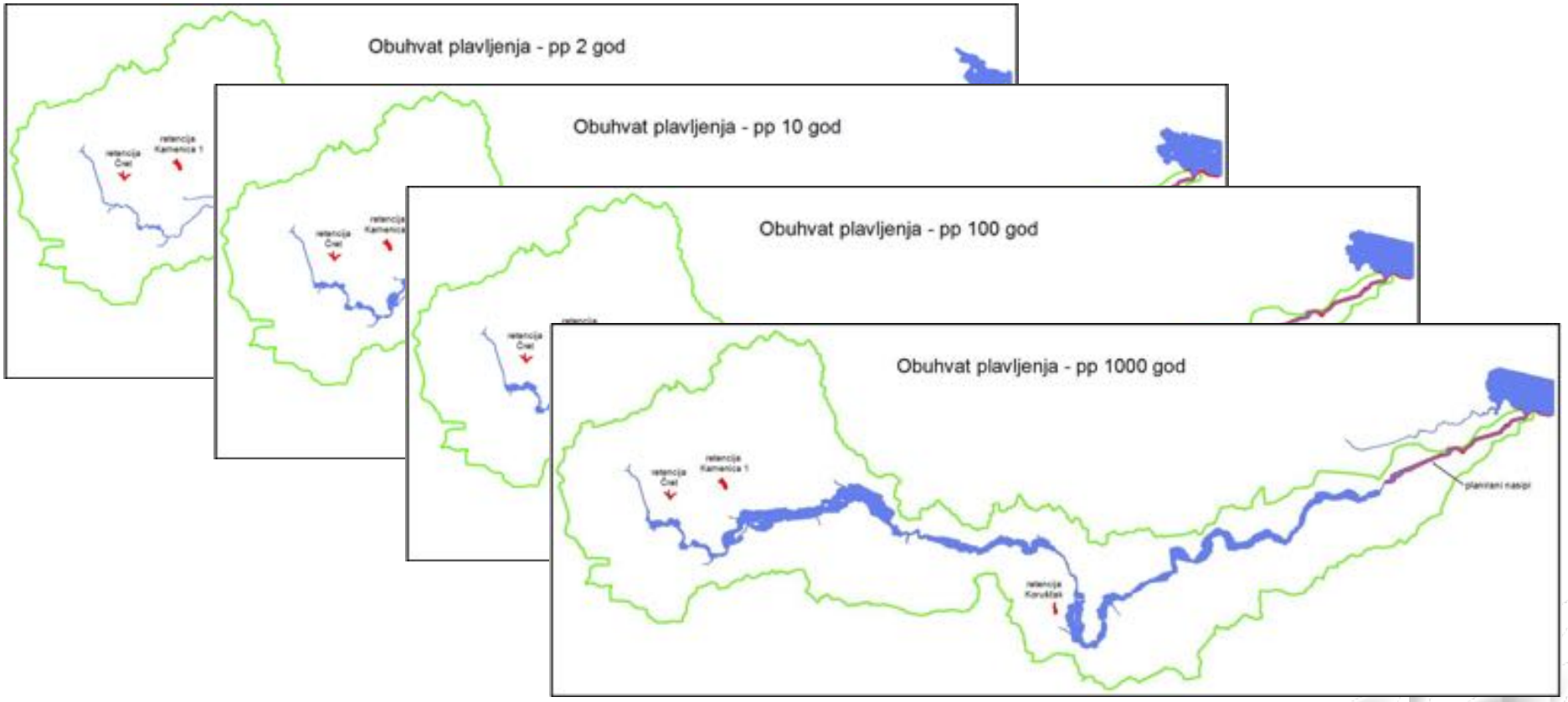




The model was validated with the recorded flood events in the basin. Comparison between a historical flood event and the modelled flood area.



A hydrological-hydraulic analysis of the Bednja basin has been made for measures T01 and T02 for the hydrological state with 2, 5, 10, 25, 50, 100 and 1000 year return period floods.



CONCLUSIONS

Models for the Bednja catchment were calibrated and validated.

The goal was to test the dynamic models with the purpose of assessing effectiveness of measures T01 and T02.

By comparing the results it is clear that the effect of reducing floodplains is the largest in the area in the downstream part of the basin.

The effects of retention basins in the upland part of the basin are present only locally, through the reduction of individual flooding depths caused by the retention of water volumes in the retention basins.

Thank you for your attention

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