APPROACH TO THE MANAGEMENT OF DRAVA RIVER FLOOD PLAIN BETWEEN 0-176 RIVER KILOMETRE FOR THE SUSTAINABLE FLOOD PROTECTION AND WETLAND RESTORATION

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Ø the study was carried out in order to define hydrotehnical, ecological and other measures for the sustainable flood protection and improvement of ecological status of wetlands on the Drava river flood plain on the most downstream river reach

CONTENTS OF THE STUDY:

1) HISTORICAL OVERVIEW OF THE DEVELOPMENT OF DRAVA FLOOD PLAIN
2) ANALYSIS OF POSSIBLE MEASURES FOR EFFICIENT FLOOD PROTECTION
3) RESTORATION OF WETLANDS IN DRAVA FLOOD PLAIN
4) CONCLUSIONS

HYSTORICAL OVERVIEW OF THE DEVELOPMENT OF DRAVA FLOOD PLAIN

The analysis included:

- Ø geomorphological changes of Drava river bed and flood plain
- Ø overview of old maps and longitudinal profiles
- Ø existing conditions of the flood plain
- Ø expected changes of the flood plain according to the future plans for building two hydroelectric power plants on this river stretch

HISTORICAL OVERVIEW OF THE DEVELOPMENT OF DRAVA FLOOD PLAIN

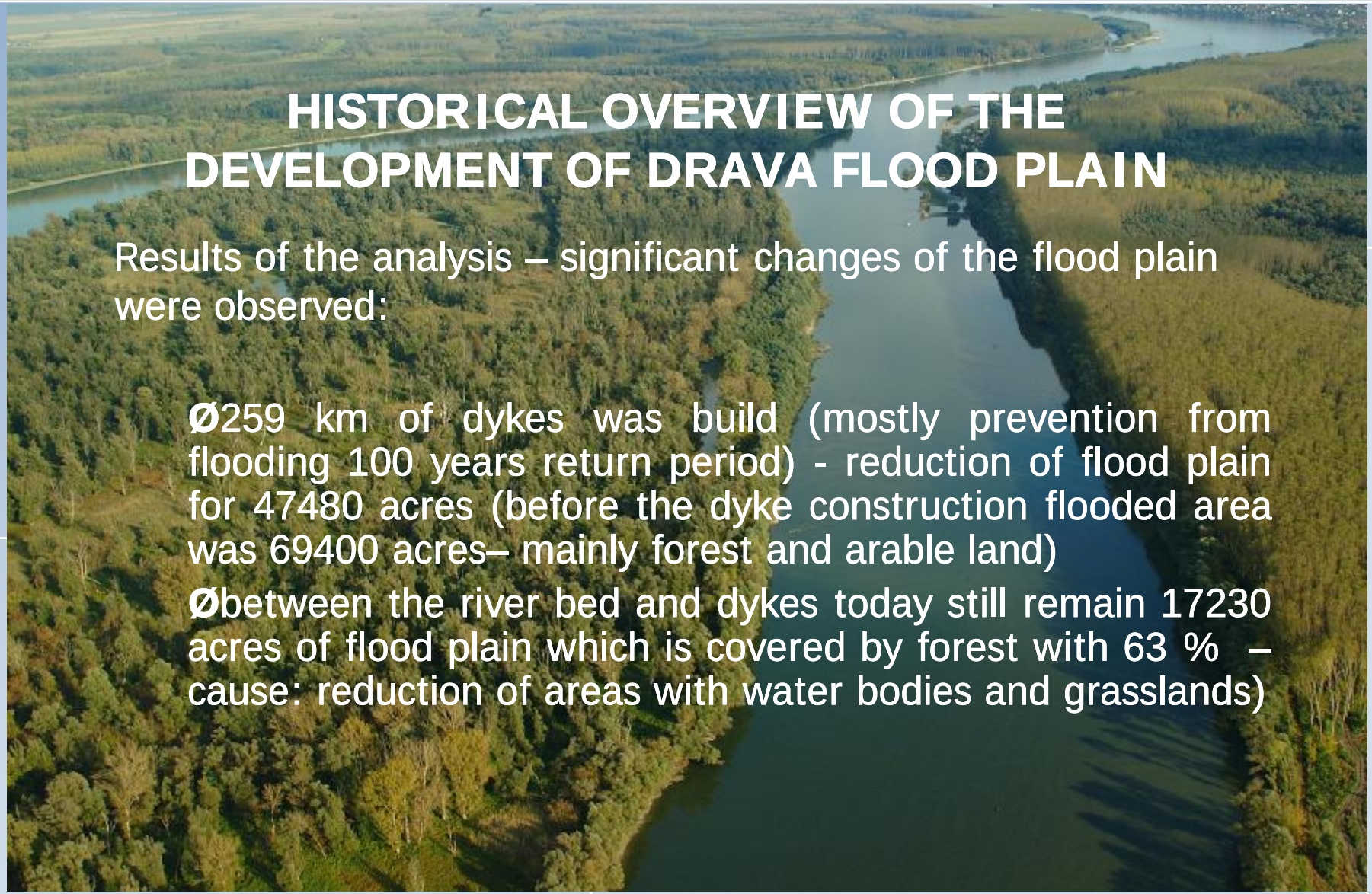
Main findings of the analysis are:

Ø morphological changes of observed river section without anthropogenic influence till the end of 18th century

Ø length of the most downstream river branch was reduced by almost 100 kilometers during 19th century with regulations works

Ø Drava river also on this stretch was most regulated river in Europe in the past – navigable up to Mura's river mouth

Øintensive regulation works, excavation of gravel and sand from river bed and building of dykes during 20th century



HISTORICAL OVERVIEW OF THE DEVELOPMENT OF DRAVA FLOOD PLAIN

Results of the analysis – significant changes of the flood plain were observed:

- Ø259 km of dykes was build (mostly prevention from flooding 100 years return period) - reduction of flood plain for 47480 acres (before the dyke construction flooded area was 69400 acres– mainly forest and arable land)
- Øbetween the river bed and dykes today still remain 17230 acres of flood plain which is covered by forest with 63 % – cause: reduction of areas with water bodies and grasslands)

ANALYSIS OF POSSIBLE MEASURES FOR EFFICIENT FLOOD PROTECTION

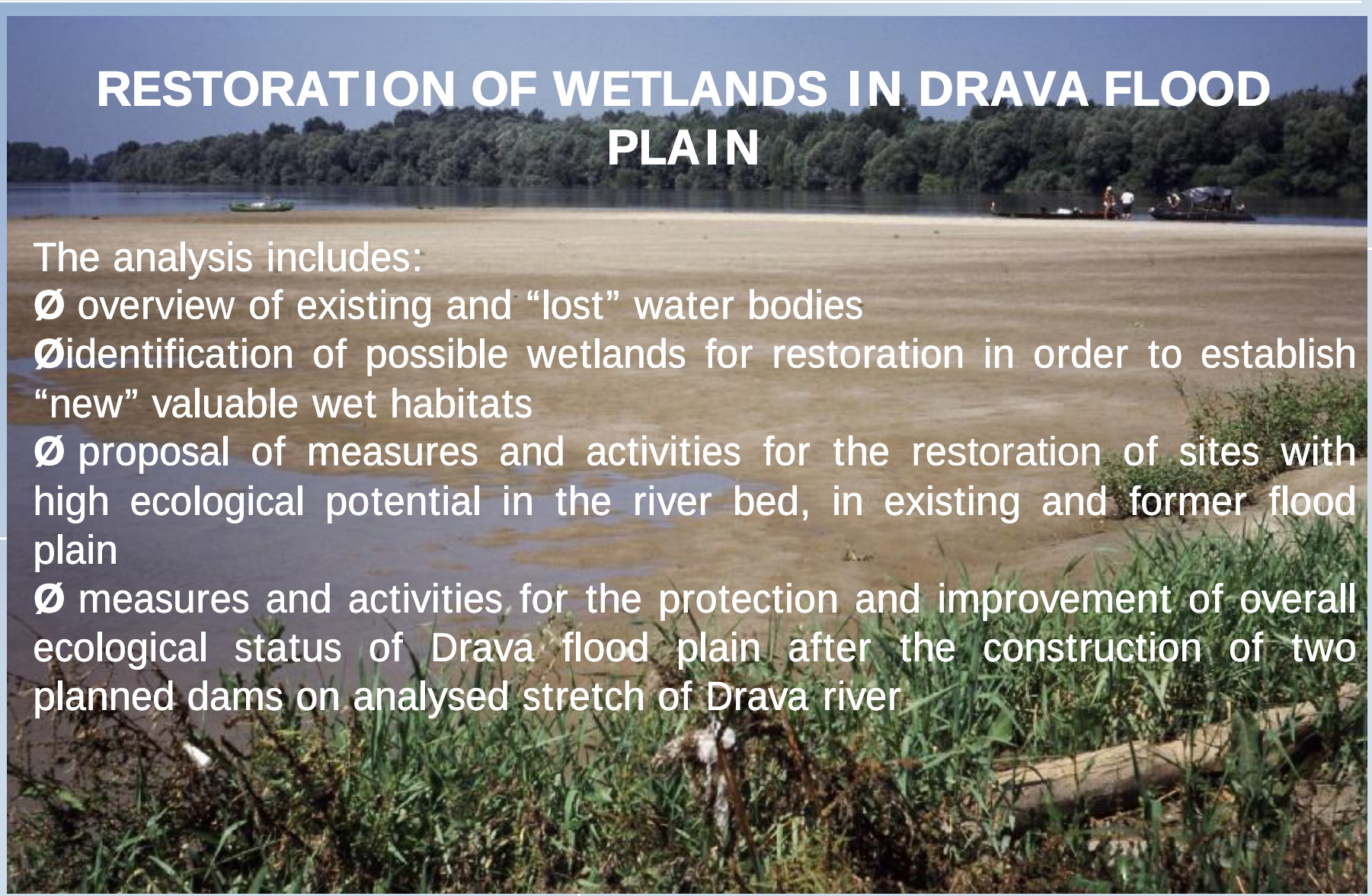
- Taking into account results of previous analysis in the next step of study the transportation capability of extreme flood waves is investigated and efficiency of existing flood protection system
- For that purpose the preliminary modeling of observed river stretch is carried out applying HEC RAS model for stationary flow state – calculation of water levels for discharges with different return periods of occurrence
- Results by model calibration and verification:
  - flood plains have much larger coefficient of roughness than expected, causing the reduction of transport capacity of the river in case of occurrence of extreme flood waves
  - most threatened river section from the aspect of flooding is section downstream of Belisce up to the city of Osijek (52-24 rkm) where existing dykes (constructed for 100 years flood) potentially can not prevent from flood with occurrence of 25 years return period

ANALYSIS OF POSSIBLE MEASURES FOR EFFICIENT FLOOD DEFENCE ANALYSIS OF POSSIBLE MESURES FOR EFFICIENT FLOOD PROTECTION

Conclusions:

- Ø increased risk from flooding on the most downstream stretch of the river (reduced possibility for the mitigation of flood waves in upstream and middle part of Drava river – constructed dams, loss of previous floodplains – existing dykes; present state of flood plain on the observed section of the Drava river)
- Ø proposed measures: enforcement of existing dykes, increase of grassland areas downstream of 77 river kilometre, eventually opening of new retention areas along the river stretch – expensive solutions)
- Ø all measures could be applied until the construction of two dams - multipurpose hydro system on observed river stretch (according to State space plan 31+200 and 74+000 rkm VHS Osijek, 85+200 and 159+000 VHS D. Miholjac) as a final prevention from flooding

RESTORATION OF WETLANDS IN DRAVA FLOOD PLAIN



The analysis includes:

- Ø overview of existing and “lost” water bodies
- Øidentification of possible wetlands for restoration in order to establish “new” valuable wet habitats
- Ø proposal of measures and activities for the restoration of sites with high ecological potential in the river bed, in existing and former flood plain
- Ø measures and activities for the protection and improvement of overall ecological status of Drava flood plain after the construction of two planned dams on analysed stretch of Drava river

Slike ni mogoče prikazati. Morda računalnik nima dovolj spomina, da bi lahko odprl sliko, ali pa je slika poškodovana. Znova zaženite računalnik in nato znova odprite datoteko. Če se bo še vedno prikazal rdeč x, boste morda morali izbrisati sliko in jo na

Abundance of wet habitats in different levels of succession with significant biodiversity despite antropogenic ifluence during the last 200 years – can be explained by presence of dynamic processes wich secure the sustainability of ecological river ecosystem

Sustainable flood protection and wetland restoration on the Drava River in Croatia

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RESTORATION OF WETLANDS IN DRAVA FLOOD PLAIN

Results of the analysis:

- present overall state of the flood plain besides negative influence on the flood wave transportation capability is also not acceptable from the bio-ecological aspects – replacement of wet habitats by forested areas
- in the most of existing wetlands hypertrophic conditions are observed because of large primary organic production – raising of bottom of water bodies
- priorities for restoration of valuable wet habitats are chosen according to their bio-ecological characteristics in order to preserve existing biodiversity on analysed river reach

RESTORATION OF WETLANDS IN DRAVA FLOOD PLAIN

Proposed measures:

- in the Drava river bed:
  - restoration of 8 old river branches by removal or lowering artificial barriers between old and active river bed – entrance of fresh water in order to prevent further forestation
  - protection of high river banks
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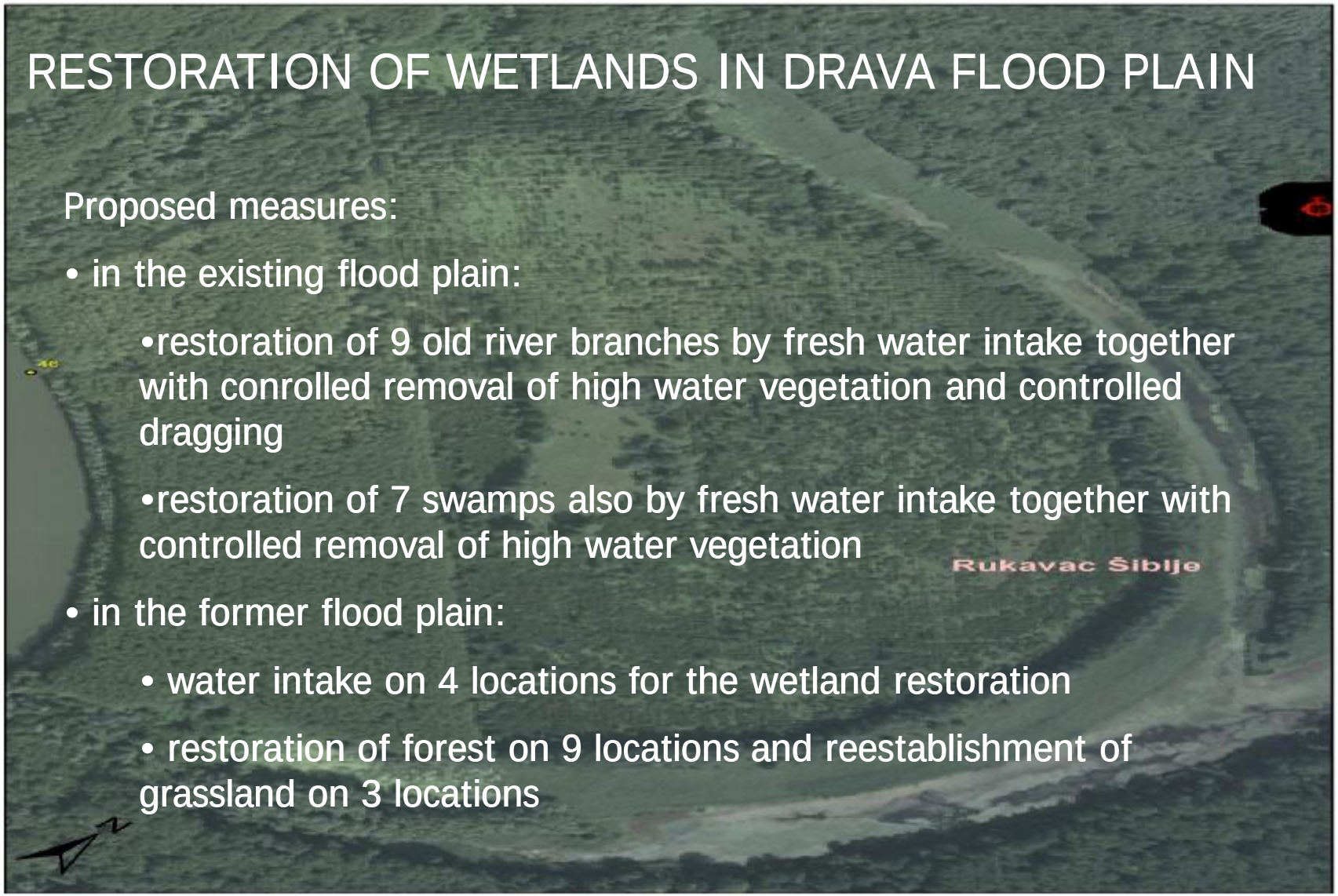
RESTORATION OF WETLANDS IN DRAVA FLOOD PLAIN

Proposed measures:

- in the existing flood plain:
  - •restoration of 9 old river branches by fresh water intake together with conrolled removal of high water vegetation and controlled dragging
  - •restoration of 7 swamps also by fresh water intake together with controlled removal of high water vegetation
- in the former flood plain:
  - • water intake on 4 locations for the wetland restoration
  - • restoration of forest on 9 locations and reestablishment of grassland on 3 locations



CONCLUSIONS

Ø the results of preliminary analysis show that present state of Drava flood plain reduce transport capability for extreme flood waves and emphasise need for restoration of wetlands along the most downstream part of the Drava river (further development of the model for unstationary flow state)

Ø the analysis of existing bio-ecological values of the Drava river and its flood plain shown that this river stretch belongs to the most preserved river ecosystem in Europe thanks to good water management practice and the presence of dynamic processes such as sediment transport and deposition, erosion of river banks, meandering and periodically flooding of inundation

ØProposed measures and activities for restoration of wet habitats will lead to the further protection and improvement of biodiversity

Øconcerning future plans for multipurpose use of this Drava river stretch, the sustainability principle should be applied in order to preserve and improve existing natural values of the area