

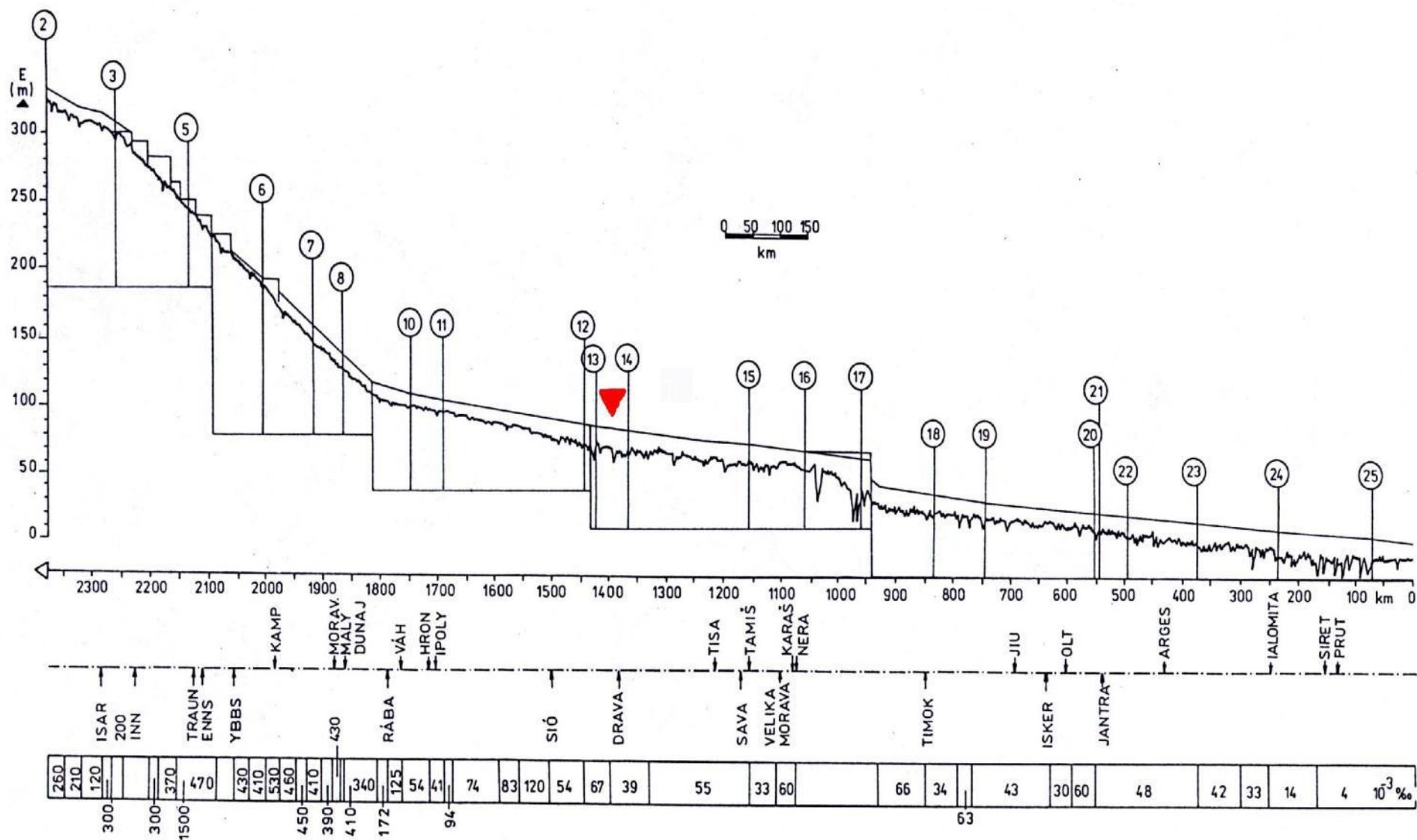
09/03/2010 ZAGREB

PRELIMINARY DESIGN FOR THE DANUBE REACH FROM 1400 TO 1410 RIVER KM

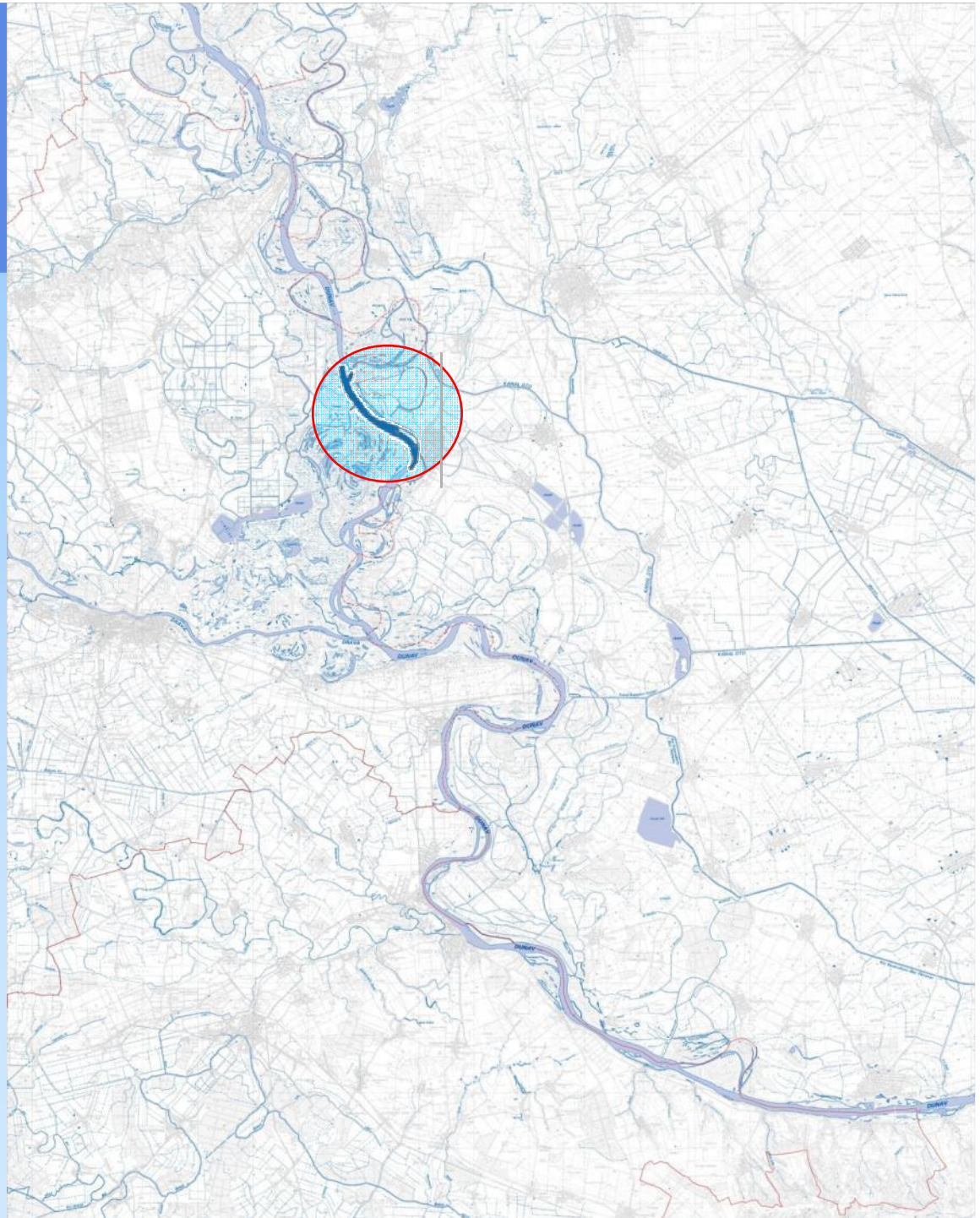
**HIDROING ON BEHALF OF THE AGENCY FOR IWT
AND
PLOVPUT**

INTRODUCTION - CHARACTERISTICS

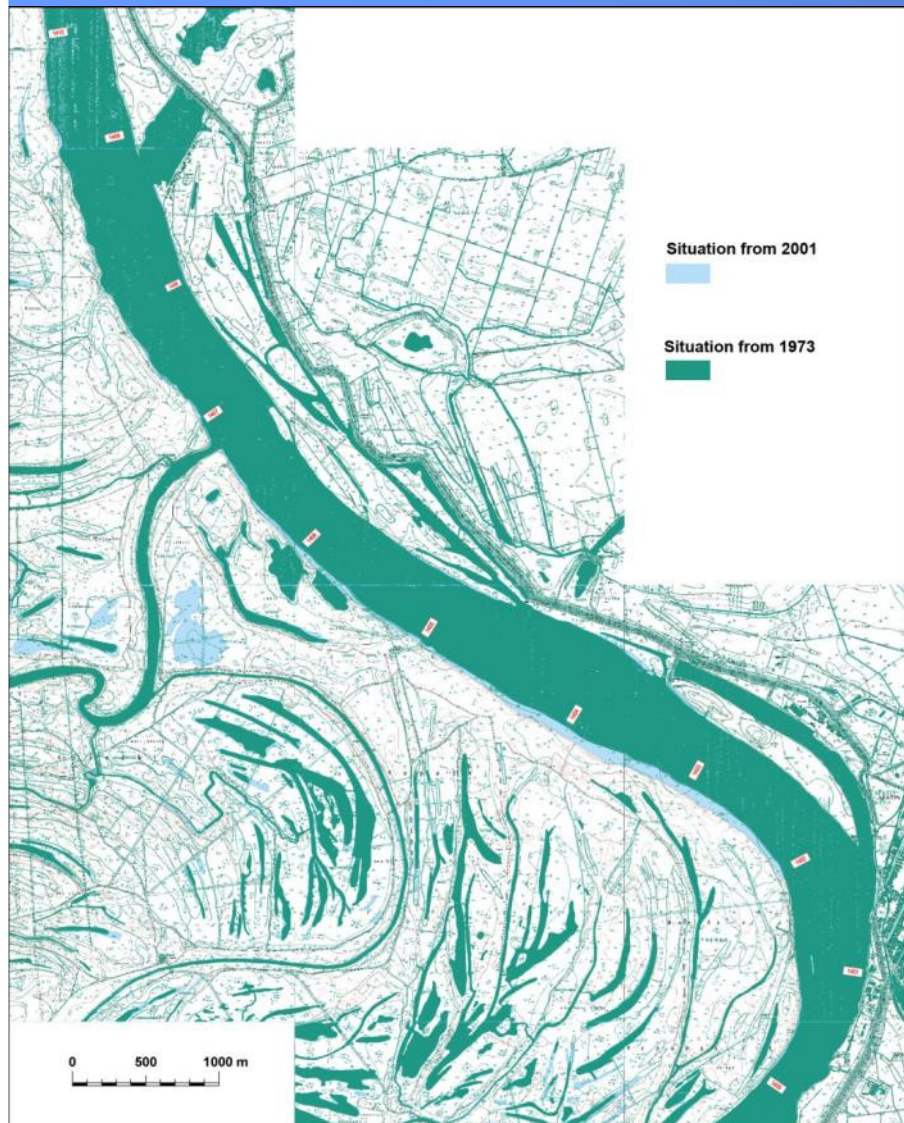
- REACH OF THE MUTUAL INTEREST IS FROM 1295.5 RIVER km (BORDER WITH REPUBLIC OF SERBIA) TO 1433.0 RIVER km (BORDER WITH REPUBLIC OF HUNGARY)
- REACH IS CHARACTERISED BY SIGNIFICANT MORPHOLOGICAL CHANGES CAUSED BY NATURAL PROCESSES OF EROSION AND DEPOSITION OF SEDIMENT
- RIVER REGULATION OBJECTS ON THE NAMED DANUBE REACH ARE NOT FULLY CONSTRUCTED HENCE THE RIVER BED STABILITY PROBLEMS OCCUR AND CONSEQUENTIALLY PROBLEMS WITH TRANSPORT CAPABILITIES (FOR WATER, SEDIMENT AND ICE), INLAND NAVIGATION, STATE BORDER, FLOOD PROTECTION ETC.
- THE RIVER REACH FROM 1400 TO 1410 RIVER km IS CHARACTERISED (AS THE REST OF THE DANUBE REACH IN CROATIA) BY LACK OF THE CONTINUED MAINTENANCE AND MANAGEMENT DUE TO THE STATE BORDER PROBLEMS AND INSUFFICIENT FUNDING



THE DANUBE REACH IN CROATIA



DANUBE REACH FROM 1400 TO 1410 km

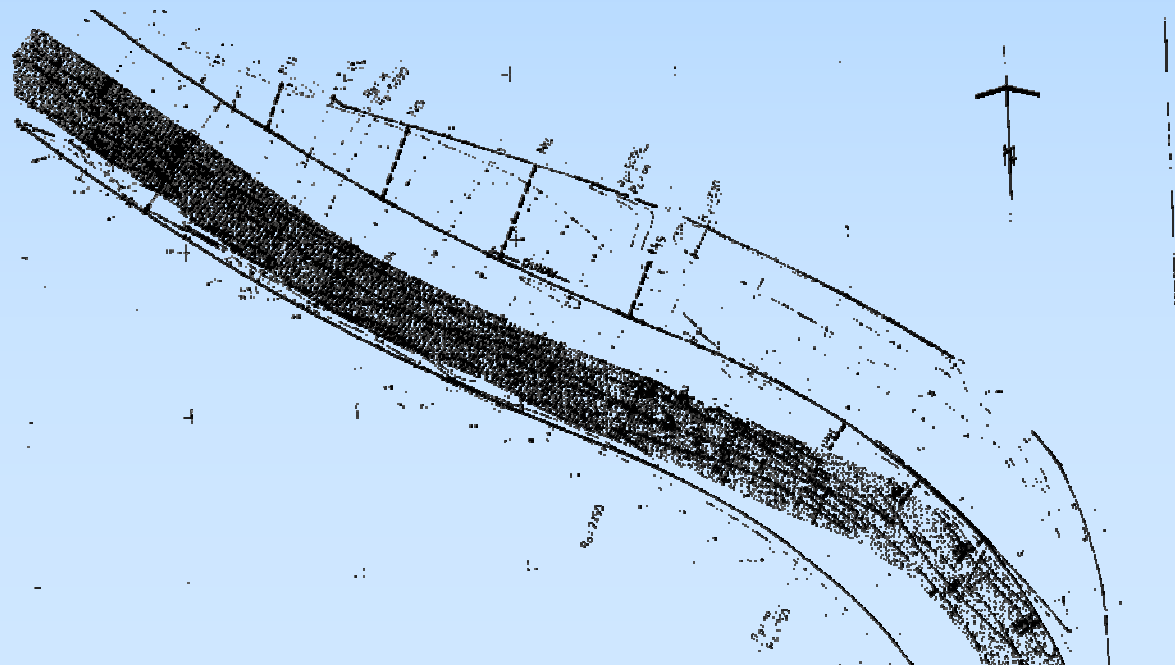


REACH FROM 1400 TO 1410 km

- FOLLOWING THE TECHNICAL INSPECTION OF RIVER DANUBE AFTER THE PEACEFUL REINTEGRATION AND DUE TO OBSERVED OBSTACLES TO NAVIGATION **SIGNIFICANT CHANGES** WERE DETERMINED TO THE DANUBE RIVER CAUSED BY LACK OF MAINTENANCE ON THE REGULATION STRUCTURES FOR MULTIPLE YEARS
- THE REACH FROM 1400 TO 1410 km WAS CHOSEN BECAUSE FURTHER EROSION OF THE RIGHT BANK WOULD CAUSE A **WATER BREACH FROM DANUBE TO THE AREA OF KOPAČKI RIT NATURE PARK** WHICH ENJOYS A SPECIAL STATUS AND NOT ONLY IN CROATIA (IT IS INCLUDED IN THE LIST OF AREAS PROTECTED BY RAMSAR CONVENTION AND ON THE LIST OF ORNITHOLOGICAL IMPORTANT AREAS BY UNESCO)
- BESIDES THE ALREADY MENTIONED PROBLEMS WHICH ARE A CONSEQUENCE OF NATURAL PROCESSES OF THE DANUBE RIVER, IT IS IMPERATIVE TO **ACCEPT THE ECONOMIC** (WATERWAYS), **SOCIOLOGICAL** (STATE BORDER), **ECOLOGICAL** (NATURE PARK) AND **LEGISLATIVE TERMS** DURING THE PLANNING OF REGULATION OF THE DANUBE RIVER
- THE FACT THAT ON THE AREA OF REPUBLIC OF CROATIA IS THE KOPAČKI RIT NATURE PARK, WHILE THE URBAN AREA OF THE CITY APATIN IS ON THE RIGHT BANK IS ALSO A CHARACTERISTIC OF THIS AREA

STARTING POINT

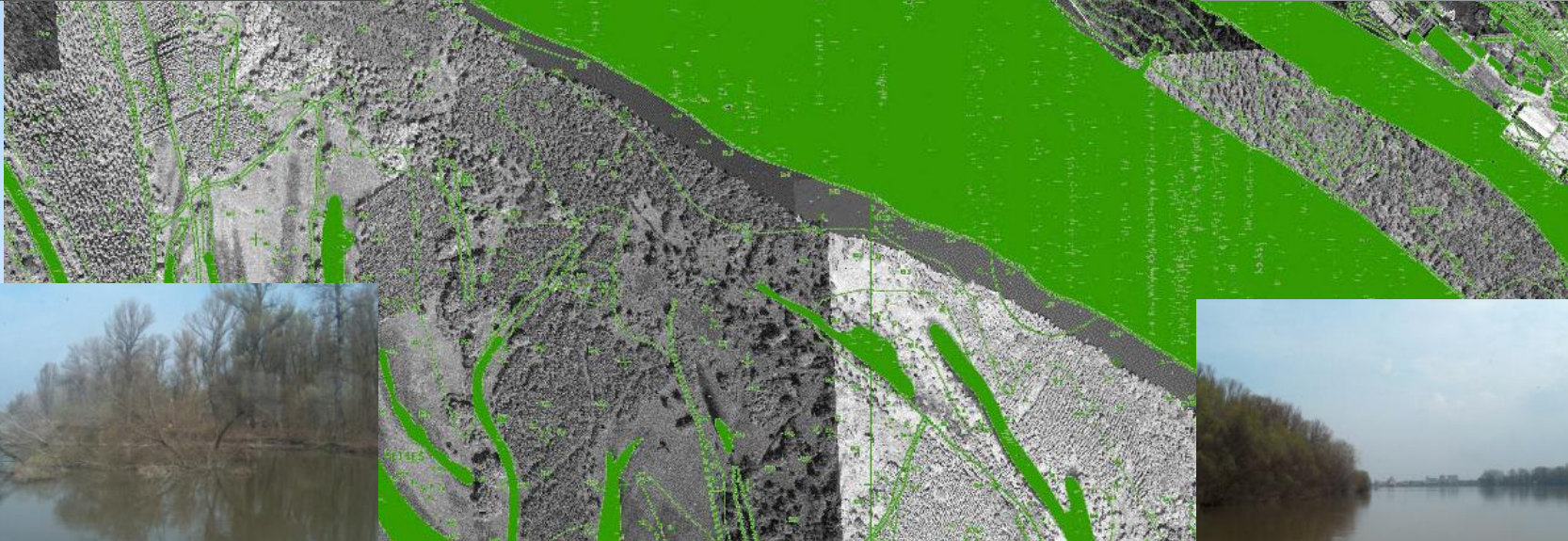
- AS A **BASIS** DURING THE WORK REGULATION ELEMENTS WERE ADOPTED IN ACCORDANCE TO **THE REGULATION PROJECT OF THE YUGOSLAVIAN PART OF DANUBE SECTOR FROM SHARED INTEREST**, MADE BY „JAROSLAV ČERNI“ INSTITUTE FOR WATER MANAGEMENT, BELGRADE, 1987.:
 - REGULATION WIDTH OF DANUBE - 300 TO 450 m,
 - MINIMAL CURVE RADIUS - 1600 m (ON AN EXCEPTIONAL BASIS 1000 m),
 - THE HEIGHT OF THE REGULATION STRUCTURES - AVERAGE LOW WATER LEVEL+1,00 m



DESIGN METHODOLOGY

- **FIELD SURVEY** WAS PERFORMED, ALL THE NEEDED WORKS TO BE PERFORMED WERE DEFINED, FOTODOCUMENTATION AND SKETCHES ON THE SCALE MAPS 1:5000 OF THE REACH WERE MADE
- **GEODETIC AND HYDROGRAPHIC SURVEY OF THE TERRAIN** – ANALYSIS OF THE DATA COLLECTED DURING THE FIELD DETOUR WAS USED TO DEFINE THE BASIS TO PERFORM GEODETIC AND HYDROGRAPHIC SURVEY
- **GATHERING AND ANALYSIS OF THE AVAILABLE REFERENCE AND DESIGN DOCUMENTATION** – PARALLEL TO THE SURVEY GATHERING OF AVAILABLE REFERENCE AND DESIGN DOCUMENTATION WAS CONDUCTED AND SPECIAL ATTENTION WAS DEVOTED TO HYDROLOGICAL MEASUREMENTS (AVAILABLE DATA – BEZDAN AND APATIN STATION)
- DEVELOPMENT OF A **MATHEMATICAL MODEL OF THE FLOW** – FLOW CALCULATIONS FOR THE REACH WERE MADE FOR AVERAGE AND AVERAGE LOW WATER LEVELS, BUT WERE NOT POSSIBLE FOR HIGH WATER LEVELS DUE TO BORDER AND VEGETATION PROBLEMS; THE REACH WAS MODELED USING A 1D MATHEMATICAL MODEL HEC-RAS

FIELD SURVEY



GEODETTIC AND HYDROGRAPHIC SURVEY

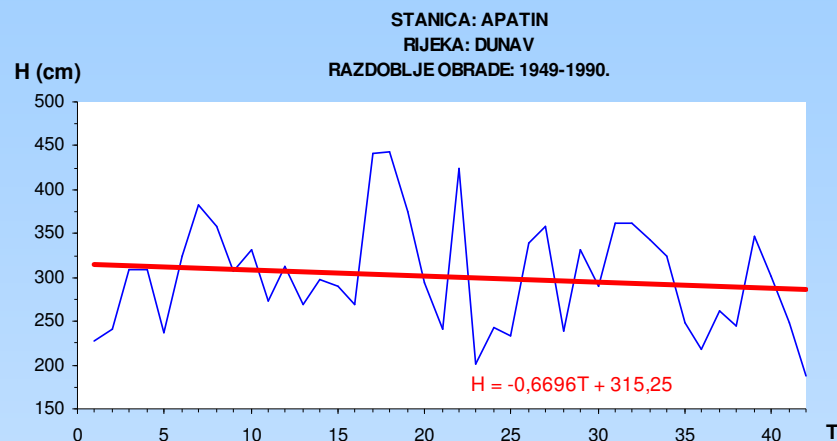
- SURVEY WAS PERFORMED USING “HRVATSKE VODE” SHIP, WHOSE PRIMARY PURPOSE IS TO CONTROL THE BED AND WATERWAYS OF DRAVA AND DANUBE RIVERS. THE SHIP IS EQUIPPED FOR HYDROGRAPHIC SURVEY WITH AN INTEGRATED SYSTEM FOR CONTROL OF INLAND WATERWAYS, WHICH CONSISTS OF THE FOLLOWING:
 1. HYDROGRAPHIC SONAR - TYPE NAVITRONIC SYSTEMS AS DESO 25, ACCURACY OF 0,01 M,
 2. RTK GPS DEVICE– TYPE SOKKIA GSR 2300, ACCURACY OF MORE THAN 0,1 M,
 3. MAINFRAME COMPUTER AND
 4. HYDROGRAPHIC SOFTWARE HYPACK, COASTAL OCEANOGRAPHICS, INC. FOR SYNCHRONIZATION OF GPS AND SONAR.



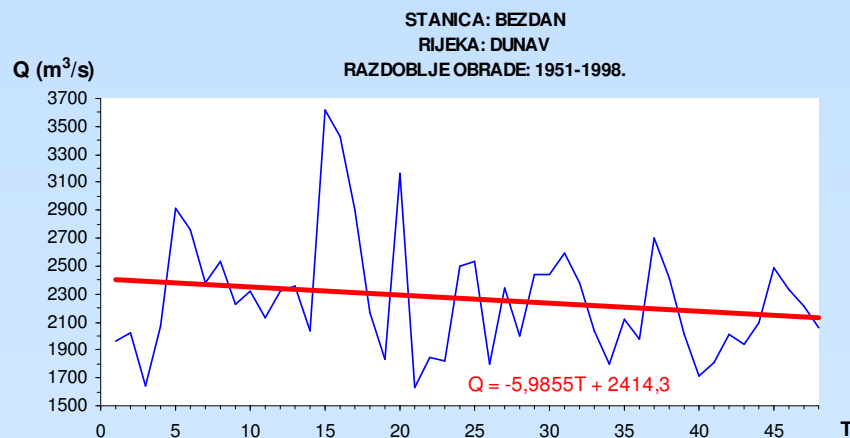
DATE	WATER LEVEL DUNAV -APATIN
04.11.2003	82
06.11.2003	127
17.11.2003	46
18.11.2003	39
19.11.2003	35
20.11.2003	35

HYDROLOGIC DATA

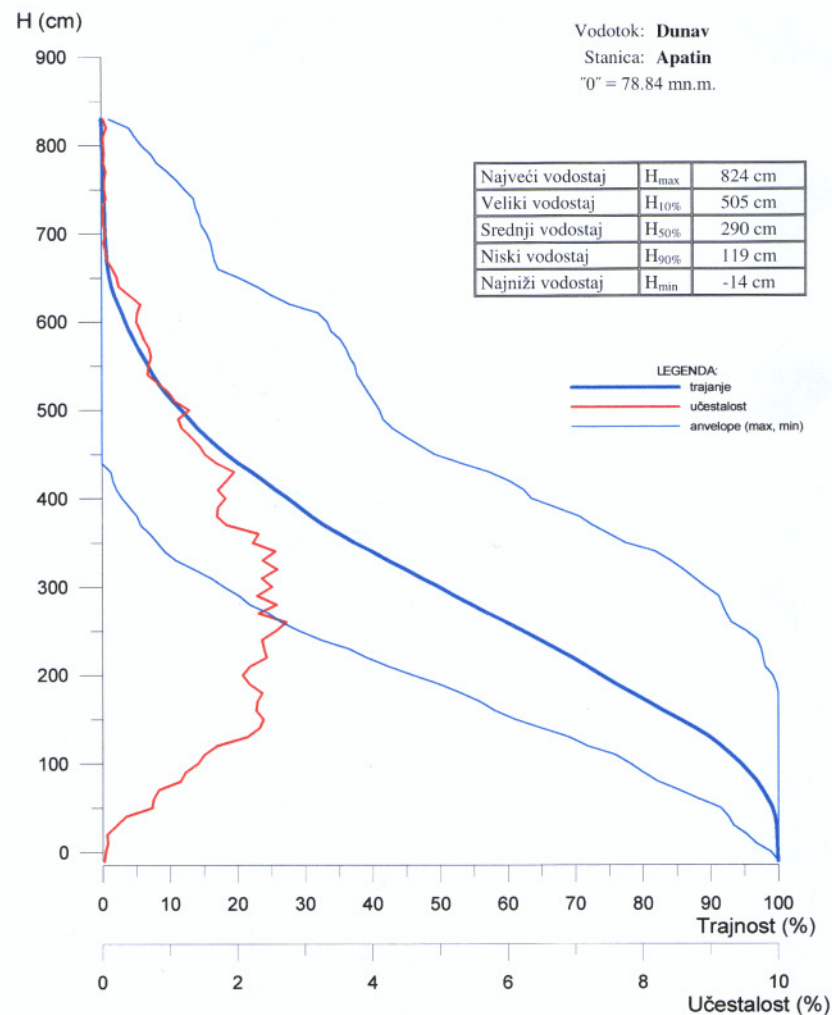
TREND SREDNJIH GODIŠNJIH VODOSTAJA - H (cm)



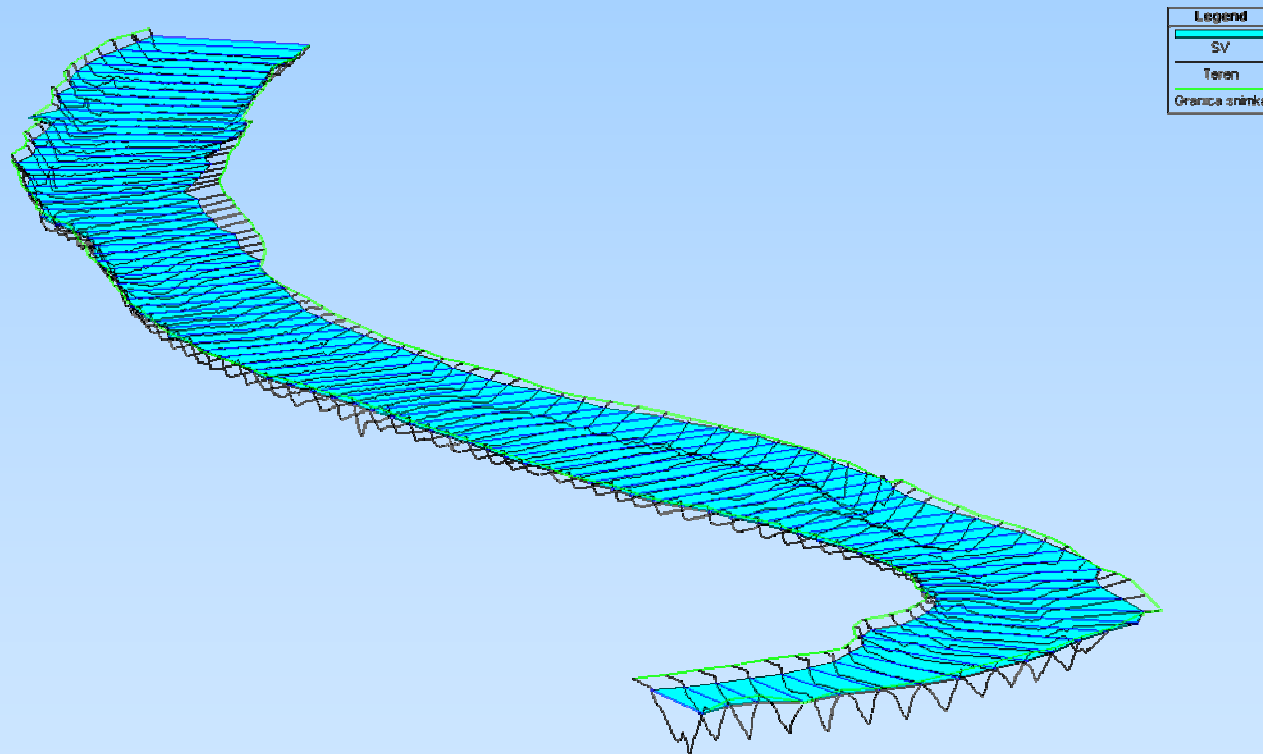
TREND SREDNJIH GODIŠNJIH PROTOKA - Q (m³/s)



KRIVULJA TRAJNOSTI I UČESTALOSTI VODOSTAJA
1949-1990.



MATHEMATICAL MODEL OF THE INITIAL STATE



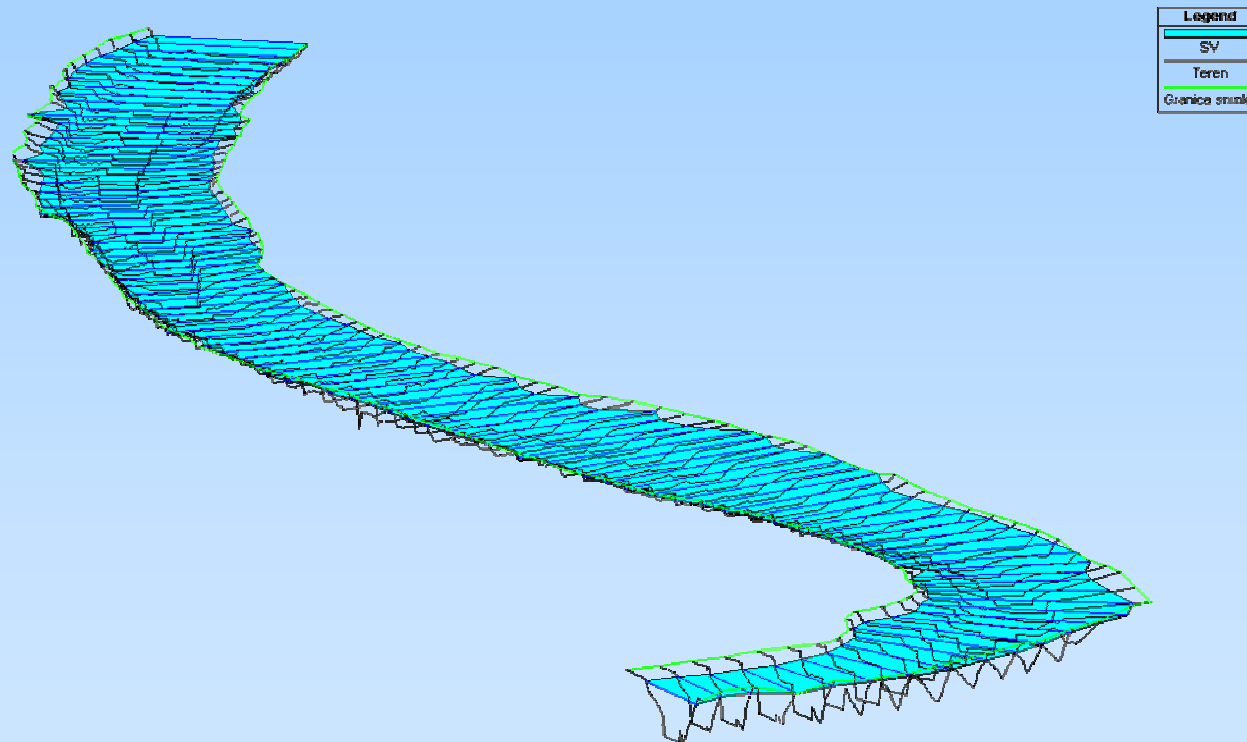
METHODOLOGY

- DEFORMATIONS OF THE RIVER BED NOTED ON THE CONCERNED REACH WERE VALIDATED BY SUBSTANTIAL VARIATIONS OF THE HYDRAULIC PARAMETERS DERIVED FROM THE 1D MATHEMATICAL MODEL AND ACCORDING TO THIS **REGULATION WORKS** ON A BROADER SCALE WERE SUGGESTED
- BUT WORKS ARE SUGGESTED IN **PHASES** WITH SYSTEMATIC MONITORING
- THE DESIGN DEALS WITH THE RIGHT BANK OF THE DANUBE RIVER SETTLEMENT ALTHOUGH THE COMPLETE REACH WAS EXAMINED
- SUGGESTED TYPES OF REGULATION STRUCTURES ARE TRADITIONAL WITH EXPERIENCES OF THEIR FITTING INTO THE ENVIRONMENT, THEY ARE ECOLOGICALLY ACCEPTABLE AND THEIR FUNCTIONALITY IS PROVEN

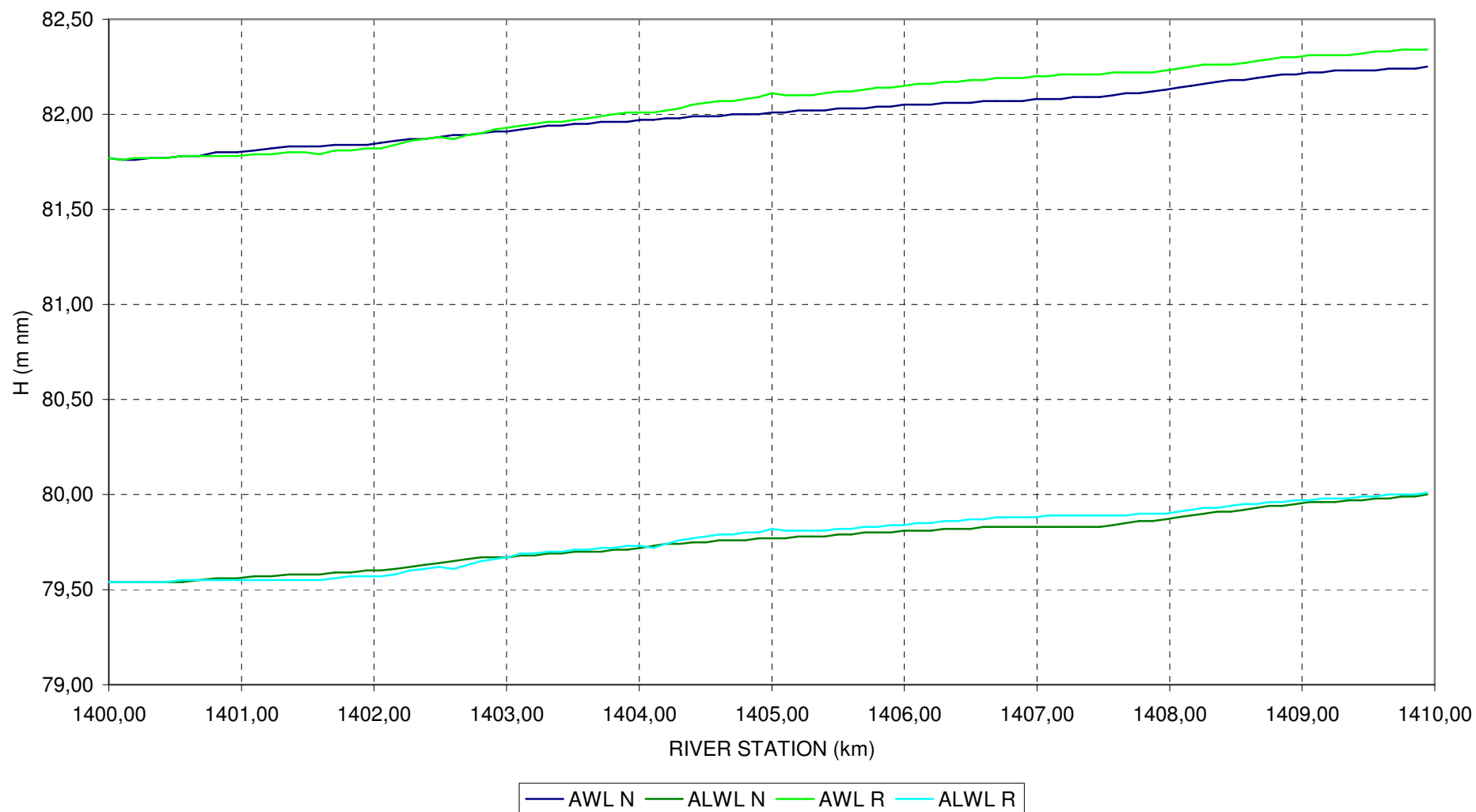
METHODOLOGY

- ANALYSIS OF THE IMPACT OF THE SUGGESTED WORKS WITH THE USE OF MATHEMATICAL MODEL – ACCORDING TO THE SUGGESTED SOLUTION THE INITIAL STATE MODEL WAS MODIFIED WITH ALL THE DATA RELATED TO THE SUGGESTED REGULATION STRUCTURES FOR THE FINAL STATE OF THE CONCERNED REACH OF THE DANUBE RIVER AND THE FLOW CALCULATIONS WERE PERFORMED AGAIN IN THE DOMAIN OF AVERAGE AND AVERAGE LOW WATER LEVELS. THE RESULTS OF THIS MODEL VALIDATED THE FUNCTIONALITY AND JUSTIFICATION OF THESE SUGGESTED STRUCTURES.
- SOLUTION ELABORATION – THE STABILITY CHECK OF THE STRUCTURES WAS PERFORMED, ALL THE OBJECTS ON THE RIGHT BANK OF THE CONCERNED REACH WERE ELABORATED USING THE SECTIONS DERIVED FROM THE DIGITAL TERRAIN MODEL IN ORDER TO DO AN ESTIMATION OF INVESTMENT VALUE AND TO DEFINE A MONITORING PROGRAMME.

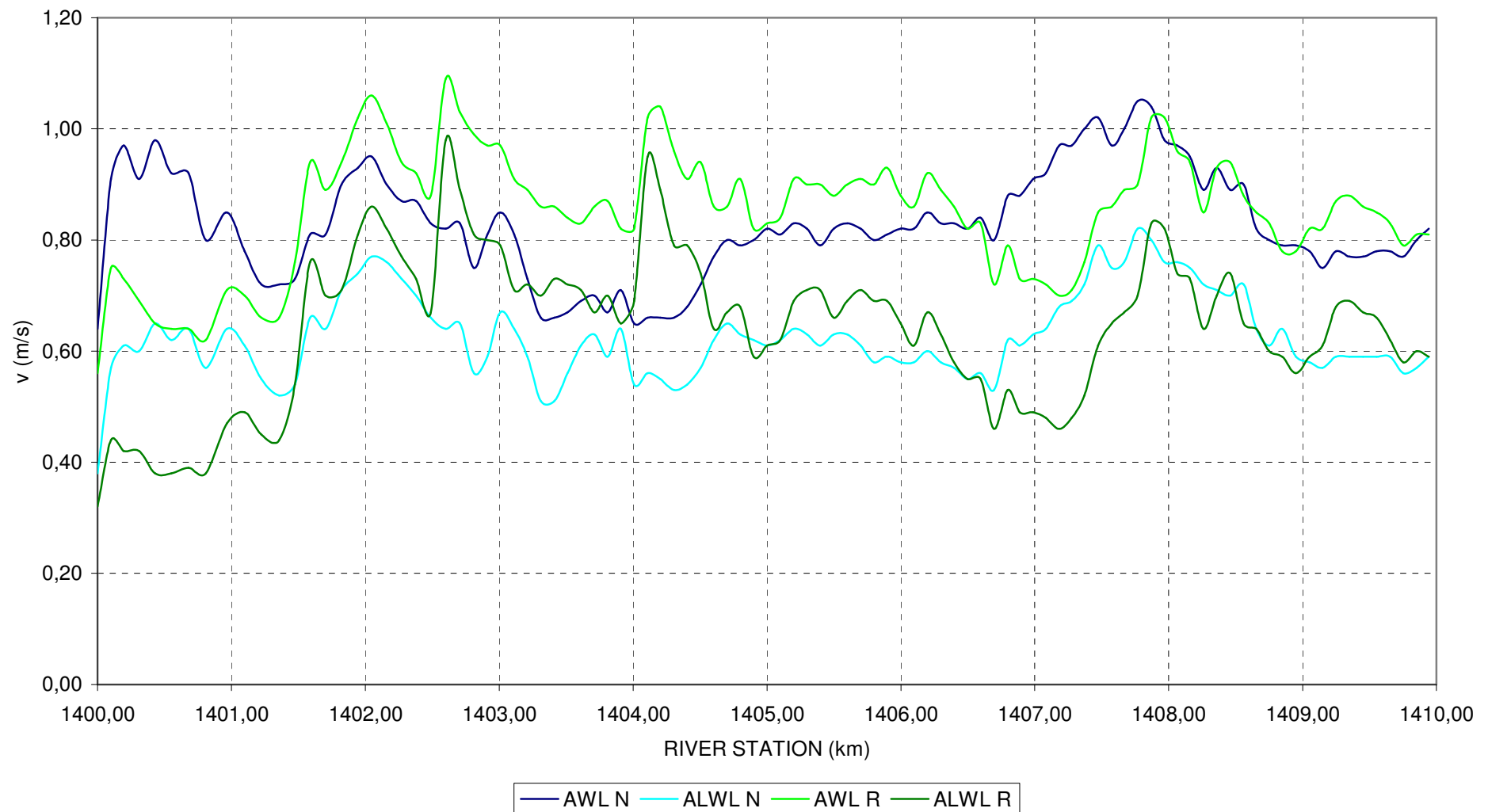
MATHEMATICAL MODEL – FINAL STATE



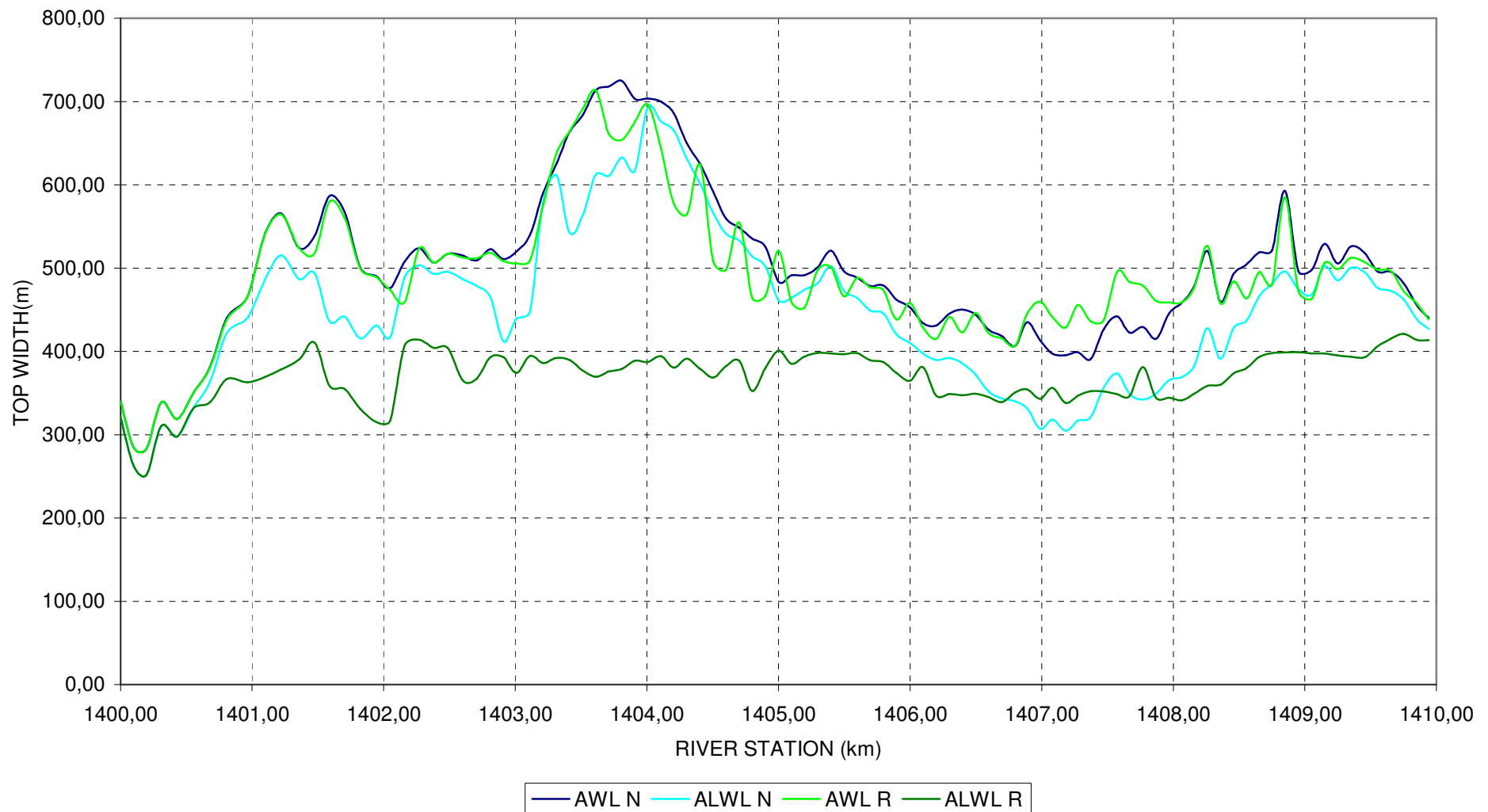
MODEL RESULTS – WATER LEVELS



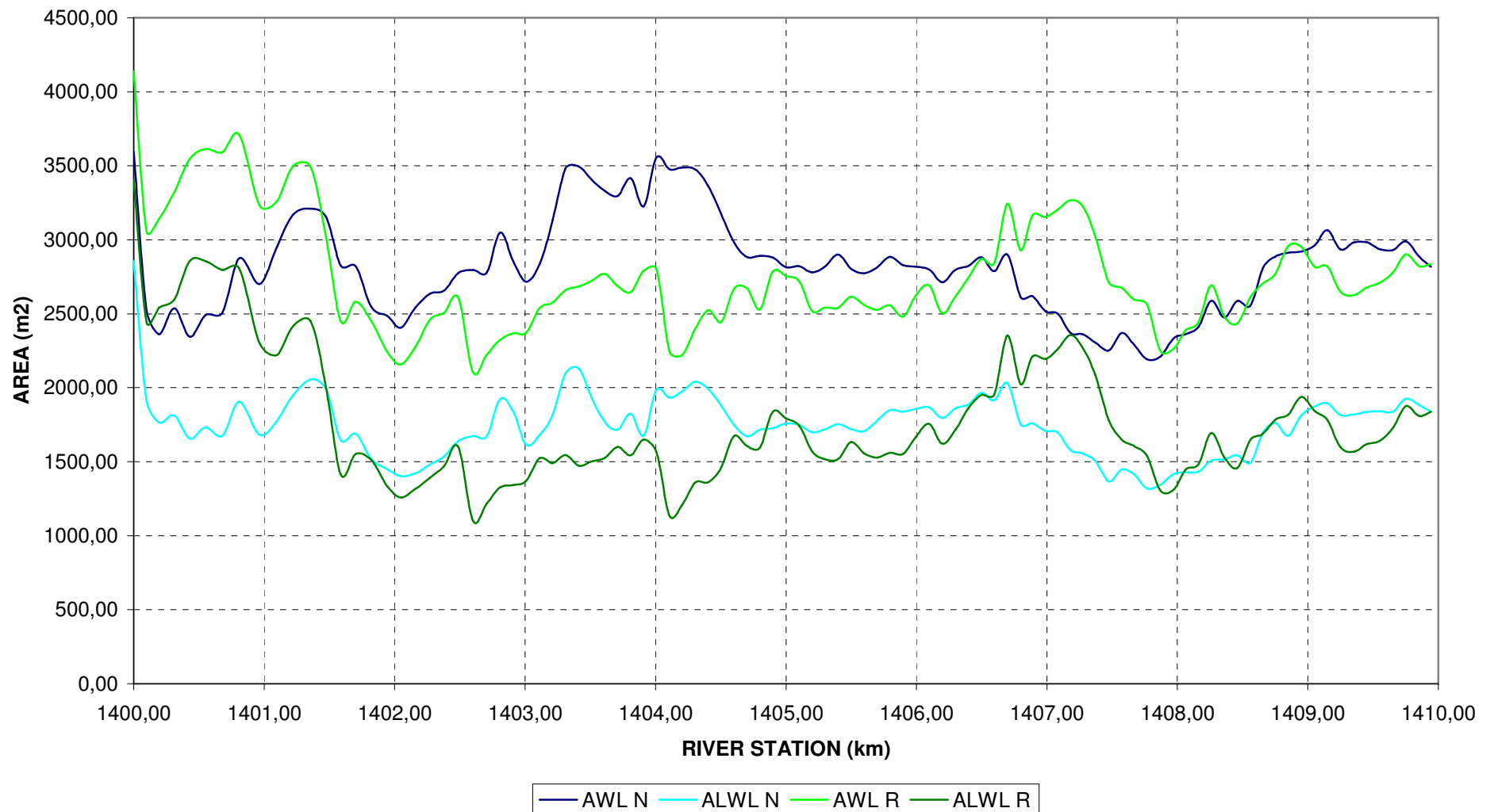
MODEL RESULTS – VELOCITIES



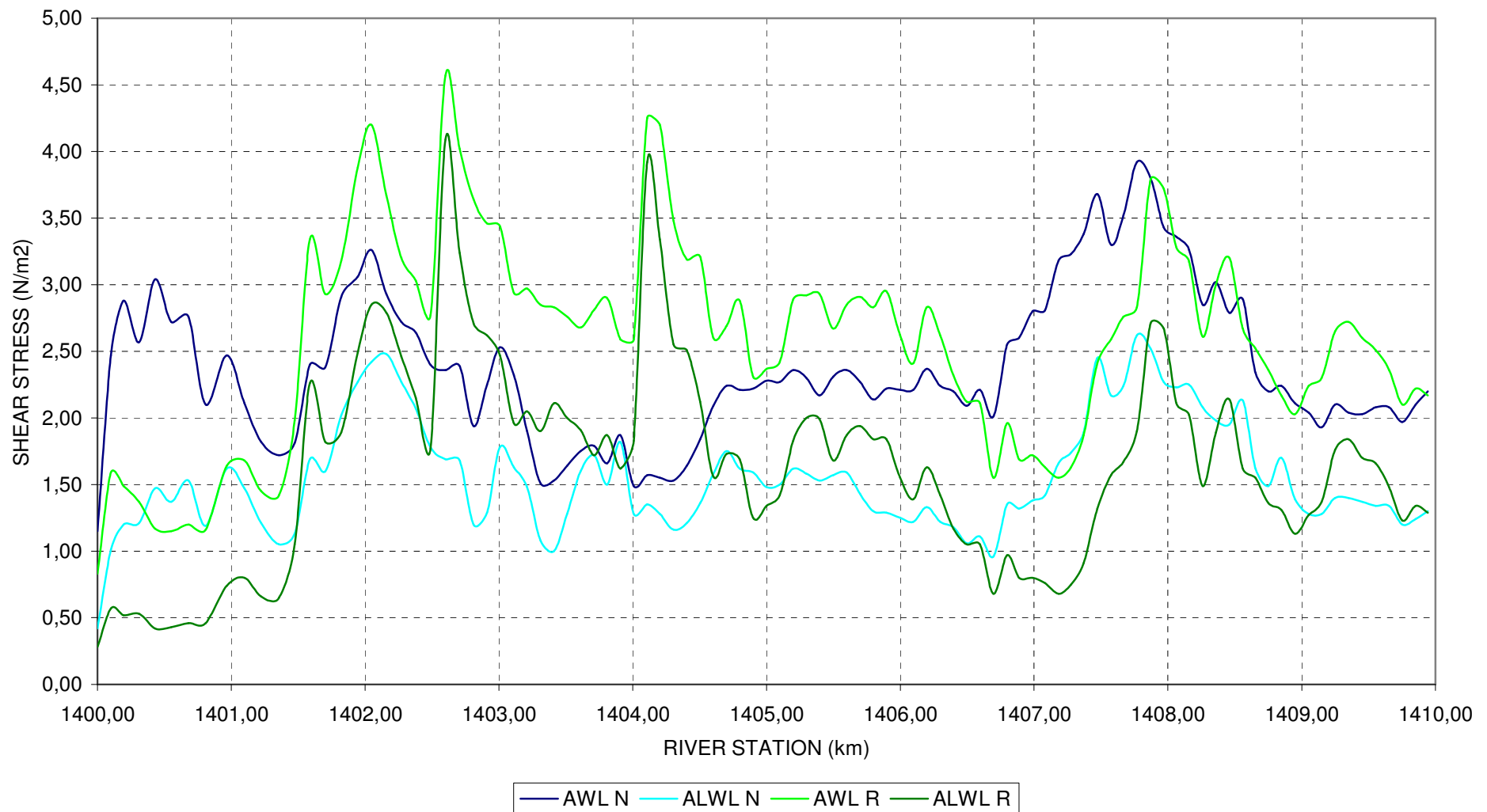
MODEL RESULTS – WATER LEVEL WIDTH



MODEL RESULTS – FLOW AREA

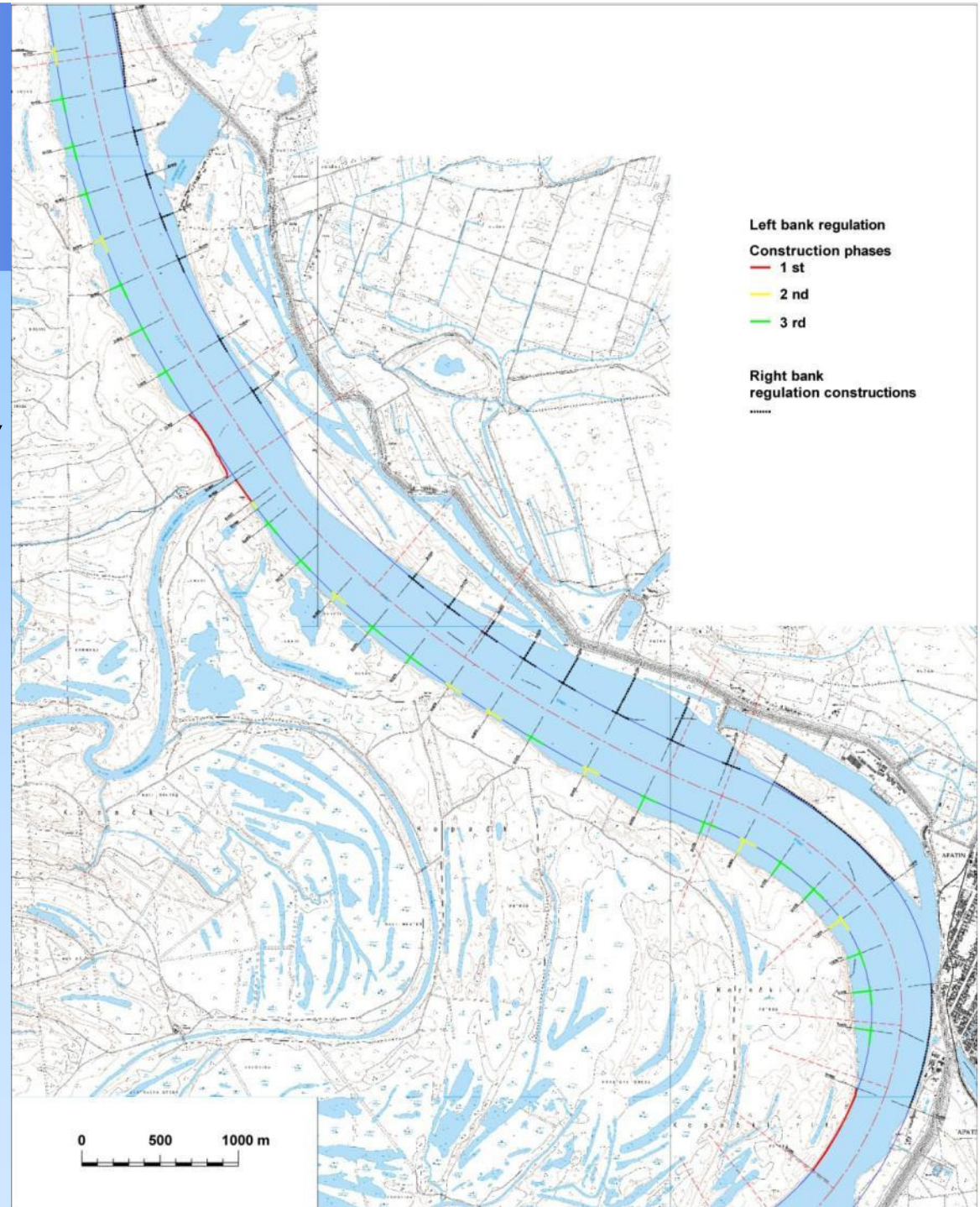


MODEL RESULTS – SHEAR STRESS



REGULATION SOLUTION

- REGULATION SOLUTION WAS DEFINED INTEGRALLY FOR THE WHOLE REACH
- OBJECTS WERE DEFINED FOR BOTH BANKS
- PHASES OF WORKS AND BoQs WERE MADE FOR RIGHT BANK
- INVESTMENT VALUE ESTIMATE FOR THE RIGHT BANK - AROUND 20.000.000,00 € FOR 10 KM



ADVICES - GUIDELINES

- **ADEQUATE DESIGN METHODOLOGY**
- **APPLICATION OF MODERN TECHNOLOGIES** (GPS, ORTOPHOTO, SATELLITE RECORDS, MATHEMATICAL MODELLING, MEASUREMENT OF HYDRAULIC AND HYDROLOGIC PARAMETERS) RELIEVES DESIGN AND PLANNING
- **INTEGRAL MANAGEMENT** AND CARE FOR DANUBE AS A UNIQUE RESOURCE DICTATES **INTERNATIONAL COOPERATION AND MUTUAL EFFORTS** (FINANCIAL AND EXPERT) **ON PROBLEM SOLUTION**
- **COOPERATIVE MEETINGS** WITH SERBIA (EXCHANGE OF INFORMATION)
- REGULATION AND WATERWAYS DESIGNS HAVE TO BE **HARMONIZED AND VERIFIED** BY BOTH SIDES WITH THE RESPECT TO THE INTERNATIONAL CONVENTIONS AND AGREEMENTS

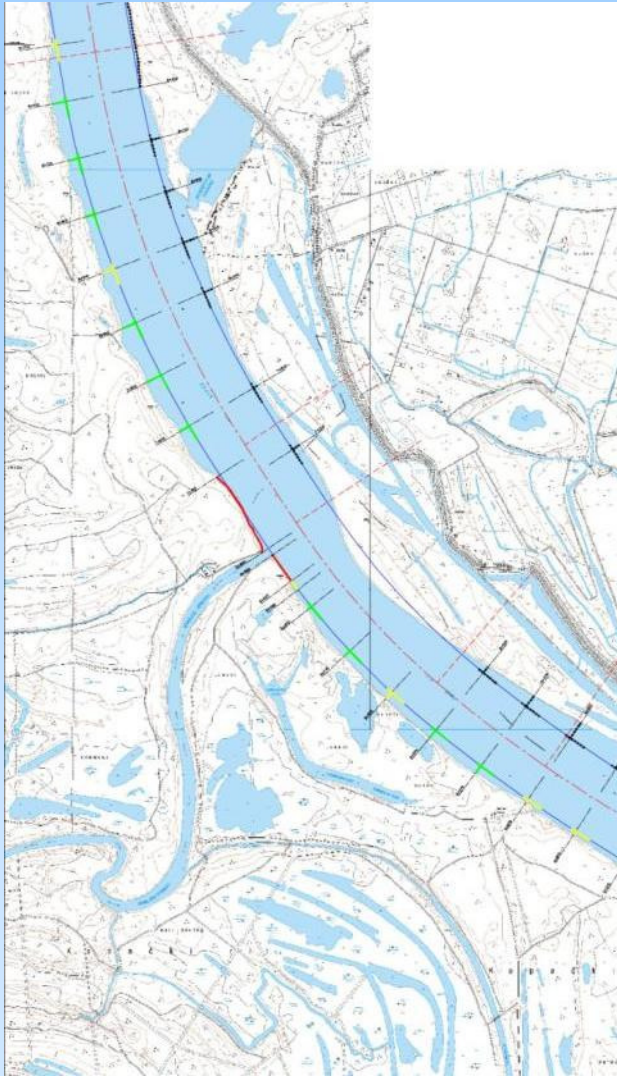
ADVICES - GUIDELINES

- WITH THE COOPERATION IN THE MANAGEMENT OF DANUBE RIVER THERE IS A POSSIBILITY OF **FINANCING USING THE EU PRE-ACCESSION FUNDS** WHICH WOULD RESULT IN THE SHARED REACH REGULATION AND THAT WOULD RECONCILE ECOLOGICAL, SOCIOLOGICAL AND OTHER PROBLEMS WHICH EMERGE IN DANUBE AS AN INTERNATIONAL WATERWAY – GREAT FUNDS ARE NEEDED BUT NO ONE SIDE CAN BEAR THEM ALONE
- IT IS NECESSARY TO OBEY THE **WATER FRAMEWORK DIRECTIVE**
- HARMONIZED **MUTUAL TECHNICAL SOLUTION** FOR THE REACH (CROATIA AND SERBIA)
- **EIA STUDY** FOR BOTH COUNTRIES (UNDERWAY)

ADVANCE

- **KNOWLEDGE MADE FROM THE PRELIMINARY DESIGN RESULTED WITH:**
 - **IMPLEMENTATION OF 2D MATHEMATICAL MODELS**
 - **IMPLEMENTATION OF THE ADCP TECHNOLOGY FOR MEASUREMENTS OF WATER FLOWS AND VELOCITIES**
 - **IMPLEMENTATION OF MULTIBEAM SURVEYS**

URGENT INTERVENTION 1405-1407



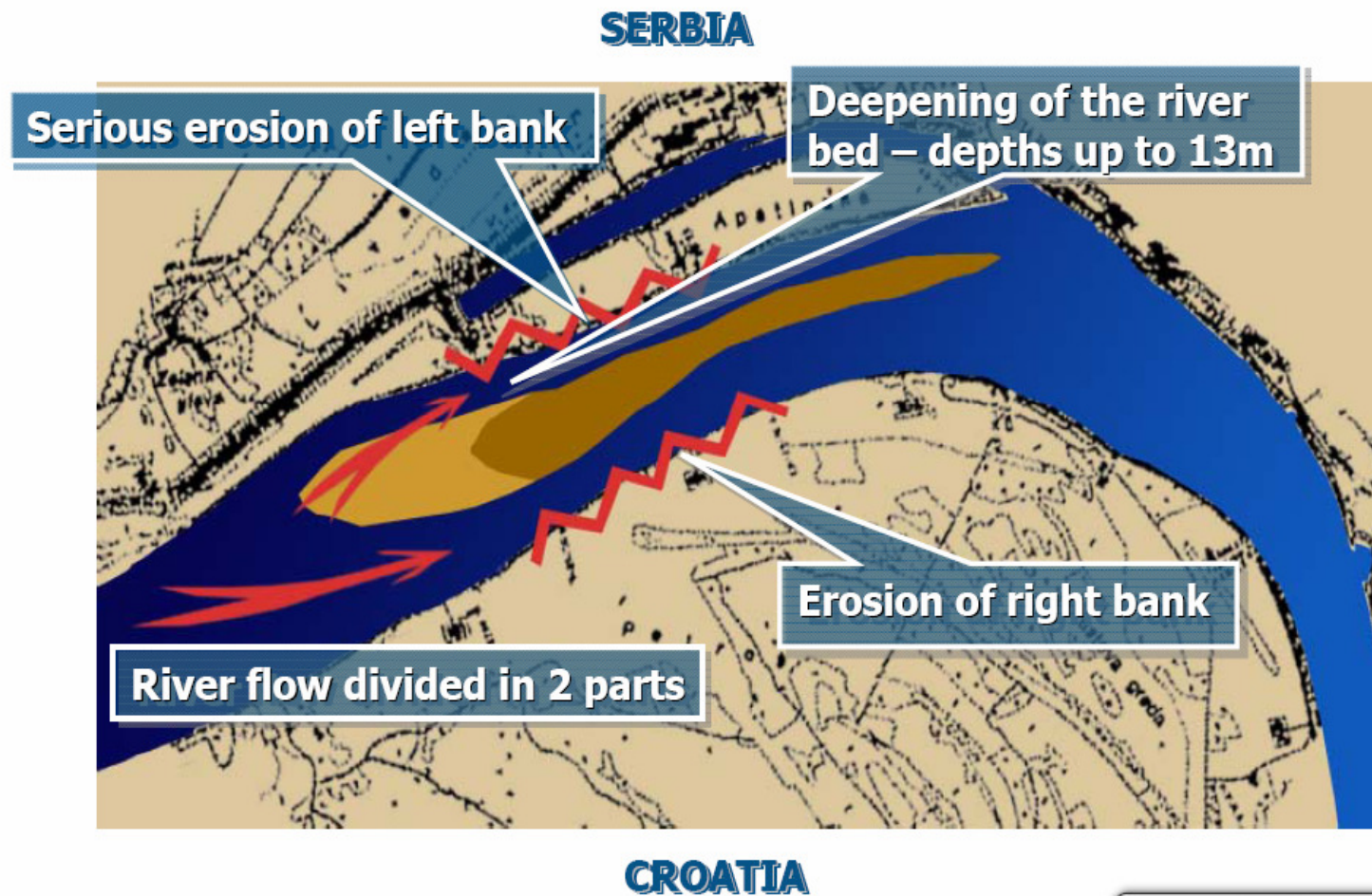




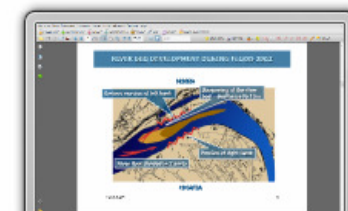
URGENT INTERVENTION 1405-1407

- **THE RESULTS OF PRELIMINARY DESIGN RESULTED IN THE MAIN DESIGN AND THE START OF THE CONSTRUCTION ON THE REACH FROM 1405 TO 1407 km.**
- **TWO “T” GROINS ARE FINISHED AS WELL AS INLINE STRUCTURE AND BANK PROTECTION**
- **WORKS A TO BE CONTINUED IN COMING YEARS TILL COMPLETION OF ALL OBJECTS**

RIVER BED DEVELOPMENT DURING FLOOD 2002

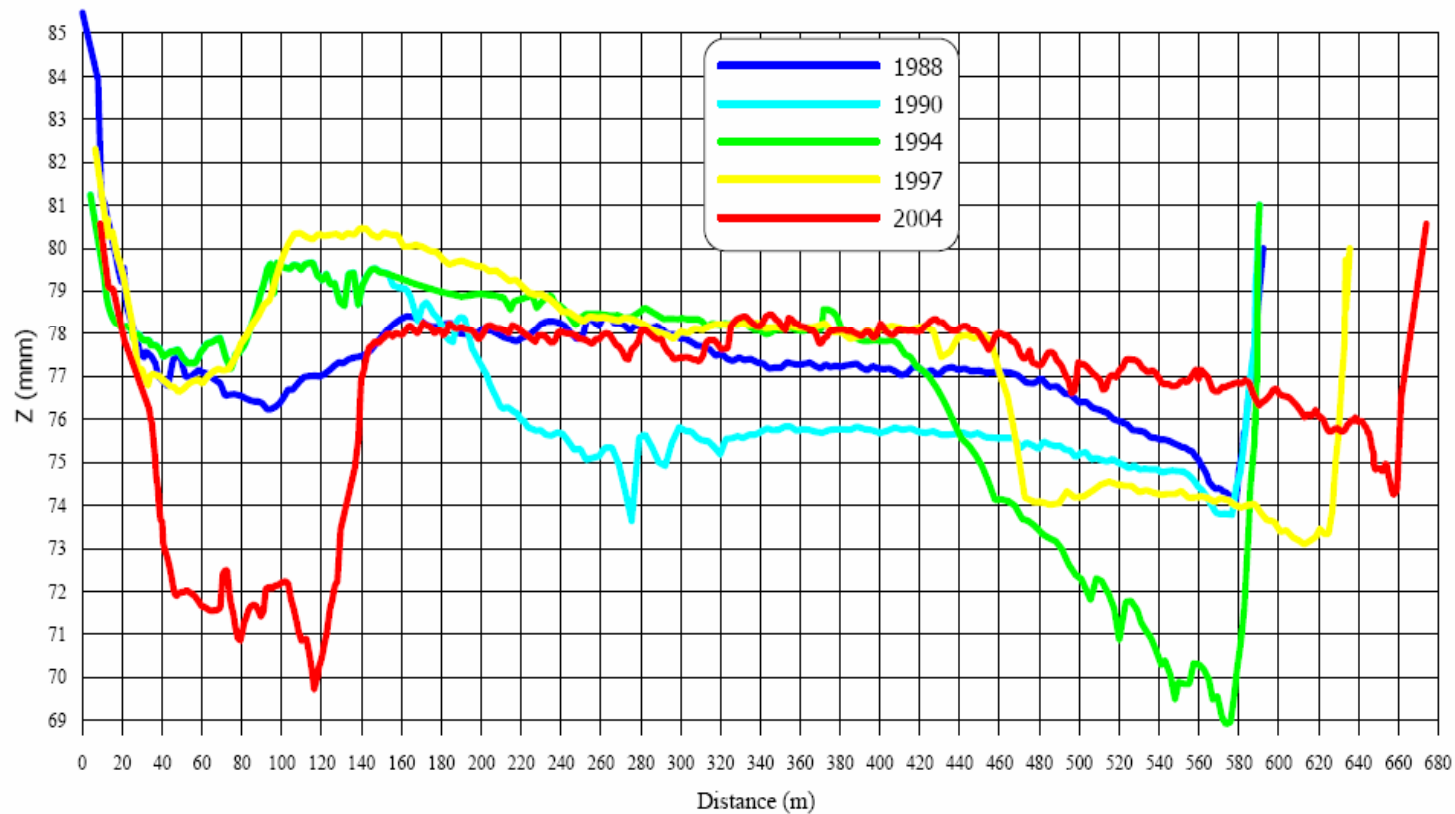


10/27/2008



EVOLUTION OF A CHARACTERISTIC CROSS-SECTION

EP 24/1

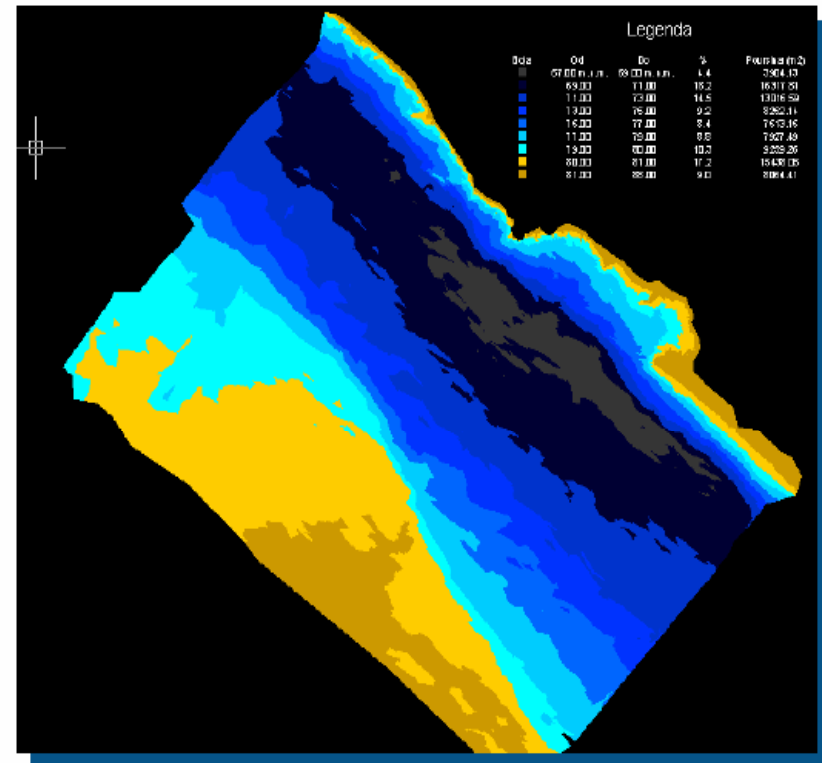
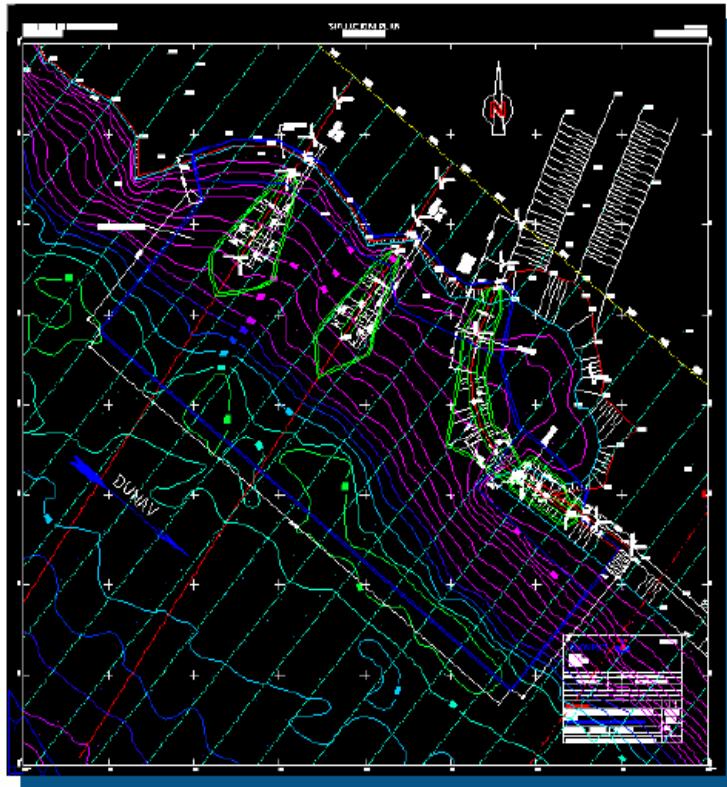


EROSION OF THE LEFT BANK IN 2002



10/27/2008

DESIGN OF LOCAL PROTECTION (2003)



Design of protection of the left Danube bank, sektor "Apatin", km 1403.66 – 1403.52, Plovput, 2003

LOCAL PROTECTION OF LEFT BANK (SERBIA)

Objective: protection of the City of Apatin, including harbor, shipyard, international ship winter shelter, customs office, and city beach

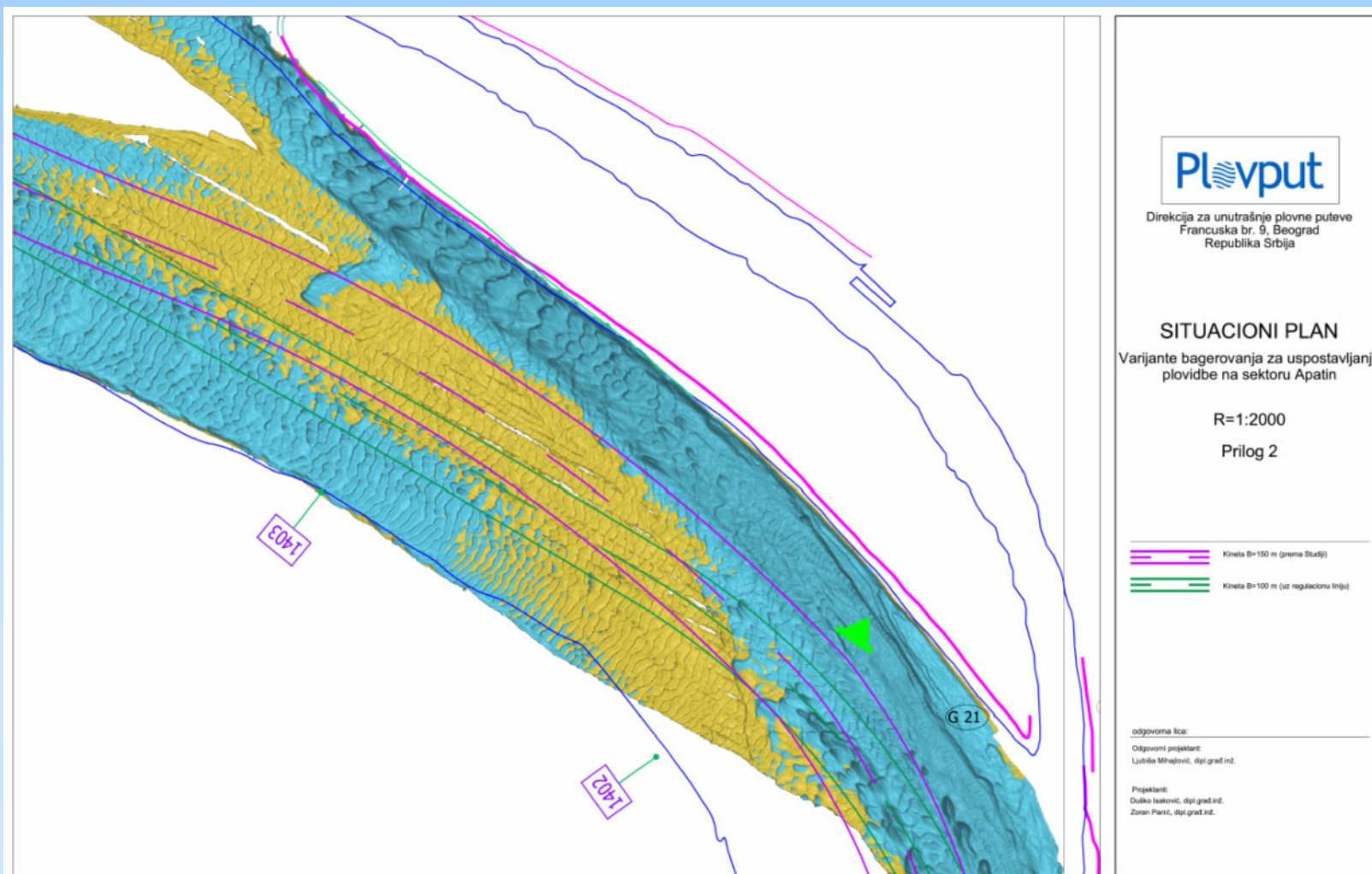


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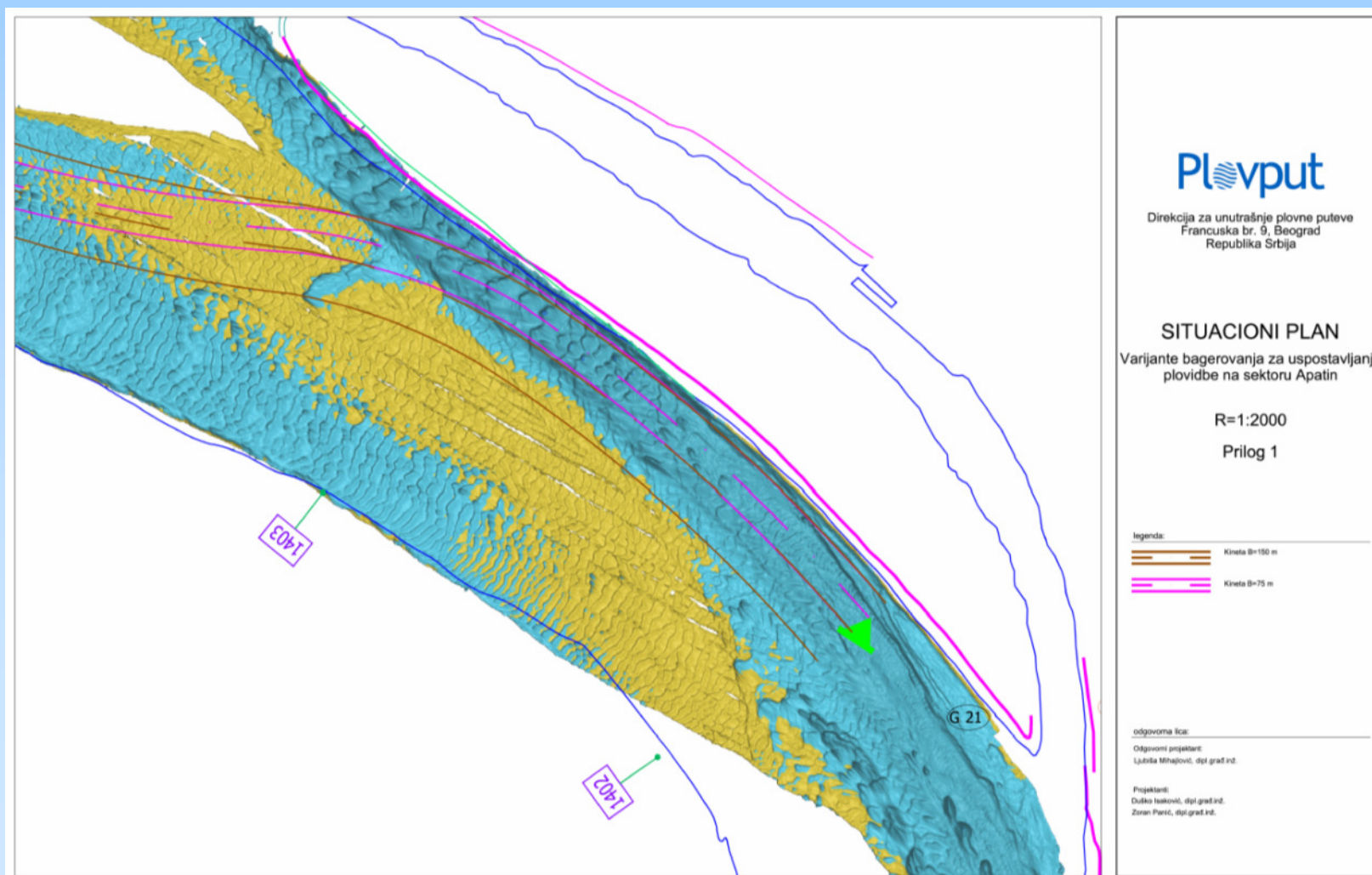


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URGENT INTERVENTION 500.000M3



URGENT INTERVENTION 30.000M3



SECTORS WITH NAVIGATION PROBLEMS

- **SECTOR APATIN**
- **SECTOR SOTIN** – BANK EROSION PROBLEMS, BIFURCATION
- **SECTOR MOHOVO** – PROBLEMS WITH VARIABLE DEPTHS
- **CONFLUENCE OF DRAVA** – SEDIMENTATION OF THE MOUTH OF DRAVA
- THERE ARE OTHER POTENTIALLY PROBLEMATIC SECTORS FOR NAVIGATION DUE TO BANK EROSION (ŠARENGRAD, VUKOVAR, DALJ) OR PROBLEMS WITH SEDIMENT DEPOSITION