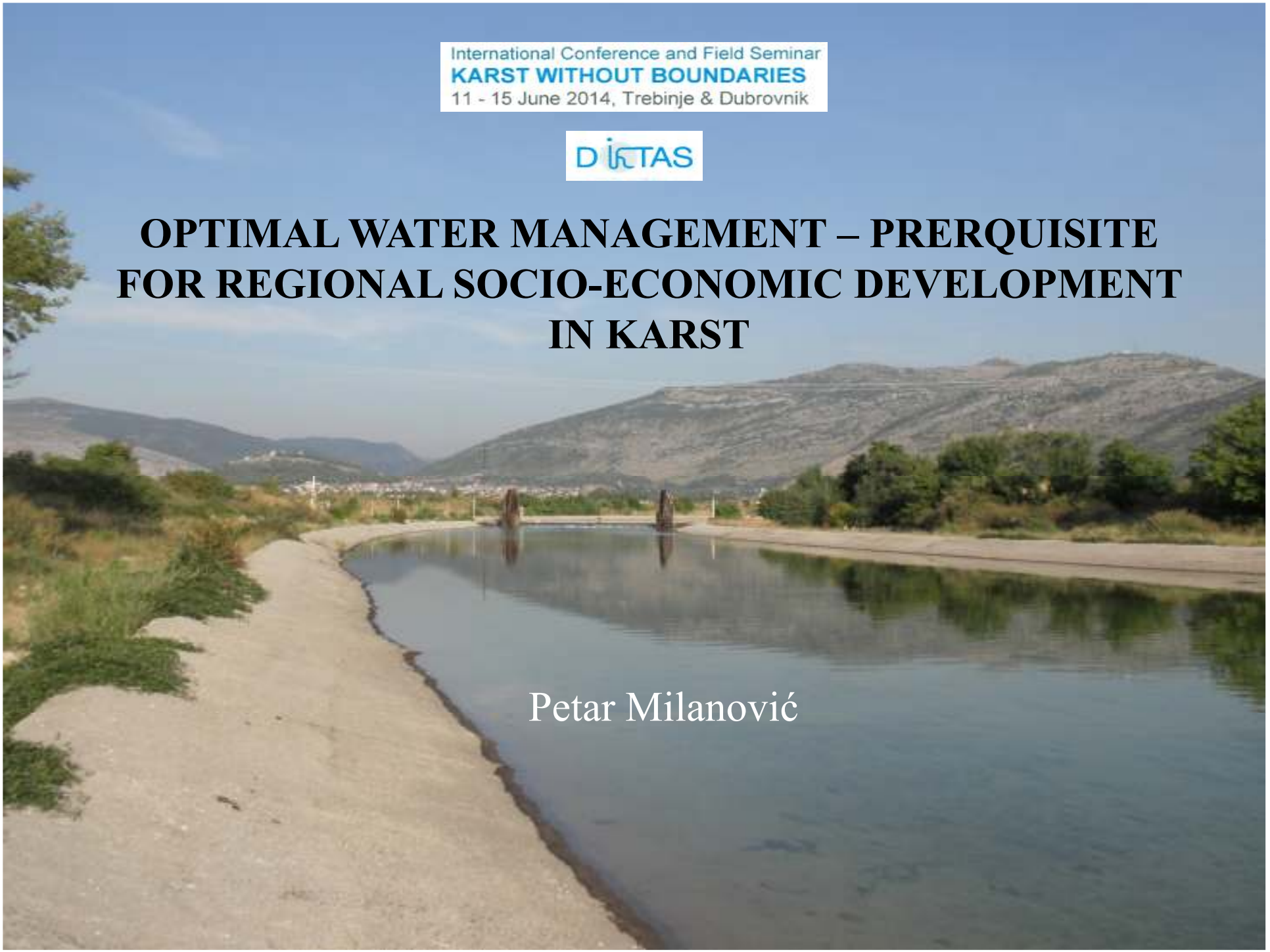


International Conference and Field Seminar
KARST WITHOUT BOUNDARIES
11 - 15 June 2014, Trebinje & Dubrovnik

DIKTAS

OPTIMAL WATER MANAGEMENT – PRERQUISITE FOR REGIONAL SOCIO-ECONOMIC DEVELOPMENT IN KARST

Petar Milanović

REGIONAL DEVELOPMENT OF AN KARST REGION DEPENDS ON OPTIMAL MANAGEMENT OF AVAILABLE WATER POTENTIAL.

REGION OF SOUTH-ESTERN DINERIDES, INCORPORATED IN DIKTAS PROJECT, IS ENDOWERED WITH HUGE NATURAL WATER POTENTIAL.

HOWEVER IT IS ONE OF MOST KARSTIFIED REGIONS WORLDWIDE.

SINKING RIVERS, UNDERGROUND FLOWS, TEMPORARY FLOODED KARST POLJES AND LACK OF ARABLE LAND ARE THE MAIN NATURAL PROPERTIS OF REGION.

IN SPITE OF HIGHEST PRECIPITATION IN EUROPE, SINCE TIME IMMEMORIAL, THE PEOPLE OF THIS REGION HAVE HAD TO COPE WITH TWO KINDS OF MISFORTUNE:

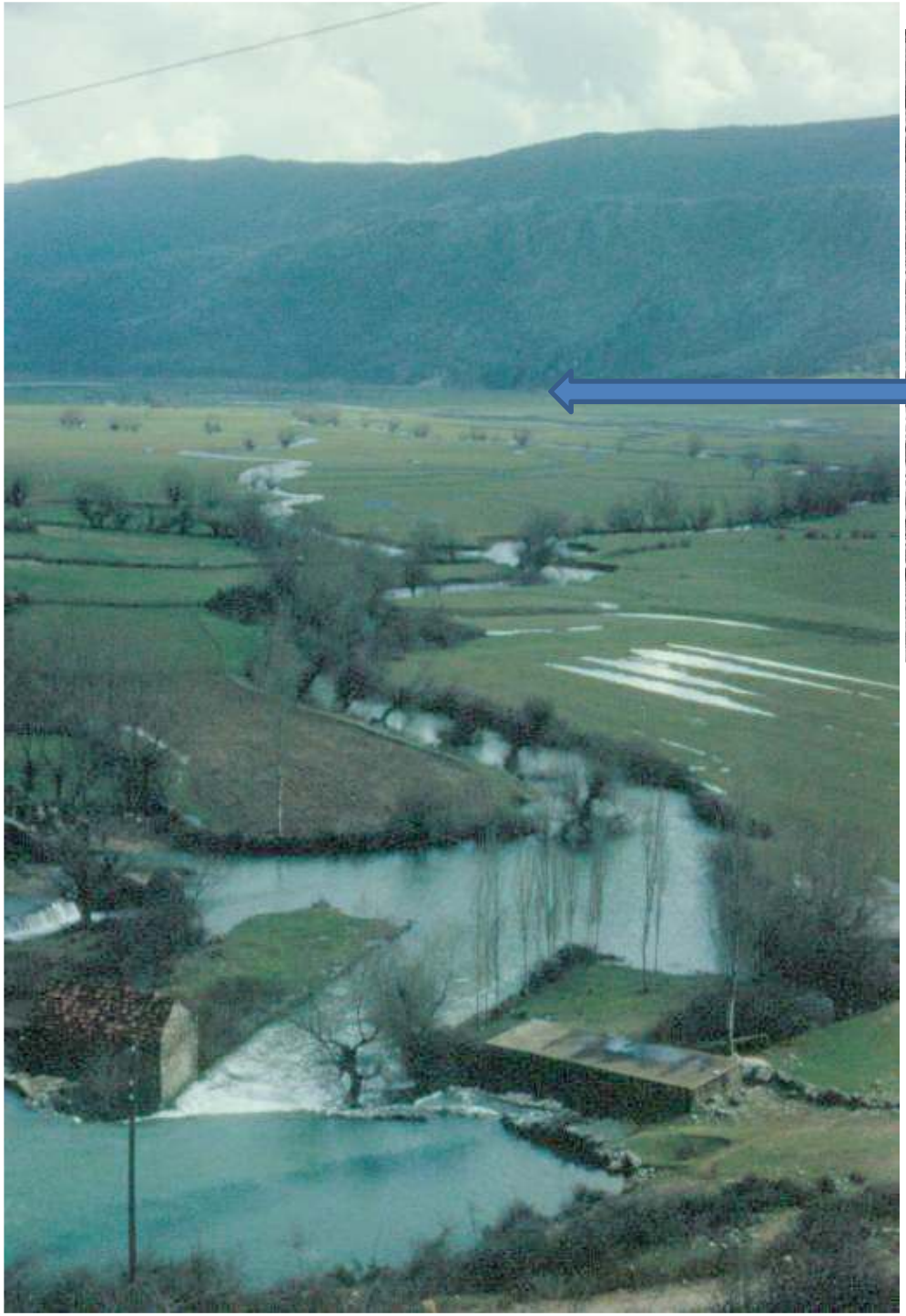
- FLOODS AND
- DROUGHTS


FLOODS

FLOODS

DROUGHTS

ARABLE LAND IS LIMITED



DABARSKO POLJE

Spring: Vrijeka

Ponor (swallow hole): Ponikva

KLJUČKA RIVER

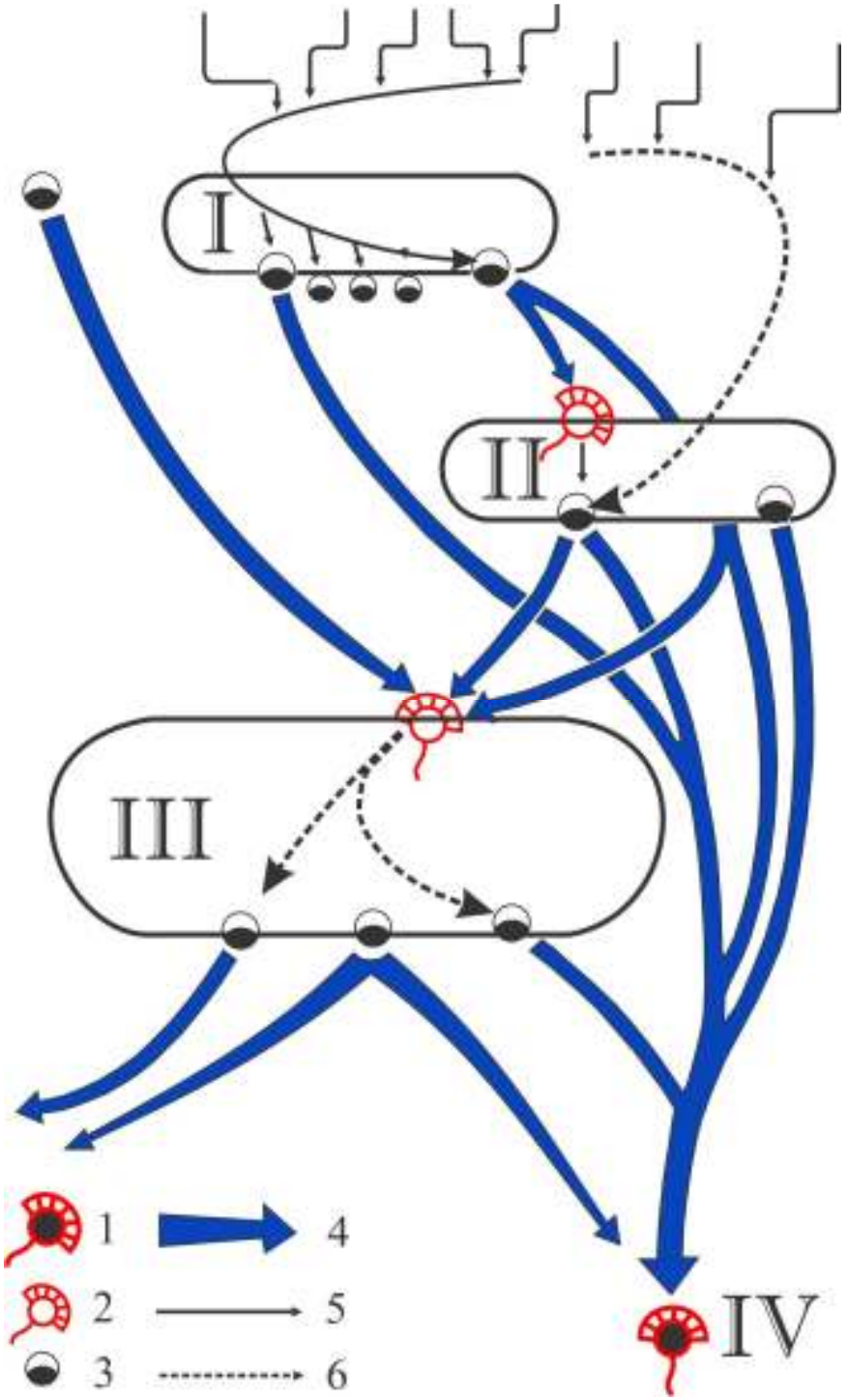
KLJUČKI PONOR

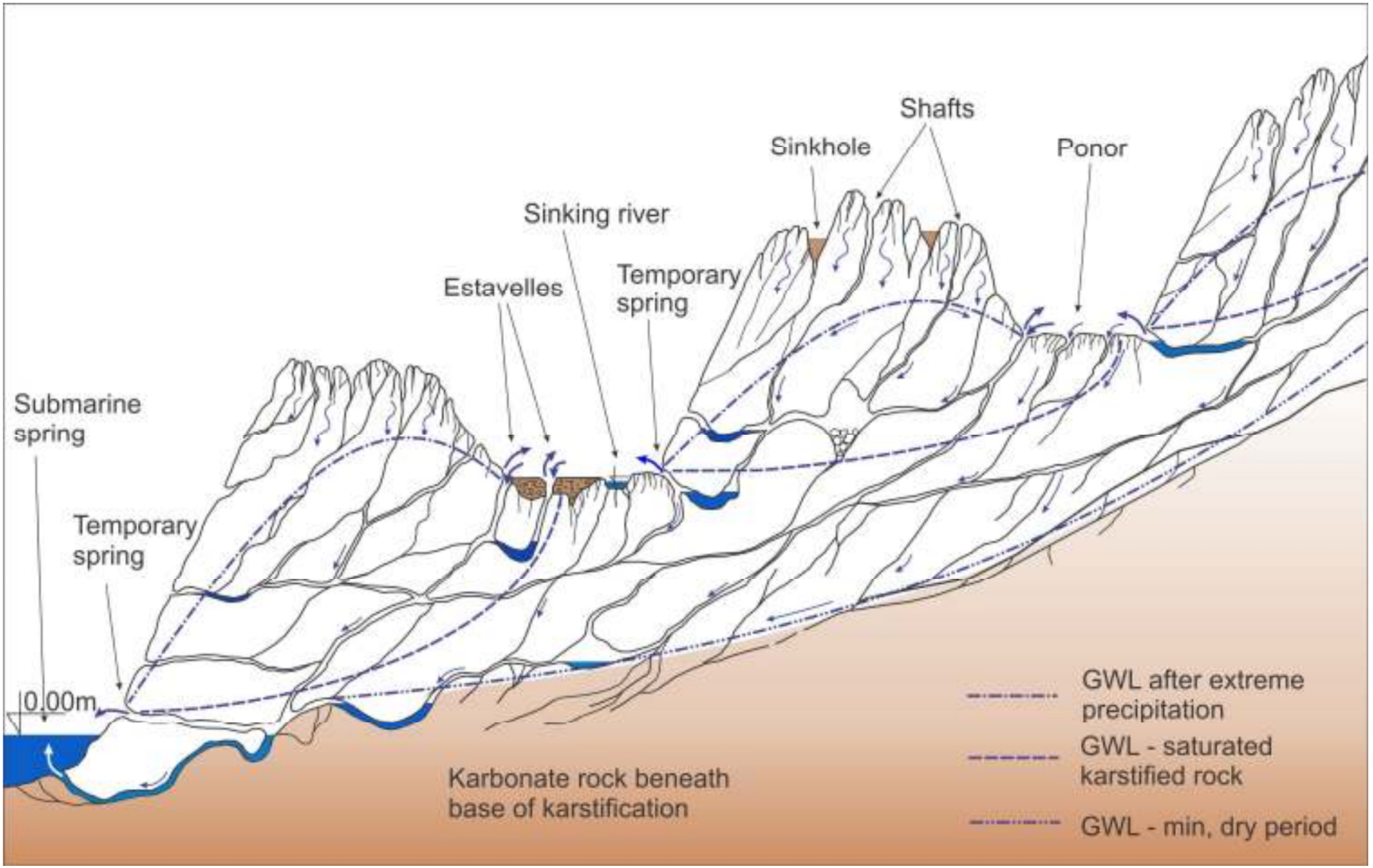
DISTRIBUTION OF PRECIPITATION IS UNEVEN DURING THE YEAR.

MORE THAN 70% OF RAIN OCCUR DURING THE WET SEASON (OCTOBER – MARCH).

THE MAIN FLOWS ARE - KARST UNDERGROUND FLOWS.

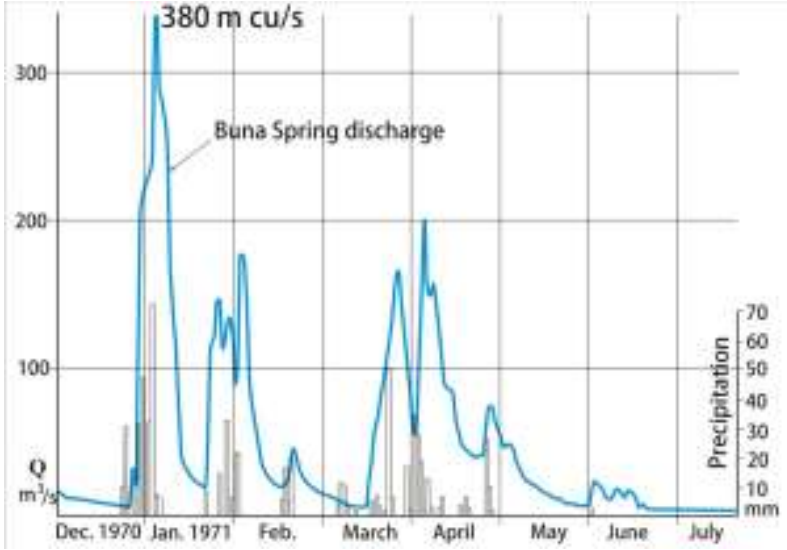
RETARDATION CAPACITY OF KARST AQUIFER IS POOR.

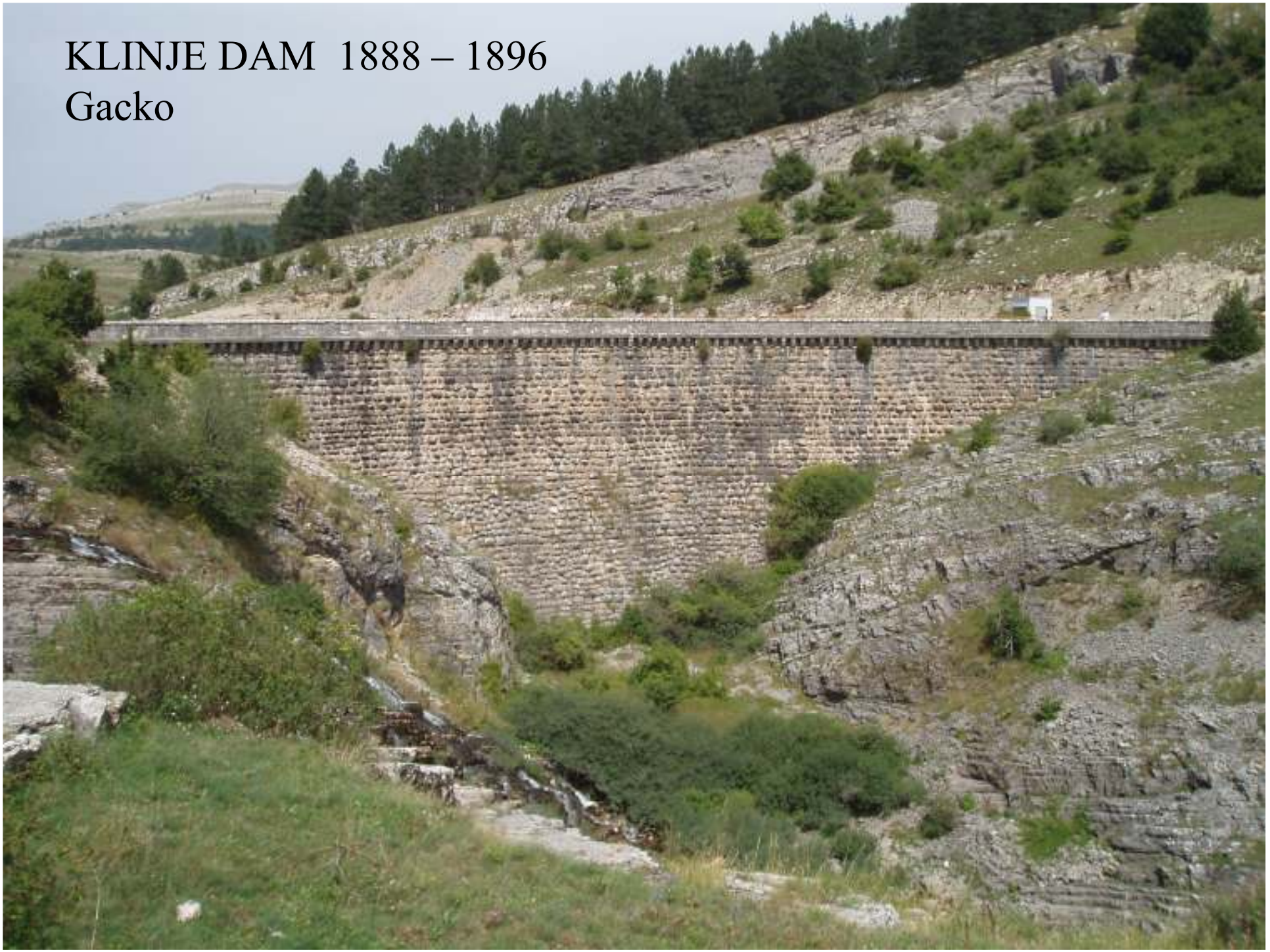

I
II
III
IV
1
2
3
4
5
6


Shafts
Sinkhole
Ponor
Sinking river
Estavelles
Temporary spring
Submarine spring
Temporary spring
0.00m
Karbonate rock beneath base of karstification
GWL after extreme precipitation
GWL - saturated karstified rock
GWL - min, dry period


OMBLA SPRING
3 – 130 m³/s

BUNA SPRING


380 m cu/s
Buna Spring discharge
300
200
100
Q
m³/s
Dec. 1970
Jan. 1971
Feb.
March
April
May
June
July
Precipitation
70
60
50
40
30
20
10
mm


KLINJE DAM 1888 – 1896
Gacko

LOCAL (PARTIAL) SOLUTIONS ARE NOT EFICIENT AND OPTIMAL.

REGIONAL CONTROL AND MANAGEMENT OF WATER POTENTIAL
IS REQUIRED.

STEPWISE DISPOSITION OF KARST POLJES ALLOWS OPTIMAL
MULTIPURPOSE USE OF GREAT WATER POTENTIAL FROM ELEVATION
1000 m TO THE SEA LEVEL.

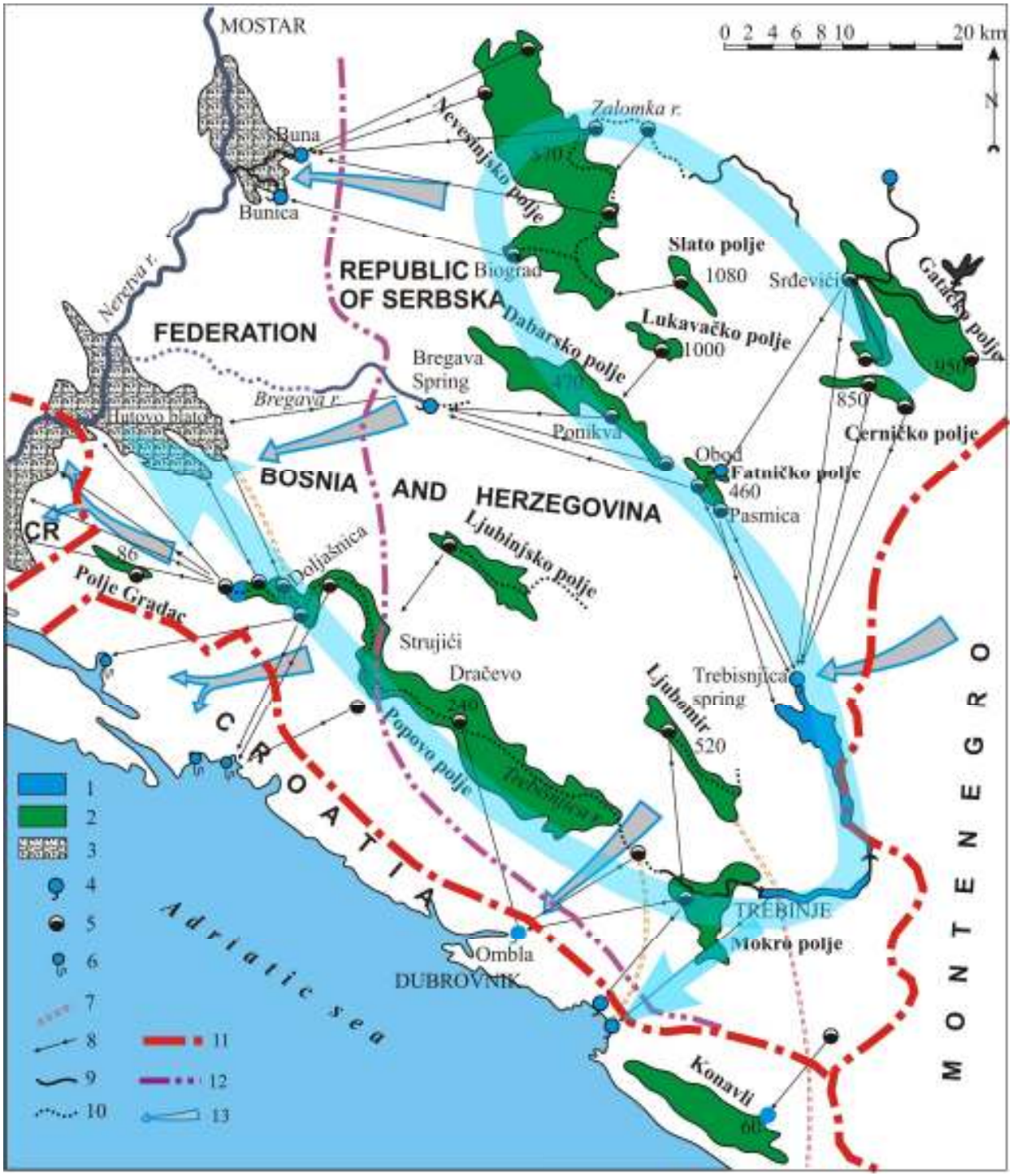
GENERAL IDEA: TO KEEP AND STORE THE PART OF WATER AT SURFACE
DURING WET SEASON FOR OPTIMAL USE DURING ALL YEAR.

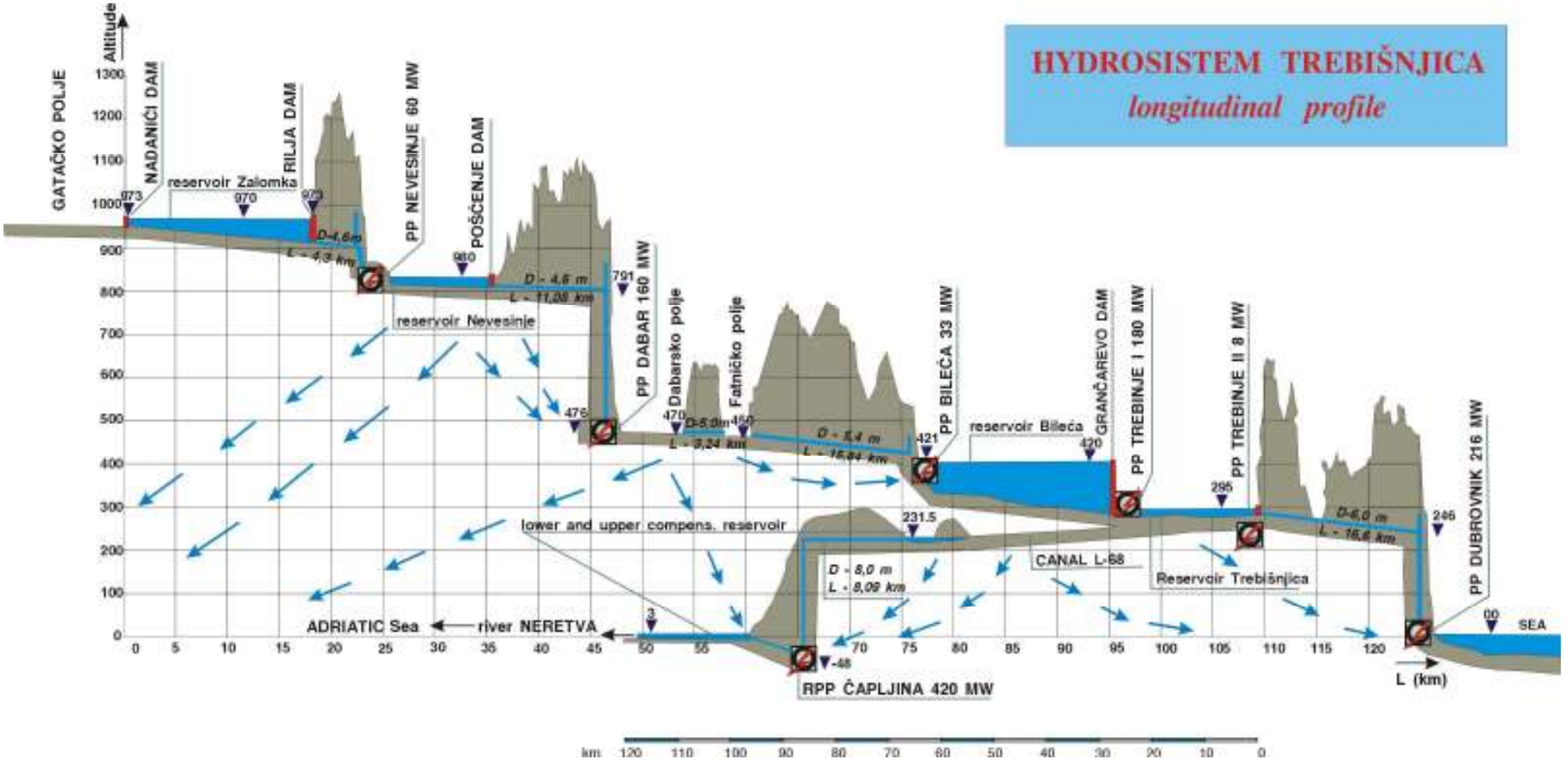
THIS GOAL CAN BE ACHIEVED ONLY BY CONSTRUCTION DAMS,
RESERVOIR, TUNNELS AND CANALS,

means by

CONSTRUCTION OF AN INTEGRATED REGIONAL HYDROSYSTEM:

TREBIŠNJICA MULTIPURPOSE HYDROSYSTEM (TMH)

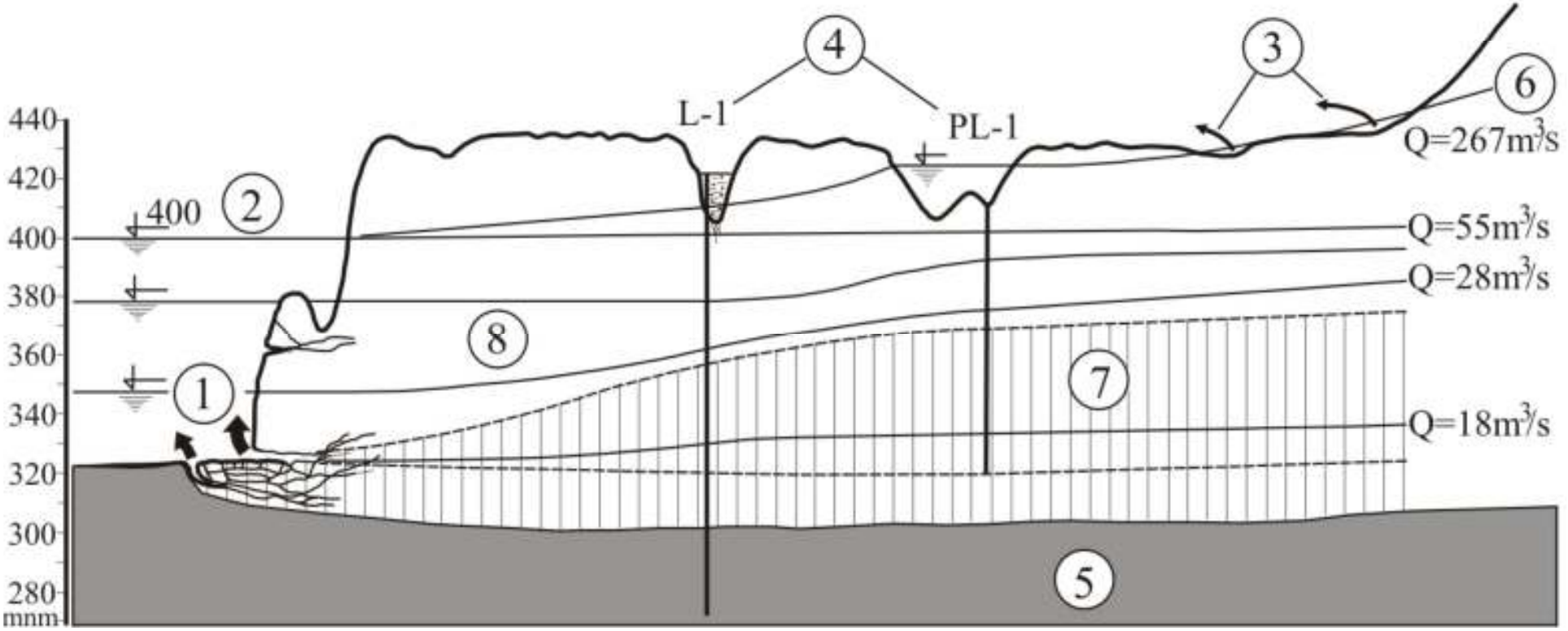

MOSTAR
0 2 4 6 8 10 20 km
N
Buna
Bunica
Neretva r.
Zalomka r.
Nevesinjsko polje
REPUBLIC OF SERBSKA
Biograd
Slato polje
1080
Srđevići
Gatačko polje
FEDERATION
Dabarsko polje
Lukavačko polje
1000
Bregava Spring
Bregava r.
Hutovo blato
Ponikva
850
Cerničko polje
Obod
Fatničko polje
460
Pasmica
BOSNIA AND HERZEGOVINA
Ljubinjsko polje
CR
86
Doljašnica
Polje Gradac
Strujići
Dračevo
Trebisnjica spring
Ljubomir
520
Popovo polje
Trebišnjica r.
CROATIA
TREBINJE
Mokro polje
Ombla
DUBROVNIK
Adriatic sea
Konavli
60
MONTENEGRO
1
2
3
4
5
6
7
8
9
10
11
12
13

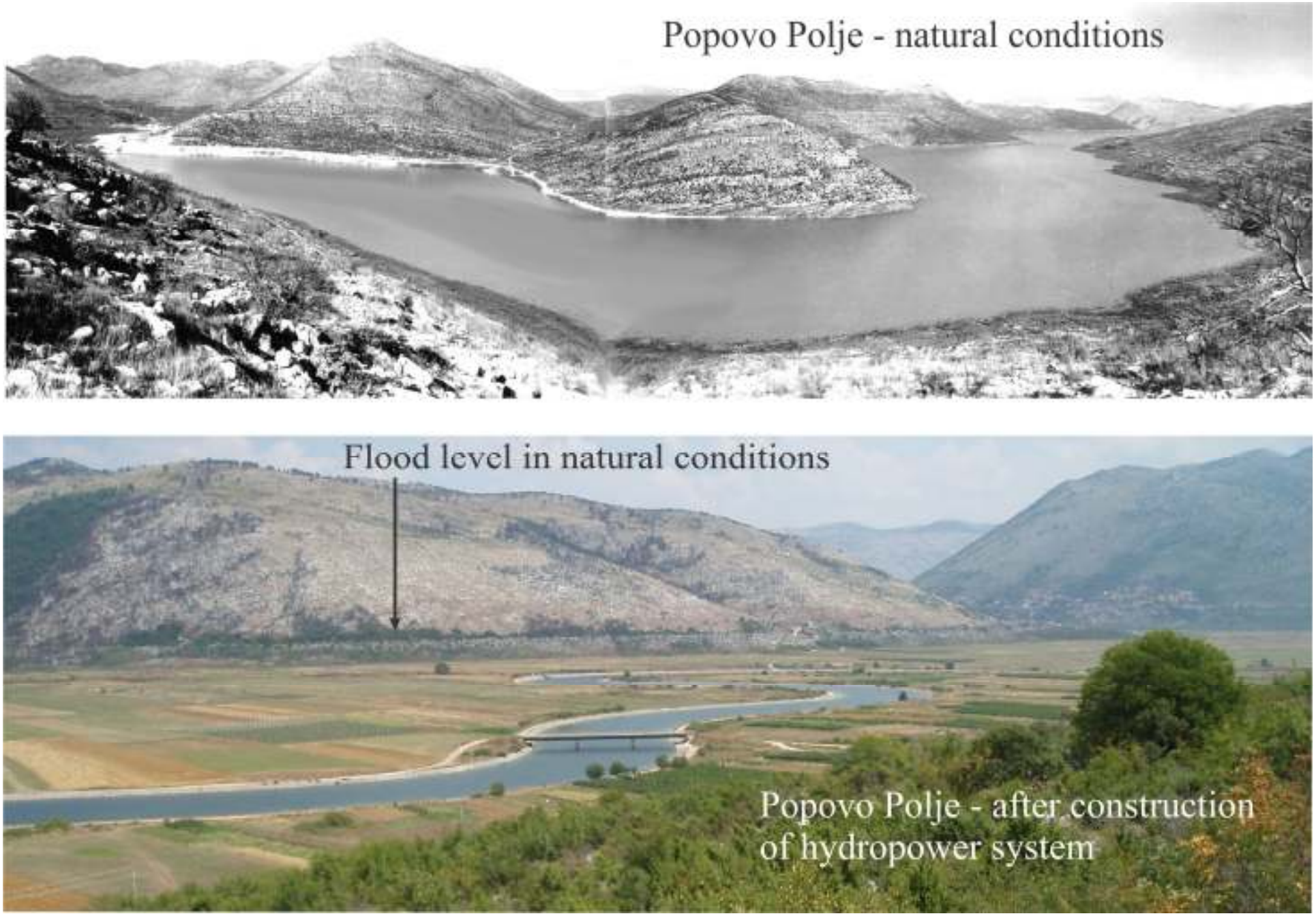

HYDROSISTEM TREBIŠNJICA
longitudinal profile
Altitude
GATAČKO POLJE
NADANIĆI DAM
RILJA DAM
reservoir Zalomka
973
970
PP NEVESINJE 60 MW
POŠĆENJE DAM
980
D - 4,6 m
L - 11,28 km
791
reservoir Nevesinje
PP DABAR 160 MW
Dabarsko polje
Fatničko polje
476
470
D-5,0m
450
L - 3,24 km
D - 5,4 m
L - 15,84 km
PP BILEĆA 33 MW
421
reservoir Bileća
420
GRANČAREVO DAM
PP TREBINJE I 180 MW
PP TREBINJE II 8 MW
295
D-6,0 m
L - 16,8 km
246
PP DUBROVNIK 216 MW
00
SEA
lower and upper compens. reservoir
231,5
CANAL L-68
D - 8,0 m
L - 8,09 km
Reservoir Trebišnjica
ADRIATIC Sea
river NERETVA
3
-48
RPP ČAPLJINA 420 MW
L (km)
km


N
MOSTAR
Nevesinjsko polje 850
RILJA DAM
reservoir Zalomka
Nevesinje
r. Zalomka
r. Buna
r. Neretva
PP NEVESINJE
NADANIĆI DAM
POŠĆENJE DAM
reservoir Nevesinje
Gacko
Vrba
Klinje
Dubrava 280
r. Opačica
Čapjina
r. Bregava
Stolac
Gatačko polje 950
Dabarsko polje 470
PP DABAR
r. Neretva
Metković
RPP ČAPLJINA
Fatnicko polje
Obod
Ljubinje
Ljubinjsko polje 470
HUTOVO
Bilecko polje 450
Bileca
PP BILEĆA
Reservoir Bileća
Popovo polje 250
Ljubomirsko polje 550
Trebišnjica River
PP TREBINJE II
PP TREBINJE I
GRANČAREVO DAM
r. Sušica
Trebinjsko polje 270
Trebinje
reservoir Trebinje
GORICA DAM
Ombla
Dubrovnik
PP DUBROVNIK
Adriatic Sea
Konavli 50
0 5 10 15 20 km


A


B


440
420
400
380
360
340
320
300
280
mnm
400
L-1
PL-1
Q=267m³/s
Q=55m³/s
Q=28m³/s
Q=18m³/s
1
2
3
4
5
6
7
8


Popovo Polje - natural conditions
Flood level in natural conditions
Popovo Polje - after construction
of hydropower system

AS A CONSEQUENCE OF HUMAN ACTIVITIES AND ENGINEERING CONSTRUCTION IN KARST REGIONS MODIFICATION AND ADAPTATION OF NATURAL SURFACE AND GROUNDWATER REGIME THE CERTAIN ENVIRONMENTAL IMPACT CAN NOT BE AVOIDED.

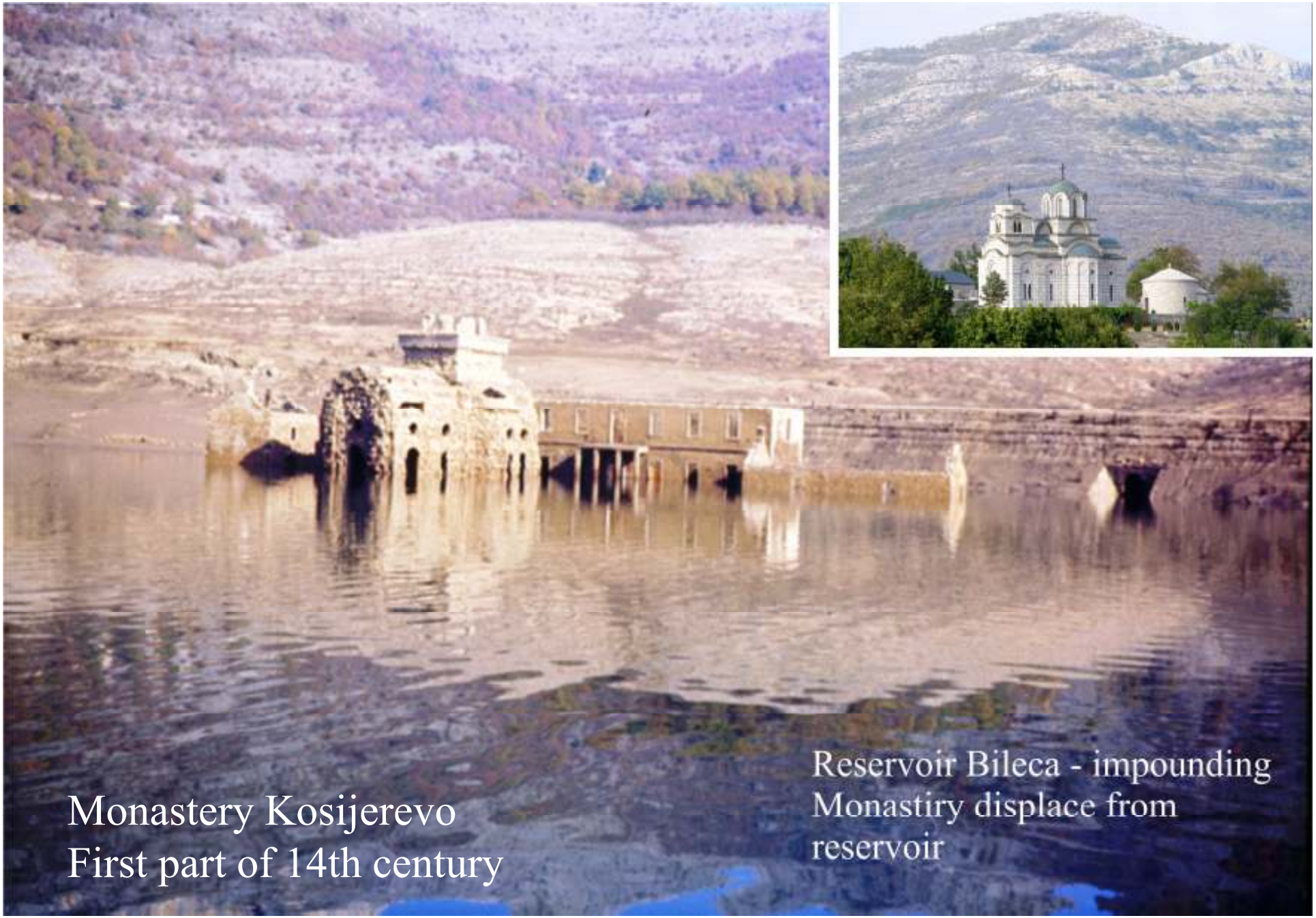
THE COMMON ENVIRONMENTANTAL IMPACTS ARE:

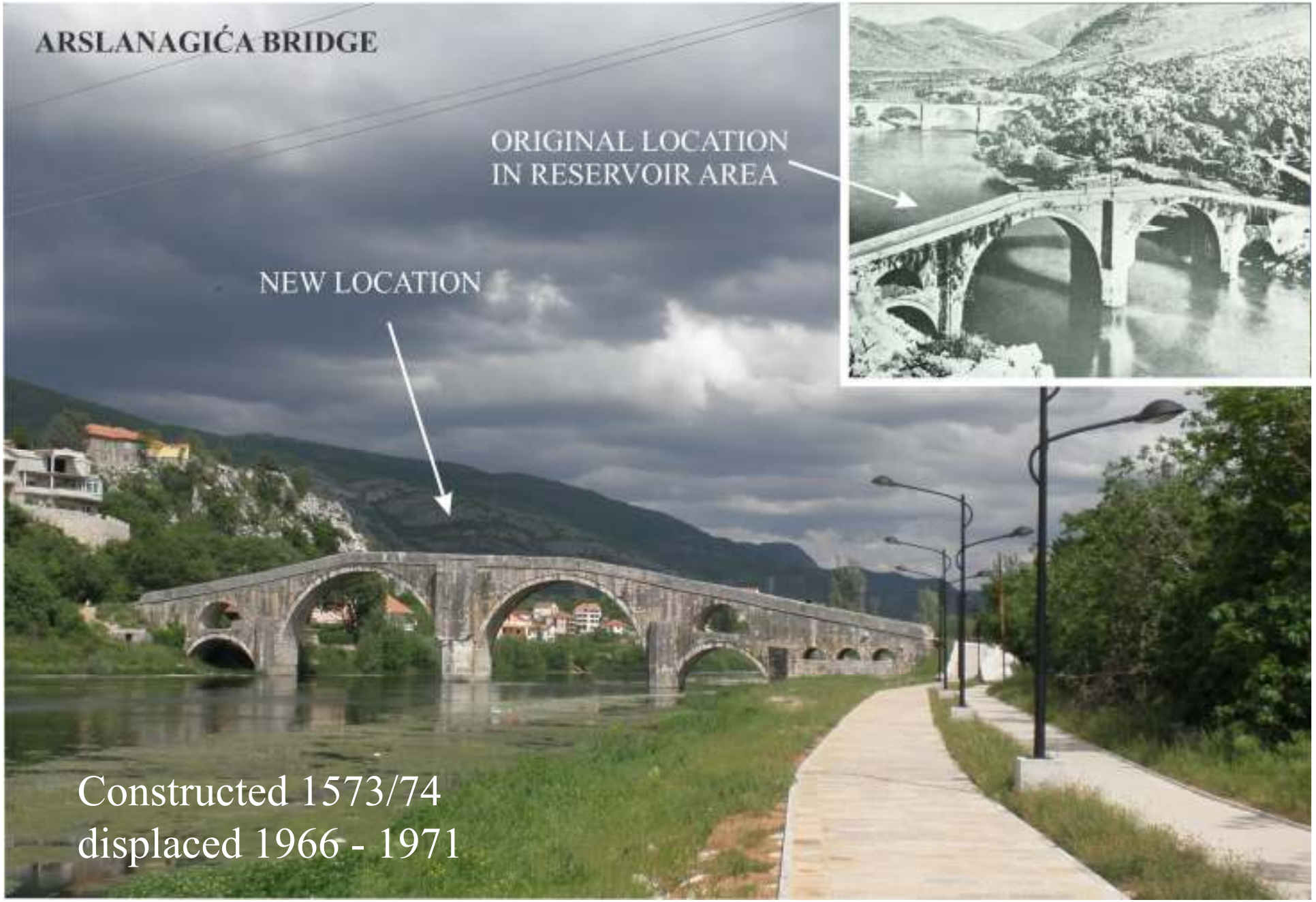
- SPRING DISCHARGE CHANGE;
- ENDEMIC FAUNA ENDANGERING;
- INUNDATION OF HISTORICAL MONUMENTS AND NATURAL RARITIES;
- THE POPULATION MIGRATION FROM INUNDATED AREAS;
- ARABLE LAND INUNDATION;
- INDUCED COLLAPSE;
- INDUCED SEISMICITY

and

SOME UNPREDICTABLE IMPACTS

THE IMPORTANT ISSUE IS HOW TO KEEP THE BALANCE BETWEEN THE NECESSITY FOR REGIONAL DEVELOPMENT AND PRESERVATION OF SENSITIVE AND COMPLEX KARST ECOLOGICAL SYSTEM, AND TO PREVENT NEGATIVE IMPACTS TO HISTORICAL A ND CULTURAL MONUMENTS AND NATURAL RARITIES.


Monastery Kosijerevo
First part of 14th century
Reservoir Bileca - impounding
Monastiry displace from
reservoir


ARSLANAGIĆA BRIDGE
ORIGINAL LOCATION
IN RESERVOIR AREA
NEW LOCATION
Constructed 1573/74
displaced 1966 - 1971

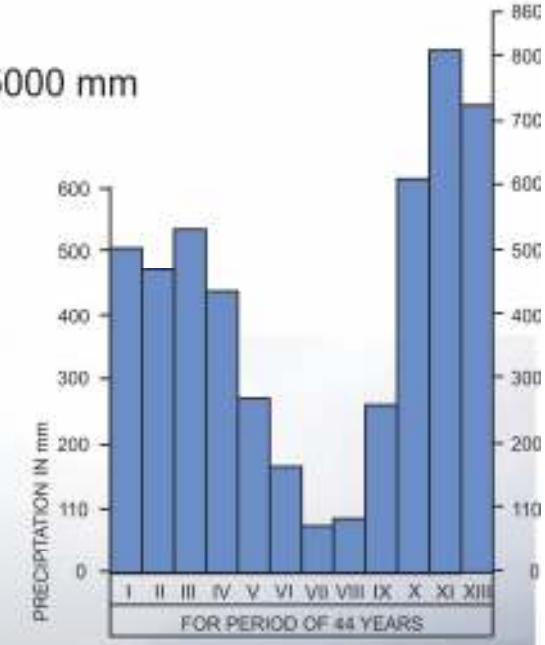
WATER POTENTIAL OF SOUTH-EASTERN DINARIDES

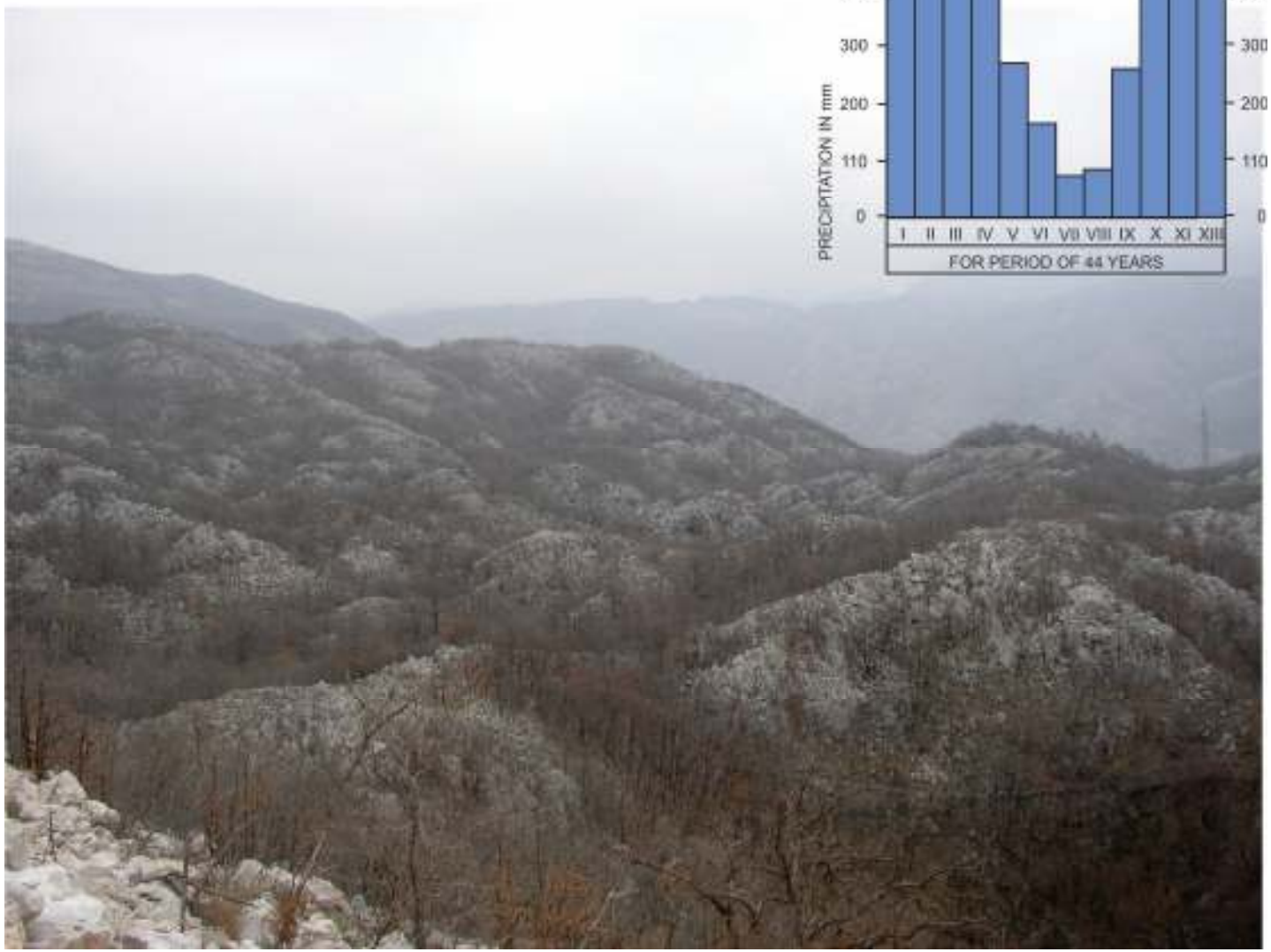
NEEDS SEVERE PRESERVATION AS MOST IMPORTANT REGIONAL RESOURCE

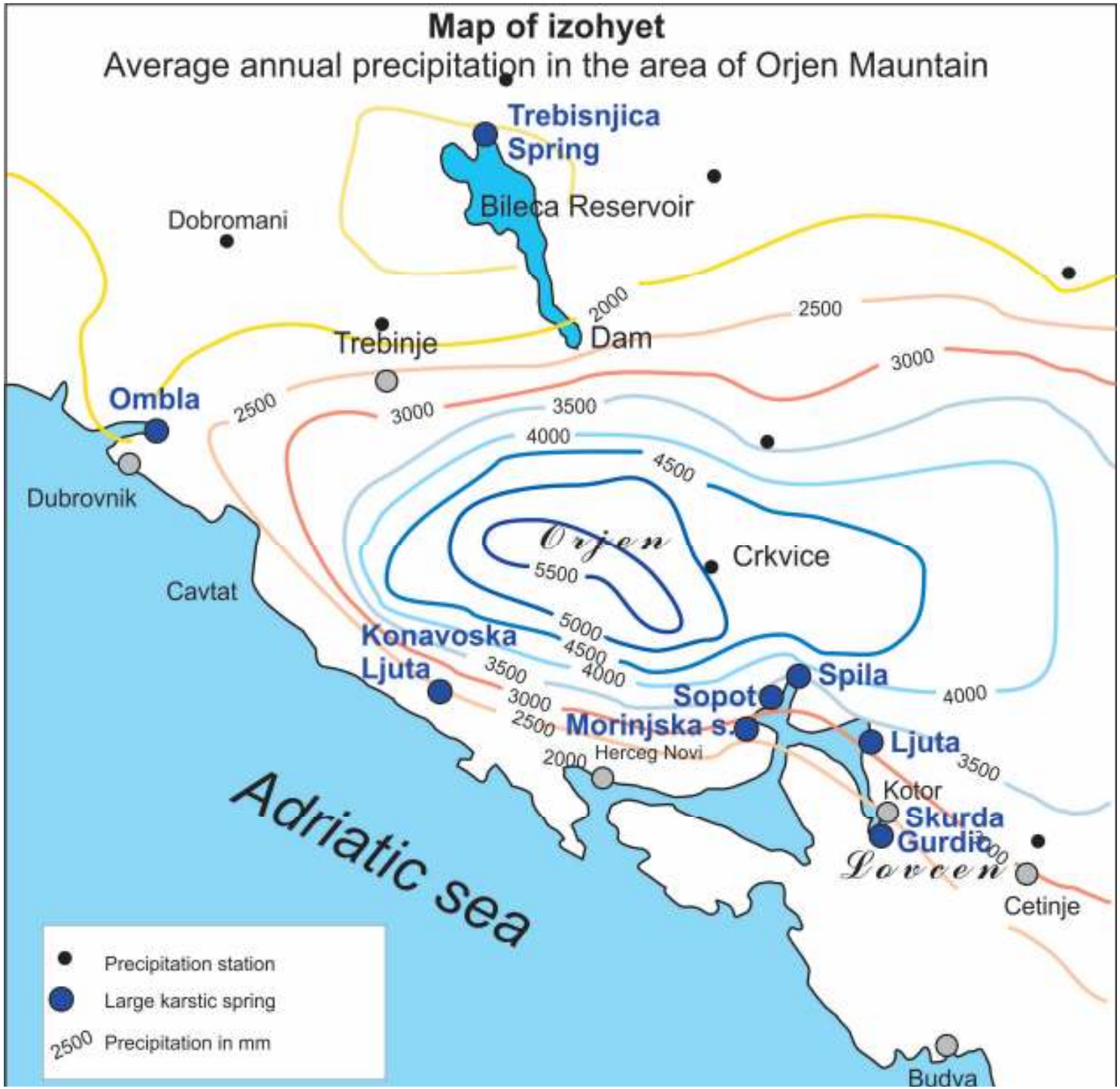
ORJEN MOUNTAIN

CRKVICE - AVERAGE ANNUAL PRECIPITATION > 5000 mm

MAXIMAL MEASURED = 8063 mm






Map of izohyet
Average annual precipitation in the area of Orjen Mauntain
Trebisnjica
Spring
Bileca Reservoir
Dobromani
Trebinje
Dam
Ombla
Dubrovnik
Cavtat
Orjen
Crkvice
Konavoska
Ljuta
Sopot
Spila
Morinjska s.
Herceg Novi
Ljuta
Kotor
Skurda
Gurdic
Lovcen
Cetinje
Budva
Adriatic sea
2000
2500
3000
3500
4000
4500
5000
5500
Precipitation station
Large karstic spring
2500 Precipitation in mm

WATER POTENTIAL OF SOUTH-EASTERN DINARIDES
- IMPORTANCE OF INTERNATIONAL SIGNIFICANCE.

ROLE OF THE MEDITERANEN “WATER TREASURE”.

POSSIBLE TAPPING AT ELEVATION 200 – 300 m.

POSSIBILITY FOR TRANSPORT AT LONG DISTANCE BY GRAVITY.

THIS CONCEPT REQUIRE PERMANENT AND PERFECT PROTECTION OF SURFACE AND UNDERGROUND WATERS.

TRANSBOUNDARY PROBLEMS SHOULD BE OVERCOME AND ENTIRE REGION SHOULD BE TREATED AS A UNIQUE HYDROGEOLOGICA AND HYDROLOGICAL ENTITY.


THANK YOU FOR ATTENTION