SETOF Soil Erosion and TOrrential Flood Prevention: Curriculum Development at the Universities of Western Balkan Countries

Torrential Floods Prevention

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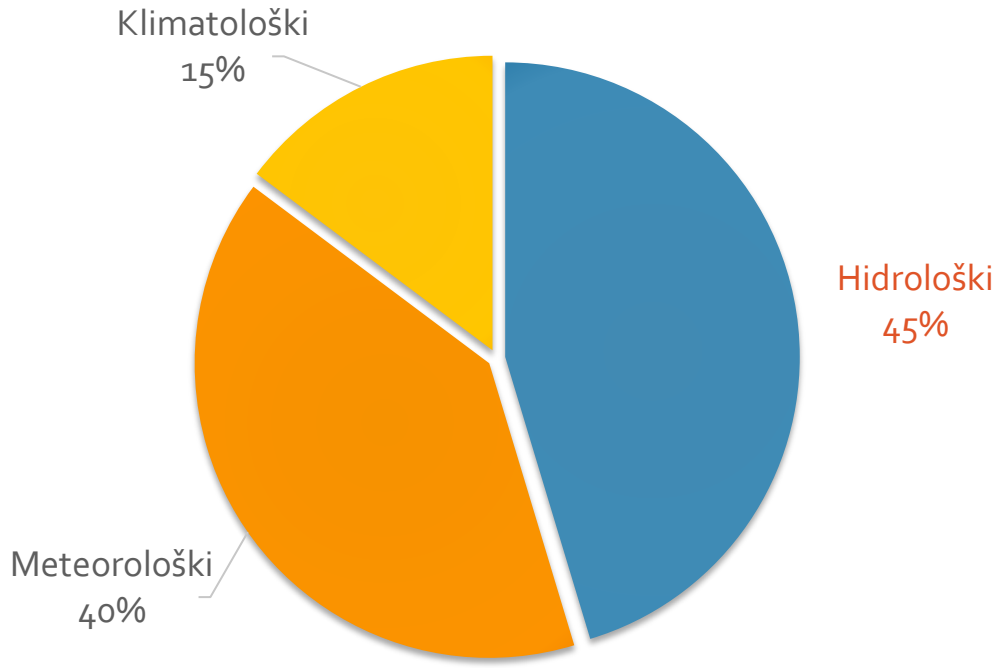
Damage due to hydromet. hazards 1980-2021

EU, 1980-2020 (EEA, 2022):

- 510 billion EUR;
- 85.000 human lives



EMDAT (2021)

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Recent Disaster in JAPAN

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MLIT Ministry of Land, Infrastructure, Transport and Tourism

2018 West Japan (over 200 dead)

2016 North Japan (27 dead)

2014 Hiroshima (74 dead)

2015 Kinugawa (20 dead)

2017 North Kyushu (42 dead)

2019 Typhoon Hagibis (96 dead)

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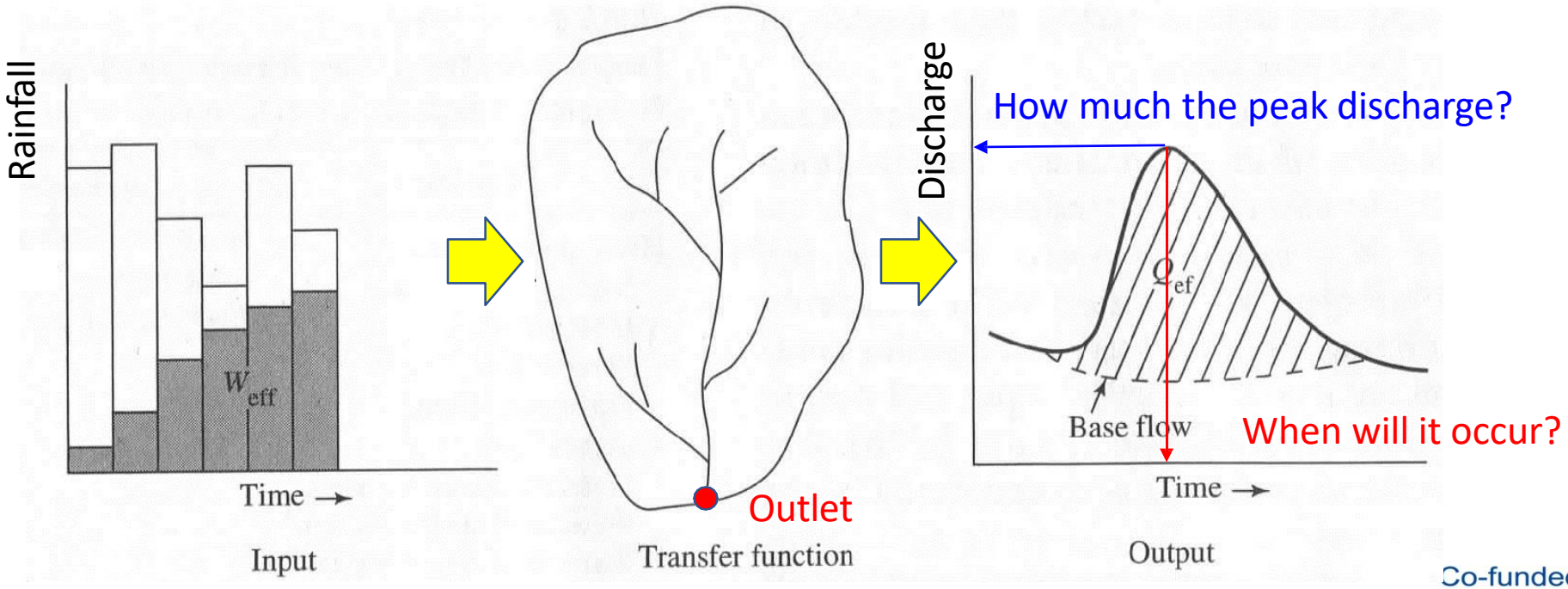
Rainfall-runoff analysis

1. Input hyetograph
2. Output hydrograph by runoff model



*Weff: Effective Rainfall

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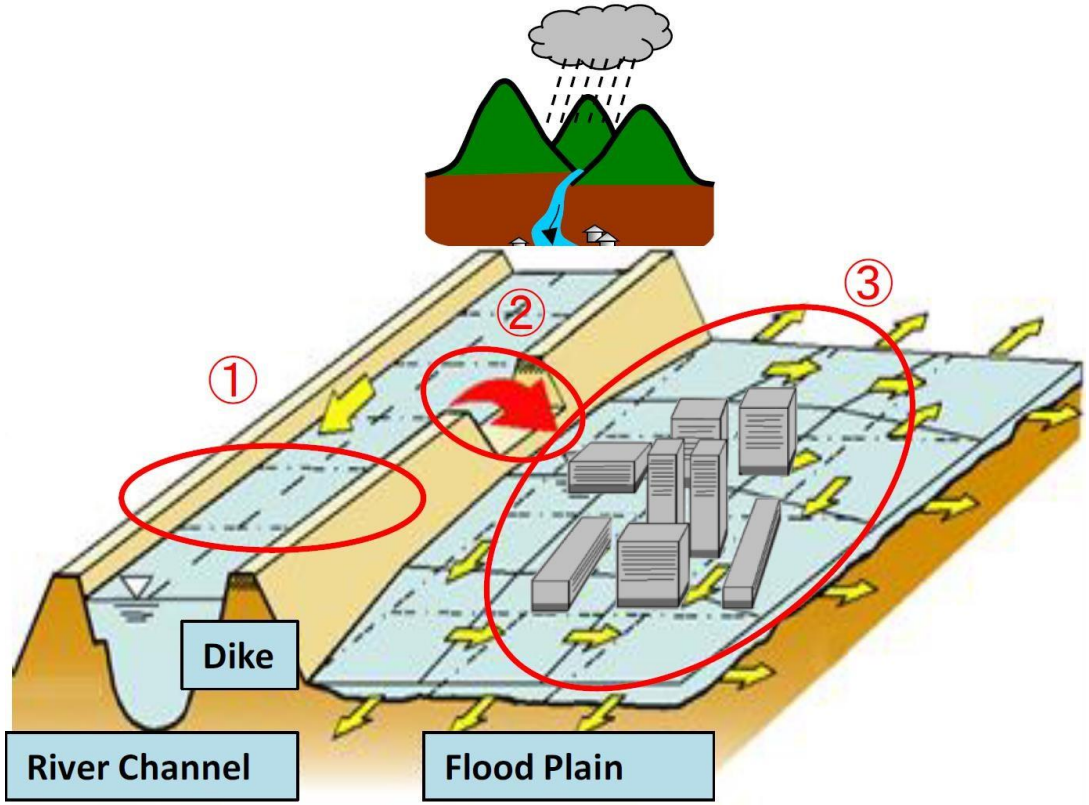
Steps for creating flood hazard map

1. Compute flood propagation (discharge & water level) in river channel (one-dimension)
2. Compute overflow to flood plain by overtopping dike or breaching dike
3. Compute flooded water movement (two-dimension)



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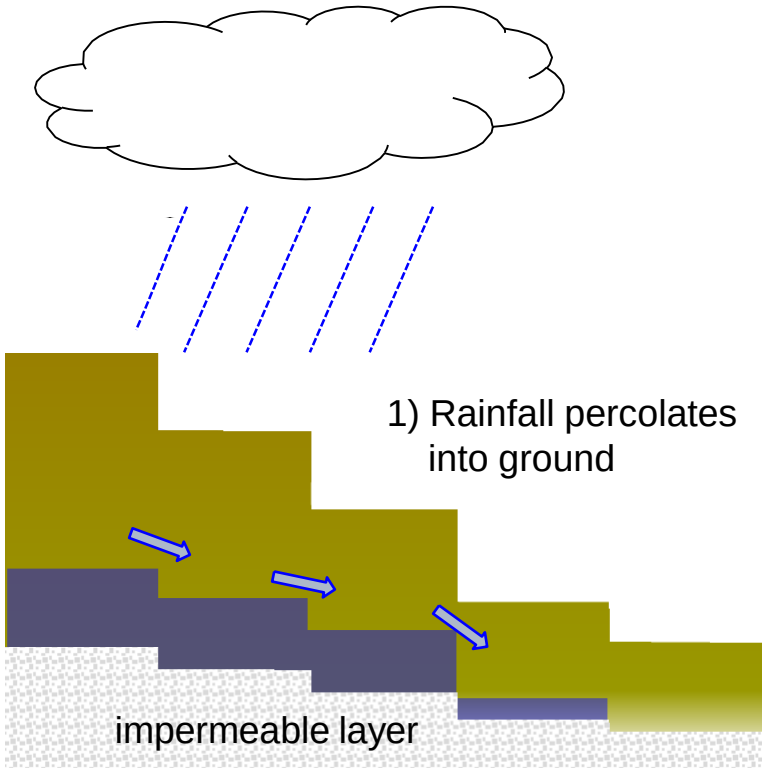
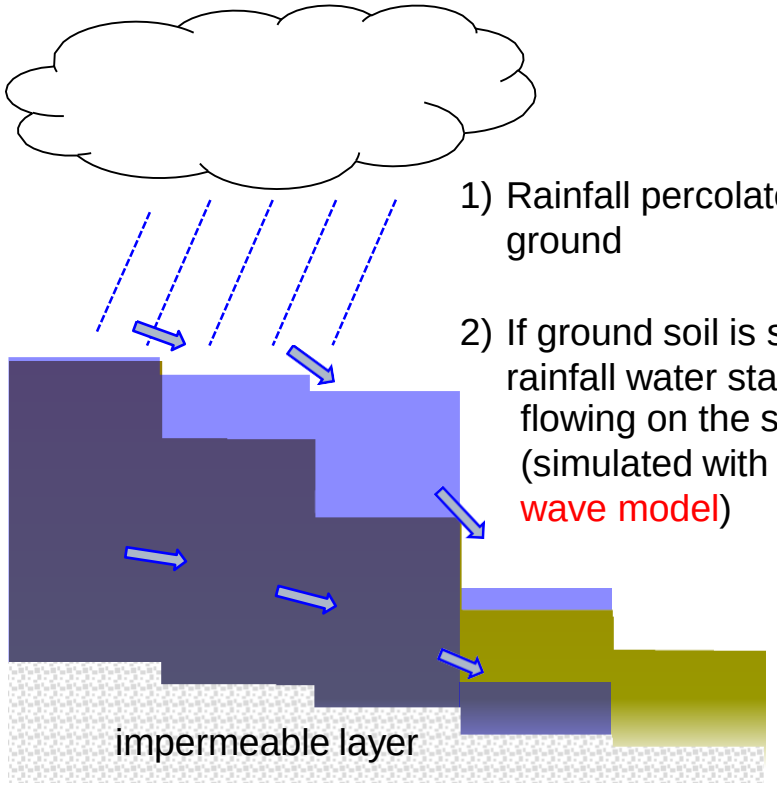
a) Before saturation



2) Subsurface water flows in lateral direction according to head differential of ground water (simulated with Darcy's Law)

b) After saturation



Depth of permeable layer is important parameter for model

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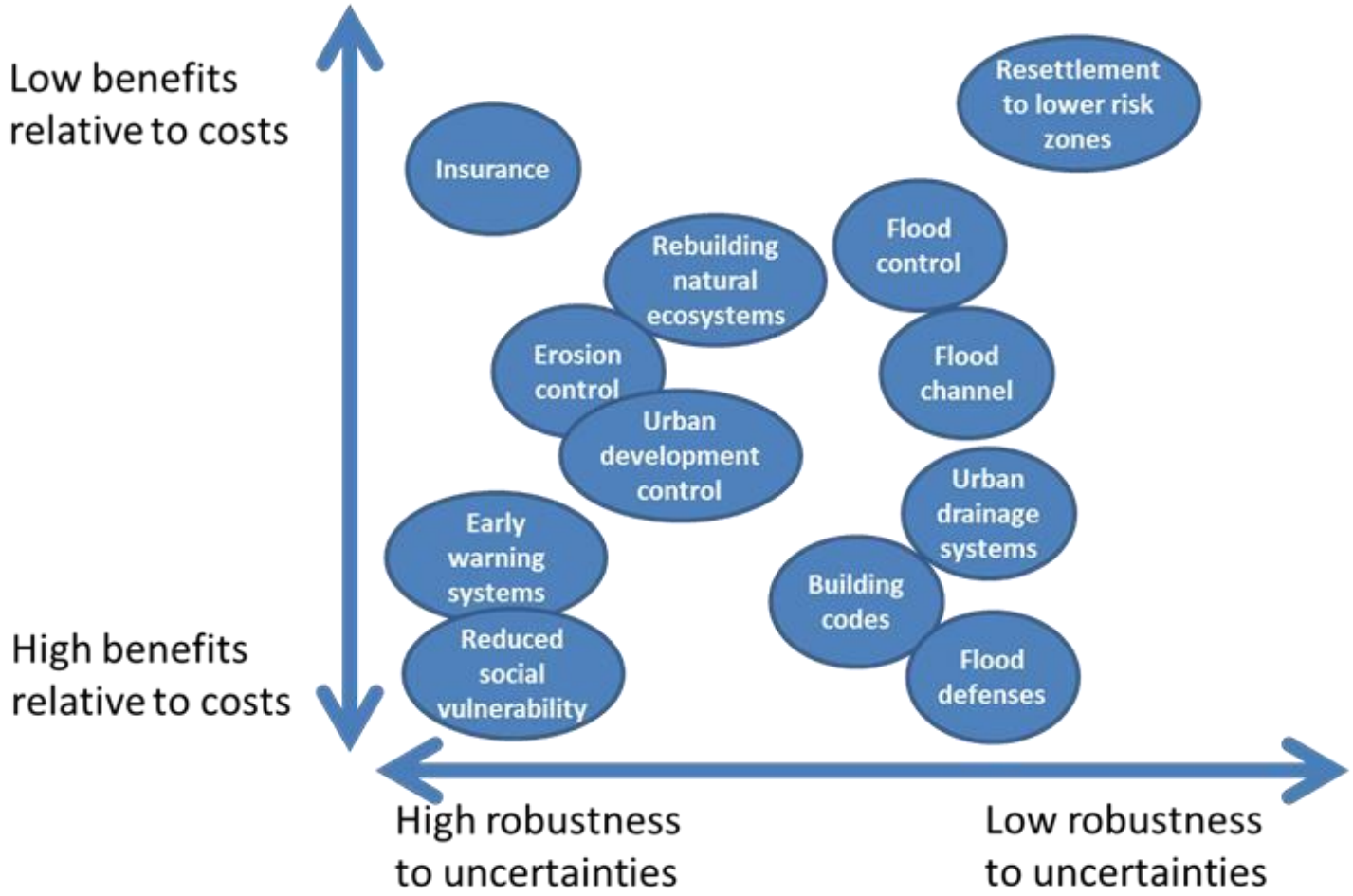
Robustness of measures when selecting options



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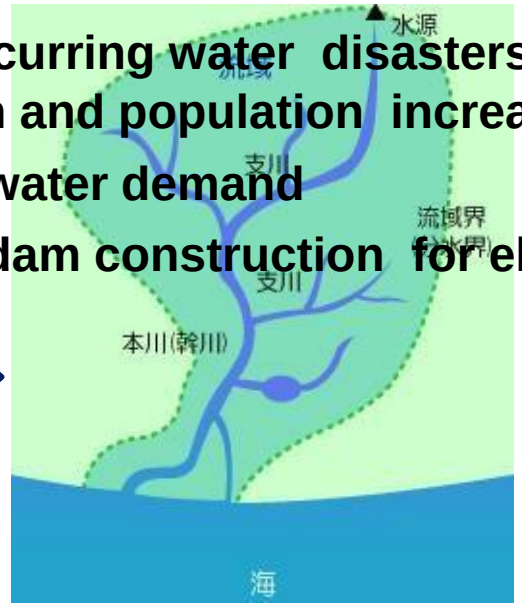
○Integrated river management:
1)well-balanced flood control and water use throughout the basin 2)Responsibilities and roles of river managers clearly defined.

●Frequent occurring water disasters
●Urbanization and population increase
●Increase of water demand
●Increase of dam construction for electric power



Coordinating regional interests is needed

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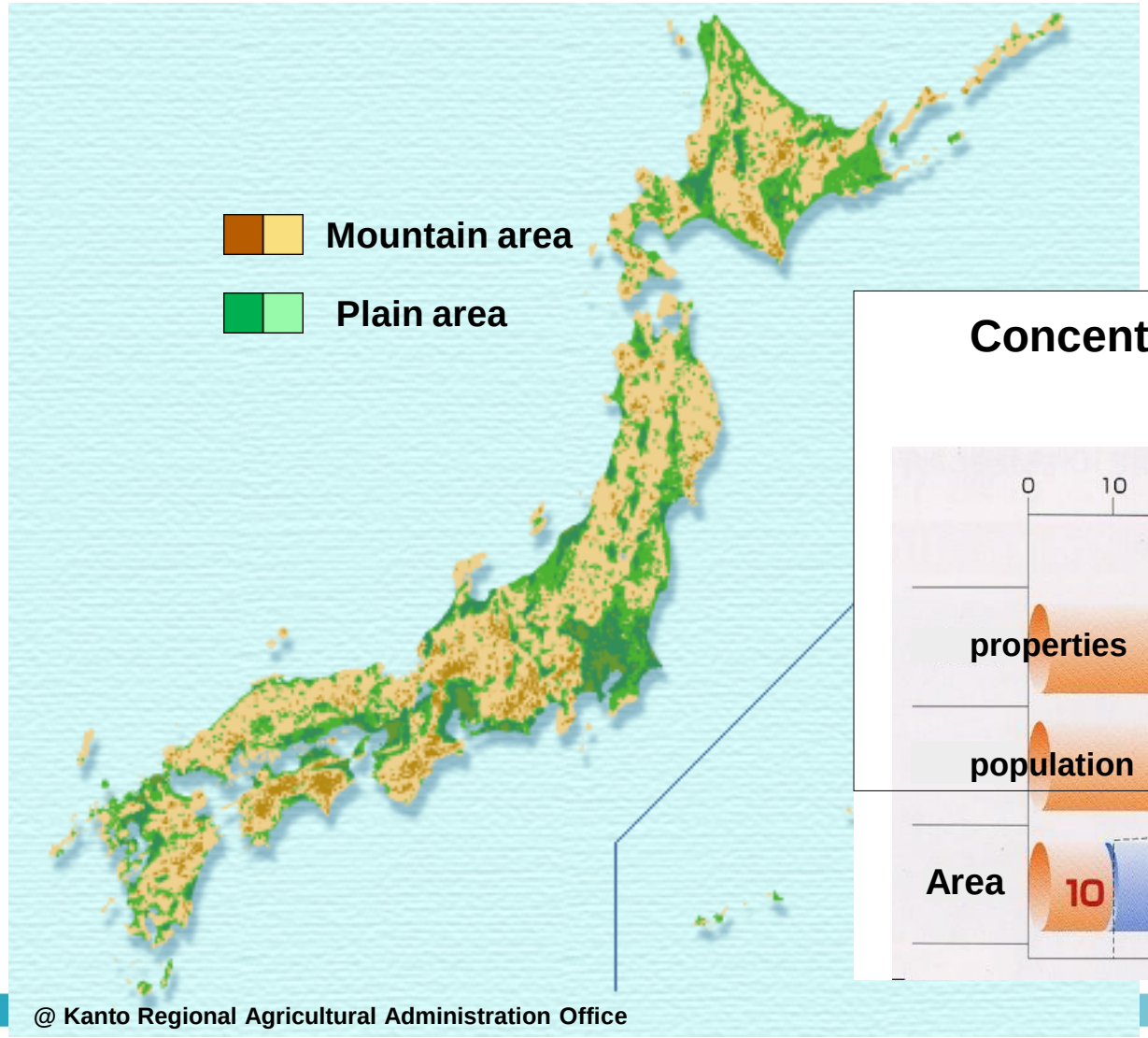
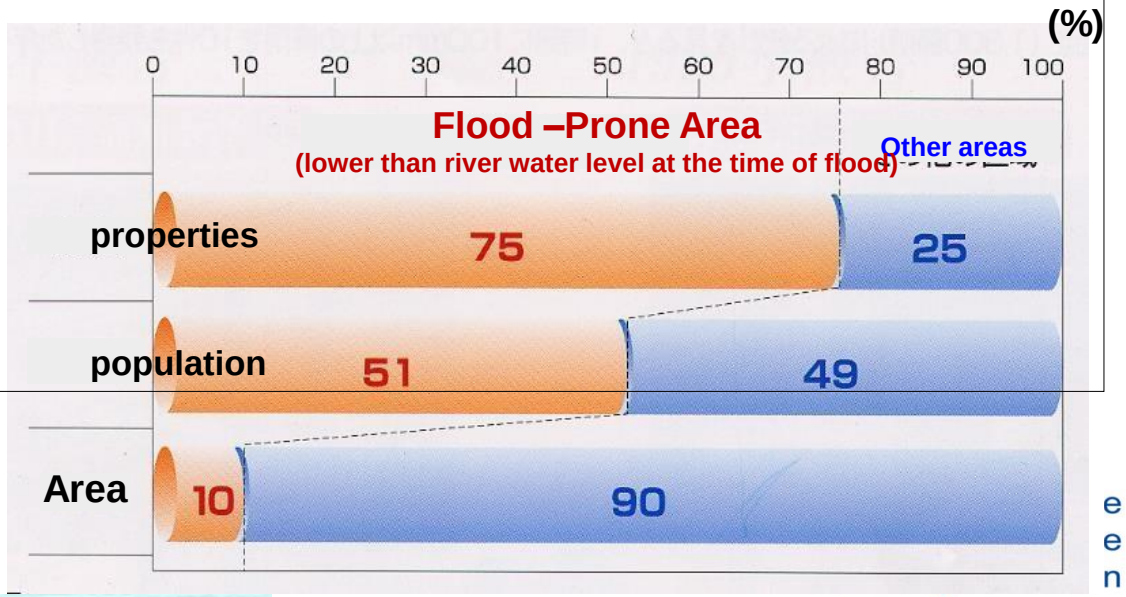
Most of land are covered by mountains, people and assets are focused in the narrow plain area.



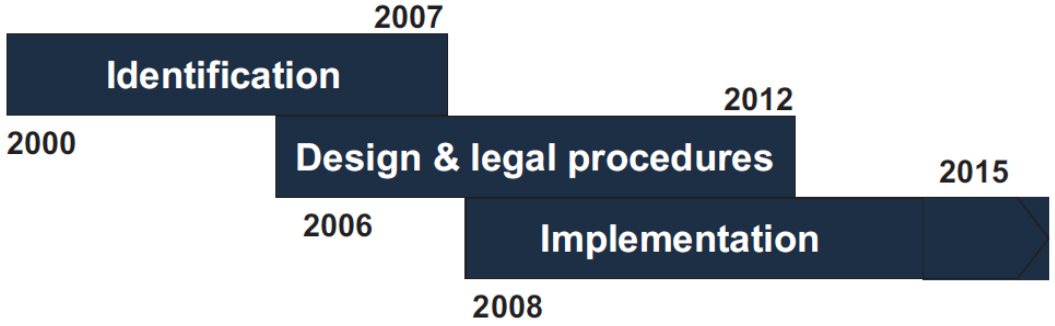
@ Kanto Regional Agricultural Administration Office

Concentration of population and assets in flood-prone area



Program: "Room for the River"

- After floods in 1993. and 1995.
- 39 locations
- Investment: 2,3 billion €
- Relocation of 150 households and 50 farms
- decreas of agricultural surfaces: 1280 ha
- increase of nature closed surfaces: 1850 ha



2017 North Kyushu (42 dead)

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Examples of structural measures

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<Embankment>

<Dams>

<Dam upgrading>

<Excavating the riverbed>

<Retarding basins>

<Water ways>

Underground retention-Tokyo

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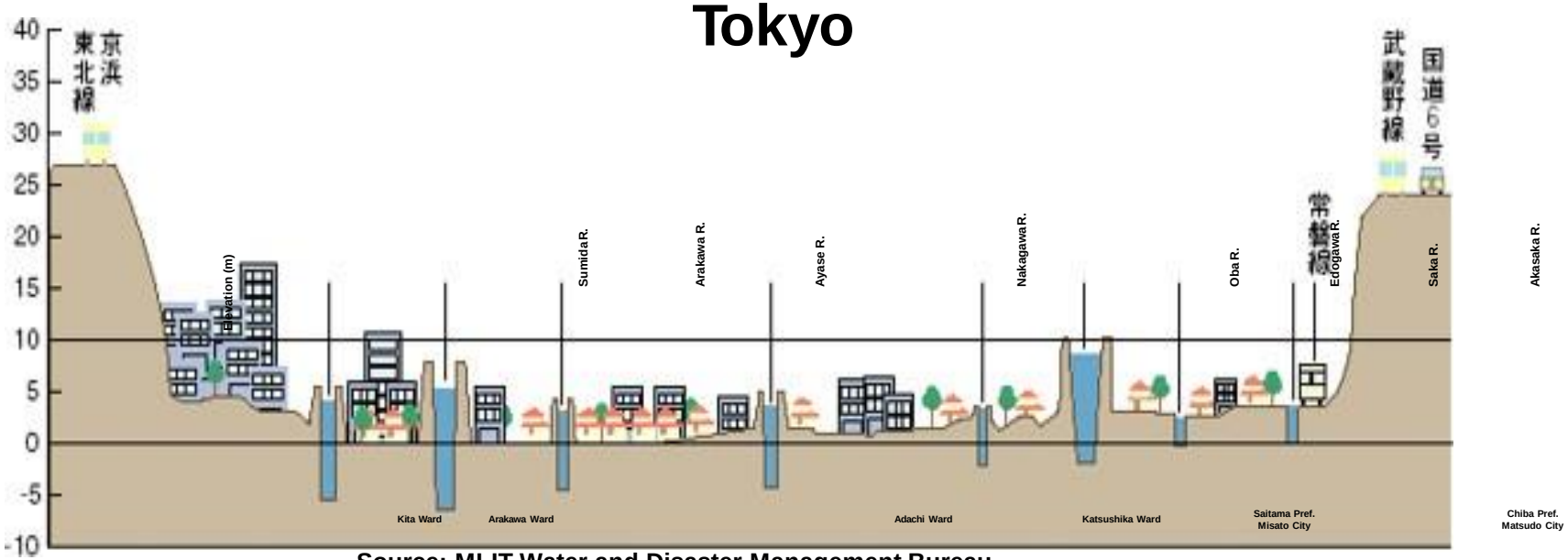
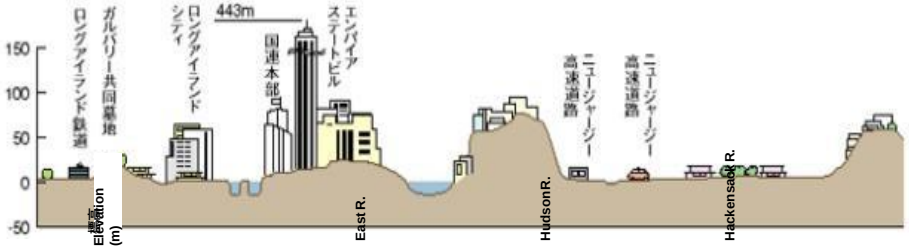
Big cities in Japan are located lower than the water level of rivers

Tokyo

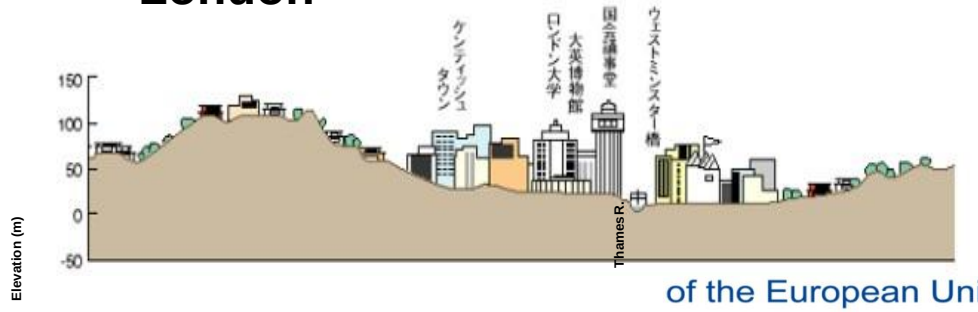


Source: MLIT Water and Disaster Management Bureau

New York



London



Devices for more efficient evacuation, Disaster Management Drill

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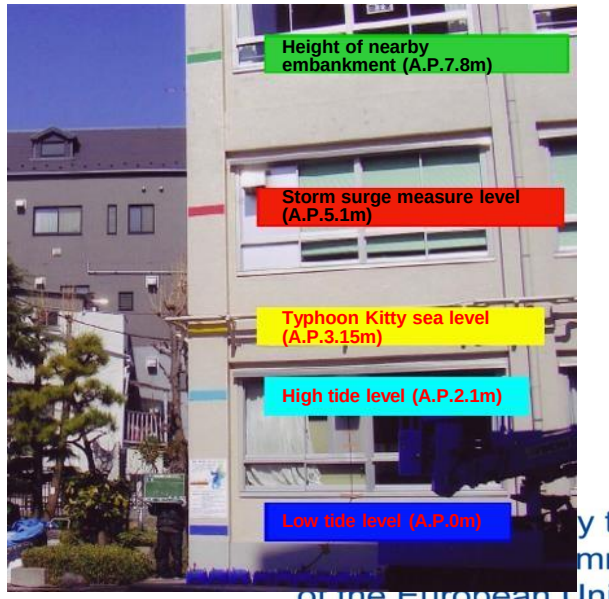
Flood mark (expected flood depth (2m))

Water level is displayed in real time
water levels of past flood are shown

Disaster prevention camp
(To confirm the evacuation route using flood hazard map by elementary school students)



Tidal levels are shown on the school building of primary school

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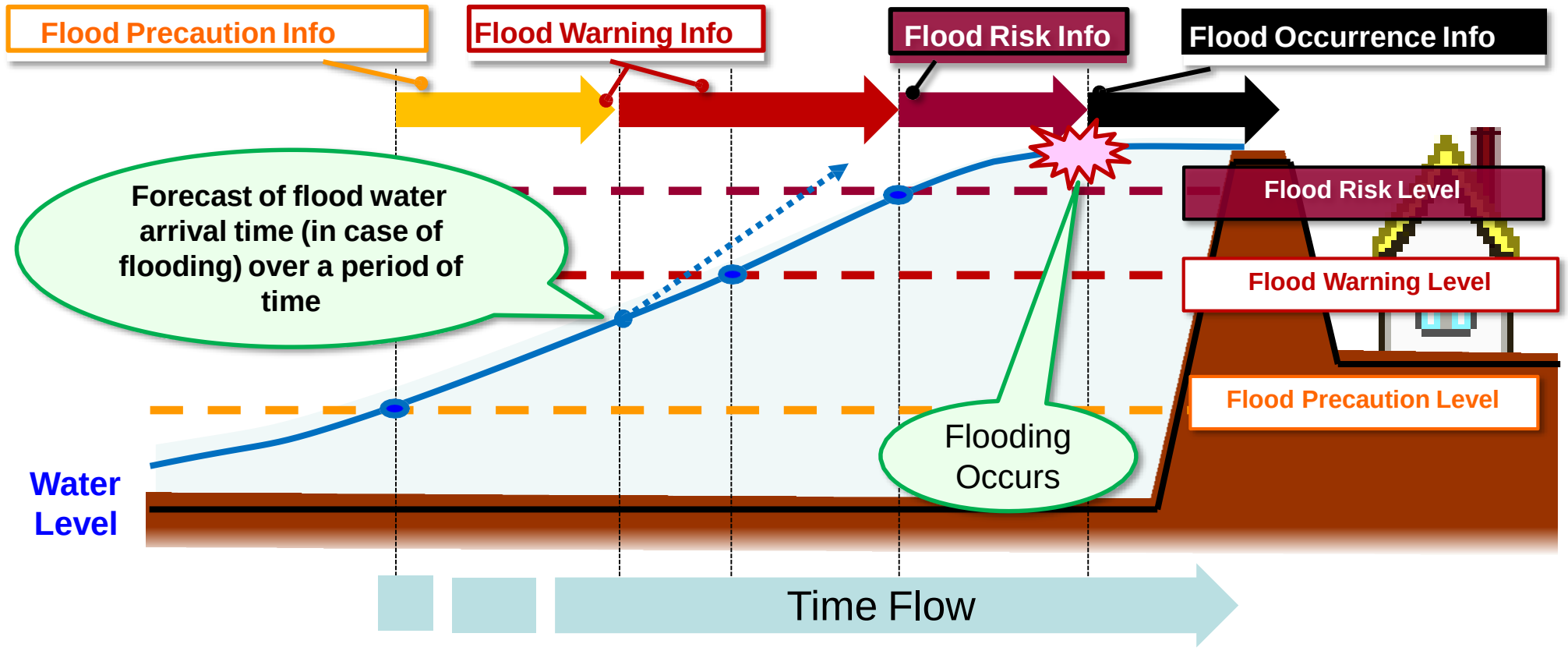
Current water levels and future water level forecasts are announced



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Expansion of observation network by 3L gauges

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MLIT Ministry of Land, Infrastructure, Transport and Tourism

Administrator	Rain gauge station	Water gauge station
River authority (MLIT for 109 rivers)	2,407	2,336
River authority (Prefectures for other rivers)	5,246	4,599
Japan Meteorological Agency	1,303	—
total	8,856	6,935

Number of observation and automatic data transfer units (as of Mar. 2016)

Conventional river station

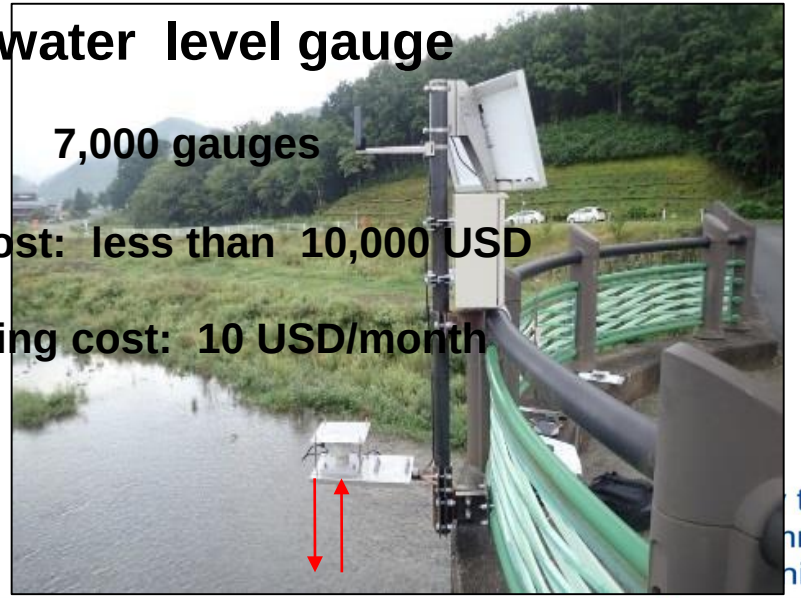
Contact type

3L water level gauge

7,000 gauges

Initial cost: less than 10,000 USD

Running cost: 10 USD/month



Non-contact type (attached to bridge

MLIT's disaster countermeasures

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When large-scale natural disaster occur, the management of the MLIT assembles for an emergency meeting at the Disaster Prevention Center and carries out the following work.

(1) Collection of information

(2) Information exchange between official residence and other government ministries

(3) Decision on emergency countermeasures

Helicopters for disaster prevention measures

Water level telemeter

Radar rain gauge system

Surveillance camera

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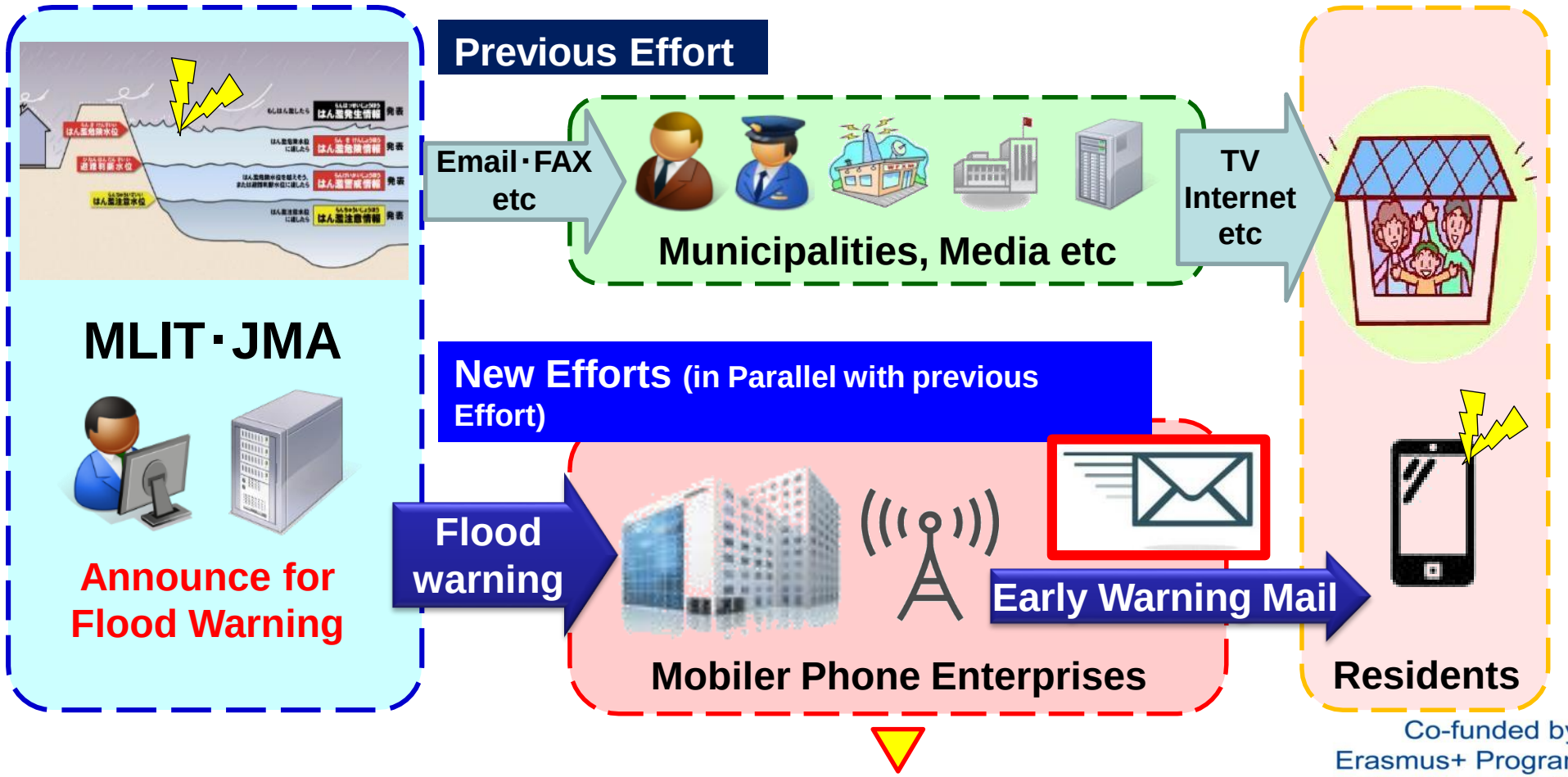
MLIT deliver an Early Flood Warning Mail in corporate with mobile phone companies to progress early evacuation for residents.



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Real-time data to residents

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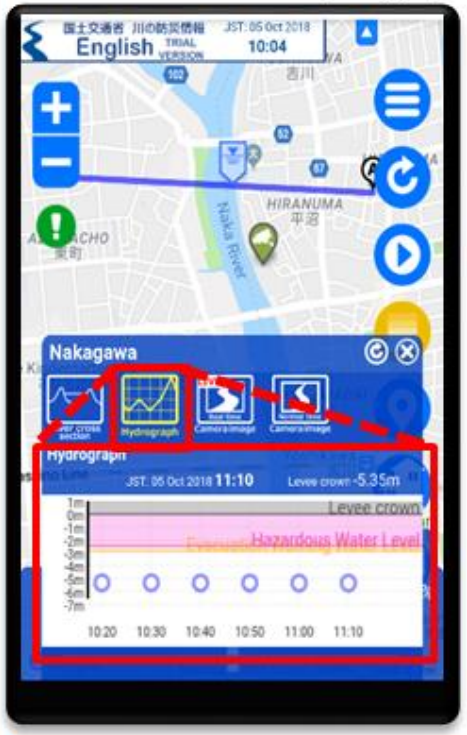
Real-time and wide-range rainfall data

CCTV camera

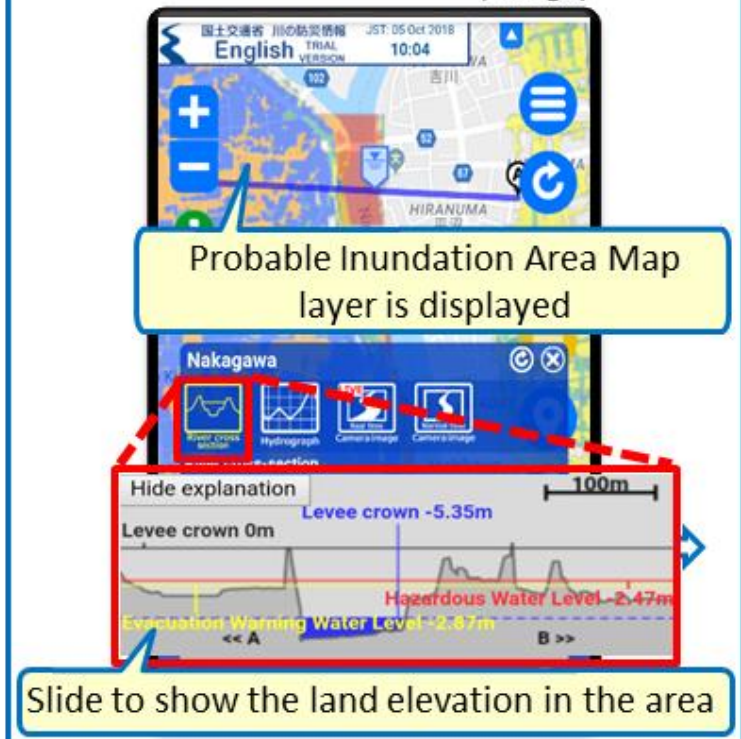
Current and past river levels, showing the trend of river level rise

(Image)



Lateral profile of the current river level, showing the risk stage of flooding

(Image)



Live image from CCTV camera, showing the condition of river and flood plain

(Image)

Real-time and on-site water level data on smart phones

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Technical Emergency Control Force (TEC-FORCE)

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MLIT Ministry of Land, Infrastructure, Transport and Tourism

○ **MLIT established TEC-FORCE to provide supports to local governments if a massive natural disaster occurs.**

○ **<u>A total of about 9,000 personnel</u> from MLIT organizations are appointed as TEC-FORCE members in advance.**

TEC-FORCE's activities

➢ Disaster response helicopters

Torrential rain in Kanto and Tohoku (September 2015)
(Joso City, Ibaraki Prefecture)

➢ Field survey

Sediment disaster in Hiroshima (August 2014)
(Hiroshima City, Hiroshima Prefecture)

➢ Drainage pumpers

Torrential rain in Kanto and Tohoku
(September 2015)
(Kurihara City, Miyagi Prefecture)

➢ Monitoring system (Ku-SAT*)

Eruption of Mt. Ontake (September 2014)
(Otaki Village, Nagano Prefecture)

➢ liaison officers

Volcanic activities on Kuchinoerabu Island
(May 2015)
(Yakushima Town, Kagoshima Prefecture)

➢ Technical advice to local government

Kumamoto Earthquake (April 2016)
(Kumamoto Prefectural government)

➢ Technical advice for search operations

Kumamoto Earthquake (April 2016)
(Minamiaso Village, Kumamoto Prefecture)

Fukuoka, 8 November 2016

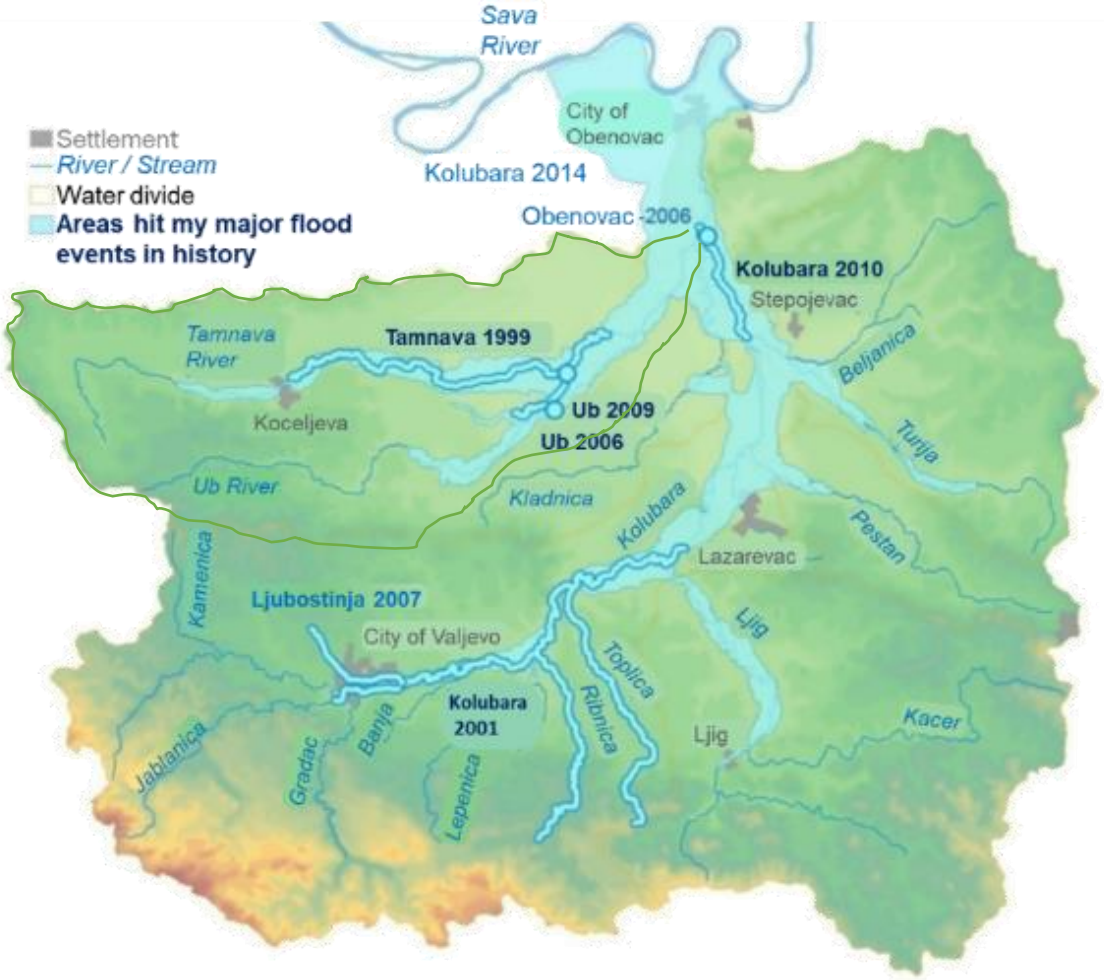
7 days later

Hokkaido, 5 September 2018

7 days later

Tamnava watershed flood protection

- Actual conditions: system of dykes (4%, 2%, 1% Qmax)
- Improvement of flood protection (UNDP, 2014-2016), grey/blue-green scenario:
  - Dyke improvement
  - 3 retention reservoires (Tamnava, Ub, Gračica)
  - Flood receiving channel Gračica-Ub (built)
  - Erosion control measures (in progress)



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„Grey“ infrastructure: traditional attitude

„Green“ and „blue“ infrastructure: local and regional measures

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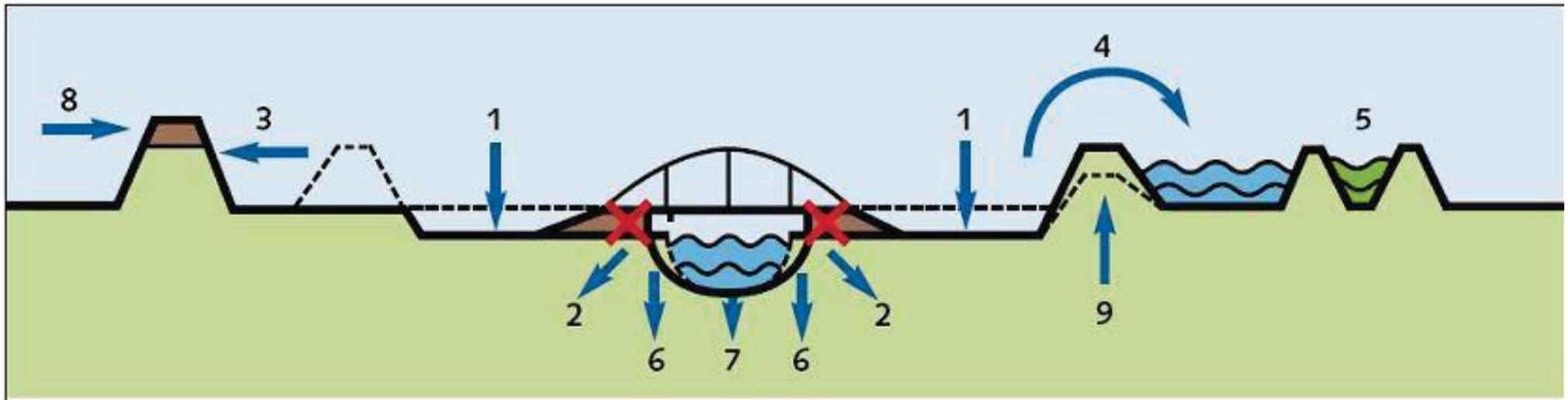

1 **Lowering of floodplains**
2 Removal of obstacles
3 Dyke relocation
4 Waterretention and storage
5 **By-pass**
6 Height reduction of groynes
7 Deepening of summer bed
8 **Heightening of dykes**
9 Dyke improvement

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Ecosystem services (Tamnava watershed)

EUR/ha/god

Usluga ekosistema	Poljoprivredne povr.	Livade	Šuma	Vlažna staništa	Reke
Proizvodnja hrane	1.4–20.5	–	0.1–16.3	0.3–1255	26.2–46.2
Snabdevanje vodom	0.1–50.8	–	4732.2 – 6001	57.8–5236	86.5–3506
Regulisanje klime	95.4–95.4	3.1–16.8	52.2 – 861	2.4–611	35.1–45.5
Zaštita od poplava	0.1–3103	–	–	312–10239	9.1 – 1055
Sprečavanje erozije	**19.8–19.8**	**–**	**16.8*–16.8***	**1082–16009**	**–**
Regulisanje vode	–	–	11–143.1	96.5–357	51.4–51.4
Biološka kontrola	51.8–51.8	97.8–97.8	32.8–32.8	198–198	–
Kvalitet vode	–	7.7–7.7	–	43.6–5922	124.6–2261
Formiranje zemljišta	19.7–19.7	21.7–21.7	–	–	–
Kruženje nutrijenata	75.7–75.7	–	–	–	–
Očuvanje staništa	–	–	2007–2007	218–2225.6	7.9–63.5
Ukupno	**264–3436**	**130–144**	**6835–9061**	**2011–42053**	**341–7028**

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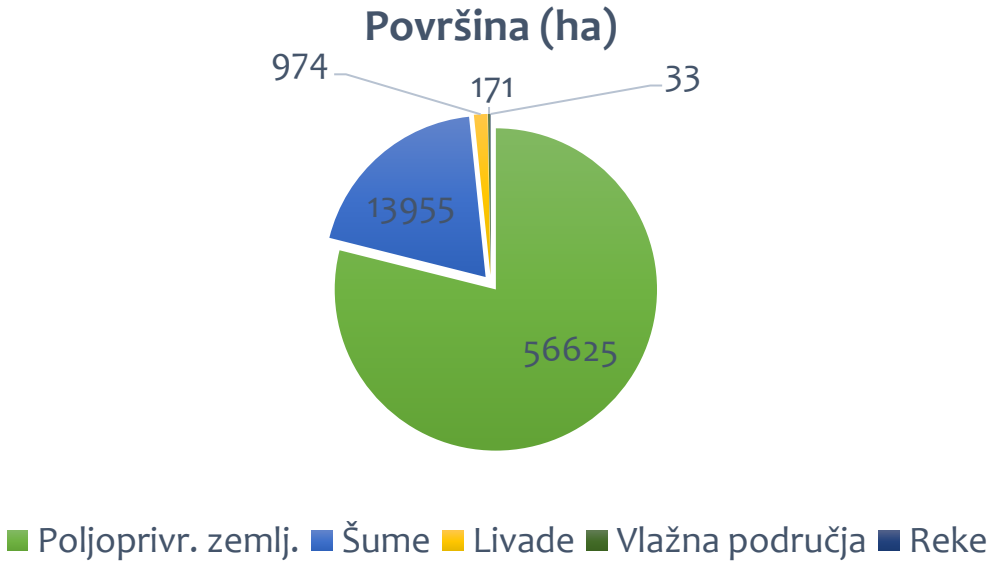
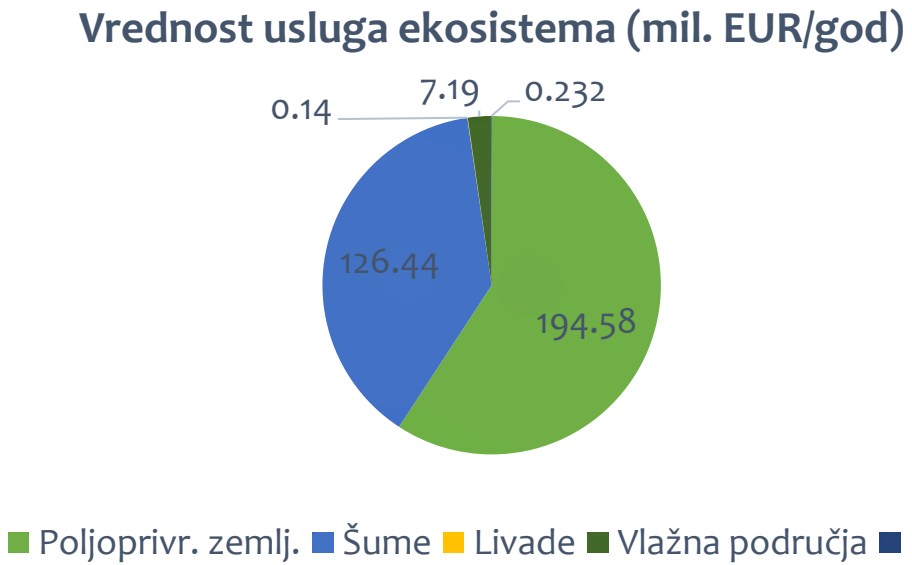
- **Total ESS: 329 million EUR/god (Tamnava watershed)**





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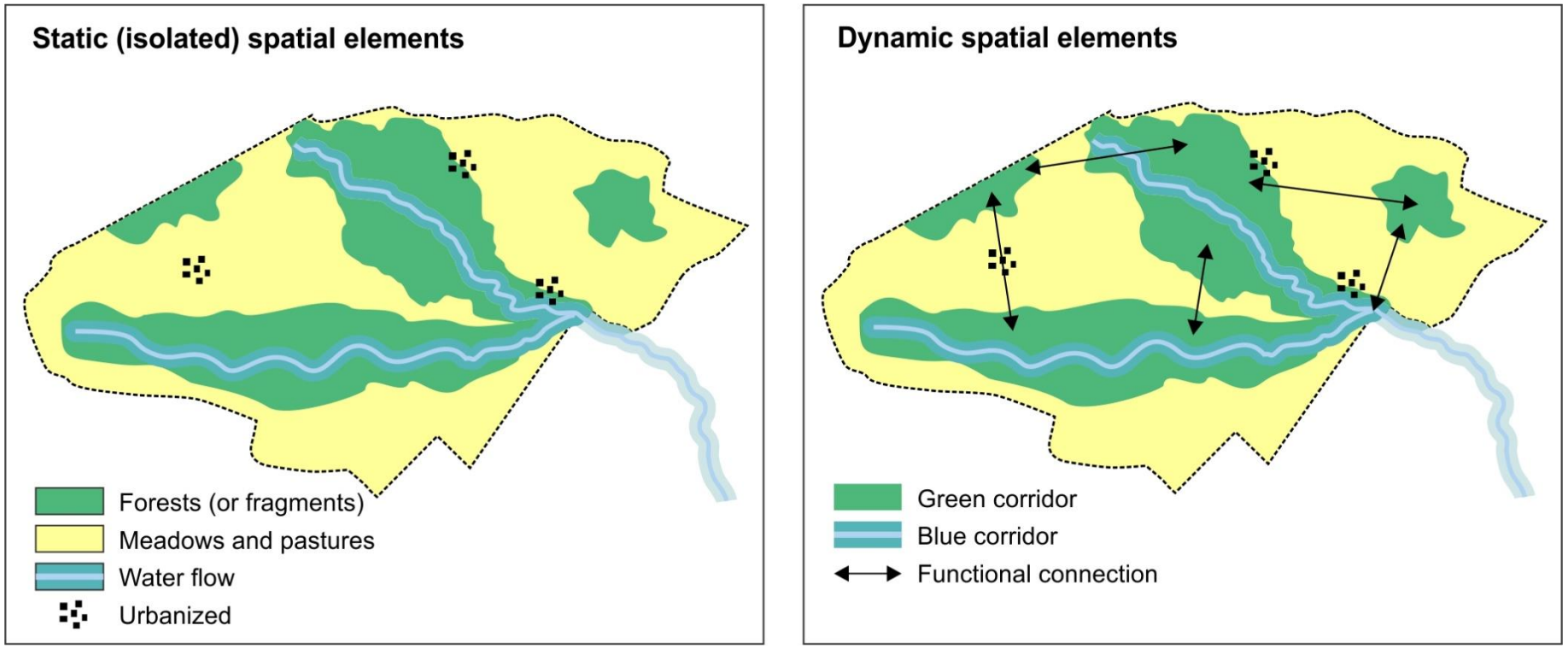
WHAT ARE "BLUE-GREEN" CORRIDORS?

- A system of open watercourses, connected with forest areas or their fragments in both riparian areas and watershed slopes.



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IMPORTANCE OF "BLUE-GREEN" CORRIDORS

- **Functional**
  Natural drainage of the terrain,
  Conveyance of maximal discharges to recipients
  Reduced fast surface runoff and sediment yield
- **Ecological**
  Treasure trove of biodiversity of autochthonous flora and fauna
- **Sports and Recreational**
  Walking paths, tracks for cycling and trimming and playgrounds
- **Aesthetic and Spiritual**
  Water bodies represent an authentic value both visually and psychologically

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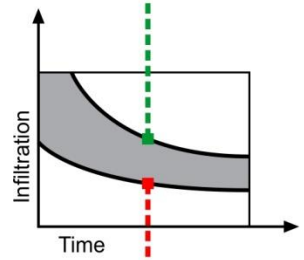
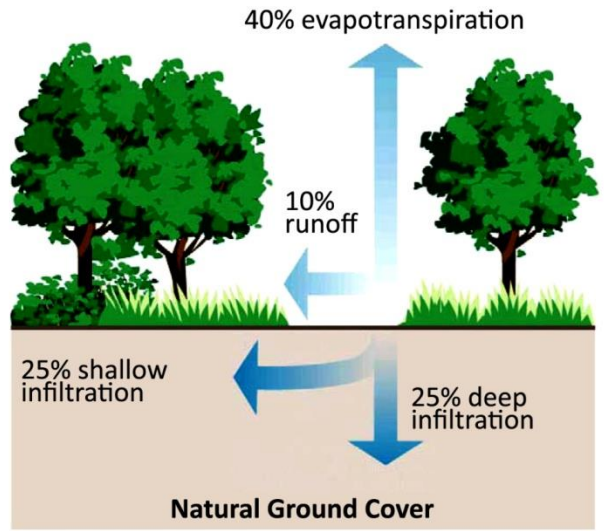
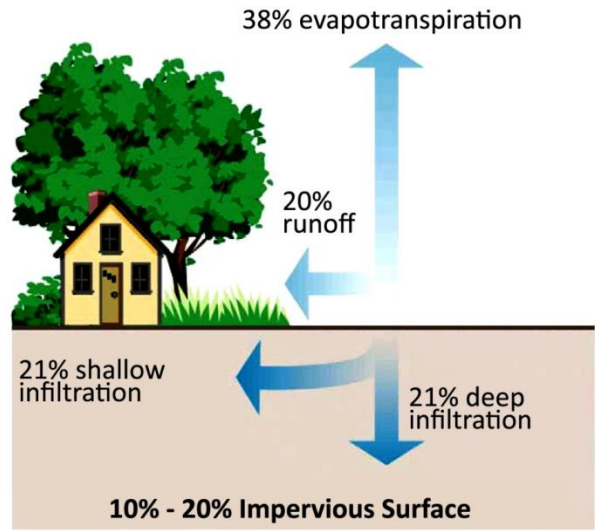
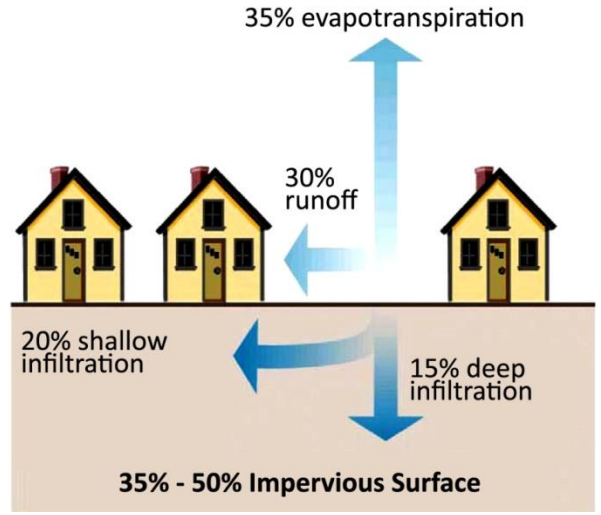


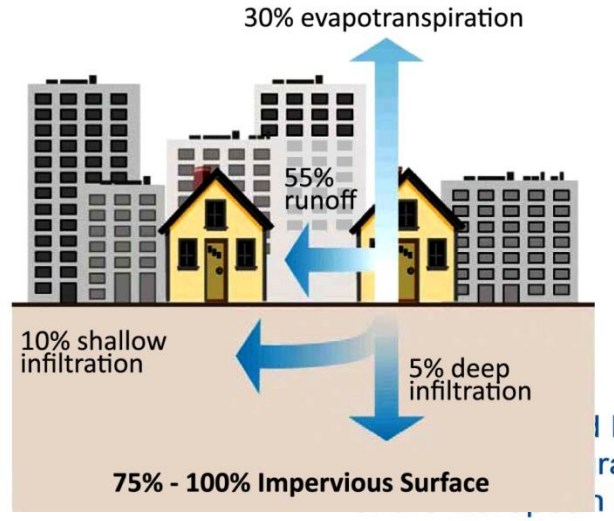
Before urbanization

After urbanization









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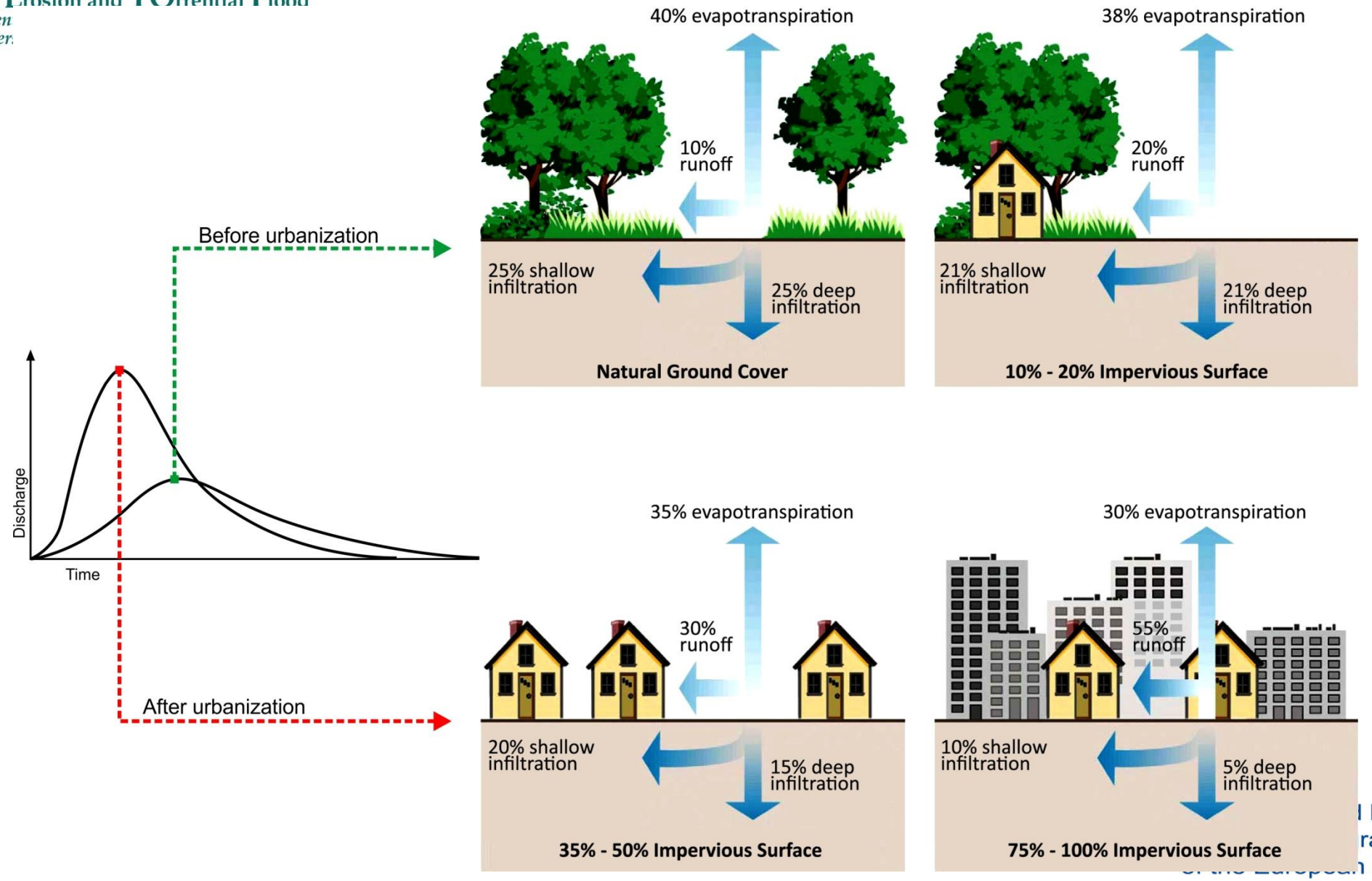

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Cheonggyecheon River, Seoul, South Korea

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San Luis Obispo Creek, San Luis Obispo County, California, USA

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Waihorutiu Stream, Auckland City, New Zealand

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Don Valley Brick Works
(Old brick factory,
Toronto, Canada)

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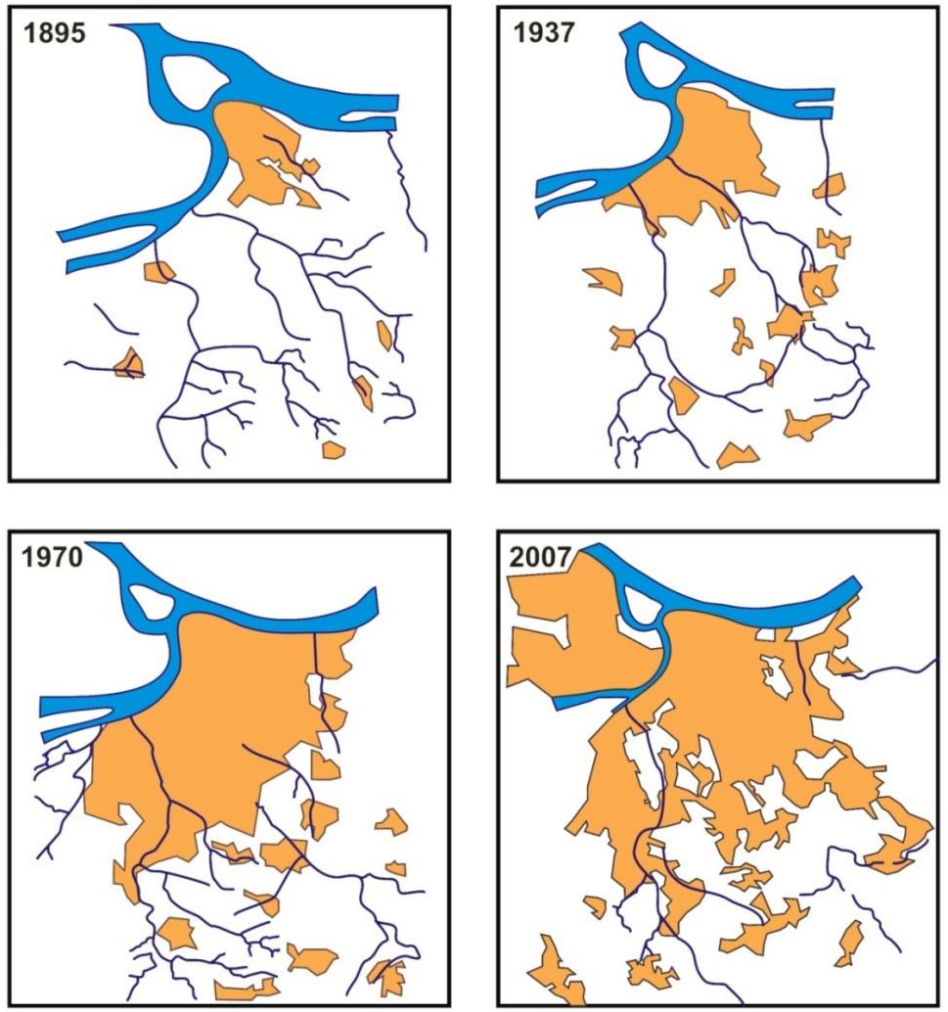
REVITALIZATION OF "BLUE-GREEN" CORRIDORS IN BELGRADE

Disappearance of natural water courses under the pressure of urbanization



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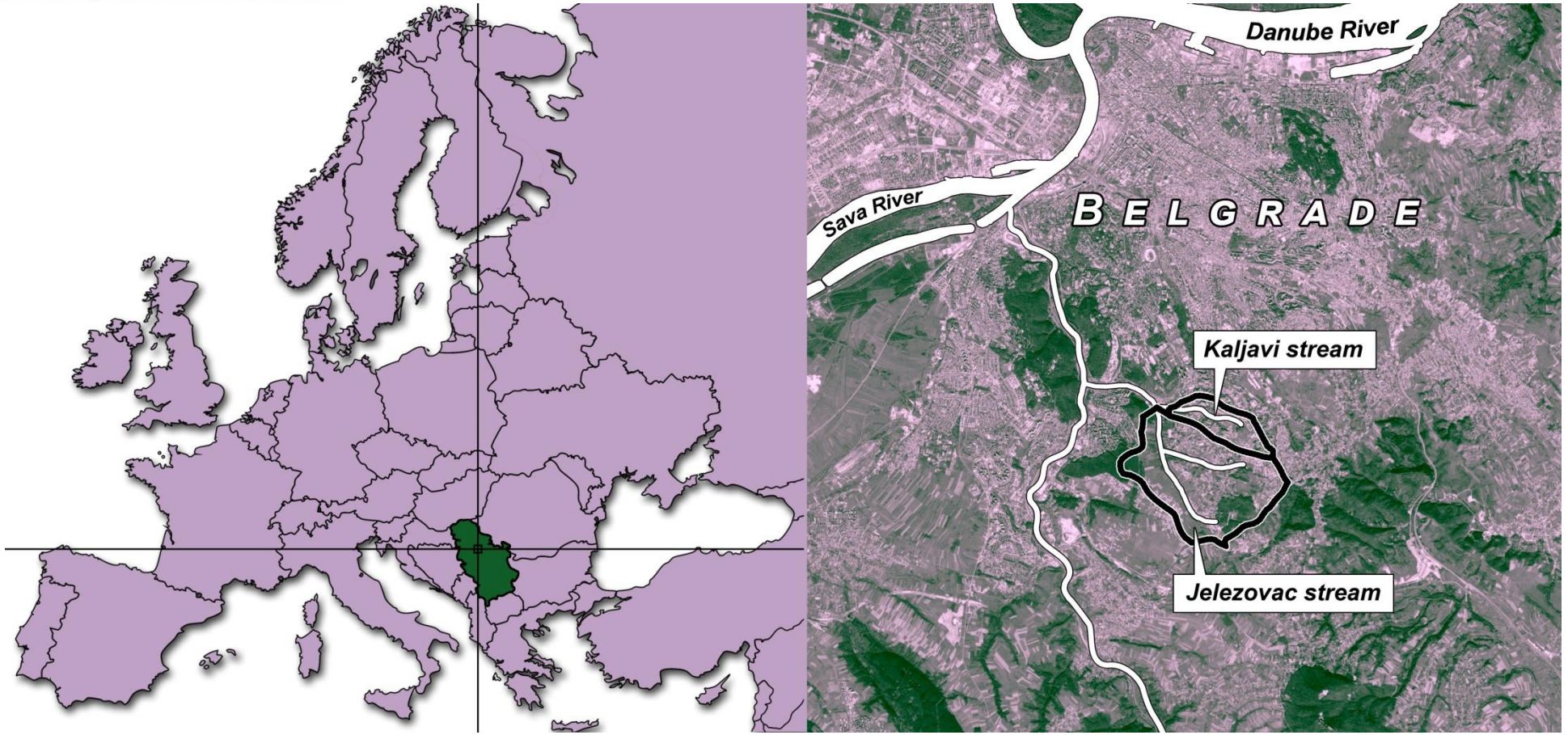
Investigated area: city of Belgrade



A pilot project of revitalization of the "blue-green" corridors in the watersheds of the Kaljavi and Jelezovacki streams

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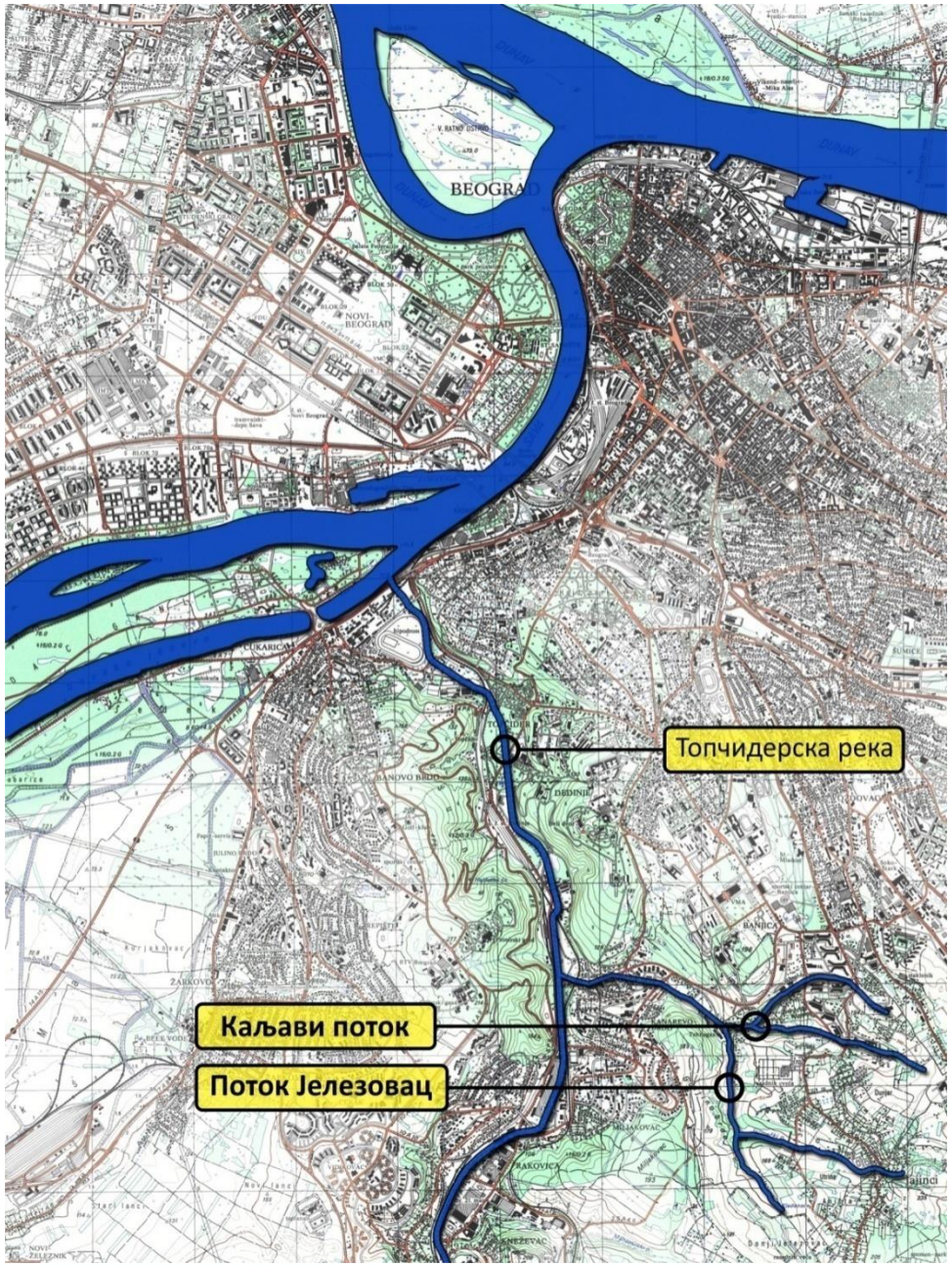
A pilot project of revitalization of the blue-green corridors in the watersheds of the Kaljavi and Jelezovacki streams



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Kaljavi stream watershed

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Jelezovac stream watershed

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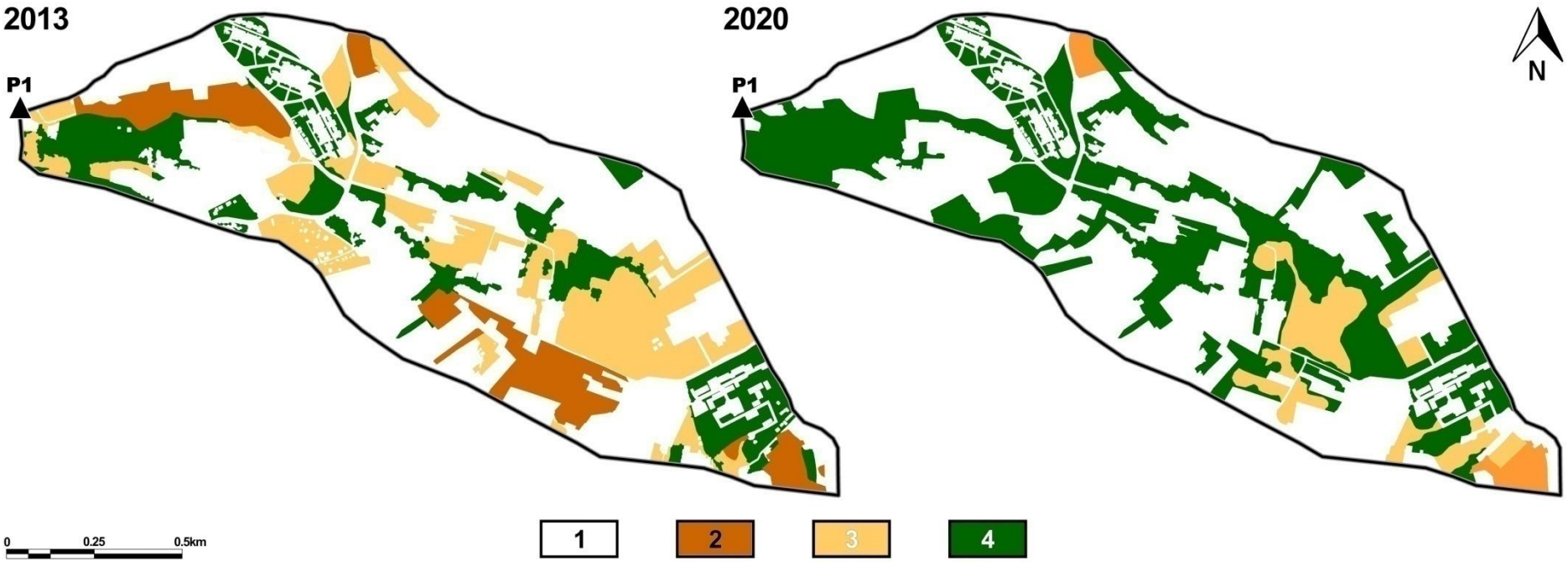
Land use in the Kaljavi stream watershed



1- Discontinuous and continuous urban fabric

2 - Complex cultivation patterns: arable land, orchards, gardens **(reduction from 10.0% to 2.1%)**

3 - Grasslands

4 - Mixed forests and forest belts **(increment from 15.0% to 34.3%)**

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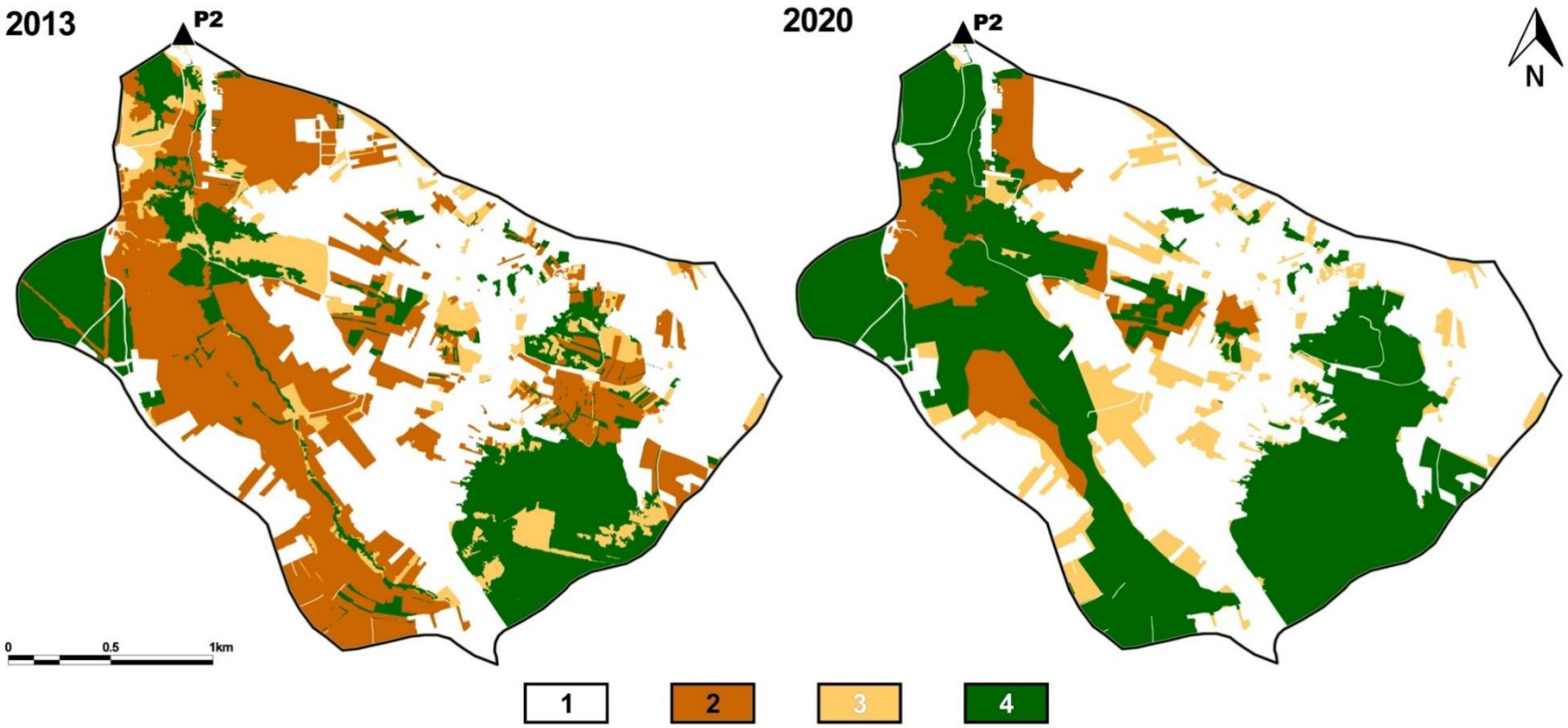
Land use in the Jelezovac stream watershed



1- Discontinuous and continuous urban fabric

2 - Complex cultivation patterns: arable land, orchards, gardens **(reduction from 30.6% to 7.7%)**

3 - Grasslands

4 - Mixed forests and forest belts **(increment from 20.4% to 38.3%)**

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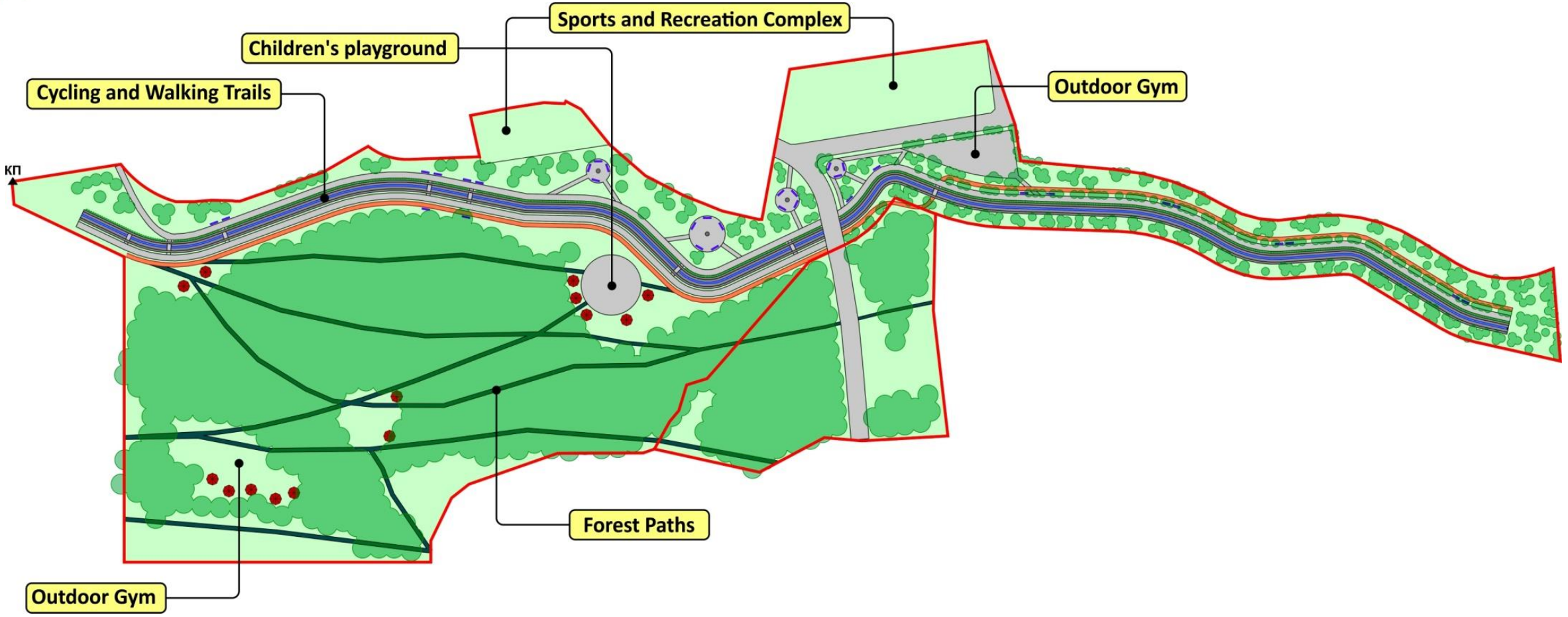

Landscape plan of a selected area of the Kaljavi stream watershed

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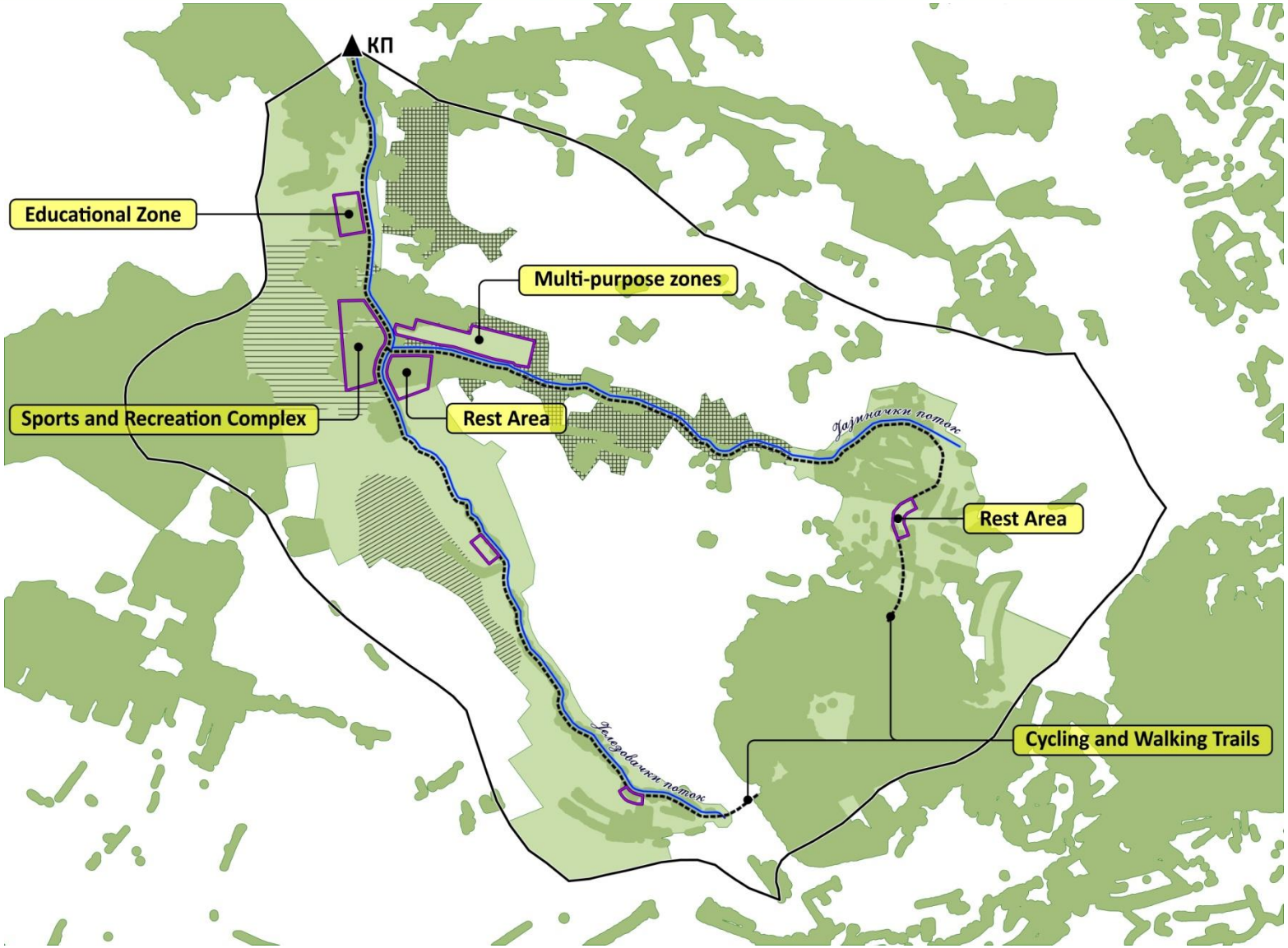
Landscape plan of a selected area of the Jelezovac stream watershed



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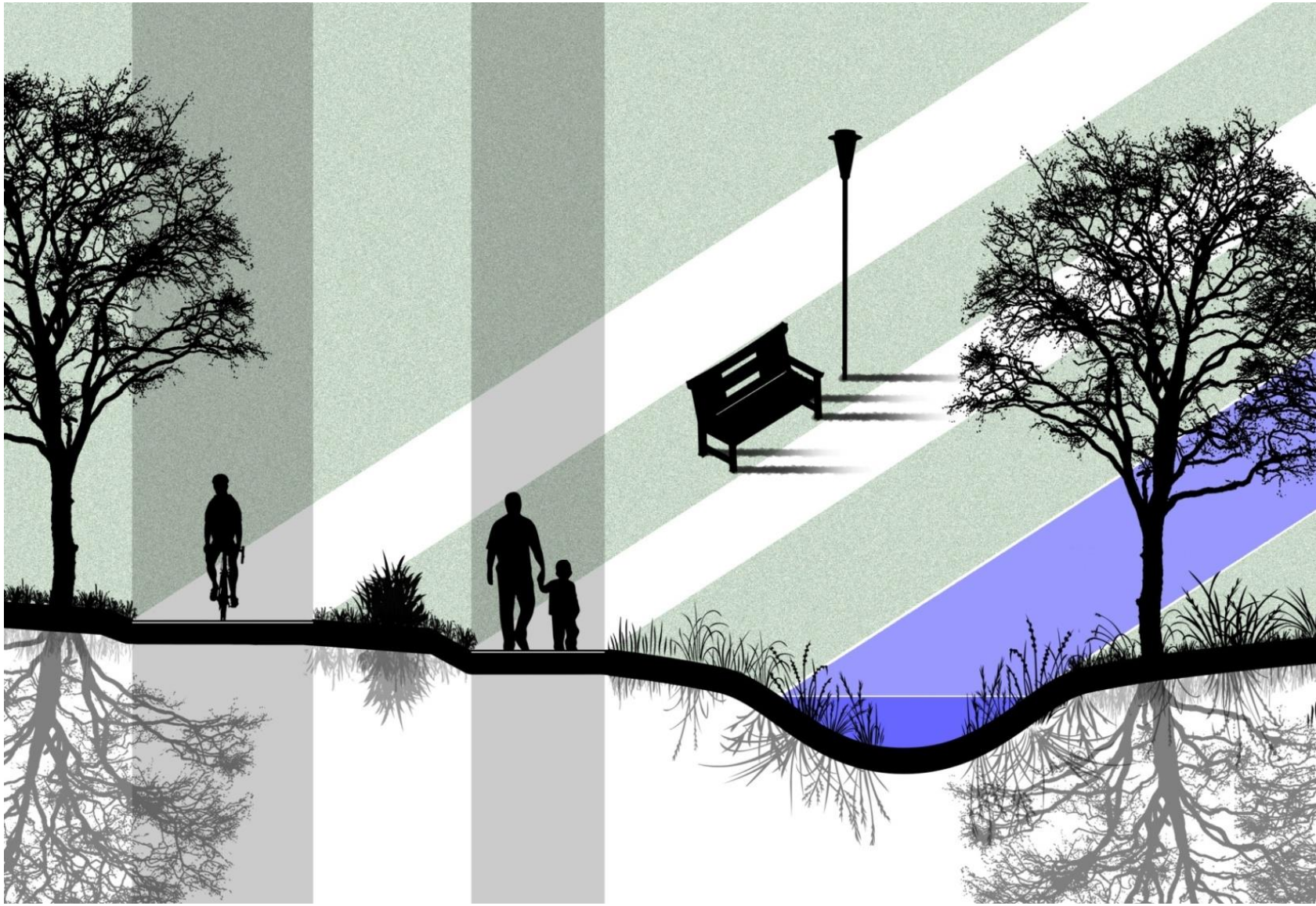
A possible layout of the riparian area of the Jelezovac stream



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A possible layout of the riparian area of the Jelezovac stream

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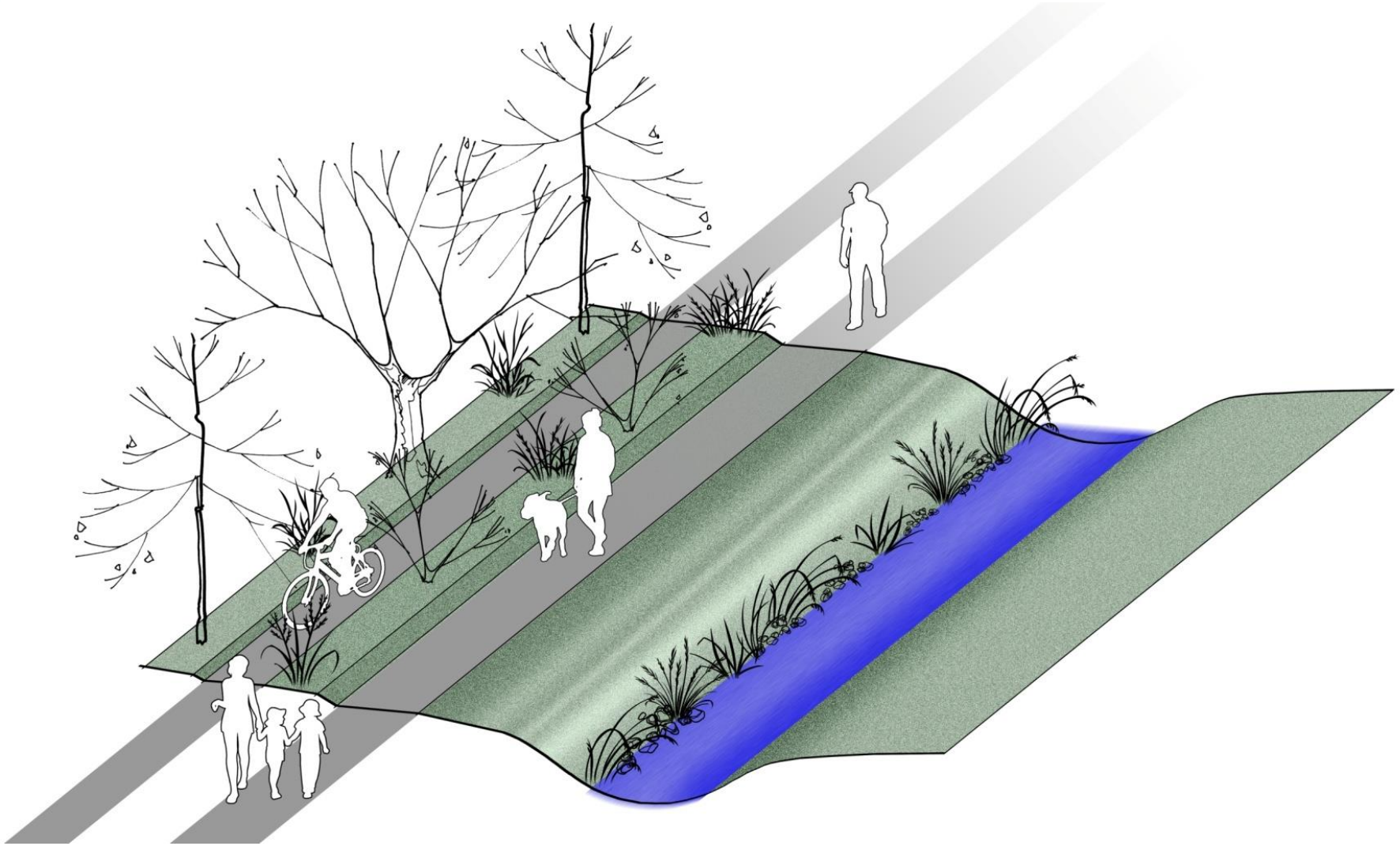
A possible layout of the riparian area of the Jelezovac stream



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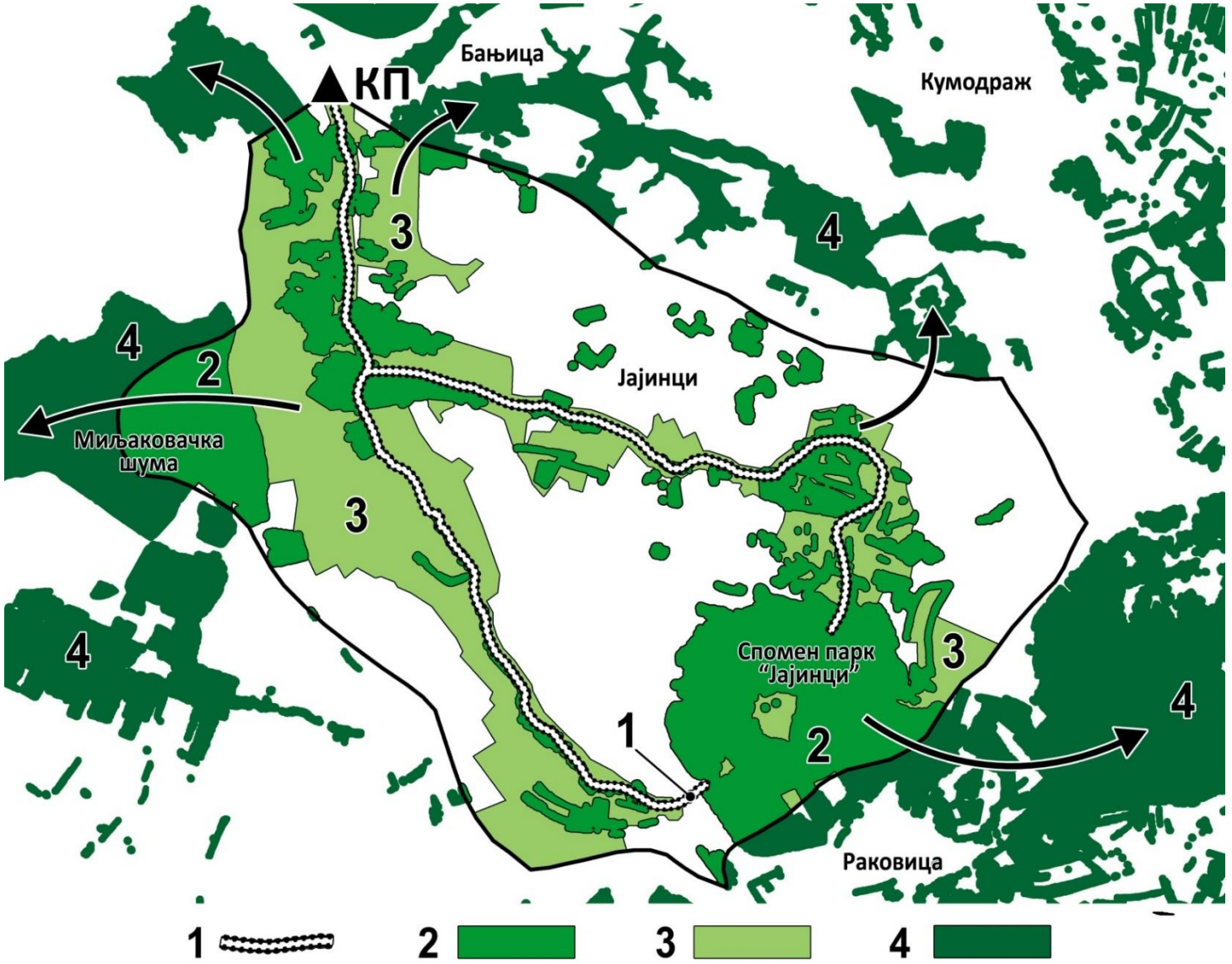
A system of connections of "blue-green" corridors in the watersheds of the Kaljavi and Jelezovac streams



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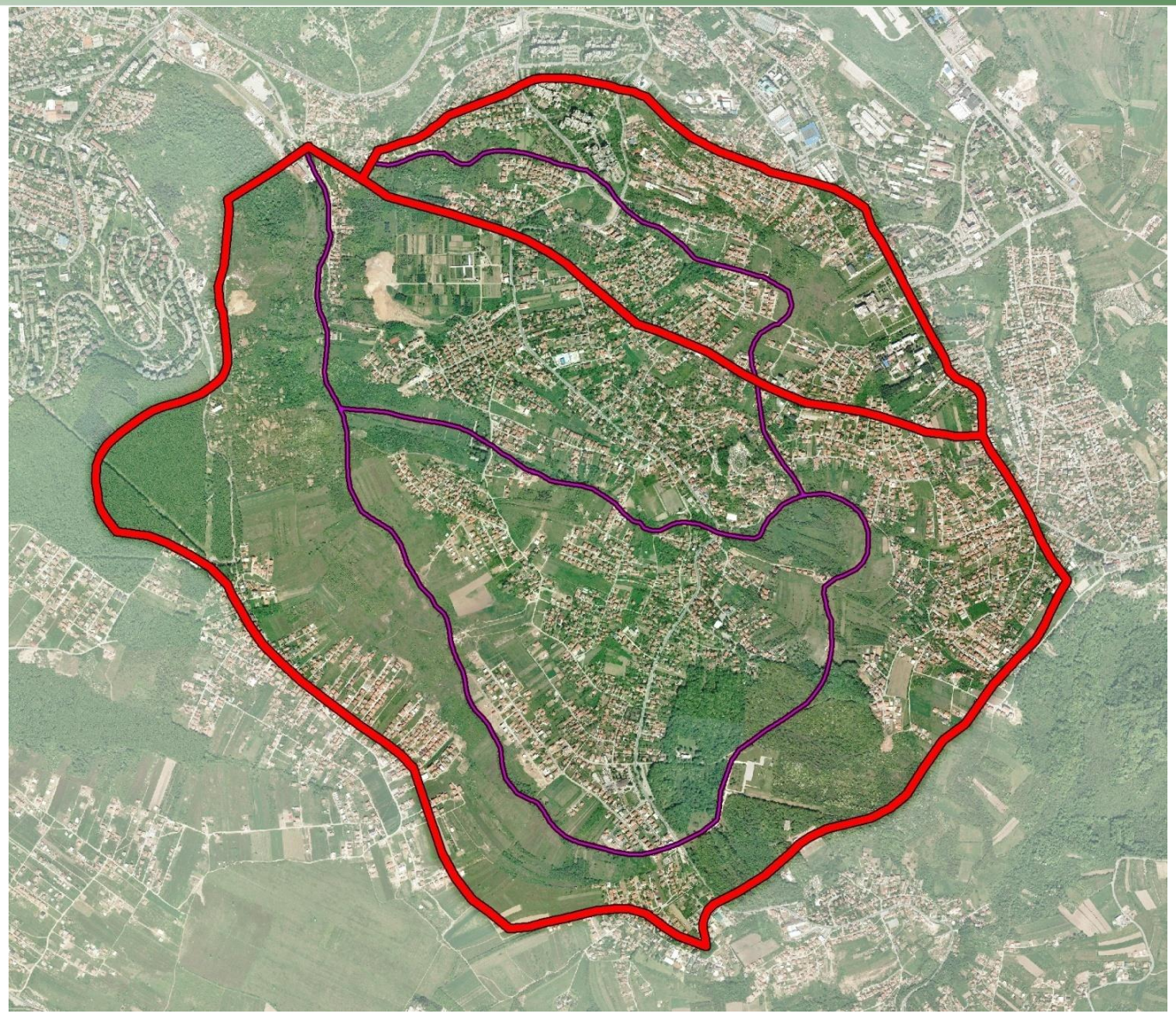
A system of cycling and walking trails in the watersheds of the Kaljavi and Jelezovac streams > Total length L=10.5 km



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Characteristic outputs of computations of sediment yields and transport under current conditions (2013) and after restoration (2020).

Parameter	Current conditions (2013)		After restoration (2020)	
	Kaljavi stream	Jelezovac stream	Kaljavi stream	Jelezovac stream
W_a (m^3)	336.9	1730.3	187.9	1084.1
W_{asp} ($m^3 \cdot km^{-2} \cdot year^{-1}$)	240.6	278.2	134.2	174.3
W_{at} (m^3)	71.8	427.4	40.0	267.8
W_{atsp} ($m^3 \cdot km^{-2} \cdot year^{-1}$)	51.3	68.7	28.6	43.1
W_{abls} ($m^3 \cdot year^{-1}$)	7.0	32.6	1.9	14.9
W_{ass} ($m^3 \cdot year^{-1}$)	64.8	394.8	38.1	252.9
Z	0.217	0.239	0.147	0.175

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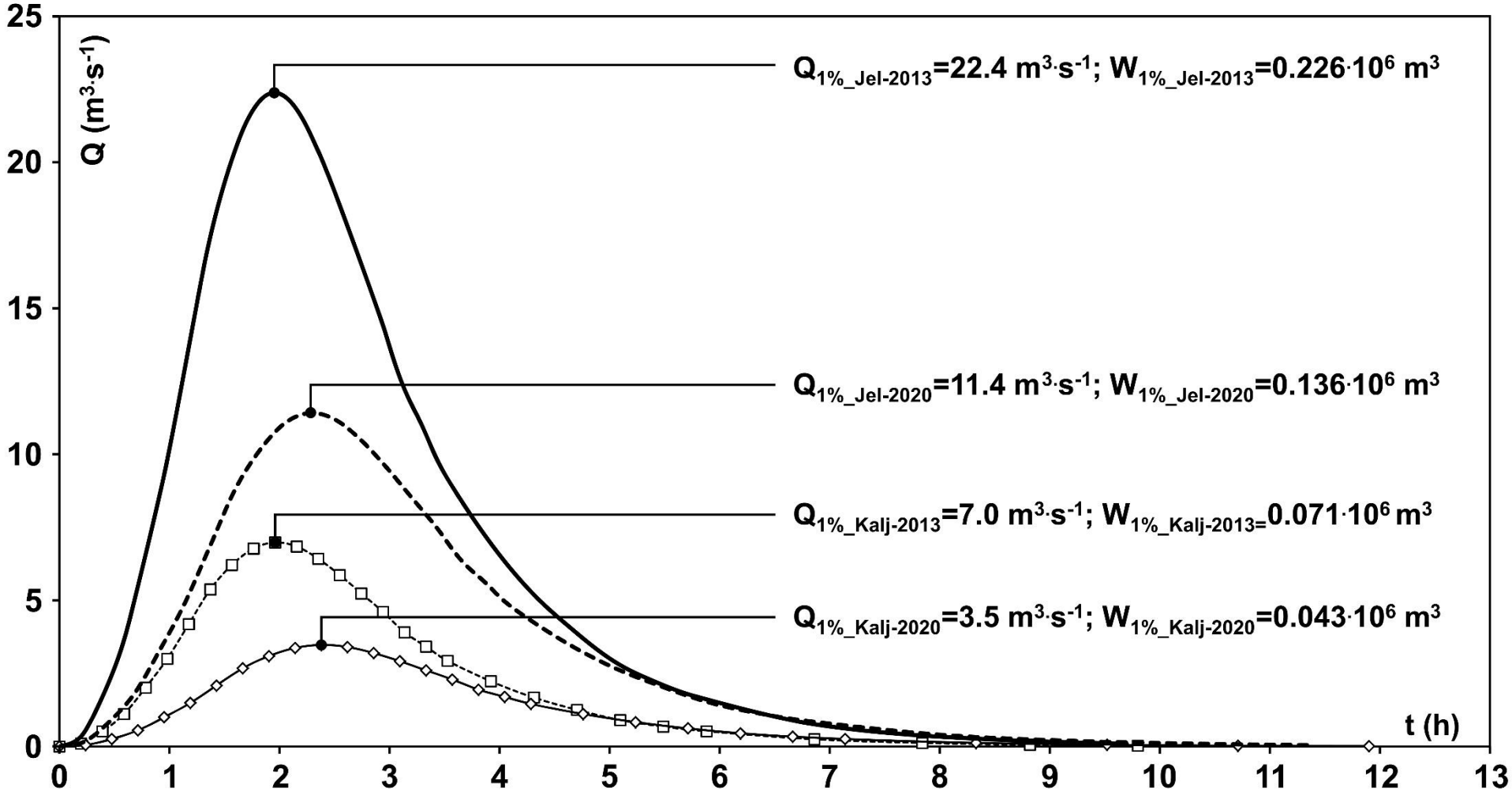
Hydrographs of maximal discharges at the Kaljavi and Jelezovac streams under current conditions (2013) and after restoration (2020)



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A system of connections of "blue-green" corridors in the watersheds of the Kaljavi and Jelezovac streams

C1 (Microscale connections; intra-watershed level); C2 (Mesoscale connections; inter-watershed level); C3 (Macroscale connections; trans-watershed level)

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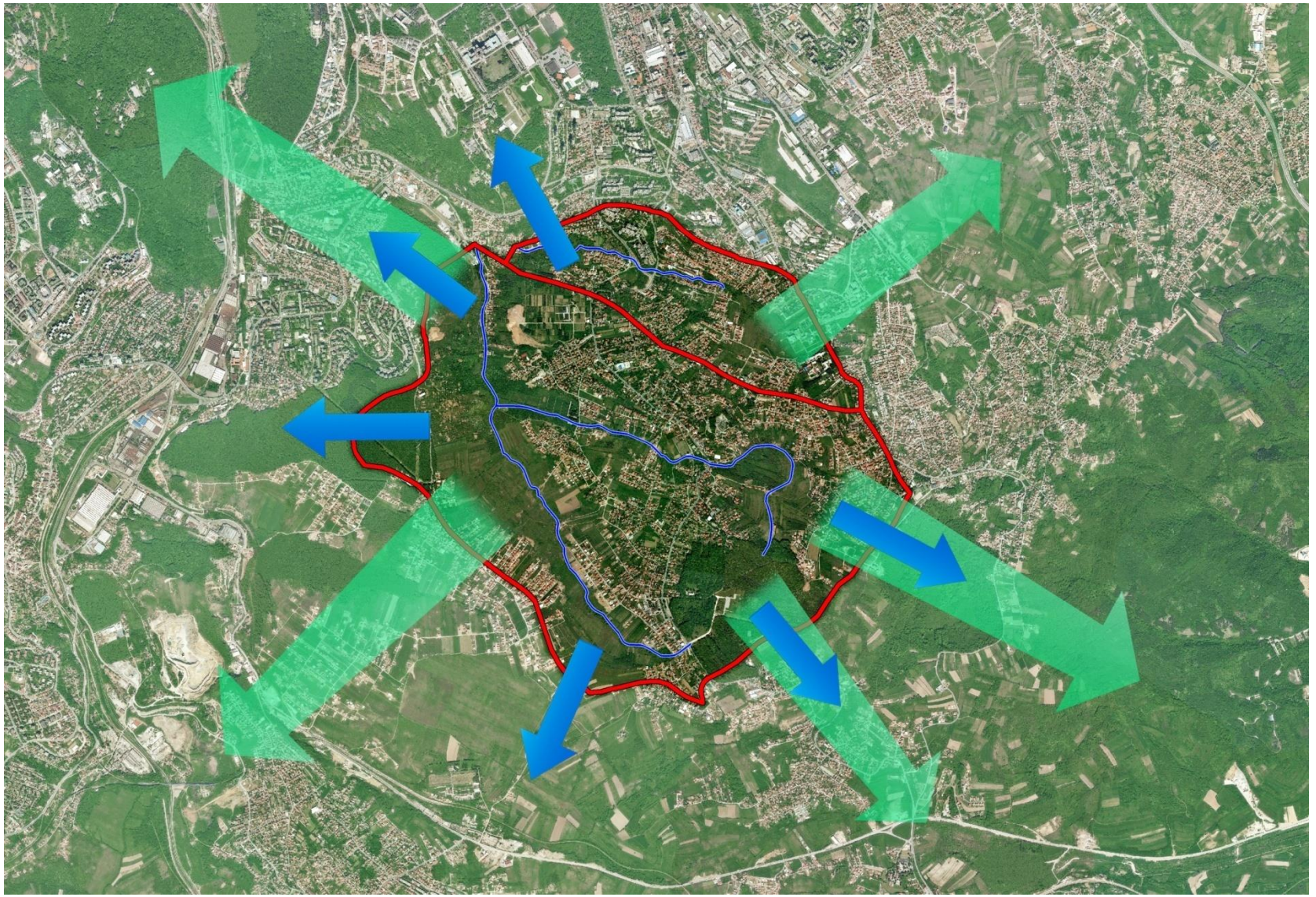
A system of connections of "blue-green" corridors in the watersheds of the Kaljavi and Jelezovac streams with "blue-green" corridors of the neighbouring watersheds



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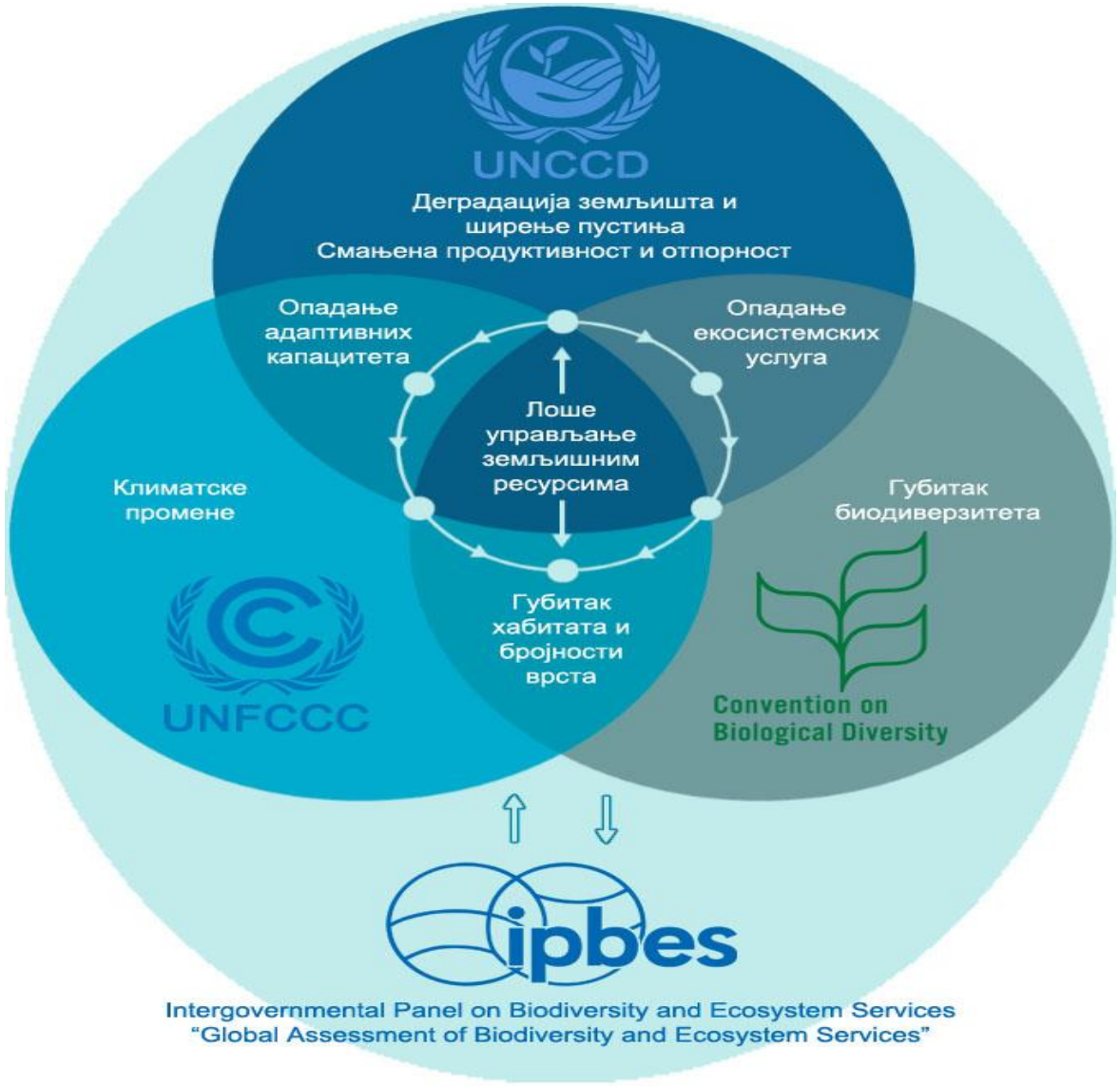
GLOBAL FRAME FOR ENVIRONMENT PROTECTION



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- 75% land surface is significantly altered;
- 66% aquatic ecosystems are endangered;
- 85% wetlands are destroyed;
- one miliion species are faced with extermination.

ipbes




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CONCLUSIONS

- Prevention of natural hazards (torrential floods, destructive erosion processes)
- Identification and protection of the remaining forest areas, other valuable green areas and watercourses (NBS, LDN).
- Evaluation of ecosystem services
- Mitigation of the effects of climate change (CO_2 sequestration, O_2 emission; reduced “heat island” effect)
- Conservation and protection of biodiversity
- Establishment of new sports and recreational zones

Rehumanization of the city space…

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