

Conflict of spatial development and water supply under climate change in case of water dependent ecosystem of Ljubljana Moor

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Introduction

Water resources are vulnerable to climate change and to many other socio-economic drivers of change. Given the real representation of vulnerability and a set of climate change adaptation options there is need to develop a common transnational strategy for vulnerability reduction. The latter is the goal of SEE CC-WARE project. Among others, ecosystem services, land use change, improving water use efficiency and economic incentives for water management have large potentials to decrease water resources vulnerability. Especially, forests, wetlands and grasslands are important ecosystems, which together with their management emerged as an important means for a sustainable future drinking water supply.

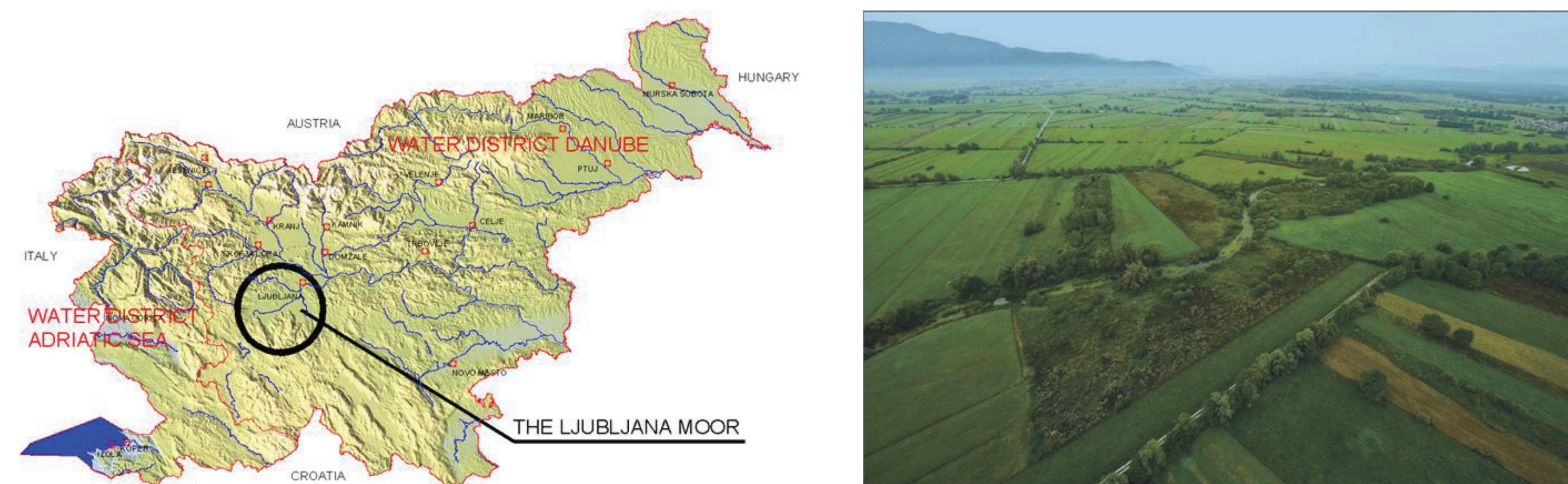


Figure 1: Ljubljana Moor location and aerial view on the area.

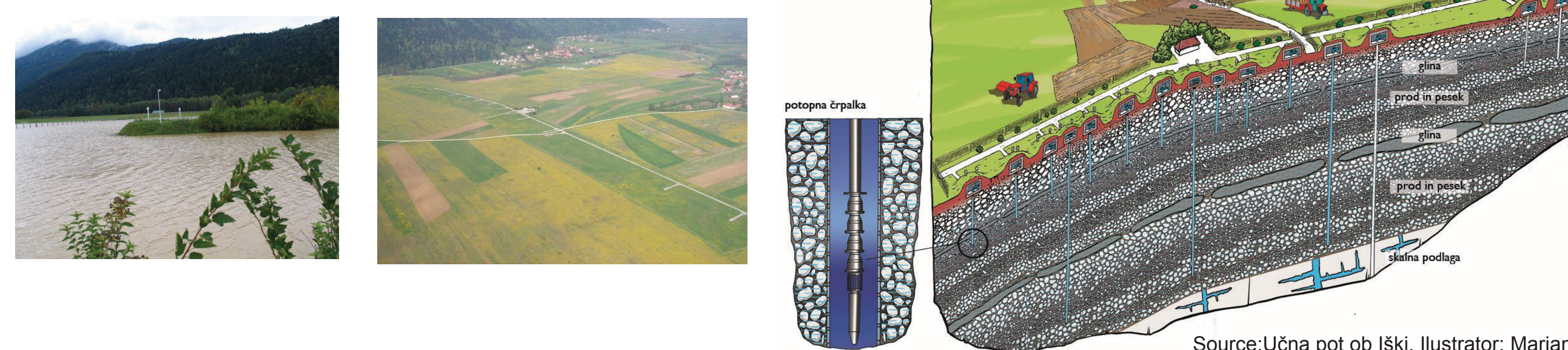


Figure 2: Groundwater well field Brest: Flood 2010, aerial view and geological cross-section

Test area

The Ljubljana Moor extends from the southern part of Ljubljana city (Figure 1) to Krim-Mokrc carstic mountains and it is almost 160 square kilometers large plain. Originated some two millions years ago through the sinking of an extensive area of the Ljubljana basin. The sedimentation basin of Ljubljana Moor is filled up in the central part with lacustrine and marshy sediments and on the borders of the basin are the gravel fans. In the basin there are layers, different thicknesses of sandy gravel, clay, sand, silt, lacustrine chalk, peat and humus. The sediments reach up to 150 m and is one of the largest aquifer in Slovenia. It is an important drinking water resource.

Acknowledgement

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Ljubljana Moor (Barje) and drinking water supply

In this area the water well field Brest (Figure 2) has been designed as important future drinking water source for Ljubljana, pumping mainly water from confined aquifer. The pressure from urbanisation and agriculture and high subsidence that is noticed in the central and eastern part of the aquifer, both pose high risk to stable drinking water supply and wetland habitats that are protected as NATURA 2000. Water protection areas with limitation of land use were delineated for protection of drinking water from Brest pumping station. These legal acts are in conflict with existing agricultural practices, spatial development plans and further urbanisation processes (including new and larger roads, flood areas disconnections and destruction). No attention has been given yet to integrated water management and there is no consideration of long term hydrological and hydrogeological processes.

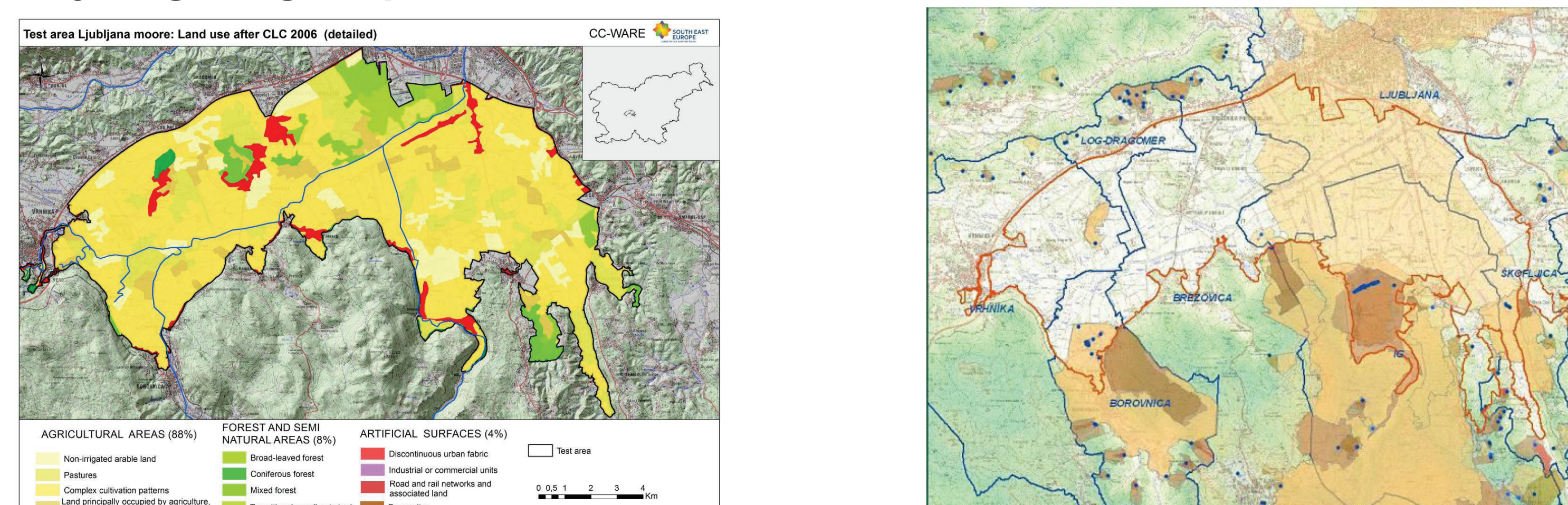


Figure 3: Land use and drinking water protection zones on Ljubljana Moor area

Land use conflicts

Water resources of the area are under high pressure. Agricultural land managers expect amelioration canals are regularly maintained (Figure 5). Land owners take advantage of high prices of land for urban development. Agricultural land and less commercially productive areas (marshes) are being changed to urban area. New roads and transportation facilities are being built, therefore the Ljubljana Moor landscape and its water regime continue to change (Figure 4).

As a consequence there are following environmental and social problems:

- urbanization (settlements, roads, dams, load – subsidence; no sewage system – cesspits - water quality issue; need for additional water supply rises – water quantity issue)
- water retention capacities (underground and surface) of the area deteriorates
- drainage - amelioration channels
- climate change: drought and flood risk changes (rises)
- ground stability of the Ljubljana Moor decreases due to terrain subsidence

Natural park Ljubljana Moor (Barje) and ecosystem services

The Ljubljana Moor is one of the biggest and most important complexes of wet meadows in Slovenia, which have, due to land use high biodiversity. In the last two centuries extensive irrigation and river regulation projects were implemented to develop agricultural land. Biodiversity of the area is high due to large zones of wet meadows, some flood forest patches, bog areas, and open water courses habitats (Figure 2). The Ljubljana Moor is therefore protected as Natura 2000 site. Ljubljana moor act as ES service and has an important role as inundation area, in biodiversity, preserving water quantity and quality and regulating micro-climate.

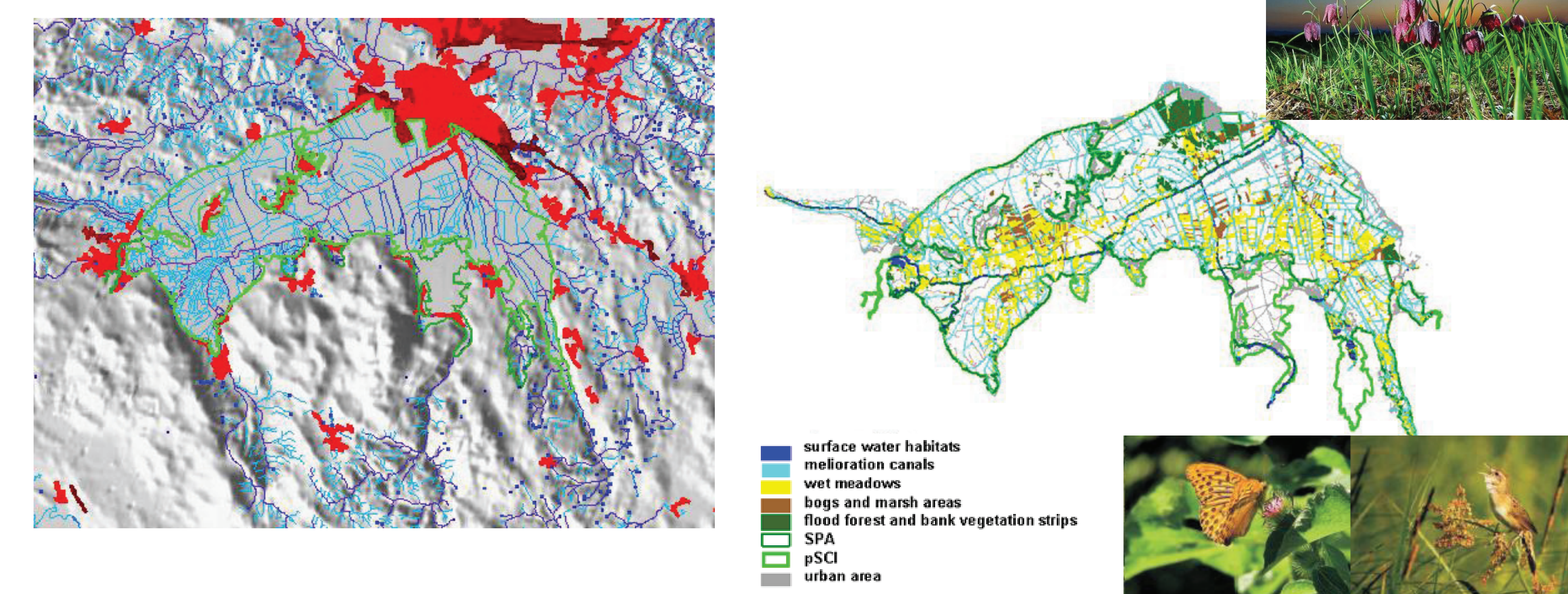


Figure 4: Urban areas (red) and Natura 2000 (right: protected habitats depending on the water regime)

Hydrological network and flooding

The most frequent flooding occur in the central and western part of the Ljubljana Moor. Regular flooding occur when the water level in the Ljubljana river at central part rises to 187,7 m above sea level (at 250 m³/s in Ljubljana) (Figure 4)

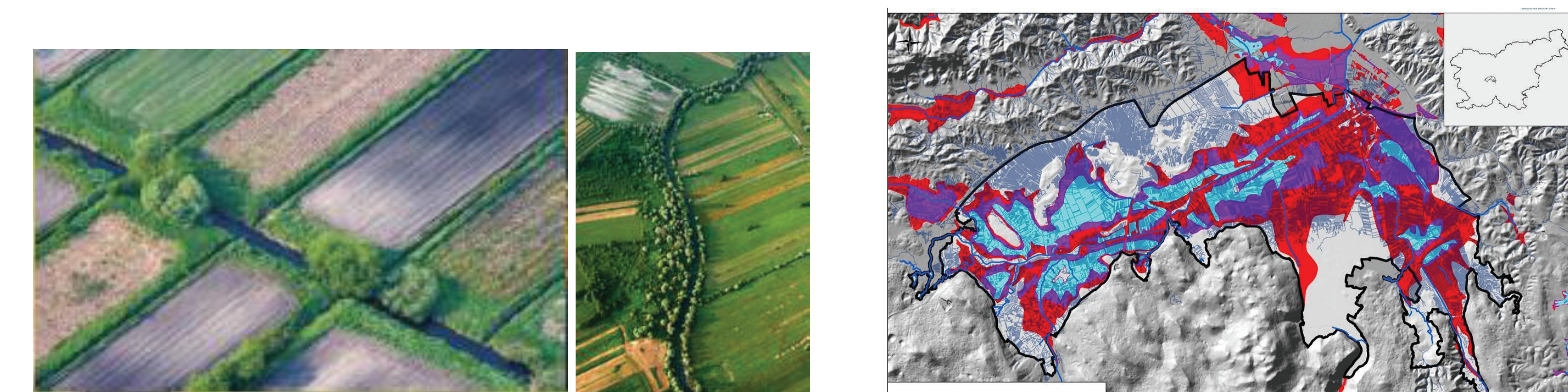


Figure 5: Drainage network - 740 km surface water / channels (160 km of main river Ljubljana with tributaries and 580 km channels)

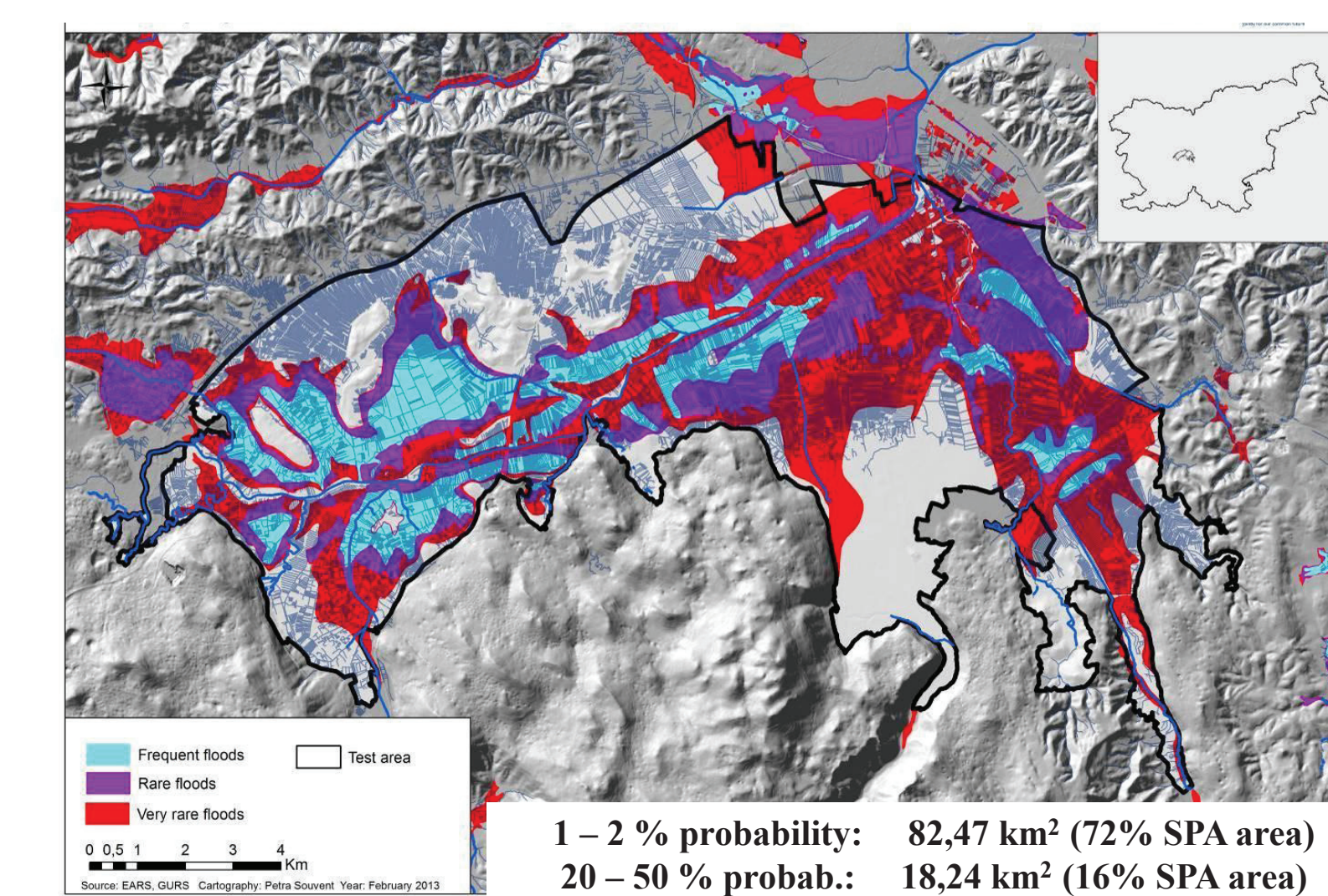


Figure 6: Flood areas (viola: regular flooding, cyan: 100 return period).