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Sub-Urban

TU1206-WG1-008

Ljubljana

TU1206 COST Sub-Urban WG1 Report

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COST TU1206 Sub-Urban Report
TU1206-WG1-008

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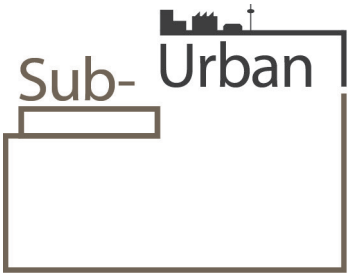

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Geological Survey of Slovenia

Content

Summary

Ljubljana is the capital and largest city of Slovenia, population 282,994 (2012) with an area of 10,000 m^2. It has a central geographic location within Slovenia. Green areas from the hinterland extend into the historical city centre via green wedges and riparian corridors giving Ljubljana its distinctly green identity.

From geological point of view is the area of Ljubljana part of Ljubljana Basin - tectonic depression, formed by tectonic subsidence and gradual filling with alluvial and lacustrine sediments. The sediments are composed of well permeable gravel and sand beds with lenses of conglomerate. Due to the great thickness and good permeability, this sandy-gravel aquifer contains significant quantities of groundwater which is main resource, exploited for the public water supply of the city Ljubljana mostly without any treatment.

The city's main development objectives are defined in the Municipal Spatial Plan (2010). City development is directed mainly at regeneration and renewal of existing developed areas and is also committed to resolving issues concerning safeguarding and development of green and open spaces. The most important objectives are to safeguard and manage the five green wedges in the city that link the city centre to the hinterland.

1. Brief introduction

Ljubljana is the capital and largest city of Slovenia. It has a central geographic location within Slovenia (Fig. 1). As a result of its natural features and well-considered urban planning, Ljubljana has a distinctly green identity. The Municipal spatial plan shows that green areas make up nearly three quarters of the entire territory of the City of Ljubljana. As part of the comprehensive vision of the development of the city, which is based on the concentration of existing settlement structures, we emphasise internal development, the concentration of settlement along the main city access routes and the regeneration of degraded areas.

The high proportion of open areas is linked primarily to the hilly, marshy and aquatic natural hinterland of the city, an area that was historically less attractive for construction and urban development. Almost 81% of all green areas lie in the city hinterland (contiguous aquatic, forest and agricultural areas) which extend right into the historical city centre via green wedges and riparian corridors.

Figure 1: Geographic location of Municipality of Ljubljana.

2. City description

2. 1 Key city data

- **Size**
  - **surface area:**
    Municipality of Ljubljana covers a total area of 275 square kilometres.
  - **number of inhabitants:**
    Ljubljana has 283 thousand inhabitants (2012).
- **Density / land use intensity**
  - **Population:**
    The population density in Ljubljana is 1029 inhabitants per square kilometre (2012).
  - **Housing:**
    Total number of housing: 120 thousand (2008).
  - **Vehicles:**
    The number of registered vehicles is 146 thousand (2012).
  - **Network infrastructure (transport, communication):**
    The length of the road network in Ljubljana is 1152 km (55 km highways) (2011). The route length of the public bus transport network is 357 km and there is 211 buses. 40 million passengers are carried per year by buses, 1.2 million via the Ljubljana airport and 3.3 million by train (2012).
  - **Land use**
    The land use in the area of Municipality of Ljubljana is shown in Figure 2 and Table 2.

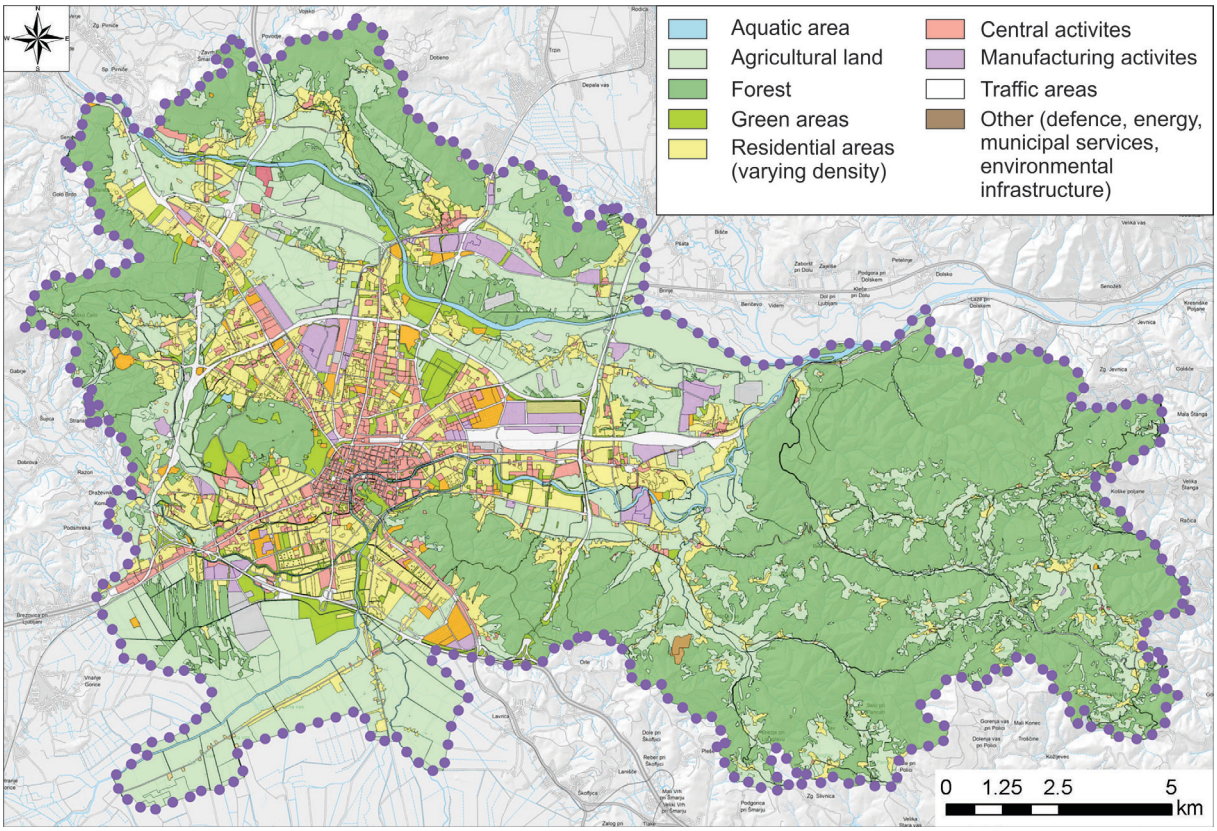

Figure 2: Land use map.

Table 2: Land use in the city of Ljubljana by share.

Type of land use	Total City of Ljubljana		Share of areas in the zone defined by the boundary of the centre (%)
	Area 10.000 m^2	Share (%)	
Aquatic areas	382,2	1,4	1,7
Agricultural land	8010,7	29,5	28,8
Forest	10789,8	39,7	34,9
Green areas	950,5	3,7	4,5
Residential areas (varying density)	3332,8	12,3	14
Central activites	1034,1	3,8	4,7
Manufacturing activities	553,7	2	2,5
Traffic areas	1475,4	5,4	6,4
Other (defence, energy, municipal services, environmental infrastructure)	615,9	2,2	2,5
Total	**27.145,1**	**100**	**100**

2. 2 Geological and physical geographical setting

Ljubljana is situated in central Slovenia in Ljubljana Basin, mainly on Ljubljansko polje and its southern part belongs to the most northern part of Barje (Fig. 3). Areas of Ljubljansko polje and Barje are from a geological point of view tectonic depressions, formed by tectonic subsidence and gradual filling with alluvial and lacustrine sediments (Fig. 4). The flat landscape is divided by hills (Golovec, Grajski hrib and Rožnik) in the middle. Those elevations represent the basement of the tectonic depression, consisting of Carboniferous and Permian rocks, which were are exposed above the surface of the younger sediments. Hills on the southern part of Barje are of a similar origin.

The Ljubljana Basin begun to subside in the Pliocene, 3 to 6 million years ago. The sediment filling was very intense in the Pleistocene – an epoch with glacial and interglacial ages, when Sava river transported material from alpine glaciers to Ljubljansko polje. The sediments are composed of permeable gravel and sand beds with lenses of conglomerate. Due to the great thickness (which exceeds 100 m in the deepest parts) and the favourable permeability, this sandy-gravel aquifer contains significant quantities of groundwater.

Barje consists of alternating alluvial and lacustrine sediments. Alluvial sediments were brought to Barje by rivers and creeks from surrounding hills and Sava river that flowed on the southern side of Rožnik until the end of the last glacial age. Pleistocene and Holocene alluvial sediments include interbedded lacustrine sediments. Lenses of clay, sand and peat are common. Gravel is often silty or clayey. Surface in central parts of Barje is covered by clayey silt. Overall thickness of sediments is up to 170 m.

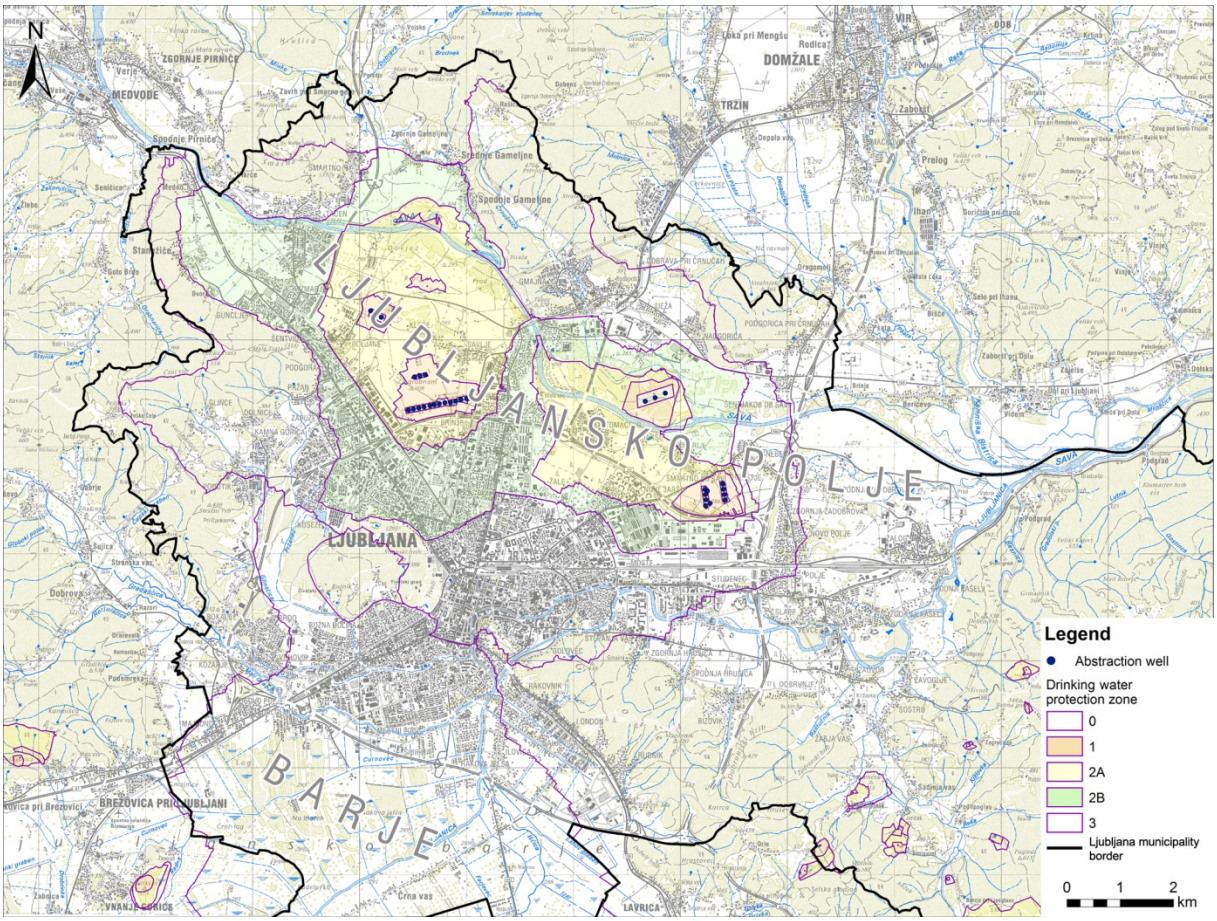

Figure 3: Map of the City of Ljubljana (northern part – Ljubljansko polje, southern part Barje) with drinking water protection zones.

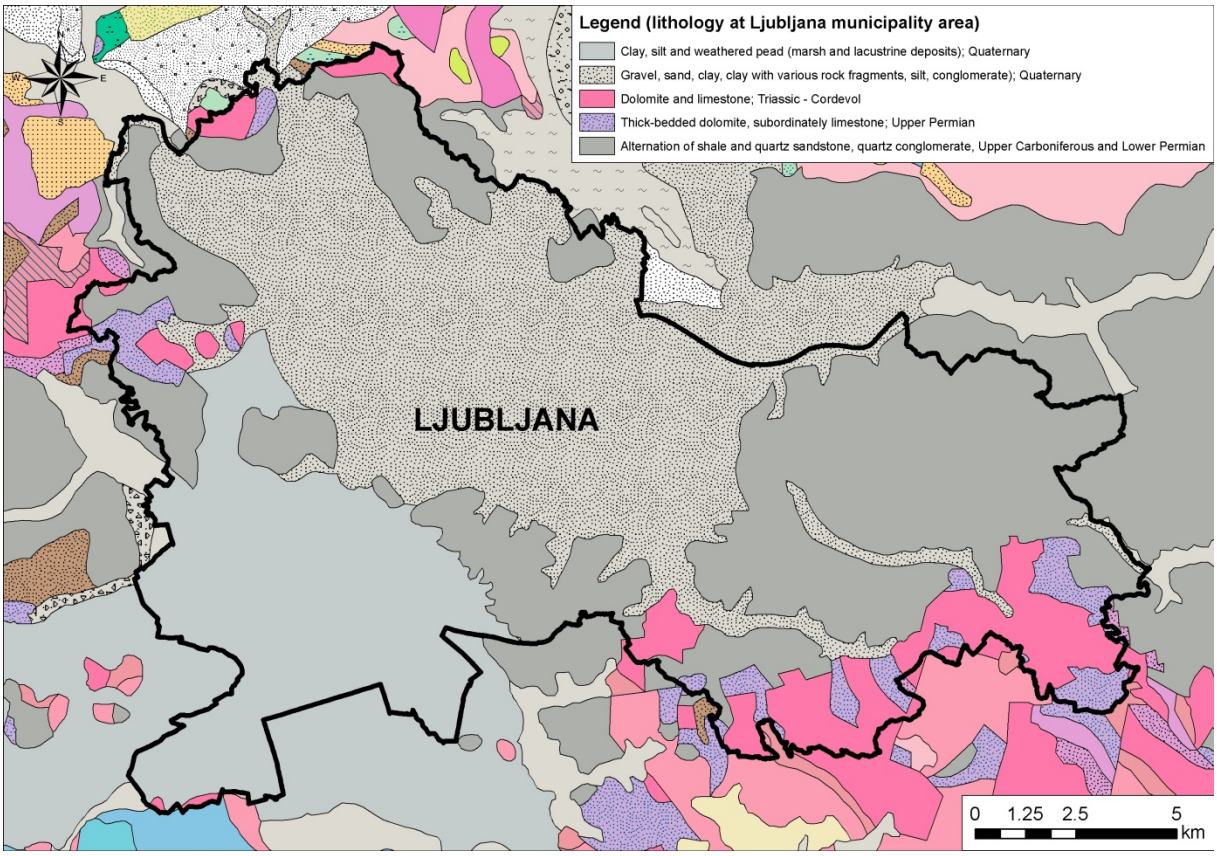

Figure 4: Geological map of the area of Municipality of Ljubljana (black line) (adapted after Buser, 2009). Ref: Buser, S., 2009. Geological map of Slovenia, 1:250.000, Geological Survey of Slovenia, Ljubljana.

Tectonics

The Ljubljana Basin is located in the transition zone between three active fault systems (Figure 5): 1) Dinaric Fault System on SW, consistent of NW-SE-striking dextral faults, 2) Periadriatic Fault System on N, consistent of E-W- to NW-SE-striking dextral faults and 3) belt of Sava Folds on E, consistent of E-W-striking reverse faults and folds. Geodetic measurements, earthquake focal mechanisms and geomorphic observations of deformed Quaternary surfaces show the three fault systems are active and present potential seismic hazard for the densely populated area. The largest known historical seismic event in the Ljubljana Basin occurred in 1895 with estimated magnitude 6.1 on Richters scale. It devastated the city of Ljubljana and surroundings. According to intensity dataset of 1895 event, this earthquake occurred on one of the faults from the Dinaric Fault System.

Earth resources

The sediments of Ljubljansko polje and Barje store important quantities of groundwater, which is the main resource exploited for the public water supply of the city Ljubljana. The most important aquifer is placed beneath the city (in Ljubljansko polje). It stores approximately 400 million cubic meters of groundwater which is of good quality and is used for drinking water supply mostly without any treatment.

Approximately 1 cubic meter of the groundwater is abstracted per second, mainly for drinking water supply (domestic use) and partly for industrial use. The abstraction for drinking water supply, located in four water fields in Ljubljansko polje, representing approximately 90% of all the water in the system, supplying approximately 300,000 people with drinking water (Fig. 3). The Ljubljana Basin sediments are a resource for gravel, clay and aggregates.

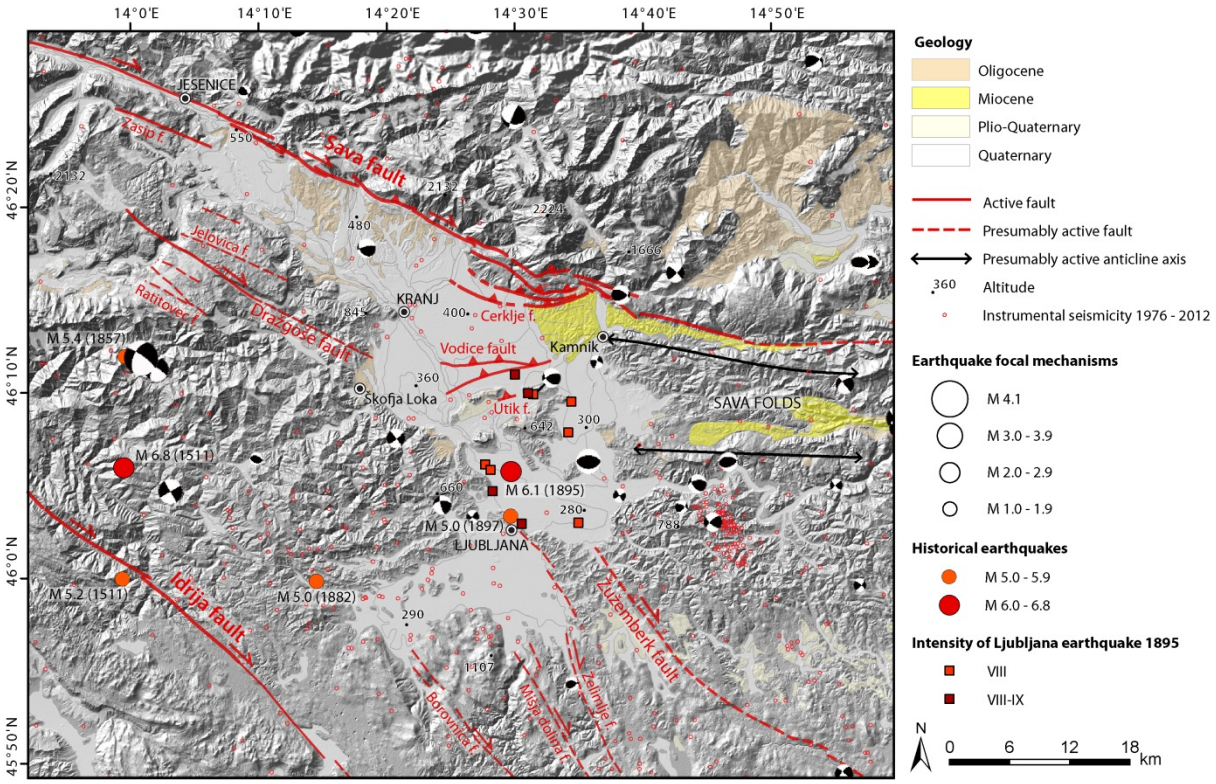

Figure 5: Seismotectonic map of the Ljubljana Basin showing active and presumably active structures (Jamšek Rupnik, 2013, and references therein).

Artificialisation of the soil

The uppermost 50-100 cm of soil in the basin is anthropogenic due to agricultural activity, while in the city itself the underground construction and archaeological remains reach down to several meters and thus the soil in the city is mainly anthropogenic reworked.

The urban subsurface (top layer)

The northern part of Ljubljana is mostly built on gravel and only partly on hard rock. The areas built on hard rock are at the hills of Golovec, Grajski hrib and Rožnik. Except on the slopes, these areas provide stable geotechnical conditions. Constructions on slopes have to take into account the potential for soil creeping on soft rocks.

The southern part of Ljubljana is built on sediments of Ljubljansko Barje (Ljubljana Marsh). The sequence of sediments ends upwards with lake and marsh sediments (clays, sands, peat, gittya) that are prone to compaction. Quarrying took place historically in small pits at

numerous places where gravel is present in the basin. In the gravelly parts of the basin the archaeological findings are confined to the upper tens of centimetres while in the Ljubljana Marsh area, the sediments may cover pre-Roman and Roman remnants of up to several meters in thickness.

Groundwater aquifers and groundwater management

The catchments of water fields are protected with drinking water protection zones (Fig. 3). The delineation of production well catchment areas into zones is based on the prescribed groundwater residence time and the hydrogeological characteristics of the aquifer. Human activities and land uses within these zones that could have an unfavourable impact on groundwater quality are restricted. The implementation of protection zones has a preventive role and reduces the risk of pollution of the groundwater. But it also affects urban development of the city.

Morphological expression of the geological setting

The major part of Ljubljana is built on fluvial or lake sediments where the surface is horizontal or gently sloping, i.e. below 5°. The northernmost parts are built near the Sava River that has cut several terraces with up to 5 m high risers. Parts built on hard rock are elevated above the plain for up to about 100 m (Rožnik, Grajski hrib and Golovec), are dissected by numerous streams and gullies and have slopes of about 10-30°. SE slopes of Grajski hrib and Golovec are steeper (up to 50°) as they run along an active right-lateral strike-slip fault.

3. Urban planning and management

The city's main development objectives are defined in the Municipal Spatial Plan (2010). In brief they are: the continued development of Ljubljana as the capital city of the Republic of Slovenia, increased support for artistic, cultural and scientific activities, and with regard to urban planning, the development of an attractive, well-ordered and innovative city, the promotion of health and safety in the city, also with respect to spatial development and the environment, and intensified continuation of the development of a sustainable city. The possibility of capitalising on recognised geographical and macro-regional territorial advantages is also respected. Being aware of Ljubljana's position as a city within the European core city network, which will dictate the orientation of spatial development in the upcoming European perspective forward until 2020, we have also upgraded our regional commitments accordingly. Since 2011 we have been organising the so called Ljubljana Forum, - a regionally responsible planning and development initiative. Last year's topic was Sustainable Management of Transport and Water Resources.

City development is directed mainly at regeneration and renewal of existing developed areas (607.2 ha in total or 83 % of all development areas). In Ljubljana we are renewing degraded areas (abandoned barracks, abandoned industrial zones, remediating waste dumps, concentrating construction in the city core and gaps) and rehabilitating degraded parts of the city (shanty settlements, illegal garden allotments, etc.). We are also actively pursuing the Sustainable mobility policy, which should bring significant changes to mobility patterns in the city, i.e. less car use and more public transport, cycling and walking. For its recent efforts on projects on public standards (the surface of pedestrian areas has been increased by 620 % in six years, introduction of the city bicycle »*Bicike(LJ)*«, introduction of the Urbana smart city card, adoption of the electro-mobility strategy, extension of city bus routes to neighbouring municipalities etc.) the City of Ljubljana has received many international awards, such as the European public space award (2012), Eurocities Award (2013), Access City Award (special recognition from European Commission).

The city is also committed to resolving issues concerning safeguarding and development of green and open spaces. The most important objectives are to safeguard and manage the five green wedges in the city that link the city centre to the hinterland. They represent key macro-spatial component sections of the urban space, as well as important city climate corridors. They also house the main subterranean aquifers in the city territory. Two major rivers pass through the territory of the municipality. Therefore emphasis is also placed on waterside features being special elements in the urban system. Planning is in most aspects balanced, e.g. when considering public vs. private initiatives.

References

Jamšek Rupnik, P., 2013. Geomorphological evidence of active tectonics in the Ljubljana Basin. PhD thesis, University of Ljubljana.

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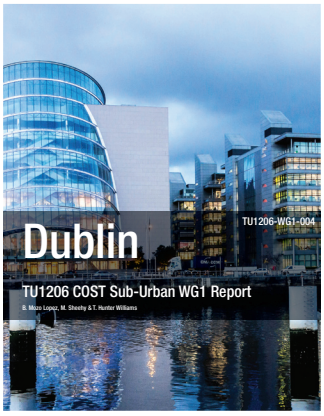
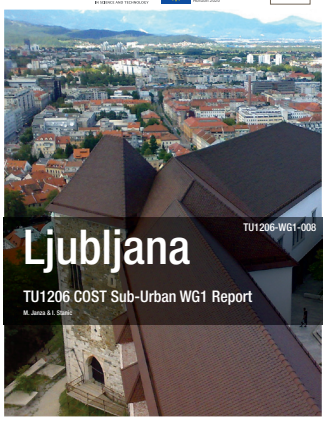
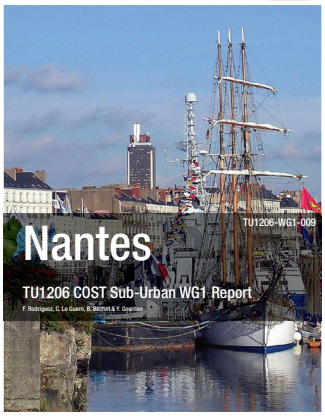
OUT OF SIGHT OUT OF MIND?

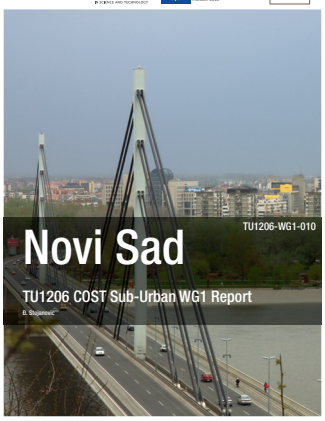
Considering the subsurface in urban planning - State of the art

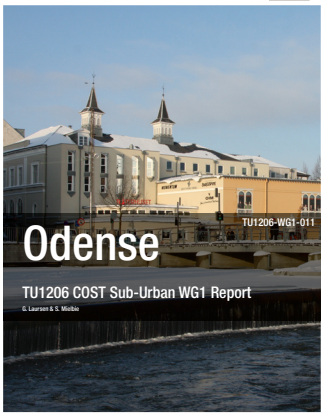
TU1206 COST Sub-Urban WG1 Report











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