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Underground space in the Alexanderplatz area, Berlin: Research into the quantification of urban underground space use

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ABSTRACT

The paper presents a case study of urban underground space (UUS) use in an area of Alexanderplatz in Berlin, Germany. The study analyses data on underground structures, as well as water supply, communications and sewerage. The focus of the study is quantification of UUS: volumes and depth of underground infrastructure, as well as functional use of underground structures. Data on UUS and land use has been collected in two case study areas, both of them include Alexanderplatz. The big case study area covers about half of a square kilometer and has about 700 thousand cubic meters of developed UUS. Main results are presented as diagrams: UUS use by function, distribution of underground infrastructure by depth, and volume of developed underground space per land area. Transport is the main function of underground structures in the area, and accounts for about 60% of UUS volume. Density of underground structures in the area is about 2–3 m.

1. Introduction: the research context and aims

Terms as urbanization, environment, development, infrastructure, transport, indicators are commonly used in scientific literature dealing with issues which can be summarized under sustainable development concept. Addressing sustainable development requires a holistic approach to the above mentioned subjects, including quantitative statistical data.

Urban underground space (UUS) studies are highly relevant to urban sustainability as a whole, as well as to its particular components like urban form, environment, transport, and energy (ITA WG 13, 2004; Sterling, 2005; Admiraal, 2006). UUS use, its benefits and drawbacks, as well as UUS role in a city, has been very well studied descriptively (e.g. Belanger, 2007; ITA WG 4, 2000; Carmody and Sterling, 1993). However little is known about the quantitative characteristics of UUS use in a way in which we describe and analyse land use. Actually there is not enough quantitative data on land use as well; however there are some works that allow statistical analysis that can be used in sustainability studies (e.g. Bertaud, 2002). Bertaud, 2002 analyses urban form and spatial organization of a number of cities, UUS, unfortunately, was not considered.

This research aims to bridge some statistical gaps in knowledge about UUS. Indeed, considering urban sustainable development, usually quite detailed statistical data is available on social (e.g. population) and economic (e.g. sales revenue) indicators (e.g. Eurostat, 2009; United Nations Indicators for Sustainable Development, 2007). Data on urban environment and land use is available to some extent, but often lacks uniformity that would allow interdisciplinary and cross regional comparisons (problems in urban indicators comparative analysis were highlighted by e.g. World Bank, 2005). Data on urban physical infrastructure is scarce, and usually has a sectoral and economic focus (e.g. OECD, 2006). However detailed statistical data on urban physical infrastructure is indispensible for addressing many sustainability questions, e.g. (1) how much space is needed for different transport modes? (2) how land use relates to energy consumption? Urban physical infrastructure, including urban underground infrastructure (UUI), becomes even more important due to climate change concerns. Urban infrastructure plays an important role in urban areas adaptation to climate change (Pachauri and Reisinger, 2007; Prasad et al., 2009). UUI is vulnerable to many climate change associated impacts on the one hand, and offers some opportunities for urban mitigation and adaptation on the other (Bobylev, 2009b).

Quantitative data on UUS, on par with other urban development indicators, should be the base for addressing pressing problems of urban sustainable development, adaptation to climate change, and environmental quality. Statistical data on UUS can be valuable for urban development planning, as well as for UUS development itself.

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This research aims to characterize UUS by volume and function in a central area of a metropolis, and Alexanderplatz in Berlin is presented as a case study.

2. Study area: Alexanderplatz, Berlin

Alexanderplatz is a square in the centre of Berlin, Germany. The history of the area around Alexanderplatz dates back to the 13th century, and since the 17th century Alexanderplatz has been an important, prominent and busy place. Nowadays Alexanderplatz is a distinct landmark of Berlin, a busy transport hub and highly frequented shopping area (Fig. 1). According to the Berlin Senate Department of Urban Development, an Alexanderplatz area renovation project, which started in 2000, provides for 350 thousands square meters (t.s.m.) of shopping facilities, 650 t.s.m. of offices, hotels and entertainment venues, and 300 t.s.m. of apartments. Exhaustive information on Alexanderplaz, including history, culture, maps, and development land use plans can be found at (www.stadtentwicklung.berlin.de).

According to the Berlin Digital Environmental Atlas, 01.15 Engineer's Geological Map (Edition 2009) (http://www.stadtentwicklung.berlin.de/umwelt/umweltatlas/ei115.htm) ground conditions in the area of Alexanderplatz have been formed by the Vistula glacial stage. Ground moraine is largely eroded, so that the Vistula-stage sands are underlain directly by older sands. Younger deposits cover around 5–10 m, and are underlain by humic sand, river sand, peat, and organic silt. Groundwater level is located at a depth of 2–4 m.

The oldest documented underground structure is a sewer 667 mm wide and 1 m high which has been in operation since 1880. Alexanderplatz was a busy transport hub back in 1930 (Fig. 2), when an existing since 1913 underground metro tunnel "A" was complemented by two new ones: "E" and "D" (these are names of tunnels, since some lines have been changing their route). Nowadays public rail transport facilities on Alexanderplatz include a railway station, three metro lines (U2, U5, and U8) and tram lines (Figs. 3 and 4).

The most important and biggest historic underground structure on Alexanderplatz is a bunker, which was built in 1945 and further expanded in 1966. The bunker has three floors and numerous pedestrian tunnels connected to adjacent underground structures and buildings, most of them are now filled with soil.

Among public attractions in the area of Alexanderplatz are a television tower, big department stores Alexa and Galeria Kaufhof. Description of buildings and their underground facilities is presented in Tables a1 and a2 of the Appendix.

Fig. 1. Areal view of Alexanderplatz, Berlin, 2007. (*Source*: www.stadtentwicklung.berlin.de photo: Philipp Eder.)

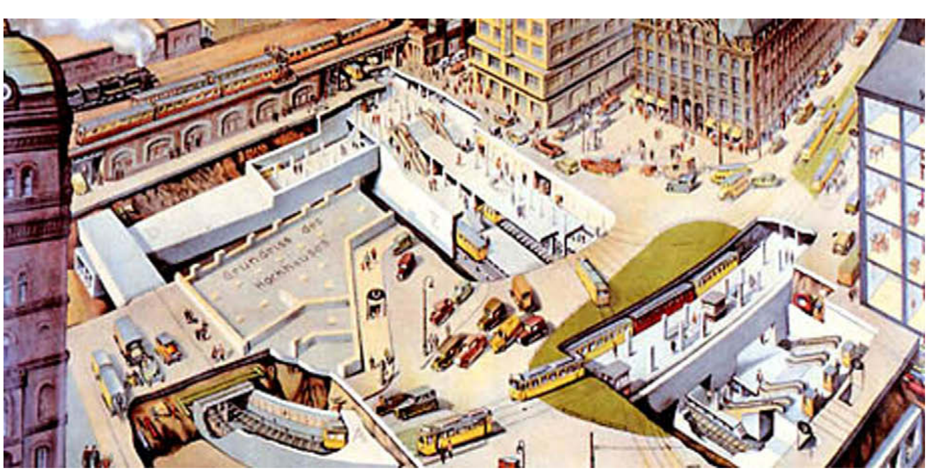

Fig. 2. Alexanderplatz was a busy transport hub back in 1930. (*Source*: www.stadtentwicklung.berlin.de.)