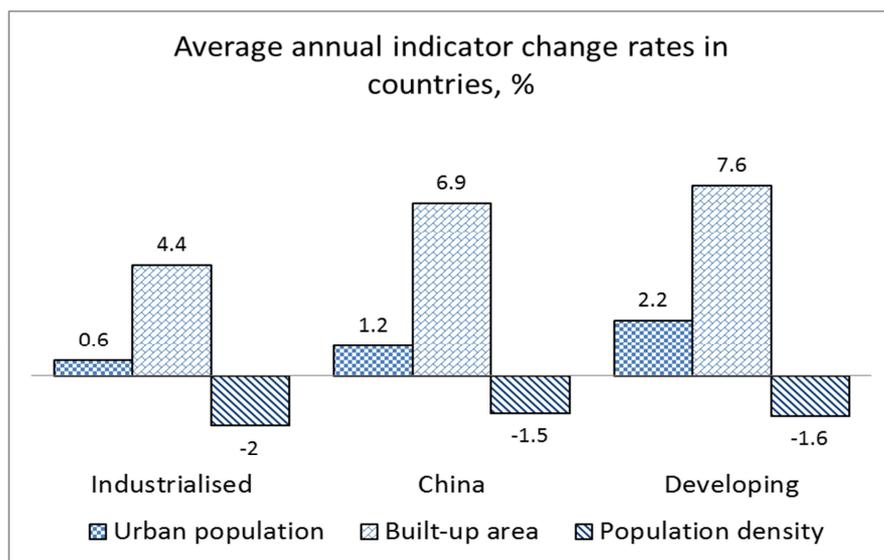


## New Space: A Compact City and Underground Space Use

Nikolai Bobylev

Urban Underground Space as a valuable resource, a space for placing structures and infrastructure, as well as a source of groundwater and geothermal energy. Development of Urban Underground Space has been accelerating rapidly in many major cities. Pressures of a changing global environment, including climate and increasingly limited land availability, place Urban Underground Space on the top of the innovative urban development agenda. The overarching goal in the urban and Urban Underground Space development should be enabling a compact, liveable, sustainable, and resilient city while improving quality of life in it.

Cities continue to sprawl both horizontally and upwards, but these development strategies have significant limitations failing to satisfy contemporary challenges, e.g. biodiversity conservation, energy efficiency, minimizing greenhouse gas emissions and sustainable transport modes. Most worryingly, consumption of land continues in the regions with falling populations, questioning success of developed countries in their sustainability efforts.



*Comparison of average global annual increase (decrease) rates in urban population, built-up area, and population density, %. Calculated using data from: China Urban Development Report, 2010; He et al, 2012; UN-Habitat, 2011; Angel et al, 2005; UN-Habitat, 2013. Published in Bobylev, 2016*

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The concept of a **Compact city** assumes that in the future people will live in dense, compact urban areas. This densification is fundamentally necessary to save land space of other than human species – flora and fauna.

**Extensively developed Urban Underground Space is an absolute requirement for a successful compact city.** This does not mean that human dwellings are to be located underground, but supporting services should. An ideal compact city might accommodate many people while consuming minimal resources, but quality of life in such dense urban environment must be taken into account to make the compact concept a success. This concern is addressed by a liveable city concept, which focuses on creating human friendly urban environments. Housing and infrastructure can change dramatically in the next decades (figure 2). Drivers for this development are innovative technologies and energy saving pressures. Infrastructure will change physically and its spatial location will also change, while keeping the same functionality (services). For Urban Underground Space that would mean a shift from widespread use of the shallow subsurface to more compact layout and deeper Urban Underground Space use, this would definitely affect urban form and land use.

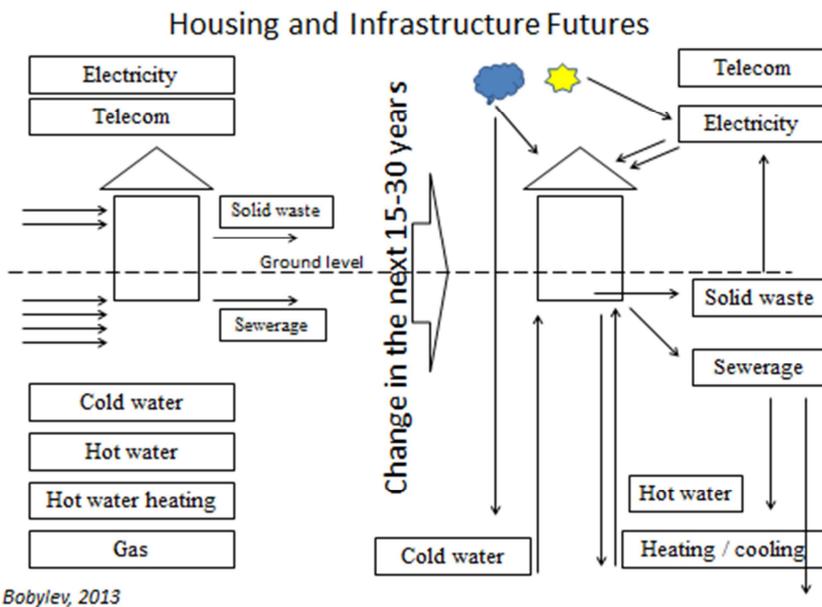


Figure 2. A vision for a change in technology and spatial arrangement of utility infrastructure. Published in Bobylev, 2016

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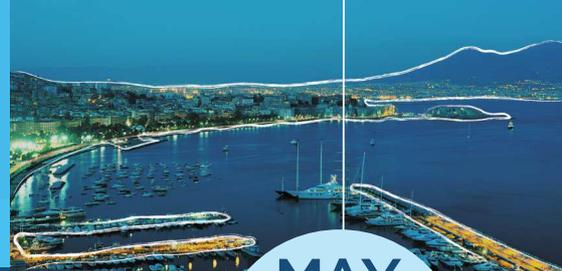
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**Transitions in Urban Underground Space** use will be happening due to an array of factors and pressures, putting Urban Underground Space forward onto urbanization agenda, but how these transitions might be happening?

**Density is a very important and at the same time confusing term in urban development.** Usually density of a parameter implies its quantity over the certain land area. There are many densities (population, built stock, infrastructure). Architect Norman Foster (2011), linked Urban Underground Space development with a densification strategy: "One of the greatest challenges facing mankind is to achieve higher density while at the same time improving urban existence. The underground has enormous potential for realizing spatial benefits." While in the twenties century density meant going upwards (skyscrapers) will it mean going deep in the twenty first? An excellent example of contemplating such a transition is the first design concept for an "earthscraper".

**Figure 3 presents a correlation between urban population and developed underground space densities** using data from six cities (Beijing, Helsinki, Paris, Quebec, Shanghai, and Stockholm), including different timeframes for some of them. Urban densification in variety of ways (economy, population, infrastructure) will characterize transitions in UUS as well, and can be considered as a pathway to grated UUS use.

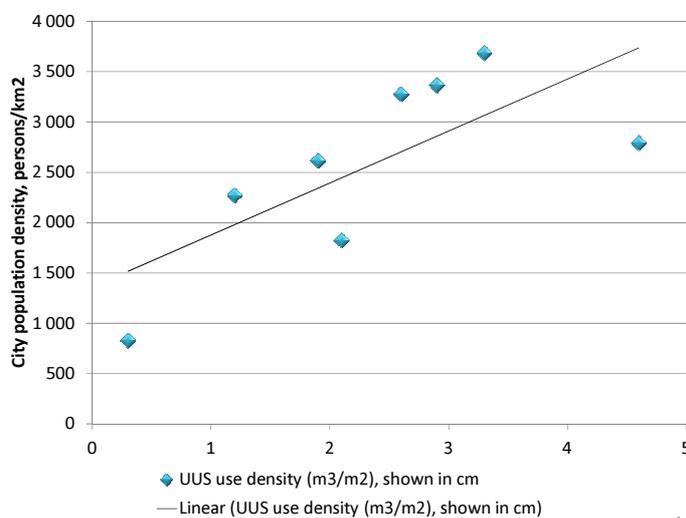


Figure 3. Urban population and developed underground space densities (published in Bobylev, 2016)

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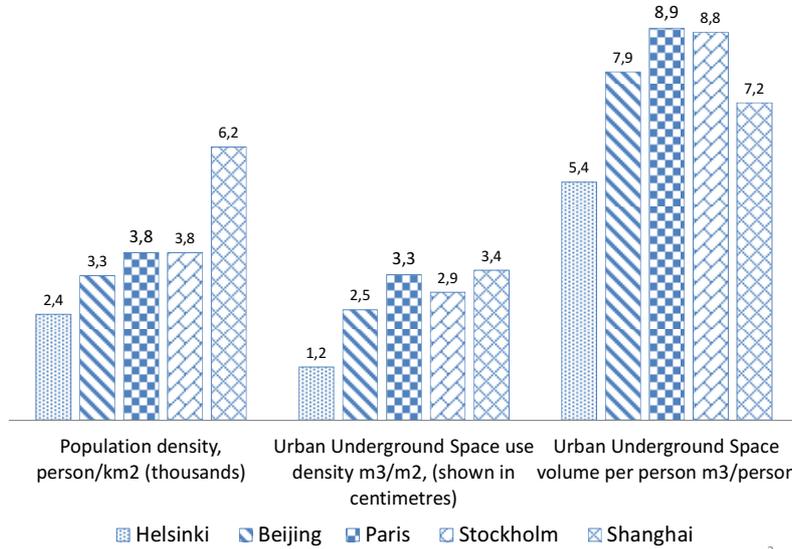


Figure 4. Urban indicators and underground space use in selected cities (published in Bobylev, 2016)

In the late 1400s, Leonardo da Vinci was already sketching ideas for three-dimensional cities with canals and roadways on different levels. Three-dimensional planning would be a real need, enabler, and accelerator of positive transitions in Urban Underground Space use.

A scope of key questions that should be considered regarding Urban Underground Space future use:

- How can we describe highly developed cities now and in the future? (e.g. quality of life, environment, public amenities, and secure provisioning of ecosystem services);
- How will Urban Underground Space look like in the future in highly developed cities? What are the pathways to those futures?
- What urban functions should/will be located predominantly underground?
- How much land can be saved by intensive use of Urban Underground Space?

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