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Why underground space should be included in urban planning policy – And how this will enhance an urban underground future ☆

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ABSTRACT

Cities worldwide tend to overlook an invaluable asset that lies beneath their surfaces. Most cities and urban regions are unaware of the benefits underground space use has to offer, both for climate inflicted and spatial constraints: In many cities, infrastructure development is being outpaced by population growth. Climate change effects are requiring radical new approaches in terms of coping with for example excessive rainfall. The available space at the surface is rapidly being used up and the biggest danger is that built-up spaces are taking over the public green spaces of cities thereby threatening livability and quality of life. Urban underground space forms a societal asset, which is often unappreciated and underestimated in terms of the role it can play within dynamic city environments and associated challenges.

This paper will explore the ways in which urban underground space can be optimally integrated into the dynamic urban context. It also explores the often contradictory functions that make underground space use complicated from a planner's perspective. The first-come-first-served strategy of underground space use has left many cities wondering how they are going to cope with the self-inflicted "chaos" under the surface. The often mono-functional uses of the underground lead to sub-optimal space use. Most cities and urban regions are unaware of the benefits underground space use has to offer. In guiding the future use of urban underground space, a comprehensive policy framework guiding its development is lacking on which decisions can be based. This often leads to the non-sustainable use of this important asset. It will be argued that both vision and planning are needed to be able to make the best use of this underrated underground real estate.

The authors will also debate that just understanding the potential of underground space is not enough. Realising its actual potential and facilitating its development will require a spatial dialogue between many stakeholders, including planners, engineers, developers and public decision makers.

1. The role of underground space in urban development

Tunnels have been part of the urban fabric of our cities for a very long time. In the late 8th and early 7th centuries BC, engineers created the Siloam Tunnel underneath the City of David, in Jerusalem. It was intended to transport water and as such is a very early example of a utility tunnel (Sneh et al., 2010). In modern times, tunnels started to play an important role in cities, first for sections of railway and later to carry the first metro systems in cities like Moscow, Paris and London (Nock, 1973). New York City could probably not function as a city without its extensive subway system, and the same holds true for London, which continues the expansion of its underground transport system today with the £15.8 billion Crossrail project (Berry, 2009).

Efficient and sustainable infrastructure is vital for economic development, which is why virtually every major urban metropolis is building or extending rapid underground transport and utility tunnel systems to cope with growing populations and the corresponding demand for mobility and infrastructure. But a city's underground space can be used to much greater effect if it is considered for a whole range of other functions too, freeing up ground-level space for other uses including green spaces, and helping to reduce the impact of climate change. "Multipurpose constructions aligned with natural systems, integrated into social context, and designed for a changing climate offer a new paradigm for public works (Brown, 2011)".

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Today, over half the world's population is urban, but population forecasts show this figure will rise to 66% by 2050. The future mega cities will be concentrated in South East Asia, the Americas, and Africa (United Nations, 2014). But Europe will see urban growth too. Of the medium-sized cities, for instance, Stockholm is one of the fastest growing, meanwhile Paris, London and Moscow will soon have to serve 10 million inhabitants and upwards. Already we see a growing trend towards making better use of the underground. Data centers, shopping centers, archives, libraries, art galleries, swimming pools, sports centers and warehouses have already been built beneath major cities. Bars, nightclubs, and even restaurants, are appearing in disused former bunkers, ideal because there are no noise issues. In the crowded city of Tokyo, Japan, engineers have created automated underground bike storage facilities, which transport bikes from the surface to racks below ground (Kohlstedt, 2015). Locating data centers underground brings multiple benefits. Not only is the land above-ground preserved for other uses, but waste heat from the computer servers can be used to efficiently heat homes, as seen in for example Helsinki, Finland (Virki, 2009).

Building underground is now possible in most soil conditions. Although it is most cost effective to build in hard rock such as granite, there are sophisticated techniques to build in soft sedimentary rock and even under water. Land use issues aside, there are many other advantages to building underground. Buildings and infrastructure housed beneath the earth's surface are better protected against climate threats caused by the greenhouse effect such as floods, heavy rain or erosion. It has been shown that underground transport infrastructure is much more resilient to earthquakes than infrastructure at grade (Admiraal, 2012).

"As the world continues to urbanize, sustainable development challenges will be increasingly concentrated in cities, particularly in the lower-middle-income countries where the pace of urbanization is fastest. Integrated policies to improve the lives of both urban and rural dwellers are needed (United Nations, 2014)". These integrated policies must include a vision on the use of a city's underground spaces. A vision not only to uncover this often overlooked hidden asset but also to prevent the often chaotic and unsustainable development of underground space once it has been discovered.

2. Urban service layer or new urban tissue?

In the previous paragraph, the variety of uses of the urban underground space has been broadly sketched. What we need to consider is that many developments come about through incidental interventions into the underground space rather than through strategically planned interventions. As such underground space can by typified as the final urban frontier waiting to be exploited by those who place the first stake and thereby claim their space. This first come first served strategy of underground space use has left many cities wondering how they are going to cope with the self-inflicted "chaos" under the surface. The lack of a vision based strategy also easily leads to the creation of monofunctional facilities that contradict the way ecological systems organise themselves as Brown (2011) argues. She proposes that: "Just as organisms self-organize by exchanging energy and assimilating waste for their mutual benefit, infra-structural systems might combine functions within single assets". In practice the emergence of multi-utility corridors is one way of combining functions. The underground date centres, already mentioned, providing energy for surrounding communities is another. But even when we succeed in creating these multi-functional facilities we do need to question how we are putting the underground space to use. Are we using it to place only uses underground that blight the surface? Are we using the underground space as an urban service layer? The answer to this question is both a 'yes' and a 'no'. There certainly is a danger of only utilising the underground for services that do not require daylight. There are many examples of industrial facilities being placed underground to free up land at the surface for other uses. The Rotterdam Dokhaven Waste Water Treatment Plant and the Madrid M30 Motorway are two projects that freed up public space at the surface (Cornaro and Admiraal, 2012). A further example of the 'Viikinmaki' Wastewater Treatment Plant in Helsinki, Finland can be found in Cornaro and Admiraal (2014). In the same paper, a proposed development of an Art District in Hong Kong by Fosters + Parners is discussed. The development specifically calls for "traffic and pollution" below, illustrating the concept of the urban underground service layer. In a sense, the use of underground space in this way can be seen as beneficial to urban areas. The land is freed up at the surface for other uses and in this sense underground space provides a much needed spatial relief valve. In terms of strategy and policy it is however very much a reactive approach to the density that is asked of cities and with Brown the authors propose that this leads to a sub-optimal and non-sustainable use of underground space in the long term.

The real appreciation of the hidden urban asset comes to light when, as Bélanger (2007) puts it, the underground is acknowledged as an urban landscape. He continues to state: "The reluctance of urban designers and academics to engage the dynamics of the underground is stunning. For almost 50 years, urban designers, landscape architects and planners have longed for car-free pedestrian environments that are safe, secure and accessible. From a planning perspective, the Toronto underground may be the ultimate form of attrition of the automobile on the urban landscape: there are no parking lots, no asphalt, and no congestion. With its mass-transit accessibility, it is an ideal pedestrian network. This reluctance may in part be attributable to a prevailing attitude that privately-controlled underground shopping is undesirable, at best dismissible. As self-contained environments, they are perceived as lying outside the so-called public domain and that they kill off street life. As a more legitimate form of collective space, street-level activity located within municipal right-of-ways therefore receives much more advocacy". The prevailing attitude as Bélanger calls it, is best described by Boddy (1992) who sees underground developments, together with sky bridges as dysfunctional elements in terms of public spaces and part of an analogous city. A city where society is ripped apart because it can't meet any longer in the public spaces as these have been reduced to underground secure places for the chosen few that can afford to use them to travel and shop. Boddy, however, continues to state that underground and overhead need to be integrated into the urban fabric. It is of the utmost importance in his opinion that underground and overhead are connected to grade, the public domain, in order to make them visible and accessible. This idea is clearly illustrated in a design made by Farshid Moussavi for an Open Air Metro. The design opens up the hitherto hidden existing underground station to the surface and thereby integrates it into the urban fabric (RATP, 2010).

A sustainable use of underground space can only be achieved when a new urban tissue is created that integrates into the urban fabric. Networks need to be visible and accessible while public spaces need to exist as much below the surface as at grade. An interesting example of this is the New York Lowline initiative.

2.1. Case-study: New York Lowline

The Lowline project is a private initiative in the Lower Eastside of New York. The project centres on the reuse of a former now unutilised underground tramway depot beneath Delancey Street to create an underground park to offer a much needed 1 acre of green

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