Urban planning: Growing cities underground

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The Deep City Method helps urban planners decide how to best exploit their underground resources.

Under the streets of Montreal lies a second city, a bustling complex of shops and restaurants. Helsinki's bedrock has been hollowed out for industrial purposes – oil storage, water treatment, a data center – with commercial applications in the making. Around the world, in Tokyo, Paris, Amsterdam, and elsewhere, cities are experimenting with underground expansion. But assessing the potential to exploit their subsurface is difficult. So difficult that many cities shy away from it altogether. Now, city developers seeking guidance can turn to the Deep City Method, a systematic decision-making framework developed at EPFL that has recently been applied to four cities in Switzerland, and four larger emerging cities in China.

"Many cities don't recognize the potential of the ground they are built on," says Li Huanqing just finished her PhD at the Environmental Economics
and Management Laboratory at EPFL. What she hopes to show is that, if they go about exploiting their subsurface smartly, the investment can help cities grow in a way that pays off in the long term. "Our objective was to provide city planners with a set of guidelines to help them exploit underground resources more efficiently. The problem is part engineering, part economics. We wanted to integrate both of these disciplines to develop our approach." Two articles outlining her work are currently in press in the journal Tunneling and Underground Space Technology.

More than space

Space is probably the most obvious underground resource, but it comes at a price. Building downwards can cost up to five times as much as conventional aboveground construction. Because many cities are under such pressure to grow, but lack the land to do so, this investment can become worthwhile. And by linking projects, coordinating them across an entire city and taking advantage of other resources provided by the underground, the price can further be kept in check.

Geothermal energy is one such resource. Made more accessible by excavations, it can be used for residential heating or industrial applications. Geo-materials are another. Excavation debris inevitably accumulates and can be used to stabilize roads or produce cement. And increased access to groundwater, and careful protection of it, can help sustainably grow cities. Managing the multiplicity of resources that can underlie a single parcel of land can be a remarkable challenge.

Most cities have a master plan detailing the use and the value of their land, but normally, nothing similar exists for the subsurface. Drawing on

experiences gained around the world, the Deep City Method, developed at EPFL's Laboratory of Engineering and Environmental Geology aims to fill this void by confronting underground land-use demand with the potential to exploit it, and assist cities in extending their legal systems into these traditionally lawless expanses. In the best of cases, the possibility of exploiting the first 100 meters of the subsurface for construction projects can represent a substantial gain in growth potential.

Switzerland, a land of tunnels and underground fortresses, has a long history of exploiting the underground. Of the four cities that were tested for their potential to expand into the depths, Geneva came out on top, before Zürich, Lausanne, and Bern. The city's high population density and GDP per capita as well as the quality of its groundwater made it stand out in particular. And Geneva is already moving towards increased exploitation of its urban subsurface, with a new subway line underway, and an underground expansion of its main railway station being considered.

In her thesis, Huanqing focused on the growing Chinese city of Suzhou, slated to have 5 million inhabitants by 2015 and conducted an extensive case study of its potential to expand underground. To her, this project was a considerable success. "We were able to establish ties to the government and work together to towards formulating a 3D land-value map, which combines land value with environmental and other constraints."

So does this mean that in the future we will all be living underground? Probably not, but building certain infrastructure projects underground frees up space on the surface, often a strongly limited resource. Now the job is getting more cities to jump on the bandwagon. As Li Huanqing says: "It is our job to show how underground space can be used multi-functionally and create demand in the future."

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