Better Cities, Better Lives

The contribution of Underground Space to Urban Development

26-10-2011 | Wuhan | ITA Technical Seminar - ISOCARP congress

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committee underground space

ITA-AITES

International Tunnelling and Underground Space Association

- Founded in 1974
- Based in Lausanne, Switzerland as an Association under Swiss Law
- ITA currently has a membership of 55 Member Nations
- ITA has both corporate and affiliate members
- ITA General Assembly is formed by representatives of the Member Nations (meets during the annual World Tunnelling and Underground Space Congress)
- ITA General Assembly elects an Executive Council which governs the association
- ITA secretariat is headed by an Executive Director

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ITA-AITES

- Four active committees
  - > ITACET in the field of education and training
  - > ITACOSUF in the field of safety
  - > ITATECH in the field of innovation & technology
  - > ITACUS in the field of Underground Space awareness
- Several active Working Groups on specific topics

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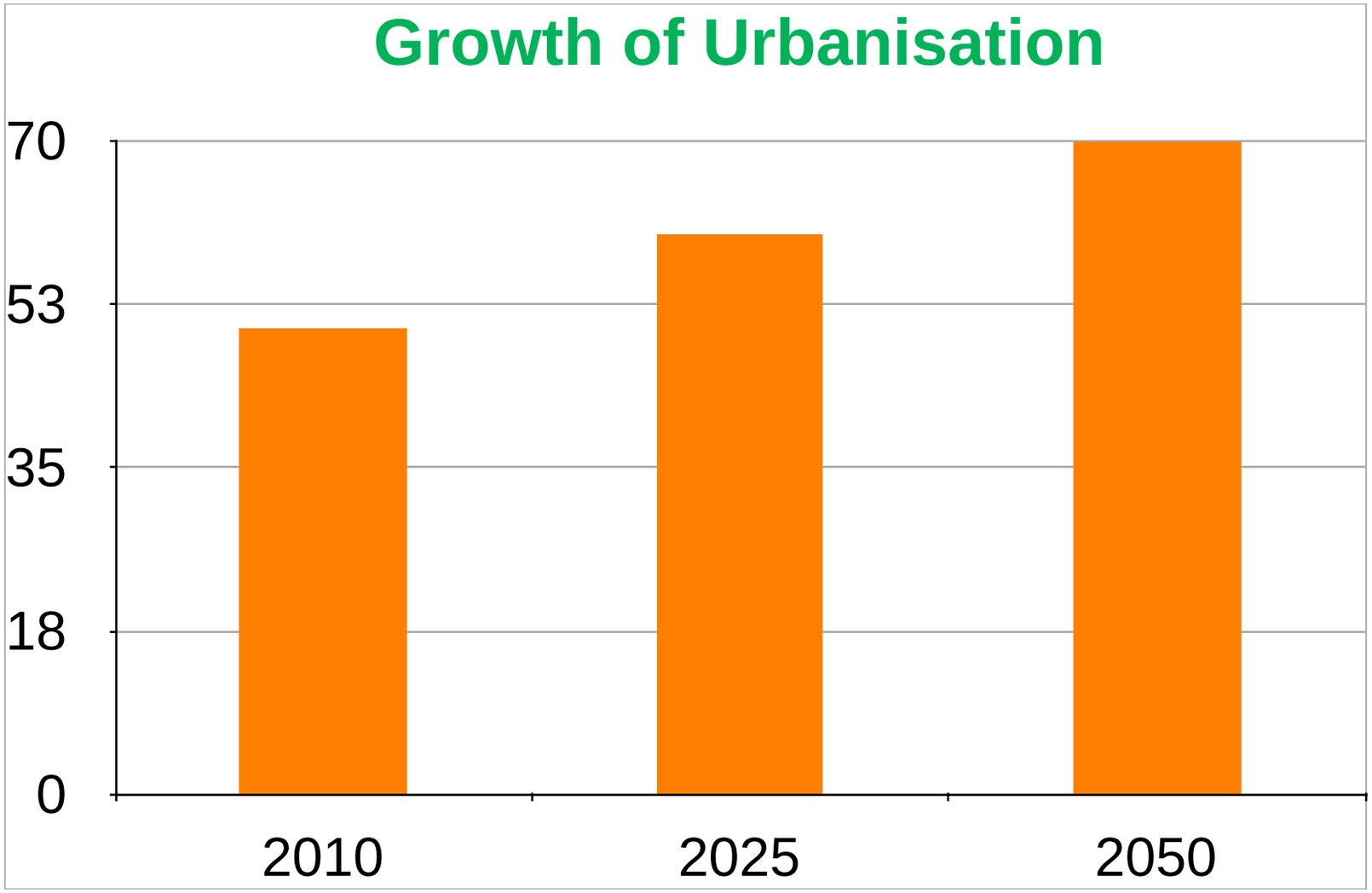
Rapid Urbanisation

Demographic Trend



source: Sustainable Urban Infrastructure – Siemens

Most densely populated countries (top 10)

2010 (in millions)		**2025** (in millions)	
1.China	1330	1.India	1396
2.India	1173	2.China	1394
3.United States	310	3.United States	357
4.Indonesia	242	4.Indonesia	278
5.Brazil	201	5.Brazil	231
6.Pakistan	177	6.Pakistan	217
7.Bangladesh	158	7.Nigeria	197
8.Nigeria	152	8.Bangladesh	192
9.Russian Federation	139	9.Ethiopia	140
10.Japan	126	10.Mexico	130

source: US Census Bureau, 2009

Megacities and exposure to flooding

Amount of people exposed to flooding in 2100

> Manila, Philippines	3.438.334
> Alexandria, Egypt	2.723.464
> Lagos, Nigeria	2.121.263
> Monrovia, Liberia	1.751.428
> Karachi, Pakistan	1.417.639
> Aden, Yemen	1.253.473
> Jakarta, Indonesia	836.130

source: Centre for Global Development, 2009

Natural Disaster and Climate Change

Cities need to adapt and cope

– Earthquakes

– Storms

– Excess rainfall

source: World Disaster Report 2010
Focus on Urban Risk – Red Cross

This is the New Normal - Newsweek

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Worldwide campaigns

– World Urban Campaign

– Resilient Cities

– How can underground space use contribute?

Sustainable Urban Underground Space Use

- Buildings
- Transport
- Energy Supply
- Water
- Waste

Buildings

Using Underground Space below buildings

- Car Parks
- Basements
- As a resource for energy
- As a resource for heating/cooling

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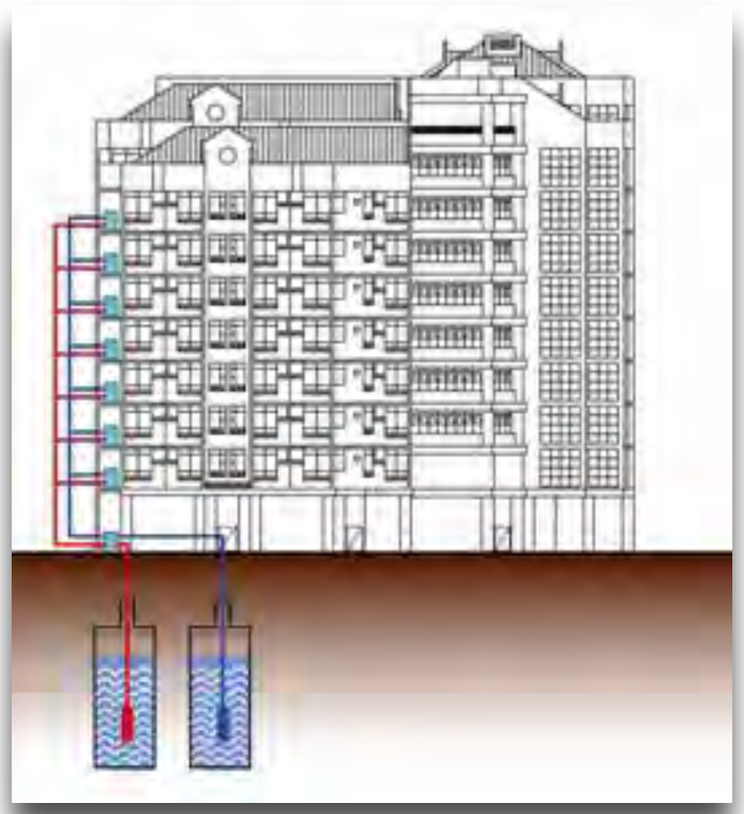
Buildings

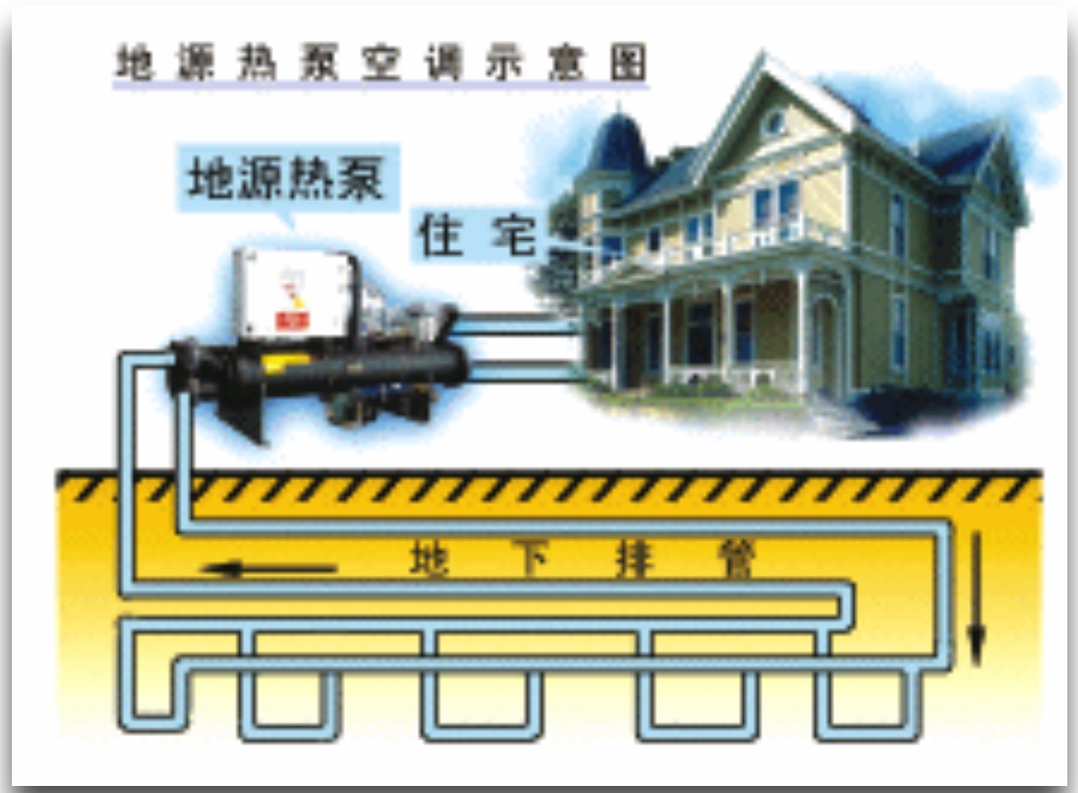
The District of Tomorrow

Students researching, designing and building a sustainable energy neutral zero impact buildings

Buildings

Resource for heating and cooling buildings





source: Shi Xiaodong

Buildings

- Ground-source heat pump, cleaner, high efficiency and energy saving
- 445 million cubic meters of geothermal energy is utilised in China
- In Shenyang, 65 million square meters of ground-source heat pump technology will be reached at the end of 2010

source: Shi Xiaodong

Transport

– Mass Rapid Transport Systems

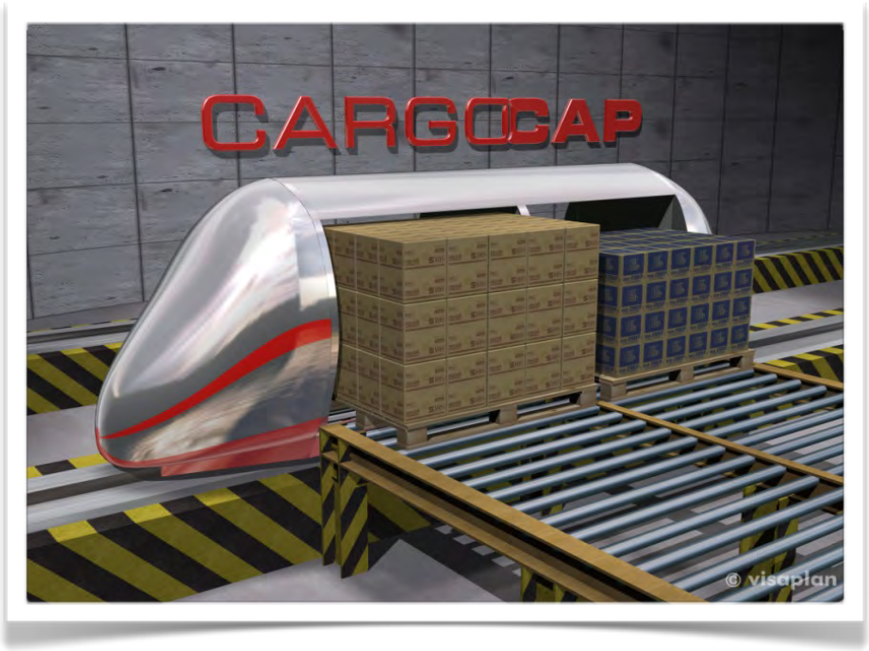
– Cables and pipes

Transport

Underground Freight Transport

– International Society for Underground Freight Transport

– Research in the Netherlands, China, US and Australia into uses in both urban areas and port areas



Energy Supply

IN-FOCUS Latin America and the Caribbean: News

TRANSPORT

Haiti

The Inter-American Development Bank has approved two grants totalling USD 54 million for Haiti to repair highways and improve secondary roads. Transport is a key sector in the Haitian government's economic recovery plan following the destruction caused by the earthquake in January. USD 29 million will aid completing rehabilitation work on RN1, one of the busiest stretches of the country's principal highway, while USD 25 million will finance work to improve the secondary road network in Haiti's southern peninsula.

HYDRO POWER

Chile

French transport and energy infrastructure company, Alstom, has signed a contract worth USD 123 million with Chilean utility Colbun for the supply of three turbines for the Angostura hydropower project being developed in Chile. As part of the agreement, Alstom will provide Colbun with two 136 megawatt (MW) turbines and one 48 MW turbine. The 320 MW Angostura hydropower project is planned for Chile's

Geothermal energy

St. Lucia set to exploit its geothermal energy potential

Emerging renewable energy company, Qualibou Energy Inc., has announced its plan to develop as much as 170 megawatts (MW) of geothermal energy on the Eastern Caribbean island of St. Lucia.

The island is part of a volcanic arc known as the Lesser Antilles. Surface manifestations of geothermal activity are centred in the Sulphur Springs area and include hot springs, steam fumaroles and boiling mud pools. The resources have been extensively explored since the mid 1970s and nine wells have been drilled to date. Steam was found in five of the exploratory boreholes with one of the deeper wells returning steam and water at 235 degrees Celsius, creating ideal conditions for electricity generation.

"The resources on St. Lucia have proven reserves of 30 MW and probable reserves of an additional 140 MW," said Stephen Baker, President and CEO of Qualibou. "In oil terms, the proven and probable reserves are 60.1 million barrels of oil equivalent (BOE), representing a very significant asset for Qualibou."

Production drilling plans are underway and a drilling schedule will be announced in the near future. "We plan to generate 120 MW of power from this resource with the first phase being 15 MW," added Mr. Baker.

Qualibou will deliver all electricity from phase one of its geothermal power project to St. Lucia Electricity Services Limited (LUCELEC), the sole electric utility of the

Source: Urban World, September 2010 - UN HABITAT

Energy Supply

THE TIMES
THE SUNDAY TIMES

Archive Article | Please enjoy this article from The Times & The Sunday Times archives. For full

From The Times

February 11, 2010

Computer power provides heat for Helsinki

Robin Pagnamenta in Helsinki

Outside, the temperature is a bone-chilling minus 14C and Helsinki is struggling with its iciest winter since 1982, but deep inside a former bomb shelter carved from the bedrock beneath an Orthodox cathedral, the city's power company is building what will soon be the world's most high-tech municipal heating system.

Here, surplus heat from hundreds of computer servers in a new data centre located beneath Uspenski Cathedral, one of the city's main tourist attractions, will be captured and pumped to heat hundreds of homes and businesses across the Finnish capital.

"This will be the greenest and most energy-efficient data centre in the world," Juha Sipila, the project manager for Helsingin Energia, the company behind the scheme, said.

In Helsinki, where winter temperatures often plunge to minus 30C, hardly anyone owns a domestic heating boiler. Instead, water is heated centrally at combined heat and power (CHP) plants to 115C and piped directly to tens of thousands of homes and public buildings.

RELATED LINKS

- Energy regulator warns of blackouts
- Dream of cool-running is becoming a reality

Helsingin Energia is the operator of Helsinki's district heating network, a 1,350km (850-mile) network of underground pipes, tunnels and pumping stations that supplies hot water to 450,000 people across one of the world's coldest capital cities.

The data centre will be cooled using seawater from the Baltic, which falls below 8C from November to May, with the excess heat pumped back into the city's heating system — a solution that Mr Sipila hopes will help to crack a pressing problem for the world's IT industry.

Energy Supply

- Hydro Electric Power
- Heat/Cold storage applications (buildings)
- Zero impact of power transmission networks

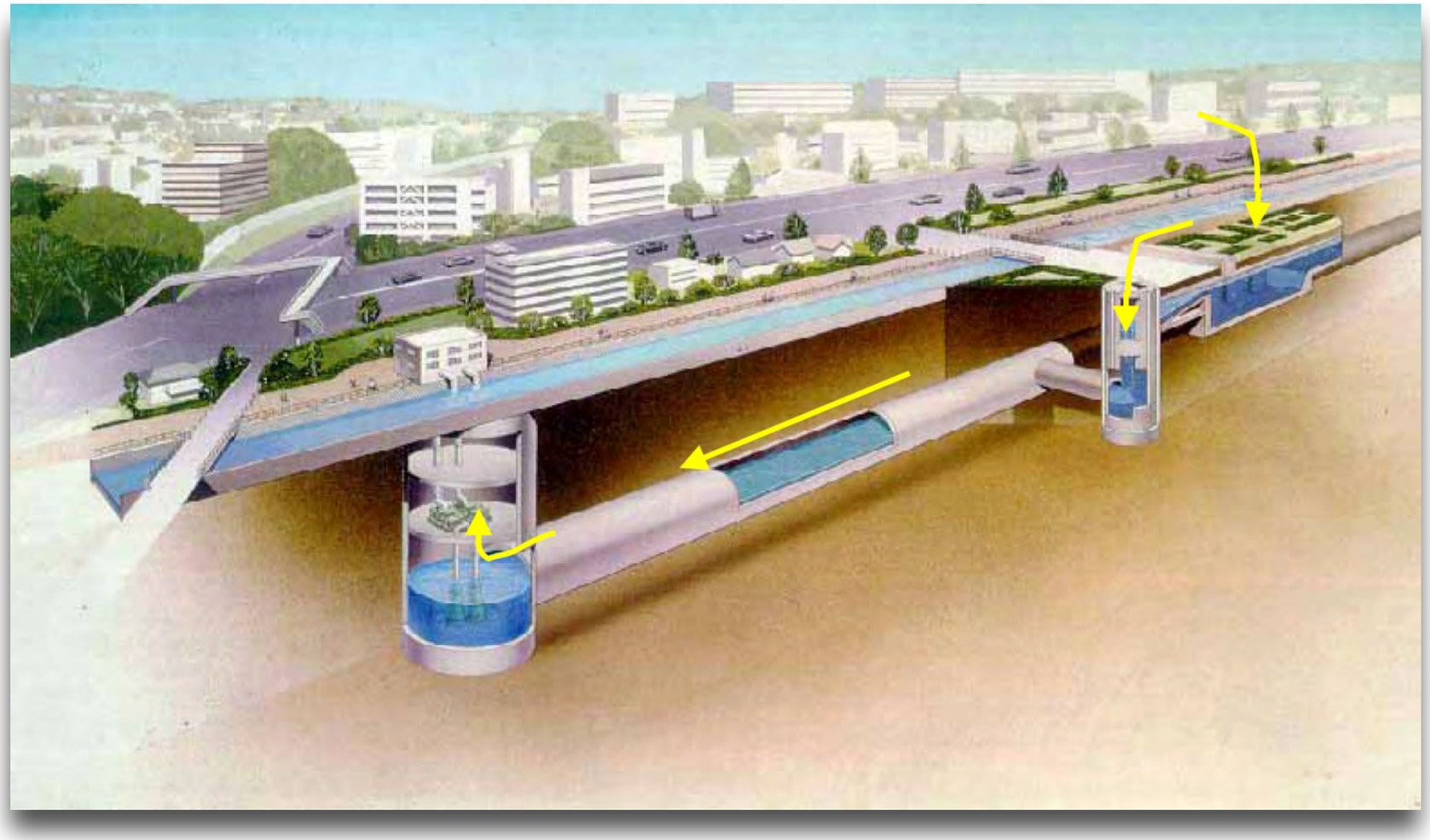
Water

Coping with excess rainfall due to climate change effects

- Ensuring no uncontrolled flooding of underground structures
- Purposeful flooding of underground structures
- Collection basins beneath underground car parks
- Purpose built underground rivers (Japan)
- SMART concept Kuala Lumpur, Malaysia

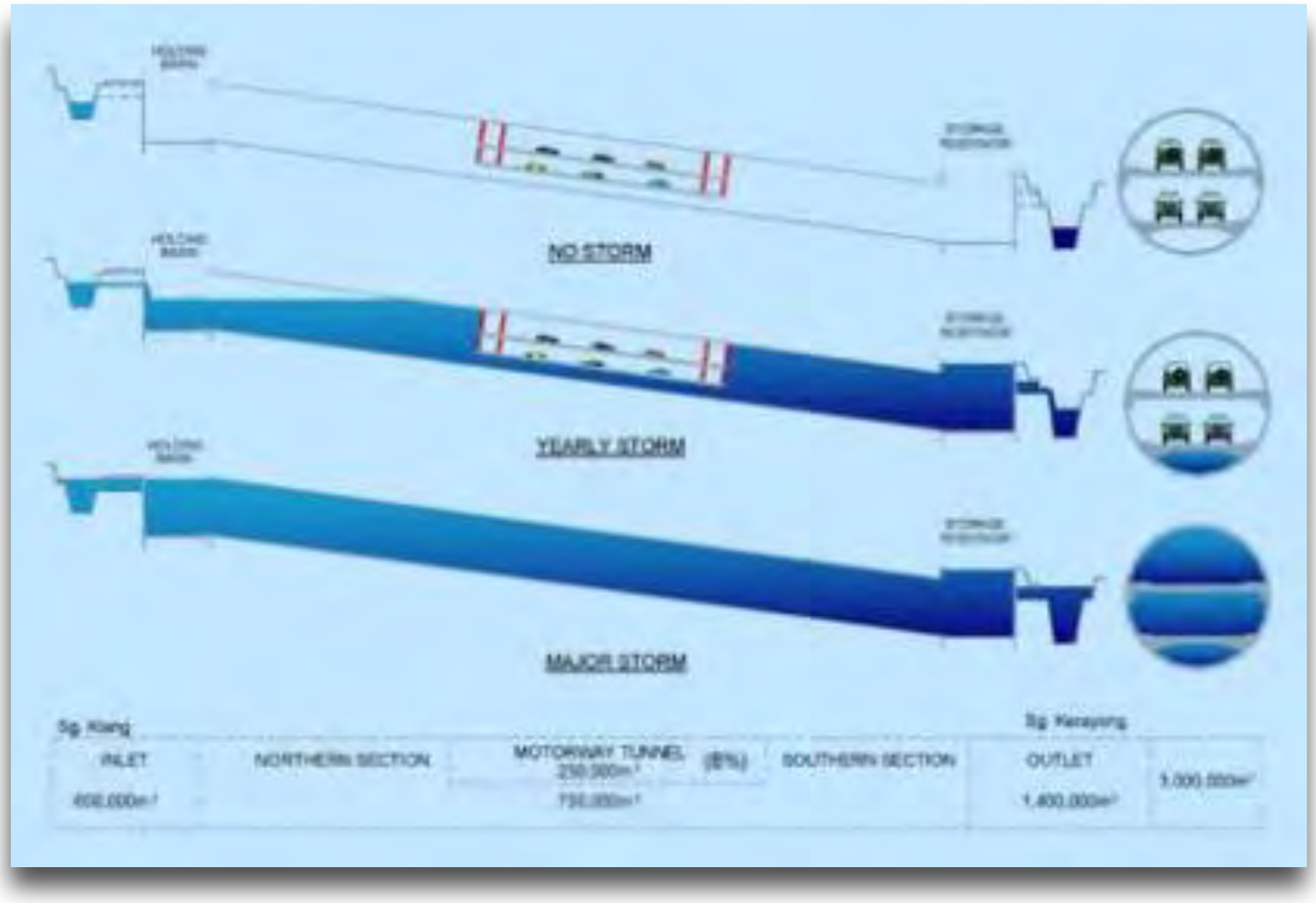
Water

Water retention project Yokohama, Japan



Water

Stormwater Management and Road Tunnel, KL, Malaysia



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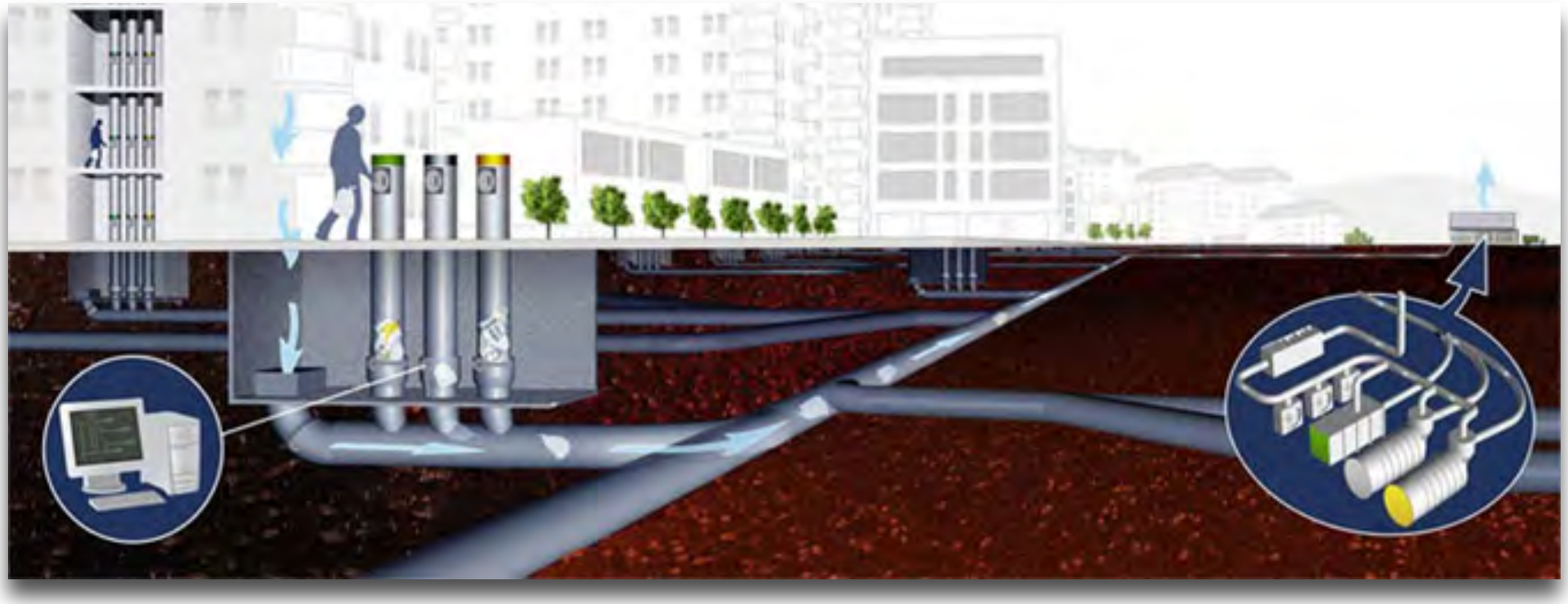
Waste

Underground Sewage Treatment Plant, Rotterdam, Netherlands

Waste

Urban Underground Waste Disposal System



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Better City, Better Life

- Underground Space has enormous potential
- Contributes to Urban Sustainable Development
- Contributes to Resilient Cities
- Potential of Zero Impact (land-use, buildings, energy)

What we need to avoid

Who decides what goes where and when?

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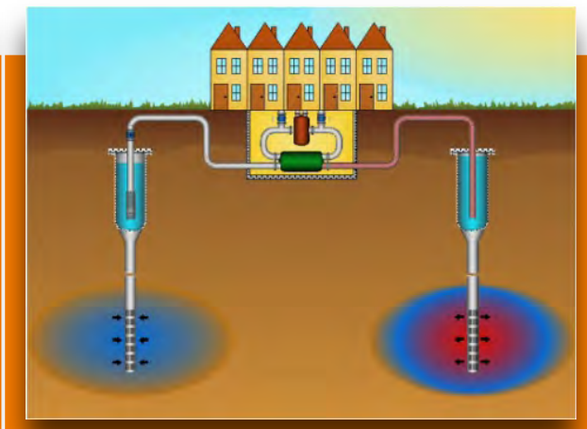
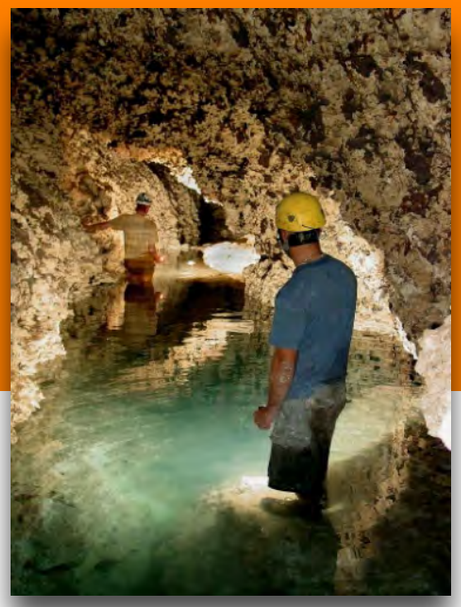
Vision on Underground Space Use





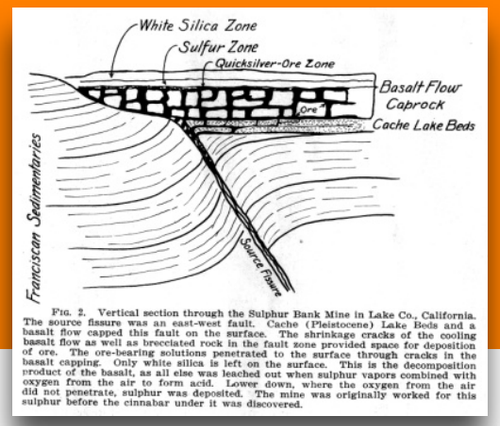
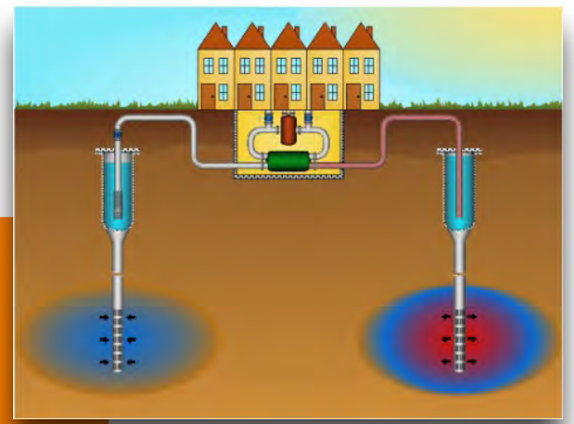


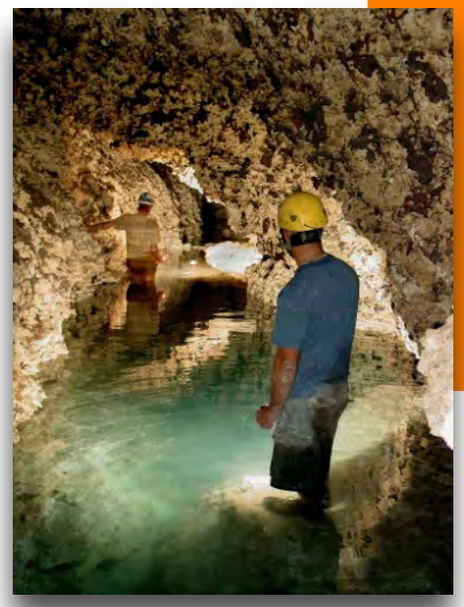
FIG. 2. Vertical section through the Sulphur Bank Mine in Lake Co., California. The source fissure was an east-west fault. Cache (Pleistocene) Lake Beds and a basalt flow capped this fault on the surface. The shrinkage cracks of the cooling basalt flow as well as brecciated rock in the fault zone provided space for deposition of ore. The ore-bearing solutions penetrated to the surface through cracks in the basalt capping. Only white silica is left on the surface. This is the decomposition product of the basalt, as all else was leached out when sulphur vapors combined with oxygen from the air to form acid. Lower down, where the oxygen from the air did not penetrate, sulphur was deposited. The mine was originally worked for this sulphur before the cinnabar under it was discovered.

Vision on Underground Space Use

Space

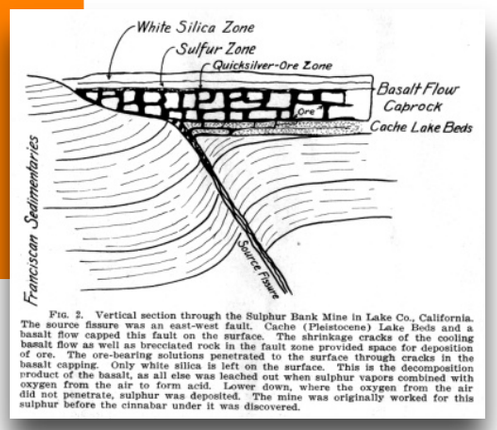
Geo-energy





Groundwater

Materials



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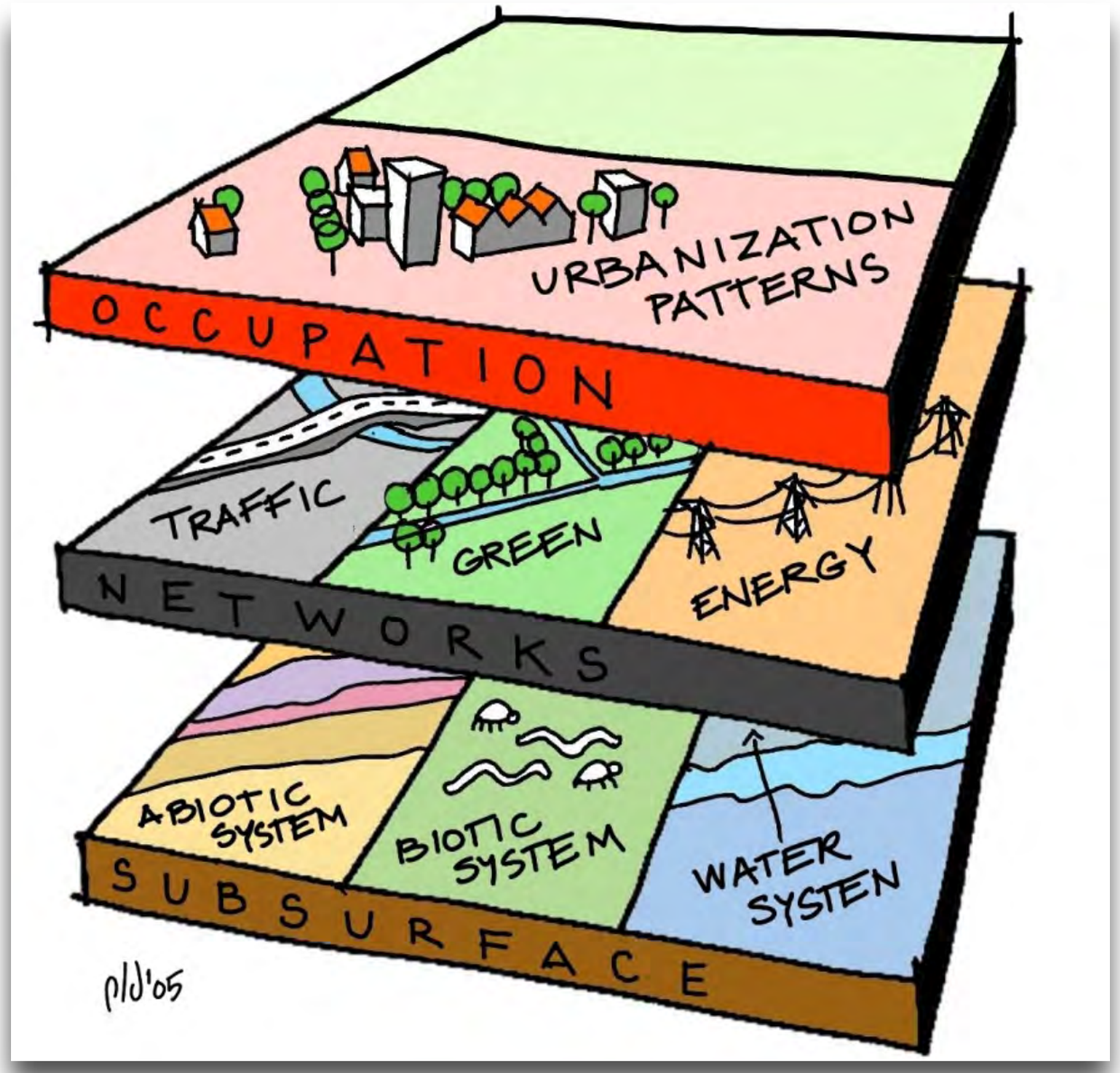
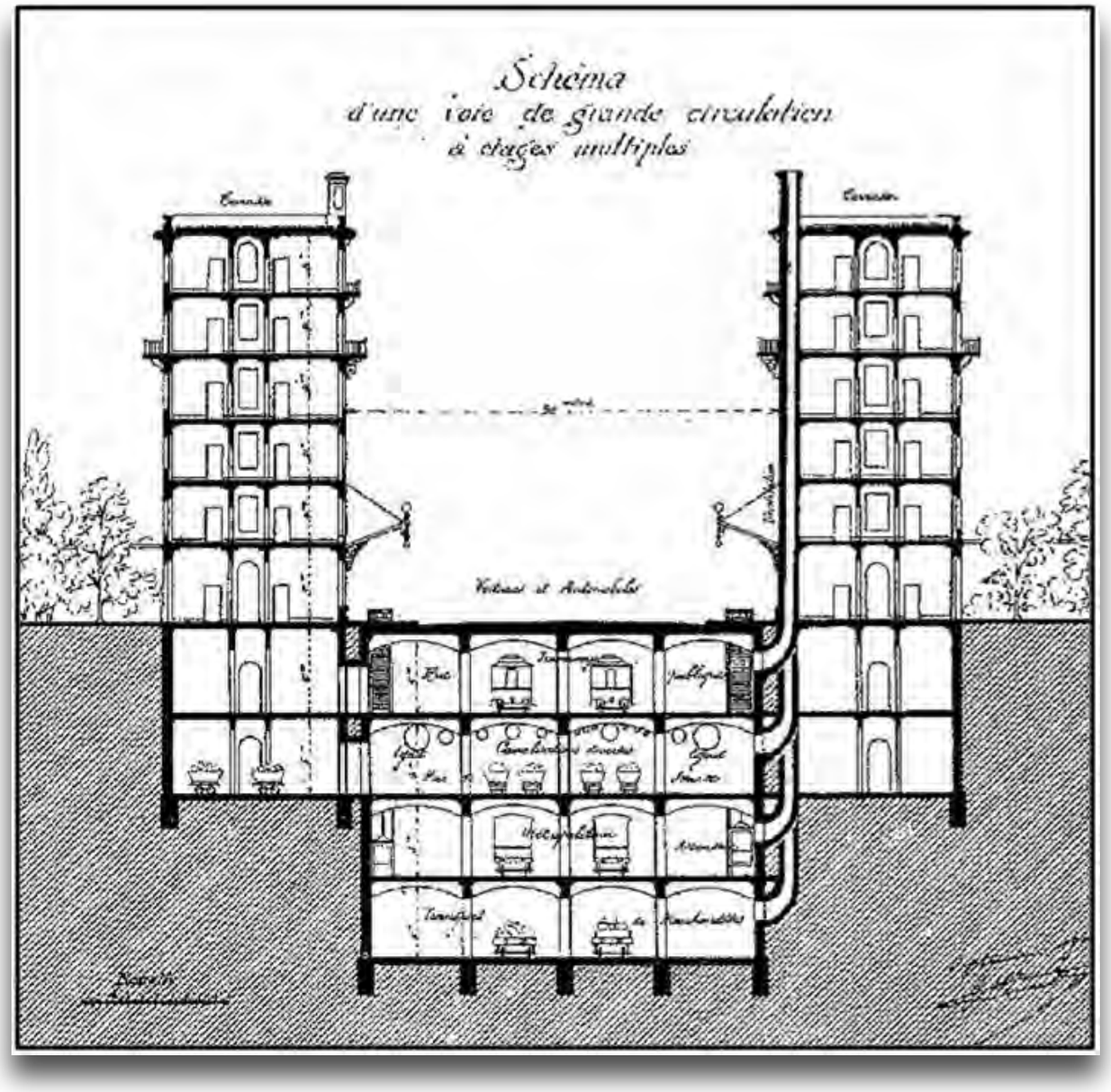


Planning Underground Space



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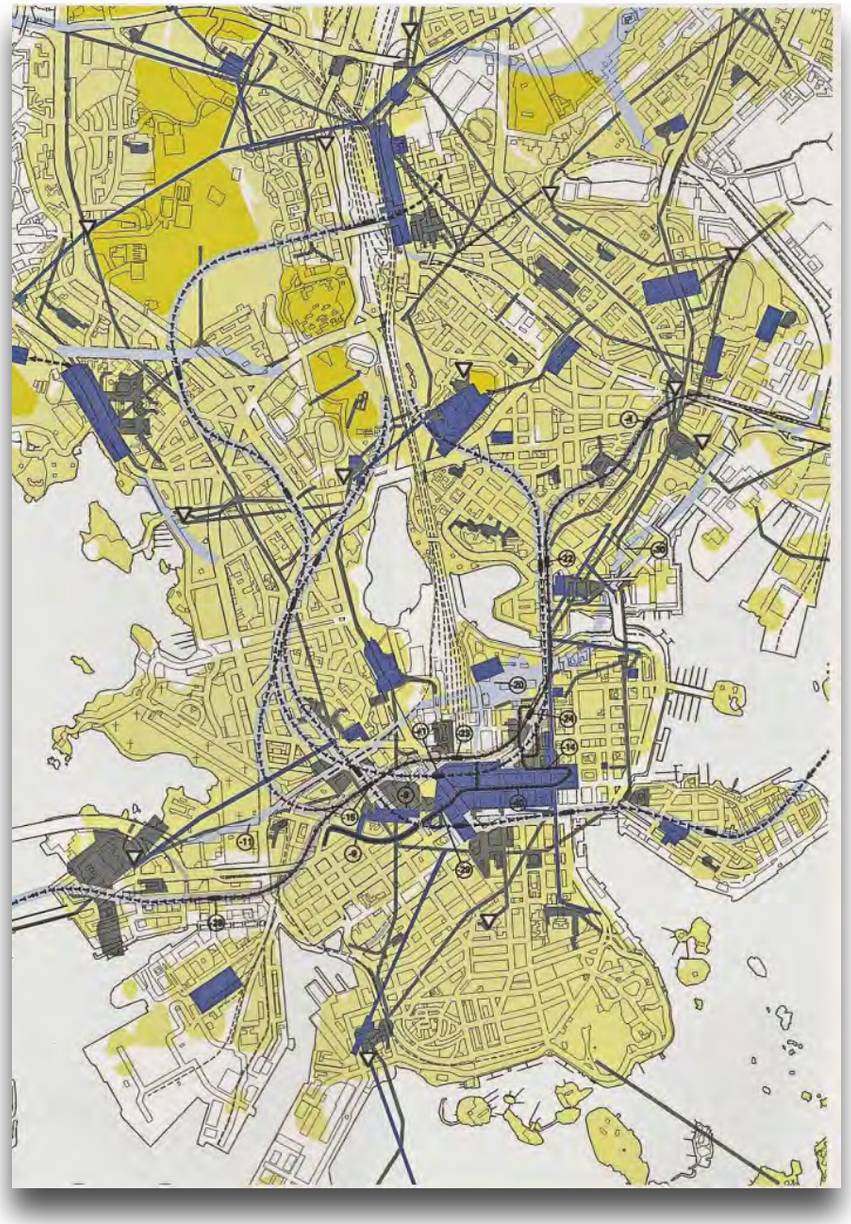
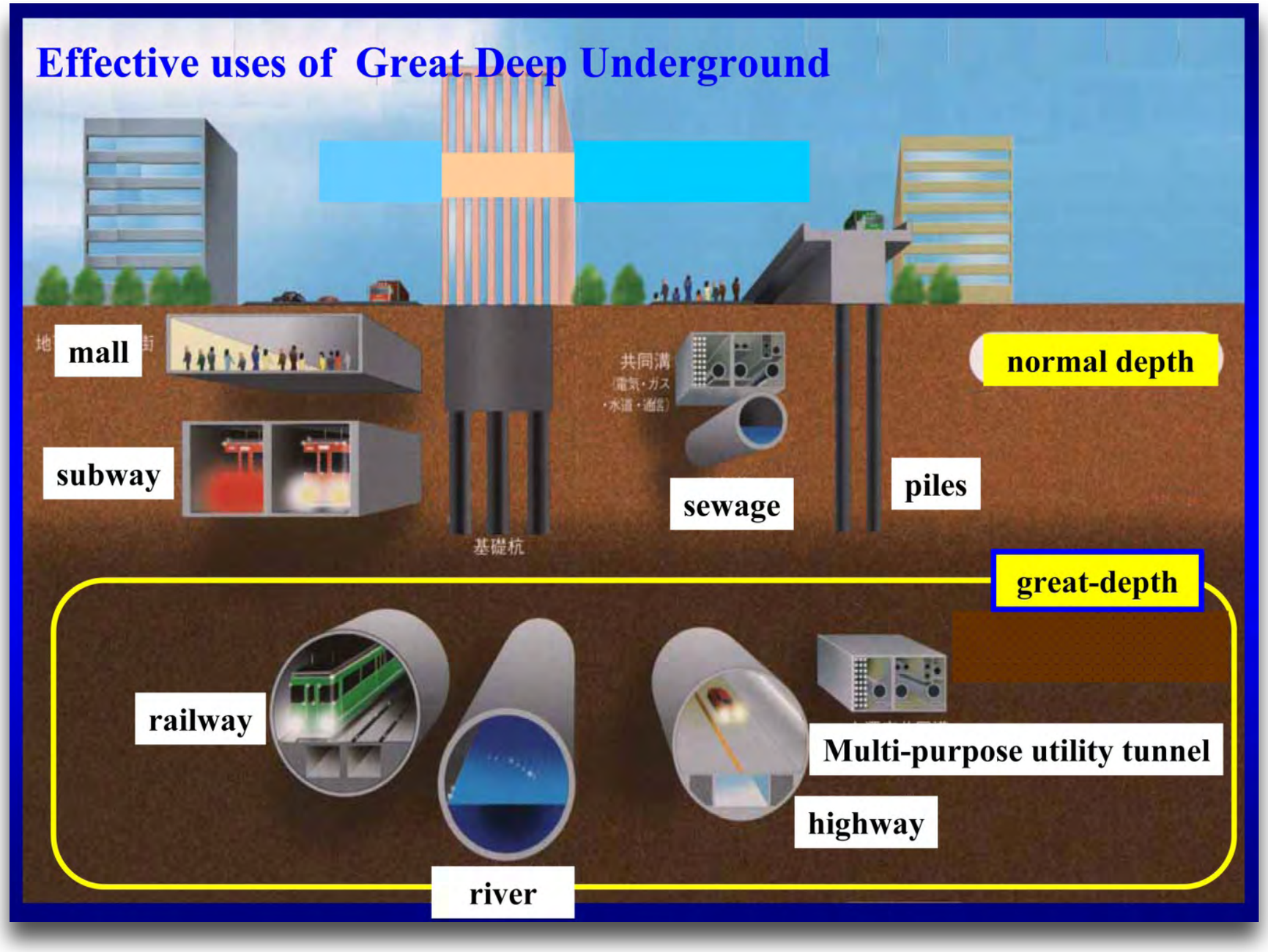


Planning Underground Space



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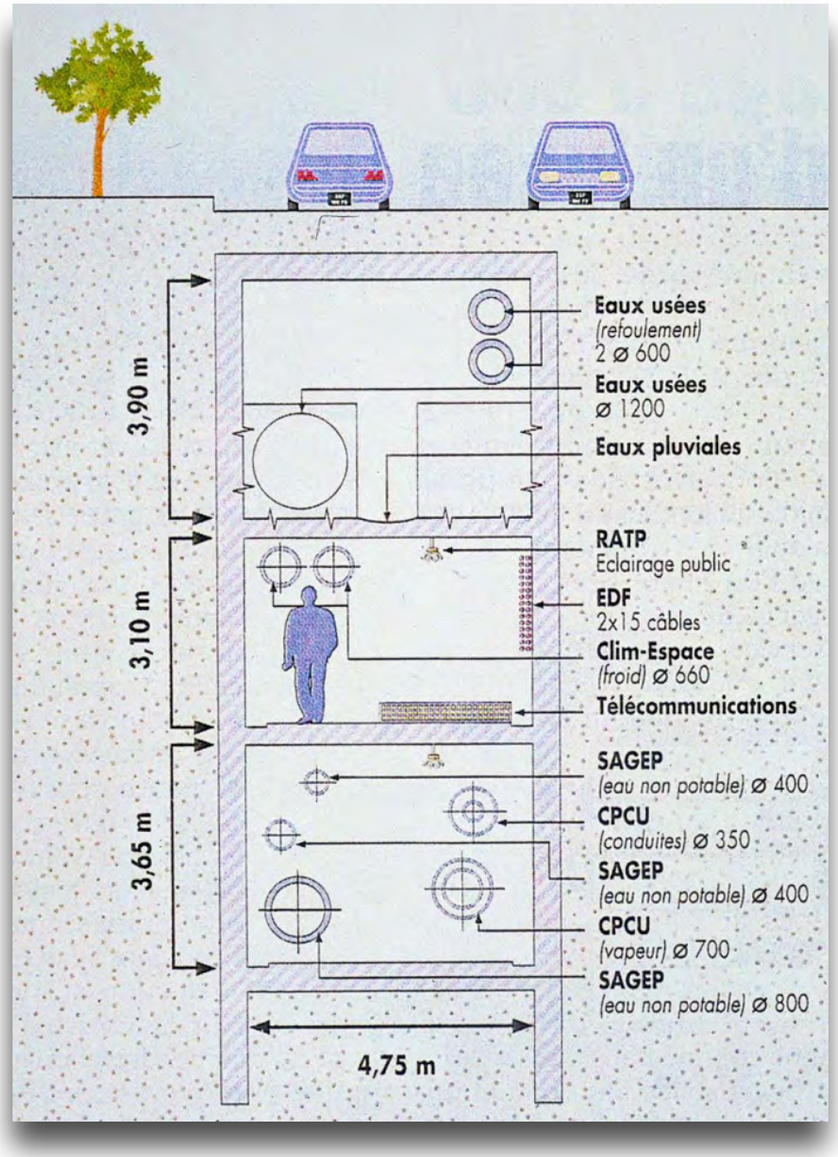
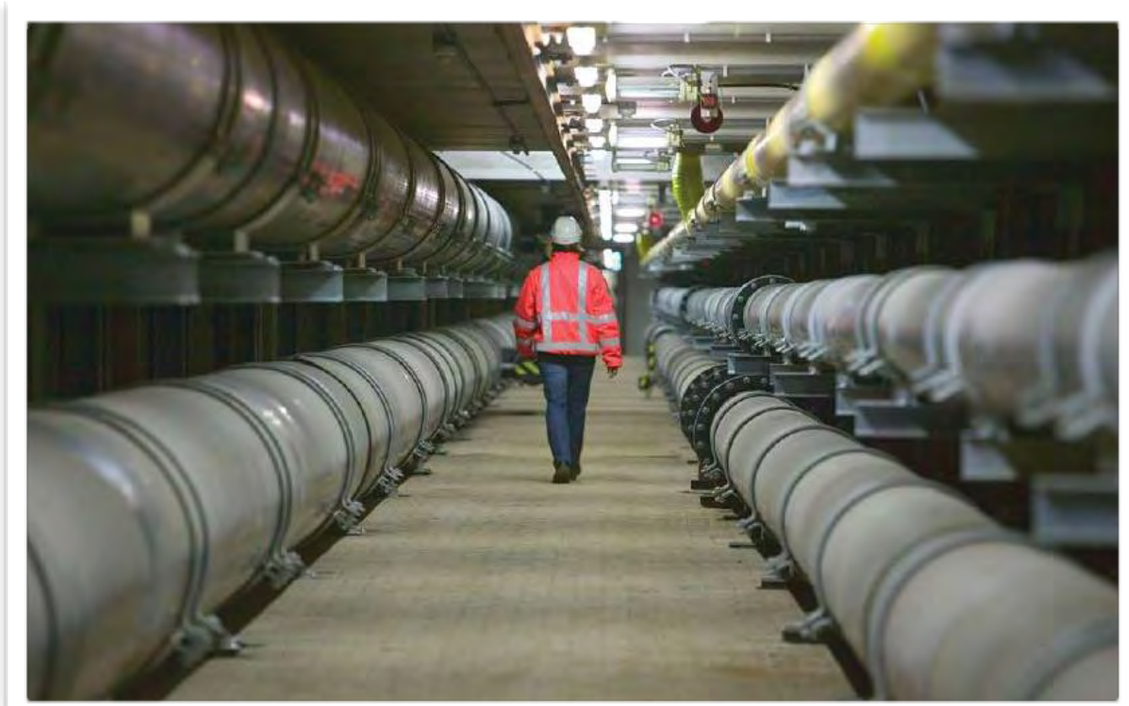
Integration of Concepts





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Integration of Concepts

- SMART concept: integrating Stormwater Management and a Road Tunnel (Transport and Water)
- Combining Underground Waste Disposal Systems with City Heating projects
- Building tunnels which are multi-functional in use, emit clean air and deliver energy for the urban neighbourhood

Creating Better Life

ITA Committee on Underground Space

- Connecting with Global Partners
  - IFME
  - ISOCARP
  - ICLEI
- Produced three White Papers on Underground Space
- Preparing White Paper and Technical Notes for UN-ISDR

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ITACUS White Papers

itacus
White Paper

Underground Space: Q&A

Worldwide there is a quest for more urban space. A quest that is driven by the fact that now more than half the world's population lives in urban areas. Maintaining liveability in urban areas is proving to be a major challenge for city governments. But also keeping the city moving and thereby supporting the local economy is proving to be an enormous task. How does the use of underground space fit in? Can the use of underground space really help in solving these problems? Seven vital questions on the use of underground space are discussed in this white paper. The one all encompassing question seems to be: can you really afford not to use underground space?

Why is the development of underground space important?

"Population growth and the advent of mega cities are increasing the pressure on sensitive areas. The underground has enormous potential for realizing spatial benefits. You could say that one of the greatest challenges facing mankind is to achieve higher density while at the same time improving urban existence."

Lord Norman Foster
British Architect

The development of underground space is important for cities because the spatial planning of infrastructure and buildings is becoming more and more difficult in urban areas. Underground Space provides new spaces for infrastructure, services & utilities without claiming valuable space on the surface. The result is that cities keep their valued public spaces.

A tunnel in hard rock preserves a historic monument in Monte Carlo, Monaco

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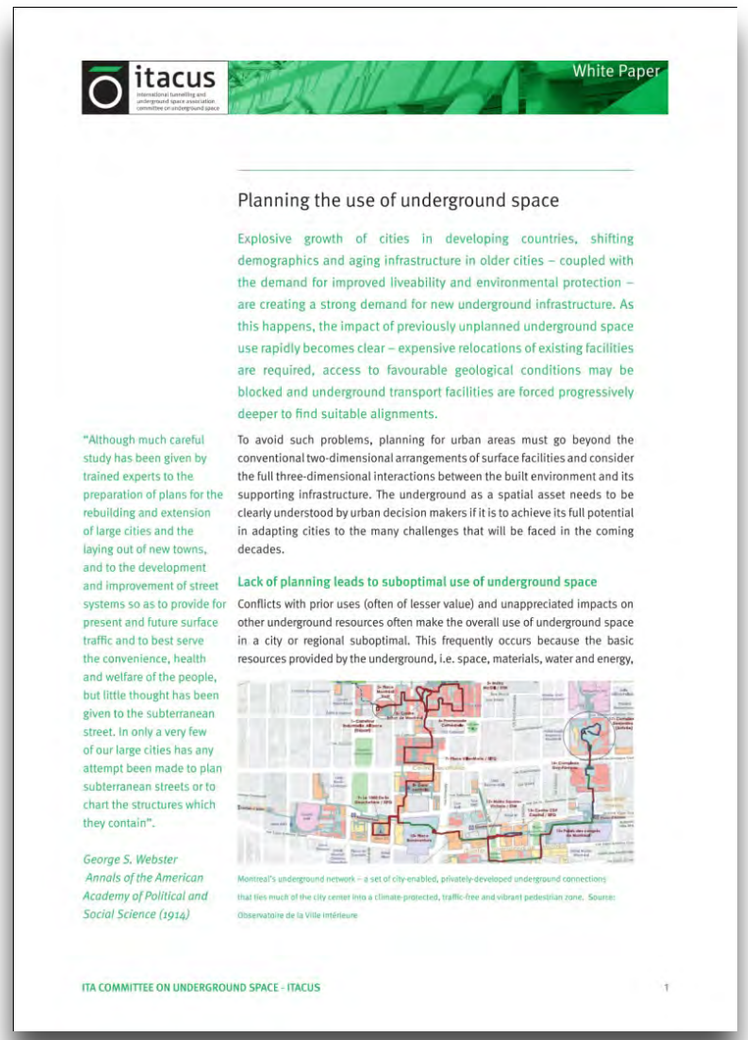

itacus
White Paper

Planning the use of underground space

Explosive growth of cities in developing countries, shifting demographics and aging infrastructure in older cities – coupled with the demand for improved liveability and environmental protection – are creating a strong demand for new underground infrastructure. As this happens, the impact of previously unplanned underground space use rapidly becomes clear – expensive relocations of existing facilities are required, access to favourable geological conditions may be blocked and underground transport facilities are forced progressively deeper to find suitable alignments.

"Although much careful study has been given by trained experts to the preparation of plans for the rebuilding and extension of large cities and the laying out of new towns, and to the development and improvement of street systems so as to provide for present and future surface traffic and to best serve the convenience, health and welfare of the people, but little thought has been given to the subterranean street. In only a very few of our large cities has any attempt been made to plan subterranean streets or to chart the structures which they contain".

George S. Webster
Annals of the American Academy of Political and Social Science (1914)

To avoid such problems, planning for urban areas must go beyond the conventional two-dimensional arrangements of surface facilities and consider the full three-dimensional interactions between the built environment and its supporting infrastructure. The underground as a spatial asset needs to be clearly understood by urban decision makers if it is to achieve its full potential in adapting cities to the many challenges that will be faced in the coming decades.

Lack of planning leads to suboptimal use of underground space

Conflicts with prior uses (often of lesser value) and unappreciated impacts on other underground resources often make the overall use of underground space in a city or regional suboptimal. This frequently occurs because the basic resources provided by the underground, i.e. space, materials, water and energy,

Montreal's underground network – a set of city-enabled, privately-developed underground connections that ties much of the city center into a climate-protected, traffic-free and vibrant pedestrian zone. Source: Observatoire de la Ville Intérieure

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White Paper

Sustainable Urban Underground Development

More than half the population of the world now lives in urban areas and the expectation is that this figure will grow rapidly in the next decades – reaching 70% in 2050. Modern cities worldwide need to cope with this rapid urbanization while at the same time protecting these large concentrations of people from natural disasters and the effects of climate change.

"Sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs."

Report of the World Commission on Environment and Development (Brundtland 1987)

The creation of sustainable urban areas with the resilience to survive natural disasters and the effects of climate change through urban resilience-building, will be critical for urban planning and engineering in the coming decades. This White Paper will explore these themes and the contribution and impact of underground space use to achieving sustainable urban development and creating resilient cities.

The contribution of underground space

Underground space use is tied to the sustainability of an urban area because the use of underground facilities can positively impact the extent to which human occupancy of a land area affects the surface environment. At the core of concern for a sustainable use of the urban underground is the maintenance of opportunity for urban development by future generations.

The three pillars of sustainable development.

Underground infrastructure contributes to sustainability of the environment in many ways: saving natural resources, including land, water, and biodiversity; reducing air pollution (mainly in the transport sector, though also for others, such as underground sewage treatment facilities) and unnecessary visual and noise intrusion; creating opportunities for less energy use and waste generation (compact city); creating structures less impacted by earthquakes and other catastrophic events; and enhancing of overall landscape and environmental quality. Facilities placed fully underground (once constructed) do not impact the surface aesthetic and can allow natural ground surfaces and flora that maintain the natural ecological exchanges of thermal radiation, convection and moisture exchange between the ground and the air. Underground infrastructure allows a reduction of land area covered by manmade structures.

Underground structures generally have long expected lives. This due in part to the removal of many environmental exposures, but also due to the heavy

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- Underground Space Q&A
- Planning the Use of Underground Space
- Sustainable Urban Underground Development

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Concluding Remarks

- Underground Space Use can play a vital role in Urban Sustainable Development
- There still is a need worldwide for this to be recognised
- Vision and Planning are required to prevent chaos but also to ensure the sustainable use of underground space
- Not using Underground Space is non-sustainable, using it without planning is also non-sustainable
- Can we really afford not to use Underground Space?