

# Urban Underground Space in a Changing World

🕒 Delivering

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🕒 Planning

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🕒 Deciding

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#01

# The ITA Global Perspective Programme

## Urban Underground Space in a Changing World

### Changing World – Major Challenges

The world today is facing many challenges. One of these is that the world's cities will need to accommodate 6 billion people by 2050. This is in 38 years' time. By 2050 it is estimated that 70% of the world's population will live in urban areas. This fact alone poses a major challenge for urban planners. Imagine the world's population now, all living in cities. This is what the figure of 70% in 2050 represents. Rapid urbanisation is one of the world's major challenges. Natural disasters and the changing climate are the second major challenge facing the world. The effects of climate change, notably as freak weather occurrences, are a recurring global phenomenon. This has enormous impact on mega cities. Earthquakes, tsunamis, major storms and flooding on a massive scale, are threatening the fabric of society and cause massive disruption. Cities need to learn to cope with this challenge and ask themselves how resilient they are to such events.

### How is the World Meeting these Challenges?

Both of the above challenges have been identified by the United Nations as major issues that require policies and action at a global level. UN Habitat is running the World Urban Campaign which has the theme 'Better City, Better Life'. The basis of this programme is not only to raise awareness but it is also a true call to action. It requires engaging the public at large, the civil society, the business sector, the research community and governments in a global movement. The campaign includes a vision of what sustainable urban development requires.

Sustainable urban development calls for resilient cities. This is one of the programme objectives of UNISDR, the International Strategy for Disaster Reduction. It asks cities to consider and prepare for natural disasters. It also asks cities to plan for these events. As cities face the task of climate change adaptation, creative thinking is required. Contemporary solutions no longer provide the answers.

We need to demonstrate that change is possible through the genius, creativity and audacity of people and decision-makers to make the wisest choices for our urban future. This is the essence of the World Urban Campaign.

*Joan Clos – United Nations Under-Secretary-General, Executive Director of UN-Habitat*



Unless we act now, we will see more and more disasters due to unplanned urbanization and environmental degradation. And weather-related disasters are sure to rise in the future, due to factors that include climate change.

**Margareta Wahlström** – *Special Representative of the UN Secretary-General for Disaster Risk Reduction*

Desolation after tsunami hits Natori, Miyagi Prefecture, Japan in 2011



## Can Underground Space Contribute?

During the ITA Global Perspective Open Session 2011 in Helsinki, the Deputy Director of UNISDR, Helena Molin-Valdes, pointed out the virtues of the SMART concept in Kuala Lumpur. The Stormwater Management and Road Tunnel is a prime example of how an underground solution can contribute to both rapid urbanisation and city resilience. The tunnel not only prevents flooding but also contributes to solving urban traffic congestion.

During the same session it was also pointed out that underground structures are less susceptible to the effects of earthquakes than surface structures. A special report on the effects of the Japan earthquake and tsunami of 2011 clearly illustrated this point.

Underground space can contribute to the major challenges which the world is facing. The ITA Global Perspective programme is aiming to develop the possibilities. First by advocating the ITACUS approach of creating awareness, building a vision and then planning the use of underground space. Secondly by demonstrating how the use of underground space can be part of sustainable urban development. Thirdly by partnering with international professional bodies in the field of planning, deciding and delivering the different options to achieve this.

## The ITACUS Approach

The ITA Committee on Underground Space (ITACUS) is committed to creating worldwide awareness on the many possibilities and advantages of underground space use. The use of underground space is placed within sustainable urban development. Building a vision on and planning how to use a city's underground space is essential.

Not considering underground space is in itself non sustainable. It ignores a valuable societal asset leaving it unused as a possible solution to the major challenges cities face. Using underground space without vision and planning, results in chaos and is also non sustainable.



### The ITA Global Perspective Programme

The ITA Global Perspective Programme is run on behalf of ITA by the ITA Committee on Underground Space – ITACUS. It consists of the following seven programme tracks.

- To organise three concurrent ITA Open Sessions dealing with the key issues of planning, deciding and delivering sustainable urban development (2011-2013)
- To call to action ITA Working Groups, ITA committees and ITA Member Nations to join a global dialogue on how underground space can contribute to the major challenges the world is facing
- To reach out and develop continuous co-operation with the Global Partners: IFME, ISOCARP and ICLEI
- To develop a policy document on how underground space can contribute to sustainable urban development for UN-Habitat and UNISDR consideration
- To organise an ITA Grant Scheme for students of urban planning in conjunction with ITACET
- To further develop the ITA Global Perspective as an initiative to identify companies worldwide that are committed to the aims of the programme
- To hold annual or bi-annual summit meetings with urban leaders to further enhance the Global Perspective and as part of an on-going commitment of ITA to the two UN partner initiatives

# ITA Global Perspective Open Session 2011 – Helsinki

Delivering Better and Resilient Cities – by *Shani Wallis*

## Key Insights

An eyewitness report of the catastrophic aftermath of the earthquake and tsunami that hit the east coast of Japan in March 2011 acted as a powerful focus for the purpose of the ITA WTC 2011 Global Perspective Open Session in Helsinki.

Another contribution threw down the gauntlet to the tunnelling community. Helena Molin-Valdes, the Deputy Director of the United Nations International Strategy for Disaster Reduction (UNISDR), challenged the association of tunnellers to join a mission to influence the design and development

of modern cities that are capable of withstanding the consequences of natural and man-induced disasters as well as the threatening effects of climate change. After describing her visit to the iconic SMART stormwater management and road tunnel in Kuala Lumpur, as an example of modern, multi-purpose underground urban development, Molin-Valdes said: “We need you. Disasters are on the rise and these events lead to loss of life and livelihoods. We need you to engage with us to share knowledge and present the reality of tunnelling and underground space engineering as part of the solutions for developing resilient cities.”

Organised by the ITA’s Committee on Underground Space (ITACUS), and presented under the 2011 theme of Delivering Better and Resilient Cities, these were two of five ‘insight’ presentations that established the framework on which discussion and forum participation was based. Han Admiraal, as Chairman of ITACUS, explained in his presentation that now is the time for the tunnelling industry to demonstrate to the world its importance in helping address the challenges that the planet is facing. He said: “We have to turn our passion for tunnelling and underground space into a global responsibility towards sustainability and resilient cities as a justification for the work we do.”

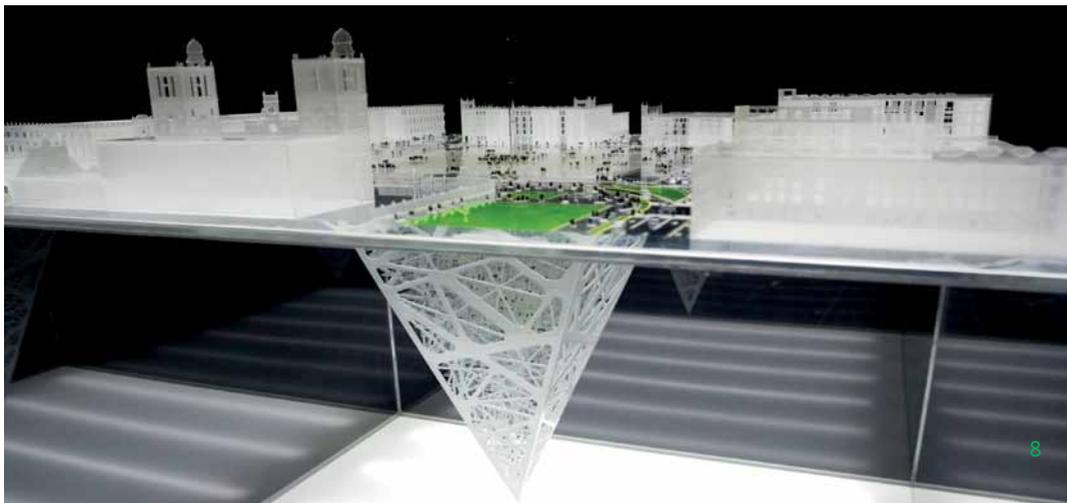
In advancing its Global Perspective, ITACUS will work with three international organisations that have the development of sustainable and resilient cities as their core concern. The first is the International Federation for Municipal Engineering (IFME), which joined the ITA Open Session in Helsinki. The Federation was formed in 1960 as part of the UNESCO organization, and today has more than 20 member nations. Through its mission of fostering continued improvement in the quality of public works and wider community

services, the IFME and its members will contribute much to the Global Perspective Programme. In Helsinki, Dan-Henrik Långström, President of the Finnish Association of Municipal Engineering, confirmed the involvement of the IFME and signed a Memorandum of Understanding with ITACUS to seal its commitment to the Global Perspective Programme.

The second Global Partner organisation is the International Society of City and Regional Planners (ISOCARP), which joins ITACUS for the Global Perspective 2012 Open Session in Bangkok.

In 2013, ICLEI, the Association for Local Governments for Sustainability, and its large membership of decision makers, will join ITACUS to discuss the programme theme Deciding Better and Resilient Cities in Geneva.

Through its consultative non-governmental status with the United Nations (UN) since 1987, the ITA (International Tunnelling and Underground Space Association) has also entered into partnership with two UN bodies – the International Strategy for Disaster Reduction (UNISDR) and the UN-Habitat Human Settlements Programme.



## The Earthscraper

A 65-story-tall skyscraper buried under Mexico City

Changing our cities, through genius, creativity and audacity is what Joan Clos, the Executive Director of UN-Habitat, calls for. In searching for examples of this in the field of Underground Space Use, ITACUS found the Earthscraper project. The Historic Centre of Mexico City is in desperate need of a pragmatic make-over. New infrastructure, office, retail and living space is required but no empty plots are available on the surface. Legislation prohibits demolishing historic buildings and height regulations limit new structures to eight stories. Given these challenges, the Earthscraper is the skyscraper antithesis in a historic urban landscape where high-rise building is forbidden and the preservation of the built environment is seen as essential. The Earthscraper is an inverted pyramid with a central void to allow all habitable space underground to enjoy natural light and ventilation.

Both organisations share a mandate to address the global issue of mass migration to mega cities, urbanisation and the resilience of modern cities to cope with natural disasters and the affects of climate change. A principal aim of the three-year Global Perspective initiative is to present a policy document, which will be supported by the city planners, city governments and city engineers represented internationally through ISOCARP, ICLEI and IFME, and have that policy document adopted by the two UN partners.

Guest speakers and presenters of the other insight presentations in Helsinki described how they encounter the use of underground space in their day-to-day professional lives.

Hannu Penttilä, Deputy Mayor for City Planning in Helsinki, described the network of underground space beneath the streets of Helsinki and explained how more underground development is being planned. Helsinki is the first city in the world to adopt an Underground Masterplan as part of its urban development policy. This is facilitated, explained Penttilä, by the fact that 60% of land in the city is owned by the local government and that the city is built on solid granite which is highly

favourable for excavating cost-effective underground facilities.

Jacques Besner, an independent consultant from Canada and former Secretary-General of the Associated Research Centres for the Urban Underground Space, was allied closely with the development of 32km of underground space in Montreal. Work that started in 1962 now links 62 buildings, and Besner described how much of the network was financed by private finance through PPP (public private partnerships). He explained the importance of determining exactly who owns the environmental space of the project, describing how an incidence of surface settlement resulted in a court case to decide ownership of the subsurface space and the responsibility therefore to deal with the settlement damage on the street. He spoke about how a relatively minor initial situation became a much greater problem by being left unresolved for several months.

Andis Kublacovs, Manager of the Northern Transport Corridor Project for the City Council of Riga in Latvia described the development of €1 billion city ring road highway project, and how an immersed tube is being developed for the river

crossing instead of a less costly high level bridge. This is in order to preserve the landscape of the city, which is the largest UNESCO World Heritage site. At another part of the project, a bored tunnel, although 40% more expensive than a surface alignment, has been supported by a citizens' vote to avoid splitting the community. The alignment goes deep beneath a cemetery, and although there has been understandable concern about the potential damage construction of a tunnel might cause, local residents have seen fit to trust the tunnelling industry.

"Latvia has no expertise or experience in building tunnels and visiting experts have assured us that there will be no affect at all on the cemetery," said Kublacovs. "We must trust them."

It was the presentation by Prof Tetsuya Hanamura (retired) of Okayama University in Japan, that gripped the attention. The devastation suffered by the city of Sendai and the 20 other towns and cities along a 600km stretch of Japan's east coast after the earthquake and catastrophic tsunami was described after his own visit to the stricken area. Prof Hanamura (who is also a member of the ITACUS Steering Board) explained that 25,000

people died or were missing as a result of the disaster but that it was the tsunami that caused most destruction.

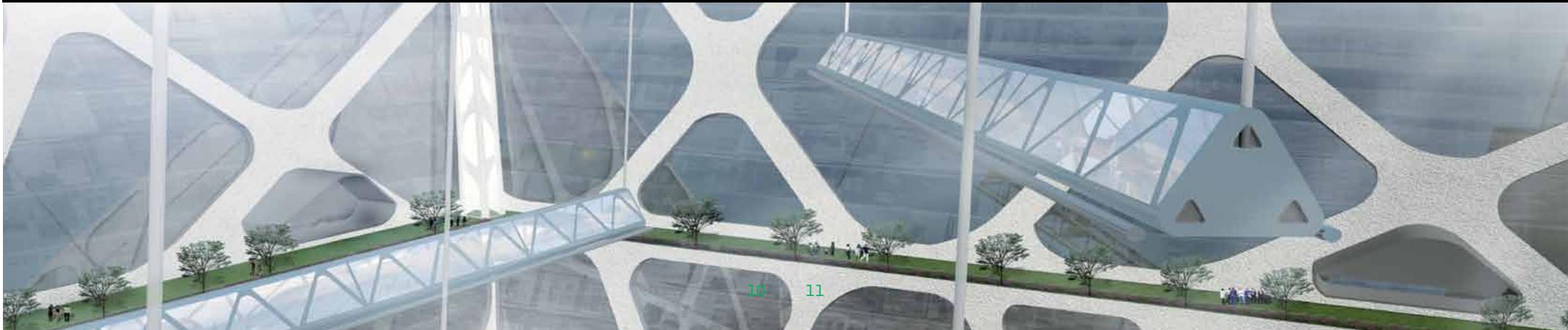
"Although a very large magnitude 9 event, earthquake damage was small compared to the wreckage of the tsunami. Most loss of life was due to drowning and while many surface buildings were swept away by a wall of water, with run-up heights of 10m and 15m at the highest, there was little or no structural damage to underground infrastructure."

He reported that liquefaction had caused damage to the Sendai sewage treatment plant, but that damage to utility tunnels was minimal and that both water supply and sewerage systems were either unaffected or restored quickly.

Electricity and shallow gas supply lines were damaged badly but the underground LNG (liquefied natural gas) storage facilities in the area were safe.

"There was no damage to the subway or railway tunnels in the area, at all, and the road tunnel at the Sendai Airport was only flooded."

**The Earthscraper** – The core is largely made of glass to ensure that all parts of the building receive natural light



The gravest consequence of the disaster was the meltdown of the reactors at the Fukushima Daiichi nuclear power plant. A tsunami wave of 15m swept over the 5.7m seawall and completely flooded the plant.

The loss of electricity knocked out the cooling seawater systems for the reactors, which then overheated, failed and released disastrous radiation into the atmosphere. Prof Hanamura raised the suggestion that all of this might have been avoided had the power plant been built underground.

"Approximately 2,000 nuclear test explosions have been conducted underground and apart from some incidents in the early stages, no significant escape of radiation material has occurred as a result", he said.

"Maybe after the current disaster recovery, the option for building underground nuclear power plants can begin."

### Discussion forum

During the open discussion, cost, funding and procurement of underground facilities were central topics.

Jacques Besner explained how the PPP model of delivery had come under much criticism. How to oblige private companies to integrate the underground space and connect it all together was another of his concerns.

"In one instance in Montreal the City had to rent the public space back from the developer to keep it open and maintain access to the metro station for the full operation time of the metro. So it was not a case of selling off public space but of renting it back. There were also issues of deciding who is responsible for maintenance of the structures; the developer or the municipality."

Several agreed that, in general, the public is unaware of being underground when in subsurface public malls and shopping arcades, providing the spaces are well lit and clean. In Montreal the City has organised art exhibitions in its underground space, and an annual half marathon through the network of pedestrian corridors attracts the public to a vibrant part of the city.

In Riga Andis Kublacovs said that the general public are in favour of tunnels but have asked questions about rising sea levels and other safety issues.

"Communication to allay the fears and worries of a community new to tunnels and underground space environments is a key issue", he said.

Another call by Harold Wagner of Austria was for traffic segregation into inner cities with a network of small-diameter TBM tunnels built to transport freight in and waste out using remote controlled trains.

"This would reduce the time and energy wasted in traffic congestion on the surface and would save about 15c/km on current delivery methods. This might not sound like much but it would add up and provide a return on investment very quickly," he suggested.

In her video link from Geneva, Helena Molin-Valdes made the same point about the SMART tunnel in Kuala Lumpur.

"The report was that in the three years since the tunnel opened, the project has been paid back in just the amount of non-losses of the flooding events that it has prevented. This is powerful data for us to use in the promotion of underground projects."

Nick Barton, a professor of rock mechanics in Norway and Brazil, suggested that going deeper with longer tunnels into bedrock might be cheaper than selecting shorter shallower tunnels in softer overlying soils.

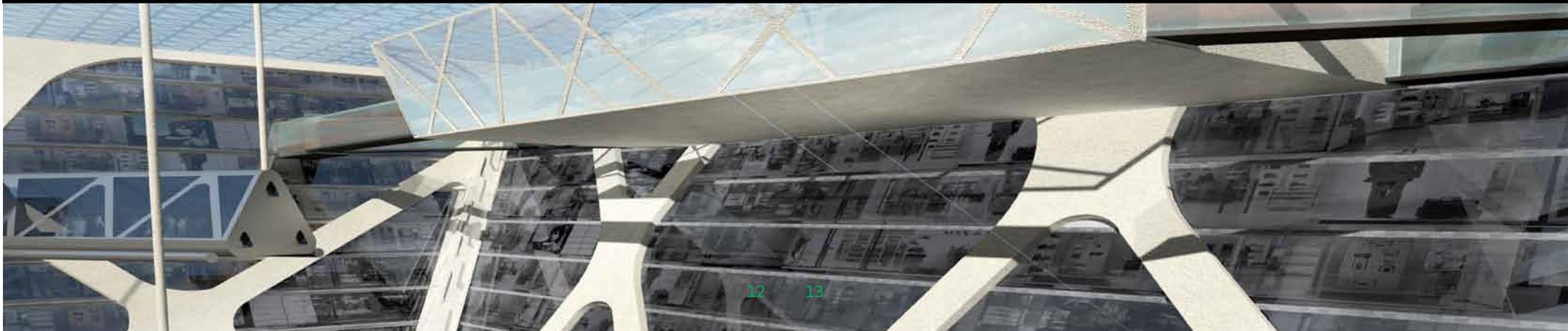
"Deeper tunnels in rock can be a quarter or a third the price of a shallower tunnel excavation and up to 10 times faster to complete", he said.

"If you are lucky enough to have good rock under your cities and you go deeper to maximize the advantage, the budgets can stretch further."

Martin Knights, Immediate Past President of the ITA, asked the panel of speakers if they could ever see a time when cities were forced by legislation to place public facilities underground.

"In Riga it is not increasing density of the urban space that is the issue. The city is actually losing population, and is only 1.1 million any way. Development is needed to solve parking issues in certain areas but the preservation of the cityscape and the issue of liveability on the surface is driving the preference for tunnels at the moment", said Kublacovs in reply.

The Earthscraper – A metro station serving the underground complex passes through the building



The same holds true in Helsinki. "The city is the first in the world to adopt an Underground Masterplan for urban planning, but it is not forced," said Penttilä.

"Rather education and awareness is the influencing factor. We are seeing that even in the suburbs, new housing developments are providing underground car parking facilities, for example, in order to save the green space on the surface. This is occurring without legislation."

In Montreal, Besner explained that the current 32km of underground space started with a few small tunnels to provide underpass crossings of the street and has developed without legislation from there.

In Japan, the underground is developed as part of the holistic approach to urban planning said Prof Hanamura.

"The underground is designed at the same time as the above-ground structures."

The need for co-operation between the different professions involved in urban planning was

also discussed. "We do not want engineers to become urban planners," said ITACUS Chairman Han Admiraal, "but co-operation has to be more efficient and effective for developing solutions."

That is certainly evident in Riga, according to Kublacovs, who explained how it was only architects involved in city planning in former times.

"Today lawyers and engineers and planners and the citizens themselves are all involved in development plans."

A significant point raised was that much of the discussion was about rich "pocket sized cities where we can do all that we want", said Penttilä of Helsinki.

"The real challenge is in developing countries, where resources are scarce and where cities are growing fastest. We need really brilliant planning to solve those problems."

Harvey Parker, a Former President of the ITA from the USA, raised two specific points. First the urgent need for training and education of

the engineers and workers needed in the coming years to develop, design and build the many underground projects that will be needed by the world's mega cities in the immediate future; and secondly, that planning decisions must not be made on capital cost alone.

"Life-cycle costs are as vital to the decision making processes as hard financial issues," he said. "There is going to be so much to do, we need to start planning right now."

In response Admiraal explained that ITACUS is working with the other committees of the ITA as well as with the resources of the ITA Working Groups to fully capitalise on the power of the Association to bring real possibilities and contributions to the Global Perspective Programme.

This is extended to its co-operation with the Programme's three global partners IFME, ISOCARP and ICLEI, and to its policy partners UN-Habitat and UNISDR.

### Close of Session

In closing the session Admiraal said that two points were highlighted through the session for him. One, the need to bring professionals together to work together for optimum effect; and two, that "for the first time we tunnellers had a direct link into the UN and its operations.

We heard how Helena Molin-Valdes of the UNISDR said 'we really need you to work with us'. That is a tremendous compliment to the ITA, to all of us as engineers, and a challenge for us to engage seriously and urgently in the big problems that this world is facing."

## We need your help to develop resilient cities.

**Helena Molin-Valdes** – Deputy Director of the UNISDR

**The Earthscraper** – The public areas of the underground building are expected to become a popular destination



# Global Policies

How two UN programmes are addressing some of the world's challenges

## UN-Habitat

Our mission is to promote socially and environmentally sustainable human settlements development and the achievement of adequate shelter for all.

The United Nations Human Settlements Programme, UN-Habitat, is the United Nations agency for human settlements. It is mandated by the UN General Assembly to promote socially and environmentally sustainable towns and cities with the goal of providing adequate shelter for all.

As our towns and cities grow at unprecedented rates setting the social, political, cultural and environmental trends of the world, sustainable urbanisation is one of the most pressing challenges facing the global community in the 21st century. In 1950, one-third of the world's people lived in cities. Just 50 years later, this proportion has risen to one-half and will continue to grow to two-thirds, or 6 billion people, by 2050.

Cities are now home to half of humankind. They are the hub for much national production and consumption – economic and social processes that generate wealth and opportunity. But they also create disease, crime, pollution and poverty. In many cities, especially in developing countries, slum dwellers number more than 50 percent of the population and have little or no access to shelter, water, and sanitation. This is where UN-Habitat is mandated to make a difference for the better.

## UNISDR

Our mandate is to serve as the focal point in the United Nations system for the coordination of disaster reduction and to ensure synergies among disaster reduction activities.

Created in December 1999, UNISDR is the secretariat of the International Strategy for Disaster Reduction (ISDR). It is the successor to the secretariat of the International Decade for Natural Disaster Reduction with the purpose of ensuring the implementation of the International Strategy for Disaster Reduction

Its core areas of work include ensuring disaster risk reduction (DRR) is applied to climate change adaptation; increasing investments for DRR; building disaster-resilient cities, schools and hospitals; and strengthening the international system for DRR.

UNISDR's vision is based on the three strategic goals of the Hyogo Framework for Action: integrating DRR into sustainable development policies and planning; developing and strengthening institutions, mechanisms and capacities to build resilience to hazards; and incorporating risk reduction approaches into emergency preparedness, response, and recovery programmes.

The Earthscraper – Much of the proposed building is devoted to office space



## Global Partners

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International professional bodies that help us in recognising the role underground space can play

### IFME

International Federation for Municipal Engineering

Globalisation, localisation and the knowledge revolution are three key driving forces in the world today. They also clearly come under the gamut of an international organisation such as IFME whose member organisations represent municipal and public works engineers working at a local level.

A key objective of the Federation is to foster technical and cultural exchange between municipal and public works engineers world-wide. International exchange of information, innovations, skills and experience is even more important in today's world than when the Federation was formed more than 50 years ago.

IFME's mission is to connect Municipal Engineers and Public Works Professionals, Public Agencies, Organisations, Institutions and Businesses around the world in order that they share a global pool of knowledge and experience. The aim is to foster continued improvement in the quality of public works and wider community services.

ITACUS signed a Memorandum of Understanding with IFME during the ITA Global Perspective Open Session in Helsinki in 2011. ITACUS will take part in the IFME World Congress, which will be held in Helsinki in June 2012.

### ISOCARP

International Society of City and Regional Planners

While cities of the global North face challenges of physical expansion and urban sprawl, those in the South are experiencing rapid and uncontrolled urbanisation, competing demands for land and other increasingly scarce natural resources, and air, water and surface pollution. Unsustainable urban development is a common challenge, especially in metropolises and megacities, whether in developed or the developing world.

In this context, the International Society of City and Regional Planners (ISOCARP) is working towards producing knowledge for better cities. A global association of professional planners, ISOCARP was founded in 1965 and today its network brings together individual and institutional members from more than 80 countries world-wide. The Society has a formal consultative status with UNESCO and is recognized as an NGO/professional partner by UN-Habitat and the Council of Europe.

During the ISOCARP congress in Wuhan in 2011, ITACUS held a Technical Seminar. Further co-operation between both bodies is being worked out and will focus on the Urban Planning Advisory Team (UPAT) concept with which ISOCARP is very successful.

### ICLEI

Local Government for Sustainable Development

ICLEI - Local Governments for Sustainability is an association of more than 1,220 local government members who are committed to sustainable development and who come from 70 different countries and represent more than 569,885,000 people.

ICLEI was founded in 1990 as the 'International Council for Local Environmental Initiatives'. The Council was established when more than 200 local governments from 43 countries convened at its inaugural conference, the World Congress of Local Governments for a Sustainable Future, at the United Nations in New York.

ITACUS is pursuing talks with ICLEI on further co-operation. Initial meetings were held during the World City Forum meeting in Abu Dhabi in 2011 and the Resilient City Conference in Bonn in the same year.

For ITA, ICLEI is a meaningful organisation as it brings together people who actually take the decisions on where cities are heading. Providing basic knowledge on the possibilities of urban underground space use is one approach which will be explored.

## Our Challenge • Their Future

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### Photography

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Tsunami Japan – © ANP FOTO 2012 / Picture: EPA/Stringer  
Earthscraper Project – with kind permission of BNKR Arquitectura



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**The Earthscraper** – An enormous complex planned for Mexico City, intended to get round the city's planning laws, that state that buildings can be no more than eight storeys high