

The Hidden Vulnerability of Mega-cities To Natural Disasters: Underground Spaces

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Risks associated with underground urban expansion often poorly studied; Modeling events like floods, tsunami essential to risk assessment and planning

The rapid and extensive underground expansion of mega-cities - for subways, malls, parking and public utilities - takes place often with too little knowledge of associated risks and too few plans to minimize the effects of a natural disaster, United Nations University experts warn.

With growing land pressures in cities (which contain about 50% of all people today, seen rising to 65% by 2030), creating new space underground becomes increasingly attractive. In many places, however, studies of potential natural disaster risks are often neglected, says Srikantha Herath, UNU Senior Academic Programme Officer.

"The concentration of people and wealth in such underground spaces is expanding and merits careful examination," says Dr. Herath. "Such facilities in many areas have not been used sufficiently long to be exposed to various types of extreme hazard events of low frequencies. Modeling a variety of catastrophic events is essential for building contingencies into underground infrastructure designs, including evacuations and the emergency containment and transport of flood waters, for example."

Via underground interconnections, water can travel considerable distances away from the flood source. However, there are often no subsurface maps; underground space is usually mapped in relation to a building overhead.

"It is essential to plan and construct underground space based on information such as connectivity, and to design carefully all uncovered entrances to underground spaces," says Janos Bogardi, Director of UNU's new Institute for Environment and Human Security (EHS) in Bonn. "At the same

time, underground spaces should be designed to withstand multi-hazards. For example, fire risks require planners to also include the ability to seal off and compartmentalize underground space quickly."

Underground disasters can also pose dangers to those in buildings overhead, he adds. Floor utility spaces in multi-story underground structures cannot hold large amounts of water and may collapse floors below. Ventilation ducts may also be compromised.

"The frequency of underground flooding events is surprisingly high in places," says Dr. Herath. Tokyo records, for example, show 17 incidents from 1999 to 2001, some involving fatalities despite extensive precautions. Most floods occurred in the rain and typhoon months, July to September. Many such coastal mega-cities are vulnerable to flood events given a terrible combination of conditions, such as a heavy rainfall combined with tides or sea surges caused by winds or earthquake. Global warming is predicted to make extreme rain events more frequent, he added.

The hidden vulnerability of mega-cities will be among topics under review by international experts at the World Conference on Disaster Reduction, being convened Jan. 18-22 in Kobe, Japan to mark the 10th anniversary of that city's devastating earthquake.

"Relative to geological time scales, urban development in the past century has taken place extremely fast. New urban development can take place completely oblivious to underlying risks as their existence has been too short to experience the extreme events," says Dr. Herath.

He cites the 1999 disaster in Venezuela as a vivid example: mudslides following a one-in-1,000 year rainfall devastated nine of the country's northern states. While mountain slope shantytowns were hit

worst, resorts and hotels recently built in coastal towns near Caracas -- on alluvial deposits left by previous mudslides -- were buried. Some 480,000 people were affected, 30,000 died.

People historically drawn to flood plains and the coast

In Asia, rice-growing communities flourished in alluvial plains made by extreme floods. More frequent low magnitude floods made these plains fertile with sediment deposits, attracting people. Also attractive were opportunities for fishing and trade.

"This additional productivity, however, came with inherent risks associated with natural hazards that produced these landforms," says Dr. Herath. "In these areas the coexistence of humans and nature has always been precarious - a gamble with nature - and it was prudent to keep a distance from the hazards in high-risk zones, giving enough room for extreme natural phenomena.

"However, with growing populations and urbanization, this "distance" has diminished and expansion of settlements into the risk prone areas has increased the exposure to hazards that ultimately leads to higher human and material losses."

Need move from 'fail-safe' to 'safe-fail'

Flood magnitude and frequency vary widely worldwide. Where floods are frequent, authorities typically invest in infrastructure controls, opening the door to agriculture and industrial development in usually fertile and ideally-located flood plains. This latter economic investment increases the potential loss due to flood, requiring ever-increasing control measures that make floods rarer. This process inevitably leads to a situation whereby further flood control works are too expensive while a flood which exceeds design levels would cause catastrophic losses.

Dr. Herath advocates moving from attempted "fail-safe" to "safe-fail" mechanisms in flood control.

"In other words, to make provisions to allow flood

control mechanisms to fail safely, causing minimal impacts for people and assets, in the event of a flood that exceeds design standards. This demands a major paradigm shift - accepting that complete elimination of flood risk is simply impossible, if not impossible, for many of the world's large cities developed along the fertile flood plains of coastal deltas and large rivers. Once this is accepted, the next step is to assess catastrophic flood risks and take mitigation measures, both structural and non-structural. More attention should be paid to the reduction of vulnerability and the strengthening of coping capacities."

Modeling natural disasters to assess risk

Preparing for a rare catastrophic flood is a huge challenge. Experiences of historic large floods are not necessarily passed from generation to generation. However, it is important to know how people coped in the past and what social and institutional mechanisms could reduce losses from catastrophic events.

It is therefore important to assess risk by modeling possible impacts of a catastrophic flood that would exceed the flood control design standards. Risk assessments, carried out in advance, helps cities prepare for a catastrophic flood, identifying potential human and economic losses. They can be used to initiate both structural and non-structural measures to mitigate losses, and to prepare responses.

UNU is collaborating on a computerized system to simulate the impact of natural disasters such as floods and tsunamis on urban centres, beginning in Asia. The computer simulation of a tsunami reaching the Japanese city of Owase is online at www.unu.edu/misc/wcdr.htm . The model simulates the evacuation of coastal population subjected to a tsunami impact under advance warning scenarios. Case studies of possible tsunamis in other major Asian cities will be discussed at the Kobe conference.

Meanwhile, UNU-EHS has begun work on measuring a community's vulnerability to natural disasters - assessing the physical, social, economic and environmental factors that determine the scale

and potential consequences of damages when a calamity strikes. Such an assessment will help policy makers set priorities for disaster prevention.

Dr. Bogardi says many infrastructure solutions exist to reduce the magnitude of hazards. Breakwaters, for example, spared the port of Chennai (formerly Madras), India from the worst effects of the recent Asian tsunami. He notes that tsunamis are a threat in every ocean, that the greatest such disaster in the 20th Century occurred in Italy.

"However, it is not viable, sometimes not even advisable, to try to eliminate the hazards completely. There will always be a hazard event that would go beyond the designed levels of infrastructure solutions, often creating unforeseen complications. A false sense of security could result in more damage. The emphasis should be on reducing vulnerabilities and improving coping capacities."

Says UN Under Secretary-General Hans van Ginkel, Rector of UNU: "Human existence was, and will always be, threatened by hazards of natural and man-made origin. Thus human security can be defined better as 'knowing risks' rather than 'eliminating risks'. In this context 'know risk' is a very timely theme for the preventative work being taken up today by the international community.

"The disaster along the rim of the Indian Ocean has forcefully revealed our vulnerability and lack of capacities to cope with the consequences of interlinked, multiple natural hazards. An adequate and functional early warning system could have saved many lives. But even then, public awareness of the possible hazards and knowledge of how to respond would have been crucial.

"UNU will dedicate human and in-kind resources to the rehabilitation efforts, and to building adequate knowledge base and human capacities for disaster preparedness and response."

Source: United Nations Institute

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