VIEWPOINT

Infrastructure, Technology AND RESILIENCE

by Alexander Zehnder

Cities face growing challenges from both natural and man-made sources. **Alexander Zehnder** argues that a commitment to developing and funding innovation, technical systems, environmental science, and infrastructure engineering can help localities improve their resilience. Professor Zehnder is the Scientific Director of Water Resources of Alberta Innovates – Energy and Environment Solutions in Edmonton, Canada, and Chair of the Sustainable Earth Office, Nanyang Technological University, Singapore.

Cities face a multitude of challenges. To gain access to water, cities were usually built near to streams, rivers and lakes, and often at the mouths of rivers. Many cities are thus threatened by recurring events such as floods, which destroy infrastructure, reduce the availability of clean water, and disrupt food and energy imports. As cities tend to be compact, densely populated and highly interconnected, the risks of many threats are concentrated in many cities. Fires that spread quickly destroy more wealth, while civil unrest, terrorism and earthquakes threaten lives as well as goods. Improvements in food and water hygiene and healthcare infrastructure have helped control the spread of infectious diseases in cities, but the latent threat remains, as seen from the recent outbreak of measles in Berlin, and the earlier SARS epidemic. Rapidly changing urban landscapes bring about new challenges to local leaders and the resilience of cities.

For centuries, technical systems and infrastructure have been central to the fight for resilience. In the Netherlands, which is essentially an alluvial plain, dams and dykes keep water from flooding settlements and agricultural land. Dyke building started around 1000 AD, and by 1250, the dykes had been connected to form a continuous line of defence against the sea. Further dykes were then built to reclaim land from the sea.

While the dykes were being built, the surrounding peat swamps were drained for agriculture, causing the dewatered peat to settle and sinking the ground level. This, combined with centuries-long efforts to straighten the upstream courses of several major rivers – the Rhine, Meuse and Scheldt – drastically increased flood risks in the Netherlands. Flooding was common, and in some cases, disastrous. In the 20th century, the Netherlands embarked on massive engineering projects, such as the Zuiderzee Works and Delta Works, to defend against the intrusion of waters from the sea and rivers. Today, the Netherlands' complex waterworks – comprising dams, dykes, canals and pumps – is probably the best known example of how technical systems can improve resilience.

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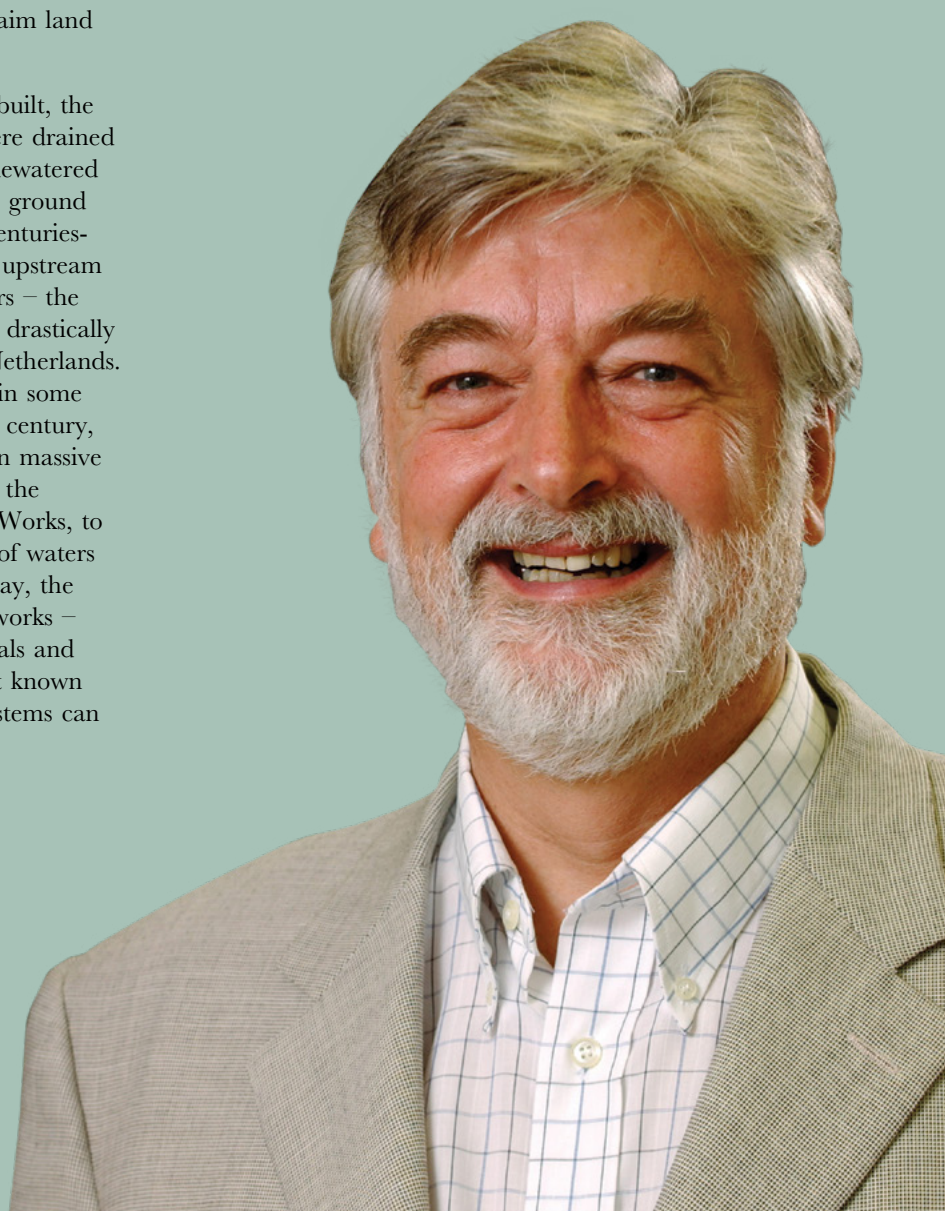

Infrastructure is not simply a physical issue, but involves planning and financial considerations. The Netherlands is increasing the height of its dykes, in response to climate change and the induced sea-level rise of up to 130 centimetres this century. These enhancements are part of the renewal of the dykes every 25 years, at an additional cost of over 1 billion Euros per year. As flood levels are anticipated to rise, the "Room for the River" project allows indefensible land to flood periodically. In such areas, residents have been relocated to higher ground. The sheer scale of these efforts makes it a national task – no city alone could have done the job.

In other places such as Switzerland, environmental engineering helps to stabilise the surrounding environment to enhance resilience where settlements and pastures are threatened by avalanches, falling rocks and mudslides. Resilience building efforts begin at the community (or valley) level, with the management of mountain forests. Natural forest regeneration is helped by regular cuts and plantings, to encourage a heterogeneous stand structure. Above the tree line, avalanche barriers protect settlements, railway lines, major roads and hydroelectric power infrastructure.

Recently, entire mountain tops in Switzerland have been destabilised due to global warming and the thawing of permafrost. One area under threat is the Engadin in the Swiss Alps. Famous resorts in the area such as St. Moritz and Pontresina are threatened by rapidly-thinning permafrost that can result in rockslides and debris flows. Pontresina is the first community worldwide to invest in resilience measures against the loss of permafrost, by building ground anchors, dams and catch basins. They have the support of eminent scientists, engineers and a strong political lobby. This type of support is critical for such efforts.

Cities and countries can learn from each other. The Dutch have spent centuries fighting floods, land subsidence and rising sea levels. Their organisational and technical responses are becoming a blueprint for many other cities, such as Bangkok, Jakarta, New York and Venice. Singapore decided to raise the minimum height of newly reclaimed land by one metre, and enhance coastal protection. In a similar vein, communities in mountainous areas such as the Andes, the Rockies and the Himalayas are learning from the experience of those in the Alps.

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The battle against natural hazards has taught us two things: disasters are much more severe, and often come earlier, than anticipated. To successfully strengthen resilience, countries need an absolute, no-nonsense commitment to innovation and action. Inactivity or a "Yes, but…" attitude is not an option.

Climate change is drastically aggravating the challenges to building resilience. According to UN figures, the global cost of adaptation for cities to achieve resilience against the effects of climate change could range from US$49 billion to US$171 billion annually. Of this amount, most will go to safeguarding infrastructure, water supplies and agriculture, coastal zones and public health. Without adaptive action, the cost of the damage will be orders of magnitude higher.

Scientific research and technology can help cities improve their resilience. Scientists are developing scenarios and predictions of how climate change may impact specific city regions. Globally, innovations are being made in the areas of engineering and architecture to improve infrastructure planning, design and construction. These will benefit many local governments, private businesses and utilities, which do not have the capacity to analyse climate issues or to design resilient solutions. While national governments may be able to provide financing, it will increasingly be up to mayors, private landowners and entrepreneurs to find specific and creative solutions.

Although environmental science can play an important role, there is currently little structured support from the scientific community for effective adaptation efforts, promoting collaboration, or getting the knowledge to where the needs are. To address this deficiency, focused planning on preparedness is needed, as are community- and stakeholder-outreach programmes. Putting together a dedicated committee or creating a new job function in the local government is one way of bringing about this focus in addressing the challenges to resilience.