MUNICIPALITIES ADAPTING TO CLIMATE CHANGE:

Reducing urban vulnerability through infrastructure

Points to remember

- GEO and ECCO-Cities processes have concluded that the use of infrastructure can be an effective adaptation strategy to limit climate change impacts;
- Infrastructure development should be preceded by an assessment process in order to evaluate the state and level of access of current infrastructure as well as the human and economic resources needed;
- Maintenance and adaptation of Infrastructure are essential to limit negative impacts caused by malfunctions and deterioration;
- Ecosystem-based adaptation options should always be considered as an alternative to infrastructure development.

From ancient settlements to the modern metropolis, physical infrastructure has provided essential social, political and economic services to urban dwellers. Today, while urban settlements are experiencing impacts from climate change, infrastructure also functions as means to reduce the population's vulnerability to hazardous events. This 'policy in practice' identifies key issues and lessons learned that policy makers should consider when planning for the development of infrastructure intended to limit impacts of climate change.

Why infrastructure?

Urban infrastructure provides indispensable social and economic services. Transportation infrastructure facilitates flows of people and goods, water and sanitation systems improve water quality and limit risks from waterborne diseases, and energy facilities enable daily activities. Moreover, urban infrastructure can reduce local vulnerability in relation to climate change. The degree to which a city (or one of its sectors) is vulnerable depends on the frequency and intensity of climate related events as well as the local capacity to anticipate and respond to these hazards. Consequently, political and socioeconomic structures as well as access to proper infrastructure are important factors[a]. The potential of infrastructure to prevent flooding, to moderate impacts from rising temperatures and to mitigate the impacts of extreme climatic events have been documented throughout the Latin American and Caribbean region by GEO and ECCO-Cities reports (i.e. city environment and climate change outlooks (ECCOs) based on the integrated environmental assessment methodology used for the Global Environment Outlook (GEO))[b].

How urban infrastructure can be used as adaptation tools?

Adaptation to climate change includes initiatives and measures to reduce the vulnerability of natural and human systems against actual or expected climate change effects.[c] The use of infrastructure as an adaptation strategy is mainly divided into two fields of work. On one hand, infrastructure can be built so as to directly limit climate change impacts on urban dwellers. Seawalls are relevant examples as they aim to limit the impacts of coastal disasters and rising sea level on coastal communities. On the other hand, adaptation can focus on increasing the resilience of existing urban infrastructure in order to adapt to new risks and pressures. Building codes and replacement of primary sewer systems are good examples as they moderate the potential harm on the urban population while reducing pressure on the environment.

How can infrastructure as an adaptation strategy for climate change be integrated in the municipal policy making process?

In order to strategically develop or adapt infrastructure that will help cities reduce their vulnerability to climate change impacts, an analysis of interactions between infrastructure, urban development and the environment is essential. In that regard, the integrated environmental assessment (IEA), a methodology used by UNEP and based on the DPSIR framework (Drivers, Pressures, State, Impact and Response) can be a valuable tool. The IEA process should take into account the state (absence, inadequacy, adequacy, etc.) and level of access of the population to current infrastructure so as to determine the degree of vulnerability of the city under study (see table 1). This first step will improve decision makers' capacity to determine if:

- Current infrastructure is resilient enough;
- The rehabilitation of existing infrastructure is possible and essential;
- New infrastructure should be put in place.

The private sector and civil society often have significant influence (formal or informal) on infrastructure both as administrators and as users. Consequently, decision makers should consult them during the policy making process so as to understand local needs, constraints and opportunities. In that regard, the Sustainable Social Housing Initiative (SUSHI) presented as a case study in Table 2 offers a valuable example of multi-stakeholder collaboration in the design of sustainable building practices for social housing programmes.

Infrastructure planning should anticipate from an early stage its consequences on the environment, vulnerability to climate change, interrelation with other infrastructure (e.g. drainage systems and waste management) as well as eco-friendly and climate-proof features, as the cost of doing so is lower if done at the beginning of the process than adding features later on. In this regard, risk adjusted life-cycle costs should be considered as adaptation and maintenance of infrastructure are critical.

As observed in the ECCO-Quito process, poor neighborhoods often lack access to proper infrastructure (sanitation, water, housing, etc.) increasing their vulnerability during climate related events[e]. Although effective urban master plans governing the location, distribution and regulation of land, services and infrastructure can be essential,

Example of indicators in relation with infrastructure and climate change used by GEO and ECCO-Cities reports for DPSIR analysis[d]

DPSIR	Examples
Pressure	Drinking water and drainage network coverage (%)
	Number and capacity of hydroelectric power stations
	Differences in consumption levels between districts (litres/socio-economic sector)
	Population with access to drinking water and drainage network (%)
State	Drinking water quality in distribution system (% of acceptable samples)
	Water deficit: production versus demand
Impact	Housing units at risk (number)
	Cost of natural disaster incidents on infrastructure ($)
	Physical intervention instruments (types and $)
Response	Investments in housing programmes (type, $ and beneficiaries)
	Formalizing property rights (number of new deeds)
	Technological physical intervention instruments (type and $)
	Drinking water coverage projections ($)

Source: UNEP (2008a)

policy makers should also consider non-structural measures that address underlying causes of vulnerability. Education, public awareness raising and socio-economic programmes can also help to limit construction in risk-prone areas, and reduce overall vulnerability.

Constraints

- While infrastructure can prevent and moderate potential climate-related damages or risks, their construction and utilization can also increase pressure on the environment (e.g. buildings are responsible for 40% of global energy use and are the source of 30% of greenhouse gas emission globally[e]);
- The use of infrastructure as an adaptation strategy is costly and construction requires long lead times;
- Infrastructure may generate a false sense of security, leading to disregard important non-structural measures (e.g. emergency planning , early warning systems, socioeconomic measures);
- Planning of infrastructure is based on the best available and actionable science at the time of design. Given that climate related data are shifting and uncertain infrastructure can become rapidly outdated.

What is being done and how effective is it?

GEO and ECCO-Cities processes have brought to light numerous examples of good practices related to infrastructure as a means to reduce climate change impacts on urban settlements.

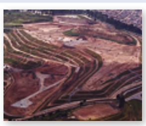
<table>
<tr><th colspan="5">Urban infrastructure: possible policy actions for adaptation to climate change</th></tr>
<tr><th>Issue</th><th></th><th>Types of infrastructure</th><th>Additional benefits</th><th>Policy tools and mutually supportive policies</th></tr>
<tr><td rowspan="2">Rising sea level</td><td></td><td>· Seawall</td><td>· Protection against rising sea level.</td><td>· Could be combined with Ecosystem-based Adaptation strategies (e.g. the rehabilitation of mangroves).</td></tr>
<tr><td colspan="4">Barbados Boardwalk
Rising sea level is expected to cost Barbados between US$283 and US$368 million in losses annually by 2050 (mainly from beach loss due to coastal erosion). In order to protect 2 km of shoreline the Barbados Boardwalk was completed in 2009 in the parish of Christ Church (55 000 inhabitants). The project is collaboration between the Barbados Coastal Zone Management Unit (created by the national government) and the Inter-American Development Bank.</td></tr>
<tr><td rowspan="3">Flood
Increase precipitation</td><td rowspan="2"></td><th>Types of infrastructure</th><th>Additional benefits</th><th>Policy tools and mutually supportive policies</th></tr>
<tr><td>· Water and sanitation</td><td>· Access to fresh water (reduction of vulnerability)</td><td>· Reducing vulnerability could limit climate change impacts on the urban population.
· Offer incentives that encourage capture of rainwater that could be use for drinking and cooking.</td></tr>
<tr><td colspan="4">Fresh water in Quito
The Rios Orientales Project was developed In order to respond to the increasing demand for fresh water in the city of Quito and its surrounding areas. Located in the provincial limit between the Pichincha and the Napo regions in the paramos of the Cotopaxi volcano, this project consists of collecting water from 31 rivers to supply the capital. The major works under the Rios Orientales project include: three regulatory reservoirs, 189km of pipeline, 47km of tunnels, water treatment facilities (in Paluguillo and Calderon) as well as electricity transmission and conduction lines.</td></tr>
<tr><td rowspan="3">Rising temperature/ heat island effect</td><td rowspan="2"></td><th>Types of infrastructure</th><th>Additional benefits</th><th>Policy tools and mutually supportive policies</th></tr>
<tr><td>· Residential buildings</td><td>· Develop building codes and standards that include climate-change risk and prevention (reduce vulnerability in addition to limit pressure on urban environment</td><td>· Assess current vulnerability of housing in the selected area;
· Develop land-use plans so as to avoid residential development in hazard-prone areas;
· Offer innovative incentives (tax rebates or exemptions) for investments in alternative energy sources, energy-efficient appliances, and climate-proof infrastructure—those incentives should be made available to all sectors of the population.</td></tr>
<tr><td colspan="4">Sustainable Social Housing Initiative (SUSHI), Brazil
A growing need for housing in poor neighborhoods of South America is often met with little consideration for durability, sustainability and environmental health. Moreover, access to basic services and risks related to location are commonly overlooked in order to save time and money. With this reality in mind, the Sustainable Social Housing Initiative (SUSHI) has brought sustainable building practices to social housing programmes in neighborhoods of Sao Paulo (Brazil). The project team works in collaboration with the State of Sao Paulo's Housing and Urban Development Agency, housing developers, construction companies, financial institutions and end users. The objectives are to improve energy and water efficiency of social housing units by integrating sustainable features available in the local market. SUSHI has mapped and assessed the state of local social housing in the State of Sao Paulo and identified solutions to some of these issues. The Initiative has also conducted seminars on energy and water efficiency in Brazil.</td></tr>
<tr><td rowspan="3">Rising temperature
GHG emissions</td><td rowspan="2"></td><th>Types of infrastructure</th><th>Additional benefits</th><th>Policy tools and mutually supportive policies</th></tr>
<tr><td>· Thermoelectric power plants for landfills</td><td>· Adaptation of infrastructure with environmental and climate-proofing considerations</td><td>· Develop land-use plan that prevents energy infrastructure from being built in hazard-prone areas;
· Offer incentives for renewable power;
· Diversify energy supply.</td></tr>
<tr><td colspan="4">Thermoelectric power plants in Sao Paulo (Brazil)
The city of Sao Paulo (Brazil) includes 11 million inhabitants producing 15,000 tons of waste daily. Waste decaying produces methane, which is a potent greenhouse gas, thus contributing to climate change. In 2007 and 2009, two of the most important landfills of the city were shut down (Bandeirantes and Sao Joao landfills). In order to burn biogas produced by decaying waste, it was decided to build thermoelectric power plants. This project will not only contribute to reduce CO2 emissions by 11 million tons by 2012, but it will also generate the equivalent of 7% of the electricity consumed in the city.</td></tr>
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Photo credit: AXSES (2009), UNEP (w/d) C40 Sao Paulo Summit (2011), La Hora (2011)

Lessons learned through the GEO-Cities and ECCO-Cities processes:

- **Infrastructure should not be the only adaptive** strategy but should also be supported by non-structural measures (e.g. capacity building, extreme weather event evacuation plans, socioeconomic programs, building codes, etc.);
- **Maintenance and adaptation of infrastructure are essential** in order to avoid malfunctions during hazard events and to prevent deterioration. In order to do so, risk adjusted life-cycle costs should be factored in;
- **Participatory environmental assessment prior to the construction of infrastructure is essential** in order to avoid "white elephants";
- **Infrastructure should be addressed by long-term policies** in order to assure to spread the costs over a large period of time. In this regard, development of infrastructure often exceeds municipal powers and budgets thus calling for collaboration with multi-scale and multi-disciplinary stakeholders;
- **The design of new infrastructure should integrate eco-friendly and climate-proof features** as the cost of doing so is lower if done at the beginning of the process than if it needs to be added afterward.

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d. UNEP (2008a),Methodology for the preparation of GEO Cities Reports: http://www.pnuma.org/deat1/pdf/Metho_GEOCitiesinddOK.pdf

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