City Climate Hazard Taxonomy

C40's classification of city-specific climate hazards

C40 CITIES
CLIMATE LEADERSHIP GROUP

Bloomberg Philanthropies

ARUP

City Climate Change Risk

Cities have long managed the risks of sudden or chronic climate hazards and threats. Many city governments and communities are familiar with the hazards they have faced in the past and are designed to function in the face of these challenges. However, scientific consensus suggests that with global climate change, extreme weather is likely to become more frequent and intense in some areas of the world, and cities may begin to encounter hazards that they have rarely, if ever, experienced before.

Accelerating urbanisation also means that the concentration of people and assets in cities is rapidly rising, leading to increased exposure to hazards. However this trend also creates opportunities for innovation to both reduce the risks from climate change and maximise any potential opportunities.

C40 is committed to assisting its member cities in working together as effectively and efficiently as possible to better achieve climate resilience. For this reason C40 is developing the City Climate Hazard Taxonomy (the Taxonomy).

The City Climate Hazard Taxonomy

The draft City Climate Hazard Taxonomy is the first step in a longer effort led by C40 to develop the Climate Change Risk Assessment Framework and Tool (CRAFT), an online reporting system and planning tool. It aims to improve, accelerate and transform local urban adaptation and drive global collaboration by tracking hazards related to the changing climate, their implications for cities, and city responses. The draft Taxonomy will be refined and finalised through close collaboration with key partners and our city members.

Purpose of the Taxonomy

The Taxonomy creates a shared terminology of city climate hazards, which serves four primary functions:

- Driving best practice city adaptation planning and action;
- Enhancing capacity for city-to-city exchange of effective adaptation approaches, tools and actions;
- Facilitating collection of robust, applicable city adaptation data;
- Streamlining city experience of accessing technical and financial assistance.

By fulfilling these functions, the Taxonomy provides a clear and concise entry point for city officials and other practitioners to understand the variety of climate hazards that may affect any city globally. Future work will help to embed this in a comprehensive understanding of climate risk.

C40, working with Arup, has completed a review of existing approaches to managing and characterising climate hazards used by city practitioners, the Disaster Risk Reduction (DRR) community, and the climate science and policy community. These sources have informed the design and content of the Taxonomy.

The Taxonomy classifies climate hazards in terms of five key groups of events:

Meteorological

Short-term or small-scale weather conditions (e.g., minutes to days).

Climatological

Long-term or large-scale atmospheric processes (e.g., intra seasonal to multi-decadal).

Hydrological

Mass movement of water or a change in the chemical composition of water bodies.

Geophysical

Originating from mass movement of solid earth.

Biological

A change in the way living organisms grow and thrive, which may lead to contamination and/or disease.[1]

Each of these groups incorporates one or more ‘main types’ of hazard. The ‘main types’ are then sub-divided into ‘types’ and – in some cases ‘sub-types’ – to provide greater levels of detail about the kind of hazardous event a city may experience. Where a city is able to identify the type or sub-type of hazard it faces, it is increasingly likely to be able to identify other cities or tools and techniques that are appropriate for helping them to manage that hazard.

1 Definitions adapted from EM-DAT, The International Disaster Database, Centre for Research on the Epidemiology of Disasters (CRED).

Given that hazards do not always occur in isolation, the taxonomy identified may display complex interactions. ‘Related natural hazards’ are phenomena that may occur at or around the same time as the hazard event.

Global climate change is expected to result in changes to local average and extreme conditions, which may affect the frequency, severity or extent of climate hazards. By the end of the 21st century, the key trends in climate conditions that may affect climate hazards are likely to include:

Rising average temperatures
Annual average temperatures are likely to rise as the climate changes. Land areas may become warmer, with fewer cold days and nights. The overall warming trend may give rise to more intense storms or wind events; changing winter weather; changes in the establishment and range of insects and disease-causing micro-organisms; and increasing ocean acidification.

Increasing frequency and intensity of extreme heat
Extremely hot days and nights may become more frequent, while warm spells and heat waves become more frequent, intense and longer. The stability of slopes may be affected as extreme air temperatures dry vegetation and soils, potentially resulting in more frequent landslides, rockfalls or subsidence events. Droughts associated with heat waves may become more frequent or intense, aggravating conditions for wild fires.

Precipitation variability and extreme precipitation events
Changing weather patterns may affect the timing, amount and type of precipitation. Natural hazards that might be affected include more intense seasonal rain or snow events, increasing the frequency and intensity of floods. Water scarcity may also increase as rainfall becomes more intermittent or reduced winter snowfall decreases the volume of melt waters. Water scarcity can lead to drought or wild fire hazards.

Sea level rise
Warmer air temperatures lead to a rise in sea level as warmer, and thus less dense, water expands and polar ice sheets melt. Higher sea levels increase the risk of coastal storm surges and push salt water into wetlands, higher up tidal rivers, and deeper into groundwater systems.

Supporting Research

The Taxonomy is based on the findings of an extensive research review. The methodology, background information and considerations that influenced the development of the Taxonomy are provided in a companion report, available from the C40 and Arup websites.

Also available in the companion report is a glossary of climate change terms to accompany the Taxonomy. The glossary will help to promote consistency in the application of climate hazard terms within global city practice.

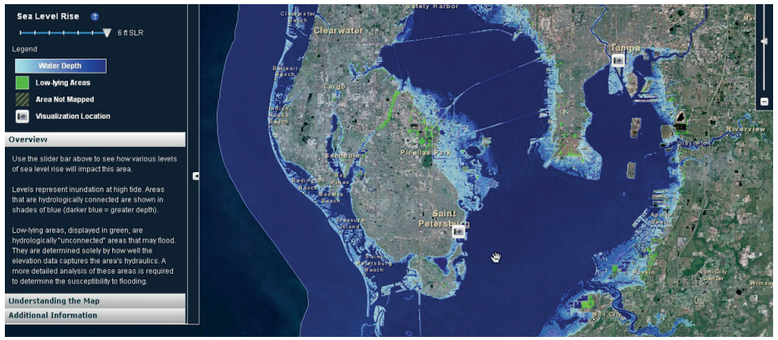
In addition, the research behind this taxonomy has also explored some likely impacts of hazards in a city environment.

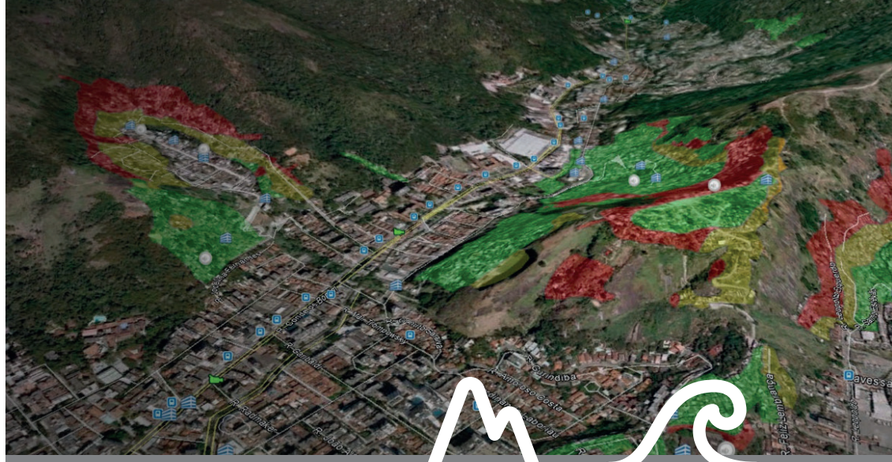
Next Steps

This draft hazard taxonomy will be used to consult with cities in the C40 network to ensure that it meets their needs. C40 will form a Technical Advisory Group of climate change experts who will provide expert guidance in the development of the final document. Based on this and other key stakeholder input the Taxonomy will be finalised in late 2014.

The Taxonomy will also be incorporated into city reporting platforms to support delivery of city commitments made under the Compact of Mayors, the world’s largest effort for cities to tackle climate change.

Thereafter, the next steps are to understand localised characteristics of exposure and vulnerability in cities. These are important considerations for any city climate change risk or vulnerability assessment, and will be explored in greater detail by on-going C40 work.





Landslide Flood

Case study

City: **Rio de Janeiro**

Climate characteristics:
Small annual temperature variations, high annual precipitation, short dry season.

Physical exposure:
Coastal, at the intersection of mountains and plains, with three large river basins.

In January 2011, torrential **rainstorms** in the state of Rio de Janeiro brought 26cm (10in) of precipitation in less than 24 hours. While southeast Brazil is accustomed to heavy rains in January, the rains in 2011 were particularly extreme.

Rainfall triggered **mass movement** of wet ground in mountains near the city. **Floods** and **mudslides** devastated several surrounding towns, destroying homes, power lines and roads. Around 900 people were killed by the event, and several thousand were left homeless. Low income and informal settlements on steeply sloping land are particularly vulnerable to the impacts of such events. Historically, Rio has experienced **extreme flooding** and **landslides** on a roughly 20 year basis. **Extreme precipitation** is expected to become more severe in the future, and the city is taking steps to improve weather forecasting and early warning systems, as well as developing resilient infrastructure in the city’s favelas.

Draft City Climate Hazard Taxonomy

HAZARD GROUP	HAZARD (MAIN TYPE)	CITY CLIMATE HAZARD (TYPE)	CITY CLIMATE HAZARD (SUB TYPE)	RELATED NATURAL HAZARDS
Meteorological	Precipitation	Rain storm	Monsoon	Insects and micro-organisms
		Heavy snow	Snowstorm/blizzard	
	Wind	Severe wind	Dust storm/sandstorm	Chemical change
		Tornado	Extratropical cyclone	Flood
		Cyclone (Hurricane/Typhoon)		Wave action
		Tropical storm		Wild fire
	Lightning	Electrical storm	Lightning/thunderstorm, derecho	Water scarcity
	Fog	Fog		Subsidence
	Extreme temperature - Cold	Extreme winter conditions	Ice, hail, freezing rain, debris avalanche	Landslide
		Cold wave	Cold snap, frost	Drought
		Extreme cold weather	Cold days	
	Extreme temperature - Hot	Heat wave		
		Extreme hot weather	Hot days	
Climatological	Water scarcity	Drought	Lack of precipitation and seasonal melt (snow, glacial)	Rockfall
	Wild fire	Forest fire		Avalanche
		Land fire	Bush fire, grass fire, pasture fire, scrub fire	Subsidence
				Landslide
Hydrological	Flood	Flash/surface flood	Glacial lake outburst	Subsidence
		River flood		Insects and micro-organisms
		Coastal flood		Landslide
		Groundwater flood	Waterlogging	Flood
	Wave action	Storm surge	Seiche	
	Chemical change	Salt water intrusion		
		Ocean acidification		
Geophysical	Mass movement	Landslide	Lahar, mud flow, debris flow	Chemical change
		Avalanche	Debris avalanche, snow avalanche	Flood
		Rockfall		
		Subsidence	Sudden subsidence (sinkhole), long-lasting subsidence	
Biological	Insects and micro-organisms	Water-borne disease	E.g. Cholera, Typhoid, Legionnaires' disease	Extreme temperature - hot
		Vector-borne disease	E.g. Malaria, Dengue Fever, Yellow Fever, West Nile Virus, Bubonic Plague	Flood
		Air-borne disease	E.g. Pneumonic Plague, Influenza	
		Insect infestation	E.g. Pine beetles, killer bees, termites	

GLOSSARY

Hazard: A dangerous phenomenon, substance, human activity, or condition. In this taxonomy, hazard refers to climate-related physical events.

Related Natural Hazard: Two or more natural hazards occurring concurrently (happening at the same time) or through a cascading relationship (happening as a result of the city climate hazard).

For further insight into the research behind the Taxonomy, please refer to the full research report available from www.c40.org and www.arup.com.

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