Towards an Integrated Vulnerability and Risk Assessment Framework for Cities Prone to Climatic and Non-Climatic Hazards

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1. INTRODUCTION

Most cities are exposed to both climatic and non-climatic hazards. This necessitates an integrated approach to assess vulnerability and risk, in the absence of which:

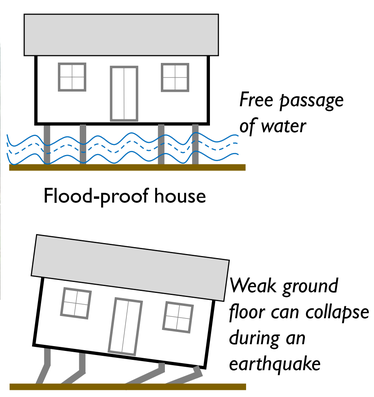
a) Policy interventions could be sporadic and fragmented;
b) Balancing between adaptation options, which are often costly, for climatic and non-climatic risks would be more challenging; and
c) It could be overlooked that an adaptation option that work for a specific hazard could counteract in case of another hazard.

Following the Great Earthquakes of 2015 in Nepal, seismic resilience has gained much attention in the country's policymaking domain although climate-related disasters are more frequent than earthquakes, causing immense loss of lives and properties every year. Most safety policies (e.g., building codes) dictate *how* buildings should be built rather than *where* they should (not) be built. It is not unusual to see the so-called 'seismic resistant' structures on sites prone to floods and landslides.

As a setback for risk-informed planning, the crucial concepts of vulnerability and risk are defined differently and often contrastingly in disaster risk reduction (DRR) and climate change adaptation (CCA) research streams, and often even within the research streams.

Building code alone does not save a building if it is not built on a safe site. If a risky site cannot be avoided, then instead of overinvesting for the sake of building code compliance, constructing a light structure would be wiser.

Image: http://kipushahid.blogspot.com/2012_09_16_archive.html



Nepal	Population: 26.5 million (2011) Area: 147,181 sq. km
4th	most climate change vulnerable country (Maplecroft's Climate Change Vulnerability Index 2011)
11th	most earthquake-prone country (drrportal.gov.np)
2/3rd	of total population now live in municipalities

More recently, the Fifth Assessment Report (AR5) of the United Nations Intergovernmental Panel on Climate Change (IPCC) has aimed at unifying notions of DRR and CCA into an integrated disaster risk management (DRM) approach to define, assess, and address risks. Unlike in the previous assessments, the AR5 puts risk at the core of CCA framework (see Field et al., 2014).

However, the AR5 lacks providing an operational framework to:

a) Translate theory into practice; and
b) Treat both climatic and non-climatic risks in a holistic manner.

The AR5 also fails to articulate "the causal chains among the various concepts... thus limiting the possibility of deriving uncontroversial operational assessment methods" (Giupponi et al., 2015).

This research aims to fulfil these gaps through an integrated vulnerability and risk assessment (VRA) framework for city systems. The framework follows the AR5 concepts, and builds on the previous works developed during Nepal's National Adaptation Plan (NAP) formulation process in 2016/17 (see MoPE, 2017).

2. INTEGRATED VRA FRAMEWORK

The city components – sub-systems (e.g., communities, neighborhoods) or sectors (e.g., housing, transport, energy, economy) – are composed of people, assets, and infrastructure. The component under consideration is paired with specific hazard drawn from a list of hazards mapped for the entire city system. Identification of hazards is basically a scientific study although perception surveys, observations, and traditional knowledge are also often useful.

In the framework, VRA is performed for each hazard. Vulnerability (V) is a function of sensitivity (S) and adaptive capacity (C), expressed as : **V=S/C**. Risk is the function of hazard (H), exposure (E), and vulnerability (V), expressed as **R=HxExV**. Each variable is assigned a normalized value (0 to1) such that if any variable is zero, risk is also null. Risks can thus be ranked or compared.

Depending on the scale of risk, impacts are qualitatively defined. *Adaptation options are identified for each hazard, and later combined for screening.* This is *different* from other approaches whereby risk is identified for all hazards, and adaptation options are sought for the combined impact. The latter approach could be ineffective particularly when adaptation options are conflicting.

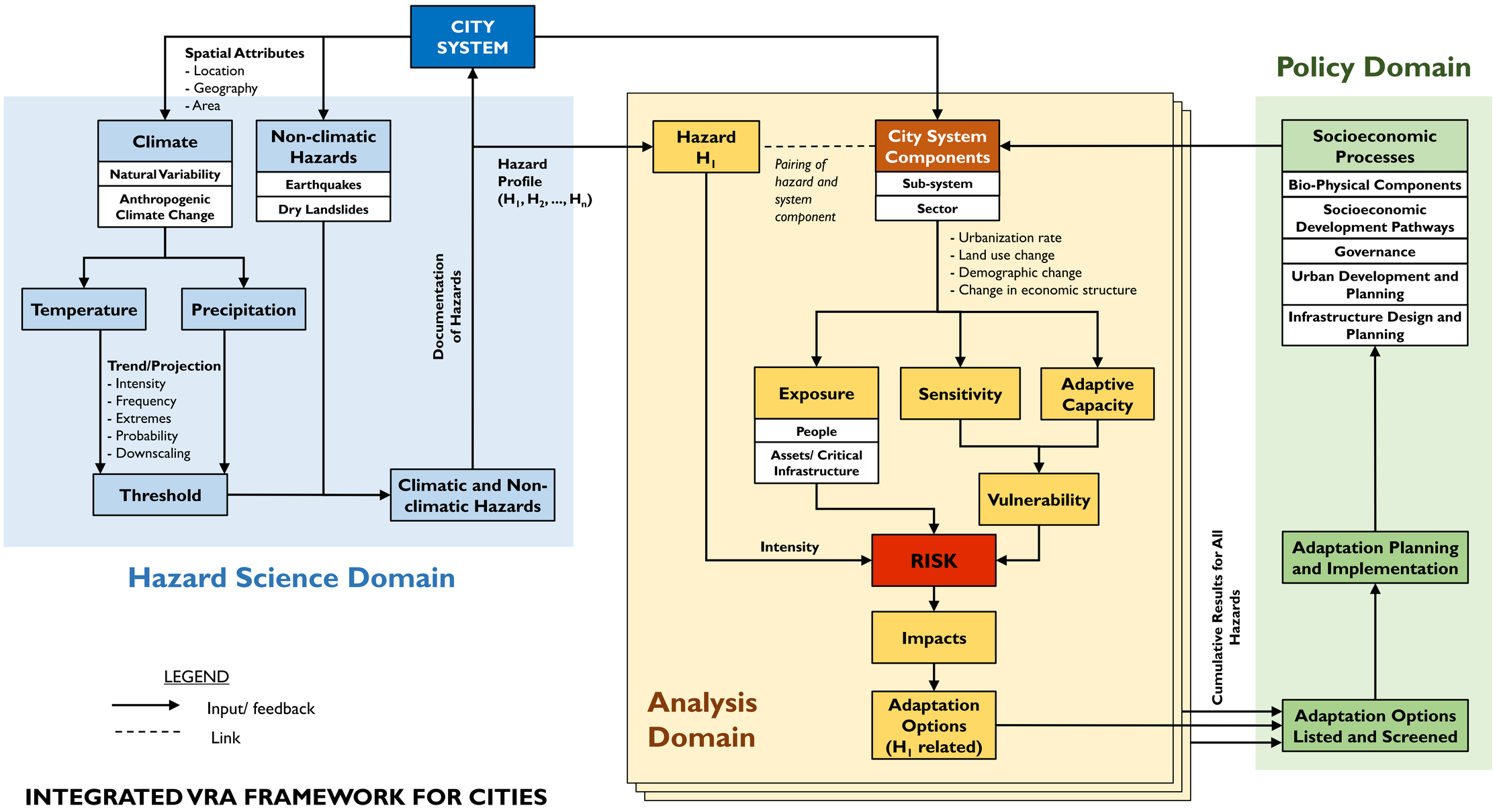
Adaptation planning and implementation should influence socioeconomic processes so as to reduce sensitivity of the city system and/or increase its adaptive capacity. The influence on exposure, on the other hand, depends on whether the city adopts "development-first" approach or "hazard-based" approach.

3. WAY FORWARD

The proposed VRA framework aims to articulate the causal chains among the AR5 concepts of exposure, vulnerability, and risks, among others. It allows treatment of both climatic and non-climatic hazards.

There are three distinct domains – the hazard science (e.g., climate science, seismology) domain concerned with the analysis of hazard data; the core analysis domain; and the policy domain concerned with adaptation planning and implementation. Thus the framework also facilitates communication between three different actors: scientists, technical analysts, and policymakers.

Despite useful flexibilities, the framework can be vulnerable to oversimplification, particularly while assigning normalized values to the indicators representing variables. Identification of and consensus on indicators is a challenging task, especially when important data are unavailable. As a future study, the framework should be tested with real-world examples.



INTEGRATED VRA FRAMEWORK FOR CITIES

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