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Review and evaluation of existing vulnerability indicators for assessing climate related vulnerability in Africa

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UFZ Report

Department of Urban and Environmental Sociology

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SUMMARY

The report provides a first theoretical setting on the concept of vulnerability, vulnerability assessment and indicators in order to identify and evaluate relevant assessment measures for the CLUVA project. It describes a set of identified indicators which serves as a starting point for selecting appropriate indicators for assessing climate related vulnerability. This is a contribution to the process of evolution of vulnerability assessment measures and to ensure a more robust and sustainable results in CLUVA. This report should therefore be seen as an initial conceptual proposition which needs to be tested empirically, peer-reviewed and discussed among experts, PhD candidates and practitioners working in the field of risk and vulnerability assessment. Only then can it be refined and fed back for further conceptual development.

At its core, the report aims at developing and discussing a vulnerability ladder that integrates four vulnerability dimensions fitting to CLUVA's contextual vulnerability discourse. Such discourse reflects on social responses and outcomes with regards to climatic events within an urban frame. Vulnerability is considered not only by meteorological hazards, but by a series of dynamical processes involving socio-cultural, economic and political processes. Hence, the report adopts vulnerability as a concept that helps understanding 'multi-scalar' drivers and pressures that occur in anticipation to a natural hazard and identifies the strengths and weaknesses of different modes of vulnerability assessment. We took into account a mix of views and vulnerability assessment techniques at two different levels. One level reflects efforts from climate and risk management experts along with urban sociologists, planners and environmental scholars. Both European and African scientists are bound to produce multifaceted outcomes considering social, environmental and climatic systems. This reflects on one side CLUVA's multidisciplinary nature. For instance, Task 2.3 (Assessing social vulnerability), seeks a dialogue between nature, society and the urban environment. This attempt requires inclusive interpretations between those concerned with the vulnerability and adaptation potential associated with urban attitudes, ecosystems, governance, land use and planning. This reflects on another side CLUVA's interdisciplinary component.

The report is organized to respond to the project's inter-linkage objectives as well as the realities and needs of involved scholars. We aimed at providing a platform for theoretical discussions on urban vulnerability and integrating the knowledge of others trough joined vulnerability questions. Another objective is to identify the strengths and weaknesses of qualitative and quantitative methods and to highlight the utility of mixed methods for assessing vulnerability. The indicators proposed to facilitate the assessment of vulnerability follow up on discussions held during two working sessions focusing on social vulnerability assessment at the project's Kick off Meeting in Ouagadougou, Burkina Faso (15–22 January 2011) and during two workshops organized in Addis Ababa, Ethiopia (8–10 June 2011) and Dar es Salaam, Tanzania (13–18 June 2011). The sessions in Ouagadougou aimed at exchanging our understanding on the terminology relative to Task 2.3 and at sharing previous experiences regarding research methodologies, data collection considerations and overall data requirements. It was established that the review of indicators shall be conducted based on the body of local knowledge and selected projects relevant to the African context. The sessions in Addis Ababa and Dar es Salaam focused on specific definitions of social vulnerability and discussions revolved around context-centred indicators. This was done based on a preliminary draft proposed in February 2011. Both workshops provided a forum for discussing specific approaches for capacity building and PhD topics as well as served as a platform for exchanges between CLUVA members and selected local actors and stakeholders. The results of discussions and joint efforts contributed to the evaluation of an identified list of indicators based on different desirable criteria.

CLUVA

CLimate change and **U**rban **V**ulnerability in **A**frica
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SEVENTH FRAMEWORK PROGRAMME
Environment (including climate change)
Call: FP7-ENV-2010

THEME [ENV.2010.2.1.5-1]

[Assessing vulnerability of urban systems, populations and goods in relation to natural and man-made disasters in Africa]

The work described here is supported by the European Commission's 7th Framework Programme through a three year research project (12/2011–12/2013) which aims at developing methods and knowledge in selected African territories to manage climate risks, to reduce vulnerabilities and to improve coping capacity and resilience towards climate changes.

The CLUVA project is an integrated effort between seven European institutions and six African research establishments. Experts in climate hazard and risk assessment, risk management, ecosystem, urban planning, governance, urban systems and social vulnerability collaborate to improve the capacity of scientific institutions, local councils and civil society to cope with hazard related events. Selected CLUVA cities are Addis Ababa in Ethiopia, Dar es Salaam in Tanzania, Douala In Cameroon, Ougadougou in Burkina Faso and St. Louis in Senegal. The cities, located in West and East Africa, feature different urban conditions and climatic configurations. They also range from medium to large and are confronted not only with increasing weather related burdens but also with the pressure of a growing population and rapid socio-economic transformation which then demand more attention on the urban dimension of African settlements.

The project is structured in six Work Packages dealing with climate change and natural hazard models (WP1), vulnerability and risk assessment (WP2), governance, and urban planning as key issues to increase the resilience (WP3), capacity building and dissemination (WP4), case study methodological application in selected cities (WP5) and project management (WP6).

A central task in CLUVA lies in assessing the social vulnerability of populations and urban territories in relation to disasters. This task (WP2/Task 2.3) based its assumption from the idea of understanding and conceptualising the condition of people when affected by a hazard. Highlighting therefore, different dimensions of a disaster and focusing on the question of how individuals and social groups anticipate, resist and cope with, as well as recover from hazardous climatic events.

This report illustrates the first results obtained within the CLUVA project. It offers a first theoretical setting on the concept of vulnerability, vulnerability assessment and indicators in order to identify and evaluate relevant assessment measures for the project.

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LIST OF ABBREVIATIONS AND ACRONYMS

AEA	American Evaluation Association
ARU	Ardhi University Tanzania
AWGDRR	African Working Group for Disaster Risk Reduction
BBC	Model developed by Bogardi, Birkmann and Cardona
CBO	Community-Based Organization
CBPR	Community-Based Participatory Research
CCA	Climate Change Adaptation
CDD	Community Driven Development
CHSI	Community Health Status Indicators
CIUP	Community Infrastructure Upgrading Program
CRED	Centre for Research and Epidemiology Disasters
CSA	Central Statistical Agency of Ethiopia
CSD	Commission on Sustainable Development
CVI	Composite Vulnerability Index
DFID	Department For International Development
DRM	Disaster Risk Management
DSM	Dar es Salaam
EAA	European Environmental Agency
EcVI	Economic Vulnerability Index
EEA	European Environment Agency
EiABC	Ethiopian Institute of Architecture, Building Construction and City Development
EM-DAT	Emergency Events Database
ETC/ACC	European Topic Centre on Air and Climate Change
EU	European Union
GDP	Gross Domestic Product
GIS	Geographic Information System
GURC	Global Urban Research Centre
ICLEI	Local Governments for Sustainability
IPCC	Intergovernmental Panel Climate Change
MAUT	Multi-attribute utility theory
MEDROPLAN	Mediterranean Drought Preparedness and Mitigation Planning
NGO	Non-Governmental Organization
OECD/DAC	Organization for Economic Co-Operation and Development/ Development Assistance Committee
PAR	Participatory Action Research
	Pressure and Release

PCA	Principal Components Analysis
PCCAA	Participatory Climate Change Adaptation Appraisal
PDNA	Post Disaster Needs Assessment
PRA	Participatory Rural Appraisal
SACCOS	Savings and Credits Cooperatives
SFVI	Social Flood Vulnerability Index
SIDS	Small Island Developing States
SITRASS	Solidarité Internationale sur les Transports et la Recherche en Afrique Sub-Saharienne
SL	Sustainable Livelihoods
SOPAC	South Pacific Applied Geoscience Commission
SoVI or SVI	Social Vulnerability Index
SSATP	Sub-Saharan Africa Transport Policy Program
UFZ	Helmholtz Centre for Environmental Research
UN	United Nations
UNCTAD	United Nations Conference on Trade and Development
UN-DESA	United Nations Department of Economic and Social Affairs
UNDRO	United Nations Disaster Relief Coordinator
UN-ECLAC	United Nations Economic Commission for Latin America and the Caribbean
UN/ISSD	United Nations International Institute for Sustainable Development
UN/ISDR	United Nations International Strategy for Disaster Reduction
UNDP	United Nations Development Programme
UN-HABITAT	United Nations Human Settlements Programme
UNU-EHS	United Nations University-Institute for Environmental and Human Security
URT	United Republic of Tanzania
US-EPA	United States Environmental Protection Agency
VCI	Vulnerability and Capacity Index
VRIP	Vulnerability-Resilience Indicator Prototype
WDI	World Development Indicators
2iE	International Institute for Water and Environmental Engineering

INTRODUCTION

African cities are undergoing a remarkable transformation process and are experiencing growth rates of considerable magnitude. While managing and steering this process is a challenging task in itself; it gains further complexity when considering the consequences of climate change on these cities. This report therefore prepares the ground for a vulnerability analysis that explores how exposed and susceptible selected African cities, specific neighbourhoods and their residents are to the consequences of natural hazards and how to cope with and adapt to its impacts. We therefore aim at developing context-centred methods to assess vulnerability and increase knowledge regarding the management of climate related risks.

CLUVA stands for 'CLimate change and Urban Vulnerability in Africa' and is a part of the seventh framework programme theme (env.2010.2.1.5-1) "Assessing vulnerability of urban systems, populations and goods in relation to natural and man-made disasters in Africa". In the CLUVA project, the practice of assessing vulnerability to natural hazards emerges from the need to detect the level of capacity, susceptibility and exposure of a system when it faces the risk of experiencing unwelcome and threatening events. Within CLUVA there are two predominant modes of exploring these issues. The first one considers a series of analyses based on projections of future climatic trends based on models and scenarios known in the literature as 'endpoint' (Kelly and Adger, 2000) or 'outcome' vulnerability (O'Brien et al., 2007). The second in contrast takes into account the inclusion of anthropogenic factors that may influence the vulnerability of residents to risk. This is referred in the literature as 'starting point' (Kelly and Adger, 2000) or 'contextual' vulnerability (O'Brien et al., 2007). We ally with this perspective and further specify the theoretical cornerstones of our conception of vulnerability. In addition, we underline certain methodological procedures and provide some recommendations on which indicators appear as particularly meaningful to assess social vulnerability in an urban, African context.

The present report therefore aims at developing and discussing a model that integrates core vulnerability dimensions fitting to CLUVA's contextual vulnerability discourse. Such discourse reflects on social responses and outcomes with regards to climatic events within an urban frame. Vulnerability is considered not only by meteorological hazards, but by a series of dynamical processes involving socio-cultural, economic and political processes. Hence, the report adopts vulnerability as a concept that helps understanding 'multi-scalar' drivers and pressures that occur in anticipation to a natural hazard and identifies the strengths and weaknesses of different modes of vulnerability assessment.

Mix views and vulnerability assessment techniques are discussed at two different levels. One level reflects efforts from climate and risk management experts along with urban sociologists, planners and environmental scholars. Both European and African scientists are bound to produce multifaceted outcomes considering social, environmental and climatic systems. This reflects on one side CLUVA's multidisciplinary nature. The other level is the interrelation of vulnerability themes within specific tasks. For instance, Task 2.3 (Assessing social vulnerability), seeks a dialogue between nature, society and the urban environment. This attempt requires inclusive interpretations between those concerned with the vulnerability and adaptation potential of CLUVA cities associated with urban attitudes, ecosystems, governance, land use and planning. This reflects on another side CLUVA's interdisciplinary component.

The discussion on assessment approaches and the set of indicators serves at a first step towards contextualizing the vulnerability of CLUVA cities along with our African counter parts. What is intended by placing vulnerability nuances into context is to:

(1) Select pertinent study areas as well as identify, contact and map relevant authorities with partners in Addis Ababa, Dar es Salaam and Ouagadougou, which are the CLUVA cities for empirical studies in Task 2.3.

(2) Specify and pre-test appropriate assessment methods according to respective context conditions and needs of local authorities and engaged stakeholders.

(3) Explore and assess the vulnerability of specific groups at individual, household and community levels to ensure the formulation of appropriate recommendations for community-specific adaptation measures.

Structure and logic of the paper

Chapter 1 reflects on the report's aim and scope. It focuses on providing a general outline of what this study covers and focuses on defining the parameter of the literature review and the implementation processes behind the report. This chapter also provides a brief outline of the CLUVA cities with regards to specific parameters.

Chapter 2 places attention towards understanding the vulnerability concept. It reflects on differentiated vulnerability ideas and provides several definitions, which encompasses a range of vulnerability concepts regrouped based on their synergetic virtue. It also highlights a historical background of the vulnerability concept and emphasizes particularly on social vulnerability and its position in current vulnerability discourses.

Chapter 3 highlights the use of conceptual frameworks for assessing vulnerability and proposes a model that integrate asset, institutional, attitudinal and physical vulnerability dimensions to form an interdisciplinary working framework for CLUVA.

Chapter 4 addresses mixed methods of assessment and provides an overview of the attributes and procedures of quantitative and qualitative assessment modes.

Chapter 5 reflects on indicators for assessing vulnerability and offers a set of indicators identified from the literature and based on experiences from the vulnerability field. Effort was made to foster contributions from local experts in Europe and Africa through a joint evaluation process. Identified indicators were ranked by relevance and presented as a final set.

CITY VIEW, ADDIS ABABA

1 AIM, METHODOLOGY AND CLUVA CITIES

1.1 AIM

The report aims at providing a first theoretical framework on the concept of vulnerability, vulnerability assessment and indicators in order to identify and evaluate relevant assessment measures for CLUVA. It describes a set of identified indicators which serves as a starting point for selecting appropriate indicators for assessing climate related vulnerability in CLUVA cities. All partners are encouraged to discuss the list proposed in Chapter 5 in order to contribute to the process of evolution and to ensure a more robust and sustainable results in CLUVA. The report should therefore be seen as initial conceptual proposition which needs to be tested empirically, peer-reviewed and discussed among experts, PhD candidates and practitioners in CLUVA cities. Only then can it be refined and fed back for further conceptual development. With this in mind the report was structured based on the following tasks:

- To develop a CLUVA vulnerability ladder that integrates core vulnerability dimensions fitting to CLUVA's inter-linkage objectives and the realities and need of CLUVA case study cities.
- To provide a platform for theoretical discussions on urban vulnerability.
- To integrate the knowledge of other CLUVA tasks trough integrated vulnerability questions.
- To identify the strengths and weaknesses of qualitative and quantitative modes of assessment.
- To recognize the utility of mixed methods for assessing vulnerability.
- To evaluate indicators based on different criteria and promoting the convergence of different point of views.

1.2 METHODOLOGY

By framing the concept of vulnerability assessment in the CLUVA context, the report substantiates its claims not only from the literature but also from presentations from CLUVA partners, conversations with stakeholders, observations from field trips, idea exchanges and discussions from workshops among other data collection modes. The results emerge from theoretical propositions with local knowledge. This is based on the assumption that a more accurate view of vulnerability in urban areas can be best obtained by balancing past discourses with current observations and hypotheses. With this in mind we forward different vulnerability ideas, highlight a historical background of the vulnerability concept and collect thoughts from CLUVA cities partners.

The literature review on vulnerability assessment initiated as an explorative exercise in which selected literature concerned with vulnerability in urban areas and methods for evaluating vulnerability to natural hazards were identified. The work conducted to date is extensive (Birkmann, 2006; Blaikie et al., 1994; Chambers, 1989; Cutter et al., 2003; Moser, 2009; O'Brien et al., 2007; Pelling, 2006, 2011; Sen, 1983; Wisner et al., 2004). The discourse varies depending on schools of thought, research backgrounds and different approaches to dominant vulnerability concepts (Hufschmidt, 2011).

The topic of "vulnerability" gained considerable attention within policy discourses in both social and natural sciences over the last decades. Giving the breath of the concept, a set of models frameworks and approaches were selected, stemming from early vulnerability ideas from Sen, Blaikie and Wisner. The selection we provide is not extensive and does not regroup all dominant vulnerability concepts. It rather offers a range of assessment approaches from which – and to some extent – 'tacit knowledge' of vulnerability is being exposed (Lincoln and Guba, 1985). The focus of the frameworks, concepts and models selected lies in making sense of context of vulnerability and how it progresses in a specific location by enabling actors to voice their ideas and take ownership of their circumstances.

We insist in finding a balance between a 'pre-established' and 'evolving' research design in CLUVA. This means that specifications offered in advance needs to be combined with interactions with participants. In fact, we maintain a certain restraint in terms of qualifying or rationalising vulnerability in CLUVA cities, we only offer at this point a proposed ladder that conceptualize reflections put forward during our discussions and exchanges with CLUVA partners into four distinct dimensions. We also take into account more recent knowledge built at the Helmholtz Centre for Environmental Research (UFZ) from international projects such as FLOODsite[1] (2004–2009), Risk Habitat Megacity[2] (2007–2011) and CapHaz-Net[3] (2009–2012). The EU-financed project FLOODsite is relevant to CLUVA as it deals with the physical, environmental, ecological and socio-economic aspects of floods with knowledge based on flood risk management. Risk Habitat Megacity is a research project that contributes to sustainability and risk management for fast growing Latin American cities. West Africa alone is expected to reach 58 million inhabitants during the decade of 2010/2020 (UN-HABITAT, 2010). Africa's collective population is becoming more urban and with this come challenges particular to urban agglomeration (cf. also Blanco et al., 2009). The strategies for sustainable development in megacities can serve as a good platform for implementing solutions that take the institutional, political, economic, and social aspects within dense settle-

[1] See http://www.floodsite.net/default.htm.
[2] See http://www.risk-habitat-megacity.ufz.de/.
[3] See http://www.caphaz-net.org/.

ments. Finally, CapHaz-Net develops an overview about the current state-of-art of research with regard to the social dimension of 'natural' hazards and disasters. This is particular relevant to CLUVA as it identifies and assesses existing practices for building actors' capacity of actors in the field of natural hazards. The focus of CapHaz-Net is in Europe, however many aspects of the theoretical background, societal assets, skills and resources necessary to anticipate, cope with and recover from natural disasters and environmental stress can be transferred or at least considered in CLUVA.

In consequence, the literature reviewed was indicative rather than extensive. Documents were selected from an existing pool of knowledge and special attention was given to those focused on Africa and in reference to climatic threats faced by CLUVA cities (e.g. flood and heavy precipitation, low water supply or decreased precipitation leading to water scarcity and drought and sea level rise). Additionally, the literature review was extended with the use of search engine using key words fitting to CLUVA. We also conducted a general search on Thomson Reuters Web of Knowledge for scientific journals addressing vulnerability assessment. Our findings reveal that vulnerability assessment studies have evolved over the last decade towards case study based approaches in which the knowledge built surrounding the vulnerabilities of populations expands from the biophysical vulnerability to the social vulnerability (Adger et al., 2004; Vincent, 2004). It appears the expansion of the theoretical discourse on the social condition of a population affected by a hazard has prompted the recognition of developing more robust assessment tools including relevant and systematic measurements that can contribute to more integrated studies (ibid).

Another thread of approaches are participatory assessment efforts (Chambers, 1989; Moser et al., 2010; Swift, 1980; Wisner et al., 1991) addressing vulnerability issues with communities. These approaches, mostly applied in developing communities, stem from the work of Freire among others. In his work, Freire stressed the idea of "conscientization" (1968), putting emphasis on people's level of enlightenment when recognizing their options. Later, this participatory idea was applied by Wisner et al. (1979) when designing a range of participatory techniques which included for instance food storage systems with villagers in Tanzania. There, the authors highlighted the challenges as well as the subtleness or participatory action research methods. In the report, attributes of qualitative vulnerability assessments which include participatory techniques are associated with more quantitative modes of inquiry, which include for the most part the development of indicators. By highlighting both techniques we maintain these methodological standpoints are more complementary then opposite. In vulnerability assessment, quantitative leaning authors acknowledge the relevance and importance of qualitative methods (Birkmann, 2006; Cardona, 2004) and qualitative contributors recognize the use of measurable outcomes (Wisner, 2006). This implies that there is a certain level of complementarity between qualitative and quantitative vulnerability assessment. The report provides a brief and partial review on both methods, however it suffice to introduce CLUVA partners to the advantages and shortcoming of each methodological perspectives and the utility of mixing them.

While exploring more deterministic approaches of vulnerability assessment one realizes the spectrum of vulnerability indicators and indices is wide. It ranges from micro-scale assessment types (i.e. household/local level) to macro-scale determinant of vulnerabilities (i.e. national/regional level) addressing a collection of vulnerability typologies with different dimensions (i.e. social, institutional, material), different types of hazards (i.e. flood, drought, earthquake, heat, storm) and regions (Europe, US, Latin America, Africa). This may be due the fact that indicator development is an old practice which can be traced historically since the 1940s (Birkmann, 2006). Hence, it is not surprising to find many frameworks and approaches, indexes and variables which attempt to contribute to

the current pool of knowledge with new 'elements'. These being for instance statistical modelling techniques which take forms of aggregations or policy-orientated measurements. These procedures focus on systematic change and/or evaluation of a region's political or economic structure which may feature certain application gaps when faced with irregular sources of data.

The review of existing vulnerability indicators was conducted in distinctive phases. Each phase narrowed the scope of the search allowing a more focused exploration. The initial phase draws from a global pool of knowledge on development issues in relations with climate change. The sources of documents reviewed emerge from intergovernmental agencies, research institutions and other agencies such as EM-DAT[4] host by the Centre for Research and Epidemiology Disasters (CRED) and other documents which focus primarily on meta-analysis of vulnerability (Tyndall Centre for Climate Change Research). Further scoping led to the body of knowledge produced from the European experience with flood, which has prompted a regional-wide effort to effectively assess the risks and the degree to which Europeans are vulnerable to a natural hazard. Among the literature consulted is the contribution of the European Environmental Agency (EAA) through the work of the European Topic Centre on Air and Climate Change (ETC/ACC) which issued a study on vulnerability assessment in urban regions by indicators and adaptation options for climate change impacts. This document among others provided a broad overview on the attributes of indicators, how can they be tested in cities. Keeping in mind the geographical, cultural and historical differences between Europe and Africa, we considered European assessment techniques with prudence. Focusing similarly on practices of vulnerability assessments found in research reports, and other online sources (e.g. UN/ISSD Climate Change Knowledge Management on Africa) which provided periodic thematic feeds allowing the validation of indicators identified in the literature.

The information on CLUVA cities came first from scientific journals, books and reports of UN-institutions. More recent precise knowledge was obtained during presentations and following discussions undertaken during the CLUVA Kick-off Meeting in Ouagadougou and subsequent workshops in Addis Ababa and Dar es Salaam. We took note of the overall state of three CLUVA cities which were visited between January and June 20011. During several trips to distinctive settlements, a photographic documentation was undertaken with particular focus on the livelihood of local population, land use, urban agriculture, and characteristics of buildings, neighbourhoods and people as well as its waste management organization.

During excursions, which provided an overall view of the urban transformation within Ouagadougou, UFZ observed the conditions of roads, canals and drainage systems that were impacted by the flood in September 2009 in the Capital. In addition, we took note of the overall state of Ouagadougou's livelihood, different economical activities, and distinctive settlements. During our visits to informal settlements in Dar es Salaam, we noticed waste management challenges as well as the risk that population located in low lying areas face. In Addis Ababa, it was revealed that those located in river banks are confronted with increasing water flow events. Exchanges with local institutions (e.g. the Goethe Institute and the International Institute for Water and Environmental Engineering (2iE) in Ouagadougou, the Fire and Disaster Prevention Agency and the Mayor's Office of the City Government of Addis as well as talks with community leaders in Dar es Salaam, help strengthen our understanding of the urban environment of CLUVA cities and allowed us to contextualize the information obtained from intergovernmental reports and scientific journals.

[4] Indicators of historical EM-DAT Emergency events database cover all countries over the 20th century. This information is available online at: http://www.emdat.be/disaster-profiles.

1.3 CLUVA CITIES IN BRIEF

The CLUVA cities, located in West and East Africa, encompass coastal, estuary, inland, and highland characteristics and feature different weather conditions such as tropical dry, tropical humid and Sub-Saharan climate. The cities range from medium to large and are confronted not only with increasing weather related hazards but also with the pressure of a growing mix of people (modern and traditional) confronted with ideals of progress, traditional beliefs, security and equality. As urban development demands improved assets, more functional institutional structure and enhanced physical and social infrastructure, it subjects CLUVA cities to continual challenges to adapt in the face of a growing and changing continent. The profiles presented below are a schematic overview of each city and merely indicates aspects, which require more in-depth explorations to contextualize vulnerability during the course of the CLUVA project.

Addis Ababa

Addis Ababa is the capital and by far the largest city of Ethiopia. Based on the 2007 Census conducted by the Central Statistical Agency of Ethiopia (CSA), Addis Ababa hosts a population of 2,740,000 (ibid., 2008). The UN-HABITAT Addis Ababa Urban Profile (2008) in contrast estimates there are approximately 4 million inhabitants. Despite a relatively low population growth rate of 2.1% (CSA, 2008), Addis Ababa is expected to reach between 6–7 million by 2015 (CLUVA City Profile Addis Ababa, 2011). The capital covers an area of about 540 km²; from which 290 km² is covered (ibid). The climate of Addis Ababa is forecasted to have an increase in precipitation variability and temperature. This will likely induce a wide range of hazards in the city including flooding and landslides in addition to droughts and fires which have been the most common hazards in the rural and urban areas. The urban green area is made of urban forest, vegetation along the river buffer, recreational public park and urban agriculture. The city is a self-governing chartered city with its own city council. It is divided into 10 Sub-Cities. Among them, Kolfe Keranio located west of the city features the highest number of habitants in contrast to Akaki Kaliti in the South with the lowest population (CLUVA City Profile Addis Ababa, 2011; Melesse, 2005). These Sub-Cities are further divided into a total of 116 Weredas/Kebeles, which are the lowest level of city administration.

Dar es Salaam

Dar es Salaam (DSM) is the largest city in Tanzania with an estimated population of 3.4 million and an annual population growth of 4.1% (CLUVA City Profile DSM, 2011). DSM is the fastest growing region among 26 others in Tanzania and ranked amongst the ten fastest growing cities worldwide. The population is expected to exceed 4.5 million in 2020 (CLUVA City Profile DSM, 2011; UN-HABITAT, 2008a; UN-HABITAT, 2008). DSM, located at the East African coast, covers almost 1,400 km². The rainy seasons extend from October–December and from May–August. The city is particularly susceptible to climate threats like sea level rise and coastal erosion, drought and water scarcity, strong winds and flooding (CLUVA City Profile DSM, 2011; Dodman et al., 2011). The region is headed by the Dar es Salaam Regional Commissioner whilst the city is managed by the Dar es Salaam City Council. The area is further divided into three autonomous municipal councils or districts: Kinondoni (531 km²) to the north, Ilala (210 km²) in the centre and Temeke (652 km²) to the south. Each council is subdivided into 11 divisions which are further segmented into 73 wards (CLUVA City Profile DSM, 2011; UN-HABITAT, 2009). Sub-wards, locally known as Mtaa, are DSM's lowest administrative level (CLUVA City Profile DSM, 2011).

Douala

Douala is the economic capital and the largest city of Cameroon; with a population of about 2.1 million people which is 20% of Cameroon's urban population and nearly 11% of the country's total population. The city's annual growth rate is 5%, compared to a national average of 2.3%. The city is divided into six communes and each of the six has one headquarter: Douala 1 (Bonandjo), Douala 2 (Newbell), Douala 3 (Logbaba), Douala 4 (Bonassama), Douala 5 (Kotto), Douala 6 (Monako). The first five communes are urban areas while the sixth one is a rural zone. The city is led by the community council of 37 members and two government representatives. Douala is a flat coastal city with extensive swampy areas (Ndjama et al., 2008). Douala features a tropical monsoon climate with constant temperatures throughout the course of the year. The city typically features warm and humid conditions. The raining period varies through the year; the annual average precipitation is roughly 4,000 mm of rainfall.

Ouagadougou

Ouagadougou is the capital of the Republic of Burkina Faso. It extends on 520 km² from which 217.5 km² are urbanized. 70% of the industrial activities of the country are concentrated in the capital which hosts a population of 1.5 million inhabitants. In 2020 the capital is expected to reach 3.4 million inhabitants, which makes it one of the most rapid growing cities in the region. Ouagadougou faces several urban challenges; among them is poverty with more than 50% of the population living in poor conditions. Those particularly exposed are women with less access to education, employment and land. Ouagadougou counts five districts, 30 sectors and 17 villages. The development of basic urban services is the municipality's most pressing issue. There is a concern to extend the network of roads, multiply the works of drainage for rainwater and organize the collection and management of solid waste. Despite the city's apparent urbanization trend, some villages being livestock and agriculture-dependent maintain traditional features. Ouagadougou and surrounding villages are located in the *Soudano-Sahelian* zone which receives 850 to 900 millimetres of precipitations annually. Water infiltrates with difficulty in the grounds due to the condition of the soil cover. Deforestation is caused by foraging for firewood, food, and grazing. The capital's surroundings are bare and dry, with little vegetation, while the natural, dense vegetation is preserved in specific protected areas.

St. Louis

The city of St. Louis is an archipelago and located on low-lying islands encompassing the Langue de Barbarie spit, Ndar Island and the Sor district along the east-west axis (Diagne, 2007). The city is surrounded by low-lying floodplains and marshes while sitting on the edge of the Sahel. As a result, St. Louis experiences periods of drought throughout much of the year and flooding during the rainy season when the river overflows. The city hosts a rapidly expanding population. It grew from 48,840 inhabitants in 1960 to 165,028 in 2005. With an annual rate growth of 2.4%, St. Louis has at present about 900,000 inhabitants and faces the challenge of providing services for a rapidly growing population from limited resources. Urban growth contributes to the cluster of individuals in areas at risk of flooding. Urban growth, poverty and natural hazards constitute main problems for the socioeconomic stability in the city. St. Louis is divided into 20 districts and 22 quarters or neighbourhoods. 28.8% of the population is living in informal settlements (CLUVA City Profile St. Louis, 2011). Some neighbourhoods are particularly at risk due to flooding and landslides caused by altered drainage patterns and destabilized slopes. In the Langue de Barbarie for instance 80,000

people suffered from the rise of sea level and inadequate access to resources (ibid.). As a means of flood prevention, the population of low-lying areas have learned to make barriers against flood-waters, but this generates additional sanitation issues causing further challenges in St. Louis.

CLUVA cities are not exempt to natural disruptions. Table 1 and 2 illustrate climatic stress and identified weather related events reported in the last years. In fact severe weather events are expected to increase in the continent. Climatic threats ranging from drought, flood and windstorms events, change in rainfall patterns, sea level rise and decrease in river basin and water availability are predicted to have negative effects on the human, economic and environmental assets of populations. (Parry et al., 2007; UN-HABITAT, 2010; Vordzorgbe UN/ISRD, 2007).

Table 1: Climatic stress identified in CLUVA cities.

	Addis Ababa	Douala	Dar es Salaam	Ouaga-dougou	St. Louis
Higher temperature and heat wave				●	
Sea level rise		●	●		●
Heavy precipitation				●	
Fluvial floods				●	●
Urban sanitary and drainage floods	●		●	●	
Decreased precipitation	●				
Drought	●				
Water scarcity	●				

Table 2: Identified weather related events in CLUVA cities.

	Identified weather related events
Addis Ababa, Ethiopia	• History of droughts which affects water resources and reduce the availability of fresh water and affect food insecurity and human health.
Dar es Salaam, Tanzania	• Flood and vector and water borne diseases such as malaria. • Decrease in river basin run-off and water availability for agriculture and hydropower generation.
Douala, Cameroon	• Sea level rise and floods affecting the livelihood of the densest coastal city of Cameroon.
Ouagadougou, Burkina Faso	• Incidence of high temperatures, heat waves and dust storms. • Variable rainfall provoking floods and damaging the physical infrastructure and existing drainage system and also affecting urban agriculture. • Cholera and malaria outbreak during rainy season pose a chronic health problem.
St. Louis, Senegal	• Sea level rise exerting pressure on the availability of land and the city development.

Adapted from CLUVA City Profiles, 2011; Government of Burkina Faso et al., 2009; UN-HABITAT, 2007, 2008, 2009.

According to EM-DAT, Burkina Faso has experienced 11 floods between 1991 and 2009. The last flood reported in September 2009 affected 11 of a total of 13 regions and was reported as one of the worst floods in the history of the country. A Post Disaster Needs Assessment (PDNA) reported loss of human life as well as significant damages in the housing sector with 60% of the household sanitation facilities destroyed (Government of Burkina Faso et al., 2009). This highlights the severity of disruptions caused by some weather events, weakening therefore the urban environment and the overall livelihood of local populations. The tables above summarize different climatic hazards stressed in the reviewed literature on CLUVA cities and highlights some weather related events that have been reported.

Reports on the state of cities concentrated along coastlines such as St. Louis, Dar es Salaam and Doula stress the vulnerability of the spatial environment and the uncertainty of future developments due to erosion, flooding and sea level rise. Burkina Faso, Ethiopia and Senegal are priority countries of the World Bank's Disaster Risk Management for 2009–2011[5]. A common threat they face is the incidence of increasing floods in their main cities (Ouagadougou, Addis Ababa and St. Louis), all showing growing urbanization trends (UN-HABITAT, 2010).

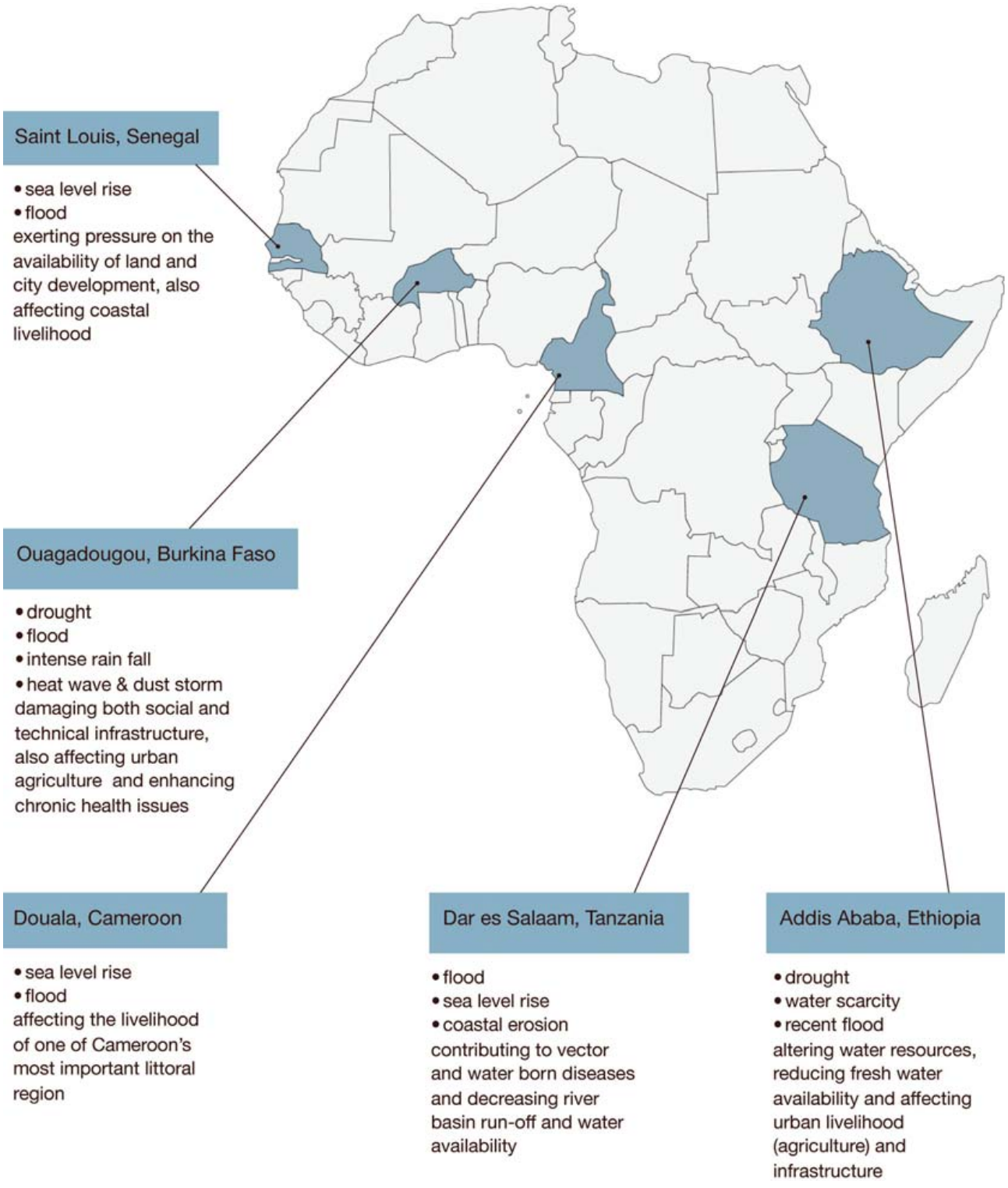
Urban flood in Ethiopia is relatively new, the country which has a long history of recurring drought, is mostly known for its water scarcity, lack of farmland and famines. However some early signs of flood events in recent years indicate that the city may have to prepare to adapt to increasing water flow events, which will further restrict access to fresh water in the city. Addis Ababa's City Brigade Office reported 23 areas exposed to floods accidents which represents the second urban threat after fires incidents with 57 areas exposed to urban fires (Oral information, Workshop June 2011).

Some identified unplanned settlements in Dar es Salaam are often flooded due to poor soil infiltration, blockage of natural storm water channels and the malfunction of storm water drainage systems. In addition, rising sea level,[6] and erosion along the coast pose serious challenges to municipal councils. Dodman et al. (2011) stress there is however a growing risk awareness at community levels. Local-based resolutions such as the ones developed by *Tandale* residents against flood (e.g. moving household items and personal belongings to elevated areas before flooding occur or building protective walls) need to be included in broader strategic responses to prevent present and future threats.

Lowlands characterize the littoral area of Douala, fed mainly by the River Wouri. The city, which is the most densely populated area of Cameroon's coastal zone, is often inundated as it is also the case of Ouagadougou which paradoxically features high temperatures and unpredictable and variable rainfall persist. Droughts, floods, heat waves and dust storms are the major climatic hazards in the capital. They in consequence enhance desertification, land degradation and population migration. Although it is unclear how changes in precipitation will affect Ouagadougou, there is however a need to address the coping capacity of the population which face severe damages when flood and other severe weather events occur. St. Louis is located in a wetland area that extends for 10 kilometres along a seafront and has experienced frequent river flooding. Along with Ouagadougou and Dar es Salaam, St. Louis features a soil cover inadequate to water filtration in addition with the challenges of managing wastewater, household waste and also rain and river water.

[5] See http://www.gfdrr.org/gfdrr/sites/gfdrr.org/files/publication/DRM_CountryPrograms_2011.pdf.
[6] Increasing headwater waves are modifying the level of the ocean's surface by about 200 m in the past five decades affecting the viability of coastal life (Dodman et al., 2011).

Figure 1: CLUVA cities map – reported climatic stress and weather related events.



Adapted from CLUVA City Profiles, 2011; Vordzorgbe, S, UN/ISRD,2007; UN-Habitat, 2010.

INFORMAL SETTLEMENT IN DAR ES SALAAM

2 VULNERABILITY: BACKGROUND AND SELECTED DEFINITIONS

The concept of *vulnerability* which has been recently applied to climate change impact assessments is a multifaceted and contested construct. It travels along with terms such at *risk*, *natural hazards, coping and adaptive capacity, sensitivity, resilience, poverty* and even *food security* in disaster and development studies literature as well as in climate change discourses. The existence of numerous definitions on vulnerability lies in the fact that there are different approaches and perspectives of what vulnerability represents. Birkmann (2006) identified over 25 different proposals of concepts, methods and systematizations of vulnerability which in his view reflects its broad and complex nature.

There isn't indeed a single concept of vulnerability. The review of the existing literature shows that the term stretches from being considered as an internal risk factor to being viewed as a multiple structure concept which integrates different spheres of knowledge (Vogel and O'Brien, 2004; O'Brien et al., 2007). Such spheres include the physical, environmental, institutional and social factors that investigate the sensitivity level of certain group or population to climate induced threats. The approach of the social sciences to issues related to a natural disaster stretches from the 1950s (Cardona, 2004). Studies evolved from the compilation of individual and collective reactions into multidimensional discourses stressing the fundamental social character of vulnerability.

2.1 VULNERABILITY ROOTS AND HISTORICAL BACKGROUND

Early studies on vulnerability dealt with droughts and famines[7]. Under the impression of the devastating famine crises in the African Sahel Region during the 1970s and 1980s, increasing attention was paid to the underlying causes of these famines. In trying to explain the occurrences of these

[7] The following short historical reconstruction is based on Kuhlicke, C.; Steinführer, A. (forthcoming). Social vulnerability to flooding. In: Bernhofer, C.; Schanze, J.; Seegert, J. (Eds.). Textbook on Integrated Flood Risk Management. Springer: Berlin.

processes two concepts, namely that of ‘adjustment’ and that of ‘poverty’ were rejected as too simplistic.

The term ‘adjustment’ goes back to the work of Harlow Barrows. In 1923 Barrows introduced the term “adjustment” to the field of geography, emphasizing the cultural efforts to adapt to changing natural conditions (Barrows, 1923). Barrow’s doctoral student Gilbert F. White took up this concept and incorporated it in his ground-breaking dissertation thesis on flood hazards and flood plain management (White, 1945). This piece of work was one of the first investigations on flood hazards, which, more rigorously than most of the research work before incorporated social aspects in order to explain the occurrences of floods. Based on this work White develop the so call “hazard research paradigm” (cf. also Kates and Burton, 1986; White, 1974).

Both White’s emphasis on the individual’s decisions and perceptions as well as his underlying understanding of the human-environment relation was severely criticized. According to the critics the hazard research paradigm would imply that personality, perception and experience are of prime importance for understanding human adjustments; questions of power and political struggle are completely left out (Hewitt, 1983, 1997).

In another strand of research, which is rooted in development research, the simple equation that poverty would result in starvation and malnutrition was rejected as too simplistic to explain collective crises such as famines (Bohle and Krüger, 1992). It was argued that this concept of poverty would not allow the consideration of the complex and diverse patterns of strategies with which even the poorest among the poor try to cope with and adapt to famine risks (cf. also Bohle and Glade, 2008). In this context, the entitlement theory of Amartya Sen (1983) became particularly influential (ibid., 1983). Sen convincingly showed that the devastating Bengal famine of 1943 had not been caused by a lack of food. Although millions of people starved to death, there was more food available than in previous years. Sen could prove that rice became an excellent investment during this time. As a consequence, it became more expensive and only wealthier people could afford it. Marginalized people, such as landless labourers or fishermen living in the rural areas of Bengal, however, could no longer afford to buy rice and were therefore starving to death. Both the rejection of the simplifying assumptions underlying White’s work as well as the work of Sen helped to develop the concept of vulnerability. As a result of both strands of reasoning, social vulnerability is a concept which:

(1) Neither considers individual perceptions and decisions nor natural processes as solely relevant for explaining the occurrence of natural disasters and

(2) Does not simply equate poverty with vulnerability (cf. also Chambers, 1989).

(3) Social vulnerability is rather a perspective on disasters that tries to understand the interrelation of complex social, economic, and political contextual conditions that contribute to the occurrences of devastating events.

A general sense of what is considered vulnerable is the differential capacity of a system, structure or group of individuals to adapt and cope with a particular threatening event. In the literature the explanations on what and who is vulnerable vary depending on the approaches, areas of research, schools of thought and interest of vulnerability stressors. For the purpose of this report, selected definitions of vulnerability are illustrated in Table 3. They provide a general outlook of the range of existing vulnerability definitions and were compiled based on their synergetic virtue as not to limit vulnerability to a potential damage to natural hazards but to consider the political, social and economic conditions of populations.

Table 3: Selected definitions of vulnerability.

Related key term	Definition	Author
VULNERABILITY		
Differential realities	Degree to which different social classes are differentially at risk.	Susman et al., 1983
	Result of poverty, exclusion, marginalization and inequities in material consumption.	Barnett, 2001
Social construct	Vulnerability is socially constructed and is the result of economic, social and political processes.	Cardona, 2004
Internal risk factor	Intrinsic predisposition of a subject or system to be affected by or to be susceptible to damage.	Cardona, 2004
Climate Factor	Degree of exposure to natural hazards and the capacity to prepare for and recover from any negative impacts.	Pelling, 2003
SOCIAL VULNERABILITY		
Level of development	Reduced capacity to adapt to a determined set of environmental circumstances.	Cardona, 2004
Precautionary principle	Incapacity to avoid danger, or to be uninformed of impending threat, or to be so politically powerless and poor as to be forced to live in conditions of danger.	O'Riordan, 2002
	Product of social, cultural and demographic characteristics which influence access to power and resources.	Blaikie et al., 1994
URBAN VULNERABILITY		
Function of human behaviour	Degree to which socioeconomic systems and physical assets in urban areas are either susceptible or resilient to the impact of natural hazards.	Mileti, 1999
Threat to wellbeing	Lack of resilience to changes that threaten welfare; these can be environmental, economic, social and political, and they can take the form of sudden shocks, long-term trends, or seasonal cycles.	Moser, 2009

2.2 SOCIAL VULNERABILITY

The term 'social vulnerability' describes in broad terms how susceptible people are to a hazard. For understanding and explaining this susceptibility the hazard itself (e.g. river flood, earthquake or fire) is of subordinate interest. On the contrary, the main focus of social vulnerability research is not the height of a flood or the intensity of an earthquake that defines its social, psychological, health and economic consequences; it is rather within the societal context that one can truly comprehend and explain how severe the consequences are. Social vulnerability research argues that it makes a difference whether a flood hits a wealthy or a poor community. From this perspective, an overall meaning of social vulnerability is:

The specific social inequality of people in the context of a disaster.

This view is closely linked with the definition proposed by Wisner et al. (2004), who attribute social vulnerability to a "combination of factors that determine the degree to which someone's life, livelihood, property and other assets are put at risk" (ibid.: 11). This understanding focuses on the social dimensions of a hazard and a disaster respectively. It is very much inspired by sociological and geographical writings in social theory and development studies, but it has also been applied by natural hazards research.

There are two basic assumptions at the core of social vulnerability. First, it is a relational construct as it relates "something or someone who is vulnerable to something else as a source of potential harm because of some property of the subject or the object" (Green, 2004: 323). It is hence a complex concept to place, for instance, a river and a household in relation to each other (cf. also Bohle and Glade, 2008). It is individuals, households, communities, organizations, regions or entire states that can be vulnerable to something. In that sense there is a reference point to social vulnerability. Vulnerable individuals are exposed to a type of natural hazards or to urban structures and societal processes that affect them.

> *Social vulnerability always needs a reference point (e.g. a certain type of risk – "vulnerability to what") and a specific context (which transforms a risk into a hazard – "vulnerability of what and of whom").*

Second, it is not only the exposure of a household that is important but also people's coping and adaptive capacities – this has an important implication, as it treats the people potentially or actually affected not as passive objects of a certain hazard, but as persons who are capable of acting. It implies a more dynamic side related to the level of awareness of a group of individuals and their knowledge about natural hazards, their motivation and attitude to act and take responsibility for their safety as well as their ability to access to different type of resources (i.e. financial aid, information) to prepare, cope with and recover from severe weather events.

We therefore propose to understand vulnerability in accordance to Blaikie et al. (1994: 9) as

> *"the characteristics of a person or group in terms of their capacity to anticipate, cope with, resist, and recover from the impact of a natural hazard".*

This definition highlights both the social and temporal dimensions of a disaster and focuses on the question of how individuals and social groups anticipate, resist and cope with, as well as recover from, a disaster or other stressing events.

During workshops conducted in Burkina Faso, Ethiopia and Tanzania the concept of social vulnerability was discussed. In general, the subject of lack of assets (i.e. poverty, health and education), lack of institutional coping mechanisms and deficient infrastructure as well as other land tenure factors were raised in association with the construct of 'social vulnerability'. Based on discussions with our research partners, observation made in specific study sites during field trips, and preliminary interviews with stakeholders, it became clear that the social vulnerability of studied subjects in CLUVA must be coupled with the physical and institutional dimension of vulnerability. Our Ouagadougou partner proposes to understand social vulnerability as followed:

> *"La vulnérabilité sociale peut être caractérisée par une situation de précarité liée à l'exclusion ou l'absence de droits civiques (aspects sociaux et politiques). Elle se caractérise également par un état de déficit en matière d'éducation, de logement décent et de besoins fondamentaux comme l'alimentation, l'habillement, la santé, l'emploi et les ressources financières."*

During the workshop conducted at the EiABC[8] a contextual definition of social vulnerability in the context of Addis Ababa was proposed by Dr. Katema as followed:

> *"Insecurity and sensitivity in the wellbeing of the individuals, households and communities in the face of changing conditions – such as the case with the deterioration in the environmental quality that bring people to the status of defenceless, insecurity and exposure to risk, shock and stress."*

[8] Social vulnerability definition proposed by Dr. Katema from EiABC was drafted during the Parallel session – Day 2 of the CLUVA workshop in Ethiopia in June 2011.

STREET VIEW, OUAGADOUGOU

3 VULNERABILITY ASSESSMENT: APPROACHES AND FRAMEWORK

Important facts for the assessment of vulnerability in CLUVA are the increasing severity of psychological, economic, social and physical damages due to natural hazards; the shortcomings of the social and technical infrastructure with regards to the rate of urban growth; the degradation of the ecosystem; the complexity of land management/market, its lack of consistency and transparency; and the limited capacity of urban governance at low administrative levels. In addition, poverty manifested through a lack of asset (education, health, material goods) pervades throughout CLUVA cities. The numbers put forward by UN-HABITAT's *State of African Cities* (2010) show uneven progress towards improving the conditions of slum dwellers with slower development in East and West Africa.

However, considering poverty as a principal cause or condition of vulnerability is not enough nor adequate in CLUVA. Even though poor people are usually among the most vulnerable, not all vulnerable people are poor; this is one of the central insights from vulnerability research. It was highlighted by some of the first vulnerability researchers that the simple equation that poverty would result in starvation and malnutrition is too simplistic to explain collective crises such as famines (Bohle and Krüger, 1992). It was argued that the concept of poverty would not allow the consideration of the complex and diverse patterns of strategies with which even the poorest among the poor try to cope with and adapt to famine risks (cf. also Bohle and Glade, 2008). The rejection of any simplifying causalities helped to develop the concept of vulnerability and formed the basis of the concept of vulnerability as developed paradigmatically by Chambers (1989).

Also in the context of CLUVA's African cities particular features of poverty are rather dynamic, context depended and manifest in different ways. For instance, since 2006 to this date, electricity rationing occurs in Dar es Salaam. This disruption is the result of low water levels in the dams that generate power (Dodman et al., 2011). This disruption related to a period of drought affects in fact dwellers from all socio-economic groups to different degree.

Apart from that, it would be too simplistic to only consider the exposure of people to various hazards: this idea has been contested, among other, by Chambers (1989), Bankoff (2001) and Cardona (2004) suggesting that vulnerability is not merely external to people. Individuals have the ability to minimize their risk when communication, education, participation and accountability are put forward in the context of risk management. Moreover, field trips taken in three CLUVA cities and preliminary exchanges with locals have shown that the risk people face has different degree depending on their capacities and their access to resources. While poor constructions, location in disaster prone areas and limited accessibility among other conditions are signs linked to physical vulnerability, some social arrangements witnessed in Addis Ababa and Dar es Salaam in the form of family support groups, and micro-financing systems appear to be a determinant form of social wealth that may serves as an indicator of capacity and resilience.

We therefore conclude that there is a necessity to develop an understanding of vulnerability and an assessment procedure that allows capturing the complex, embedded and nuanced manifestations of vulnerability in an urban context. We assume that vulnerability is often co-produced in everyday interactions among residents and local authorities their environment and infrastructures. This implies that vulnerability needs to be more contextualized, not only empirically but also conceptually (cf. also Kuhlicke et al., 2011).

3.1 SELECTED APPROACHES, FRAMEWORKS, MODELS AND PRACTICES OF VULNERABILITY ASSESSMENT

A common approach for assessing vulnerability is the development of conceptual models which enables those concerned with the effect of certain climatic threats for a particular region, to identify the vulnerable systems and population segments most affected. The importance of assessing vulnerability emerges from the idea of understanding and conceptualising the condition of people when affected by a hazard. This is closely related to the EU Commission's risk assessment guideline in which vulnerability is defined as "the characteristics and circumstances of a community, system or asset that make it susceptible to the damaging effects of a hazard" (UNISDR, 2009).

As much as there isn't a concise definition of vulnerability, there is no universal model or approach towards assessing the characteristics of vulnerable groups. Among the variety of approaches to assessing vulnerability are those that combines hazard and vulnerability in a risk reduction perspective based on an IPCC approach which defines vulnerability "as a function of the character, magnitude and rate of climate change in variation to which a system is exposed, the sensitivity and adaptive capacity of that system" (Parry et al., 2007: 6). Approaches relative to the IPPC model centre their analysis on broad external vulnerability causes. For instance, the BBC model (Birkmann, 2006) explicitly links vulnerability to the three pillars: environment, society and economy in a form of cyclical loop in order to define the causes of vulnerability. While the Move model (ibid.) understands society and the environment as a coupled system. Here, the exposure, vulnerability and lack of resilience of society can lead to economic, social and environmental risks. It was observed that aspects of the system can be influenced by risk governance.

The international community defines the measuring of vulnerability as a key activity in the final document of the World Conference on Disaster reduction, the Hyogo framework for Action 2005–2015 (UN, 2005). The Risk Assessment and Mapping Guidelines for Disaster Management issued by the European Commission (2010) recognizes the different scales at which different social and economic dimensions of vulnerability operate and stresses the need to improve coherence and consistency among risks assessments. The guideline highlights the necessity to incorporate fac-

tors related to human, economic, environmental, political and social realm when examining the impacts[9] of hazards. Thus contextualising vulnerability not only responds to the objectives of CLUVA but also echoes the need to improve coherence and consistency of risk assessment practices. The following subjects with regard to national vulnerability analysis were stressed:

- Identification of elements and people potentially at risk (exposure)
- Identification of vulnerability factors/ impacts (physical, economic, environmental, social/political)
- Assessment of likely impacts
- Analysis of self-protection capabilities reducing exposure or vulnerability

Table 4: Selected frameworks, models, approaches and practices of vulnerability assessments relevant to CLUVA.

Conceptual frameworks and models	Authors/ Organizations	Description	Hazard type
Vulnerability as a social condition	Blaikie et al., 1994; Hewitt, 1997; Wisner et al., 2004	The assumption that vulnerability is a social condition, a measure of societal resilience or resistance to hazards.	Natural Hazard
Sustainable Livelihoods (SL) Framework	DFID, 1999	Focused on the drivers of poverty and livelihood-oriented development. The model includes five types of assets that form the core of livelihood resources and argue that people pursue a range of livelihood outcomes by which they hope to improve or increase their livelihood assets and to reduce their vulnerability.	Shocks, trends and seasonality
Pressure and Release (PAR) model; Access Model	Wisner et al., 2004.	Assesses the progression of vulnerability. The Pressure aspect focuses on the processes which generate vulnerability, while the Release aspect focuses on the reduction of the disaster through relieving the pressure and reducing the vulnerability. The Access Model is an expansion of the PAR Model relating to human vulnerability, exposure, social impacts and responses to a physical hazard.	Natural Hazard
Hazardscape framework	Mustafa, 2005	A concept that combines material and discursive realities and focuses on understanding various aspects of hazards taking into account differences of discourses from dominant population groups.	Natural hazard

[9] By impacts the guideline refers to a number of quantified and non-quantified indicators that could potentially be manipulated through a semi-quantitative scale. The guideline takes into account vulnerability interactions in multi-risks assessments (European Commission, 2010: 17).

Participatory Approaches			
Participatory Rural Appraisal (PRA); Participatory Action Research (PAR)	Chambers, 1983; Chambers and Conway, 1992; Cannon et al., 2003; Moser, 1998; Winchester, 1992	Development focused, PRA and PAR are families of approaches and methods to enable local (rural or urban) people to express enhance, share and analyse their knowledge of life and conditions, to plan and act.	Natural hazard
Community-Based Participatory Research (CBPR)	Israel et al., 1998; Hatch et al., 1993	CBPR is related to PRA and PAR. It aims to involve the community in the research process and combing knowledge with action and achieving social change to improve health outcomes.	Health
Programs/ Initiatives			
Cities and Climate Change (Climate Change, Urban Flooding and the Rights of the Urban Poor in Africa (2006))	Action Aid International	A Participatory Vulnerability Assessment including interviews with communities and various stakeholders at the city level to understand the impacts of flooding and adaptation strategies of the poor.	Natural Hazard/ Health
Preparing for Climate Change: A Guidebook for Local, Regional and State Government (2007)	ICLEI – Local Governments for Sustainability	A three-step vulnerability assessment: 1) Sensitivity analysis based on observed and projected climate data, available resources and the impact threshold of the urban system, 2) Evaluation of the city's adaptive capacity including legal and regulatory, economic, governance and biophysical factors; and 3) combing findings from 1 and 2 to prioritise vulnerable location or communities and suggest adaptation measures.	Climate related natural hazards
Climate Change Adaptation and Disaster Preparedness in Coastal Cities of North Africa	World Bank, Middle East and North Africa Region	Assess vulnerability for the year 2030 in five areas: 1) sea level rise, coastal erosion and submersion; 2) urban flooding; 3) water resource availability; 4) increase in room temperature; 5) earthquakes and tsunamis. Develop action plans to improve cities' adaptation.	Natural Hazard
Asset-based Climate Change Adaptation Framework	World Bank/University of Manchester – GURC	A participatory research methodology with three components: 1) Participa-tory Climate Change Adaptation Appraisal (PCCAA), 2) Rapid Risk and Institutional Appraisal, and 3) Consultation and validation of results.	Natural Hazard

Adapted from Kuhlicke, 2010; Moser et al., 2010; Tapsell et al., 2010.

Table 4 illustrates selected frameworks, models, approaches and practices of vulnerability assessments undertaken in developing contexts. The conceptual frameworks and models have in common an understanding of local assessment-based values with a problem-solving component. These approaches look first at understanding the social context of vulnerability and how it progress in specific areas.

Participatory approaches focus on creating action plans at community levels enabling actors to share their results and take responsibility for their community. The focus is on a private domain particularly concerning individual actors and different kind of local groups. Such approaches have an empowering agenda offering those involved to increase their autonomy (Pavey et al., 2007) and developing skills to face local or wider-scale dominance (Pelling, 2007). Participatory assessment approaches take into account the development of locally driven and owned capacity development which is clearly supported by the international community[10].

3.2 CLUVA VULNERABILITY LADDER IN URBAN AREAS

At the centre of the model for a vulnerability ladder in urban areas we take into account the generic attributes of vulnerability to natural disaster and weather events. We understand it as a concept that aims to understand and explain the social reasons for the production of risky situations and hazardous developments. In this sense, we put the social, economic, political and cultural causes for the production of vulnerable conditions at the forefront of our analysis (Blaikie et al., 1994).

The vulnerability ladder exposed below integrates four specific dimensions of vulnerability – *asset, institutional, attitudinal and physical* – as a collective umbrella of vulnerability to the impacts of a disaster. This umbrella follows the work of Moser (1998), Moser et al. (2010), Mustafa (2005), and Mustafa et al. (2010) who have used these terms before.

In the following we introduce the vulnerability ladder more in-depth. The first component of the ladder considers at the heart of our assessment, the generic components of vulnerability which takes into account the exposure, susceptibility/sensitivity and coping and adaptive capacity of a system. Subsequently, the ladder stresses the resources and capacities that individuals and groups have when faced with a natural disaster (i.e. asset). It then recognizes urban governance at local levels as central in any inquiry on vulnerability (i.e. institutional). It also considers aspects of trust and social inclusion, network and risk awareness as key items to understand the urban dynamics when a disaster occur (i.e. attitudinal) and finally acknowledges the state of the urban environment within which all the above dimension interact (i.e. physical).

By integrating asset, institutional, attitudinal and physical vulnerability, an explicit linkage between CLUVA tasks and work packages occur. For instance, we propose to assess some physical components of vulnerability that deals with the conditions of the urban built environment. This includes for instance the local use and management of green structure (Task 2.2) which in turn plays an important role with livelihood and other social considerations of vulnerability. There lies a close link between Task 2.2 and Task 2.3. Moreover, we aimed at investigating adaptation mobilization processes at local levels, in other words how actors get together to solve a common problem and how

[10] See the Hyogo Framework for Action 2005–2015 which states that both communities and local authorities should be empowered to manage and reduce disaster risk: http://www.unisdr.org/eng/hfa/docs/Final-report-conference.pdf.

their voices are heard at higher government levels. This requires a close collaboration with CLUVA partners focused on urban planning and governance systems in WP3.

3.2.1 Generic components of vulnerability: Coping/Adaptive Capacity, Susceptibility/ Sensitivity and Exposure

At the centre of the model for a vulnerability ladder in urban areas we take into account the generic attributes of vulnerability to natural disaster and weather events. We understand it as a concept that aims to understand and explain the social reasons for the production of risky situations and hazardous developments. In this sense, we put the social, economic, political and cultural causes for the production of vulnerable conditions at the forefront of our analysis (Blaikie et al., 1994).

A closer look at the various conceptions of vulnerability (for an overview see Hufschmidt, 2011) reveals that vulnerability is quite often, although mostly implicitly, distinguished in a phenomenological dimension and a causal dimension (Kuhlicke, 2010). The phenomenological dimension tries to capture how vulnerability appears in different societal contexts. The causal dimension is based on assumptions about the relationship between causes and effects. This dimension aims to explain the reasons why a group of people, for instance, is more exposed to environmental risks than others.

The causal dimension is interested in explaining the reasons for why a group of people does not have the capacity to influence their fortunes and/or why a group of persons is more exposed to hazards than others. Hence, it is interested in uncovering the causal forces at work defining vulnerability of actors. In vulnerability research traditionally, the most important causes are seen in the socio-political-economic structures. This view is, for instance, explicated by Watts and Bohle who aim to unravel the “causal forces of hunger and famine” (ibid., 1993: 43). They identify causal powers such as entitlements, empowerment and political economy that cause specific effects; that are vulnerable conditions. Another prominent example is presented in Blaikie and his colleagues in ‘At Risk’ (Blaikie et al., 1994); in their ‘Disaster Pressure and Release Model’ (PAR) they identify root causes translating into dynamic pressures and resulting into unsafe conditions.

Figure 2 illustrates the conceptual framework for vulnerability to a natural hazard in which the coping and adaptive capacities relates to what Chambers (1989) defines as the internal side of vulnerability and refers to individuals or a group of individuals and considers their abilities to come to terms with stressing, threatening or damaging events by coping with or adapting to them. Susceptibility/sensitivity describes the preconditions to suffer harm because a person or a group experiences some level of fragility or disadvantageous conditions. Exposure simple describes the physical precondition to be harmed (cf. also Fuchs et al., 2011).

Figure 2: Conceptual framework of vulnerability to natural hazards in urban areas.

Exposure: Physical precondition to be affected

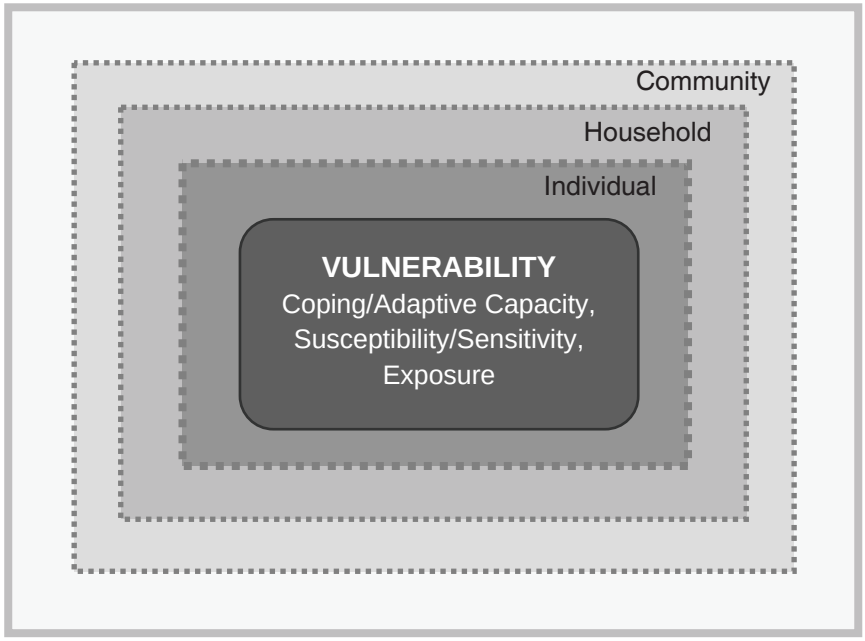
Susceptibility/Sensitivity: Precondition to suffer harm because of some level of fragility or disadvantageous conditions

Coping and Adaptive Capacity: Ability to prepare for, cope with and recover from the impact of a hazard

3.2.2 Assessment at individual, household and community level

A second consideration is the level or spatial scale at which vulnerability assessment in urban areas in CLUVA is to be conducted. In our view, any inquiries dealing with the condition of individuals requires contextualization which is disproportional at a city level. An inductive ladder of assessment at a lower level (i.e. neighbourhood, particular community or group, household and individuals), not only offer signs that are not easily visible at a city scale but also allows a concrete framing of vulnerability. This approach is open-ended and explorative by nature and draws on a circumstantial idea of vulnerability. One that is in line with O'Brien's 'contextual vulnerability' viewed as the 'starting point' of vulnerability assessment. Such perspective focuses on the conditions of the system that enables a hazard to become a disaster. While the 'outcome vulnerability' follows a top-down perspective and considers which impacts climate change has on urban areas, the latter approach follows a bottom-up perspective and considers how society is vulnerable to and adapts to climate. According to O'Brien et al. (2007) outcome vulnerability frames the assessment of vulnerability within a less perceivable "human-security framing" that takes into account increasing coping, adaptation to change and considerations surrounding uncertainty.

Figure 3: Vulnerability to natural hazards at individual, household and community level.



Household and community vulnerability assessment levels respond to the 'human framing' aspect, where potential risks have a direct effect on the livelihood of individuals. In Addis Ababa for instance, these levels translate into *Weredas/Kebeles* whereas in Dar es Salaam attention may be given at *Mtaa* levels *(e.g. Suna, Msasani, Hananasif, or Bonde la Mpunga).* As illustrated in Figure 3, a contextual assessment would rather focus on the ability of residents living in identified communities to anticipate, cope with and recover from the impact of a hazard according to the respective conditions of the physical context of that specific community. The assessment would additionally indicate the degree of exposure and the capacities of residents (i.e. willingness to adapt, motivation, skills and resources) to deal individually and collectively with potential threats.

We recognize that any definition of what a 'household' and/or 'community' has significant implications on our research question and how sensitive a household assessment in the different CLUVA cities is to any chosen definition. A standardized definition of household would probably pose some conflicts to the intersection of key terms adopted in CLUVA. In this light, we take reference from local interpretations provided by case study partners. The working definitions or rather examples below serve a starting point for framing the scale of our vulnerability assessment and are intended to be discussed further among partners, tested in the field and reflected upon in further reports.

Household:

A household is defined as a person or a group of persons, related or unrelated, who live together and share a common source of food.[11]

[11] Definition provided by ARU from URT (2007), Tanzania Household Budget Survey 2006/07, National Bureau of Statistics.

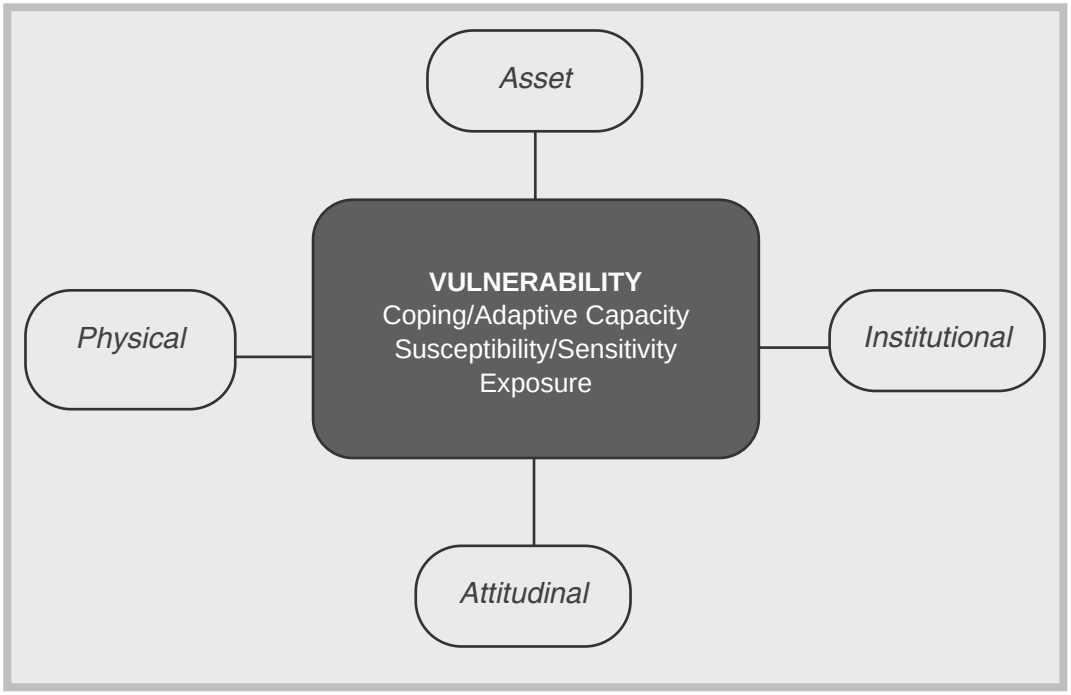
Community:

The concept “community”, although often referred to, is not simply given: In many cases it is understood as the lowest administrative level. Many disaster studies conceptualize a community as a geographical unit (neighbourhood, town, region, etc.) within which people interact on a daily basis. It is understood as a local unit which performs important social functions (e.g. Quarantelli and Dynes, 1976). However, as Kirschenbaum (2004) points out, traditional community-based approaches usually defined their object of research by taking physical and geographical borders as a matter of fact instead of referring to subjectively defined borders and cross-local networks (ibid.: 96). In this vein, communities are understood as being comprised by social networks of individuals belonging together because of specific interests and objectives as well as of ties based on kinship or positive emotions. Taking a more constructionist perspective one could even argue that “community” is also a category upon which people draw, rhetorically and strategically focusing on the attribution of meaning to a geographical locality or a social unit. Communities in this respect are created through symbolic attributions (Cohen, 1992). In this context, communities are understood as relational constructs that exist if people have a specific awareness of themselves in relation to other people. The most significant kind of awareness is based on the boundaries by which a group differentiates itself from others. Thus, a community is largely defined through the construction of boundaries (e.g., we/they, us/them). This implies also that the concept community may have multiple meanings to the different members of a community. The group may be homogeneous in a structural sense but quite heterogeneous in its usage of and identification with a community. CLUVA needs to take the view and interpretation of local actors into account. The term community refers here to the area respective to the lowest administrative level ranging between 5,000–10,000 inhabitants. For instance a community may reach the size of a *Kebele* in Addis and/or an *Mtaa* in Dar es Salaam.

3.2.3 Key vulnerability dimensions identified in urban areas

Four main vulnerability dimensions: Asset, institutional, attitudinal and physical are interlinked to assess the vulnerability of individuals, households and communities in CLUVA. This is based on the premise that climate change research needs to be embedded in socio-economic, political, environmental and cultural realms in order to effectively identify the action processes to avoid loss or activate recovery in the event of a disaster. Asset, institutional, attitudinal and physical dimensions of vulnerability are identified as separated yet interactive phenomenological and causal forces at work. They refer to the human livelihood and material resources of individuals and groups identified as vulnerable, the state of local authorities and civil action groups that operate among them, the condition of the physical environment surrounding them and the risk management attitude that guide their decision.

Figure 4: Asset, institutional, attitudinal and physical dimensions of vulnerability.



Asset vulnerability

The perspective of linking asset to vulnerability stems from the idea of understanding the internal causes of vulnerability with regard to the shape of lives of those who face climatic threats. Asset is seen here not only in economic or material terms but also refers to other manifestations of wealth such as health and education. In other words, the term embodies the human, economic and social resources that individuals possess given them advantages, i.e. a certain margin in a changing urban environment.

In the context of natural hazards induced by climate change in CLUVA, asset vulnerability not only requires an identification of the condition of the resources that individual have but also their ability to cope and their capacity to adapt to from negative climatic events. This implies for instance investigating on how residents of *Hananasif* tackle flood events in their area and how do they exploit relief opportunities with local government.

Asset based assessment with regard to vulnerability has been conducted with the aim at identifying what are the different resources that individuals have (Barrett, 1999; Chambers, 1995; Moser, 1998). These assessments have been mostly targeted at identifying what the poor possess based on the premise that the more and diverse these assets are the less vulnerable they are. These ideas were developed in the 1990's in association with poverty, food security and vulnerability, giving birth to a number of frameworks and approaches adding to an already extensive literature on asset and rights. One example is how food security was stressed as a determinant function of asset by Barrett (1999). In his view 'asset forms the foundation of food security', in other words someone with financial equity has access to food.

A review at the scholarly literature on asset and vulnerability leads to different studies, which included among them the 'Asset Vulnerability Framework' from Moser (1998). This approach regroups an extensive household asset portfolio distinguishing asset types such as labour, human capital, productive assets, household relations and social capital, which aim at demonstrating how

the collection of asset interplay with the concept of vulnerability. More recently, the author proposed a new asset focused framework with a differentiation in the assessment of the dynamics of individuals or groups, “asset vulnerability analytical framework” and the evaluation of their actions and initiatives “asset adaptation operation framework”.

The term asset has been used before to denote a set of resources (Barrett, 1999; Ford Foundation, 2004; Moser, 1998). While Moser’s asset definition extends to an array of tangible and intangible assets, the functions of asset identified in CLUVA include the economic condition, the education level, the demographic structure as well as the health of identified actors.

Institutional vulnerability

Institutions refer to formal agreements (rule, laws and constitutions) as well as informal agreements (norms of behaviour, conventions) that mould interaction in a society. They include hence the “formal and informal procedures, routines, norms and conventions embedded in the organizational structure” of the local governance context (cf. Hall and Taylor, 1996: 938). Such institutions may be an important factor in increasing and/or decreasing the vulnerability of local households, organizations and entire urban areas.

A key factor for the analysis will be local governance structures. This includes the “sum of the many ways individuals and institutions, public and private, manage their common affairs. It is a continuing process through which conflicting or diverse interests may be accommodated and co-operative action may be taken. It includes formal institutions and regimes empowered to enforce compliance, as well as informal arrangements that people and institutions either have agreed to or perceive to be in their interest” (Commission on Global Governance, 1995: 2).

Attitudinal vulnerability

Just like vulnerability, social capital is a term currently widely used and discussed (but only recently also in hazard research) (for an overview cf. Steinführer and Kuhlicke, 2007). The concept “has become one of the most popular exports from sociological theory into everyday language”, despite the fact that it “does not embody any idea really new to sociologists” (Portes, 1998: 2). Despite all the differences, in both conceptualisations social networks play a crucial part. Social networks form an important nexus between the individual and social structures. Therefore, network analysis is interested in the “in-between”, i.e. in the structure, quantity and quality of social relations as units of analysis. In the context of floods and other hazardous events, one might assume that social networks function as resources for information, material compensation, emotional support and physical help and are something exclusively “positive”. However, network theorists provide ambiguous hypotheses concerning the actual role of social networks in different situations. In this report, social capital will be used in a non-romantic manner (which is one of the criticisms related to Putnam (1993) by taking into account social capital as an individual resource (i.e. related to the various social networks a person creates and belongs to and the economic, social and cultural resources they provide) as well as a collective asset (i.e. a community resource for which trust and shared norms are basic requirements).

The question of how aware people are of a risk is not only a question of theoretical relevance; it also has relevant practical implications. How people decide and act, whether they consider themselves as being exposed to risks or whether they see themselves in the position to mitigate the risk of flooding is also influenced by the way how people perceive this risk. In this sense, some argue a

heighted awareness of a hazard is a first step for preventing the occurrence, or at least reducing its impact, and hence a central component of adaptation strategy. Which information do residents need in order to take preventive steps and which information do people trust? Risk awareness can be defined as the everyday processes by which humans perceive risk without referring to statistical data and exact calculation models. Risk awareness is hence the more or less intuitive awareness of risks based on the evaluation of its likelihood as well as its adverse consequences.

Physical vulnerability

Managing the physical vulnerability of the built environment implies considering the urban ecosystem, existing green areas, the use of land as well as buildings and the infrastructure. In short the overcall characteristics of manmade land cover. Fell (1994) considers the physical vulnerability of a location the expected degree of loss to an element at risk and in particular the built structure (ibid.; Fell and Hartford, 1997). Based on this rationale what is located on the land cover is what is considered vulnerable and that includes the built structure in addition to the population.

The role of the green structure for the protection of urban neighborhoods through flood and storm water retention, soil protection and mitigation of heat is particularly relevant to increase the coping and adaptive capacities of societies. We view the urbanization process and the management of ecosystem services as processes that cannot be disintegrated, rather combined in particular in locations which face potential hazards. As cities continue to grow, so do the resource demands imposed on the urban ecosystems and the impacts on the livelihood of populations.

Twelve core themes highlighted in table 5 are proposed to indicate climate change vulnerability in CLUVA. These themes were further developed into indicators as seen in Chapter 5.

Table 5: Identified vulnerability indicator themes.

Asset	Institutional	Attitudinal	Physical
Economic condition	Local governance structure	Social capital	Green areas
Education level	Local institutions and actors	Risk awareness	Land Typology & Use
Demographic structure			Infrastructure (social & technical)
Health			Housing

The ladder integrates the following themes which play an important role in adopting a multi-scalar' vulnerability as a concept that helps understanding different drivers and pressures that occur in anticipation to a natural hazard and identifies the strengths and weaknesses of different modes of vulnerability assessment.

Themes of Asset Vulnerability:

- Economic condition: The status of financial freedom and opportunities of an individual or a group which involves employment, type of economic activities and material wealth
- Education level: Commonly referred as education attainment in OECD terms is the ladder of learning experience from the more basic (e.g. literacy) to the more complex or abstract (e.g. post graduating studies)
- Demographic structure: Which aims at tracing certain character of an individual or group, by taking into account details related to the age, the household structure and composition age of occupants
- Health: The state of physical and mental wellbeing which is related with the presence or absence of diseases, the general condition of the body in response to its environment

Themes of Institutional Vulnerability:

- Local actors and institutions: include local actors directly or indirectly affected by the consequences of natural hazards or the impact of climate change as we as involved in their management. Institutions refer to formal and informal agreements regulating and governing their interaction. Good local governance contributes to the quality of lives of communities which considers citizen's voice and provide them with a platform for exercise their leadership.
- Local governance structures: include the "sum of the many ways individuals and institutions, public and private, manage their common affairs. It is a continuing process through which conflicting or diverse interests may be accommodated and co-operative action may be taken. It includes formal institutions and regimes empowered to enforce compliance, as well as informal arrangements that people and institutions either have agreed to or perceive to be in their interest." (Commission on Global Governance 1995: 2)

Attitudinal vulnerability:

- Social capital: Includes individual resources (i.e. related to the various social networks a person creates and belongs to and the economic, social and cultural resources they provide) as well as a collective asset (i.e. a community resource for which trust and shared norms are basic requirements).
- Risk awareness: Is defined as the everyday processes by which humans perceive risk without referring to statistical data and exact calculation models. Risk awareness is hence the more or less intuitive awareness of risks based on the evaluation of its likelihood as well as its adverse consequences.

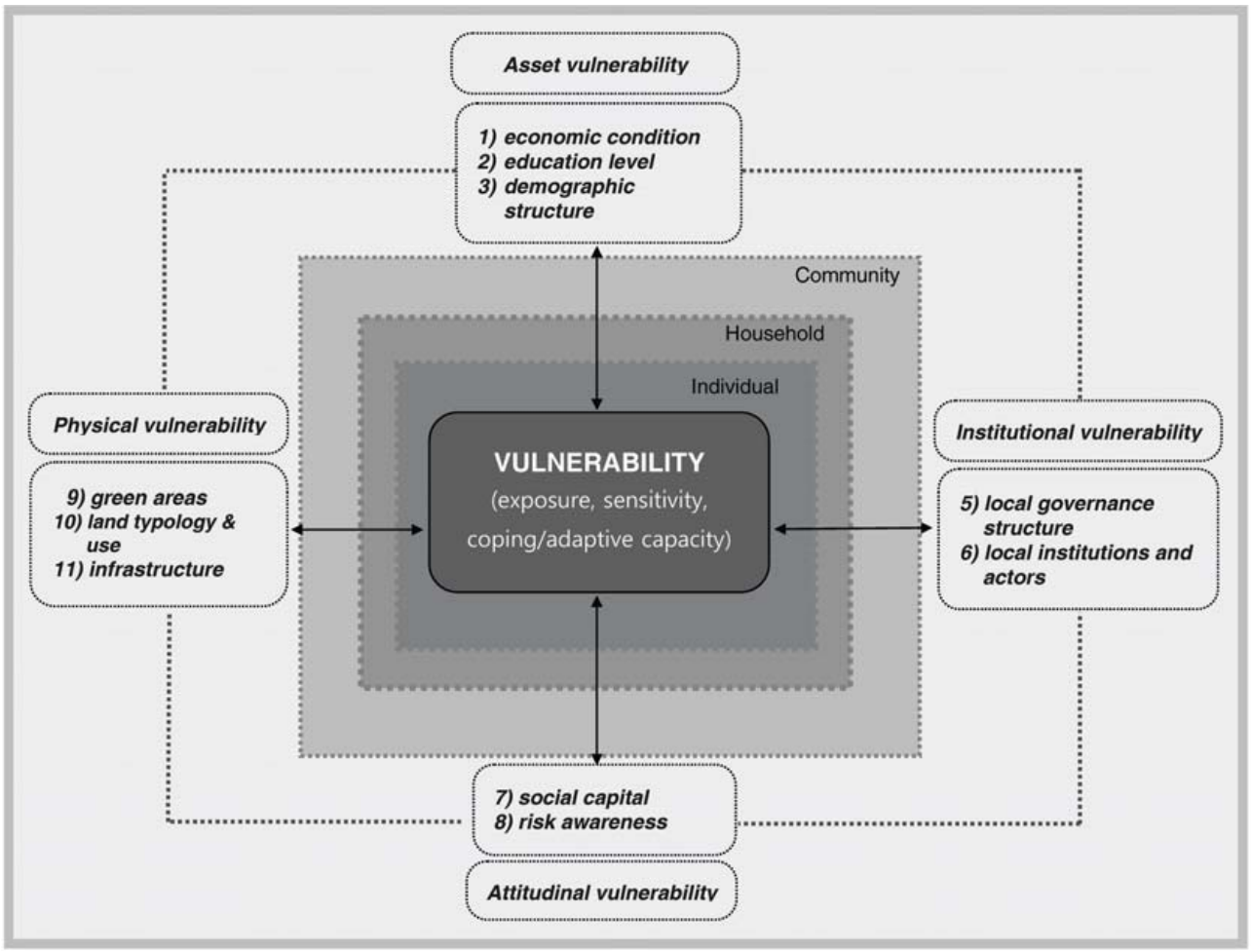
Physical vulnerability:

- Green areas: Parks, green lands, open areas play an important role in the urban environment. Green spaces along with their ecological benefits symbolize peace, help reduce stress and provide amenities for a community.
- Land typology and use: Is regarded as the nature of the land and its different types of exploitation, namely agricultural, industrial, military, residential, recreational, or other purposes. The term refers here as the systematic use of land and patterns of management and planning.

- Infrastructure: Is distinguished into social and physical infrastructure. The social infrastructure refers to the facilities that ensure education, health care, community development, income distribution, employment and social welfare to a population. The technical infrastructure commonly refers to existing energy and water supply services, as well as sanitation and transportation and communication system which represents the basic facilities needed for a community or society in an urban area to function.
- Housing: is considered as building and structures that individuals use to live in. In the context of CLUVA these buildings vary based on location, culture, economical characteristics.

Figure 5 combines the vulnerability ladder with its four dimension and related themes to form an interdisciplinary working framework for CLUVA. This ladder is followed by a discussion on mixed modes of assessment which may provide a more diverse repertoire of tools and hence more possibilities for in depth explorations at household and community levels.

Figure 5: Overall CLUVA model for a vulnerability ladder in urban areas.



FLOOD-PRONE AREA IN DAR ES SALAAM

4 MIXED METHODS FOR ASSESSING SOCIAL VULNERABILITY

Qualitative and quantitative methods have been both tested in the past to identify which group may be more sensitive to a hazard and what type of climatic threats they face (Adger et al., 2004; Chambers, 1983; Cutter et al. 2003; Mustafa et al., 2010; Tapsell et al., 2010; Vincent, 2004; Wisner, 2006). Contextual vulnerability assessments, which take into account the social dimension of populations, emerge largely from conventional research traditions which features important differences but aren't necessarily opposite (Kuhlicke et al., 2011). The fundamental difference between a qualitative and a quantitative research design is that the combination of measures using either words/open instruments or numbers/close instruments lean towards one way or the other. A qualitative approach has an inductive assessment inclination. Those who engage in this form take into account the participation of individuals (Chambers, 1989; Moser, 2009; Wisner, 2006). A quantitative approach retains a deductive assessment disposition. Those interested in measuring data by relating variables are more inclined to proceed this way. Quantitative vulnerability assessments commonly involve the selection of indicators[12] obtained by a combination of norms (Vincent, 2004; Adger, 2006; Birkmann, 2006).

Mixed methods represent a combination of qualitative and quantitative approaches. Creswell (2009) suggests that a mixed approach "resides in the middle as it incorporates elements of both" (ibid.: 3). This research paradigm emerged from the need to expend the scope of studies particularly in the social sciences realm where complex human and urban incidents mandate a combination of assessment approaches. In fact, the blend of methodological approaches is not new. In 1959 the idea of mixing different methods emerged from a pragmatic knowledge philosophical stance that allows the use of multiple techniques to data collection (ibid.). Mixed method may also include themes and pattern interpretations based on participatory vulnerability assessment as well as in depth explorations that are bound by location, time and activity.

[12] Although much more prominent in quantitative studies, indicators can also be assessed qualitatively. They are considered as potentially useful tools for measuring the causes or processes triggering vulnerability (see Chapter 5).

In CLUVA, mixed method assessment enables us to combine the quantitative data policy makers generally request and utilized and the nuanced and more complex qualitative determinants that provide other type of explanations as to what are the coping capacity and resilience of at risk population. The mixed method approach allows multiple forms of vulnerability assessment drawing on all possibilities. This includes for instance, the convergence of pre-existing statistical/census data with a strong correlation between socio-economic and/or demographic settings and vulnerability along with focussed sessions providing the opportunities for interactive work and the exploration of less quantifiable data. Table 6 summarizes the difference between qualitative, quantitative and mixed assessment.

Table 6: Difference between qualitative, quantitative and mixed assessments.

Qualitative assessment	Quantitative assessment	Mixed assessment
Exploring and understanding the meaning individual or groups ascribe to a particular problem – Building from participatory processes – Flexibility in the structure – Complex situation	Examining the relationship between variables. They are then measured in a way that data can be obtained in the form of numbers using statistical procedures – Deductive procedure	Combination or association of qualitative and quantitative research elements in tandem which goes beyond simply collecting and analysing both kinds of data.

Adapted from Creswell, 2009.

4.1 QUANTITATIVE VULNERABILITY ASSESSMENT

When it comes to assessing vulnerabilities in urban areas, a demarcation can be made between quantitative and qualitative modes of inquiries. Each procedure relies on different techniques and allows different practices and interventions. A quantitative vulnerability assessment follows a normative/deductive approach based on indicators and indices, while a qualitative vulnerability assessment features a participatory/inductive approach based on stakeholders and participants' own identification of vulnerability and capacity (Kuhlicke and Steinführer, 2010; Kuhlicke et al., 2011).

Quantitative methods often aim at identifying areas, actors, communities facing the most threat and in greatest need. The dominant assumption is a strong correlation between the socio-economic/ demographic sphere in other words the asset of an actor or a group within its immediate context (may it be physical or institutional). The purpose is to classify identified groups or location with a goal of measures and strategies implementation.

Some advantages of quantitative approaches are (based on Kuhlicke et al., 2011):

- Vulnerability is put on the public agenda and inserted in government rational (Benson, 2004)
- Provide information for strategies measures and plans
- Provide simple and understandable information and allows comparison of the vulnerability of specific areal units (e.g. locality, regions, nation states) (Fekete et al., 2009)

Potential limitations and challenges are:

- Often fail in that they produce too many 'false positives', as, for example, not all elderly people are equally vulnerable throughout the entire risk cycle (Wisner et al., 2004)
- Mostly rely exclusively on statistical (e.g. census) data or on the use of quantitative techniques neglecting the local/regional context (AEA, 2008; Pelling, 2007; Wisner et al., 2004)
- Challenge of down-scaling the assessment as many national level assessments can result in loss of information and capturing local pockets of variability
- There is a lack of empirical studies of social vulnerability hampering the validation of indices and indexes (Fekete, 2009; Kuhlicke et al., 2011; Tapsell et al., 2010)

Quantitative procedures are confirmatory by nature (Teddlie and Tashkkori, 2009: 23). Vulnerability assessment may often take the form of deductive, logic and model based procedures which aimed at providing numeric answers to questions such as: who is vulnerable? Vulnerable to what? Who should provide solution when faced with a climatic event? The assessment procedures centre mainly on two aspects: 1) describing the vulnerability phenomenon and/or 2) looking for differences between groups or among hazard variables. The attributes and procedures commonly undertaken are illustrated below:

Table 7: Quantitative attributes and procedures.

Quantitative attributes	Quantitative procedures	Examples
Top down structure dependent on indicators and indices measuring and comparing policy oriented appraisal	Official statistical and census data analysis	BBC model (Birkmann and Co., 2006) SoVI index (Cutter et al., 2003)
	Questionnaire	
	Maps and mobility log book	
	Aerial photos	

Adapted from Kuhlicke and Steinführer, 2010.

Quantitative approaches are indicator-based modes of inquiry largely dependent on statistical data and based on measuring and comparing units of measurement. This method is particularly prone to the aggregation of variables and proxies, the standardization of components, mapping on categorical scale as well as regression exercises. These are approaches that are policy related as they offer a mean to measure an event or a progress. Decision/policy makers often require simple, clear, quantitative information and tend to favour quantitative modes of assessment.

4.2 QUALITATIVE VULNERABILITY ASSESSMENT

Qualitative methods in turn, seek to better understand actors' own perception of vulnerability and capacities to cope and adapt to possible threatening climatic events, as opposed to quantitative modes of inquiry. There isn't a dominant assumption; a qualitative approach explores multiple realities in contrast with a predicting, controlled and single truth. Actors are therefore encouraged to

provide their own interpretations of their own vulnerability. This approach is inherently context-based as participants describe their needs as well as the difficulties they face in their own communities. The purpose here is to identify various forms of capacities, to reinforce their level of transferability and raise awareness at level.

Some advantages of qualitative approaches are (based on Kuhlicke et al., 2011):

- Actors can identify and assess their own vulnerabilities and capacities (Bankoff et al., 2004; Pelling, 2007)
- Allows the integration of local stocks of knowledge, experiences, and perceptions into the assessment
- Makes different and possibly conflicting views and opinions apparent and allows mutual learning processes

Potential limitations and challenges

- Up-scaling is a challenge as results are dependent on the definition
- Context and therefore, making comparison and aggregation across locations difficult

Qualitative procedures are often but not always explorative by nature (Teddlie and Tashkkori, 2009: 25). Vulnerability assessments may often take the form of inductive, narrative based procedures which aimed at arguing from the particular to the general. Qualitative interventions aim at responding to questions such as how does vulnerability manifest? How actors cope with particular events? Why consider local-based resolution when faced with a climatic event? The assessment procedures conducted focus on the following aspects: 1) describing the different interpretations of the vulnerability phenomenon 2) identifying key multipliers and empowering them 3) providing platform for exchange, communication and change between interest groups. The attributes and procedures commonly undertaken are illustrated below:

Table 8: Qualitative attributes and procedures.

Qualitative attributes	Qualitative procedures	Examples
Bottom up structure contextualizing and patterns interpretations identifying capacities and empowering actors	Interviews with key actors	PAR model (Wisner et al., 2004)
	Participant observation	
	Everyday life story capture	
	Workshop within case studies	PCCAA (Moser et al., 2010)
	Audio visual use	

Adapted from Kuhlicke and Steinführer, 2010.

Qualitative approaches are inherently multiple source methods as they rely on a diversity of tools such as interview and observation to make sense of the differentiate context of vulnerability. Qualitative procedures are natural setting prone, meaning the data is collected from the locations where the problems and/or phenomenon occur. The entire procedure focuses on understanding the meaning of particular vulnerability issues. For instance, with regards to social capital issues at household and community levels, qualitative procedures are more likely suitable to capture the extent to which locals trust the institutions and organizations that operate among them and how their voices are heard.

4.3 MIXED VULNERABILITY ASSESSMENT

In recent years, the utility of a combination of quantitative and qualitative modes of inquiry have been seen to simultaneously address situational and causal questions. This is due to a growing recognition of the quality of both techniques. Mixed methods when applied adequately provide better and stronger inferences (Teddlie and Tashkkori, 2009). That is to say that mixed methods are able to broaden the combination of assessment techniques particularly regarding sampling, data collection and data analysis.

There is a growing recognition of vulnerability assessment as being both vertical and horizontal (Tapsell et al., 2010). It suggests therefore that several layers of explanations are required to adequately pin point the causes of stress in a given society. The decision for combining qualitative or quantitative approaches rest in the type of research questions posed. Indeed the choice of vulnerability assessment methods lies in what needs to be assessed and what is the most efficient sustainable and sensible way to conduct this assessment. The literature illustrates some questions that may help clarify the selection of appropriate vulnerability assessment methods (Kuhlicke and Steinführer, 2010; Tapsell et al., 2010; UNU-EHS PhD Block Course, 2011):

- Who and what is vulnerable?
- Vulnerable to what? (stressors/hazards)
- In what context and circumstances? (location)
- Who want to know and why? (actors, interest)
- What type of information is required?
- What is the purpose of the assessment? (use of end product)

Questions such as ‘Who is vulnerable?’, ‘What is vulnerable?’ or ‘What is the context and circumstances of vulnerability’ have different focus and have been traditionally associated with situational data. While inquiries formulated along the lines of how does vulnerability manifest among those at risk and why are more concerned with causal attributes. These questions carry different meaning and have different strengths. They lead to different types of answers which require data sources based on data collection methods either more compatible with quantitative (i.e. confirmative) or quantitative (i.e. explorative) methods.

Among quantitatively leaning vulnerability assessment tools are remote sensing, field surveys and the use of local statistics, known to highlight exposure of the critical infrastructure and settlement areas (Birkmann, 2006). Fekete (2009) used for instance a set of socio-economic and survey data and used factor analysis to identify and categorize variables correlated with floods. Another common practice is mapping vulnerability to determine at risk locations and population. O’Brien et al. (2004) note however that some maps may be misleading at a more detailed level and differences between vulnerability groups within certain communities are not necessarily captured in vulnerability maps. Hazard modelling techniques are also used to evaluate for instance the potential impact of heat waves (Kropp et al., 2009). The use of data census is known to help determine demographic vulnerability. However there is a risk of overlooking intangible factors as well as a segment of the population who may not be considered in official numbers or are not easily identified by maps due to their nomadic nature. Other well-sought techniques are remote sensing unknown aspects of vulnerability or identified exposed groups. Components of vulnerability could be then standardized per building blocks based on the identification and aggregation of relevant variables (Ebert and Müller, 2010). These techniques require however a certain degree of manpower as well

as computing knowledge and technology (e.g. latest available version of topographic dataset). Additionally it may not entirely serve the purpose of providing internal structure of households located in flood prone areas.

More qualitative tools are structured interviews used to evaluate the conditions and perceptions of direct physical impacts; as well as institutional mapping, listing and ranking and the development of matrices which aim at identifying the significance of institutions supporting local adaptation to potential hazard (Moser et al., 2010). The entire qualitative assessment process keeps a focus on participants (Chamber, 1989; Mustafa, 2005) and attempts to understand the meaning that they hold about the risk they face. In that sense, this approach may offer more context-based answers to the question related to 'who and what is vulnerable?'. This however does not come without challenges. Participatory assessments can be time-consuming, the process depends on the level of commitment of different actors and transferability as well as comparability remains an issue (Chambers, 1994).

With CLUVA, multiple interactive techniques are recognized as not only useful but necessary. CLUVA's objectives cannot be met by neither quantitative nor qualitative methods exclusively as one approach is not enough to accurately answer the multidimensional aspects of vulnerability in CLUVA cities. This lead us to consider how to best couple numerical and graphic techniques with participatory modes of inquiry in other words what are the mechanisms for working back and forth between concerns deep-seated in communities and larger database source such as census data and maps. Mixed methods provide the opportunities for presenting a 'stronger inference' 'greater diversity of divergent views' (Tashakkori and Teddlie, 2003: 15). The latter is particularly central to converge both outcome and contextual vulnerability assessment in CLUVA.

Table 9: The utility of mixed methods for CLUVA.

Stronger inferences within tasks and between CLUVA WPs	Complementary attributes for instance the use of maps at community and city level offers a greater breath of vulnerability studies and the use of interviews with community leaders offer a greater depth in the conditions of a particular setting. The combination of both offers more accurate interpretations.
Greater diversity of results from outcome and contextual vulnerability perspectives	CLUVA involves the points of views of different disciplines with sometimes divergent perspectives. Mixed methods offer the possibility of including views instead of dismissing them. This lead to a re-examination of conceptual frameworks and assumptions underlying research results.

GREEN ALLOTMENTS IN ADDIS ABABA

5 INDICATORS FOR ASSESSING VULNERABILITY

5.1 OVERVIEW OF FUNCTIONS AND DEFINITIONS OF INDICATORS

The practice of using indicators (i.e. indexes) to assess the vulnerability of populations at both national and local levels was reinforced in the final document of the World Conference on Disaster Reduction, the Hyogo Framework for Action 2005–2015 (Hyogo framework for Action 2005–2015; United Nations 2005) and is at the core of Task 2.3. The report stresses as priority actions the development of indicators to assess the impact of disasters on social, economic and environmental conditions as well as the need to horizontally communicate the results to decision makers, stakeholders and the population at risk. The call here is for the international community to develop realistic and measurable indicators with the following purposes:

(1) Develop and track progress in disaster risk reduction

(2) Enable decision-makers to assess the impact of disasters

(3) Support early warning systems

(4) Conformed with the respective development goals of the Millennium Declaration

Indicators are widely used. Their extensive application can be found not only in risk assessments but also in planning, in health, in environmental protection and many other fields where there is a certain requirement for policy, monitoring or evaluation. This means that indicators have different purposes and may take various forms. They can be considered as ‘measurement categories’ or may also serve as an evaluation instrument (Siedentop and Wiechmann, 2004). They can be used as tools, as communication and/or awareness instruments for political and practice purposes. They are also utilized for research activities and monitoring functions (Weiland et al., 2011). Urban indicators for instance, can be identified as ‘rate indicators’ having the purpose of describing a change over time, as ‘goal/steering indicators’ which focus rather on a given objective or as ‘performance indicators’ which are commonly utilized to evaluate behaviours within any given political setting (Weiland, 1999). A review of social indicators conducted by Fenton and McGregor (1999) lead to the proposal of the following functions: ‘informative indicators’ used to provide a description of the

social context and associated changes. 'Predictive indicator' fitting to specific social sub-systems, 'Problem-oriented indicators' focused on policy and action, 'Program evaluation indicators' used to monitor a progress and finally 'Target delineation indicators' used to identify subgroups towards which policy is directed. Most recently, Perdicoúlis and Glasson (2011) stress three types of function of indicators in relation with planning tasks, adapted from Hezri's 'taxonomy of indicators' (2004). They are: 'alert' (relating to standards of operation), 'calculation' (referring to numerical attributes), and 'understanding'/'modelling' (conveying a certain replication function of indicators) (ibid.: 361).

The breath of indicators was stressed by Flowers et al. (2005), who recognize the range of functions attached to the term as well as the profusion of terms used as indicators. Indicators[13] can sometimes travel under other aliases such as profiles, factors or variables. This may be attributed to the fact that although not perfect or unique, indicators generally tend to provide a representative estimation of what is considered important in a given system (Perdicoúlis and Glasson, 2011). Moreover this abundance of associated terminology and interpretations may well rest in the complex processes associated with urban, environmental, climatic changes as well as the interconnection between different fields of research.

The use of indicators appears repeatedly in the vulnerability assessment literature, as they are perceived as tools that can – when applied adequately – predict the likely effect of a disaster (Briguglio, 2003) and are found useful for measuring development and change overtime. According to Schneiderbauer (2010), indicators make the complex, abstract and multidimensional concept of vulnerability operational. In order words, indicators rationalise the concept of vulnerability into measurable constructs that help evaluate the state of a system or organization.

Using indicators to assess the degree to which people are susceptible to a hazard has a long history. Several approaches appear to dominate the literature on indicator development: Deductive approaches are theoretically centred using frameworks and models while inductive developments are data driven (AEA, 2008; Harvey et al., 2009; Schneiderbauer, 2010). Both approaches use past and present knowledge to develop indicator components and appear to be more leaning to a quantitative mind frame. In contrast the third approach known as a normative stance involves 'subjective' criteria from experts or stakeholder. This in turn relates more to a qualitative thinking which involves a more intuitive value judgement based on observation and experience in the field.

Given the fact that there is no shortage of indicators to assess vulnerability, the challenge in CLUVA will be to establish comprehensive criteria for choosing the appropriate indicators as they vary in definitions, conceptual frameworks and schools of thought. According to Gallopín (1997) an indicator is a sign that expresses or 'summarizes' information relevant to a particular event (ibid.: 4). Birkmann (2006) in return refers to an indicator as "a variable which is an operational representation of a characteristic or quality of a system able to provide information regarding the susceptibility, coping capacity and resilience of a system to an impact of an albeit ill-defined event linked with a hazard of natural origin" (ibid.: 57). Both definitions refer to a certain measuring competence that indicators have to provide an estimation of a phenomenon. The following table offers a selection of other definitions found in the literature.

[13] We make a distinction between an indicator and a variable. The difference is that many indicators have a compound nature with a certain level of abstractness, whereas variables are descriptive and attached to a specific value. In that sense, the set of indicators presented below may include qualitative or quantitative variables considered as components of an indicator.

Table 10: Selected definitions of indicators.

(Working) definitions of indicators	Reference source
Something that provides a clue to a matter of larger significance or makes perceptible a trend or phenomenon that is not immediately detectable. [...] Thus an indicator's significance extends beyond what is actually measured to a larger phenomenon of interest.	Hammond et al., 1995
Indicators are variables that represent systems' attributes (quality, characteristic, property) and thus inform about the condition and/or trend of the attributes which in the end is essential for decision-making.	Gallopín, 1997
A summary and synthesized measure that indicates how well a system might be performing. An indicator is used to indicate a concept, construct or process that is not possible to be measured directly.	Flowers et al., 2005
Quantitative or qualitative factor or variable that provides a simple and reliable means to measure achievement, to reflect the changes connected to an intervention, or to help assess the performance of a development actor.	OECD/DAC, 2002
Environmental indicator: A parameter or a value derived from parameters that describe the state of the environment and its impact on human beings, ecosystems and materials, the pressures on the environment, the driving forces and the responses steering that system. An indicator has gone through a selection and/or aggregation process to enable it to steer action.	Schauser et al., 2010
Indicators are functions from a couple of observable variables to a non-observable variable e.g. vulnerability. *Harm indicators* evaluate a state of an entity based on normative judgements of what constitutes a good or bad state. *Vulnerability indicators* indicate possible future harm including both the forward-looking aspects as well as the normative aspect of defining harm.	Hinkel, 2009, 2011
An indicator can be defined as a sign or a signal transmitting a complex message in a simple and useful manner. They reflect particular aspects of a system's condition and are used to describe status, forecast change, identify stressors or stressed systems, assess risk, and influence management actions.	Kurtz et al., 2001
Indicators are a kind of measurement. They are generally sets of information used to determine the status quo or changes of a characteristic of a system.	Schneiderbauer, 2010

Among many indicators initiatives are the efforts of intergovernmental agencies, research institutions as well as universities who have produced a large amount of work on measurement techniques. Perdicoúlis and Glasson (2011) highlight the work of OECD, EEA, UN-DESA, US-EPA, and the World Bank. Such types of commonly use a large number of potential vulnerability indicators from a palette of indicators, which as mentioned before are driven either by 'data' or by 'theory' (Vincent, 2004). The World Bank alone offers about 800 indicators[14] from which 298 indicators are viewed as popular World Development Indicators (WDI)[15]. They are drawn from 1960 to 2010 from

[14] Also noted by Vincent, 2004.
[15] For more information See: http://data.worldbank.org/data-catalog/world-development-indicators.

about 209 countries. Selected themes covered by the World Bank are agriculture & rural development, infrastructure, urban development, poverty, education, environment, labour and social protection, public sector and social development, which are in fact related to some extent to themes associated to the contextualization of vulnerability. The table below illustrates four examples of relevance of WDI themes in vulnerability assessment practices.

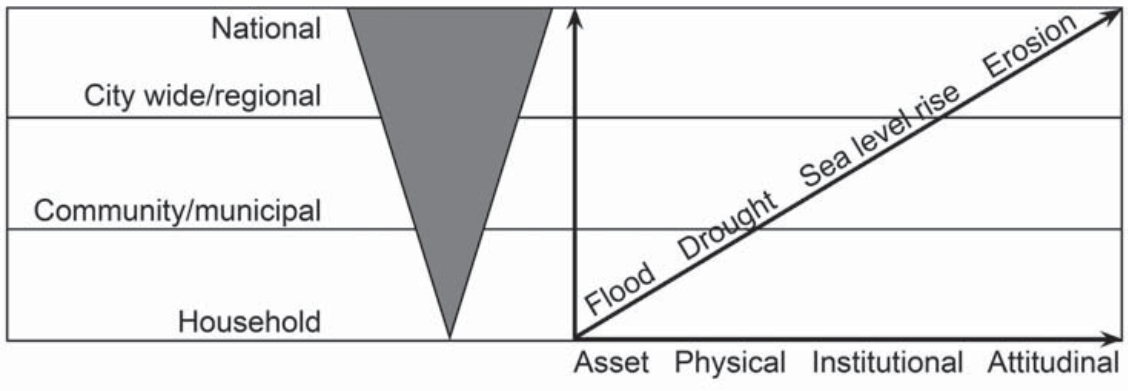
Table 11: Relevance of WDI themes for contextualizing vulnerability.

Selected WDI themes	Relevance to vulnerability assessment
Infrastructure	Evidence infrastructure and effectiveness of urban services can provide some insight to the physical condition of a region and its level of exposure and susceptibility to natural hazards in urban areas.
Poverty	Evidence of lack of assets and/or the percentage of people living under the poverty line poverty provide an overall picture of the degree of vulnerability of a population.
Education	Evidence of education attainment is a measure of human capital (UN, 2007). It has an important linkage to human resources and access to information as well as the set of skills of populations, all relevant when facing climate threats.
Health	Health system at a national level includes all organizations, groups and individuals that can restore and maintain health. Floods, droughts and any other severe weather events put more pressure on health facilities and may cause the system to fail.

It is then not surprising that vulnerability indicators stem from development indicators. Often, the choice of macro-scale indicators as determinants of vulnerability is based on expert choice and extracted from statistical systems from different governments. National level vulnerability indicators are commonly based on generic measures of “economic wealth, inequality, food availability, health status, education, physical and institutional infrastructure, access to natural resources and technology, and geographical environmental factors” (Agder, 2004: 45).

The question of scale or spatial level is of particular importance in the development of indicators as it contributes to scoping what exactly needs to be assessed. In the view of King and MacGregor (2000), “the construct of intent determines the scale” (ibid.: 53). National or multinational indicators are often conceptualized to reflect some kind of progress. They are developed to join past and present initiatives to future objectives and are based on a broader national agenda (Philips, 2003). These indicators are usually aggregated from two or more values in the form of an index (Gallopín, 1997) and contrast with local-based indicators having more specific desired outcomes. Community indicators for instance are more useful to pin point the demographic characteristics of vulnerability whereas household indicators might be more useful to determine the relative vulnerability of identified at risk groups. In both cases, participation rates should be taking into account as they allow communities to recognize its physical and social resources.

Figure 6: Relation of indicators to the scale and dimension of vulnerability in CLUVA.



There are several compilation of vulnerability indices with focus in developing countries. They highlight a range of indicators, components, variables and proxies and the extent to which they attempt to measure vulnerable conditions. See the work of Tapsell et al., 2010; Thornton et al., 2006 and Vincent, 2004. Tapsell et al. (2010) for instance summarized 20 social vulnerability indexes or approaches mostly applied in Europe, the United States and Australia. Regrouped by hazards, scale and modes of assessment, most of the indicators identified, remain at a level which provides a general type of demographic and economic characteristics, spatial, infrastructural and institutional structure of a particular vulnerable group. This generalization implies however, that the social vulnerability of individuals and households are yet to be fully captured. Furthermore, on the question of social vulnerability indices, there is evidence of a disproportion in the knowledge generated in terms of indices generation as opposed to indices validation (Fekete, 2009). In that regard, effort should be made in CLUVA not only to accurately identify indicators adequate to the African cases studies but also to evaluate and test their relevance/acceptance.

In CLUVA, we propose to consider indicators as:

> *composite terms that inform us and can provide a type of measure to evaluate the conditions of at risk populations and to estimate their exposure, susceptibility and/or coping and adaptive capacity with regard to the impact of natural hazards. They serve as an assessment tool that indicates a phenomenon and help us measure and communicate different realities of urban vulnerability. Indicators for vulnerability assessment are inherently linked to the mode of assessment. They can be in principle quantitative or qualitative. In any case they must be understandable, valid and context-sensitive.*

There are considerable constraints surrounding the use of indicators in measuring vulnerability. Despite that many indicators and indices have been introduced and are used by risk managers and local councils. This Chapter offers merely a snapshot on the use of indicators. For more extensive contributions on the subject see (Adger et al., 2004; Barnett et al., 2008; Birkmann, 2006; Briguglio, 2003; Brooks et al., 2005; Eriksen and Kelly, 2007; Gallopin, 2003; Thornton et al., 2006; UN, 2007; Vincent, 2004; Vincent and Cull, 2010; Weiland et al., 2011) among other publications. We merely aimed at highlighting the breath of indicators as an introduction to the following set of identified indicators. This set is based on the proposed CLUVA vulnerability ladder in urban areas and initials discussion with CLUVA partners in an attempt to integrate both theoretical/model-driven and context-based indicator development approaches.

5.2 PRELIMINARY INDICATOR SET IDENTIFIED TO ASSESS VULNERABILITY IN URBAN AREAS

Considering that vulnerability indicators can be selected from a great and divergent mass of information from either primary or secondary data sources, the set illustrated in tables 12 and 13 does not embody nor present all possible indicators for vulnerability assessment. It highlights rather those that are more predominant in the recent vulnerability discourse; those that have been applied or tested in the past and that have been discussed in working sessions as potentially suitable in CLUVA cities. In essence their aim is to reflect the interaction between social, environmental and institutional factors, which play a role in the vulnerability of individuals, households and communities.

The indicators proposed follow up on discussions held during two working sessions focusing on social vulnerability assessment at the CLUVA Kick off Meeting in Ouagadougou, Burkina Faso (15–22 January 2011) and during two workshops organized by CLUVA partners in Addis Ababa, Ethiopia (8–10 June 2011) and Dar es Salaam, Tanzania (13–18 June 2011). In Ouagadougou, it was established that the review of indicators should be conducted based on selected relevant literature and local knowledge. The sessions in Addis Ababa and Dar es Salaam revolved around identifying context-centred indicators.

The sessions conducted in Addis Ababa included CLUVA European and African partners as well as stakeholders from Addis' local institutions. Participants were asked to take part in a brainstorm exercise on indicators that may best fit each vulnerability dimension. As shown in Figure 7, indicators for themes related to the economic condition, education level and demographic structure of affected population were clearly identified. Items as 'source of income', 'years of schooling', 'able to read and write', 'family status' were noted and discussed. There was a general agreement relative to the indicators proposed for asset vulnerability. The level of income or the proportion of working individuals was seen as key item which play a role in the safety net of household in Addis, along with the demographic structure which was considered particular central to evaluate the degree of burden on the household given that women, elderly, children and disables are more dependent, therefore potentially at risk.

Answers such as 'distance from transport & infrastructure', 'level of involvement in focal groups', 'level of enforcement of existing laws' corresponded to institutional vulnerability themes. These type of indicators were difficult to pin point, hence emerged the idea of assessing the institutional vulnerability in a qualitative manner. It was suggested that a more detailed set of questions were necessary to investigate the degree to which locals were heard and what are the mechanisms of communication between local residents and their leaders.

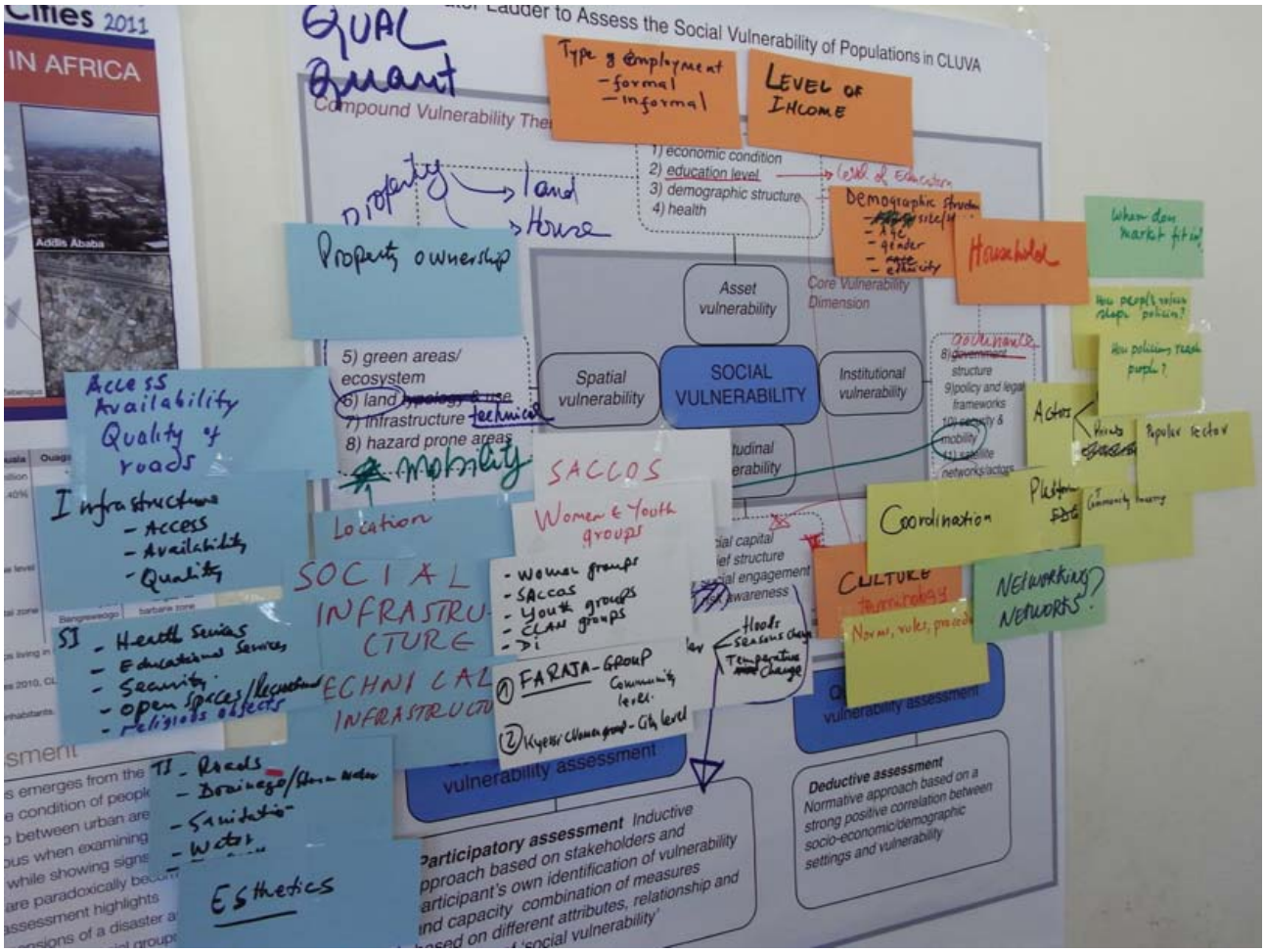
Figure 7: Results from Task 2.3 session on indicators for vulnerability assessment during the Addis Ababa workshop.

Responses associated to social capital and risk awareness included for instance ‘number of activities related to flood prevention’, ‘number of religious structure in a community’, ‘number of CBOs’ and ‘amount of Mahber’. The latter represents the number of locally based affiliations typical for Addis. They are described by Addis partners as followed:

> *“Local people collect money among them; it is a mutual assistance. You invest your own money and you take it later. This system of mutual assistance at the local level is common in Ethiopia. It is run by an informal organization, with community who organises and manages the money. The local community chose a leader among themselves especially the financial leader. It is a group of people who have a common understanding: they live together or they are friends. If you need money to buy something and you don’t have access to bank, you can get it from the community. Here you are force to save money every month.”*

In Dar es Salaam, discussions revolved around Task 2.3’s conceptual approach of vulnerability as well as indicators fitting to both formal and informal urban contexts. As shown in Figure 8, indicators highlighted for asset vulnerability were for instance ‘level of income’, ‘type of employment’ (formal/informal). Additionally, variables such as age and gender were emphasized to capture the demographic structure in households. It was observed that the type of employment (i.e. source of income) played an important role in capturing the asset-specific effects of vulnerability in identified study locations.

Figure 8: Results from Task 2.3 session on Indicators for vulnerability assessment during the Dar es Salaam workshop.



During discussions on institutional vulnerability, keywords such as ‘public, private and popular sector’, ‘private actors’ ‘community meetings’, ‘coordination’ were not considered as indicators per se, as they don’t offer a mean of evaluating local government structures. As it became difficult to narrow the concept into a single measurable construct, a series of questions were rather raised. It was concluded that relevant indicators could be related to the existence of platforms for group discussion or instances when people could express their concerns and raise them to a higher level. This implies answering questions ‘how people’s voices shape policies and how policies reach people? Is there a policy to coordinate different actors?

While addressing the question of social capital and risk awareness, the concept of Savings and Credit Cooperative Society (SACCOS) was presented as an example of grassroots affiliations which play a central role in the coping capacity of individuals. SACCOs are a network of credit unions in Tanzania. They are grassroots financial institutions which offer their members a savings opportunities and access point to loans and serves as a valuable support system against unexpected illness, accident, family death or any other emergency including floods.

With regard to the physical conditions that may influence the vulnerability of individuals and groups, participants highlighted the following indicators: ‘property ownership’, ‘size and location of buildings’ ‘availability, access and quality of technical infrastructure (roads, drainage, water, sanitation, energy)’ as well as ‘social infrastructure (health, education, security, open spaces, religious objects)’. It was observed that indicators attached to asset and the physical vulnerability were more adapted for a quantitative assessment whereas attitudinal and institutional indicators responded more to a qualitative mode of inquiries.

Both workshops in Addis Ababa and Dar es Salaam were proven to be determinant in identifying quantifiable and explorative indicators that provide information on matter of significance fitting to the context of these CLUVA cities. The sessions essentially brought forward some key items that should be considered and also served as platforms for clarifying terms that may have different significance depending on their context.

Table 12 exposes indicators identified at a household level, while table 13 highlights those used at a community level. Household indicators offer an insight on the livelihood of individuals, whereas community indicators might help local leaders recognize the physical and social resources they have to address collective problems. The differentiation between indicators at household and community levels is relevant here because each scale adopts different values in time, space, population and therefore has difference significance. Household level indicators for instance, are based upon more personal and domestic factors.

Table 12: Selected vulnerability indicators at household level.

GENERIC HAZARD TYPE			
Theme	**ID**	**Identified indicator**	**Description**
Hazard prone area	i1	Location of buildings in hazard prone area	Indicates the location of buildings or settlements identified in hazard prone areas. Determines the likelihood of damages in an area by water flow, water stagnation and waste water floods
	i2	Type of hazards identified	Indicates potential damages by providing accounts of past climatic events having an impact in human and economic livelihood of the household

ASSET VULNERABILITY			
Theme	**ID**	**Identified indicator**	**Description**
Economic condition[16]	i3	Source of income	Indicates the level of employment or type of economical asset in the household. An important consideration is evaluating whether incomes reported are 'stable' regardless of local hazards. This implies a certain level of preparedness or capacity to take measures against a potential risk
	i4	Material asset	Indicates the existence of goods and material capital in the household
Education level[17]	i5	Level of literacy	Education plays a central role in coping and adaptive capacity as it is linked to access to information and resources as well as better risk acknowledgment, which ultimately reduces vulnerability. The level of literacy indicates the number of household occupants being literate and the years of school designate the level of school attendance (primary, secondary and tertiary) or number of years of school. Common variables are 'no. of household occupants with primary/secondary education', or 'years of school', or 'highest school degree in the household'.
	i6	Years of school	
Demo-graphic structure	i7	Household size	Indicates number of residents living and sharing financial responsibilities per residential unit, this indicator designates the number of people (men, women, children and elderly) that may be either affected or capable of coping with a disaster. It has been seen that large households may also be better equipped to resist possible natural threats due to their extended social networks and manpower (Ebert, 2011)
	i8	Household composition	It relates to the family or relationship structure in a household and intent to capture existing co-residency characteristics. Associated variables are age and gender[18]. Attention to gender is due to the fact that women along with children and elderly appear to be more vulner-able as their capacity to act may be restricted (Cutter et al., 2003;, O'Brien and Mileti, 1992; Wisner et al., 2004) In some cases, the ethnic, clan or group affiliation of household occupants may provide clues related to their heritage, distinctive culture and common language
	i9	Ethnic background	
Health	i10	Medical condition/ problems	Indicates the existence of waterborne diseases and other chronic health threats in the household. Variables can include the average number of unhealthy days in the past month (CHSI, 2009)

ATTITUDINAL VULNERABILITY			
Theme	**ID**	**Identified indicator**	**Description**
Social capital	i11	Level of trust	Indicates the level of trust extended to other members of the household
	i12	Degree of social inclusion	Indicates an increase or decrease of social isolation in the form of kinship ties. An associated variable is the proximity, which immediate family members live from one another (Mustafa et al., 2010) or the level of closeness of family relations.
	i13	Level of social network	Indicates the number and types of memberships, professional/social/financial, religious or sport organizations a household member belongs to. Also provides information on the degree to which there is cohesion of groups of households
	i14	Degree of collective action	
	i15	Length of residence	Indicates the number of years living in the dwelling unit. This is particularly relevant to dwellers living in hazard prone area as this indicator signals the degree to which occupants are aware of potential risks
Risk awareness	i16	Perceived risk	Indicates the recognized risk that individuals occupants face in the household
	i17	Hazard experience	Relates to any previous experiences or account of (death, damages, injuries, material losses) due to a disaster. Could be expressed as the number of human and/or material loss. The indicator provides an estimate of human and economic impact of a potential disaster in the household
	i18	Knowledge of protection measure	Indicates the level of awareness and knowledge about possible resources and measures to resist, cope and adapt to a possible disaster
	i19	Training of health and emergency human resources	Indicates the degree to which individuals have access to education and awareness raising programs

[16] Evaluating the economic condition of affected or at risk population is common practice in both quantitative and qualitative assessments. Economic resources are generally considered a sign of opportunities and ability to overcome threats. In developing communities these resources take different shapes (i.e. stable employment, informal occupation, material asset such as land, properties and livestock, small businesses, selling goods, micro finance support, among others). Mustafa (2010) suggests that the diversity of livelihoods is a contributor to capacity and the stability of livelihoods, a contributor to vulnerability.

[17] Any indicator assessing the education level needs to be context relevant, as education systems in CLUVA cities may differ from one another. A way of overcoming these differences is to calculate the years of school.

[18] Gender is commonly associated to vulnerability. Studies focusing on women facing hurricanes have shown that women suffer the impact of extreme climatic events disproportionately then men. Women living alone are more likely to have informal income, their ability to act swiftly and seek safety maybe restricted by their responsibilities as care-takers (Enarson and Morrow, 1997; Morrow 1999).

INSTITUTIONAL VULNERABILITY			
Theme	**ID**	**Identified indicator**	**Description**
Local governance structure	i20	Type of local government	Indicates the existing structure through which residents' voices are heard and whether their concerns are taking into account in local government plans. Also indicates the degree to which local residents can express their needs. May also provide signals related to the degree to self-mobilization at household levels
	i21	Participatory decision making	
Local institutions and actors	i22	Existence of CBO, NGO and other local institutions	Indicates the degree to which households have access or contact with local institutions and whether they have benefited from them
	i23	Existence of an emergency plan	Indicates the awareness or knowledge of existence of any emergency plan

PHYSICAL VULNERABILITY			
Theme	**ID**	**Identified indicator**	**Description**
Green areas	i24	Existence of trees	Indicates the number of existing trees in proximity to the household. Trees intercept rainfall and reduce urban run-off into sewers improving water quality and also prevent soil erosion
	i25	Existence of green parcels or urban cropland area	Indicates the practice of farming for income earning or food producing purposes in the household. This indicator is known to be linked to food security and food safety factors (UN, 2007)
Land use	i26	Density	Indicates the number of persons per residential unit or cultivable land. Indicator can be linked with household size
	i27	Land ownership and property title	Indicates the degree of welfare of a household derived from ownership. Also determines different usage rights
	i28	Land use change	Provides information on changes in productive and protective uses of land for the establishment of dwellings (UN, 2007). Also provides signals on the demand for housing
Social infra-structure[19]	i29	Existence of schools	Indicates the availability and accessibility to existing mechanisms for social welfare in the household. Provision of schools and health facilities are crucial for the wellbeing of individuals particularly when a disaster occurs. Schools, churches and sport facilities have been known to serve as shelters in the event of severe weather
	i30	Existence of churches and other worship facilities	
	i31	Existence of sport facilities or areas for recreation	

Technical infra-structure	i32	Access to energy supply	Provides information on accessibility and affordability of energy and water being essential components of basic technical infrastructure. Indicates the type of energy and water provision services or mechanisms in the household to obtain electricity using communal grid and/or using other energy supply options as primary fuel for cooking. A variable is the use of solid fuel as source of cooking. Also serves as a proxy[20] for indoor pollution
	i33	Access to water supply	
	i34	Level of sanitation	Indicates the existence of sanitation facility in the household. Associated variables are connection to the municipal sewage system, existence of septic tanks and latrines
	i35	Solid waste generation and management	Indicates the amount of solid waste generated, collected and disposed of (in sanitary landfills or in dumpsites) per household. Poor waste disposal have local impact such as soil and ground water contamination, wastewater floods and spread of disease through vectors. This indicator provides information on the pressure of waste practices on the urban environment and household livelihood
	i36	Access to communication technology	Provides a measure of internet, mobile phone, telephone (landlines), television access and use in the household. Telecommunication is critical to sustain the development of individuals and is closely linked to social, economic and institutional factors (UN, 2007).
	i37	Existence of road network	Indicates the reliability of road and its capacity to function in determined conditions. It may provide information on the existence of connections among several reference points to the household and their level of exposure when face with a potential hazard
	i38	Transportation	
Housing	i39	Type of housing	Indicates the construction type or building features. Associated variables are number of rooms, size of the unit, type of materials among others

[19] The social infrastructure refers to the facilities that ensure education, health care, community development, income distribution, employment and social welfare to a population. The technical infrastructure commonly refers to existing energy and water supply services, as well as sanitation and transportation and communication system which represent the basic facilities needed for a community or society in an urban area to function.

[20] A proxy is referred as an indirect indicator that approximates or designates a situation in the absence of a direct measure.

Table 13: Selected vulnerability indicators at community level.

GENERIC HAZARD TYPE			
Theme	**ID**	**Identified indicator**	**Description**
Hazard prone area	i1	Location of buildings in hazard prone area	Indicates the location of buildings or settlements identified in hazard prone areas. Determines the likelihood of damages an area by water flow, water stagnation and waste water floods
	i2	Type of hazards identified	Indicates potential damages by providing accounts of past climatic events having an impact in human and economic livelihood of the community

ASSET VULNERABILITY			
Theme	**ID**	**Identified indicator**	**Description**
Economic condition	i3	Source of income	Indicates the level of employment or type of economical asset in the community. An important consideration is evaluating whether the percentage of incomes reported are 'stable' regardless of local hazards. Also the percentage of 'vulnerable employment' can be addressed as well as the degree of dependency on local employment
	i4	Material asset	Indicates the existence of collective goods and material resources in the community
Education level	i5	Level of literacy	Refers to male and female literacy rate in the community. Years of school indicates the percentage of male and female with primary, secondary and tertiary education
	i6	Years of school	
Demo-graphic structure	i7	Household size	Indicates the mean of household size and composition in the community that may be either affected or capable of coping with a disaster.
	i8	Household composition	Indicates the difference of co-residency characteristics in the community. Associated variables are age group and gender. Attention to gender is due to the fact that women along with children and elderly appear to be more vulnerable (Cutter et al., 2003; O'Brien and Mileti, 1992; Wisner et al., 2004). The percentage of ethnic, clan or group affiliations may provide clues related to the heritage, distinctive culture and common language in the community
	i9	Ethnic background	
Health	i10	Medical condition/ problems	Indicates the percentage of diseases identified in the community. Proxies are average life expectancy, and or cause of deaths

ATTITUDINAL VULNERABILITY			
Theme	**ID**	**Identified indicator**	**Description**
Social capital	i11	Level of trust	Indicates the level of trust extended to other members of the community and local institutions. This indicator is based on the rationale that when individuals in communities trust each other and the institutions that operate among them, they can easier reach agreements concerning disaster prevention and warning. A proxy is the trust in official information
	i12	Degree of social inclusion	Indicates the degree of social isolation in the percentage of isolated households in the community
	i13	Level of social network	Indicates the existence of professional/social/ financial groups, religious and/or sport organizations active in the community. Also provides information on the degree to which there is cohesion of groups in the community
	i14	Degree of collective action	
	i15	Length of residence	Indicates how old is the community in other words its number of years of existence
Risk awareness	i16	Perceived communal risk	Indicates the recognized risk faced by the community
	i17	Hazard experience	Relates to any previous experiences or account of (death, damage, injuries and material losses) due to a disaster in the community. Also could be expressed as the number of human and/or material loss. The indicator provides an estimate of human and economic impact of a potential disaster in the community
	i18	Knowledge of protection measure	Indicates the level of awareness and knowledge about possible resources and measures to resist, cope and adapt to a possible disaster
	i19	Training of health and emergency human resources	Indicates the degree to which the community has access or has been involved with education and awareness raising programs

INSTITUTIONAL VULNERABILITY			
Theme	**ID**	**Identified indicator**	**Description**
Local governance structure	i20	Type of local government	Indicates the degree of representativeness of the community in higher local government bodies and its level of participation in decision-making processes. Indicates the degree to which communal gatherings (i.e. community meetings) take place and may provide signals of self-mobilization which is linked to collective action
	i21	Participatory decision making	
Local institutions and actors	i22	Existence of CBO and NGO and other local institutions	Indicates the numbers of active local organizations in the community and their level of contact with local residents and/or local leaders
	i23	Existence of an emergency plan	Indicates the awareness or knowledge of existence of an emergency plan for the community

PHYSICAL VULNERABILITY			
Theme	**ID**	**Identified indicator**	**Description**
Green areas	i24	Existence of trees	Measures the proportion of land area covered by trees in the community
	i25	Existence of green parcels or urban cropland area	Indicates the percentage of practices of farming for income earning or food producing purposes in the community. Can be linked to food security and food safety factors (UN, 2007)
Land use	i26	Density	Indicates the number of persons per residential unit or cultivable land
	i27	Land ownership and property titles	Indicates the percentage of house owned or the number of holding property titles. It provides an indication of dwelling usage rights and the level of decision making power in the community
	i28	Land use change	Provides information on changes in productive and protective uses of land to facilitate urban planning and policy development (UN, 2007). The change in land use may also indicate to what degree land degradation, soil cover loss and landscape changes occur in the community
Social infra-structure	i29	Existence of schools	Indicates the existence of mechanisms for social welfare in the community. Provision of schools and health facilities are crucial in the establishment of a community's wellbeing particularly when a disaster occur. Schools, churches and sport facilities have been known to serve as community shelters in the event of severe weather
	i30	Existence of churches and other worship facilities	
	i31	Existence of sport facilities or areas for recreation	

Technical infra-structure	i32	Access to energy supply	Provides information on accessibility and affordability of energy services, being essential components of basic technical infrastructure. Indicates the percentage of households with access to electricity using communal grid or using other energy supply options as primary fuel for cooking. A variable is the percentage of households using solid fuel as source of cooking also serves as a proxy for indoor pollution and can contribute to deforestation and land degradation when there is a high demand to meet households' needs (UN, 2007)
	i33	Access to water supply	
	i34	Level of sanitation	Indicates the percentage of households with sanitation facilities. Associated variables are connection to the municipal sewage system, existence of septic tanks and latrines
	i35	Solid waste generation and management	Indicates amount of solid waste generated collected and disposed of (in sanitary landfills or in dumpsites) per household. This indicator provides information on the pressure of waste practices on the urban environment and livelihood of communities as well as the economic pressure on their municipalities. Poor waste disposal have local impact such as the contamination of soils and ground water, waste water floods, spread of diseases
	i36	Access to communication technology	Provides a measure of internet, mobile phone, telephone (landlines), television access and use in the community. Telecommunication is critical to sustain the development of communities and is closely linked to social, economic and institutional factors (UN, 2007). A proxy is the number of mobile subscribers given the fact that mobile phone have overtaken fixed landlines in recent years
	i37	Existence of road network	Indicates the level to which the road network is reliable and its capacity to function in determined conditions. It may provide information on the existence and reliability of connections among several points and their level of exposure when face with a hazard. A common proxy is the level of accessibility which in transportation terms refers to the ease of reaching destinations such as places of employment, education and recreation
	i38	Transportation	
Housing	i39	Type of housing	Indicates the percentage of construction type predominant in the community

5.3 CRITERIA FOR THE EVALUATION OF INDICATORS TO ASSESS VULNERABILITY IN URBAN AREAS

The indicators illustrated in Table 12 and 13 were presented to CLUVA partners for their evaluation based on a set of criteria. These criteria stem from considerations suggested in the literature as well as from the idea that any CLUVA indicator should be based from the notion of being measurable and analytically soud on one hand and understandable as well as trustworthy.

Birkmann for instance, (2006) proposes that indicators need to be 'relevant' as well as 'analytically and statistically' sound (ibid.: 65). This suggests that attention should be given to converting abstract factors of vulnerability into a systematic construct that can be measured. Weiland et al. (2011) stress the informative nature of indicators and therefore suggest them to be understandable by both practitioners and researchers. Technical criteria for selecting indicators put forward by Flowers et al. (2005) include a certain degree of well-behaviour, specification, repeatability, feasibility as well as the ability to construct and deconstruct. With regard to ranking indicators, Cutter et al. (2003) put forward the idea of using weighing schemes as not all vulnerability indicators are necessarily equal. Among weighing attempts proposed to reduce the level of subjectivity in balancing indicators is the development of a statistical multi-criteria analysis which attempt offsetting comprehensiveness and applicability (Meyer et al., 2007).

Overall, it can be said that a common criteria to select relevant indicators should be defined by a set of standard norms as well as certain goals and priorities on what is relevant and applicable. Based on suggestions offered by Berry (1997), Flowers et al., (2005), Gallopín (1997), Parris (2000), Tapsell et al. (2010), and Weiland et al. (2011) as well as observations made by CLUVA partners, we propose that the construction of indicators must be then clear and transparent. It must not be ambiguous and should be understandable by different groups.

5.3.1 Basic criteria for the evaluation of indicators to assess vulnerability in urban areas

As basic criteria we consider that selected indicators should meet the following two critical requirements in CLUVA. The value of indicator must be measurable or at least observable (Galoppín, 1997) and it must be relevant to the different hazards identified in CLUVA cities.

Table 14: Basic criteria for the evaluation of indicators to assess vulnerability in CLUVA.

Measurable & analytically sound: The indicator should offer a mean to indicate a behaviour or event. It requires a certain precision in the data collected for both statistical purposes and/or qualitative interpretations. It also needs to be pertinent to the important issues of a community.
Hazard relevant: Selected indicators must be relevant to measure the impact of identified hazard to CLUVA cities (i.e. flood, drought, sea level rise). In addition, it must be contextual as to provide information on identified problems and reflect the concerns relevant to those problems. For instance when the issue is flood aggravated by sanitary conditions, the indicator needs to reflect both the potential damages to flood as well as the causal conditions (i.e. the condition of local drainage, waste disposal practices among others).

5.3.2 Desirable criteria for the evaluation of indicators to assess vulnerability in urban areas

Desirable properties of selected indicators are a good level of comprehensiveness and reliability (i.e. authenticity of raw data). This means that indicators need to clearly signal or summarize information relevant to the reality of CLUVA cities. In addition, we view the availability of data and the overall resource capacity as pragmatic considerations that play a central role in the quality and suitability of each indicator.

Table 15: Desirable criteria for the evaluation of indicators to assess vulnerability in CLUVA.

Easy to interpret: Selected indicators need to be understandable to all stakeholders involved in CLUVA (scientists as well as practitioners). Indicators failed because they may be too abstract or difficult to understand. In that sense, selected indicators need to be clear and understandable by different groups.
Trustworthy: The indicator should be able to reflect reliable information. In CLUVA, the authenticity of raw data is central to the performance of the indicator. Relevant indicators are those that can be researched reliably over a period of time and provide an accurate vision of the situation under scrutiny.
Data availability: A successful indicator is based on data that is available and transferable. The indicator should provide timely information that is accessible and relevant to the context of CLUVA.
Resource capacity: The indicator should be selected based on considerations of time requirement, financial possibilities and human resource. Well-grounded indicators are those able to deliver desired results in the most feasible economical terms.

CLUVA case study partners were requested to fill in a Likert-style questionnaire designed to measure the attitudes and opinion of African scholars regarding the identified indicators. Contributions were conducted individually and collectively. Collective evaluations involved preliminary discussions and a consensus was reached among participants.

By criteria 1. “Easy to Interpret”, 2. “Trustworthiness” and 4. “Resource Capacity”, contributors were asked to indicate their level of agreement or disagreement by means of a five point scales including ‘strongly agree’, ‘agree’, ‘neither agree nor disagree’, ‘disagree’ and ‘strongly disagree’. With regard to Criterion 3 “Data availability”, evaluators were asked to estimate the availability of data attached to each indicator using a polar ‘yes and no’ format.

The following table illustrates indicators that are perceived as relevant within different vulnerability dimensions of hazard, asset, attitudinal, institutional and physical. Here we choose to simply highlight evaluated indicators rather than providing a ranked list summing up the score across the different criteria. This evaluation is therefore qualitative and the table below is for the most part indicative. It shall allow a more structured discussion about the application of indicators within the different case studies, which will be a next step in the case study cities. With regard to physical vulnerability all indicators were evaluated as quite meaningful.

Table 16: Indicators evaluated as meaningful to assess vulnerability in urban areas at household and community levels.

GENERIC HAZARD TYPE		
Theme	**ID**	**Evaluated indicator**
Hazard prone area	i1	Location of buildings in hazard prone area
ASSET VULNERABILITY		
Theme	**ID**	**Evaluated indicator**
Education level	i5	Level of literacy
Demographic structure	i7	Household size
	I8	Household composition
ATTITUDINAL VULNERABILITY		
Theme	**ID**	**Evaluated indicator**
Social capital	i13	Level of social network
	I14	Degree of collective action
	I15	Length of residence
Risk awareness	I16	Perceived risk
	I17	Hazard experience
INSTITUTIONAL VULNERABILITY		
Theme	**ID**	**Evaluated indicator**
Local government structure	I20	Type of local government
Local institutions and ac-	I22	Existence of CBOs, NGOs and other local institutions

In addition to the evaluation, CLUVA partners offered several ideas to be expended and discussed in further steps. They are as followed:

1. Location of indicators within the proposed vulnerability dimension: The location or correct placement of some indicators within the different dimensions of the CLUVA vulnerability ladder was signaled. For instance, the location of i25 *Existence of green parcel/or urban cropland* area was questioned based on consideration of farming as a mean of subsistence. Remarks to relocate i1 *location of the buildings* to 'physical vulnerability' and i27 *Land ownership* to institutional vulnerability are also noted. We will take these comments into account when preparing the next steps in actually conducting the vulnerability assessment in the case study cities.

2. The question of scale: The majority of household indicators appeared to be upscale at community levels and to some extent also at city levels. However, a more accurate differentiation between household and community indicators was suggested at the physical vulnerability dimension. Again, we will take these comments into account when preparing the next steps in actually conducting the vulnerability assessment in the case study cities.

3. The attention to the meaning and working definitions of indicators: A clearer definition on "land use change" was suggested. Some indicators related to attitudinal vulnerability considered as subjective were noted for further discussions. Training of health and emergency human resources was

pointed out as unclear to some partners. Further steps are required to provide more precision in selected indicators by CLUVA partners.

4. Other indicators proposed:

- Emphasis should be given to ‘Resources supply’ – both water and energy.
- The use of different energy sources (kerosene, charcoal, firewood, etc.) and the different us of firewood (e.g. by different types of ovens) could serve as an indicator for vulnerability.
- Personal transport availability.

5. Identification of variables, identification of measurement/unit/coding and the formulation of questions: Further steps include that case study partners identify more measurable variables, especially regarding compound indicators such as density, solid waste generation, collection and disposal, level of income, type of housing, existence of road network and transportation. In addition, several indicators will have to be measured differently, such as in binary, numeric, ordinal or nominal scales. It was suggested that a ‘Data generating question’ column could be useful for collecting relevant data.

6. Observations from Dar es Salaam:

- In the Tanzanian context, level of education is used as an indicator to reflect on literacy level and years of school.
- A common indicator is ‘household demographic composition’ which includes household size, age distribution, gender, sex and marital status.
- There is a low percentage of people with access to sewage and energy services therefore, variables such as type of energy and type of sanitation should be considered.
- Trustworthiness issue related to ‘access to energy supply’, ‘water supply’, ‘level of sanitation’, ‘solid waste generation and management’ will depend on their level of disaggregation.

7. Observations from Addis Ababa:

- The level of income plays a major role in determining the social vulnerability and should be considered as an indicator.
- The source of income is not always single rather it is more than one in most families and depends on factors such as season and market demand. Therefore it is rather difficult to report the stability of a household income.

8. Observations from Ouagadougou:

- Further vulnerability indicators were proposed with regard to aspects of mobility of residents and migrants as well as modes of transportation (bicycles/motors/cars). Another indicator proposed was ‘religion’.
- For asset vulnerability it would be necessary to stress what is the main activity and other sources of financial support obtained in the household. Also a proxy could be considered as the level of consumption or the number of meals per day.
- Gender ratio is to be considered such as No. of women as head of household.
- For physical vulnerability: ‘Zone lotie/Zone non lotie’ considering formal and informal settlements.

CONCLUSION

CLUVA cities encompass coastal, estuary, inland, and highland characteristics and feature different weather conditions such as tropical dry, tropical humid Sub-Saharan climate. In this report, the profiles of each city are offered as schematic overviews and allow a first insight in the specifics of the urban environment in which the project unfold and also provide a good base for more in-depth explorations to contextualize vulnerability. Further, we provide a clarification of the concept of "social vulnerability". We also put forward several definitions and highlight a common understanding generated through exchanges with CLUVA case study partners during several workshops. Three aspects of social vulnerability are noted here: 1) The specific social inequality of people in the context of a disaster. 2) The needs of a reference point (e.g. a certain type of risk – "vulnerability to what") and a specific context (which transforms a risk into a hazard – "vulnerability of what and of whom"). And 3) the characteristics of a person or group in terms of their capacity to anticipate, cope with, resist, and recover from the impact of a natural hazard.

Within the CLUVA context we propose a vulnerability ladder as a conceptual framework for a specific assessment approach to develop appropriate and relevant indicators. The first component of the ladder considers at the heart of our assessment, the generic components of vulnerability which takes into account the exposure, susceptibility/sensitivity, and coping/adaptive capacity of a system. Subsequently, the ladder stresses the resources and capacities that individuals and groups have when faced with a natural disaster (i.e. asset). It then recognizes urban governance at local levels as central in any inquiry on vulnerability (i.e. institutional). It also considers aspects of trust and social inclusion, network and risk awareness as key items to understand the urban dynamics when a disaster occurs (i.e. attitudinal) and finally acknowledges the state of the urban environment within which all the above dimension interact (i.e. physical).

Therefore, we propose four main vulnerability dimensions (asset, institutional, attitudinal and physical), which put the social, economic, political and cultural causes for the production of vulnerable conditions at the forefront of our analysis. The dimensions are described broadly in the report and represent a common understanding of a framework for a CLUVA vulnerability assessment within the consortium. Exchanges with CLUVA partners which took place in the form of workshops in case study cities, served to contextualize our assessment at communities, households and individuals levels. Our suggestion of including four main dimensions in CLUVA allows the establishment of strong links to other tasks, and hence contributes to the overall integration of vulnerability assessment in the CLUVA context.

A mixed method assessment approach including qualitative and quantitative social science-based methods is proposed. Mixed methods allow a combination of techniques to explore the social vulnerability of communities, households and individuals in the selected study areas. Furthermore, it enables us to combine the quantitative data policy makers generally request and utilized and the nuanced and more complex qualitative determinants that provide other type of explanations as to what are the coping capacity and resilience of at risk population. The mixed method approach allows multiple forms of vulnerability assessment drawing on all possibilities. This includes for instance, the convergence of pre-existing statistical/census data with a strong correlation between socio-economic and/or demographic settings and vulnerability along with focussed sessions providing the opportunities for interactive work and the exploration of less quantifiable data. Whereas quantitative approaches are indicator-based modes of inquiries largely dependent on statistical data and based on measuring and comparing units of measurement, qualitative methods in turn seek to better understand actors' own perception of vulnerability and capacities to cope and adapt

to possible threatening climatic events. The proposed mixed method approach uses the advantages of both methods and generates synergies which limit the weaknesses of each single method.

The report also stresses the development of indicators as priority action to assess the impact of disasters on social, economic and environmental conditions by the international community as well as the need to horizontally communicate the results to decision makers, stakeholders and the population at risk. The call here is to develop realistic and measurable indicators with the following purposes: 1) to develop and track progress in disaster risk reduction 2) to enable decision-makers to assess the impact of disasters 3) to support early warning systems 4) to conform with the respective development goals of the Millennium Declaration.

We propose to consider indicators in CLUVA as composite terms that inform us and can provide a type of measure to evaluate the conditions of at risk populations and to estimate their exposure, susceptibility and/or coping and adaptive capacity with regard to the impact of natural hazards. They serve as an assessment tool that indicates a phenomenon and help us measure and communicate different realities of urban vulnerability. Indicators for vulnerability assessment are inherently linked to the mode of assessment. They can be in principle quantitative or qualitative. In any case they must be understandable, valid and context-sensitive.

Our attention centres on household and community indicators. Household indicators offer an insight on the livelihood of individuals, whereas community indicators might help local leaders recognize the physical and social resources they have to address collective problems. The differentiation between indicators at household and community levels is relevant here because each scale adopts different values in time, space, population and therefore has difference significance. A total of 39 indicators were identified at household and community levels and are illustrated in the form of a table including vulnerability dimensions, related themes, indicator ID, indicator construct and description.

The indicators were presented to the CLUVA partners for an initial evaluation concerning basic and desirable criteria. The basic criteria are: measurable and being analytically sound as well as hazard relevance. The desirable criteria are: ‘easy to interpret’, trustworthiness, ‘data availability’ and ‘resource capacity’. The evaluation procedure in which CLUVA partners concerned with WP 2 and WP 3 were involved, reveals a more meaningful indicator set based on CLUVA’s targets. Some of them are: ‘location of buildings in hazard prone area’, ‘level of literacy’, ‘household size’, ‘household composition level of social network’, ‘degree of collective action’, ‘length of residence’, ‘perceived risk, hazard experience, local governance structure’, ‘existence of CBO, NGO and other local institutions’ as well as most of the physical vulnerability indicators identified for CLUVA.

Finally we would like to stress, that this report combines theoretical propositions obtained by a literature review and topical local knowledge steaming from recent stakeholder discussions, field observations as well as intensive exchanges with partners. This report therefore offers a conceptual base and methodological frame for further interdisciplinary and cross-cultural research on climate related vulnerability in Africa.

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