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City Vulnerability Assessment Kampala

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Urban Management Tools for Climate Change - UMTCC

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Outline

- Introduction
- Definitions
  - Risk
  - Vulnerability
- Climate change impacts
- Vulnerability Assessment Principles
- Method
- Case study

Introduction

- Relationship between climate change, sustainable development and Disaster Risk Reduction
- Urban populations in poor countries are affected and yet they are adapting
- Already a difficult for poverty reduction and "development" and risk reduction
- Limited knowledge on how to adapt at local and household level
- Questions – what do we need to know, how should we find it out?

What do we need to know, how should we find out?

- Who is affected by climate change and at what magnitude?
- What makes the people, infrastructure, systems vulnerable to climate risks?
- How do we analyze vulnerability differentiation in a city?
- What adaptation measures for what kind of vulnerabilities?
- *Reading resources!!*

- *Brooks, N. (2003). Vulnerability, risk and adaptation: A conceptual framework. Tyndall Centre for Climate Change Research. Working Paper 38. Available at:http://www.tyndall.ac.uk/sites/default/files/wp38.pdf*

Definitions

1. Theoretical consideration
2. Conceptualizations of vulnerability
3. Practical issues
4. The use of scenarios

Definitions

- Risk has been described as probabilistic natural **natural events**, that are predictable. Dominant theory that informed **Emergency response, Disaster management**

- Risk can be looked as a **process** with understanding that risk arises from uncertainty, actual or perceived about a) **the likelihood** and b) the **value of events** c) **state of the vulnerable unit** *(Gigerenzer G 2002)*

- Risk as **'constructed'** by social economic and institutional processes that determine the 'state'
  - **Low frequency – High Impact disasters**
  - ***High frequency – Low Impact disasters***

- High frequency – low impact disasters erode the 'state' of the vulnerable units increasing future risk. This is hypothesized as **spatially differentiated**

Godfrey, N., Savage, R. (2012). Future proofing cities: risks and opportunities for inclusive urban growth in developing countries. Atkins Epsom, 188. Available at: http://futureproofingcities.com/downloads/Executive_Summary_Online_Hi-Res.pdf?dl=1

Definitions of Vulnerability

1. ”an aggregate measure of human welfare that integrates environmental, social, economic and political exposure to a range of harmful perturbations” (Bohle et al. 1994)

2. “…the exposure to contingencies and stress, and difficulty in coping with them. Vulnerability thus has two sides: an external side of risks, shocks and stress to which an individual or household is subject; and an internal side which is defencelessness, meaning a lack of means to cope without damaging loss” (Chambers 1989)

3. ”*Vulnerability:* the degree to which a system is susceptible to, or unable to cope with, adverse effects of climate change, including climate variability and extremes. (IPCC 2001)

Why assess vulnerability?

1. Identify magnitude of threats, such as climate change;
2. Guide decision-making on risk embedded development
3. Prioritize response and reisk reduction for climate change adaptation;
4. Identify measures to reduce vulnerability.

What is the opposite of vulnerability?

- Is there an opposite?
- Is it resilience, adaptability, or human security?

Conceptualizing vulnerability

- Vulnerability can be conceptualized in different ways.
- Any conceptualization of vulnerability can be interpreted in different ways.
- Conceptualizations and interpretation of vulnerability have implications for what is measured and how it is measured.
- Vulnerability measures can have political and economic consequences; transparency (in both concepts and methods) is necessary.

Different conceptualizations different interpretations

- Biophysical vulnerability
- Social vulnerability
- Economic Vulnerability

Climate change vulnerability

IPCC vulnerability framework:

V = f(E, S, AC)

E = Exposure

S = Sensitivity

AC = Adaptive Capacity

Exposure

- The degree of climate stress upon a particular unit of analysis

- Climate stress:
  - long-term climate conditions
  - climate variability
  - magnitude and frequency of extreme events

Sensitivity

- The degree to which a system will respond, either positively or negatively, to a change in climate.

Adaptive Capacity

- The capacity of a system to adjust in response to actual or expected climate stimuli, their effects, or impacts.

The degree to which adjustments in practices, processes, or structures can moderate or offset the potential for damage or take advantage of opportunities created by a given change in climate.

Interpretation 1:

- Vulnerability analysis as a means of defining the extent of the climate problem
- Vulnerability = Impacts – Adaptations
- Adaptability defines vulnerability
- Vulnerability is the end-point of the analysis

Interpretation 2:

- Vulnerability analysis as a means of identifying what to do about climate change.
- Vulnerability is shaped by adaptive capacity.
- Vulnerability determines adaptability
- Vulnerability is the starting point of the analysis.
- Under this interpretation, we need measures of the social processes that contribute to vulnerability.

Key issues and principles

- Vulnerability is a characteristic, trait, or condition; not readily measured or observable, thus we need proxy measures and indicators;
- Vulnerability is relative, not absolute;
- Everyone is vulnerable, but some are more vulnerable than others;
- Vulnerability relates to consequences or outcomes, and not to the agent itself;
- Defining levels of vulnerability that prompt actions or interventions is a social and political process.

Key issues and principles

- End point: We need better RCP, better process models, and better quantifications of adaptation;
- Starting point: We need better understanding of coping capacity, adaptive capacity, outcomes of social processes, and measures of well-being.

Measuring vulnerability: Practical challenges

- How should indicators be chosen?
- Are adequate data available?
- How should composite indicators be developed?
- How can measures of vulnerability be validated?
- Theory driven: Start from theory or hypothesis; find indicators that might support or reject the hypothesis.
- Data driven: Examine lots of data, look for patterns and examine correlations or statistical relationships. Generalizations can be used to develop conceptual models and theories.

Data

- Need for reliable, readily available, and representative data for desired indicators of vulnerability.
- Compiling city data is difficult. City level vulnerability assessments often rely on minimal datasets and global datasets which are aggregated

Data

"Data are usually treated unproblematically except for technical concerns about errors. But data are much more than technical compilations. Every data set represents a myriad of social relations."

Dynamics of vulnerability

- Vulnerability is dynamic; yet indicators used are often static.
- Snapshots of vulnerability do not tell us who is becoming more vulnerable (or less vulnerable) as time goes on.

Creating composite indices

- Vulnerability is multi-dimensional; there is no one indicator that adequately represents vulnerability.
- Composite indices can provide a more complex measure of vulnerability.
- Many potential methods exist for aggregating indicators (e.g., indiscriminate aggregation, weighted indicators, targeted indicators, contingent indicators, dynamic indicators, heirarchical vulnerability indices, vulnerability profiles)

Verifying measures of vulnerability

- Is the outcome acceptable?
- Does the ranking match what people expect based on their experience?
- Can anomalies be explained?
- Who should be the judge?
- How can dissenting views be represented?

Source: Downing et al. 2001

Measuring vulnerability: Scenarios

- When we are concerned about future conditions (e.g., under climate change), and we want to project vulnerability into the future, we need scenarios.
- Focusing on present-day vulnerability to future climate change can provide a starting point for actions or interventions to reduce vulnerability; less useful for assessing the extent of the climate change problem.

Different types of scenarios:

- Climate change scenarios: Generated by G2 of general circulation models andrepresentative Concetration Pathways (RCPs) or synthetic scenarios (+/- 10% precipitation, 30 cm sea level rise, etc.);

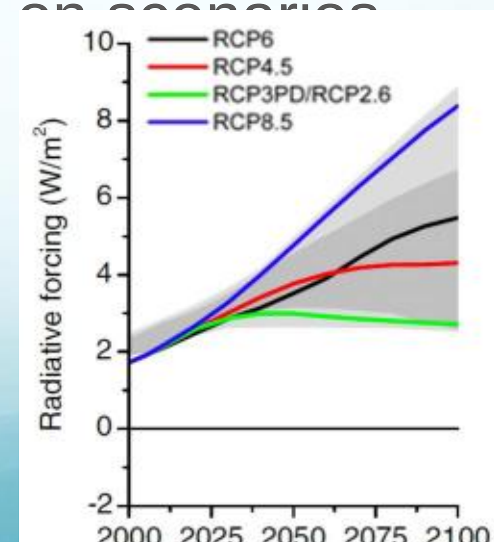
- The output of RCPs depend on assumptions about greenhouse gas emissions, feedbacks, etc. RCPs 2.6 4.5 6, and 8.5 scenarios represent emissions according to different development trajectories;

- Vulnerability will depend on social and economic trends (economic development, population growth);

- However, globalization is creating structural social, economic and political changes, thus extrapolation of trends into the future may not be sufficient to describe the future.

Scenarios

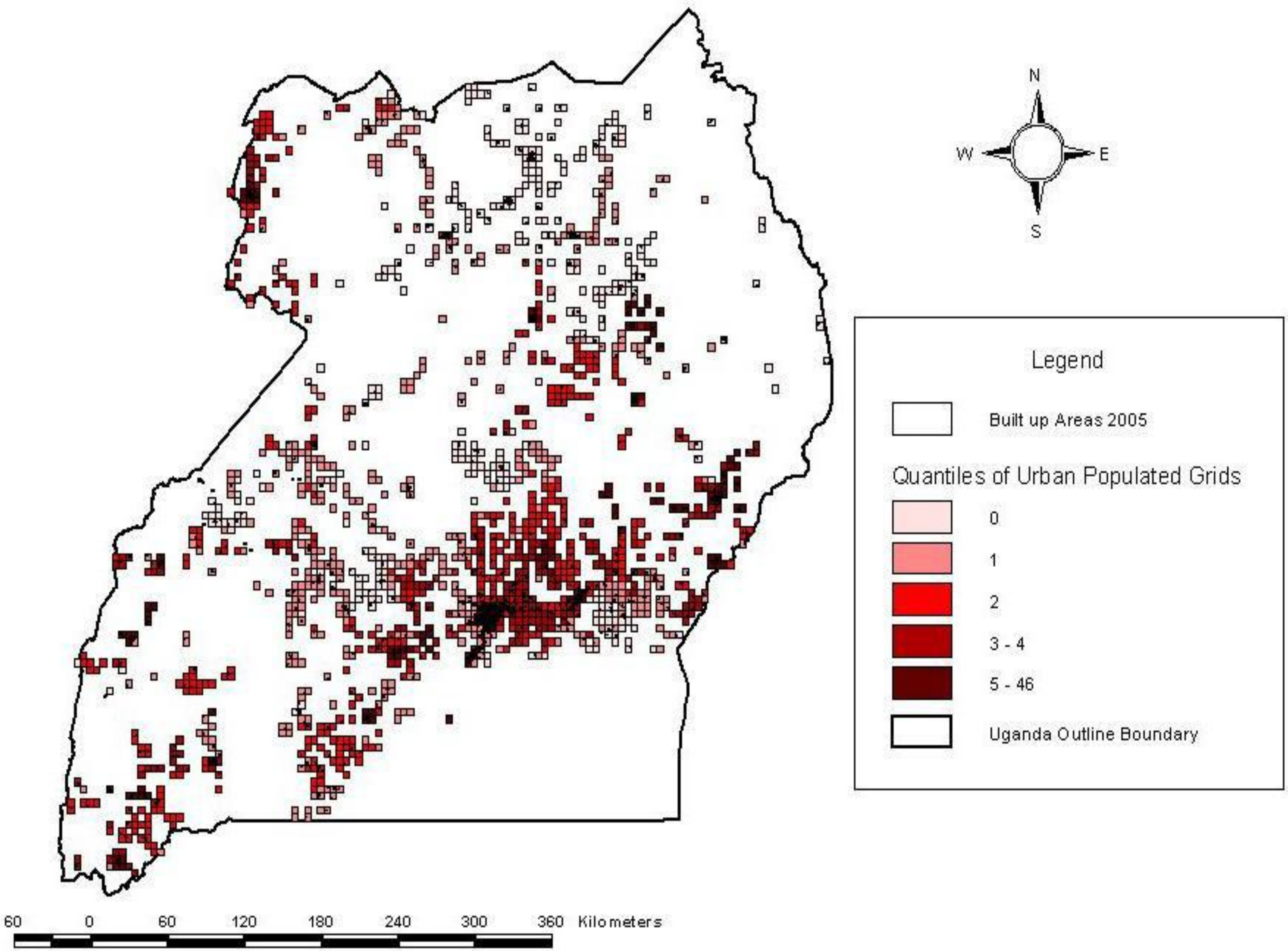
- How can we incorporate future scenarios into measures of vulnerability?
- What types of uncertainty are added to vulnerability measures?
- How can measures of vulnerability based on scenarios be validated?



Urban vulnerabilities in Uganda

- The background
  - Despite being at low level of urbanization at 14%, the rate of 3.73% is high compared to response
  - Rate considers statutory urban centers
  - Urbanization by implosion need not to be ignored
  - Central region more urbanized yet its where rainfall increase over 60 year period was recorded
  - Other urban areas are in water stress areas but also in flood prone areas

Populated Grids of Urban Areas in Uganda



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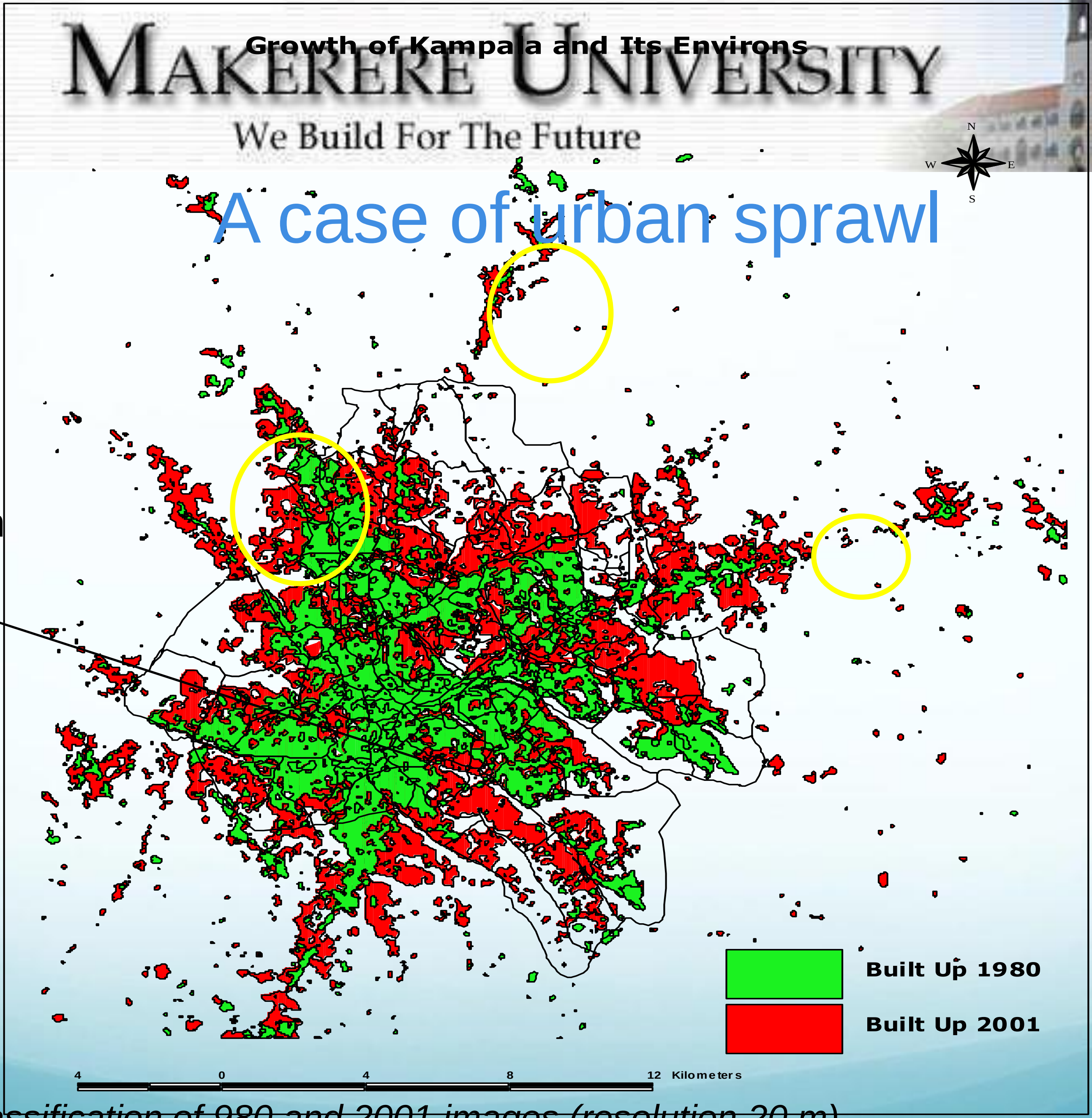
A case of urban sprawl

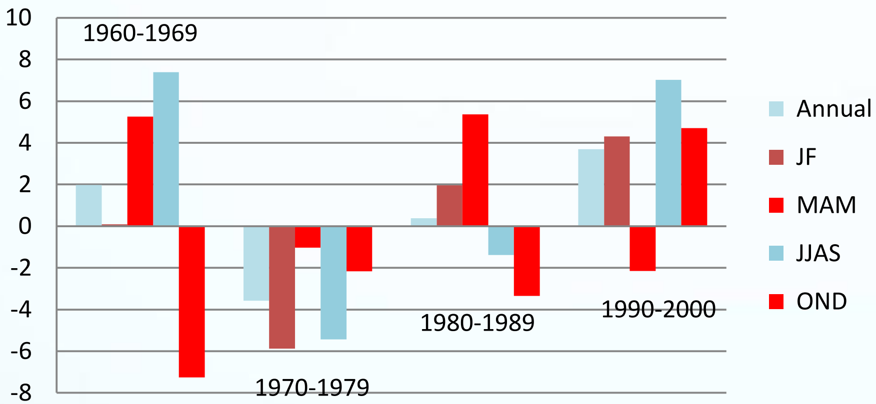


Core urban zone

Source: Classification of 980 and 2001 images (resolution 20 m)

Observed

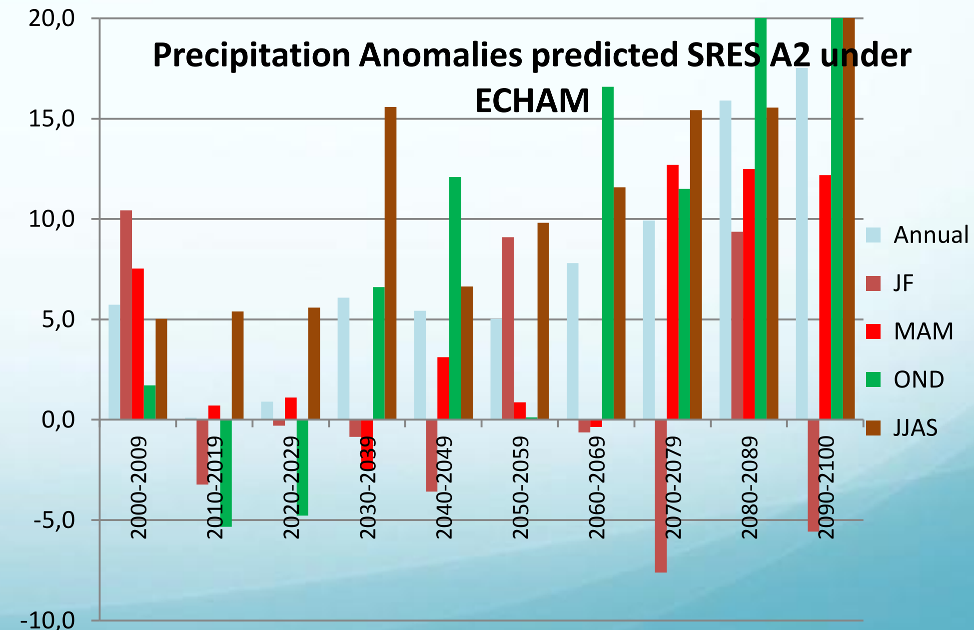
Precipitation Anomalies in Uganda Relative to 1970 - 1999 Mean



Decreasing in annual and MAM rainfall 3.4 m per month

Sub-regional variations Lake Victoria an increase by 90 mm annually decrease in OND

Predicted



Source; http://country-profiles.geog.ox.ac.uk/UNDP_data/Uganda/Uganda.alldata.zip

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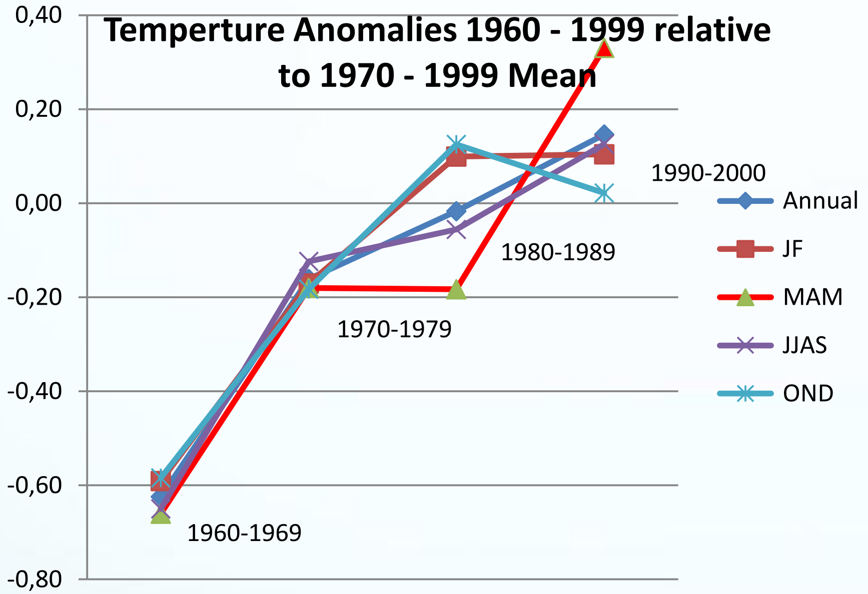
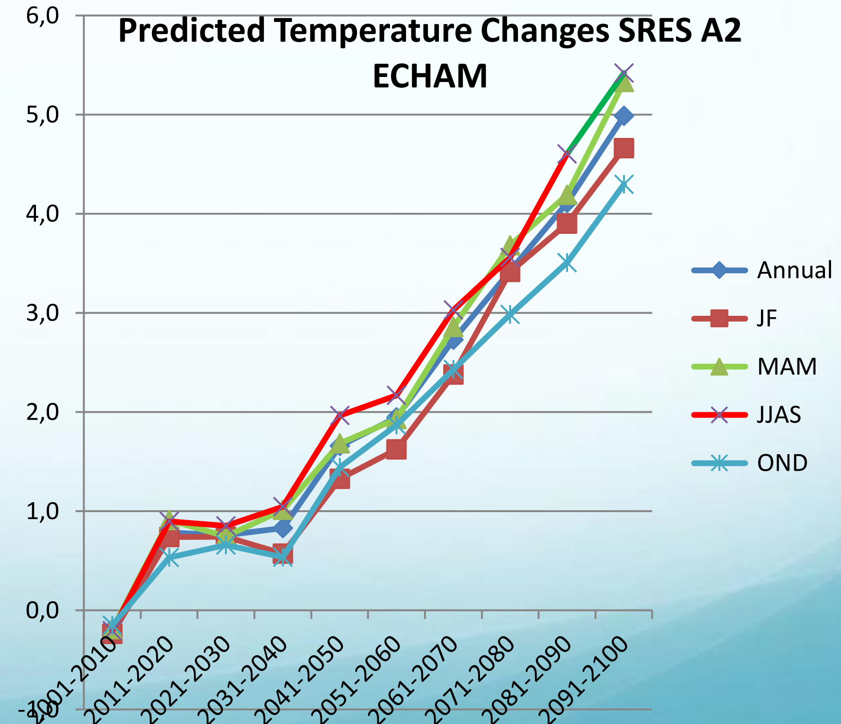
Observed

Decadal increase of 0.37^0 C
Mean annual increase by 1.3^o C

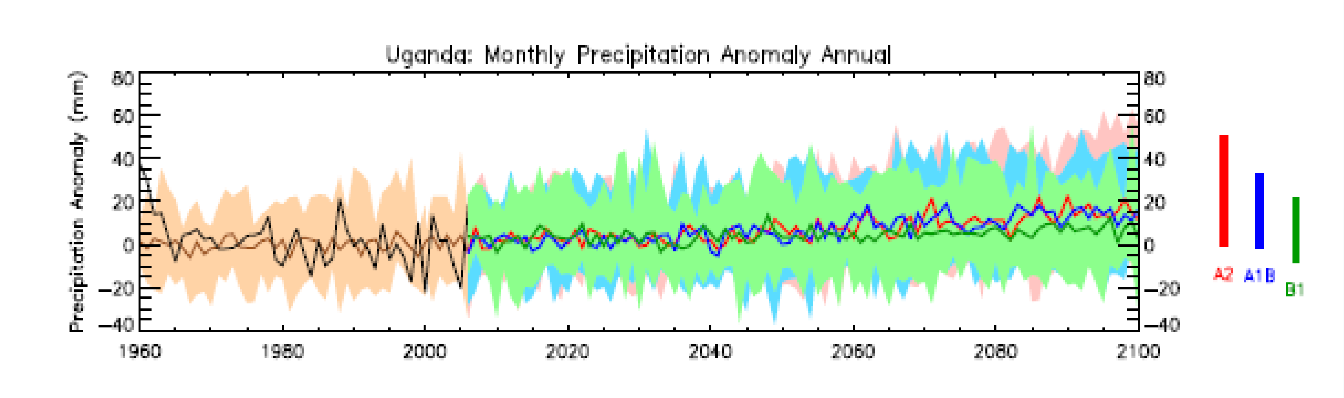




Predicted

Google: UNDP climate country profiles

- *Temperature:* significantly warmer by a few degrees in 2090. Very little change up to 2030. Impacts unknown: drought, lake Victoria water balance, local weather systems?
- *Rainfall* there is already a large variability



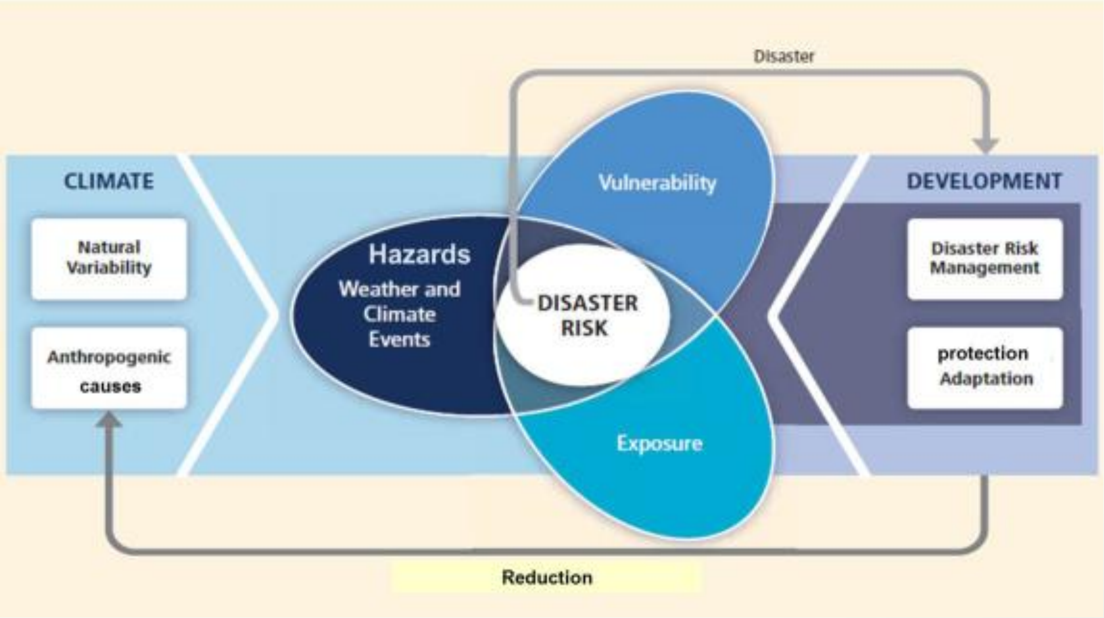
- *Extremes*: larger proportion of rainfall in large events (statistically not significant, but best to be prepared!)
- KDMP: daily rainfall recurrence analysis:
  designs based on 1:10 year daily rainfall = 100 mm

Tyndall Centre for Climate Change Research, *McSweeny et al. (2011)*

What is vulnerable?

- Sectors vulnerable to climate change
  - Road infrastructure
  - Ancillary infrastructure
  - Human settlements
  - Water systems
  - Critical Infrastructure
  - Energy sector
  - Livelihoods

Method



Vulnerability

V = *f*(E x S x AC)

E = Exposure
S = Sensitivity
AC = Adaptive Capacity

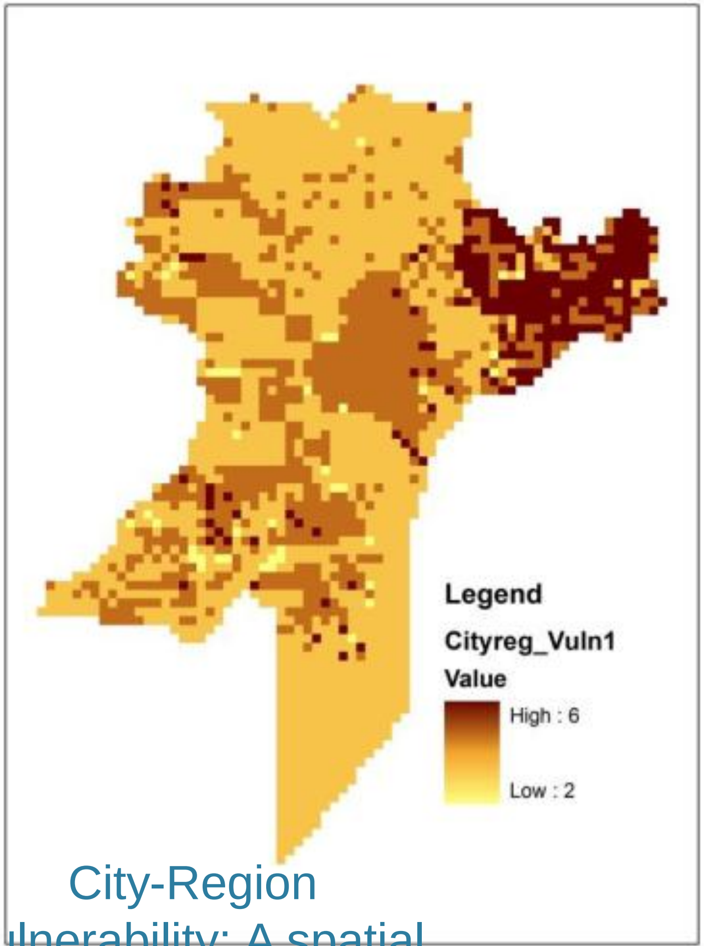
Indicators on different measurement scale

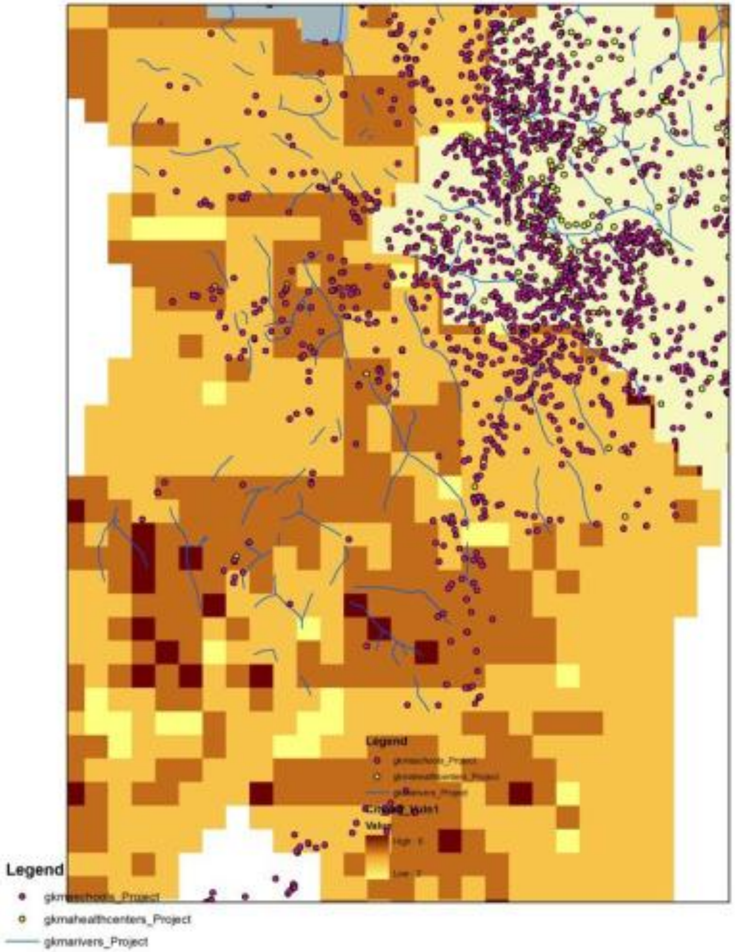
O'brien et al. 2007

The Kampala City Case

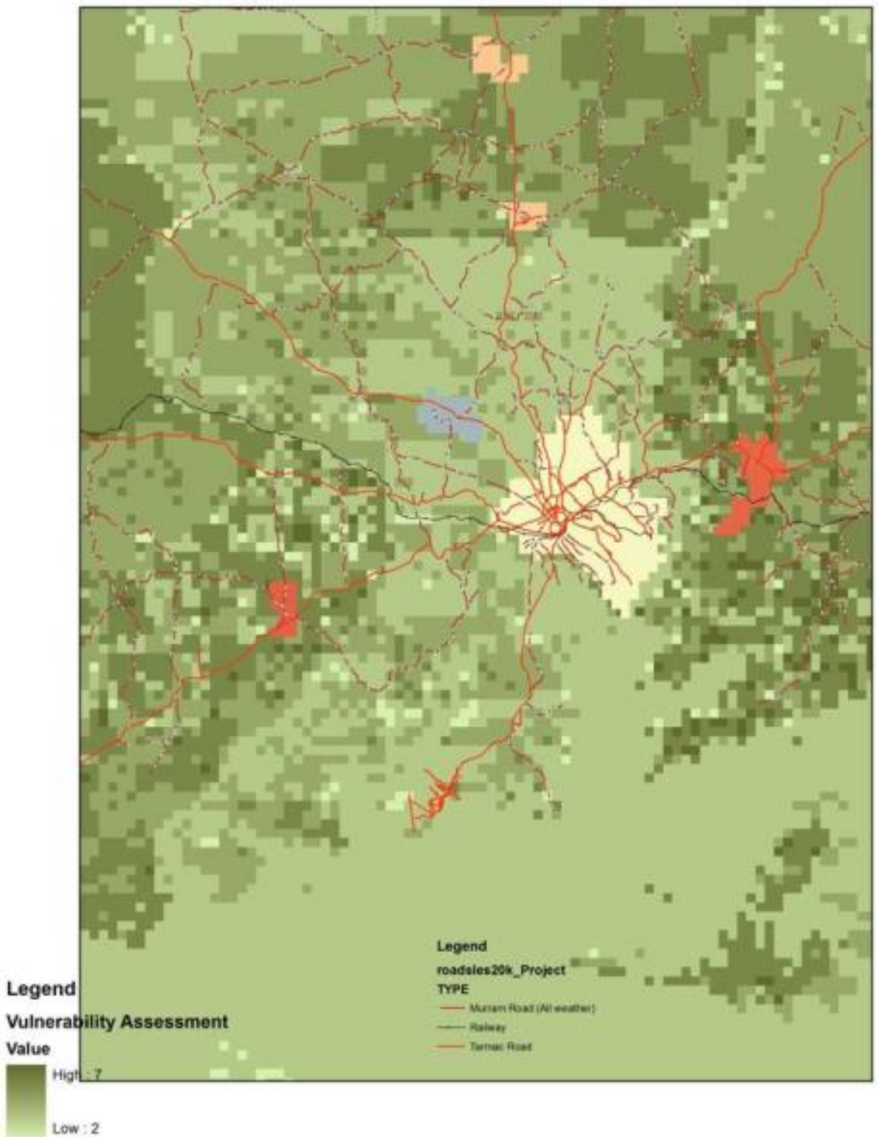
- Urban population, Livelihoods and urban sectors at risk
- Freshwater resources
- Ecosystems and their properties, goods & services
- Industry, settlements & society
- Human health
- Urban infrastructure

- Kampala is a rapidly growing city with chronic urban poverty levels of 35%
- Challenges from unparalleled processes of development, demographic changes, and climate change
- Requires changes to development but also preparedness for climate change impacts; ‘hardening’ up and or building resilience systems and everyday life



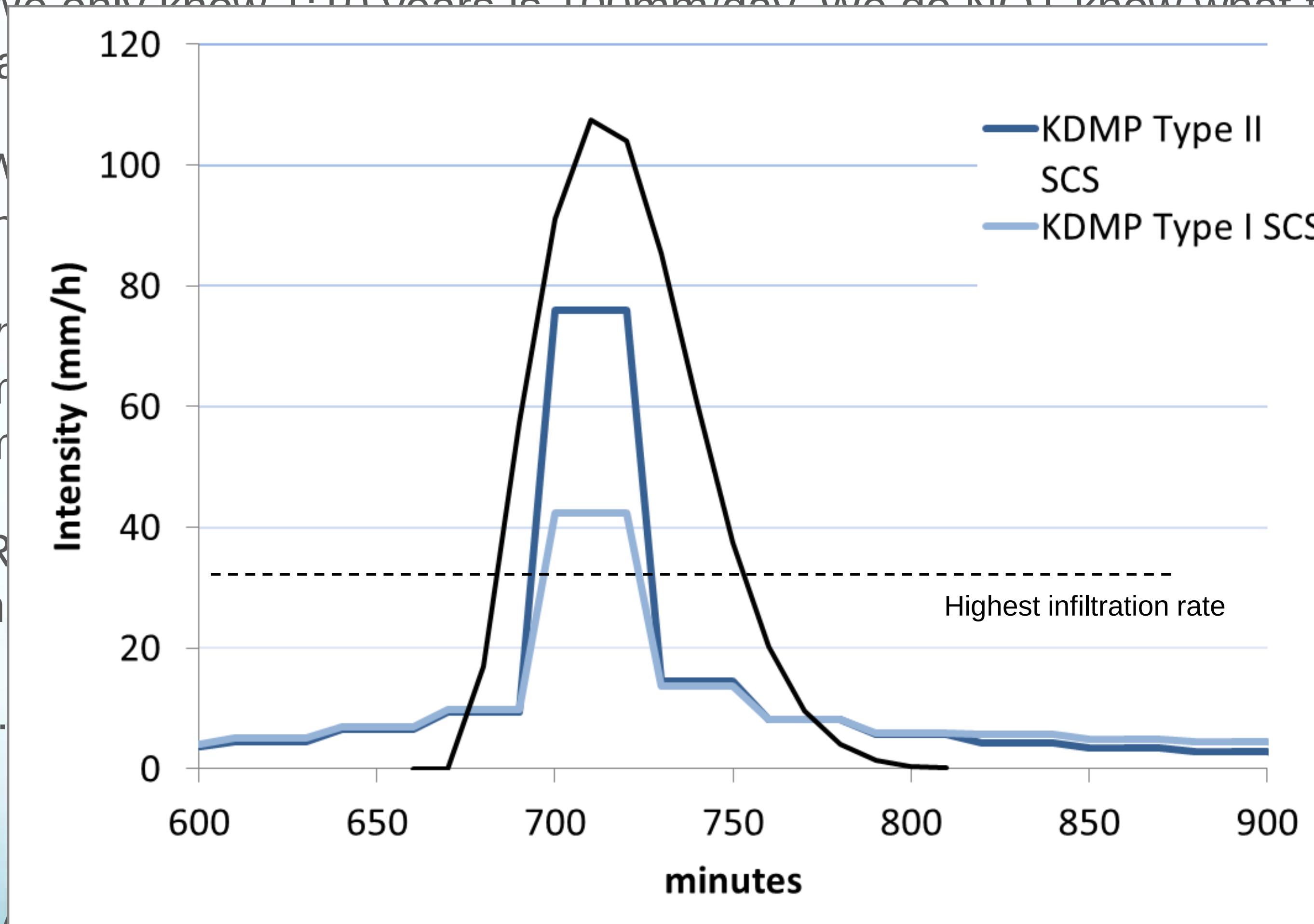


City-Region Vulnerability; A spatial dimension



Infrastructure hotspots in region

- We only know 1:10 years is 100mm/day. We do NOT know what this ra…
- W… in…
- *In*… m… m… SCS
- R… h… not
- ..



- Measuring rainfall intensity data is very *urgent*: for engineering design, for early warning, for flood hazard zonation modelling etc.

Rooftop
some interception
no infiltration
max runoff

Vegetation, bare soil
interception
infiltration
less runoff

Drain
no interception
some infiltration
guided runoff

Murrum road
no interception
min. infiltration
less runoff

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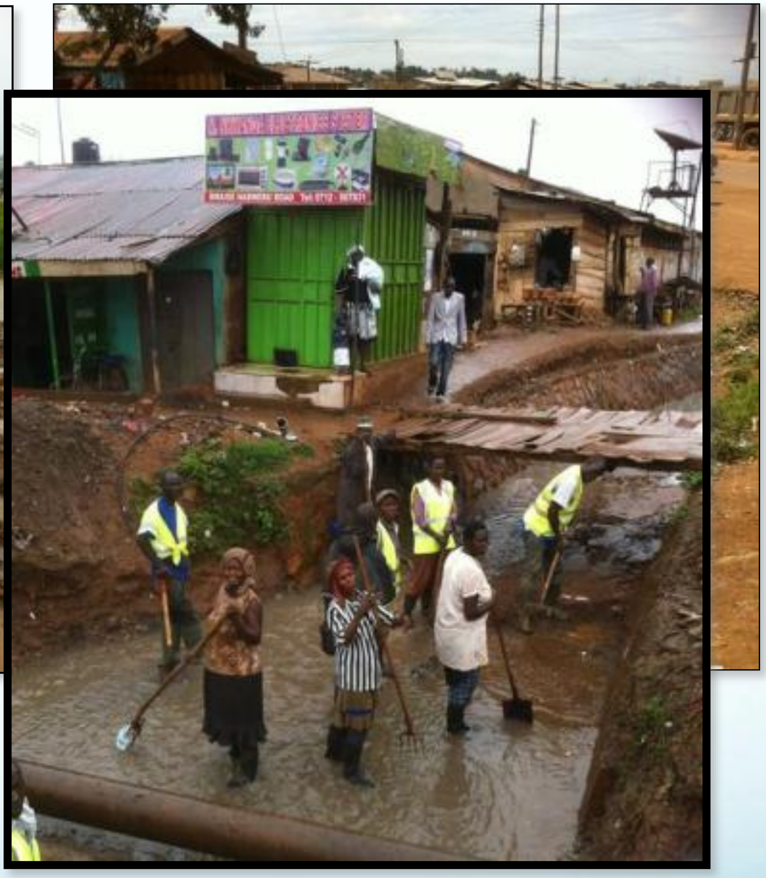
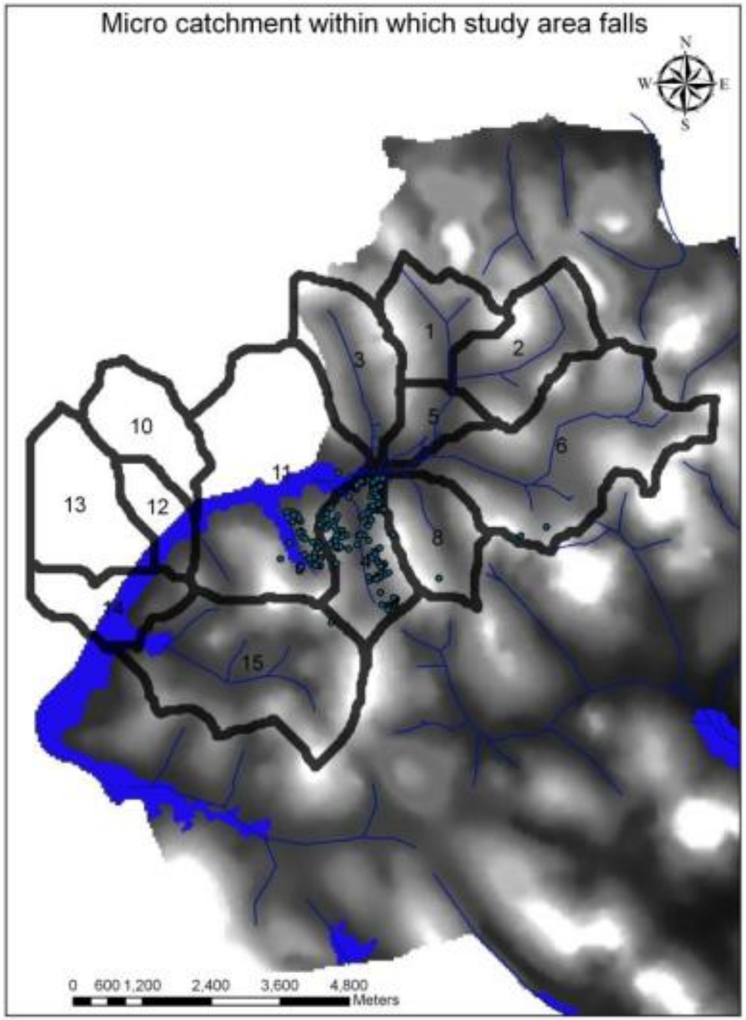
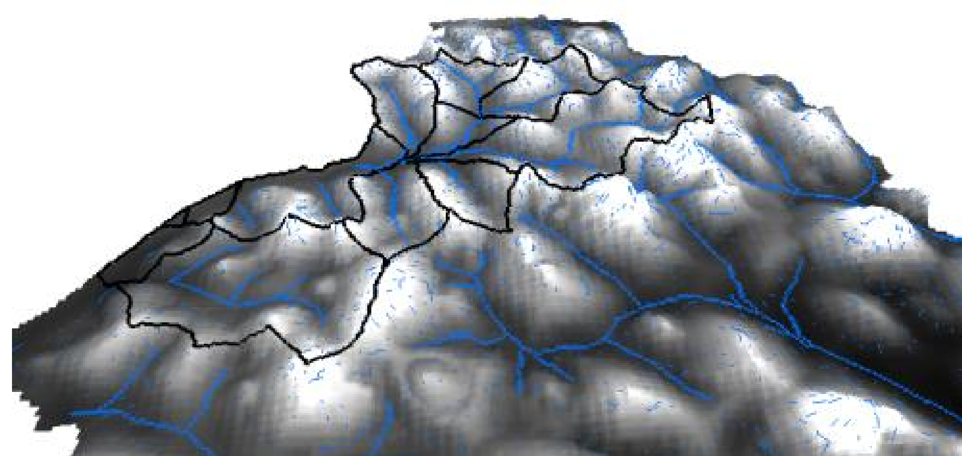


DRAINAGE SYSTEM ASPECTS



- The flood waters recede after a period of between 1 day to 1 week
-
- All types of slow onset, rapid onset and flash floods



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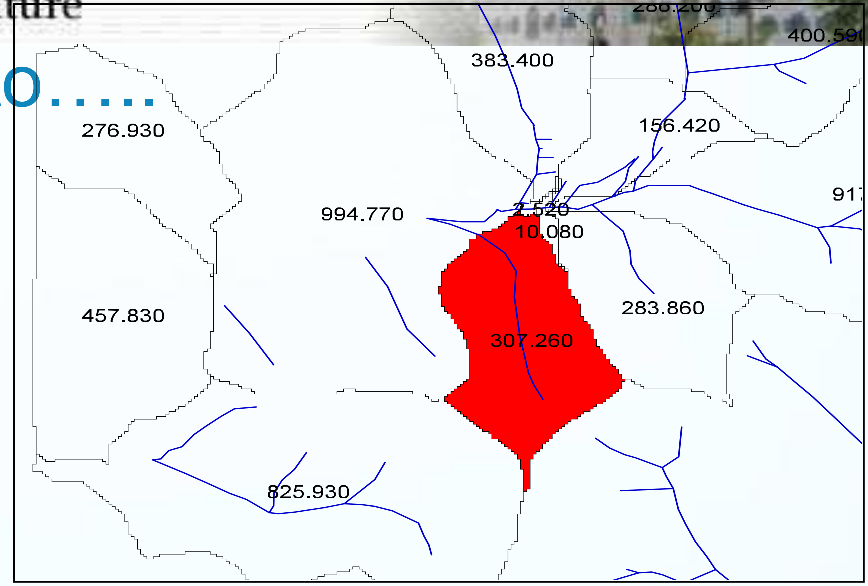
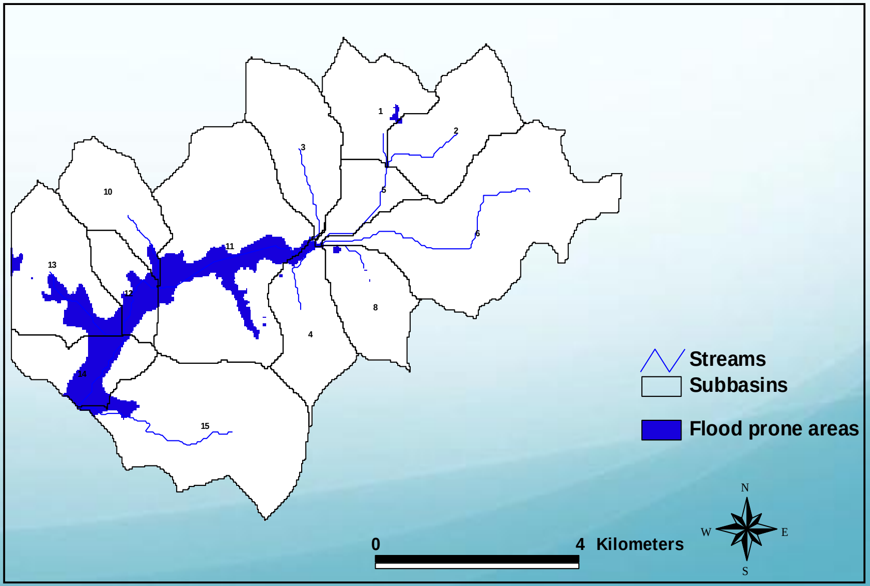
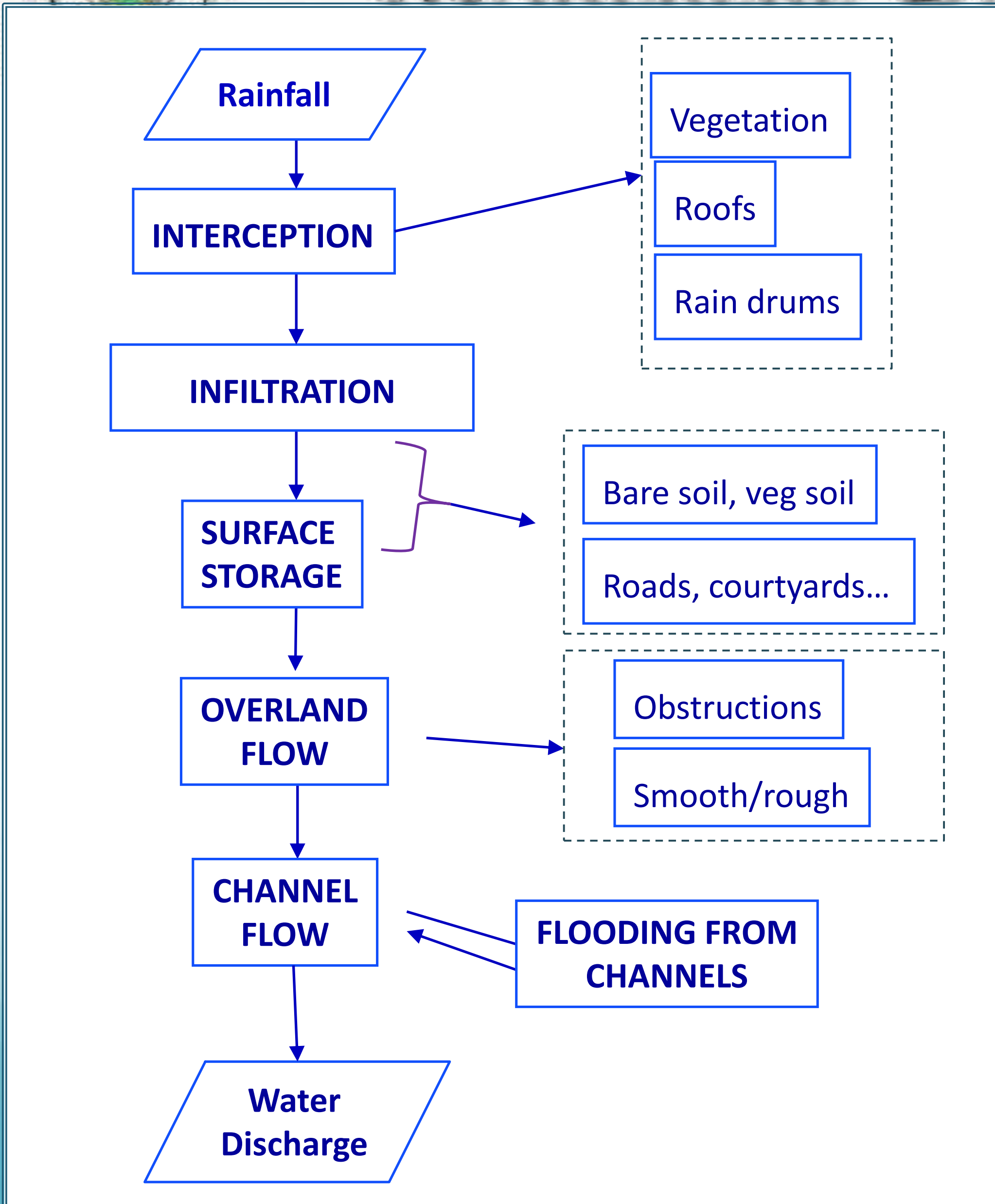
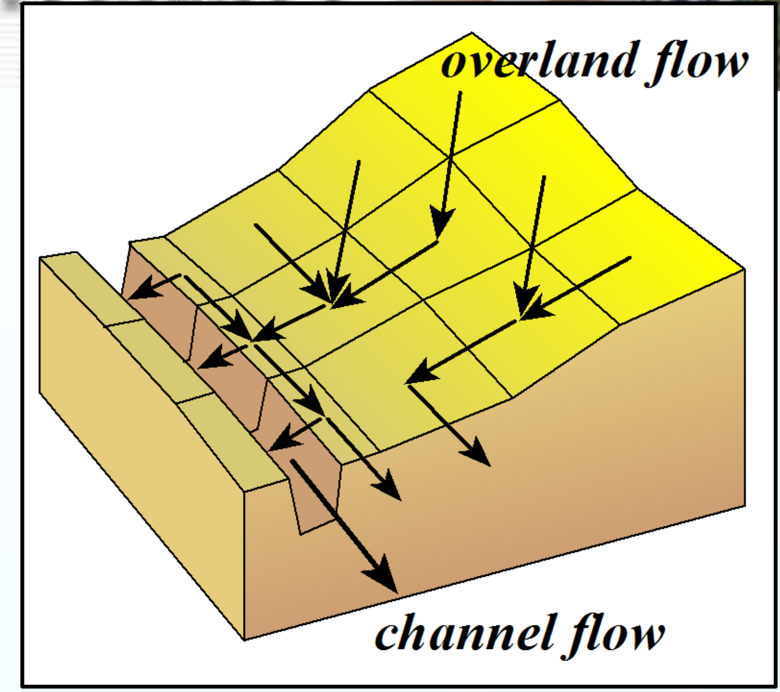
Knowing what and how to…..

- The peak discharge of the stream 0.13 m^3/s
- Runoff contribution of sub basins (11.26 to 87.78 m^3/s)
- Runoff yield ranged from 0.069 to 2.79 $m^3/km^2/day$
- An overlay of housing structures revealed that 40% are in flood prone areas









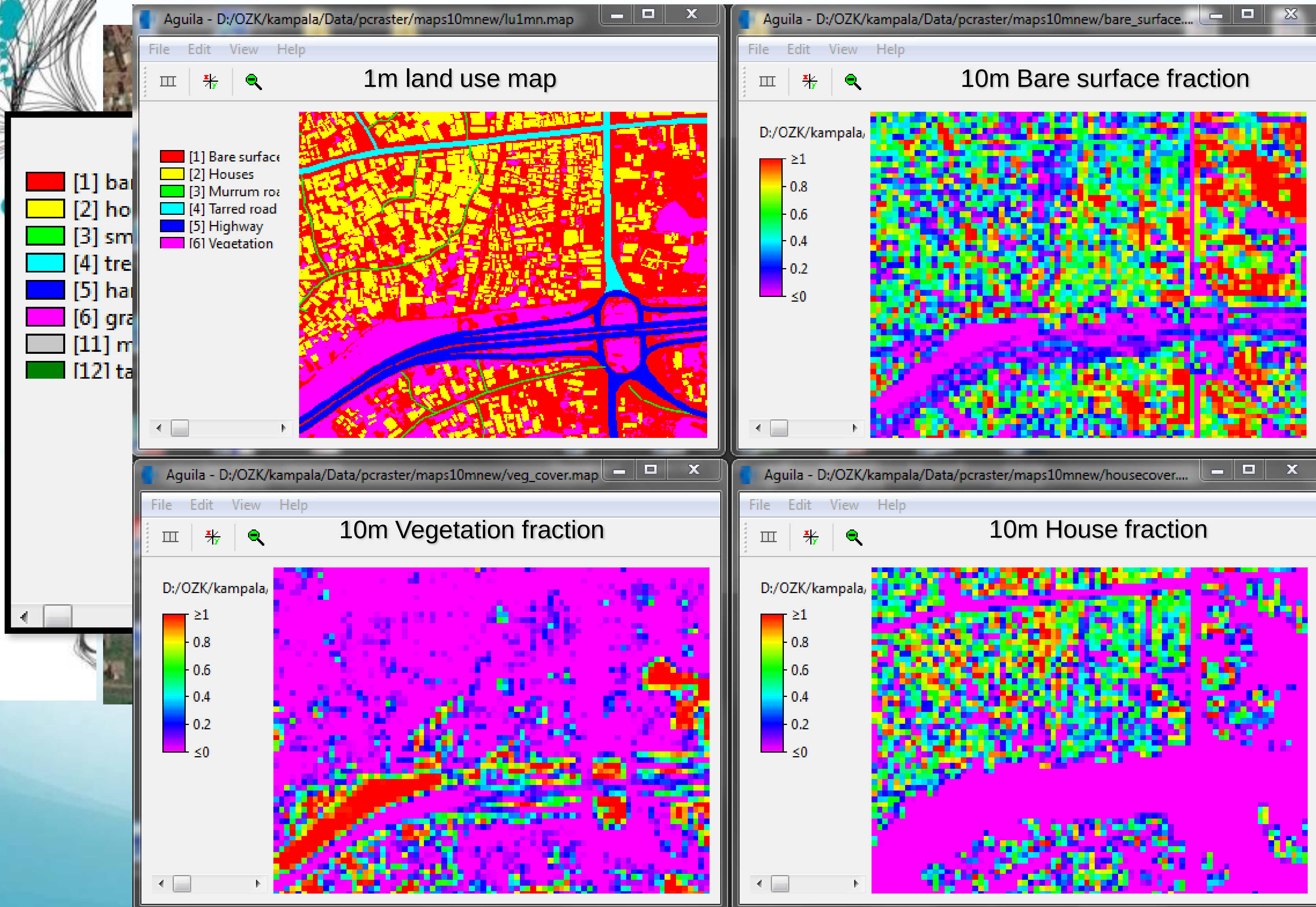
openLISEM model system

Spatial, rainstorm based
Open-source, freeware

Easy to learn, hard to master!

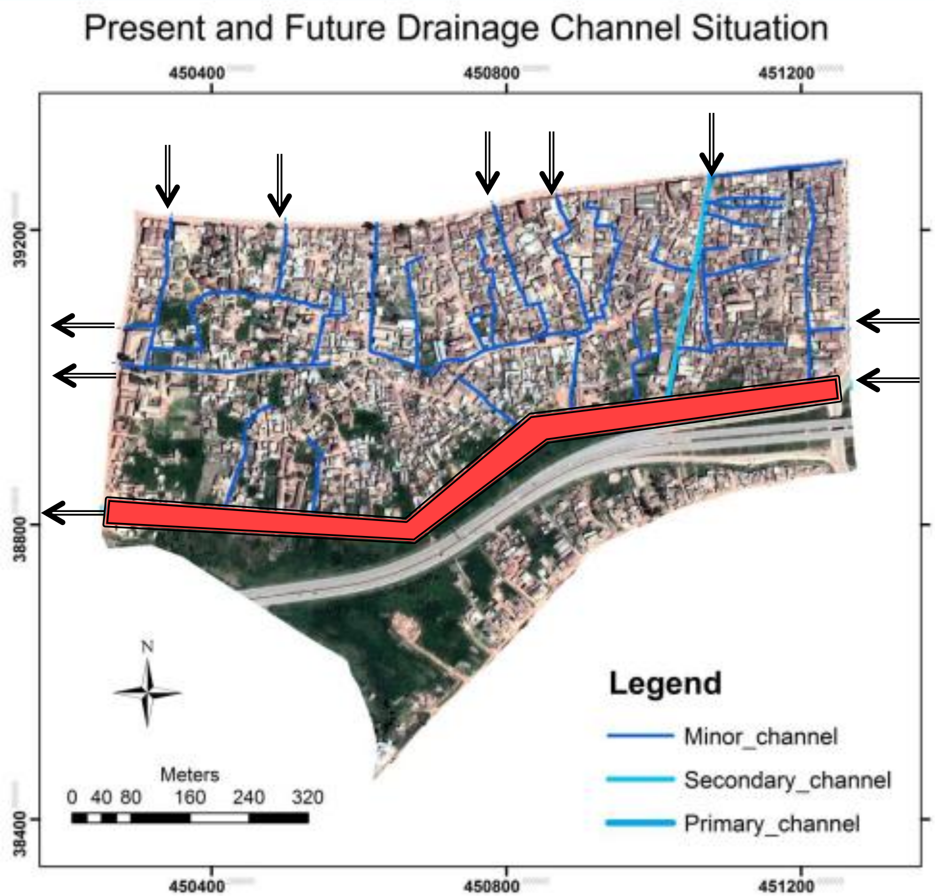
http://blogs.itc.nl/lisem

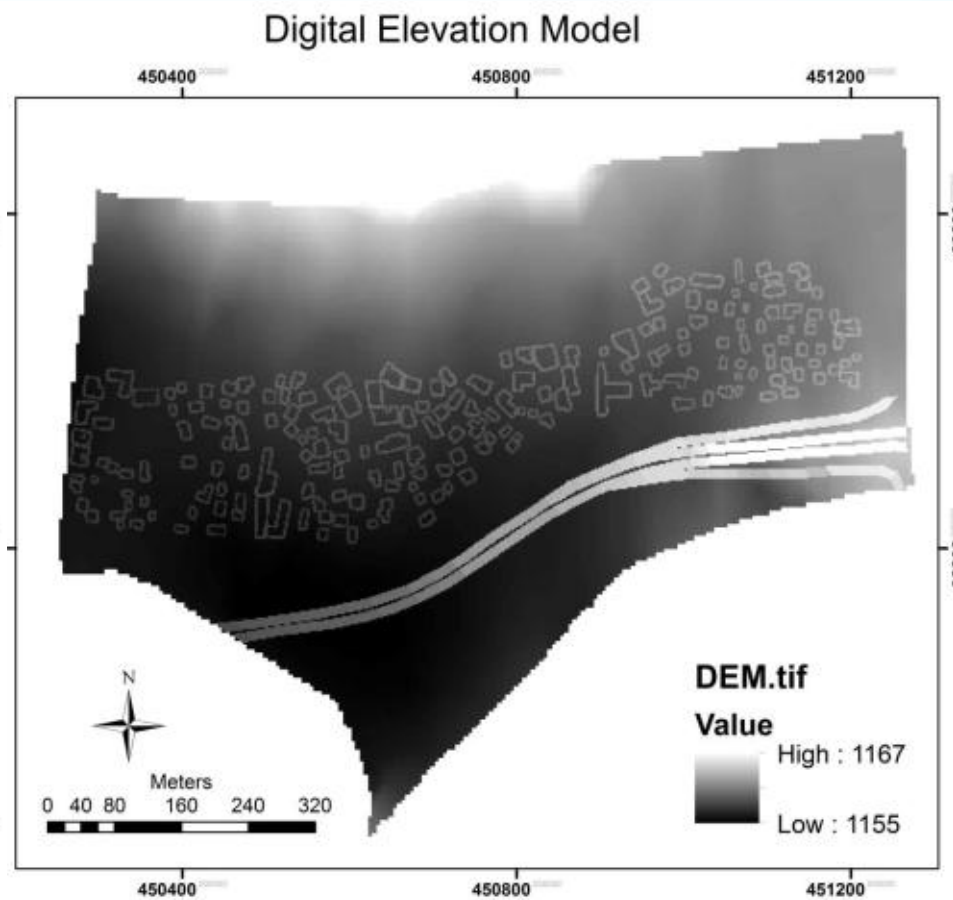
DATA FROM FIELD AND SATELLITE IMAGES



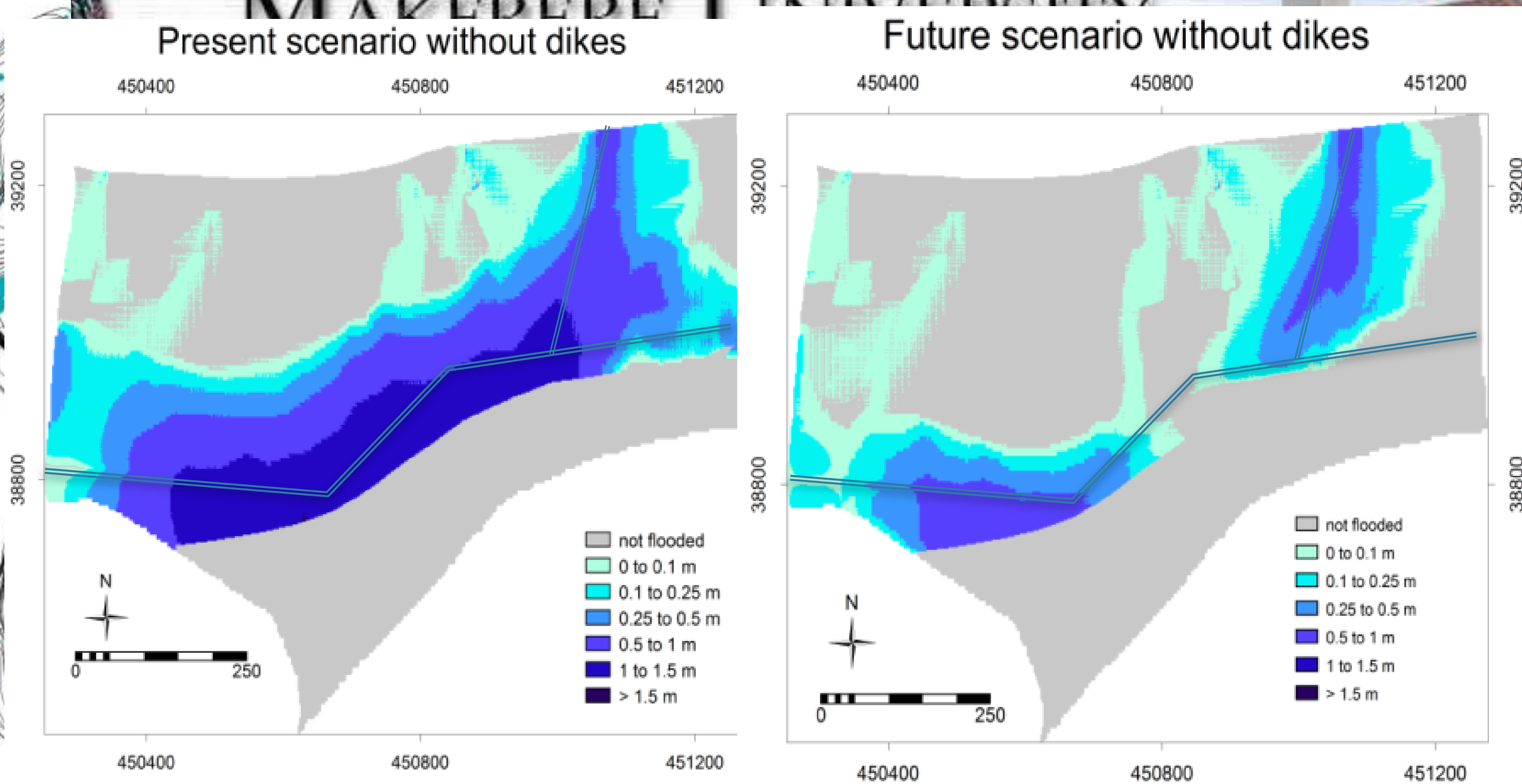
DOWNSTREAM: A DETAILED LOOK AT BWAISE III

(JIGME CHOGYAL MSC GRADUATE ITC)





- Present drainage situation based on the present drainage channels measured during field work
- Future drainage situation is based on future improved drainage channel (primary channel)



Strong improvement but still flooding:

- in the deepest part and in the uninhabited “wetland side” of the channel
- along the northern secondary incoming channel

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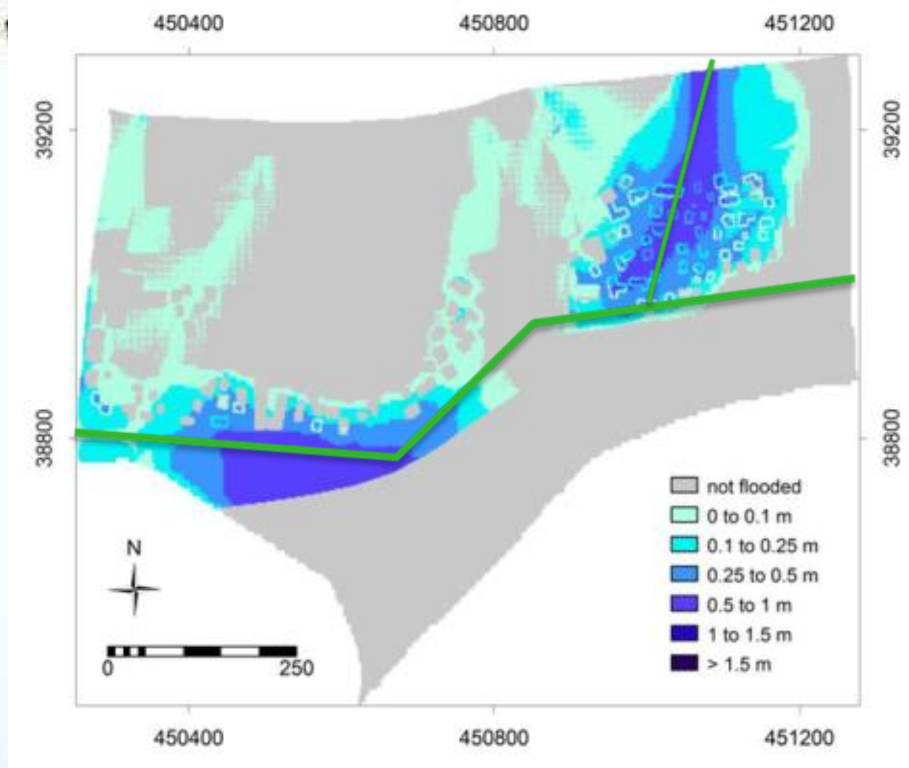

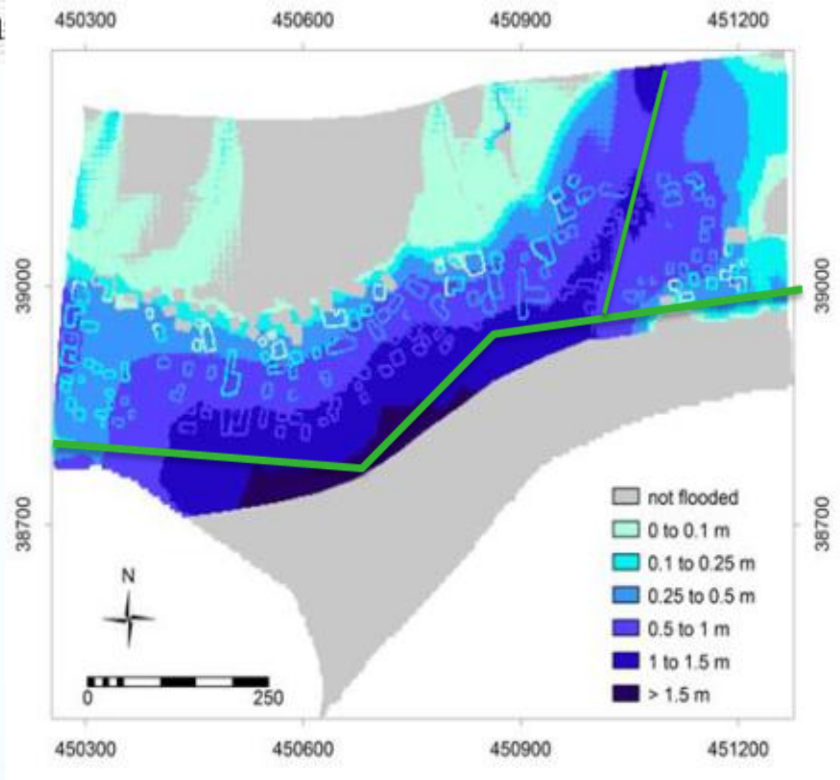

What vulnerability assessments say

- Preparing institutions for climate change readiness
- Mainstreaming adaptation
- Build knowledge that reduces risk
- Embed development with risk reduction

Concluding remarks

- Vulnerability is locale and context specific
- Development can enhance resilience and reduce vulnerability
- The roles of different actors and entry points for resilience
- Methodological approaches and methods transparency

- Questions and comments

- Thank you!