Climate Proofing of Built Environments: Urban storm water drainage systems

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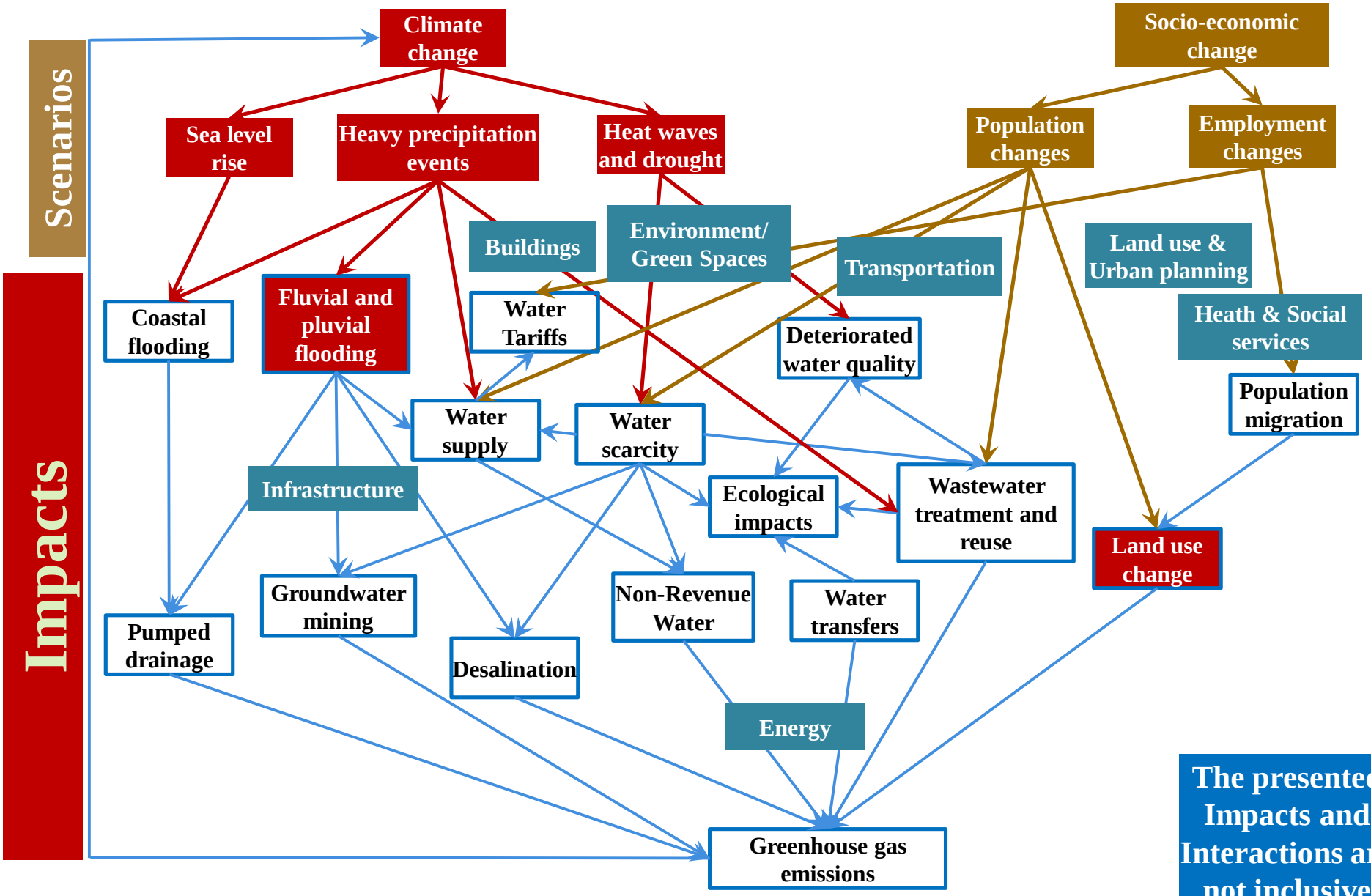
Expert Group Meeting on Coordinating Responses to Climate Change and Disaster Risk Reduction in the Arab Region
Beirut, 19-20 December 2017

Outline

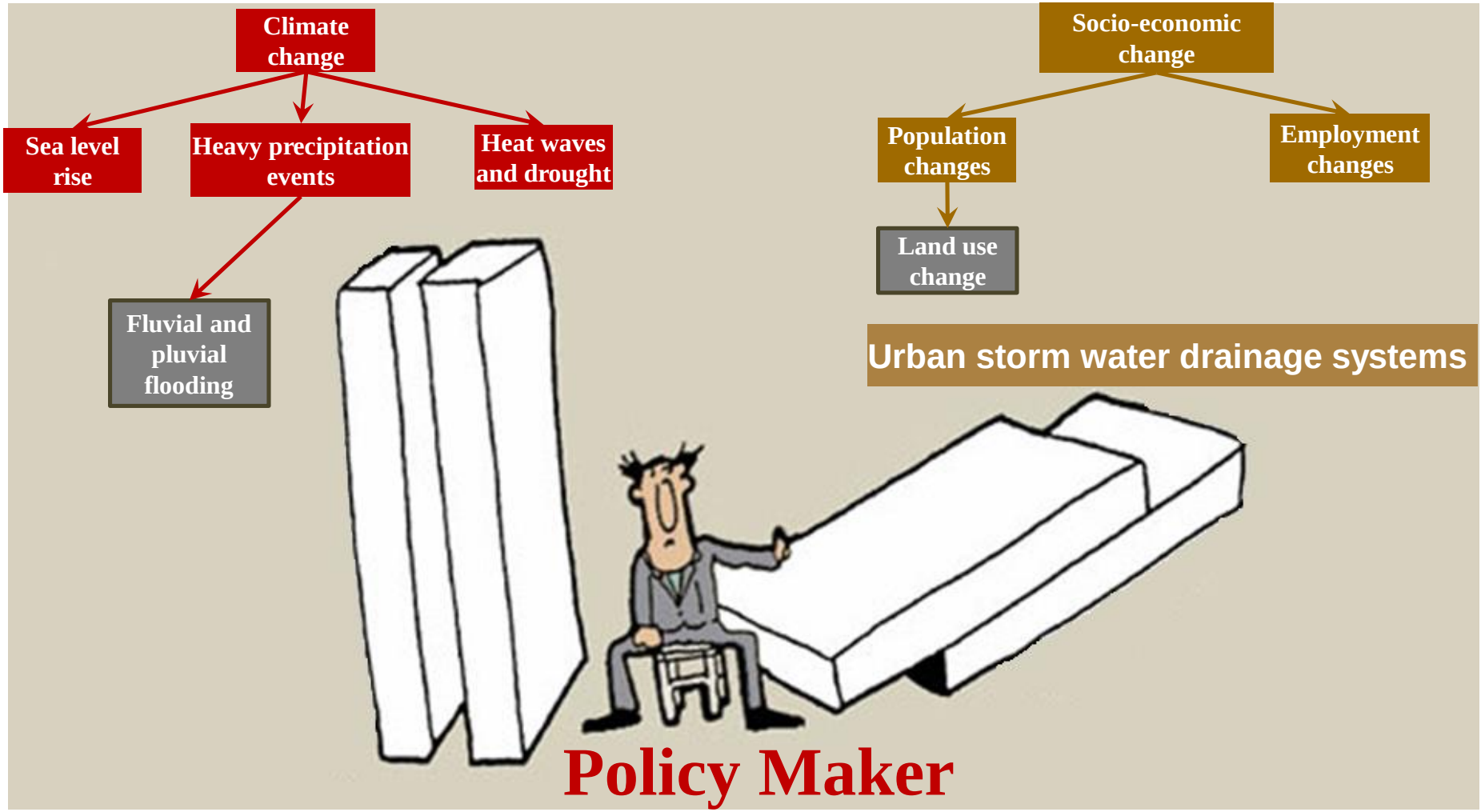
1. Interactions in Urban system/climate change impacts
2. Bridging Climate Change Scenarios and Simulation Models & Tools
3. Screening of adaptation measures
4. Bridging Adaptation Options and Policy Making
5. Uncertainty assessment

Interactions in Urban system/climate change impacts



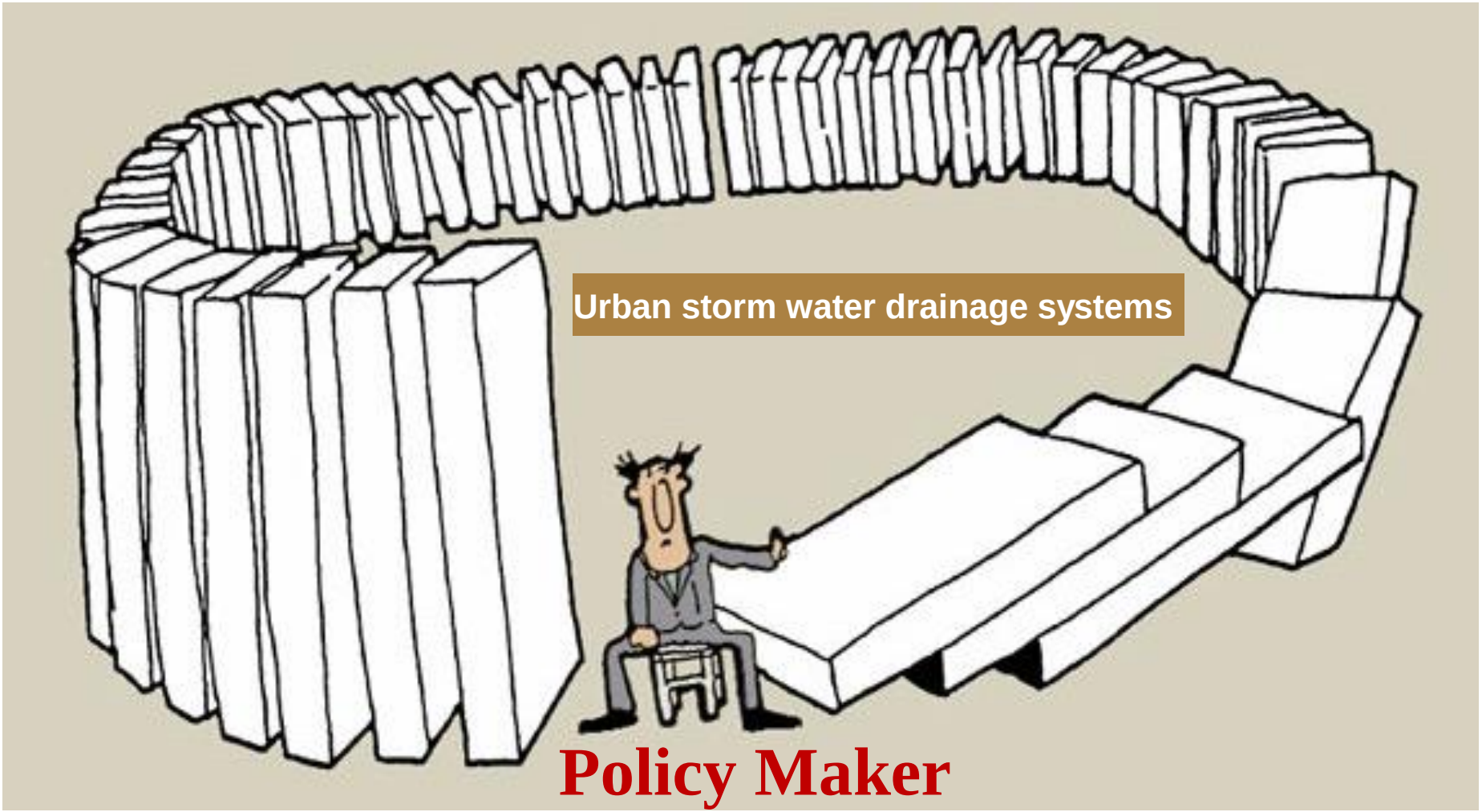
Climate Change Adaptation: Bridging Theory and Practice

In most application, only Direct Impacts are computed



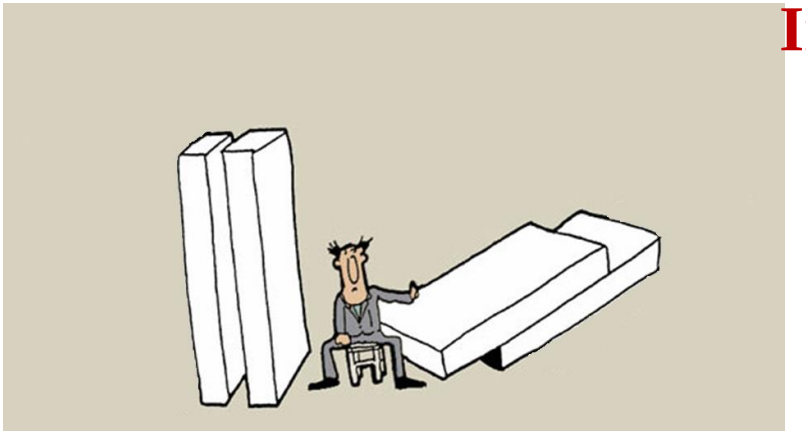
Climate Change Adaptation: Bridging Theory and Practice

What about the Indirect Impacts ?



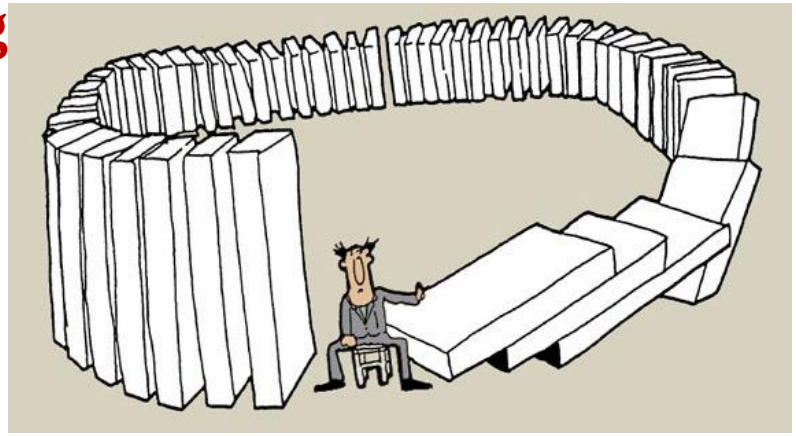
Climate Change Adaptation: Bridging Theory and Practice

Direct Impacts



Informing Policy Making

Indirect Impacts



Jay Forrester (System Dynamics)

Systems Analysis as a Tool for Urban Planning (1970)
IEEE Transactions on systems science and cybernetics, Vol. ssC-6, No. 4

Ali Karnib (Input-Output Theory)

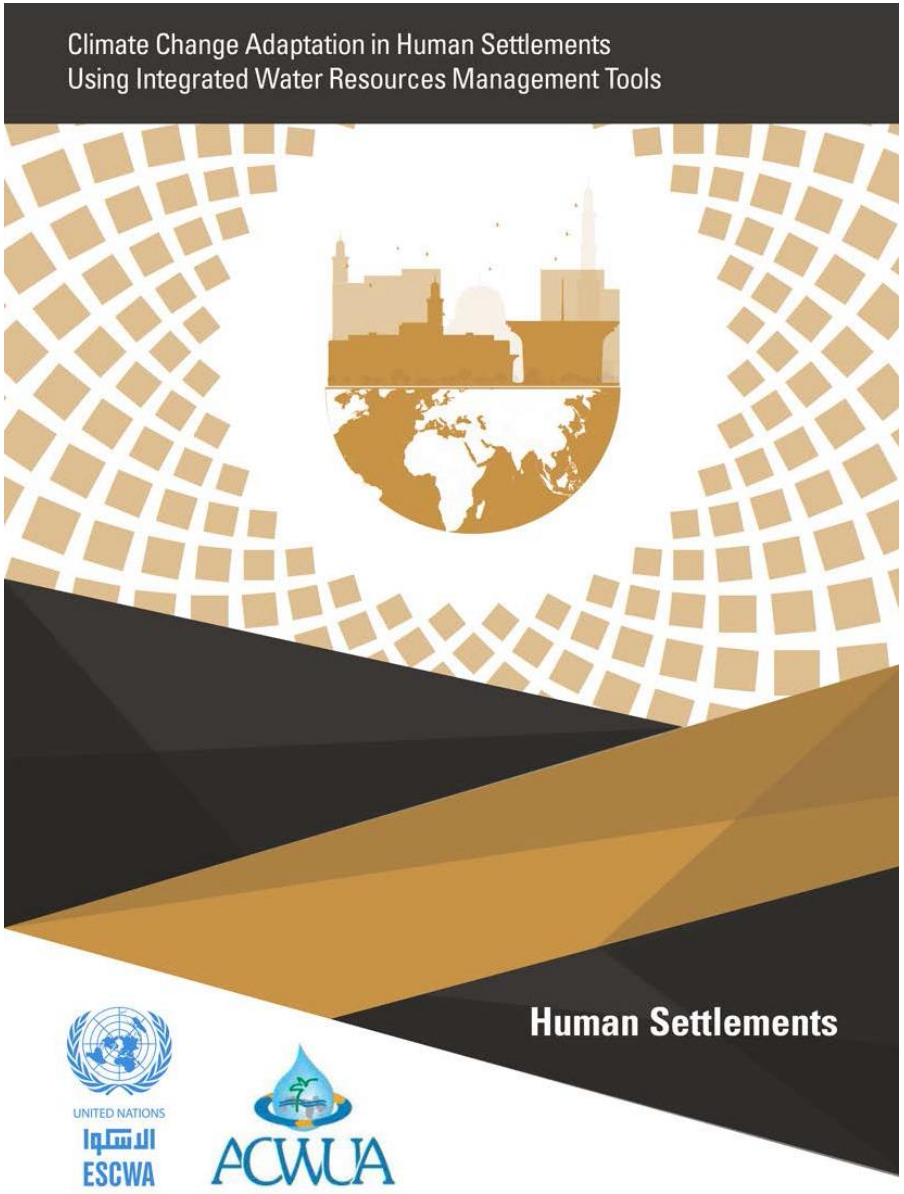
A Quantitative Approach to Analyze the Interlinkages across the SDGs (2017), Journal of Sustainable Development, Canadian Center of Science and Education, Vol. 10, No. 5, 173-180.
https://www.researchgate.net/profile/Ali_Karnib

Bridging Theory and Practice:

1 **Bridging Climate Change Scenarios and Simulation Models & Tools**

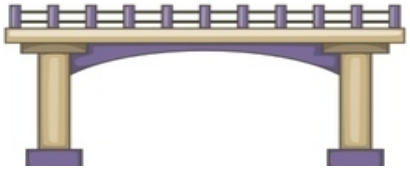
2 **Bridging Adaptation Options and Policy Making**

https://www.unescwa.org/sites/www.unescwa.org/files/publications/files/human-settlements-integrated-water-resources-management-english.pdf



Bridging Climate Change Scenarios and Simulation Models & Tools

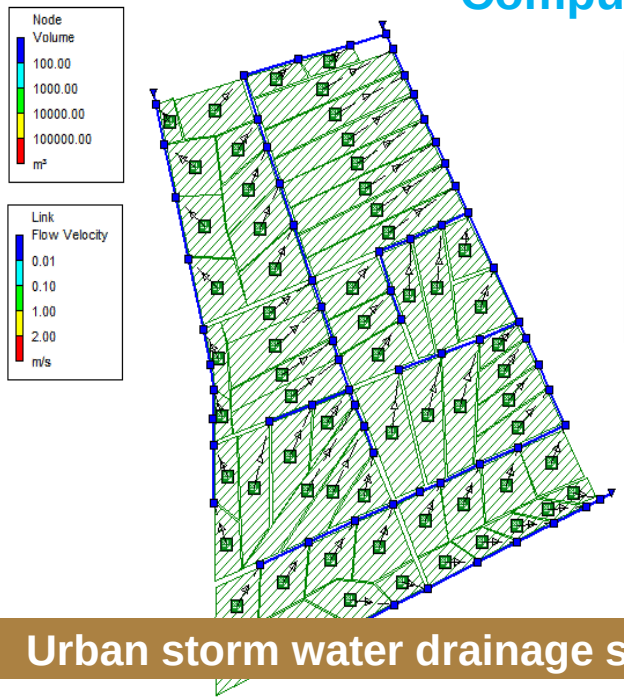
Climate Change Scenarios



Simulation Models & Tools

Storm and Sanitary Analysis (SSA)

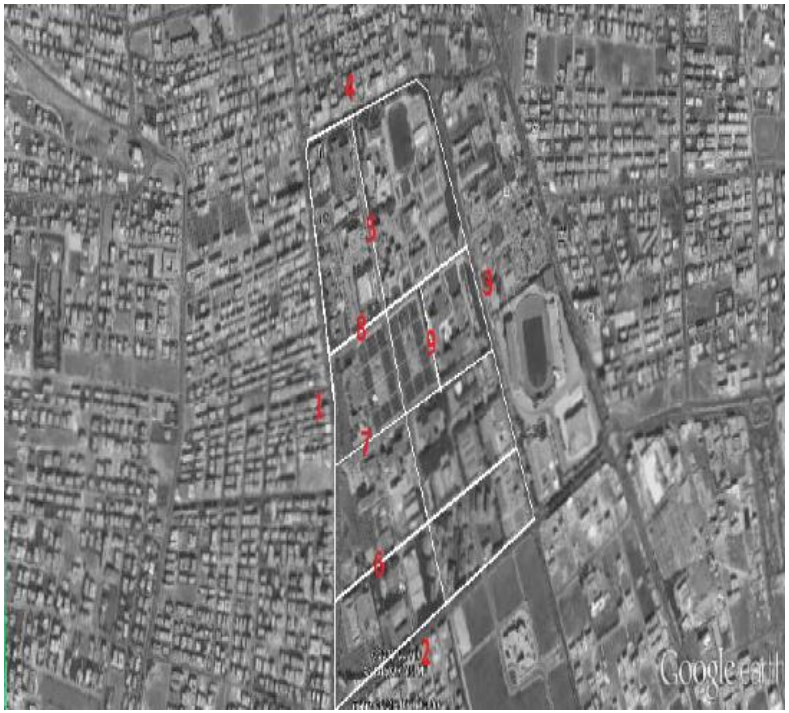
Computer software



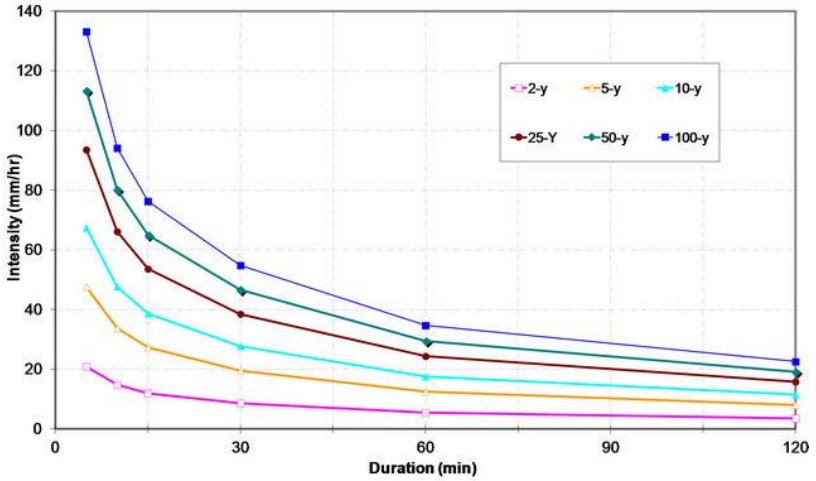
Urban storm water drainage systems

Bridging Climate Change Scenarios and Simulation Models & Tools

Topography and Land use



Intensity-Duration-Frequency curves

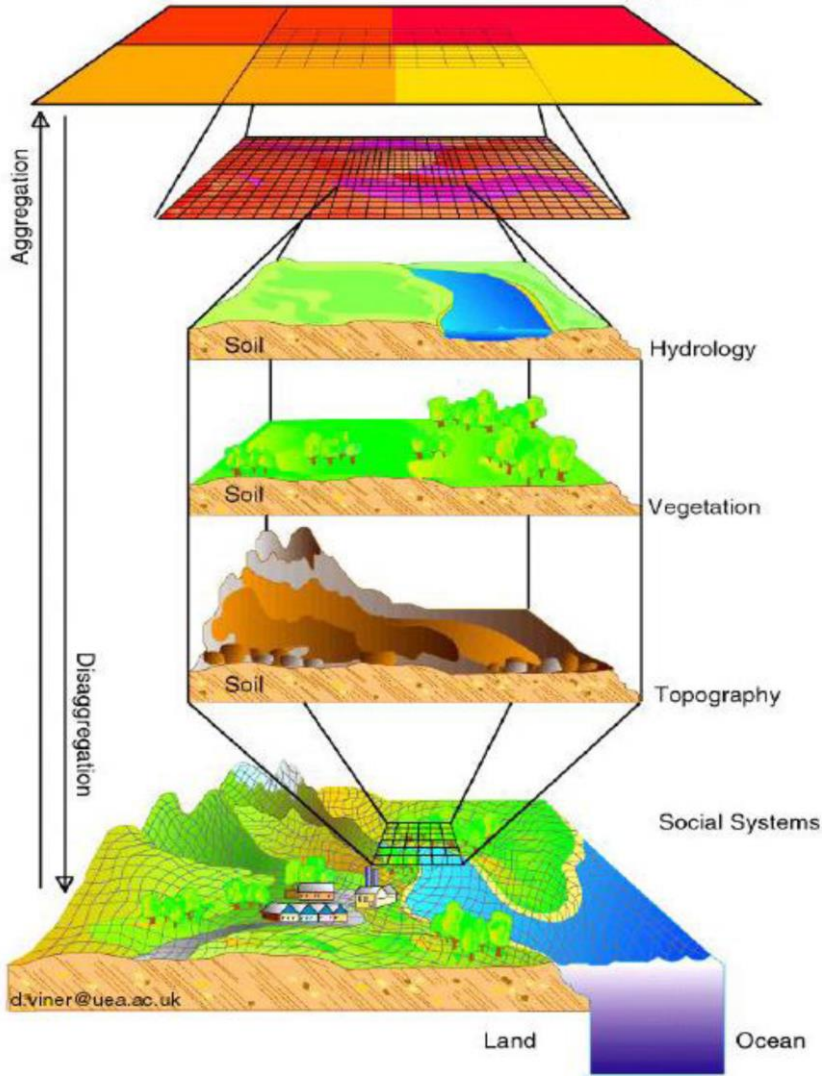


Updated IDF

Slobodan P. Simonovic (2016) **A web-based tool for the development of Intensity Duratior Frequency curves under changing climate,**
Environmental Modelling & Software 81, 136-153

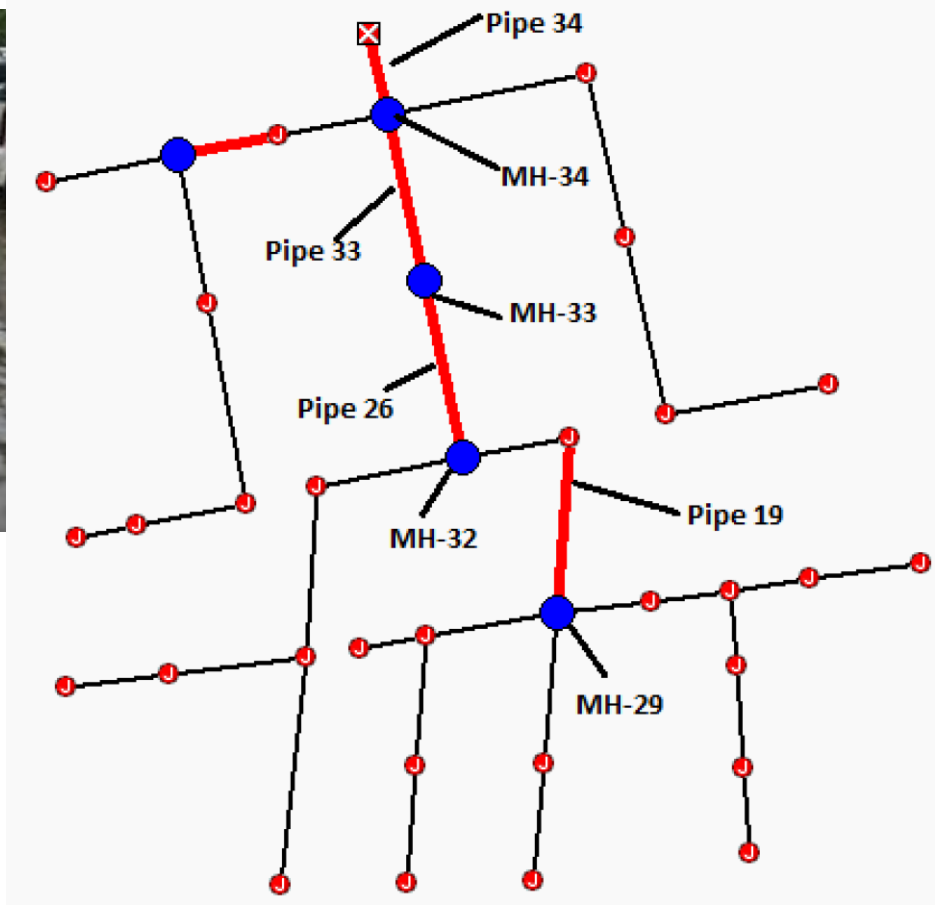
1- Downscaling

2- Updating IDF



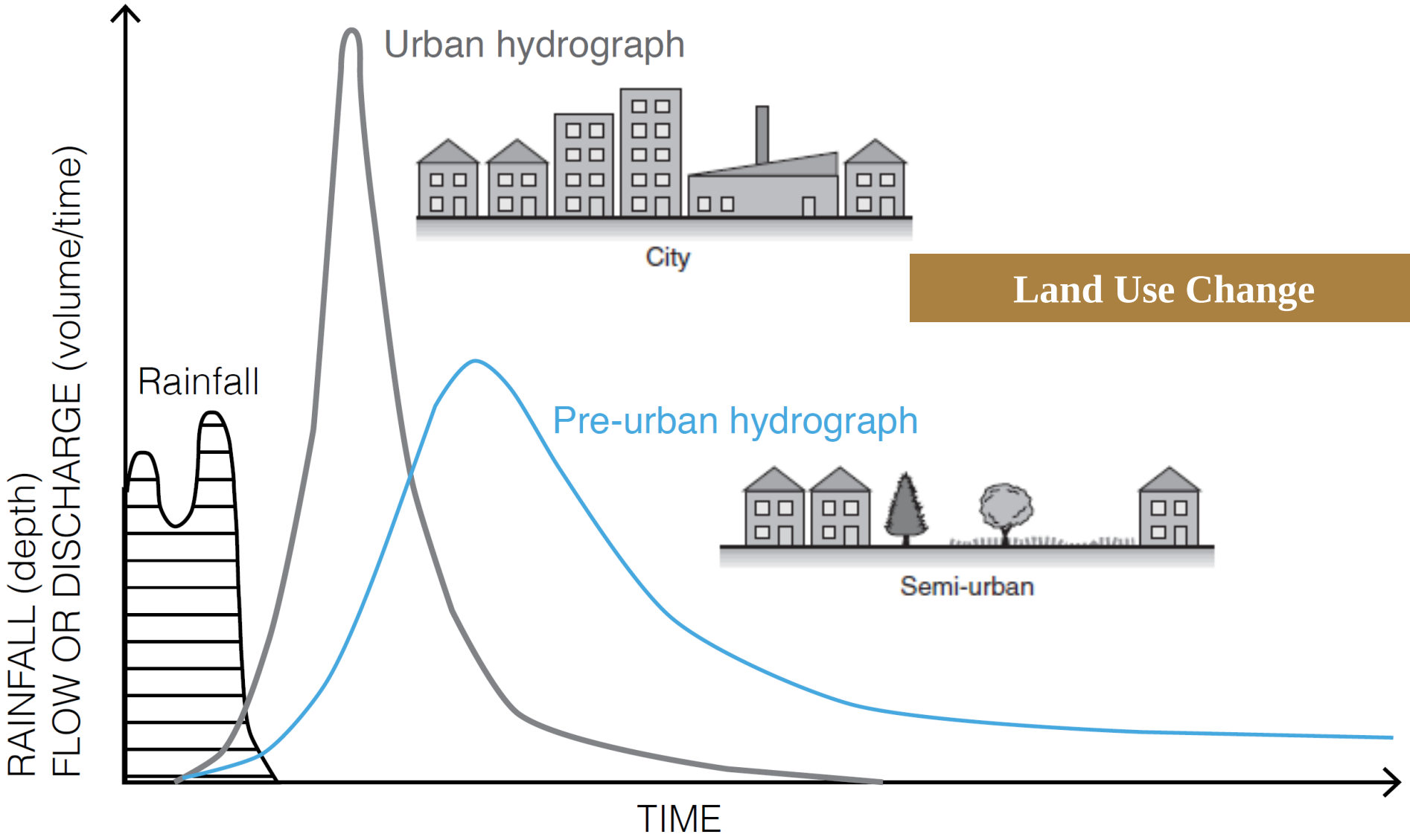
Resulting change should not be interpreted as an exact number but only as indicative of the expected magnitude of future change

Bridging Climate Change Scenarios and Simulation Models & Tools



Flooded Network after Analysis by Storm and Sanitary Analysis (SSA)

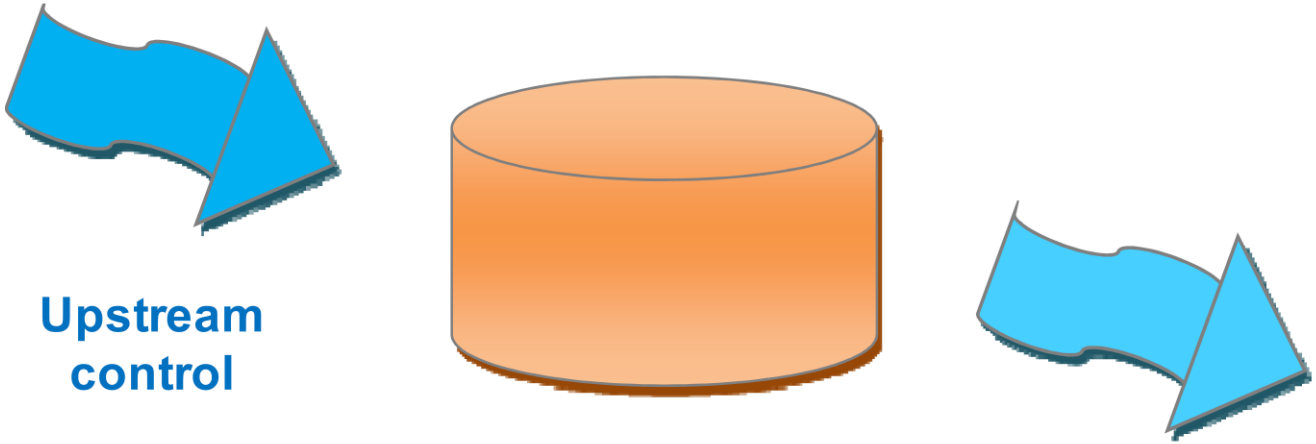
Bridging Climate Change Scenarios and Simulation Models & Tools



Screening of adaptation measures

Climate change adaptation implies a risk reduction process by means of managing hazards and/or vulnerabilities

Categorization of adaptation options based on their impacts on the hydrological runoff process.



Upstream control

Example: green roof, ponds and local infiltration

'In system' control

Topographic change, flood defence, land use change, individual assets protection

Downstream control

Pipe enlargement, road management, pumps and relief channels

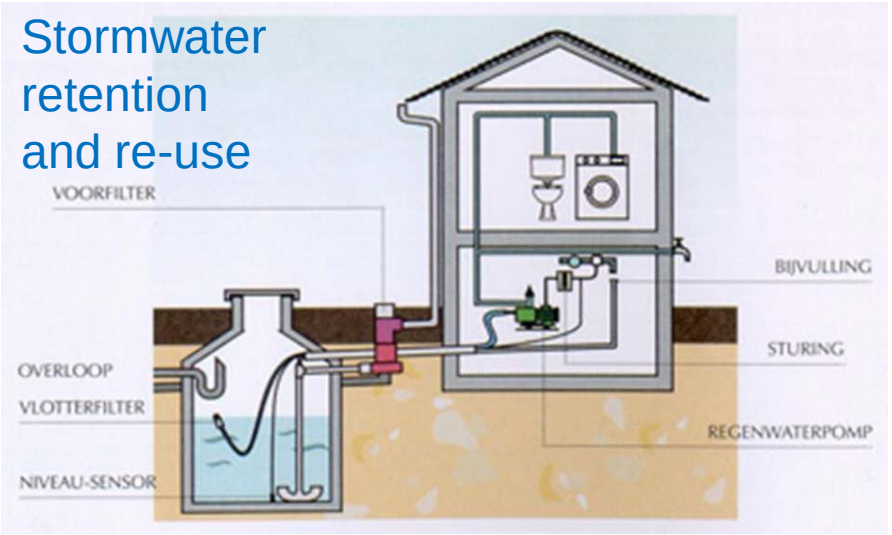
Permeable pavements:

Individual infiltration:

Stormwater storage and infiltration in public spaces

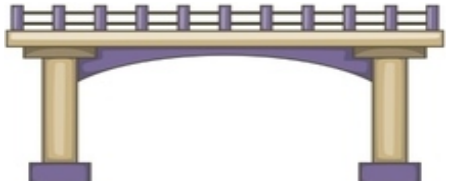
Improved interfacing between urban water management and spatial planning / urban design

Stormwater retention and re-use



Bridging Adaptation Options and Policy Making

Policy/ Adaptation Options



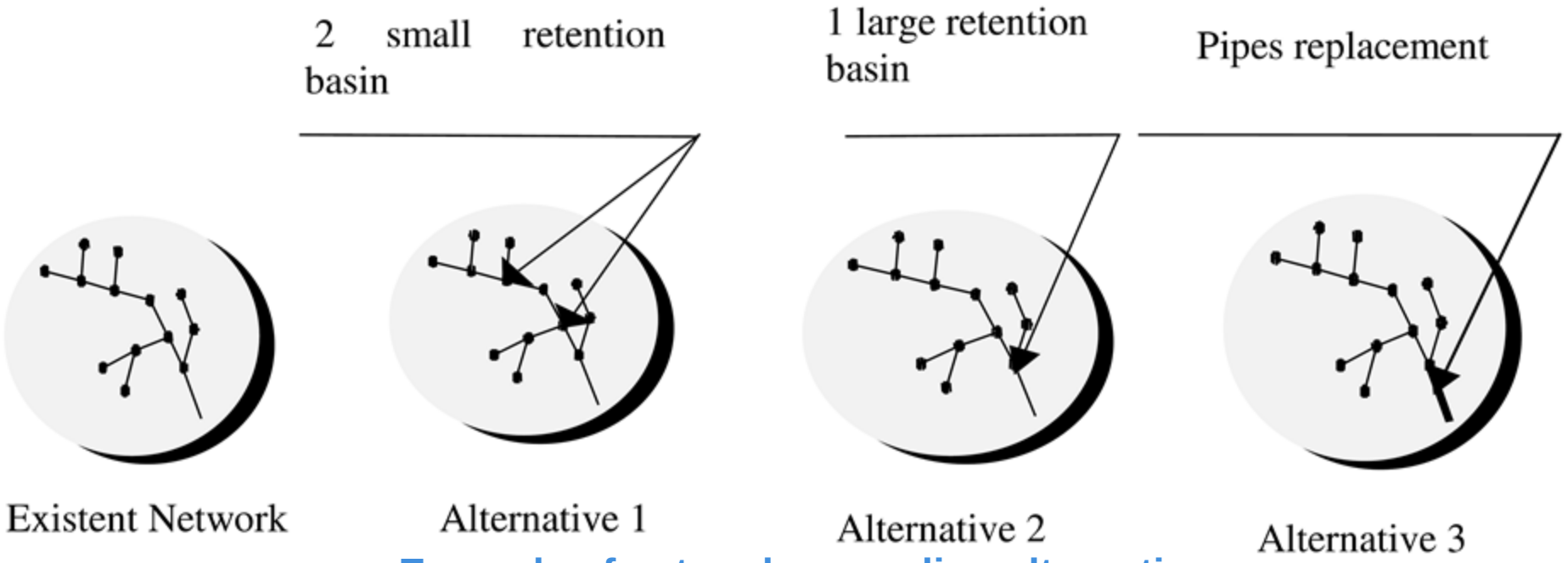
Policy/ Decision Making

Multi-Criteria Decision Making Matrix

	Economic	Technical	Environmental	……	Risk degree
Alternative 1					
Alternative 2					
Alternative 3					

Bridging Adaptation Options and Policy Making

Evaluation of the Risk degrees associated to the failure of urban storm water drainage systems



Example of network upgrading alternatives

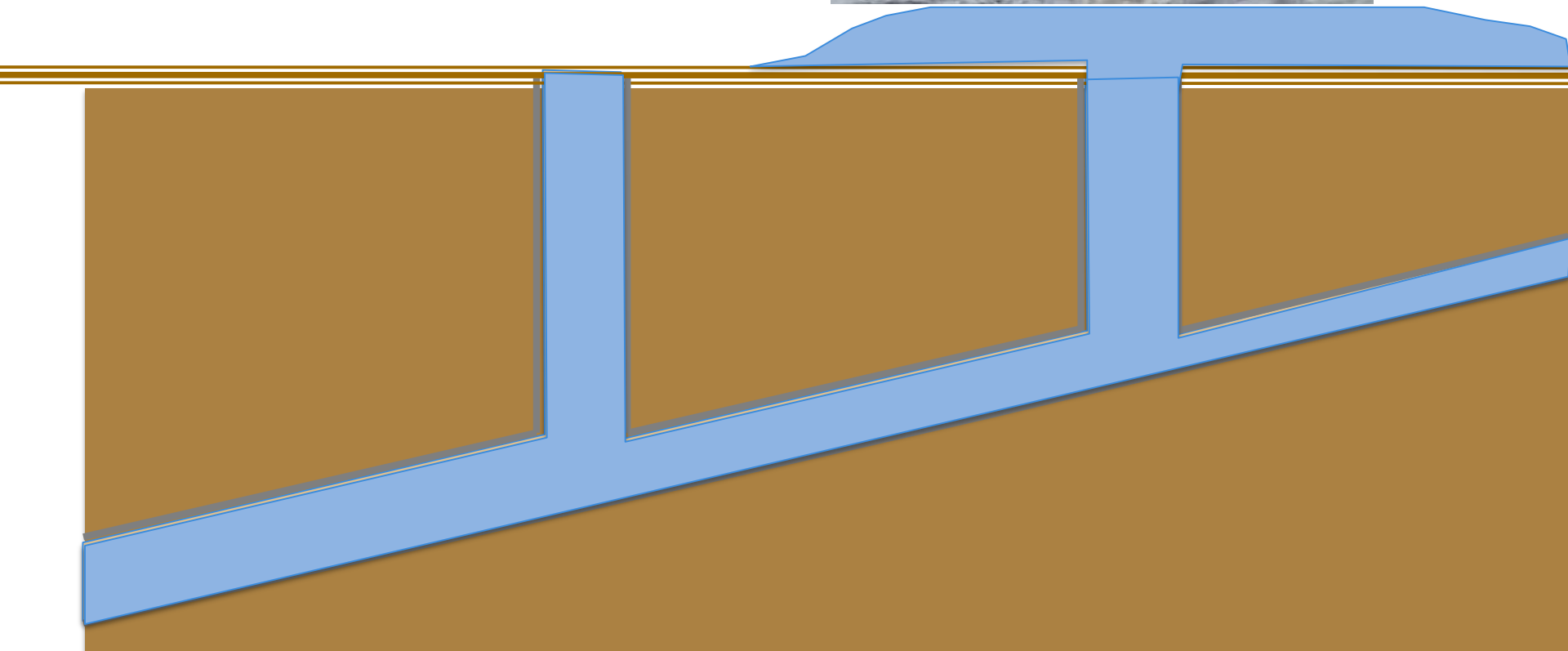
Source: Karnib Ali, Al-Hajjar Jihad, Boissier Daniel (2002) An expert system to evaluate the sensitivity of urban areas to the functioning failure of storm drainage network, Urban Water Journal, Elsevier Edition, vol 4, nb. 1, pp. 43-51. https://www.researchgate.net/profile/Ali_Karnib

Evaluation of the Risk degrees

Basic information

The Hydraulic simulation

Knowing the operational behavior of the network using hydraulic simulation model



Basic information

The Identification of ponding areas

The size of the ponding area depends on the topography and the nature of the soil around the failed pipe.

Evaluation of the Risk degrees

Density of population

Density of traffic

Density of residential land use

Density of commercial land use

Density of industrial land use

Density of public utilities

……

Risk degrees = Function of the risk variables

Source: Karnib Ali, Al-Hajjar Jihad, Boissier Daniel (2002) An expert system to evaluate the sensitivity of urban areas to the functioning failure of storm drainage network, Urban Water Journal, Elsevier Edition, vol 4, nb. 1, pp. 43-51. https://www.researchgate.net/profile/Ali_Karnib

Evaluation of the Risk degrees

Expert system

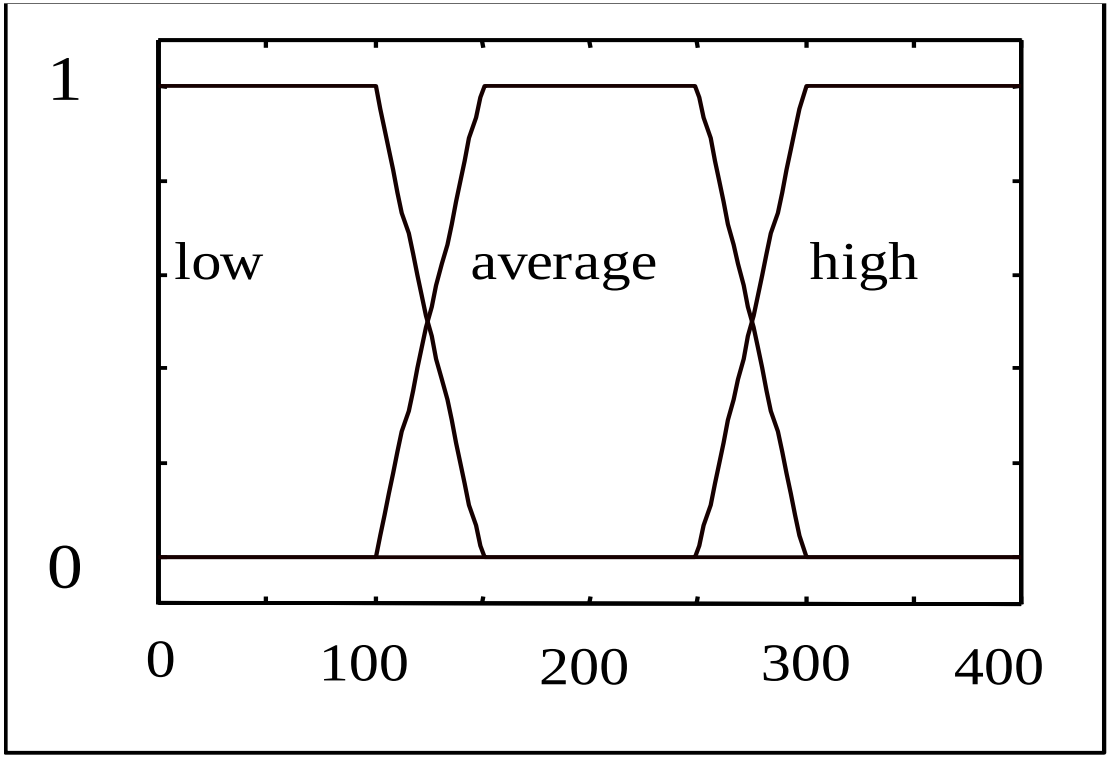
IF Density of population is average

THEN The Risk degree is average

IF	THEN
Density of population is average	The risk degree is average
Density of commercial land use is high	The risk degree is high
.....	.....

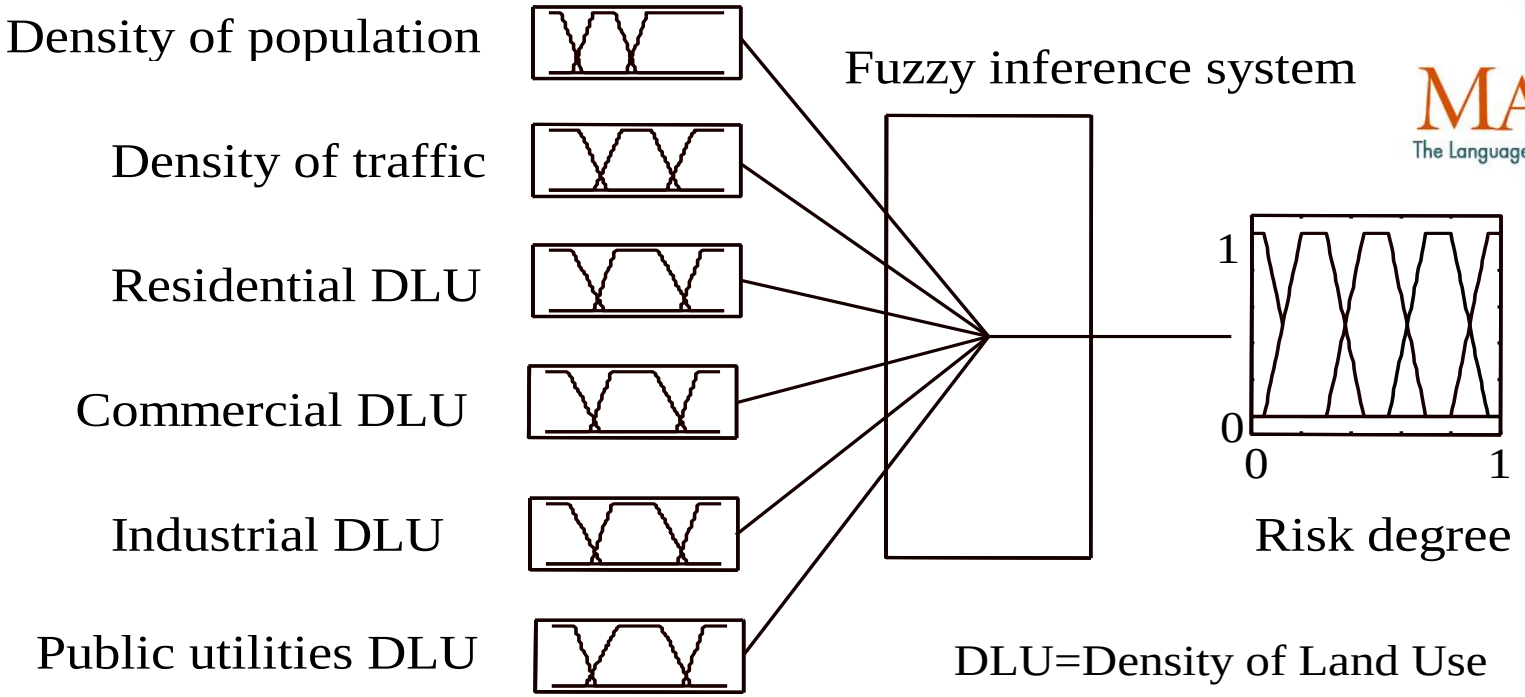
Examples of rules to determine the risk degree

Evaluation of the Risk degrees

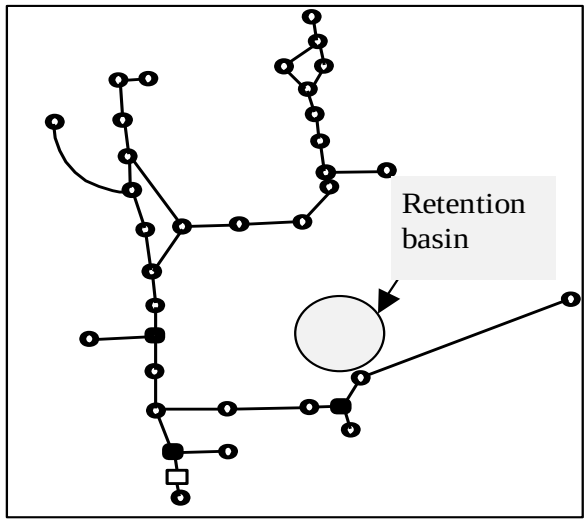


Evaluation of the Risk degrees

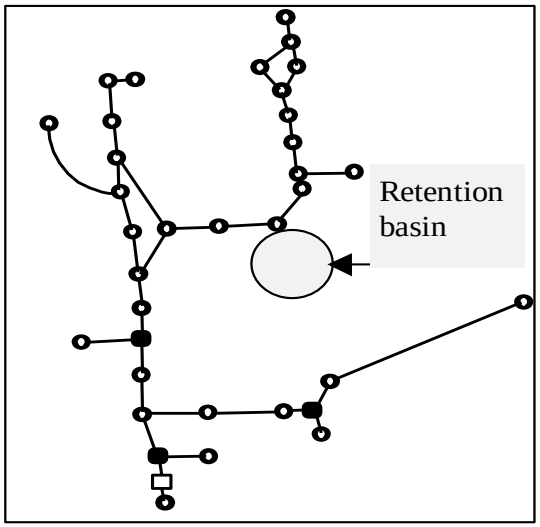
Expert system



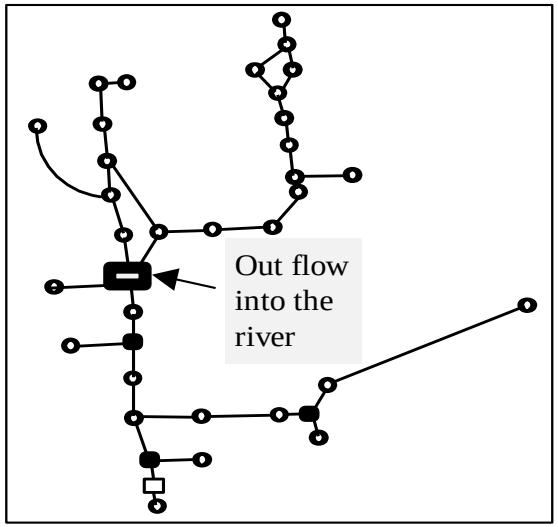
Evaluation of the Risk degrees



Alternative A_1



Alternative A_2



Alternative A_3

Goal 11. Make cities and human settlements inclusive, safe, resilient and sustainable

11.1	By 2030, ensure access for all to adequate, safe and affordable housing and basic services and upgrade slums
11.2	By 2030, provide access to safe, affordable, accessible and sustainable transport systems for all, improving road safety, notably by expanding public transport, with special attention to the needs of those in vulnerable situations, women, children, persons with disabilities and older persons
11.3	By 2030, enhance inclusive and sustainable urbanization and capacity for participatory, integrated and sustainable human settlement planning and management in all countries
11.4	Strengthen efforts to protect and safeguard the world's cultural and natural heritage
11.5	By 2030, significantly reduce the number of deaths and the number of people affected and substantially decrease the direct economic losses relative to global gross domestic product caused by disasters, including water-related disasters, with a focus on protecting the poor and people in vulnerable situations
11.6	By 2030, reduce the adverse per capita environmental impact of cities, including by paying special attention to air quality and municipal and other waste management
11.7	By 2030, provide universal access to safe, inclusive and accessible, green and public spaces, in particular for women and children, older persons and persons with disabilities

Informing Policy Making

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Karnib Ali (2017) **Qualitative Nexus Model for Evaluating Direct and Indirect Interlinkages across the Sustainable Development Goals**, International Journal of Development and Sustainability, Vol. 6 No. 9, pp. 1150-1158. http://www.ccsenet.org/journal/index.php/jsd/article/view/69679

Karnib Ali (2017) **Mapping the Direct and Indirect Interlinkages across the Sustainable Development Goals: A Qualitative Nexus Approach**, International Journal of Development and Sustainability, 6, 9, 1150-1158. https://isdsnet.com/ijds-v6n9-15.pdf

Uncertainty assessment of climate change adaptation

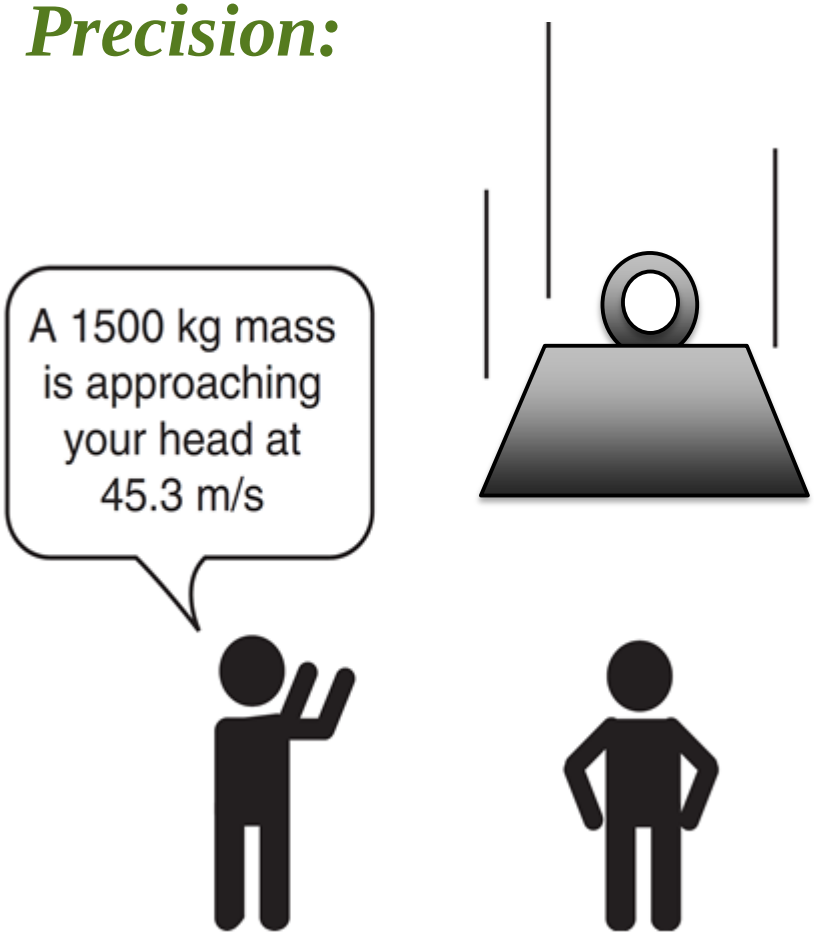
Urban storm water drainage systems

- Model structure uncertainty
- Input uncertainties
- Context uncertainty
- Parameter uncertainty
- Indirect Impacts
- Model outcome uncertainty
- Statistical uncertainty
- Scenario uncertainty
- Imperfect knowledge of the system

Uncertainty assessment of climate change adaptation

Urban storm water drainage systems

Precision:



Significance:

Informing Policy Making

THANK YOU

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