The impact of Climate Change on Mean Annual Flood Damage and the Associated Impact on Disaster Risk Reduction Measures (Cost Benefit)

2nd Annual Conference in Disaster Risk Reduction

Presented by:
Dr. Herman Booysen
PrGIScP (SA)
NETGroup
Research Associate, Department Geography, University of the Free State

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Contents

- Climate Change
- Flood Damage
- Impact of Climate Change on Flood Damage
- Impact on Disaster Risk Reduction

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Introduction

"The most immediate threats to humankind relate to increased variability in the intensity and frequency of storms and other extreme weather-climate- related events such as floods and droughts, heat waves in major urban areas and the impact of sea-level rise on low-lying coastal regions"

Professor G.O.P. Obasi
Former Secretary General, World Meteorological Organization, 2003

Climate Change

- Anthropogenic climate change, or ‘global warming’, is caused by increasing concentrations of greenhouse gases
- These gases trap the heat in our atmosphere by preventing radiation from escaping into space.
- The concentration of CO2 in the atmosphere has increased its highest level in at least the past 420,000 years

- The result of rising greenhouse gas concentrations with a higher average temperature are:
  - An increase in the global mean sea level
  - Widespread retreat of glaciers, a decrease in snow cover, shifts of plant and animal ranges etc
- With respect to precipitation, the general projection is that the hydrological cycle will become more intensive.
- This results, on average, in a wetter climate, though, there are substantial differences between regions.

- Rainfall over land has increase 5 – 10% in the Northern hemisphere
- North and West Africa and part of the Mediterranean have seen less rain
- In parts of Africa and Asia, the frequency and intensity of droughts have increase in recent decades
- The Red Cross stated that the number of floods resulted in disasters where people needed help, increase eight fold from 2004
- Studies shows potential future increases in flood peak of approximately 15% in temperate zones due to increased storm activity and overall increases in depth of precipitation
- Climate Change not only raises the risk, but also increases the uncertainties

- Research done by the “U.S. Geological Survey” shows that a 100 year flood (1 flood every 100 year) risk can change to between 3 to 6 times in 100 year in the 21 century
- A change from 1% to 3% – 6% chance of occuring in 1 year

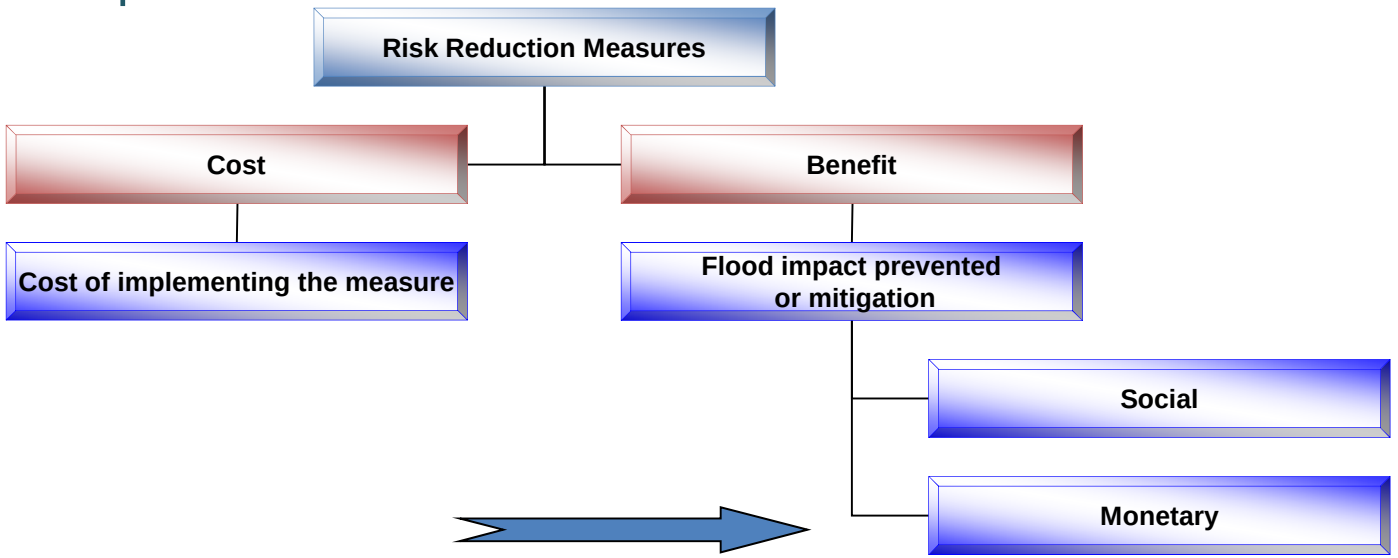
Contents

- Climate Change
- Flood Damage
- Impact of Climate Change on Flood Damage
- Impact on Disaster Risk Reduction

- Calculation of Flood Damages

Flood Damage

- One of the main reasons for calculate potential flood damage is to support the implementation of flood risk reduction measures as part of Disaster Risk Reduction
- Calculation of the costs and benefits when planning what measures to implement



Flood Damage

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Cost

1 Year — 30 Years — **R ?**

Benefits

1 Year — 30 Years — **R ?**

R ? VS **R ?**

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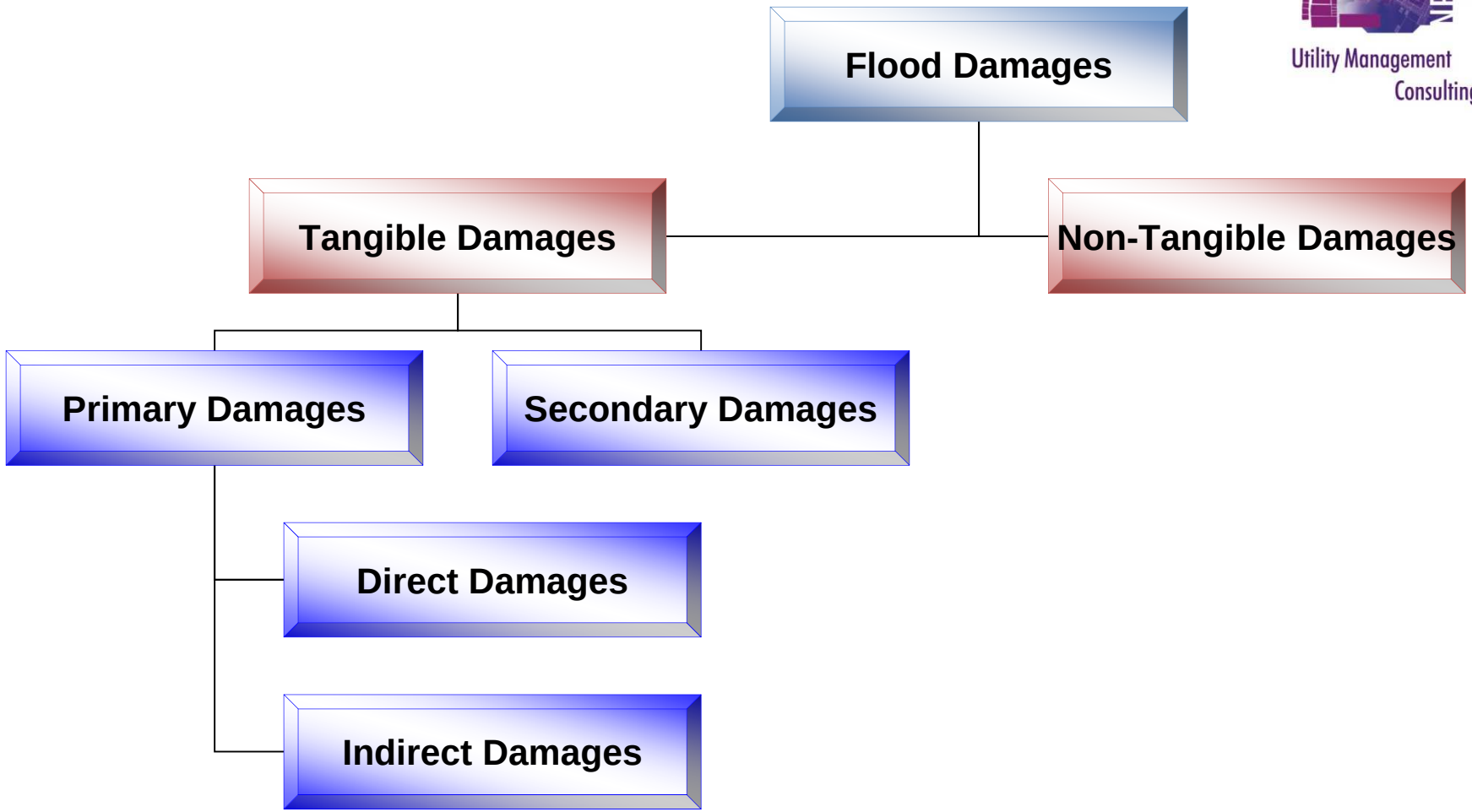
Flood Damage - Types



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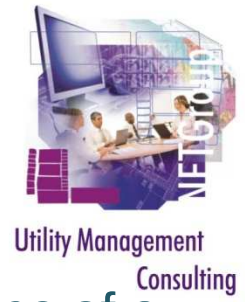
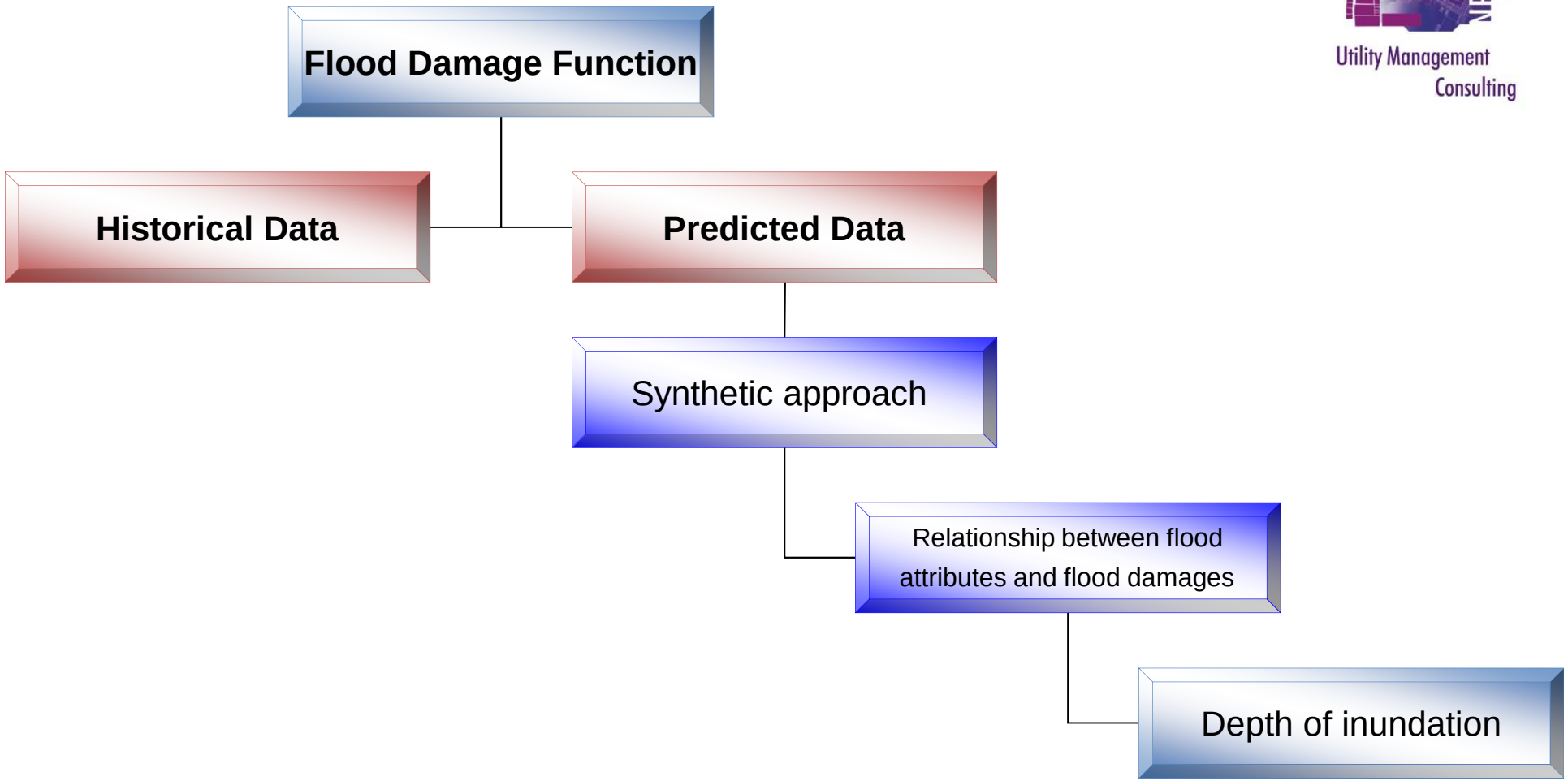
Flood Damage Assessment



- Historical Flood Damage Assessment
  - Calculation and reporting on damages after the occurrence of a flood
- Prediction of flood damages
  - Relationship between flood damages and one or more flood parameter such as depth of inundation and duration of the flood
  - Damage to specific property
    - Residential
    - Commercial and
    - Industrial
  - Flood damage Function

Flood Damage Function



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Flood Damage Function Cont

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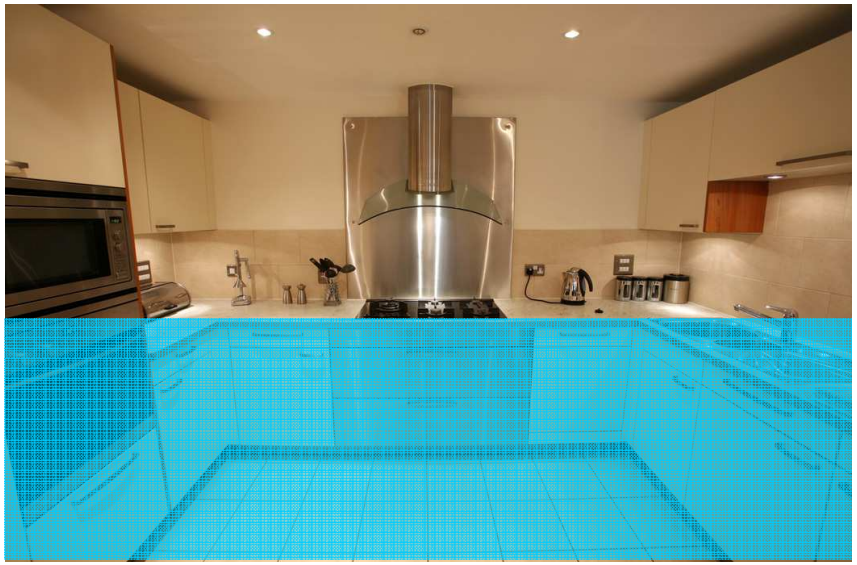

1,5m = R Damage for a specific category of residential property

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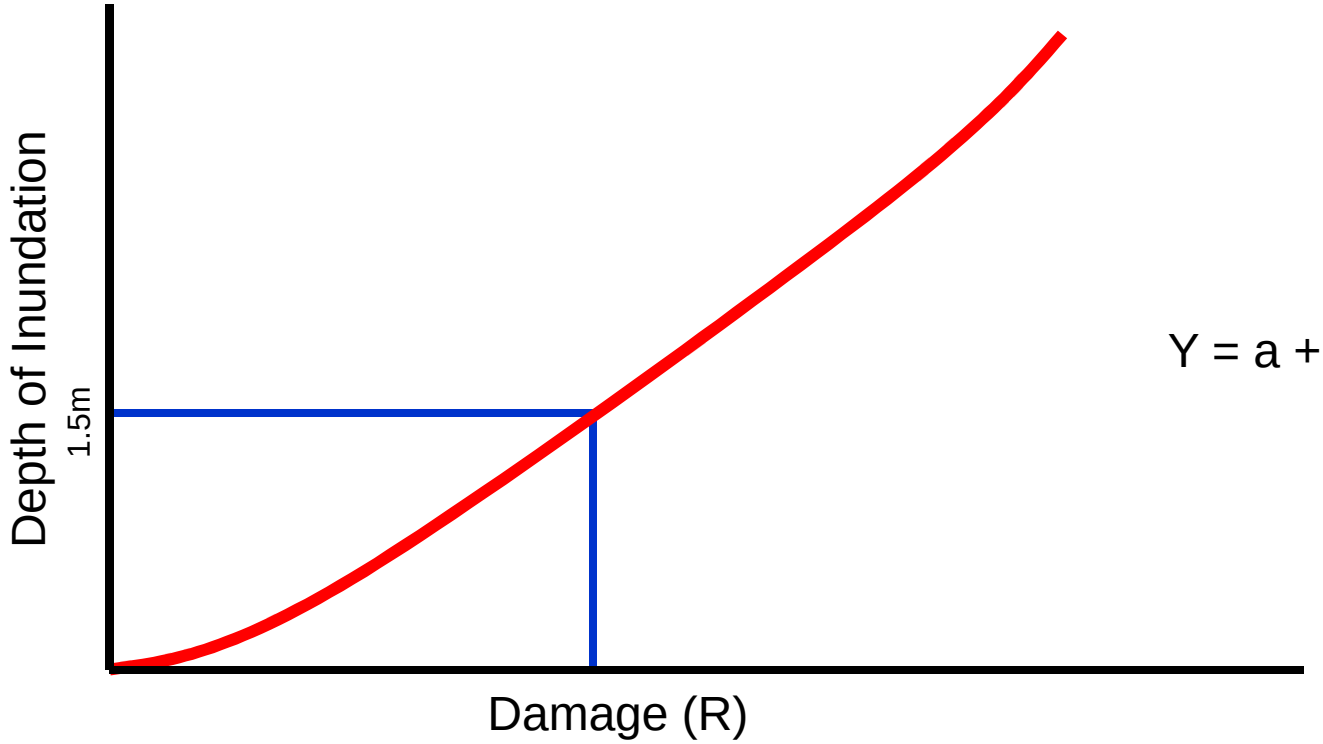
Flood Damage Function Cont



$$Y = a + bX^2$$

Flood Damage Function Cont

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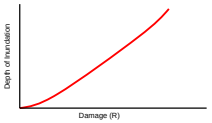

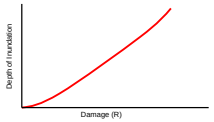

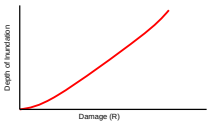

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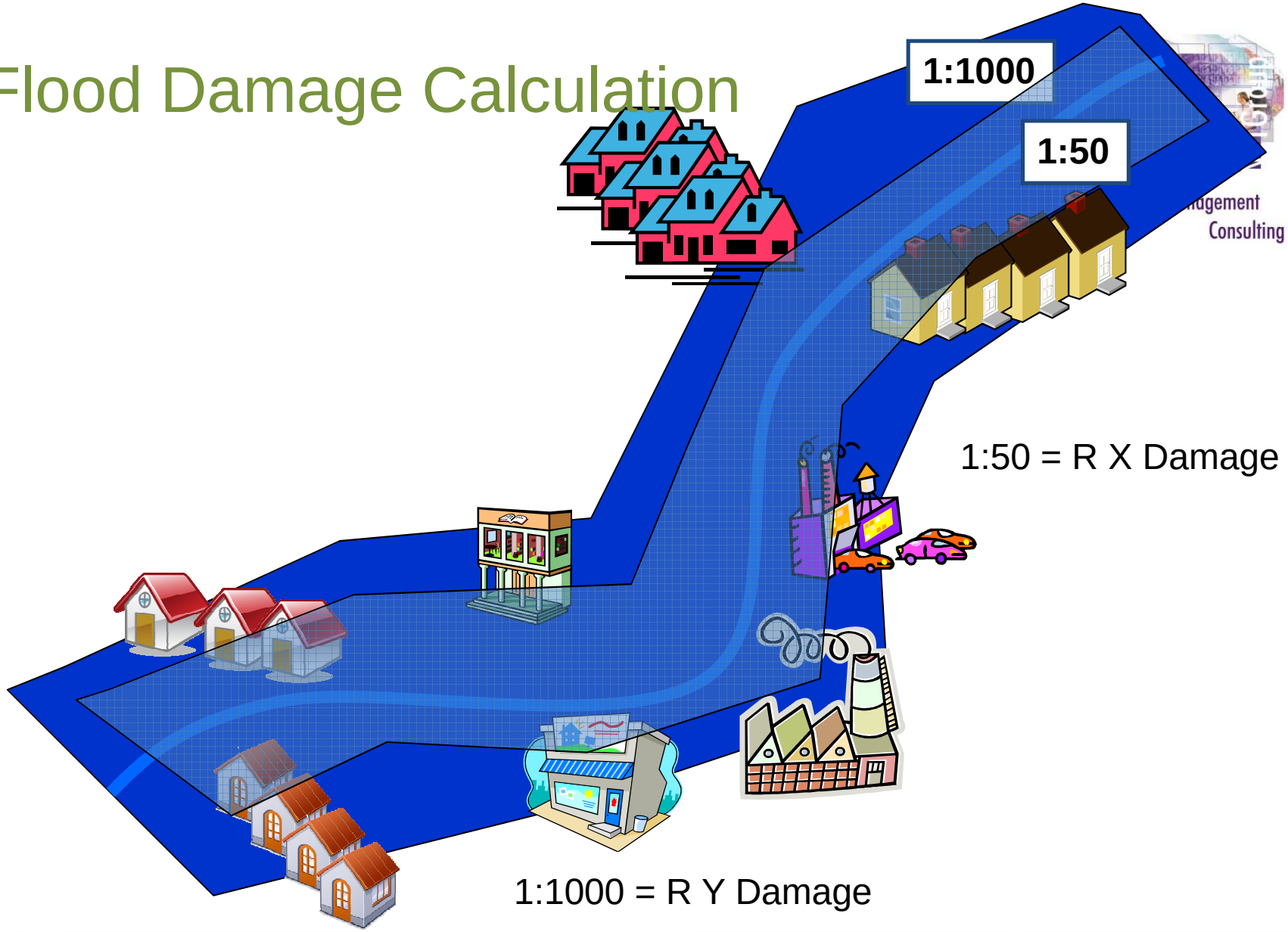
Calculation of Flood Damages

- Land use survey
- Classification of property
  - Types of residential properties
  - Types of commercial properties
  - Types of industrial properties
- Calculation of depth of inundation per flood event
- Use flood damage function to calculate flood damage per property
- Sum property damages per flood event

Flood Damage Calculation



Flood Damages per flood event

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1:5 = R A Damage

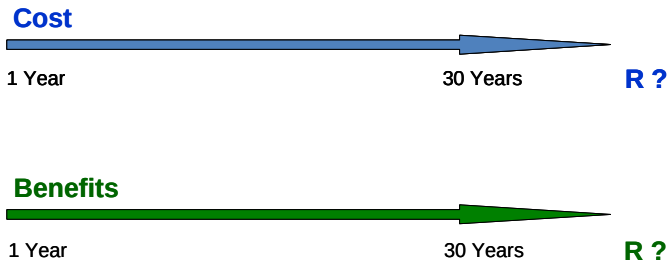
1:20 = R B Damage

1:50 = R C Damage

1:100 = R D Damage

1:1000 = R E Damage

1:10 000 = R F Damage (Regional Maximum Flood)



R ? VS R ?

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Mean Annual Damage (MAD)

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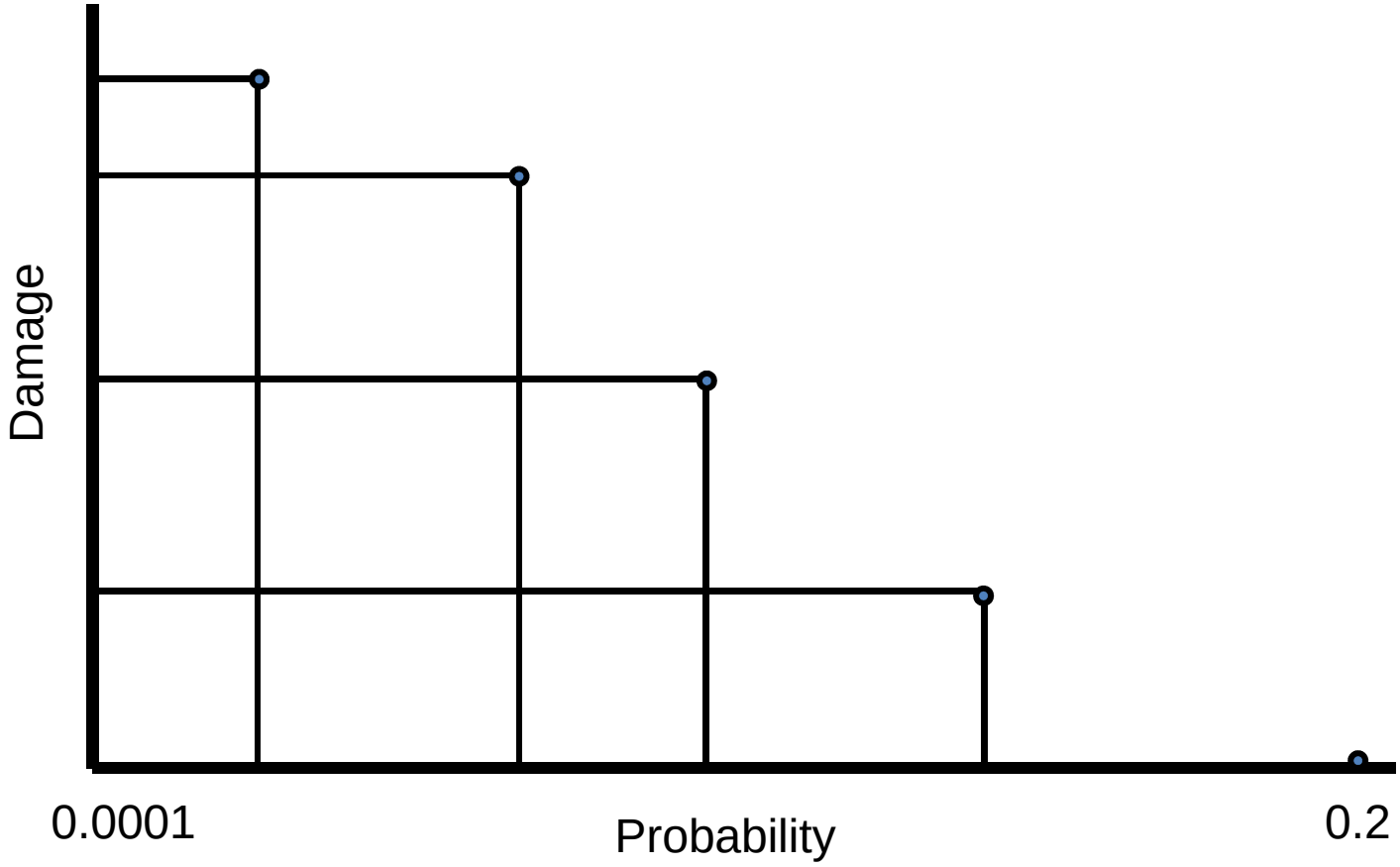

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Mean Annual Damage (MAD)

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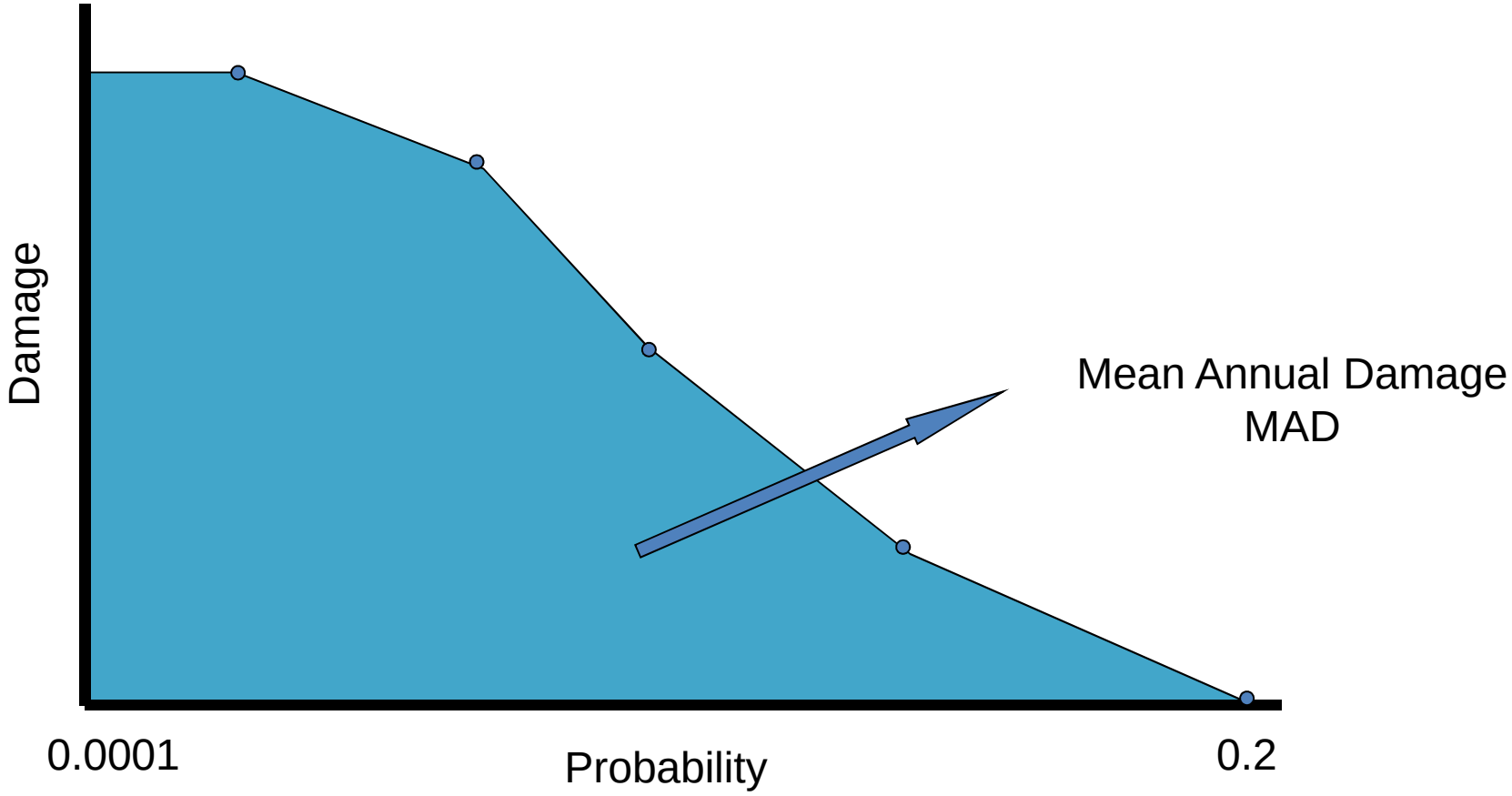

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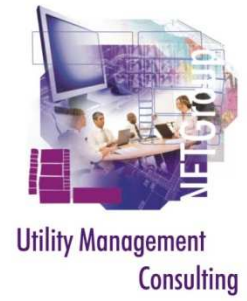
Flood Damage Mitigation Options

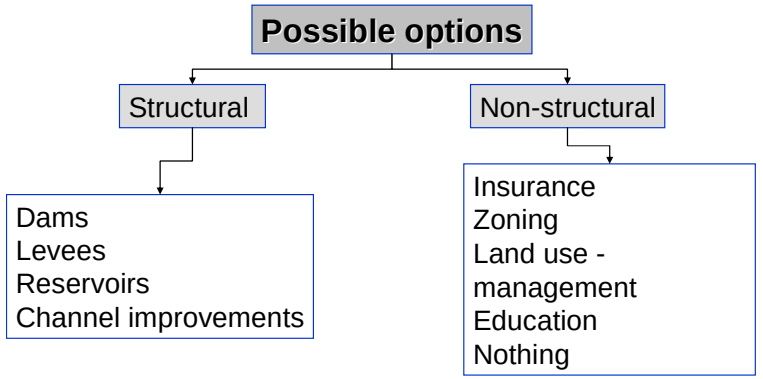


Possible options

- Structural
  - Dams
  - Levees
  - Reservoirs
  - Channel improvements
- Non-structural
  - Insurance
  - Zoning
  - Land use - management
  - Education
  - Nothing

Address peoples vulnerability to floods

Flood Damage Mitigation Options



Flood Plain Management Plan

Study Area

- Upington Residential

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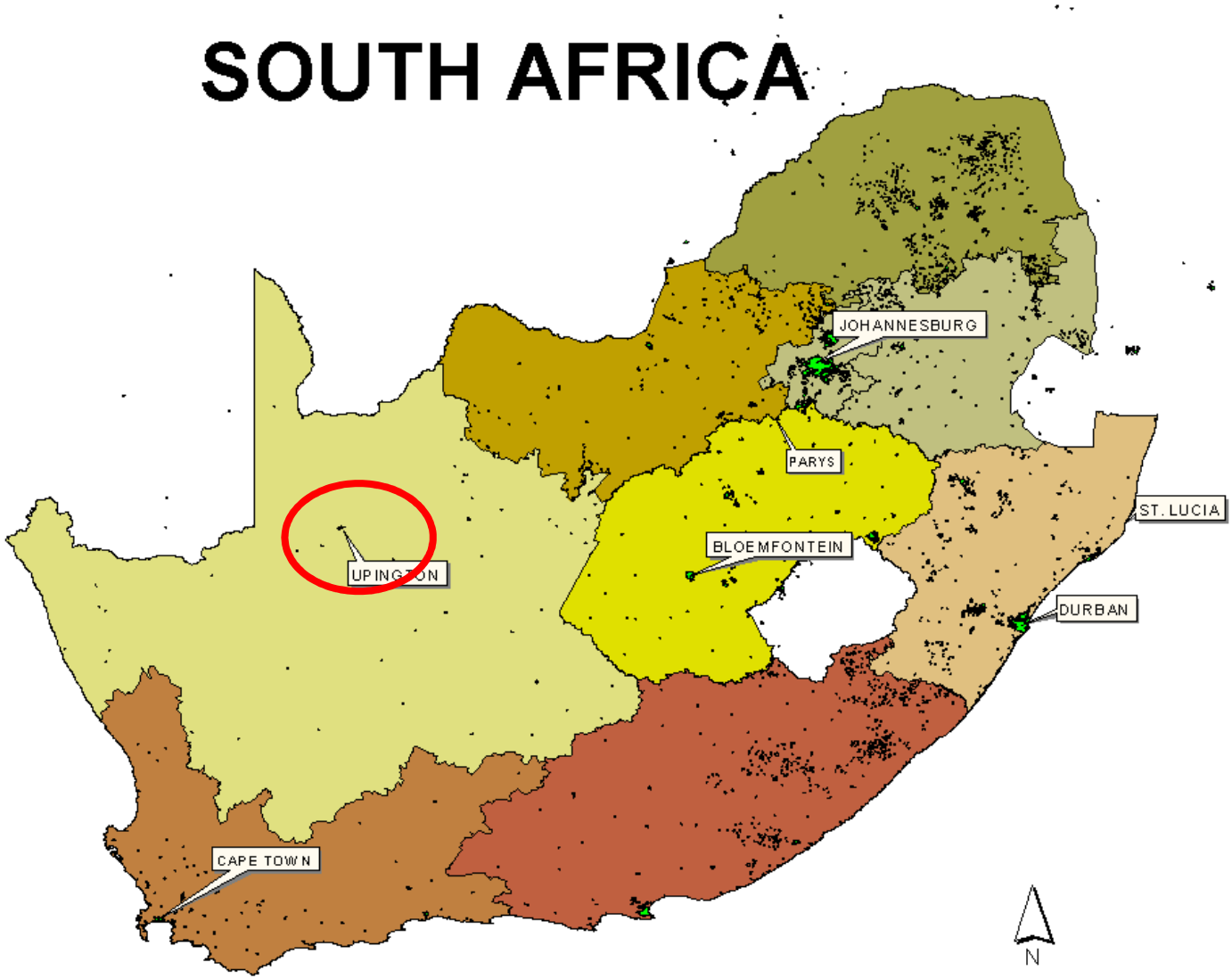
SOUTH AFRICA



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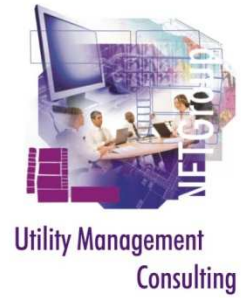
Upington Residential Flood Damage



- Based on researched that was done in 1995
- Probability was increased with percentage points
  - 1%, 2%, 5%, 10%, 15% en 20%
  - Precise impact of climate change is uncertain

Show the impact of climate change on Flood Damage Assessment and on Disaster Risk Reduction

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- Climate Change
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Climate Change and MAD

Percentage Increase	Probability						
0%	**0**	**4**	**5**	**10**	**20**	**50**	**1000**
1%	0	3.96	4.95	9.9	19.8	49.5	990.1
2%	0	3.92	4.9	9.8	19.61	49.02	980.39
5%	0	3.81	4.76	9.52	19.05	47.62	952.38
10%	0	3.64	4.55	9.09	18.18	45.45	909.09
15%	0	3.48	4.35	8.7	17.39	43.48	869.57
20%	0	3.33	4.17	8.33	16.67	41.67	833.33

Climate Change and MAD

Propability	Mean Annaul Damage
0%	R 1,550,983.96
1%	R 1,566,493.80
2%	R 1,582,003.64
5%	R 1,628,533.16
10%	R 1,706,082.36
15%	R 1,783,631.56
20%	R 1,861,180.76

MAD for Upington Residential sector adjusted to 2008 prices

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Net Present Value of Cost and Benefit

	0%	1%	2%	5%	10%	15%	20%	Cost of mitigation options
1	**R 1,550,983.96**	**R 1,566,493.80**	**R 1,582,003.64**	**R 1,628,533.16**	**R 1,706,082.36**	**R 1,783,631.56**	**R 1,861,180.76**	**R 19,000,000.00**
2	R 1,550,983.96	R 1,566,493.80	R 1,582,003.64	R 1,628,533.16	R 1,706,082.36	R 1,783,631.56	R 1,861,180.76	R 0.00
3	R 1,550,983.96	R 1,566,493.80	R 1,582,003.64	R 1,628,533.16	R 1,706,082.36	R 1,783,631.56	R 1,861,180.76	R 0.00
4	R 1,550,983.96	R 1,566,493.80	R 1,582,003.64	R 1,628,533.16	R 1,706,082.36	R 1,783,631.56	R 1,861,180.76	R 0.00
5	R 1,550,983.96	R 1,566,493.80	R 1,582,003.64	R 1,628,533.16	R 1,706,082.36	R 1,783,631.56	R 1,861,180.76	R 0.00
6	R 1,550,983.96	R 1,566,493.80	R 1,582,003.64	R 1,628,533.16	R 1,706,082.36	R 1,783,631.56	R 1,861,180.76	R 0.00
7	R 1,550,983.96	R 1,566,493.80	R 1,582,003.64	R 1,628,533.16	R 1,706,082.36	R 1,783,631.56	R 1,861,180.76	R 0.00
8	R 1,550,983.96	R 1,566,493.80	R 1,582,003.64	R 1,628,533.16	R 1,706,082.36	R 1,783,631.56	R 1,861,180.76	R 0.00
9	R 1,550,983.96	R 1,566,493.80	R 1,582,003.64	R 1,628,533.16	R 1,706,082.36	R 1,783,631.56	R 1,861,180.76	R 0.00
	0%	**1%**	**2%**	**5%**	**10%**	**15%**	**20%**	**Cost of mitigation options**
	R 14,620,993.16	**R 14,767,203.09**	**R 14,913,413.02**	**R 15,352,042.82**	**R 16,083,092.48**	**R 16,814,142.13**	**R 17,545,191.79**	**R 17,377,047.02**
14	R 1,550,983.96	R 1,566,493.80	R 1,582,003.64	R 1,628,533.16	R 1,706,082.36	R 1,783,631.56	R 1,861,180.76	R 0.00
15	R 1,550,983.96	R 1,566,493.80	R 1,582,003.64	R 1,628,533.16	R 1,706,082.36	R 1,783,631.56	R 1,861,180.76	R 0.00
16	R 1,550,983.96	R 1,566,493.80	R 1,582,003.64	R 1,628,533.16	R 1,706,082.36	R 1,783,631.56	R 1,861,180.76	R 0.00
17	R 1,550,983.96	R 1,566,493.80	R 1,582,003.64	R 1,628,533.16	R 1,706,082.36	R 1,783,631.56	R 1,861,180.76	R 0.00
18	R 1,550,983.96	R 1,566,493.80	R 1,582,003.64	R 1,628,533.16	R 1,706,082.36	R 1,783,631.56	R 1,861,180.76	R 0.00
19	**R 1,550,983.96**	**R 1,566,493.80**	**R 1,582,003.64**	**R 1,628,533.16**	**R 1,706,082.36**	**R 1,783,631.56**	**R 1,861,180.76**	**R 190,000.00**
20	R 1,550,983.96	R 1,566,493.80	R 1,582,003.64	R 1,628,533.16	R 1,706,082.36	R 1,783,631.56	R 1,861,180.76	R 0.00
21	R 1,550,983.96	R 1,566,493.80	R 1,582,003.64	R 1,628,533.16	R 1,706,082.36	R 1,783,631.56	R 1,861,180.76	R 0.00
22	R 1,550,983.96	R 1,566,493.80	R 1,582,003.64	R 1,628,533.16	R 1,706,082.36	R 1,783,631.56	R 1,861,180.76	R 0.00
23	R 1,550,983.96	R 1,566,493.80	R 1,582,003.64	R 1,628,533.16	R 1,706,082.36	R 1,783,631.56	R 1,861,180.76	R 0.00
24	R 1,550,983.96	R 1,566,493.80	R 1,582,003.64	R 1,628,533.16	R 1,706,082.36	R 1,783,631.56	R 1,861,180.76	R 0.00
25	R 1,550,983.96	R 1,566,493.80	R 1,582,003.64	R 1,628,533.16	R 1,706,082.36	R 1,783,631.56	R 1,861,180.76	R 0.00
26	R 1,550,983.96	R 1,566,493.80	R 1,582,003.64	R 1,628,533.16	R 1,706,082.36	R 1,783,631.56	R 1,861,180.76	R 0.00
27	R 1,550,983.96	R 1,566,493.80	R 1,582,003.64	R 1,628,533.16	R 1,706,082.36	R 1,783,631.56	R 1,861,180.76	R 0.00
28	R 1,550,983.96	R 1,566,493.80	R 1,582,003.64	R 1,628,533.16	R 1,706,082.36	R 1,783,631.56	R 1,861,180.76	R 0.00
29	R 1,550,983.96	R 1,566,493.80	R 1,582,003.64	R 1,628,533.16	R 1,706,082.36	R 1,783,631.56	R 1,861,180.76	R 0.00
30	R 1,550,983.96	R 1,566,493.80	R 1,582,003.64	R 1,628,533.16	R 1,706,082.36	R 1,783,631.56	R 1,861,180.76	R 0.00
	R 14,620,993.16	**R 14,767,203.09**	**R 14,913,413.02**	**R 15,352,042.82**	**R 16,083,092.48**	**R 16,814,142.13**	**R 17,545,191.79**	**R 17,377,047.02**

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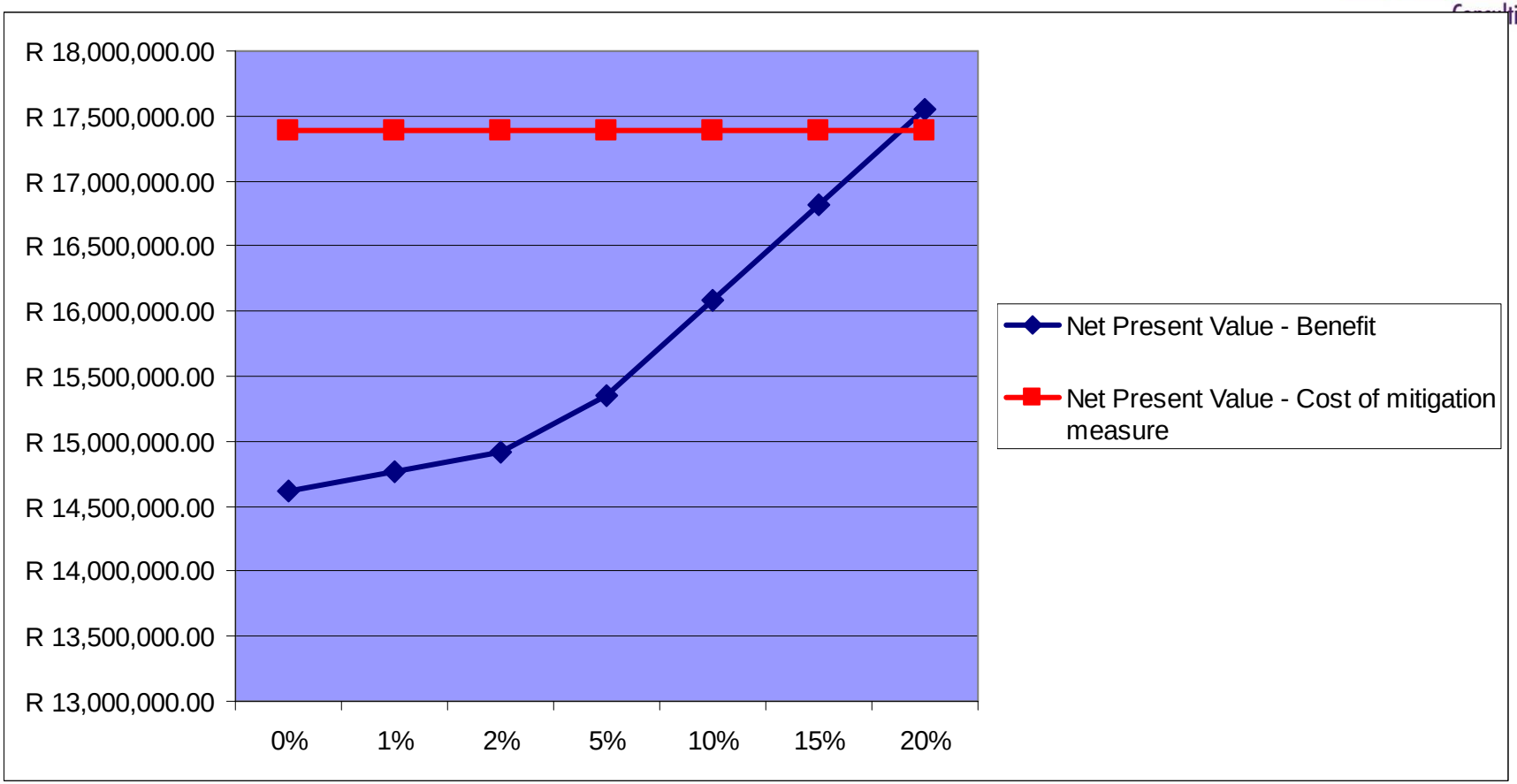
Net Present Value of Cost and Benefit



Flood Damage Mitigation Options

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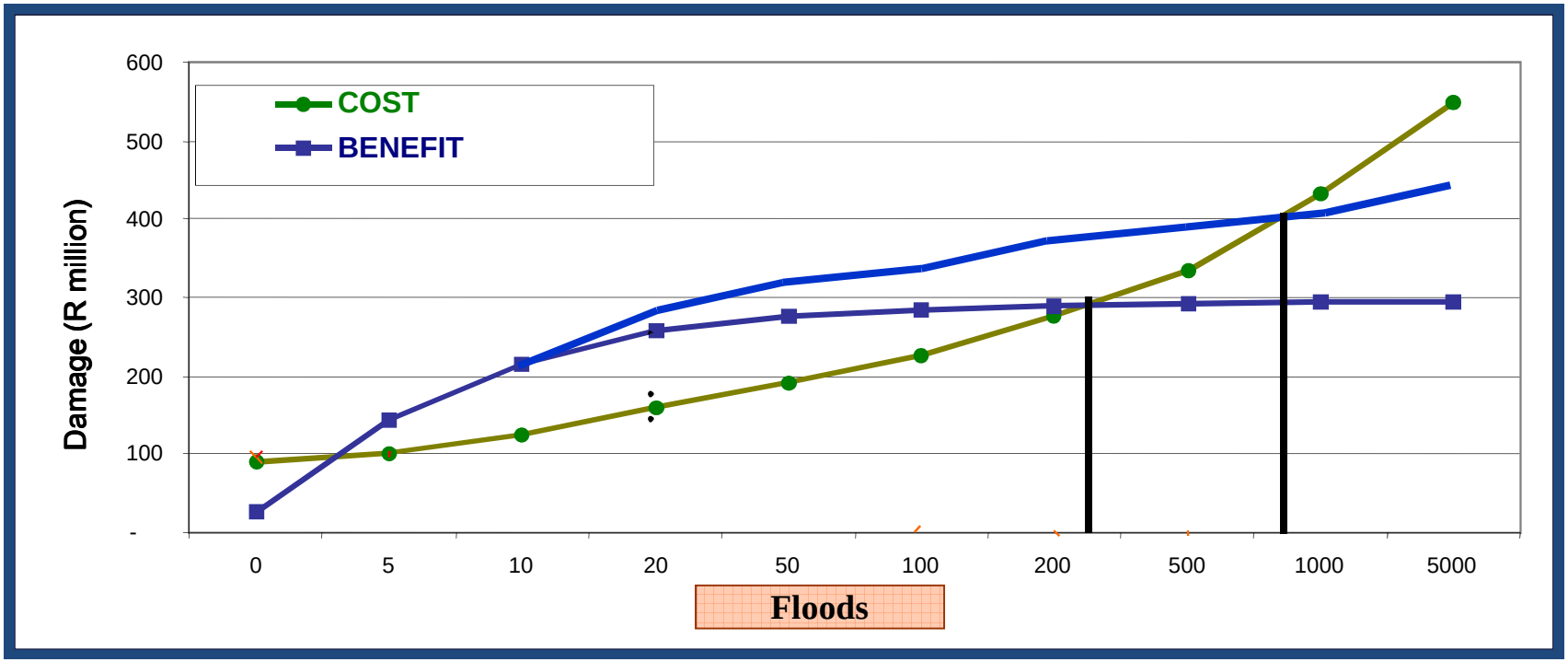
OPTIMAL LEVEE HEIGHT



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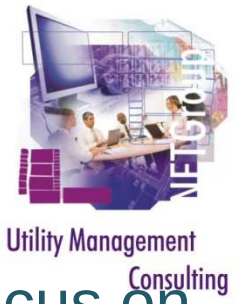
Conclusions



- Adapting to climate change requires a particular focus on disaster risk reduction
- While climate change is contributing to raising disaster risk, measures to mitigate the risk need to focus on reducing vulnerability in the context of developing efforts
- Climate Change increase the uncertainty regarding the probability of flood occurrence
  - Focus on more certain aspects such as reducing vulnerability

Important to include climate change into any Flood and Flood Damage research and projects

Questions / Ideas