Country Report
Sri Lanka

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1st AWCI CCAA study Workshop
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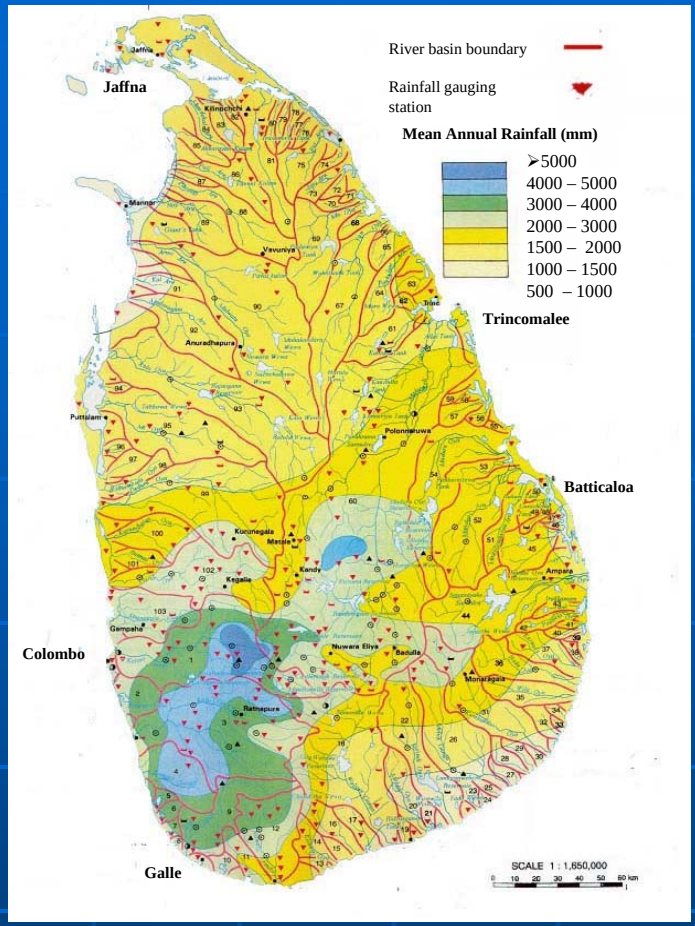
Demonstration Basin Characteristics

The Kalu Ganga is the second largest river in Sri Lanka

Basin Area	= 2690 km^2
Upper Elevation	= 2250 m
Length of the River	= 129 km

Average Annual Rainfall is more than 4000mm

Annual Flow Volume is more than 7300 M.C.M

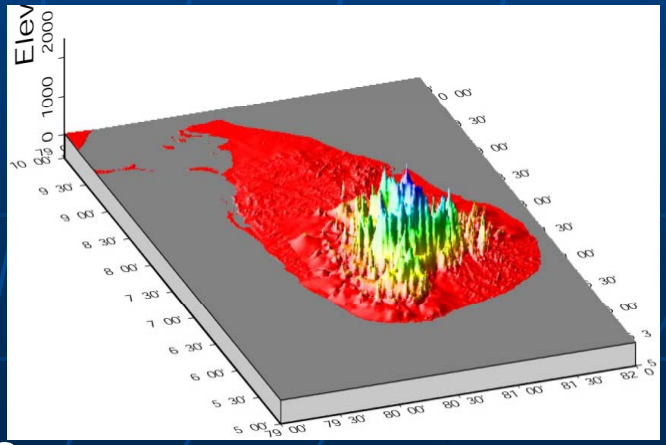


Upper Catchment

- Steep river slopes with narrow valleys

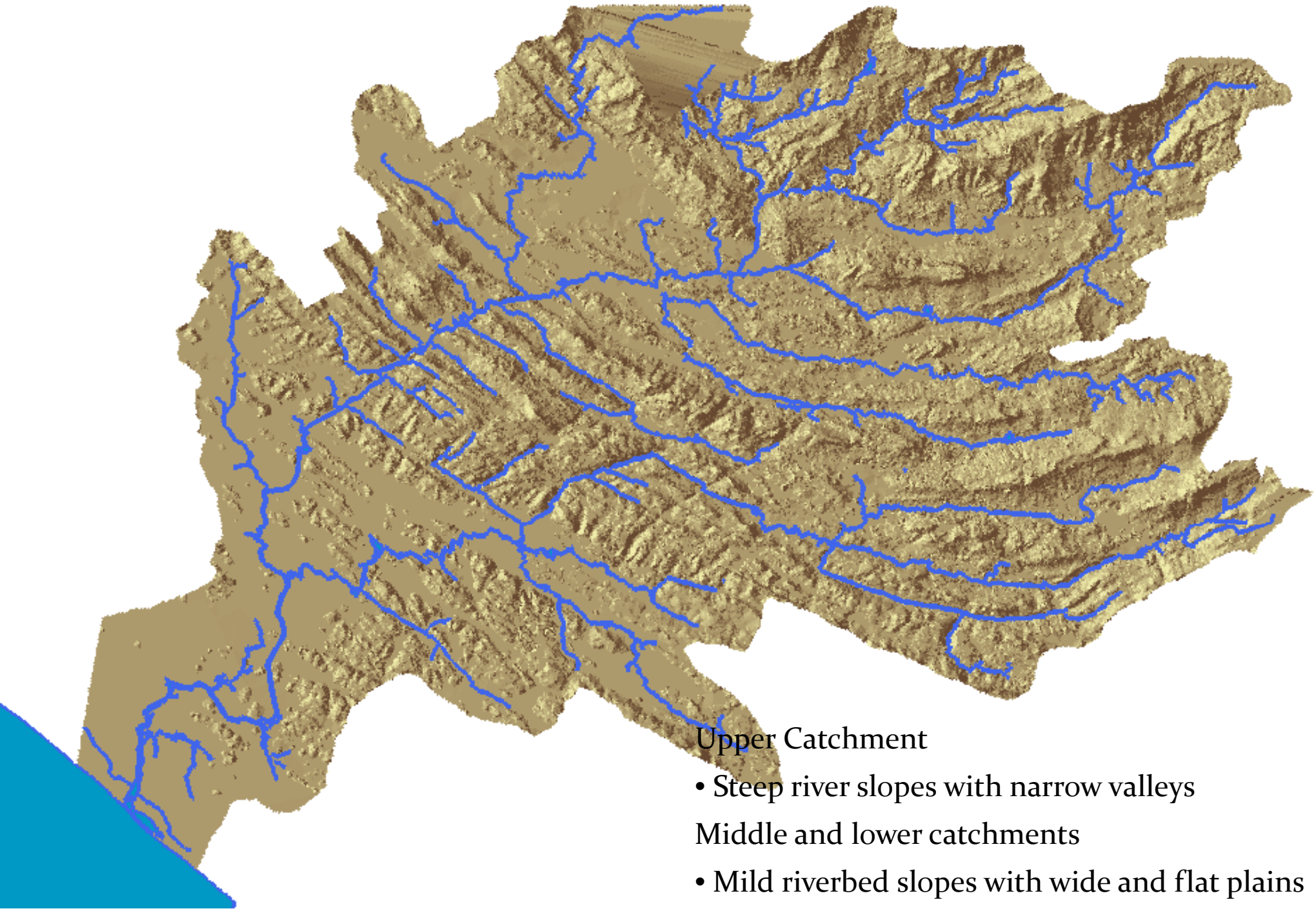
Middle and lower catchments

- Mild riverbed slopes with wide and flat plains
- So, make the floods



Due to the geographical location, the Kalu Ganga catchment receives rain during both of the monsoons

Topography of the Kaluganga Basin



Upper Catchment

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Middle and lower catchments

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Objectives

The broad objective is to minimize the damages caused to the lives, economy and the environment due to floods in the basin.

Specifically, the project will demonstrate:

- real time flood forecasting for implementation of early warning systems
- identification of inundation levels at different floods and
- identify alternative structural and non structural methods
- identify adaptations for flood risk reduction

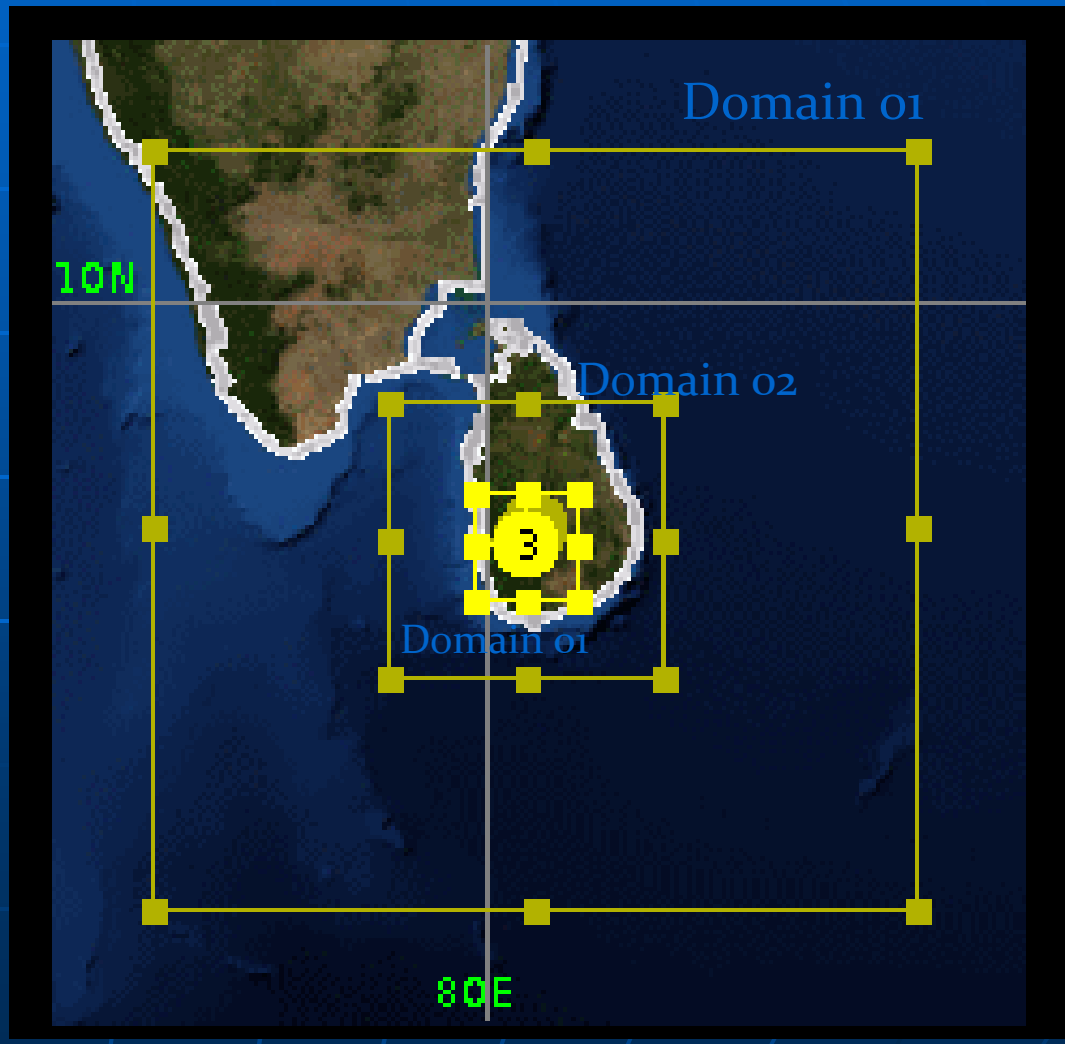
1. Weather modeling by WRF for flood prediction and flood warning

Gaouri Silva et al, *UNU , UoP*

Arrangement of three domains

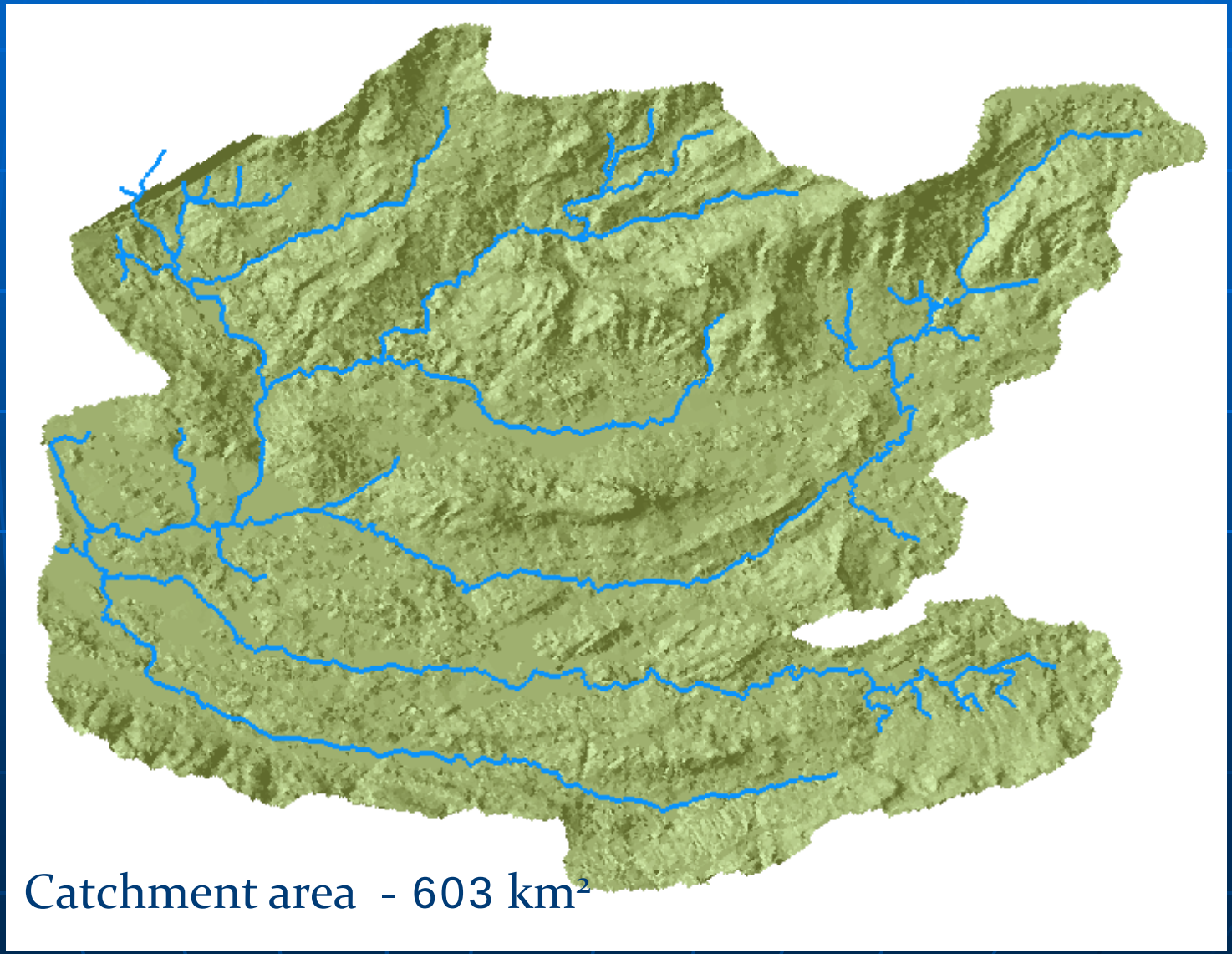
Domain sizes

- Domain 01: 1350km x 1350km (27kmx27km cell)
- Domain 02 – 450 km x 450 km (9kmx9km cell)
- Domain 03 – 150 km x 150 km (3kmx3km cell)



Kaluganga upper catchment Gaouri Silva et al, *UNU , UoP*

Since Rathnapura is more vulnerable to floods upper catchment was selected for the analysis



Catchment area - 603 km²

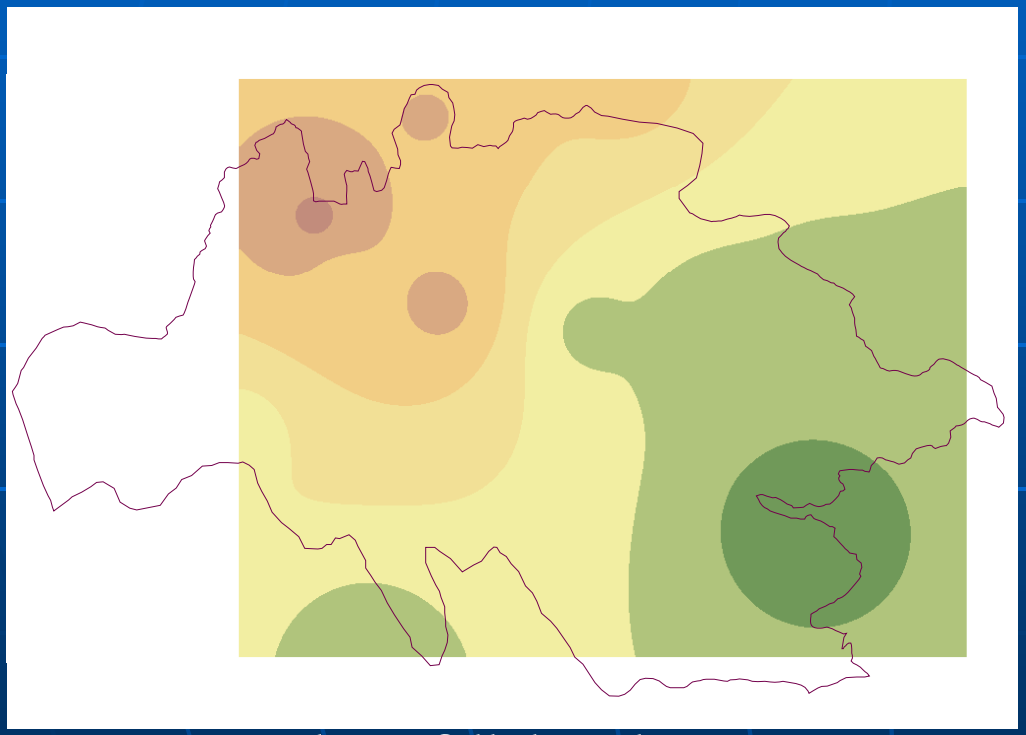
Weather analysis from WRF for Kaluganga catchment

Gaouri Silva et al, UNU, UoP

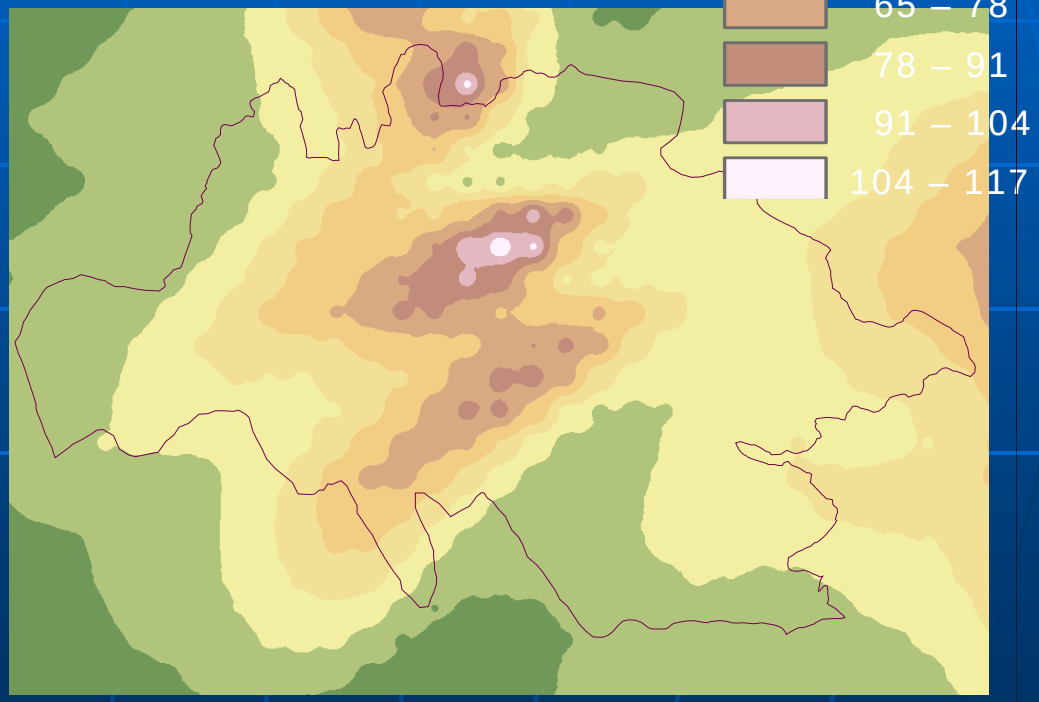
Microphysics - Lin et al. scheme

Land surface physics - Noah Land Surface Model

Number of soil Layers – 4



Actual rainfall distribution

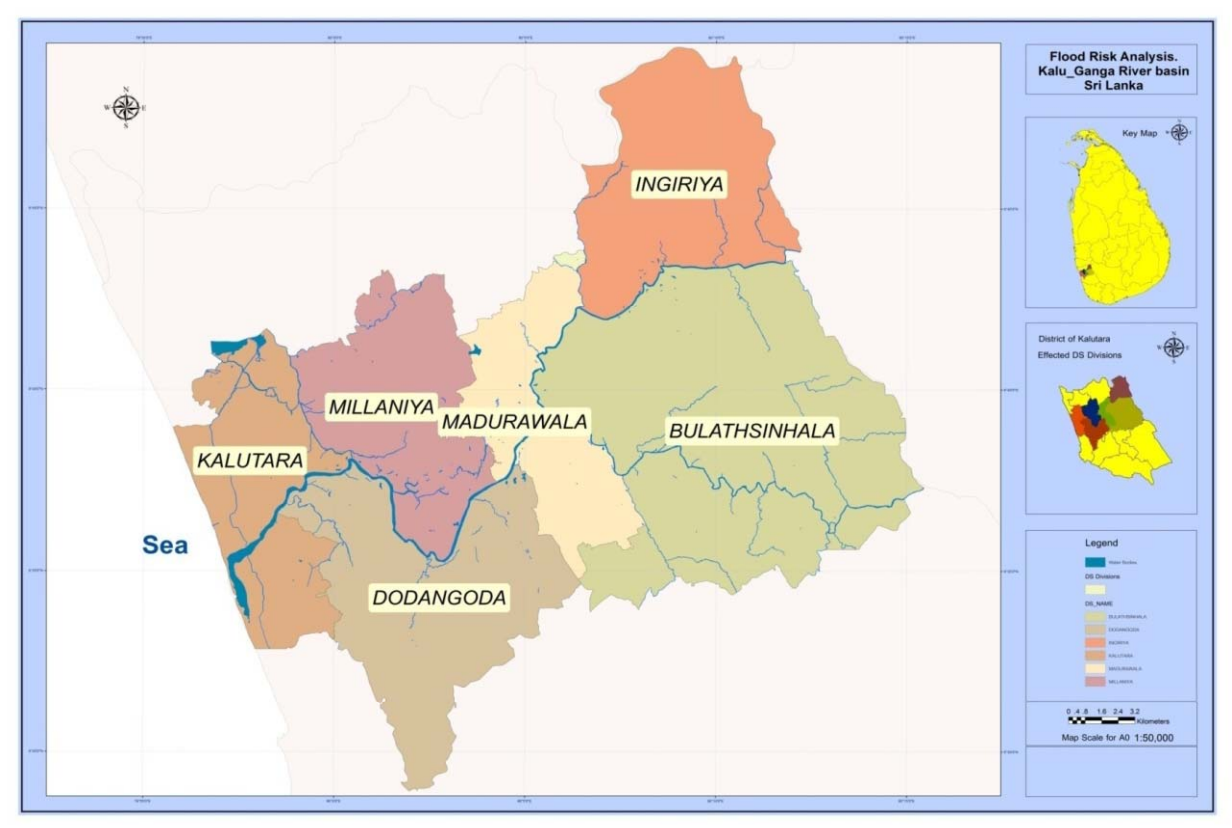


Predicted rainfall distribution from WRF

The model gives little over prediction in upper catchment area and gives little under prediction in lower catchment area

2. Climate Change Impacts on Floods and Adaptation Measures

Hemali Nandalal et al,
JAXA , UoP



- Study concentrates on the lower reaches of the river
- Area of interest is nearly 500 km^2
- This includes 5 Divisional Administrative Divisions (DSD)

Hemali Nandalal et al,
JAXA , UoP

Methodology

- Annual maximum values were extracted from daily rainfall data from 1901 – 2010.
- The data series was divided into four intervals;

1901 – 1930; 1931 – 1960; 1961 – 1990; 1991 – 2010

- Parameters of Gumbel distribution were estimated for these four data series and the trend was found.

Results

Hemali Nandalal et al
JAXA , UoP

Expected rainfall with 100 year return periods

Periods of years	Predicted Gumbel parameters		Expected 100 year rainfall	Maximum rainfall observed so far
	m	Alpha		
1901-1930	133.10	0.02900	291.7	269.2
1931-1960	128.12	0.02206	336.5	394.4
1961-1990	125.21	0.01801	380.5	294.9
1991-2020	123.14	0.01513	427.0	392.5------
2021-2050	121.54	0.01290	477.9	
2051-2080	120.23	0.01108	535.3	

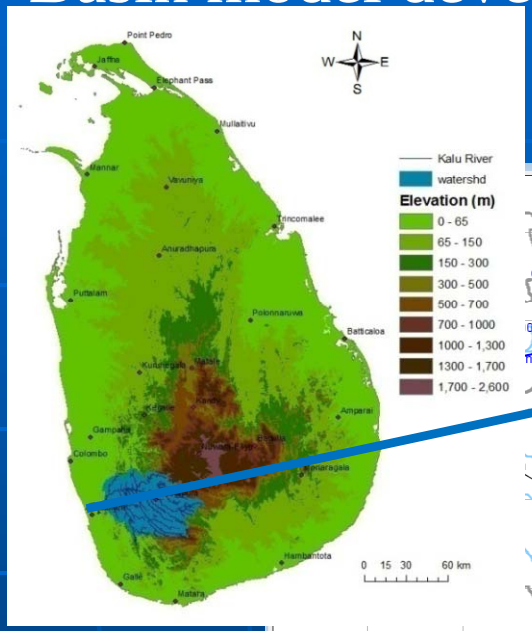
- The results indicate that the rainfall has varied in the past

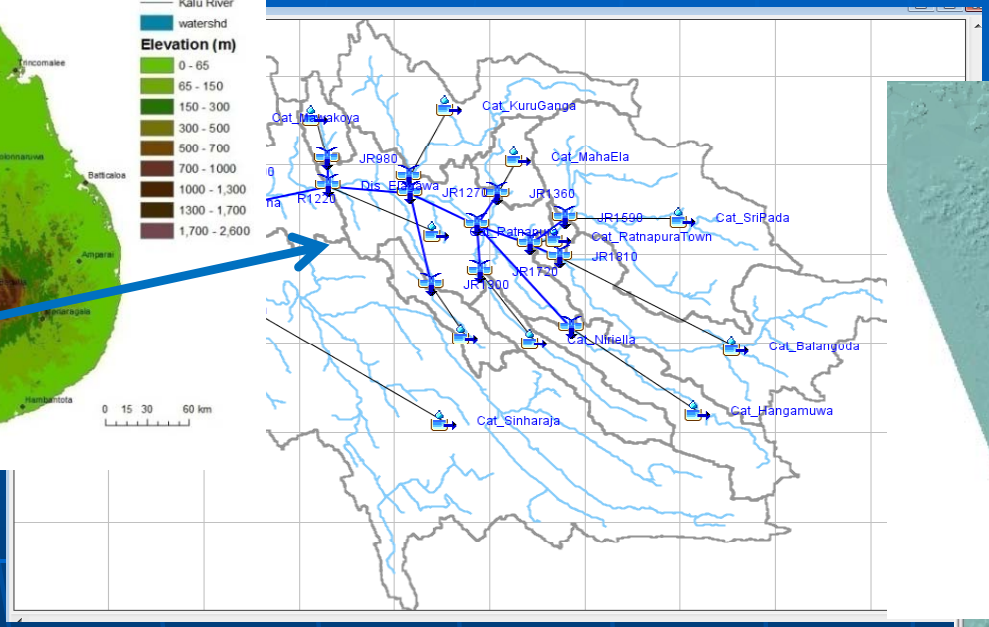
- If the same trend in the climate change exists the extreme rainfalls over the Kalu-Ganga river basin have increased and more severe floods could be expected to occur in the basin in the future

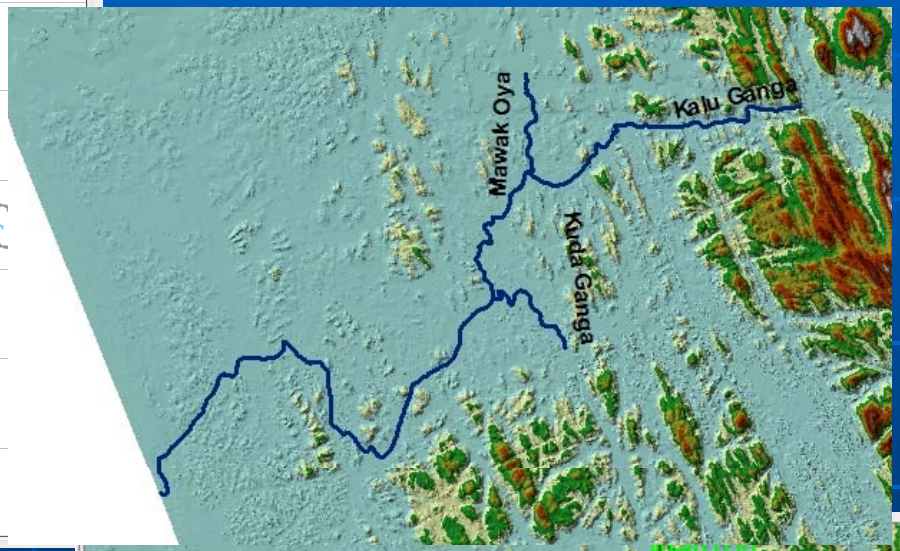
Application of HEC-HMS

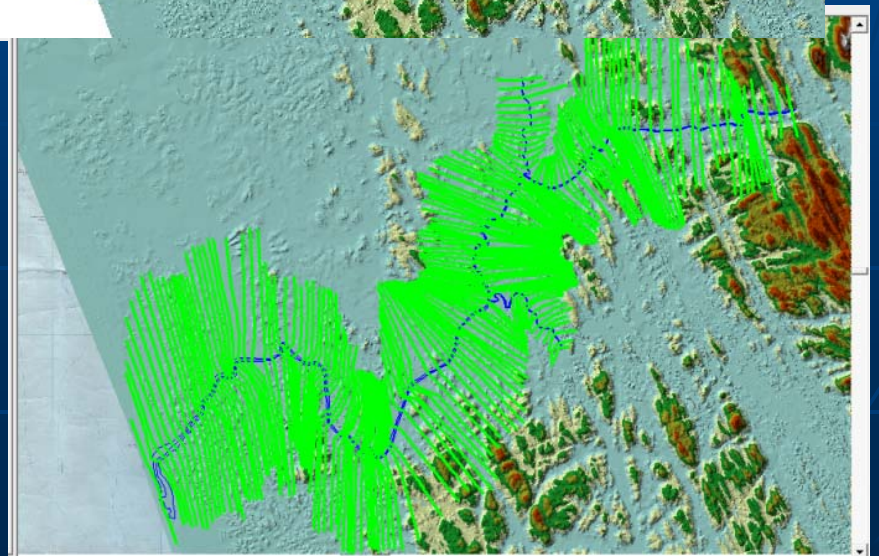
Hemali Nandalal et al
JAXA , UoP

Basin model developed using HEC-GeoHMS





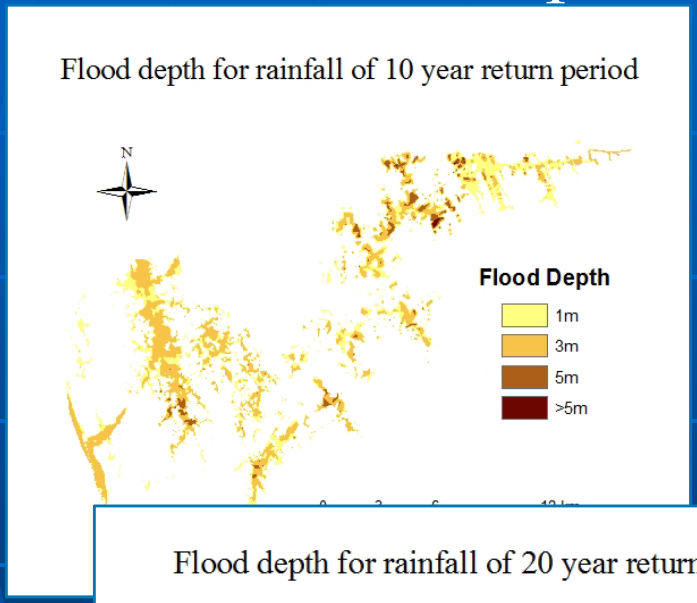


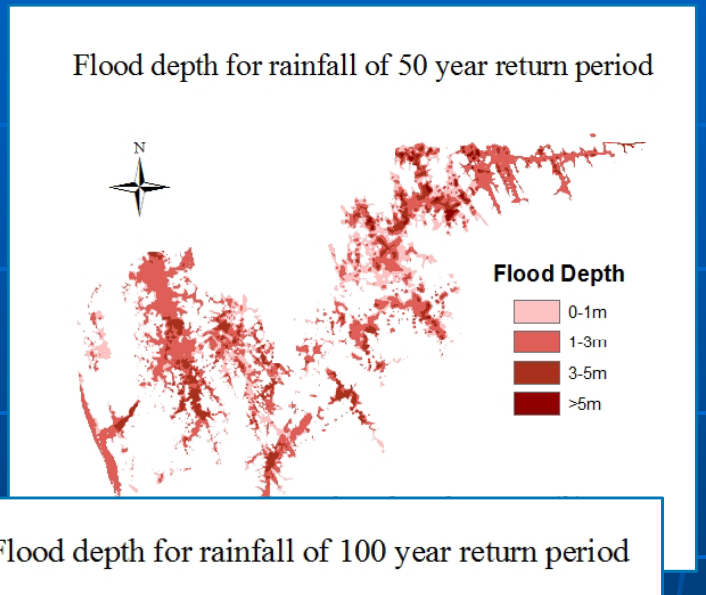


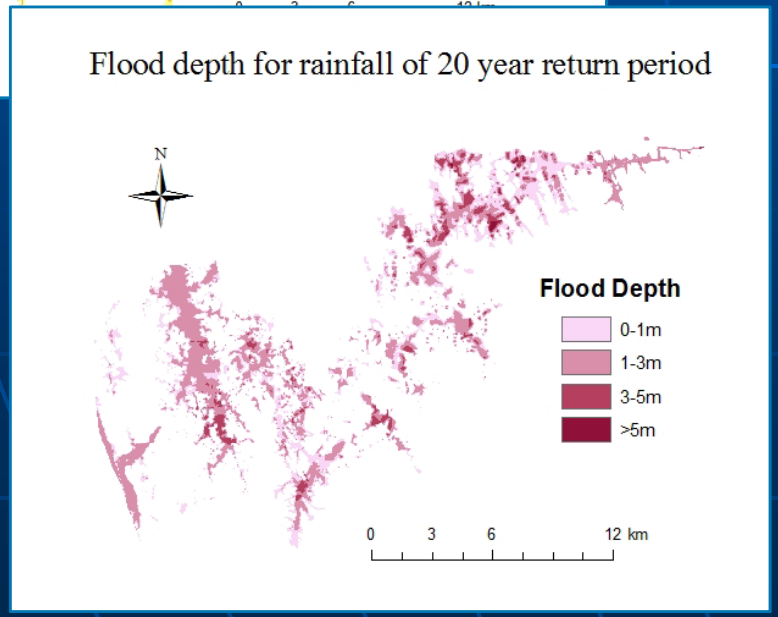
Application of HEC-RAS

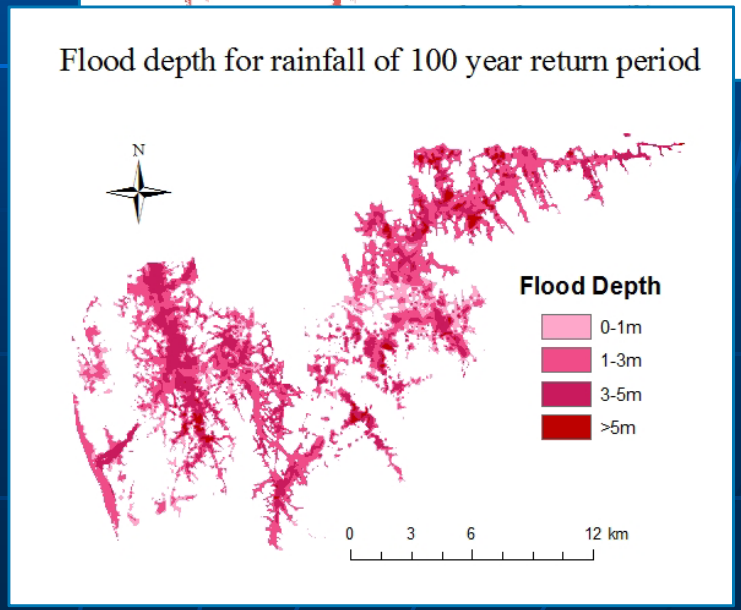
Hemali Nandalal et al
JAXA , UoP

Flood Hazard Maps from HEC-RAS









Adaptation

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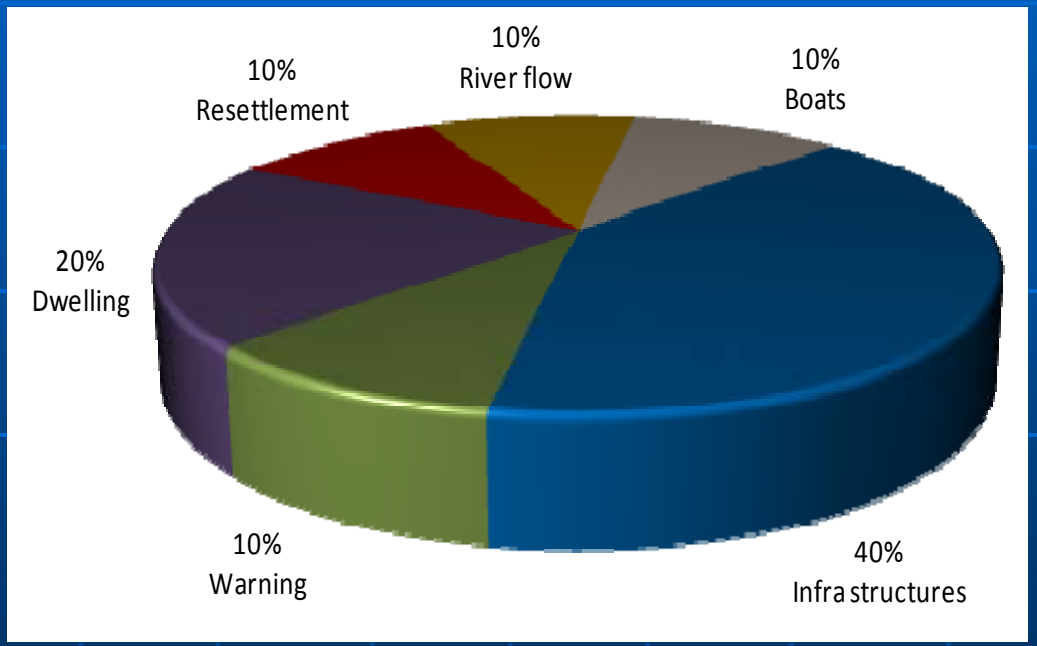
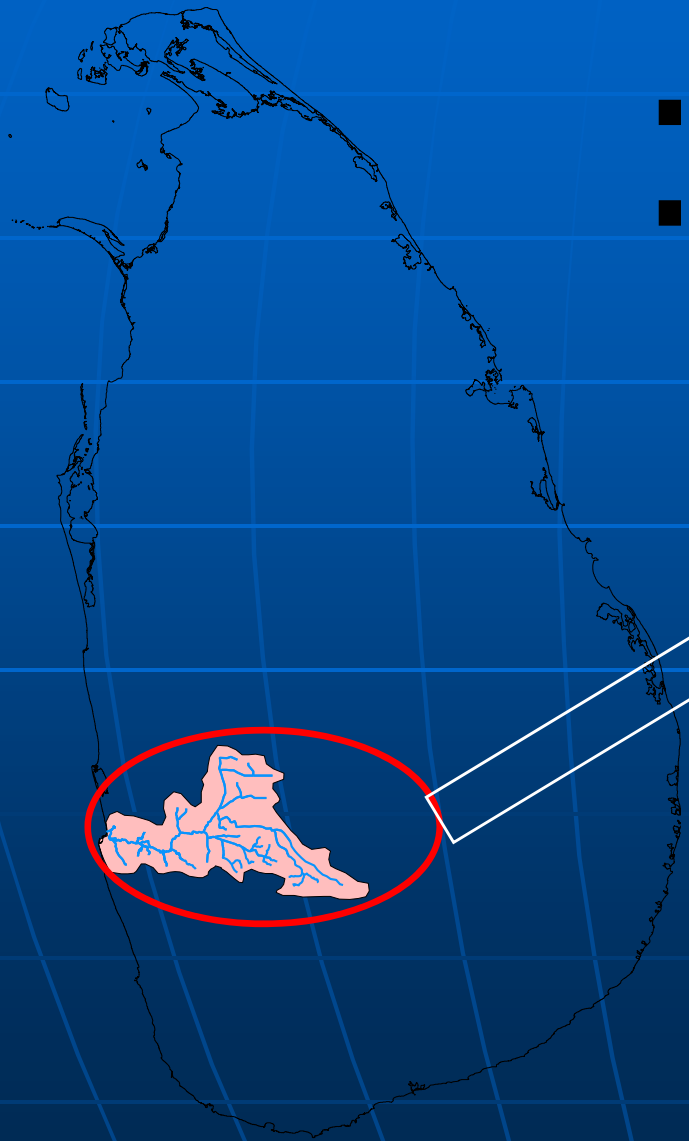
Preference for non-structural flood alleviation measures of the residents

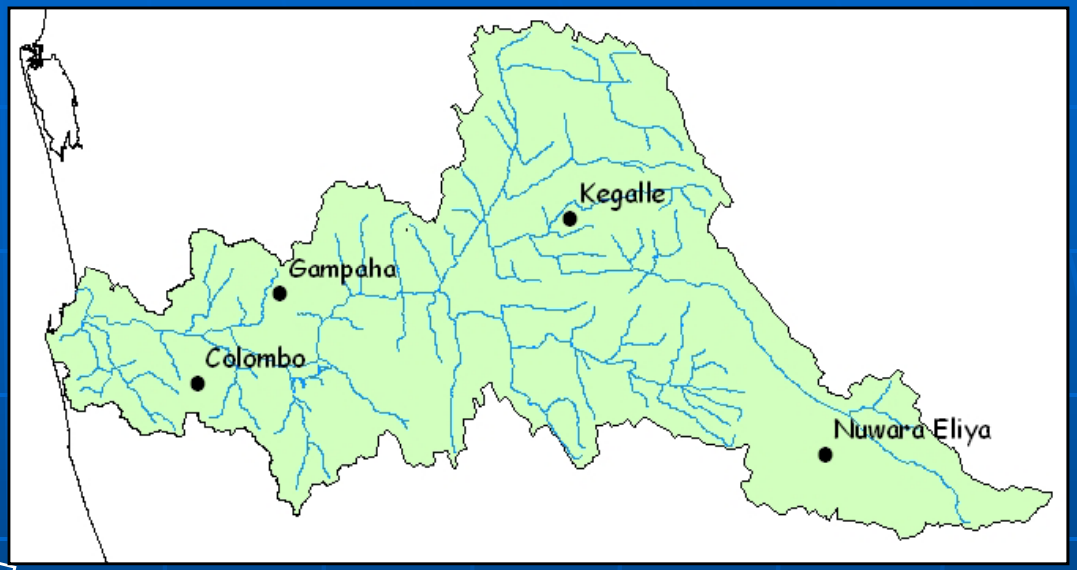


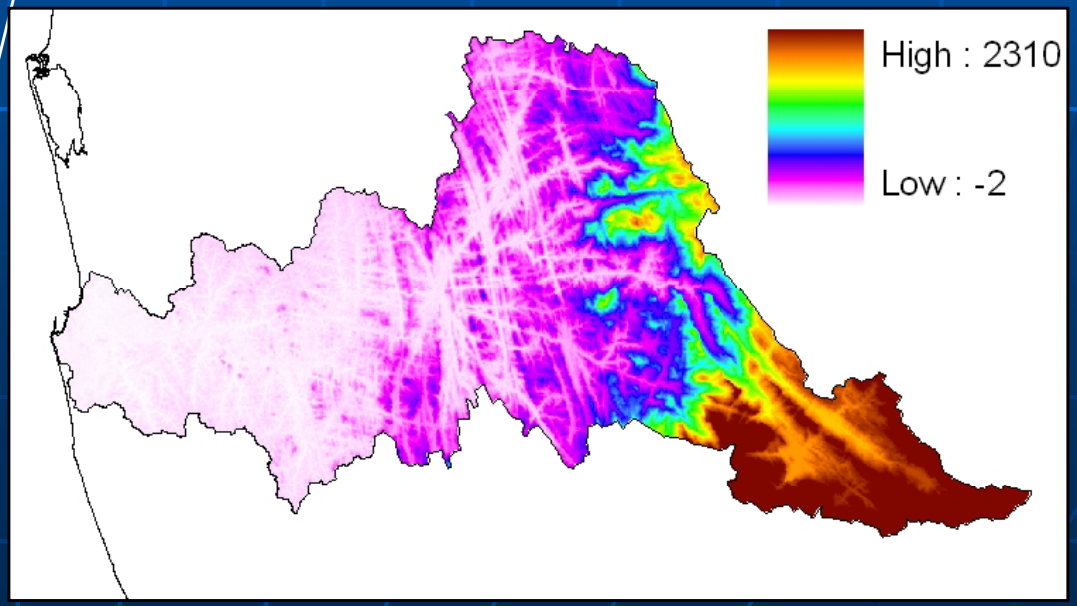
A fuzzy inference model was developed to decide the percentages of funds that can be allocated to different demands to achieve the maximum adaptability of the community.

Gaouri Silva et al, *UNU , UoP*

3. Climate Change Impacts on Floods and Adaptation – the Kelani River







Kelani Basin Information

- Total Basin Area = 2292 km^2
- Uppermost Elevation = 2250 m
- Average Annual Rainfall = 3450 mm

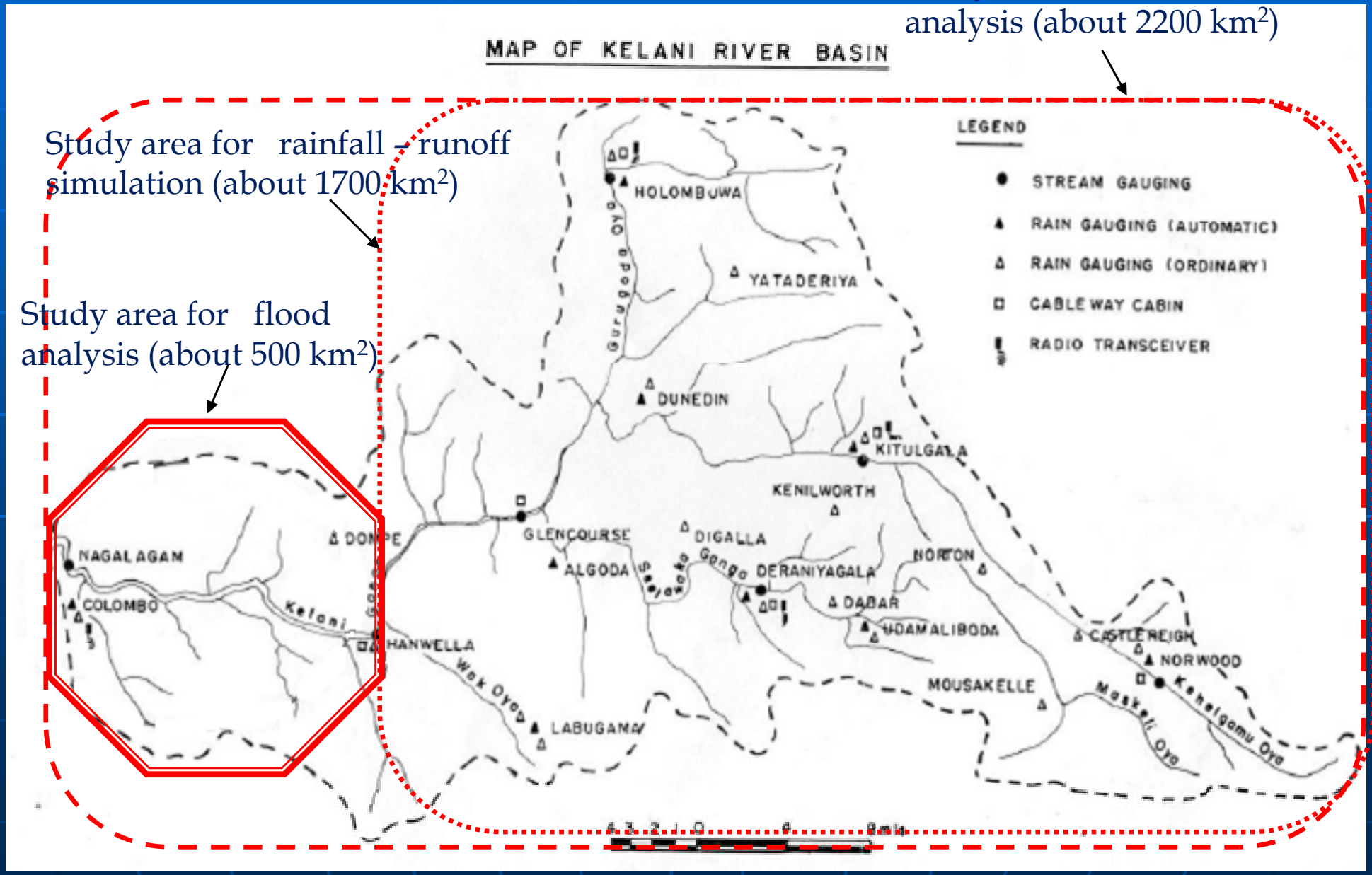
➢Kelani catchment receives rain from both northeast and southwest monsoons and cause frequent floods

➢Rainfall time series of Sri Lanka shows a trend of increased lengths of dry periods along with an increasing trend of rainfall intensity, especially after the late seventies

➢Kelani river flows through the capital city and therefore, flood loss damage is high

Gaouri Silva et al, *UNU , UoP*

Study Area



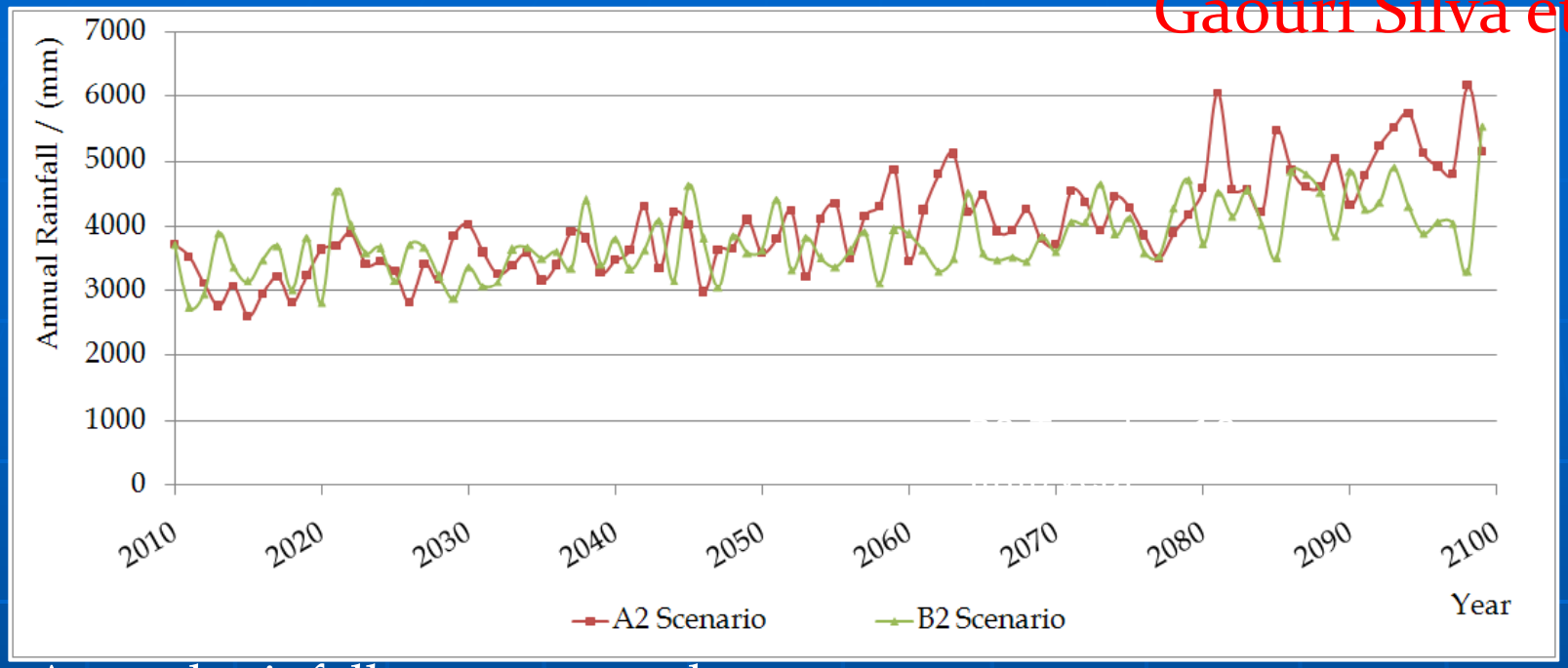
Source: Department of Irrigation, Sri Lanka

Models used

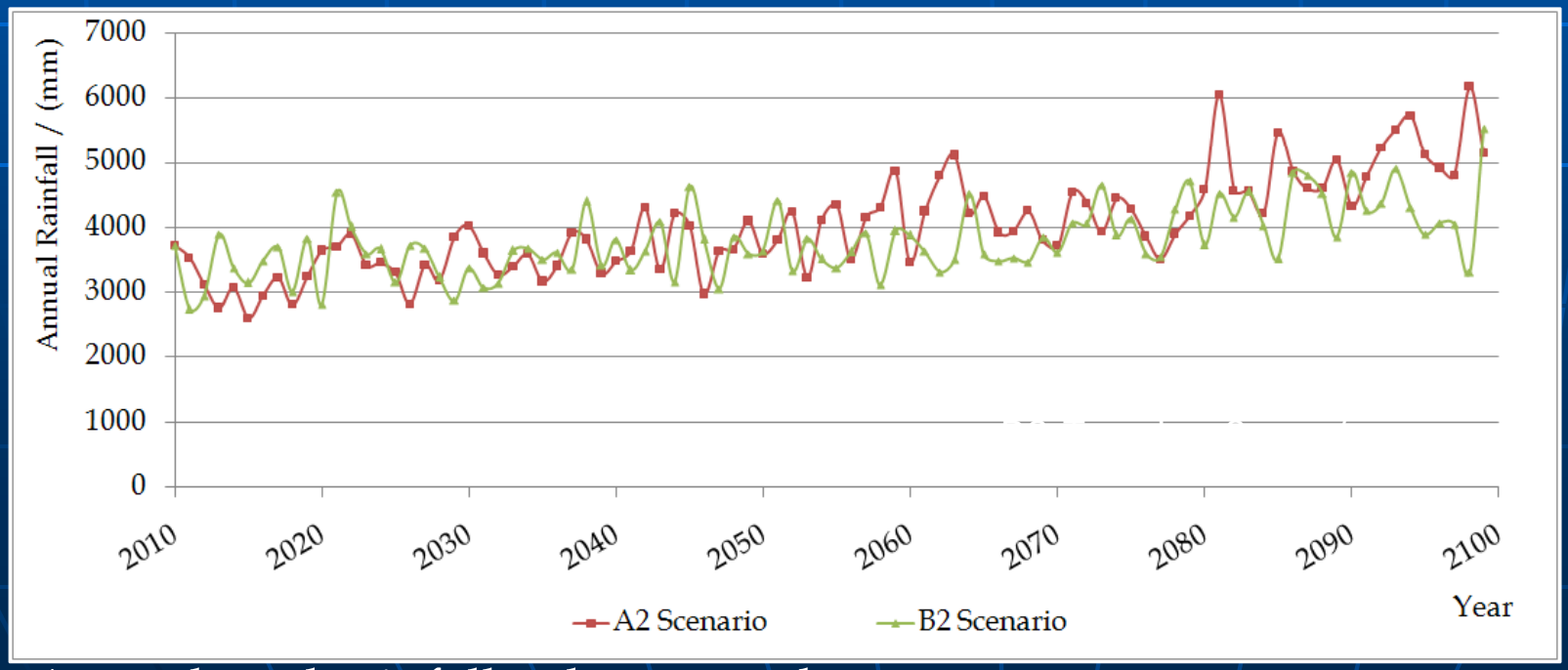
- Statistical Downscaling Model (SDSM) – for rainfall forecast under A2 & B2 scenarios
  - Calibration – 1961 to 1975, Validation – 1976 to 1990
- Hydrologic Engineering Center – Hydrologic Modeling System (HEC–HMS) – for rainfall runoff simulations at the entry to the lower basin (Hanwella gauging station)
  - Calibration – November 2005, Validation – April, May & June 2008, May 2010 and 2005 to 2010
- FLO–2D – for flood and inundation analysis at lower catchment from Hanwella
  - Calibration – November 2005, Validation – April 2008, June 2008 and May 2010

Future climate forecasts

Gaouri Silva et al, *UNU , UoP*



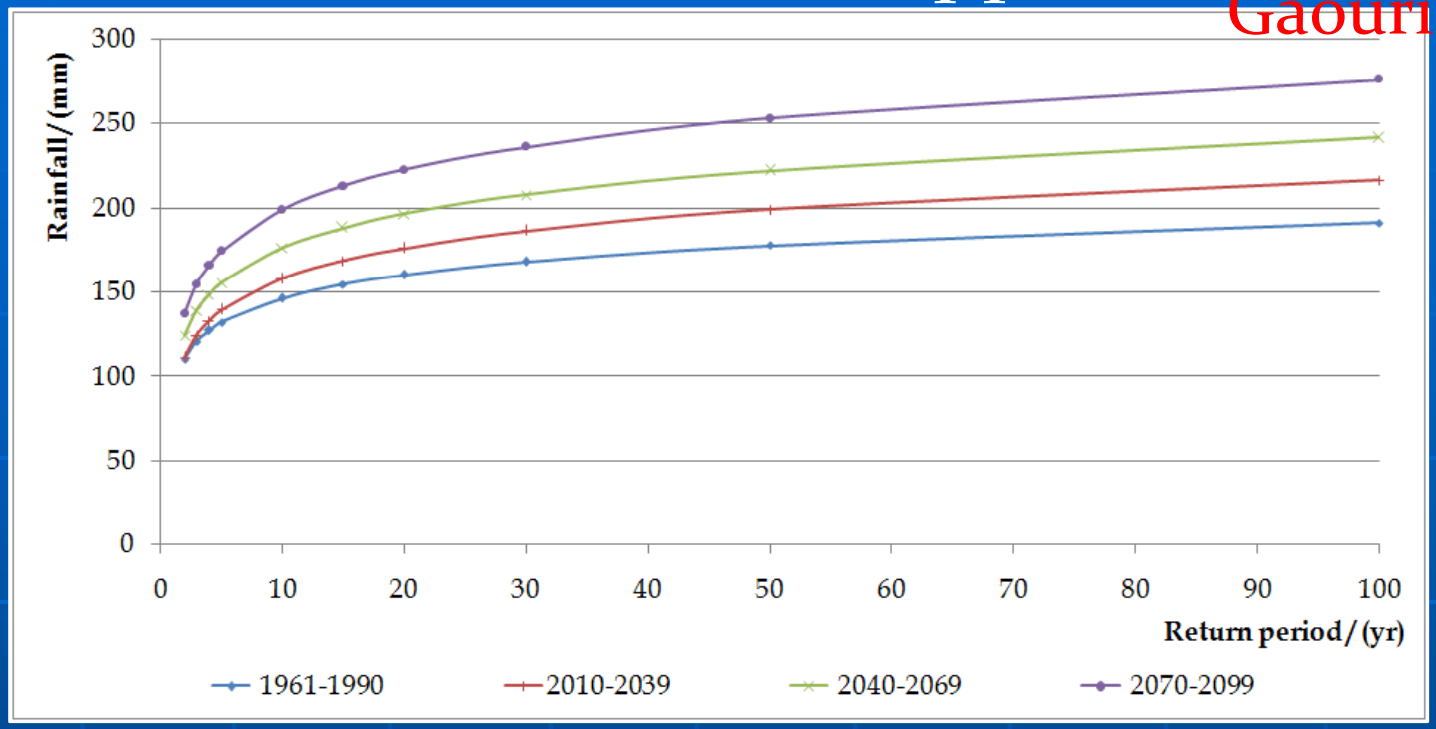
Annual rainfall at upper catchment



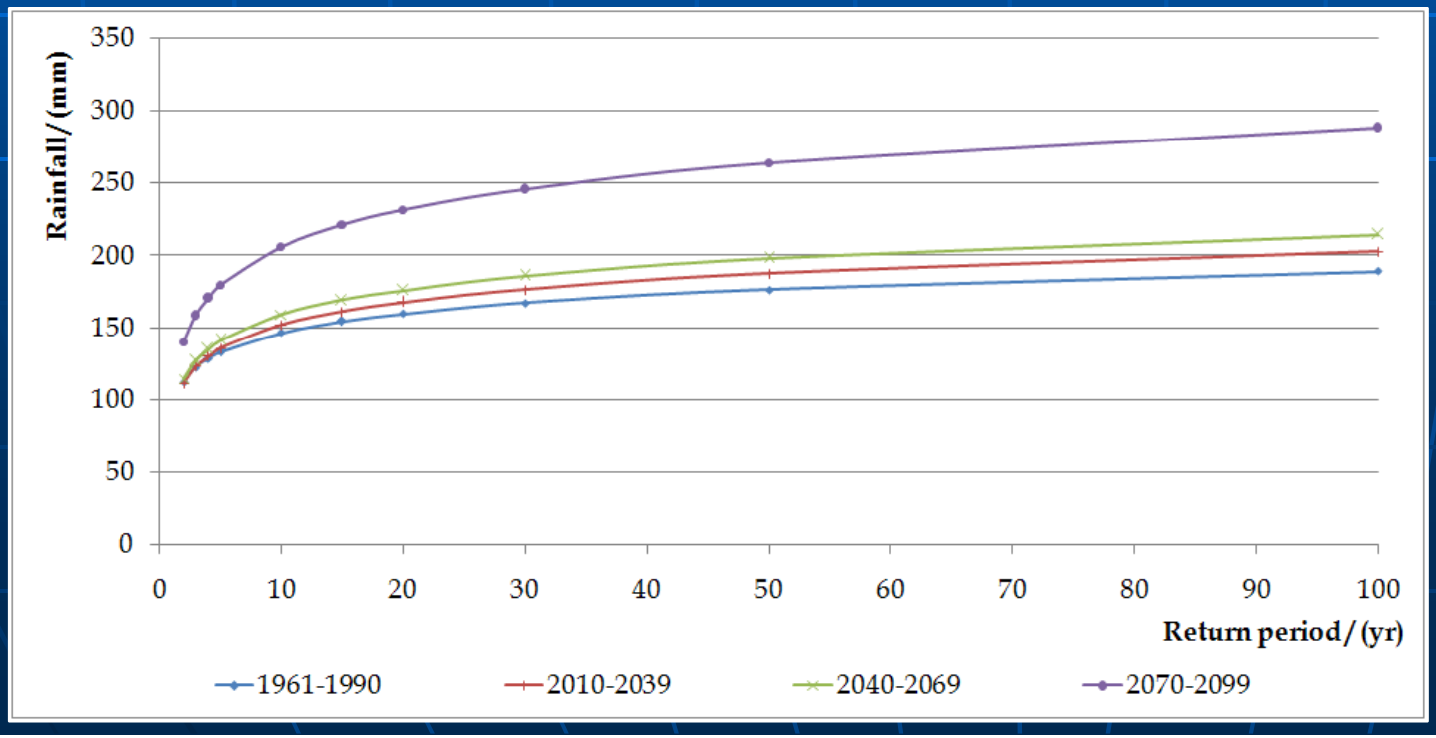
Annual total rainfall at lower catchment

Gumbel distribution for upper catchment

Gaouri Silva et al, *UNU , Uo*



Frequency analysis according to A2 scenario



Frequency analysis according to B2 scenario

Frequency analysis for discharge at Hanwella

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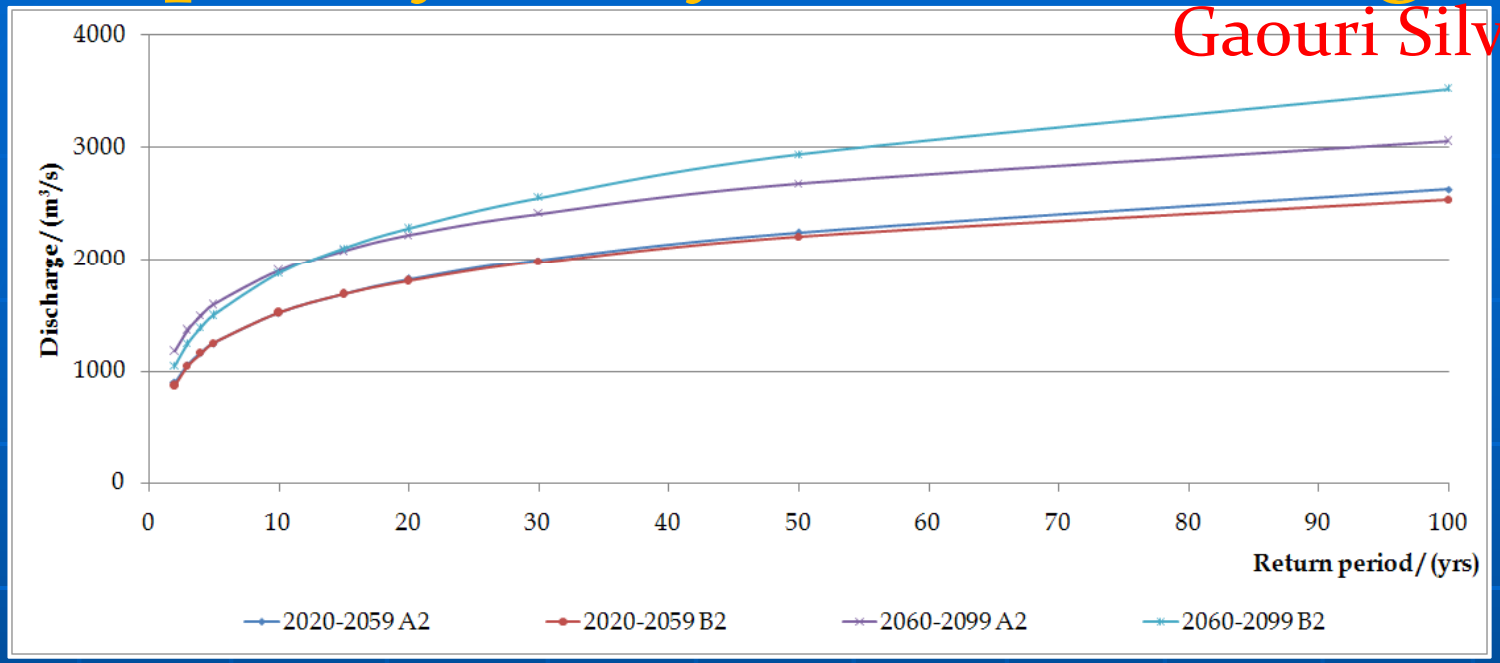
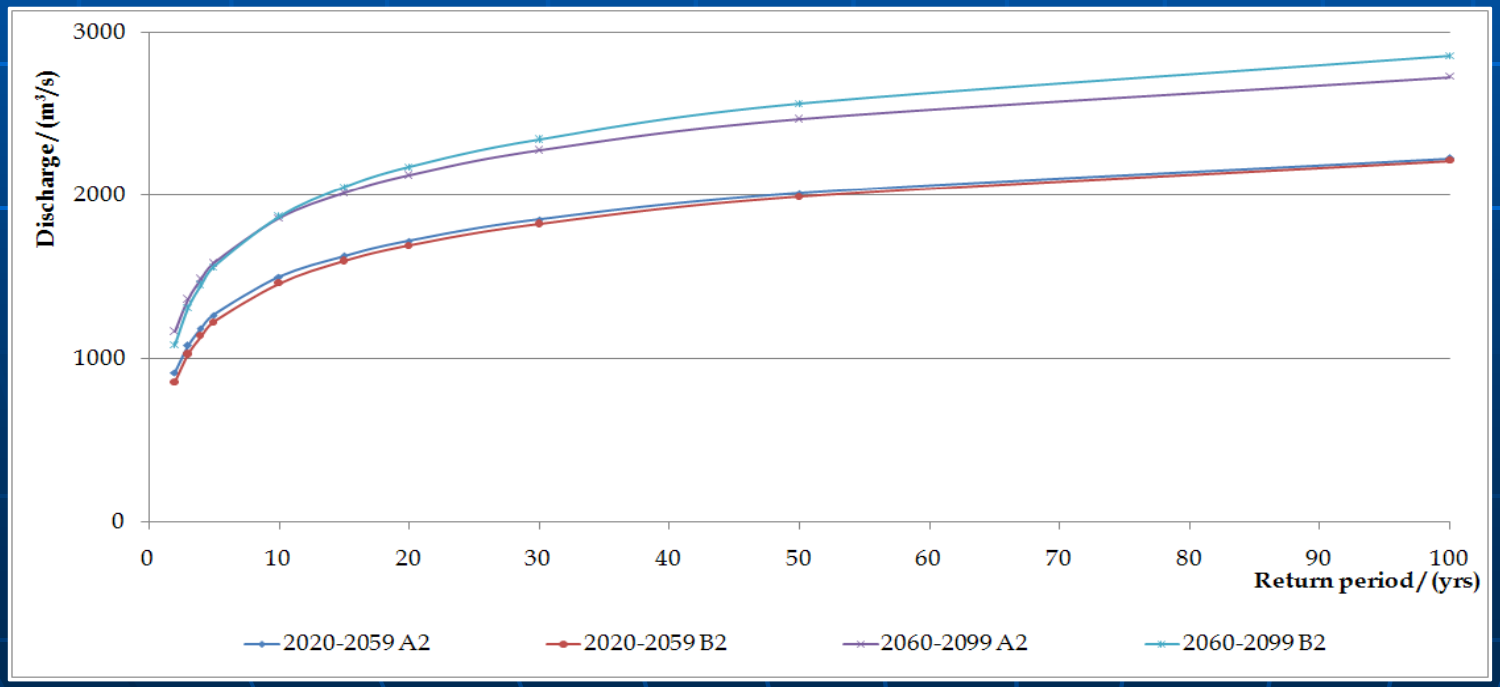


According to GEV distribution



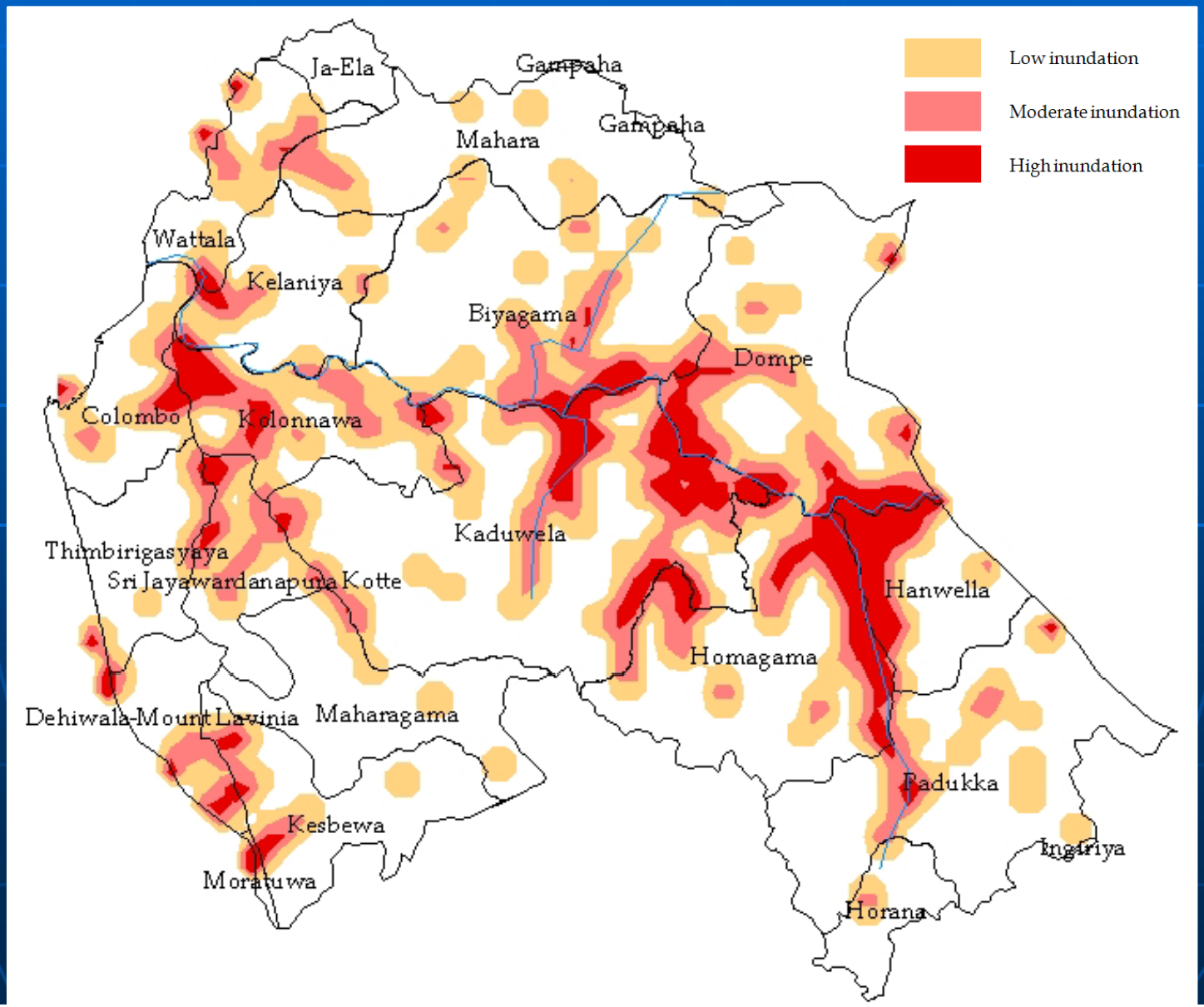
According to Gumbel distribution

Discharge having an increasing trend from 2020-2059 period to 2060-2099 period

Inundation mapping

Gaouri Silva et al, *UNU , Uo*

100 year return period rainfall (Gumbel distribution) according to 2040-2069 under A2 Scenario



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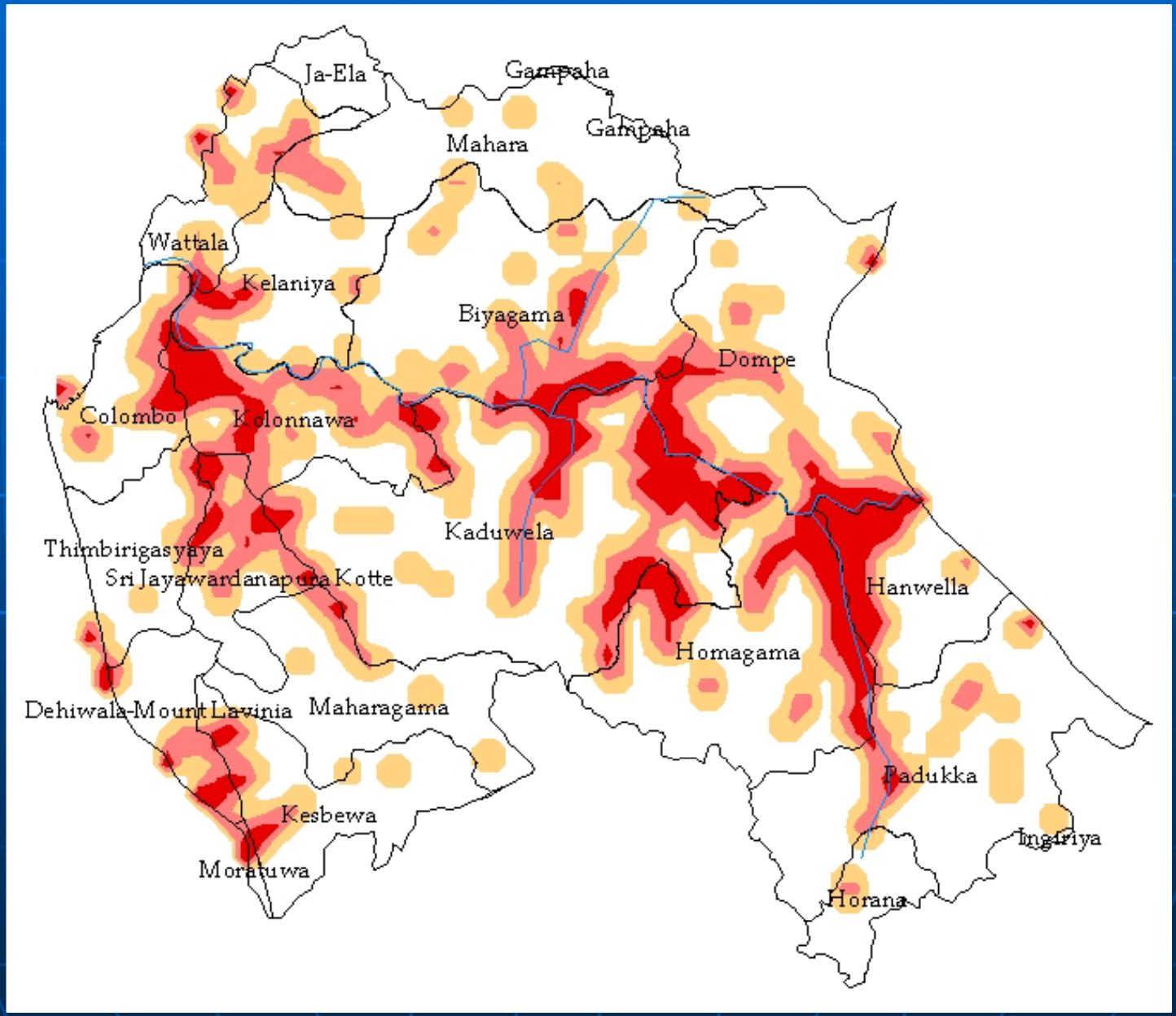
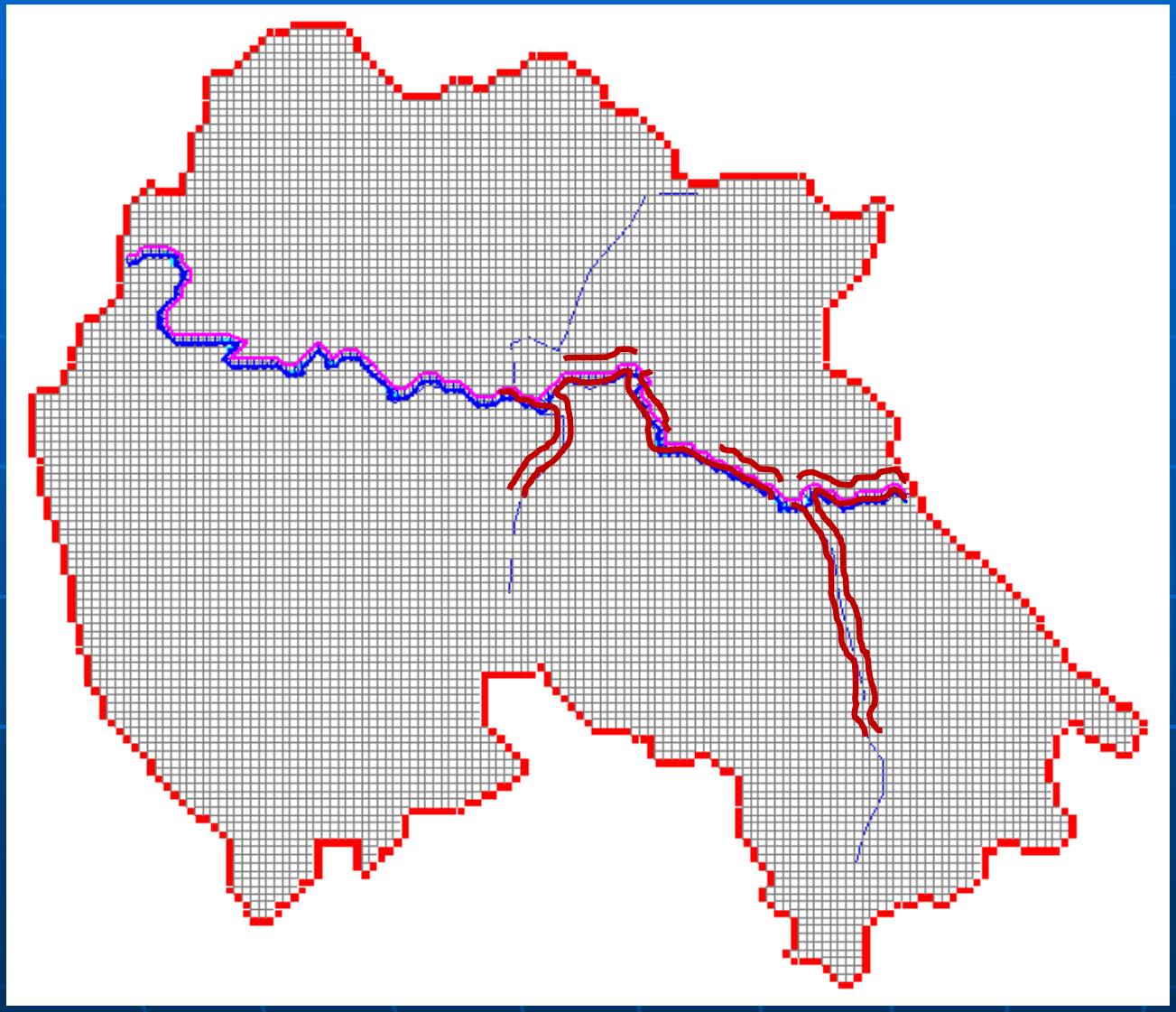
100 year return period rainfall according to 2040-2069 under B2 Scenario



Structural measure to reduce flood damage

Gaouri Silva et al, *UNU* , *UoP*



A levee along the river was introduce to minimize the area under flood in Hanwella, Homagama and Kaduwela areas.

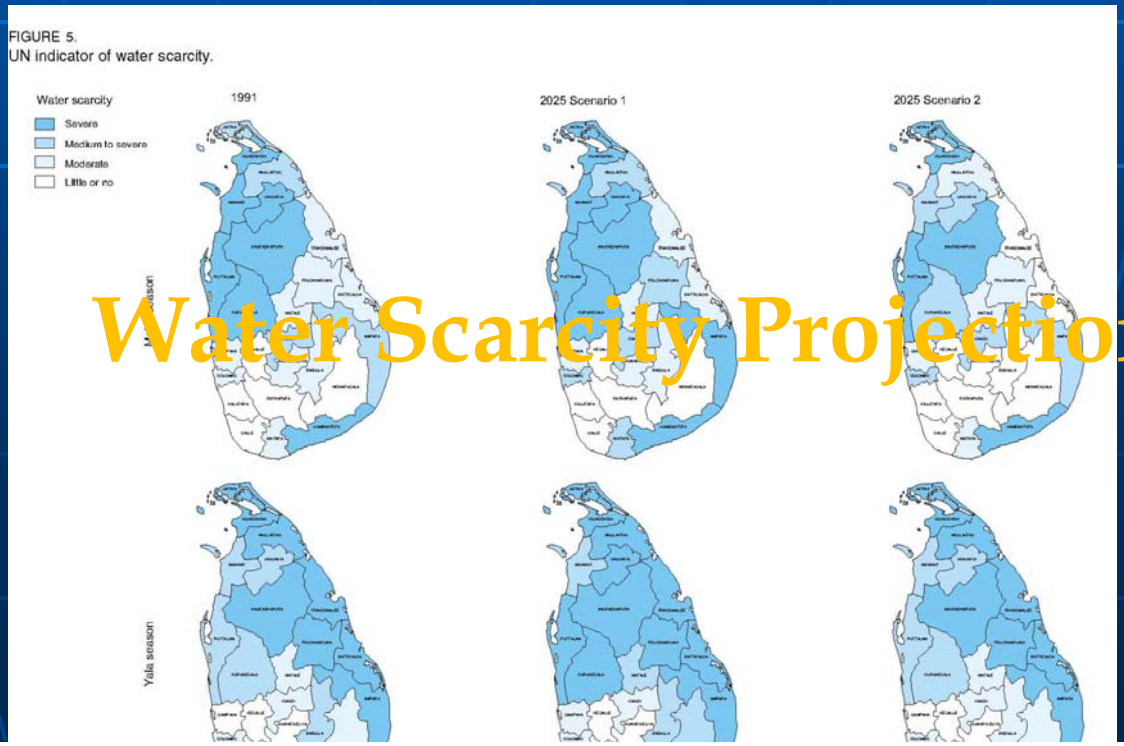
WCI

In order to alleviate water scarcity, flood disaster reduction, water sharing conflicts and to improve water productivity

<u>WCI would be a catalyst to facilitate</u>

•integration of new advancements in climate forecast, weather predictions into the decision making

•recognition and implementation of adaptation methods



Water Scarcity Projections


Thank you

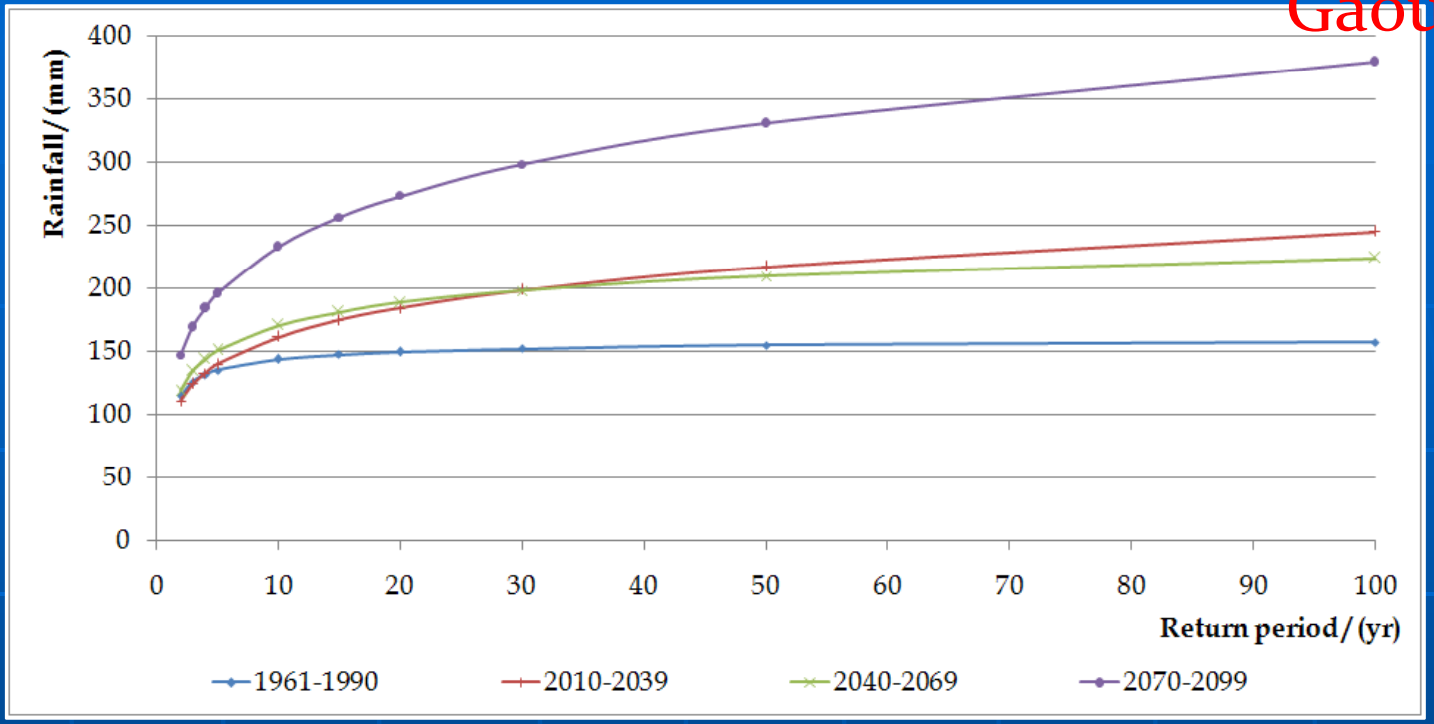

Thank You

SriLanka_KaluGanga (Status of 2003/01-2004/12) 12 stations as of 2009-12-13

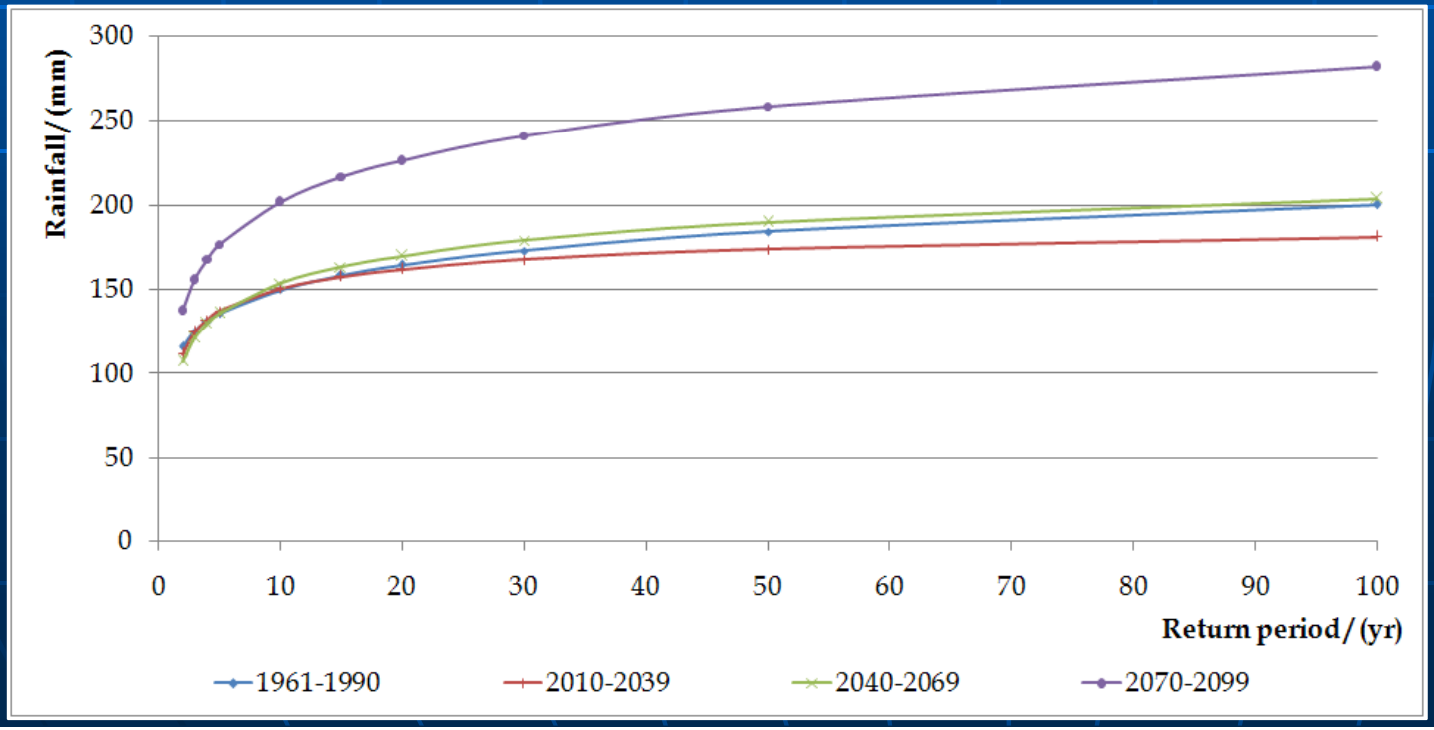
site	station	G	I	D	B	C	M	U	total	%	
SriLanka_KaluGanga	001:Putupaula (2003/1 - 2004/12 in DB)	721	0	5	0	0	5	0	726	100 %	
SriLanka_KaluGanga	002:Millakanda (2003/1 - 2004/12 in DB)	729	0	2	0	0	0	0	731	100 %	
SriLanka_KaluGanga	003:Ellagawa (2003/1 - 2004/12 in DB)	731	0	0	0	0	0	0	731	100 %	
SriLanka_KaluGanga	004:Dela (2003/1 - 2004/12 in DB)	637	0	2	0	0	92	0	639	100 %	
SriLanka_KaluGanga	005:Alupolla (2003/1 - 2004/12 in DB)	731	0	0	0	0	0	0	731	100 %	
SriLanka_KaluGanga	006:Hapugastenna (2003/1 - 2004/12 in DB)	425	0	0	0	0	306	0	425	100 %	
SriLanka_KaluGanga	007:Ratnapura (2003/1 - 2004/12 in DB)	731	0	0	0	0	0	0	731	100 %	
SriLanka_KaluGanga	008:Dependene (2003/1 - 2004/12 in DB)	731	0	0	0	0	0	0	731	100 %	
SriLanka_KaluGanga	009:Kalutara (2003/1 - 2004/12 in DB)	607	0	0	0	0	124	0	607	100 %	
SriLanka_KaluGanga	010:Gonapenigala (2003/1 - 2004/12 in DB)	700	0	0	0	0	31	0	700	100 %	
SriLanka_KaluGanga	011:Horagoda (2003/1 - 2004/12 in DB)	699	0	0	0	0	32	0	699	100 %	
SriLanka_KaluGanga	012:Bandaragama (2003/1 - 2004/12 in DB)	731	0	0	0	0	0	0	731	100 %	
site	station	G	I	D	B	C	M	U	total	%	

GEV distribution for upper catchment

Gaouri Silva et al, *UNU* , U



Frequency analysis according to A2 scenario



Frequency analysis according to B2 scenario

Results

Results of the frequency analysis

For Ratnapura gauging station	1901-1930 (1)	1931-1960 (2)	1961-1990 (3)	1991-2009 (3)
Average of the data series	150.64	163.66	152.03	158.16
Std. dev. of the data series	40.38	77.15	56.35	81.08441
Scale parameter (α)	0.031	0.016	0.0227	0.015
Location parameter (m)	132.47	128.95	126.68	121.69