Flood Risk Assessment Due to the Impact of Climate Change

Development of Basin Investment Plans
Climate Resilience Improvement Project (CRIP)

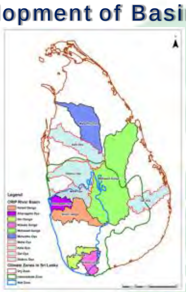
Eng. M. D. Thilini Wasana Kumari
Irrigation Engineer, Irrigation Department, Sri Lanka

Eng. M.A. Jayakody,
Chief Engineer, Irrigation Department, Sri Lanka
Eng. P. A. A. P. K. Pannala,
Director (Irrigation Special Project), Ministry of Agriculture, Rural Economic Affairs, Livestock Development, Irrigation and Fisheries & Aquatic Resources Development

Background

Sri Lanka is highly vulnerable to climate change impacts. Extreme weather events such as high intensity rainfall followed by flash floods and landslides, and scarce rainfall resulting in droughts and extended dry periods are now becoming common occurrences in Sri Lanka.

Development of Basin Investment Plans (DBIP)



Phase-I River Basins:

- Kelani Ganga
- Attanagalu Oya
- Mahaweli Ganga
- Gin Ganga
- Nilwala Ganga
- Malwathu Oya

Phase-II River Basins:

- Maha Oya
- Deduru Oya
- Kala Oya
- Gal Oya

FLOOD RISK ASSESSMENT

Objectives

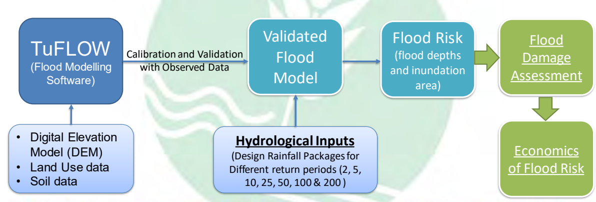
- Assess and quantify the risk of flood at a basin scale
- Understand the impact of Climate Change on flood risk
- Help decide what, where & how much to invest to mitigate flood and the negative impacts of climate change

Flood Risk Assessment Case Framework

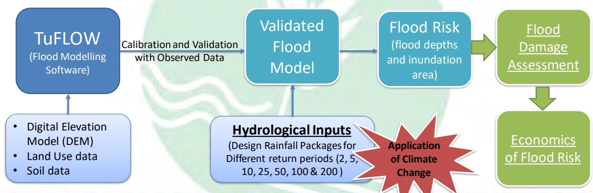
- Seven (7) Cases
  - Current Condition (Climate & Land Use)
  - 3 x Climate Change scenarios
  - 2 x basin development scenarios

Climatic Conditions		Basin Development	
		Current 'no basin development'	Future (2040) 'basin development'
Current Climate		Case 1 (base case)	-
Future Climate	Pessimistic	Case 2	Case 5
	Average	Case 3	Case 6
	Optimistic	Case 4	Case 7

Methodology for Case 01 (Current Situation)

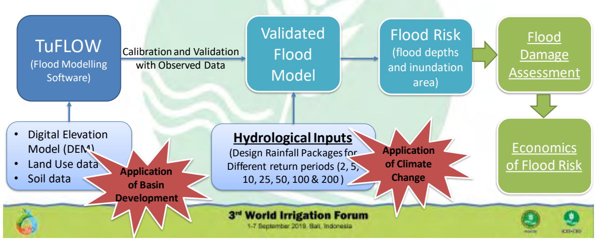


Methodology for Case 02-04 (Flood Risk Due to the Impact of Climate Change)



7

Methodology for Case 05-07 (Flood Risk Due to the Impact of Climate Change & Basin Developments)

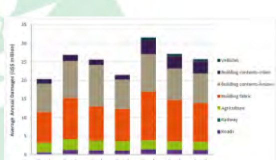


3rd World Irrigation Forum
1-7 September 2019, Bali, Indonesia

8

Results

Economic Asset	Average Annual Damage (USD million)						
	Case 1	Case 2	Case 3	Case 4	Case 5	Case 6	Case 7
Roads	0.64	1.27	1.14	1.1	1.42	1.29	1.24
Railways /Embankment	0.03	0.05	0.04	0.04	0.05	0.04	0.03
Agriculture	2.53	2.9	2.65	2.57	2.43	2.23	2.16
Building Fabric	8.32	11.04	9.21	8.62	13.11	11.16	10.52
Building Contents : Residential	7.63	9.99	11.22	7.9	10.07	8.48	7.96
Building Contents : Other	1.2	1.61	1.35	1.24	3.8	3.42	3.26
Vehicles	0.0	0.01	0.0	0.0	0.71	0.6	0.57
Average Annual Damage	20.35	26.87	25.61	21.47	31.59	27.22	25.74

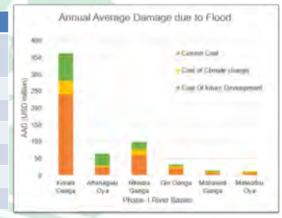


3rd World Irrigation Forum
1-7 September 2019, Bali, Indonesia

9

Results Cont..

River Basin	Annual Average Damage (USD million)		
	Case 01 Current Cost	Case 02 Cost of Climate Change	Case 05 Cost of Future Development
Kelani Ganga	240	282	363
Attanagalu Oya	23	28	65
Nilwala Ganga	60	78	100
Gin Ganga	20	27	32
Mahaweli Ganga	7	10	15
Malwathu Oya	7	11	12



3rd World Irrigation Forum
1-7 September 2019, Bali, Indonesia

10

Summary

- Climate change is an unpredictable science.
- The results of the study show that the cost of flood damages in all river basins would be increased due to the climate change and this could be further increased due to the developments in the basins expected by the year 2040.
- Accordingly, this indicates that all the six river basins need to be developed against floods in order to reduce the annual socio-economic loss to the country due to the floods.

3rd World Irrigation Forum
1-7 September 2019, Bali, Indonesia

11

Thank You

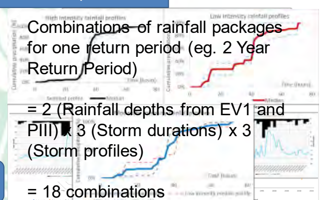
3rd World Irrigation Forum
1-7 September 2019, Bali, Indonesia

12

Hydrological Inputs

Rainfall Packages for different return periods

- Rainfall Depths (EV1 and PIII)
- Rainfall Storm Duration (3, 5, 9)
- Storm Profile (High, Low, Moderate)
- Areal Reduction Factor (ARF)

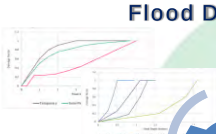


Combinations of rainfall packages for one return period (eg. 2 Year Return Period)

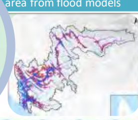
= 2 (Rainfall depths from EV1 and PIII) x 3 (Storm durations) x 3 (Storm profiles)

= 18 combinations

Flood Damage Assessment

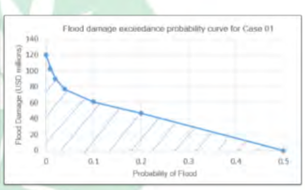


- Exposure Database: Key GIS data layers identifying the assets at risk of flood damage.
  - buildings, transportation, agricultural land etc.
- Depth-Damage Functions: Flood depth - damage functions + maximum damage values for private and public assets = direct economic damages
- Model output for each of the return periods: Flood depths and inundation area from flood models



Economics of Flood Risk

Return Period	Probability of Flood	Economic Damage Value (USD million) for Case 01
2	0.5	0
5	0.2	47.1
10	0.1	61.1
25	0.04	77
50	0.02	89.8
100	0.01	102.8



Application of Climate Change

Observed Weather Data → Marksim stochastic weather generation tool → Global Circulation Models (GCM) associated with the Representative Concentration Pathways (RCP). → Baseline & 10 climatic change daily rainfall data series → Selection of CC factors for each return periods → Pessimistic / Optimistic / Average

Return period	Pessimistic	Average	Optimistic
2 year	1.196	1.082	1.042
	RCP8.5_GISS_E2_H	RCP6_MIROC5	RCP6_FIO_ESM
5 year	1.195	1.074	1.027
	RCP6_GISS_E2_H	RCP6_MIROC5	RCP6_FIO_ESM
10 year	1.211	1.071	1.024
	RCP6_GISS_E2_H	RCP6_CSIRO_MK3_6_0	RCP6_FIO_ESM
25 year	1.226	1.069	1.022
	RCP6_GISS_E2_H	RCP6_CSIRO_MK3_6_0	RCP6_FIO_ESM
50 year	1.236	1.065	1.021
	RCP6_GISS_E2_H	RCP6_MIROC5	RCP6_FIO_ESM

Application of Basin Developments

- 2040 population
- 2040 Land use
- 2040 Infrastructure change