South Asia Flash Flood Guidance System (SAsiaFFGS) Operational Training Follow-up Workshop – Step 4

05 – 07 June 2018, New Delhi, India

Status of Operational Flash Flood Forecasting and Early Warning Capabilities Sri Lanka

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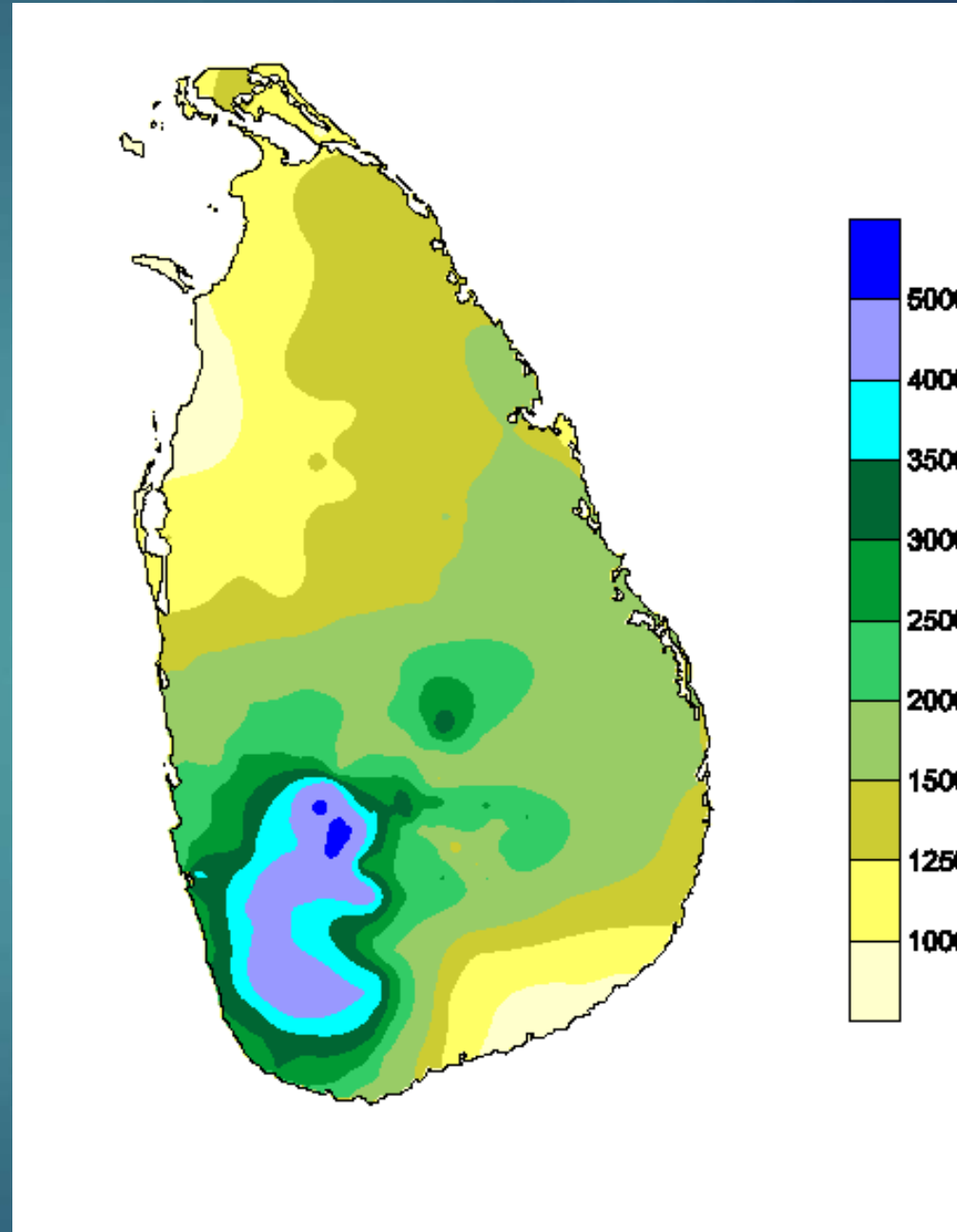**DEPARTMENT OF IRRIGATION**
SRI LANKA

Presentation Layout

➢ Meteorological Aspect

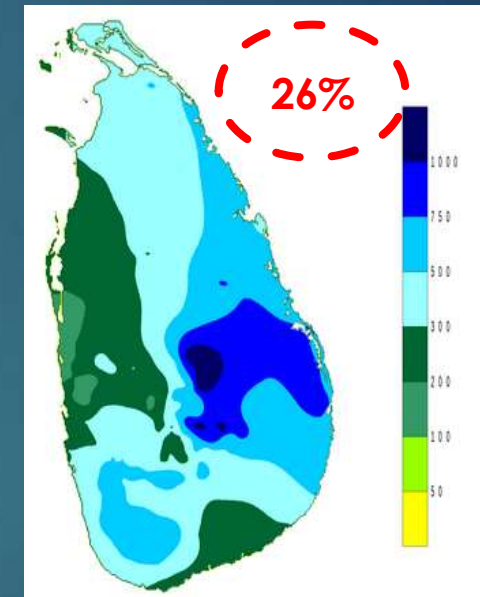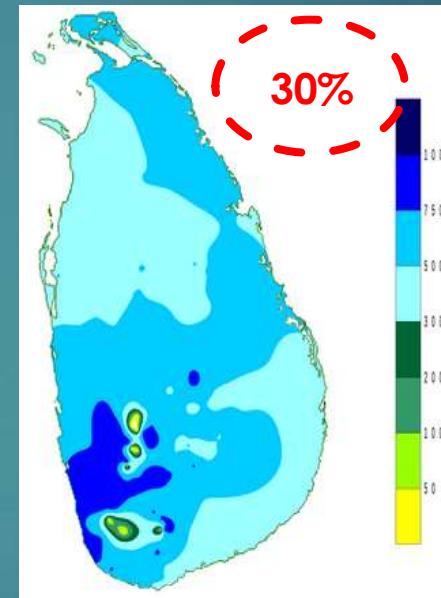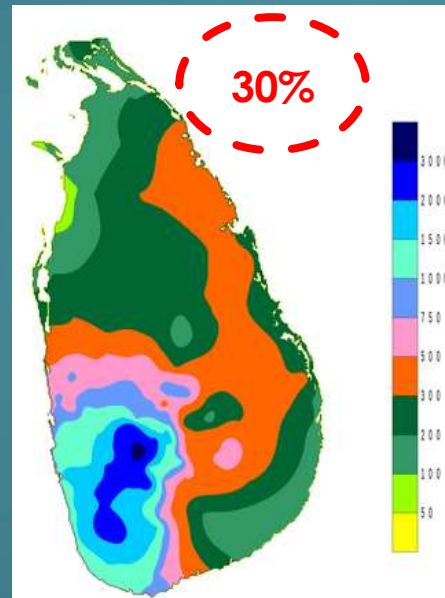➢ Hydrological Aspect
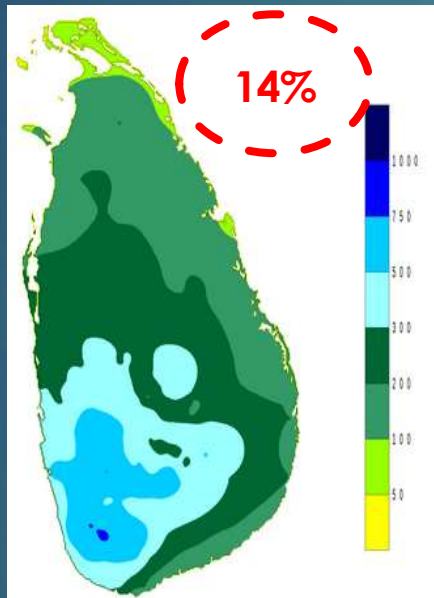
Meteorological Aspect

Topography and Climate of Sri Lanka

- Rainfall in Sri Lanka has multiple origins:
  - Monsoonal
  - Convectional
  - Depressional

- Sri Lanka is subject to two main wind regimes:
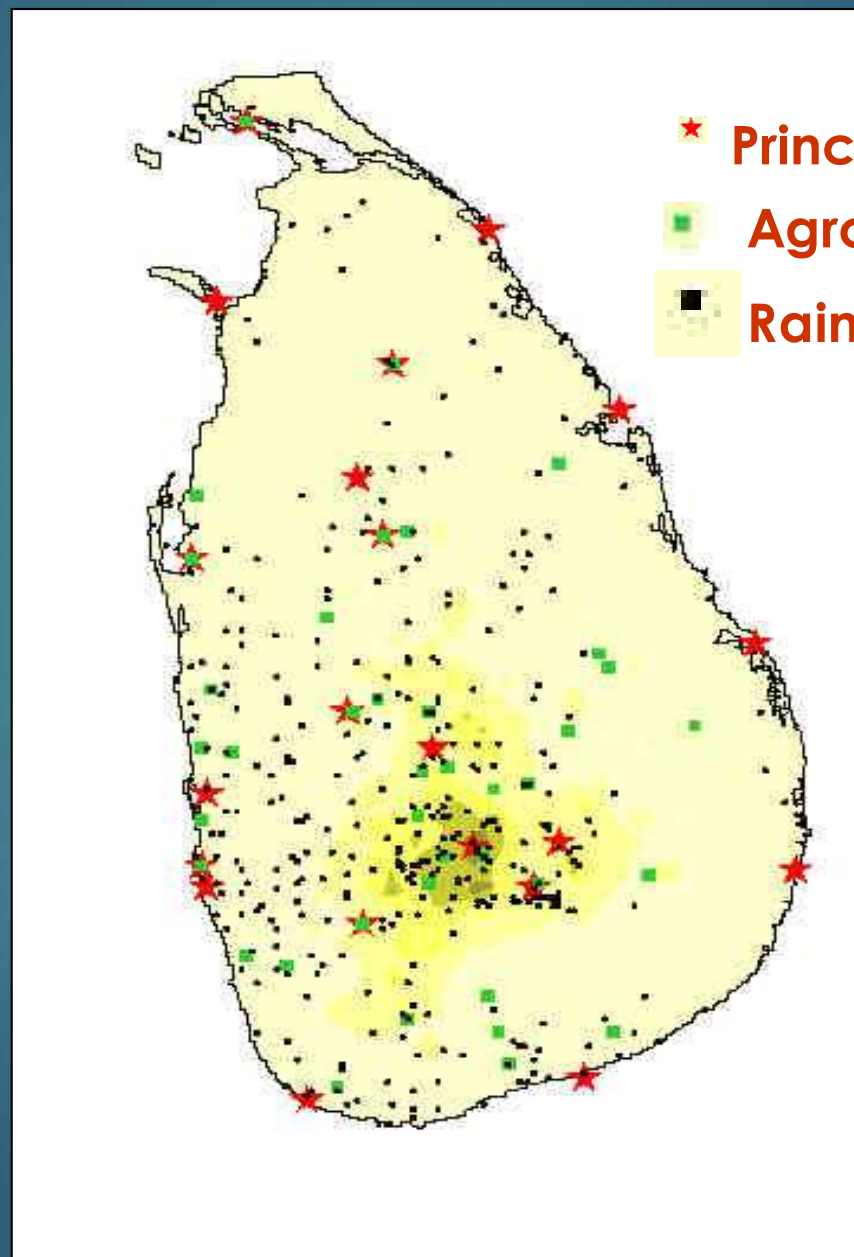 - Southwest
  - Northeast

Topography and Climate of Sri Lanka

Seasonal rainfall distribution of Sri Lanka

Season	First Inter-monsoon	Southwest Monsoon	Second Inter-monsoon	Northeast Monsoon
Period	March – April	May – September	October - November	December – February
Rainfall	260 mm	546 mm	548 mm	459 mm

★ **Principal Meteorological Stations** 23

Agro meteorological Stations 35

Rain gauge Stations 520

- **Pilot balloon observations**

⭐ Radiosonde Observation
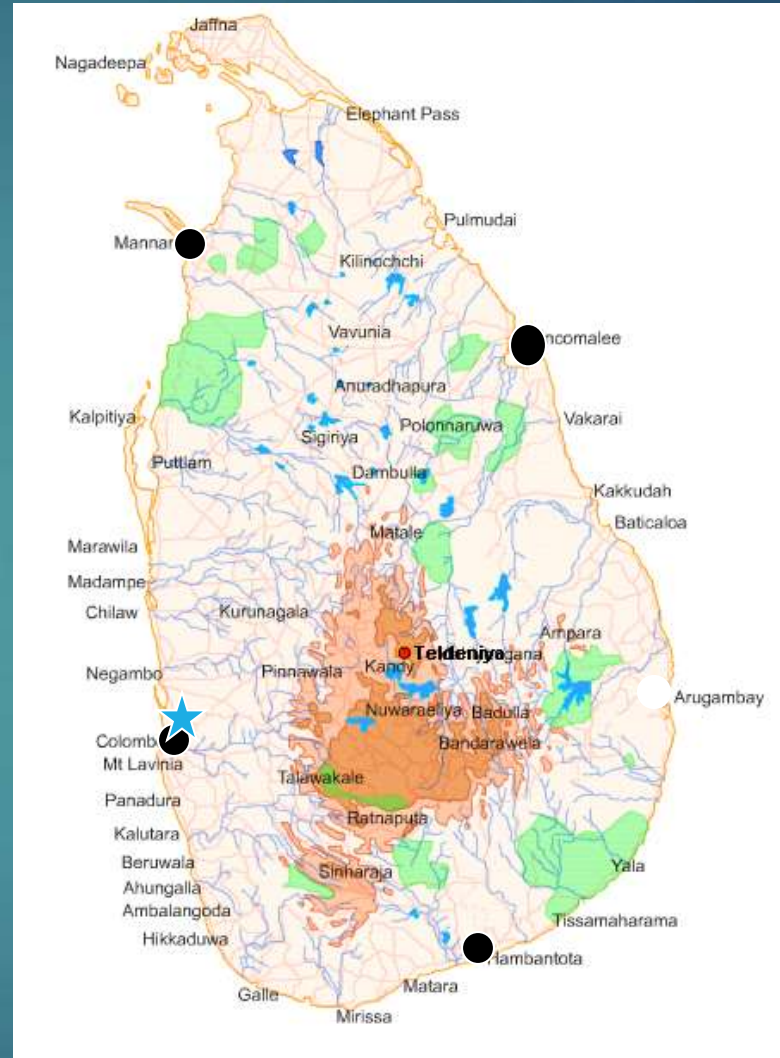
Automatic Weather   Stations

Meteorological and Disaster Information Network donated by JICA it is consist of the Automatic Weather observation Station system (AWS)
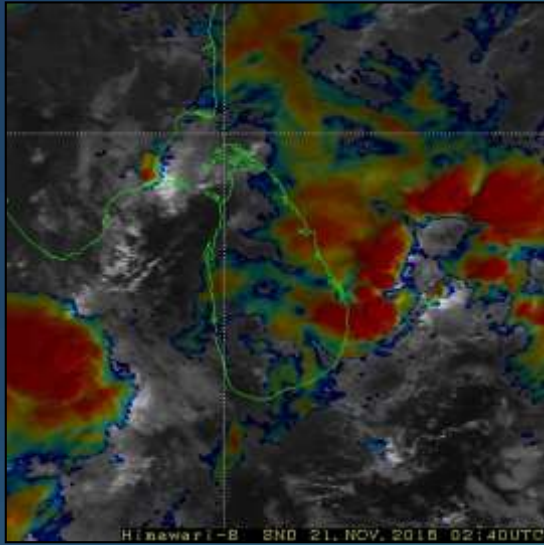
The AWS consists of 38 stations;
20 - Synoptic Meteorological Stations
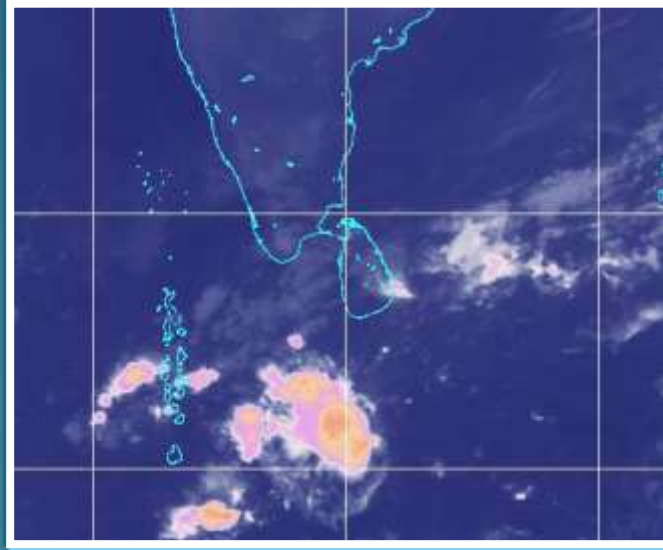18 - Collaborator Stations
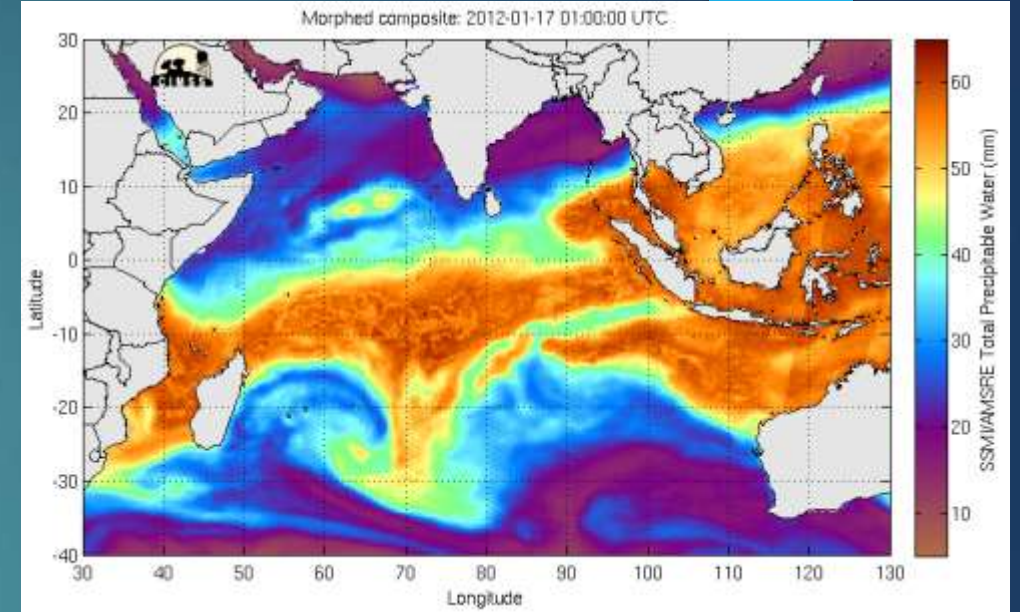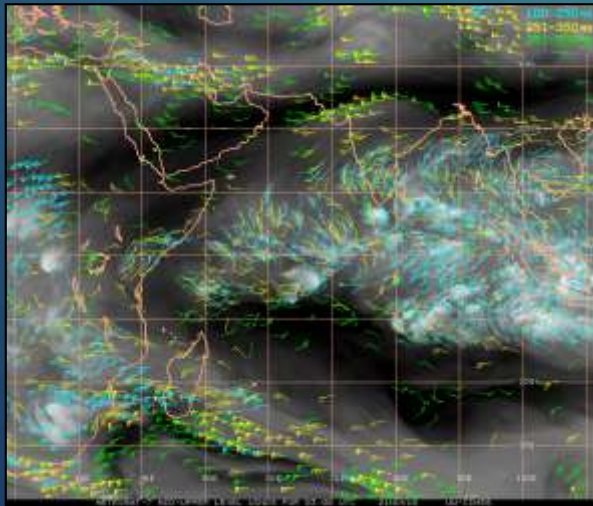Currently new automatic rain gauges are being installed
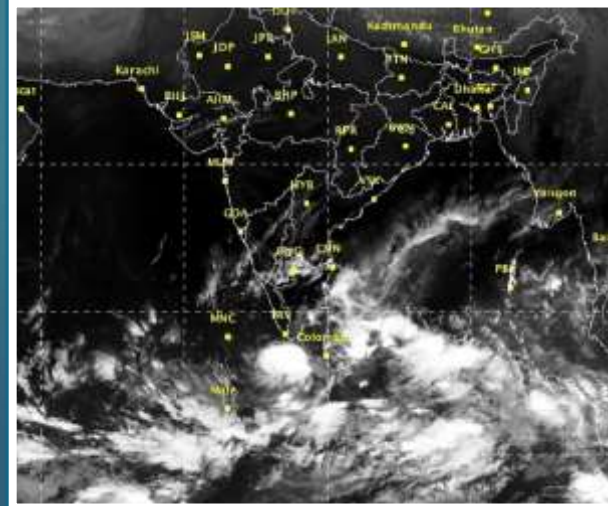
Satellite Products used in Forecasting

Himawari

CMACAST

MIMIC

METEO-7

INSAT

ASCAT
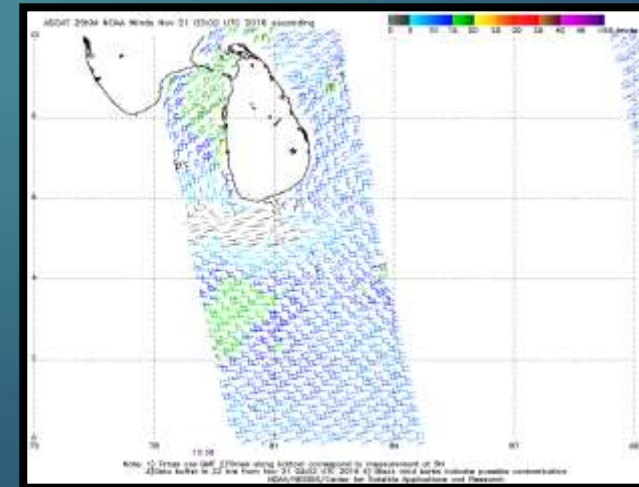
Numerical Weather Prediction(NWP) activities in the department

Use of Weather Research and Forecasting model (WRF) and Data assimilation techniques (WRFDA)
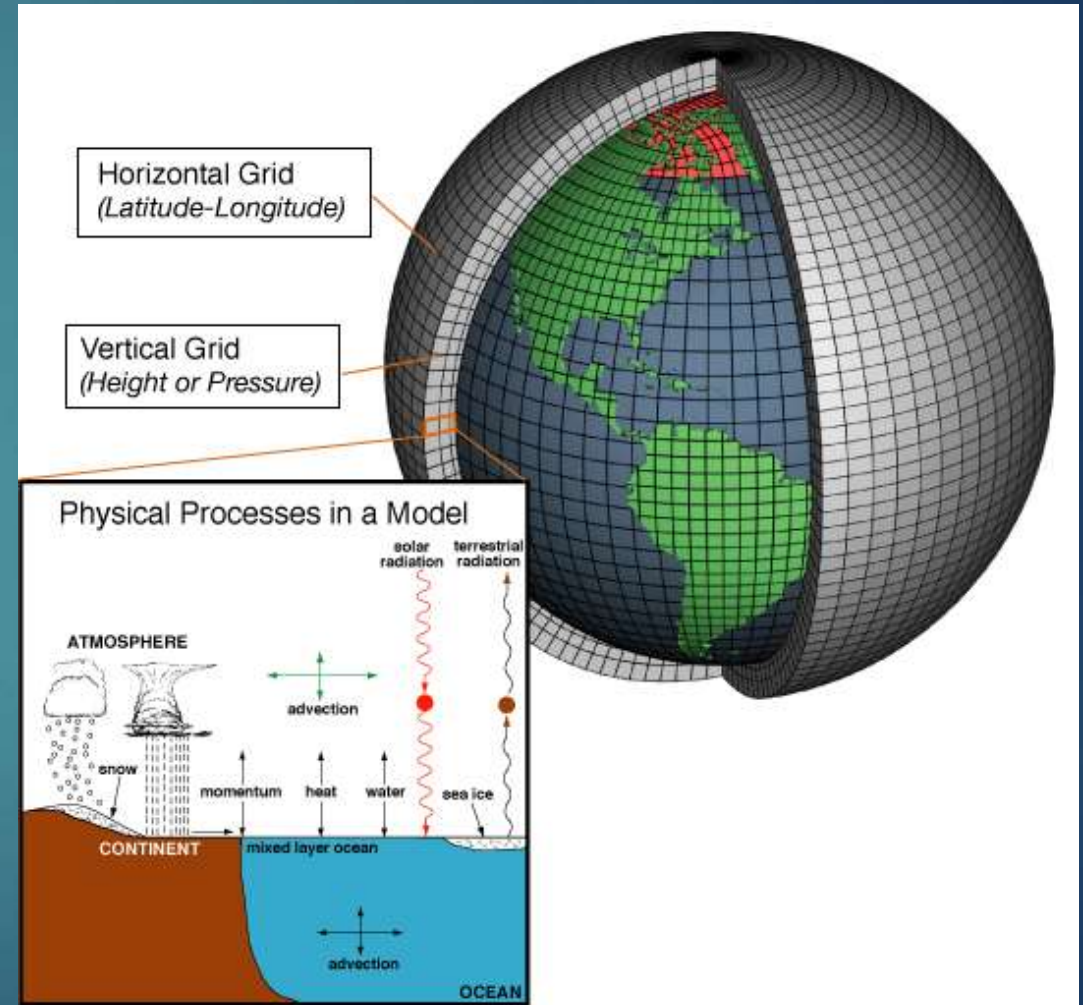
GFS(0.5X 0.5 degree ~ 50km X 50km) Initial
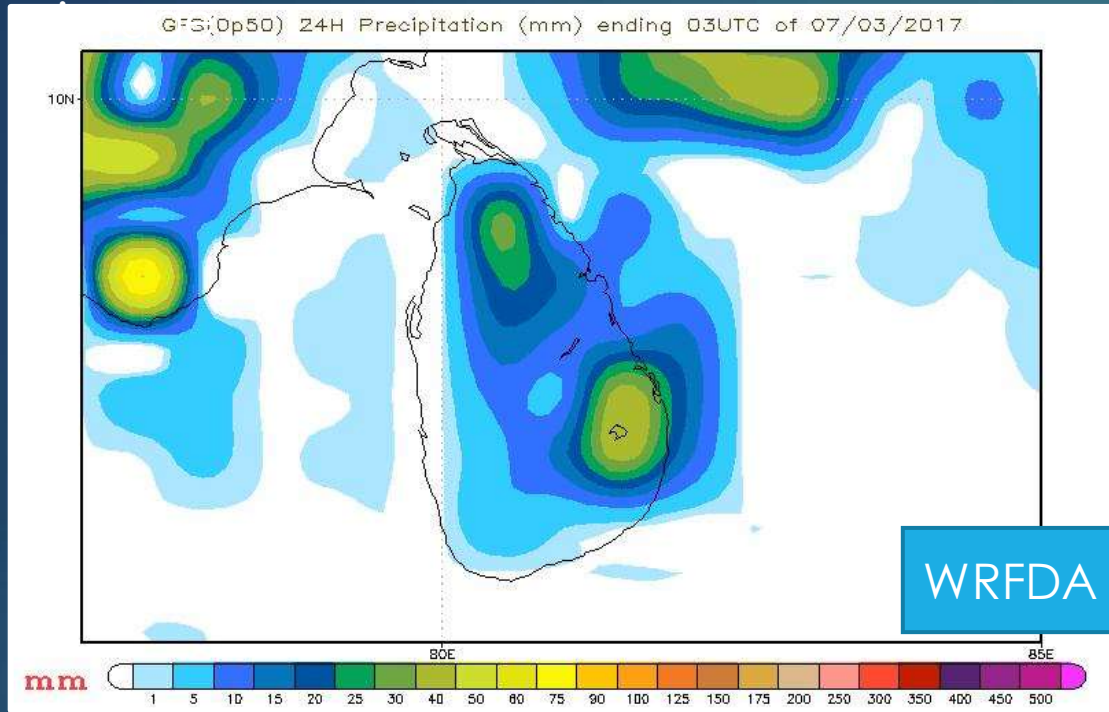
WRFDA (5X5 km)

WRFDA (5X5 km)
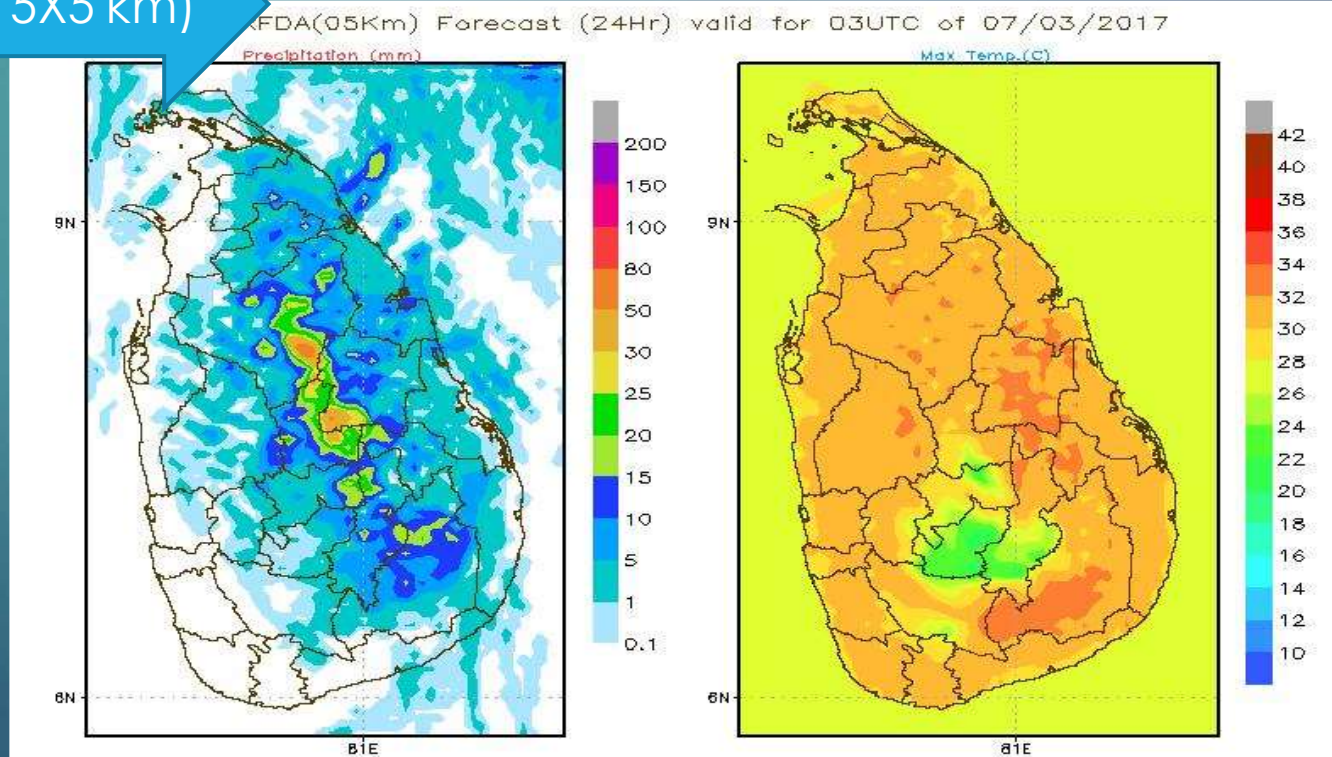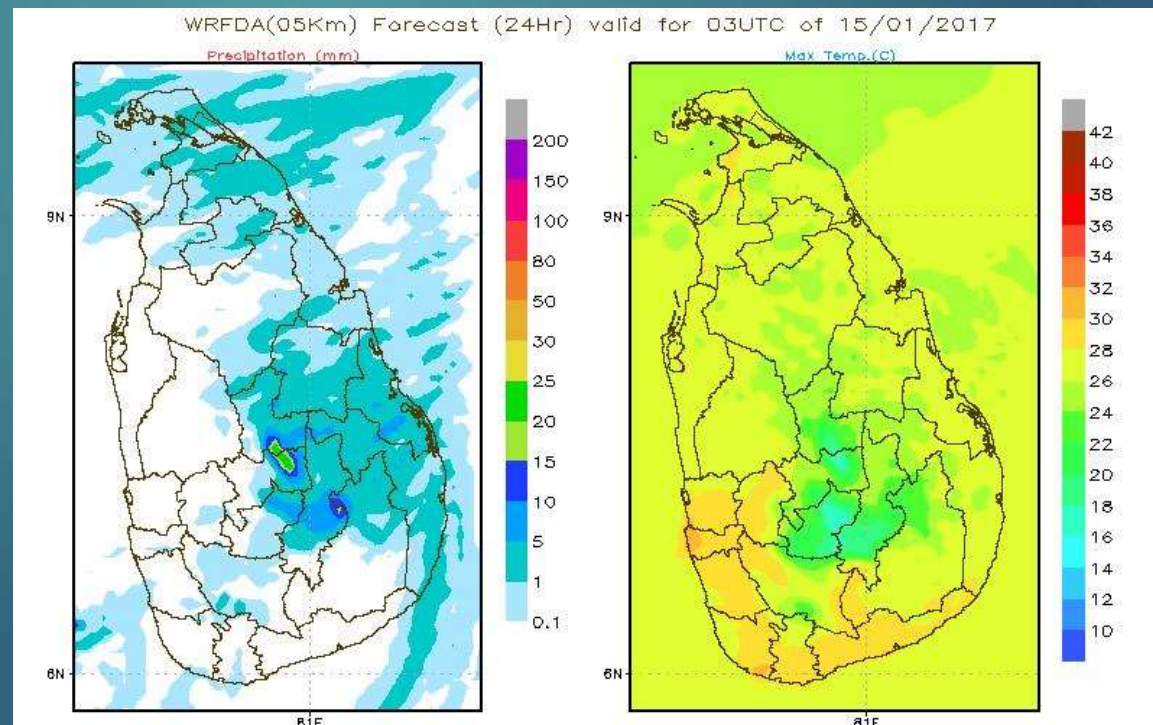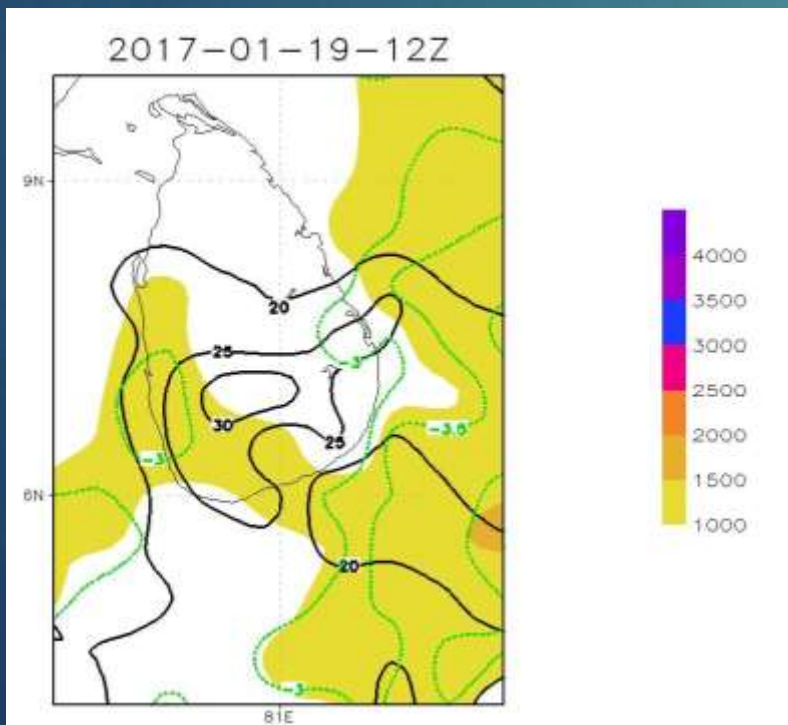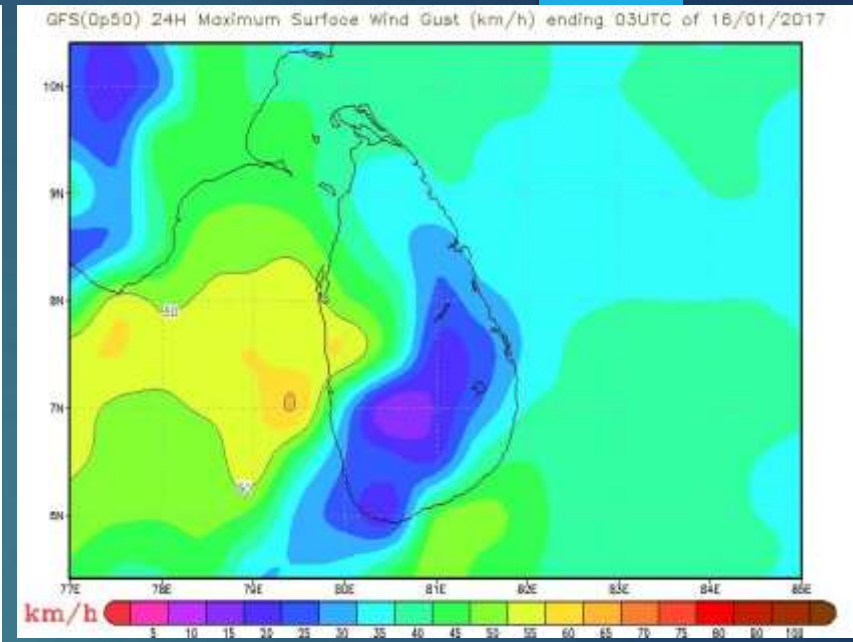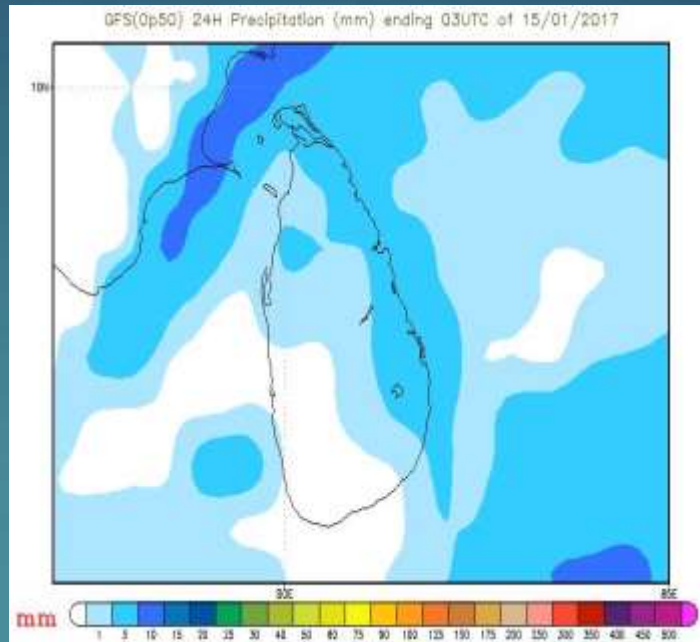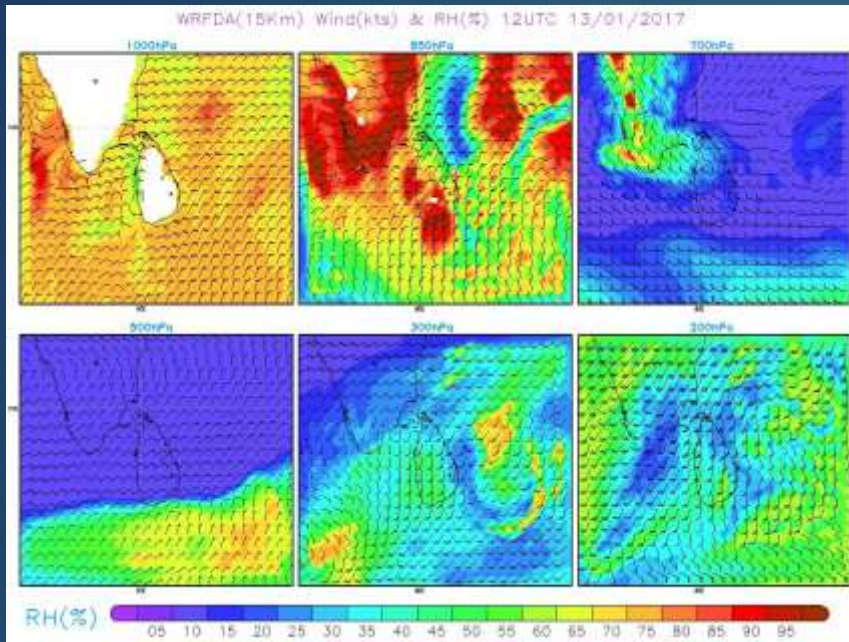
WRF Products
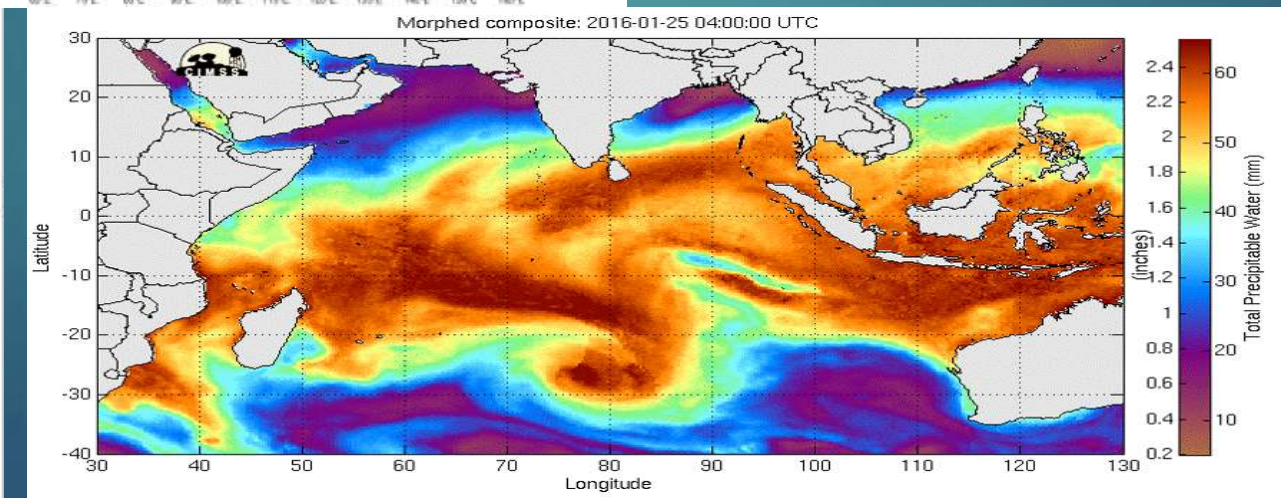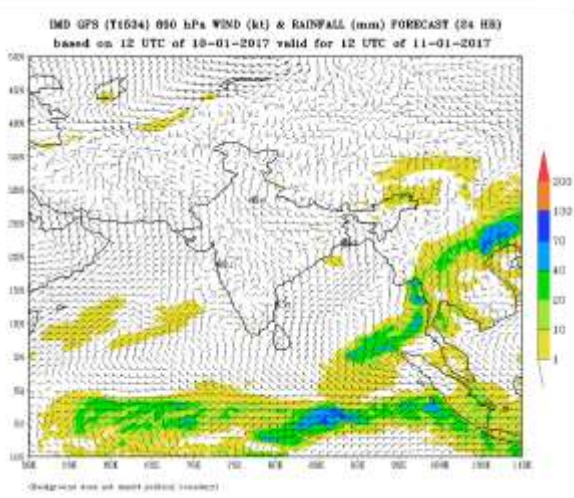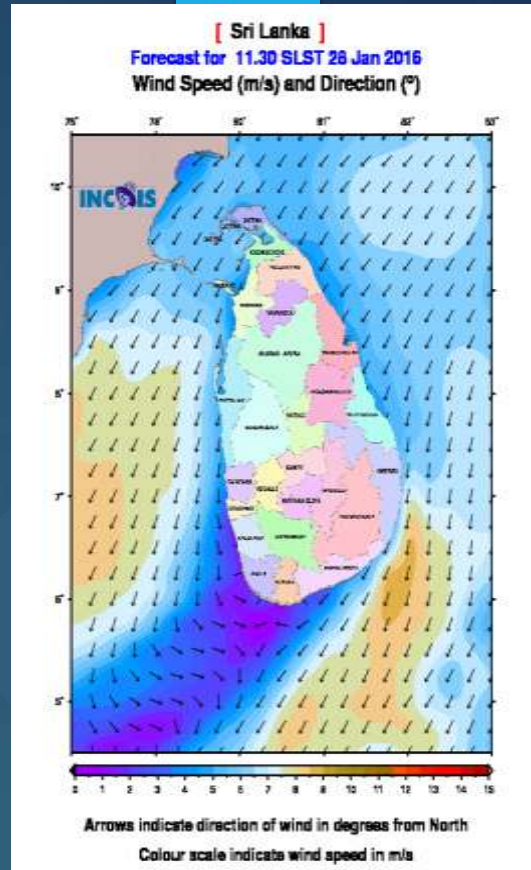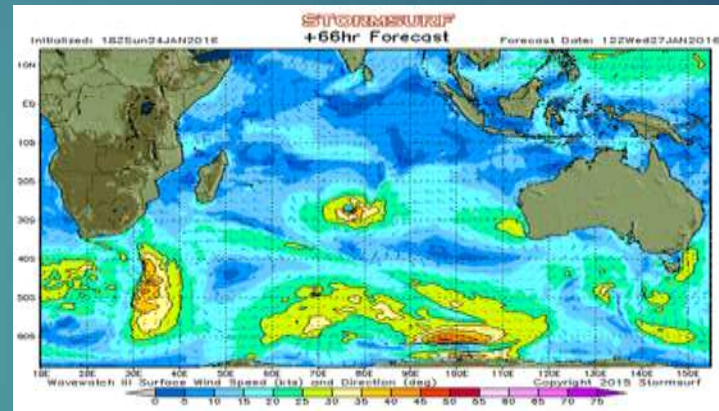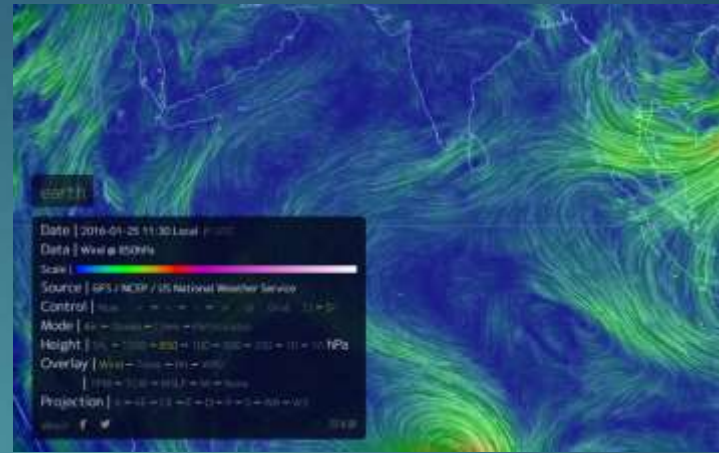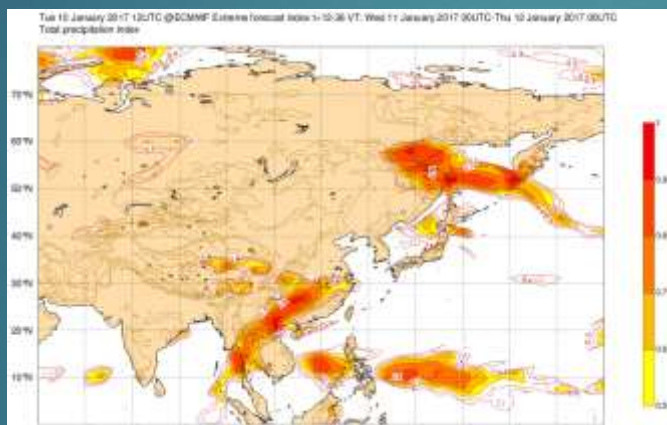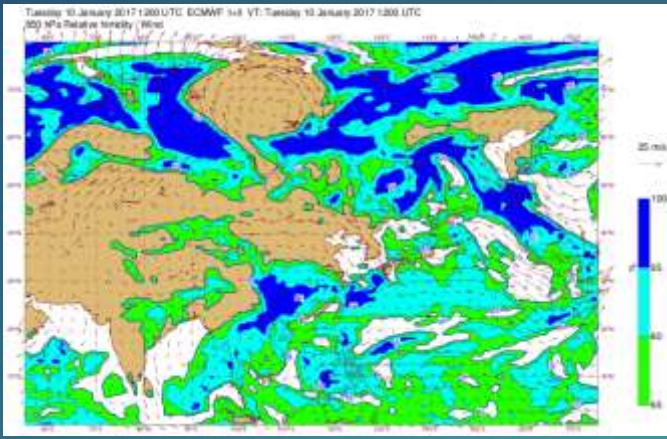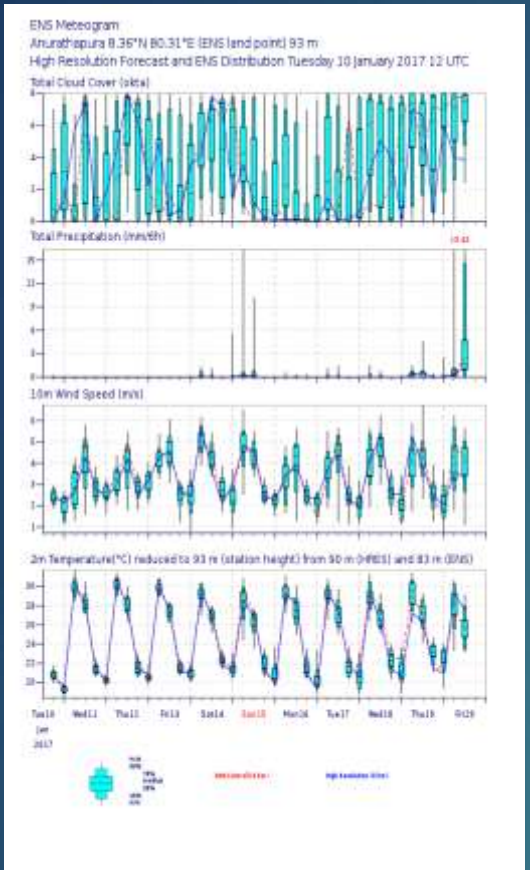
NWP Products (Global)

Recently observed weather related hazards

- Flood is becoming more frequent than Droughts events

year	Hazard
2010	Flood
2011	Flood/Drought
2012	Flood/Drought
2014	Flood/Drought
2015	Flood
2016	Flood/Drought
2017	Flood/Drought
2018	Flood/Drought

Early Warning Process – Sri Lanka

Separate agencies are responsible for early warning in the case of different disasters.

Disaster	Responsible Agency for Early Warning
Cyclones and heavy rainfall/strong winds	Department of Meteorology
Floods	Irrigation Department
Landslides	National Building Research Organization
Tsunami	Department of Meteorology (with the consultation of Geological Survey and Mines Bureau)
Earthquakes	Geological Survey and Mines Bureau

Early Warning System of Sri Lanka
Heavy Rainfall

Warning Criteria

Amount /Intensity	Alert status
Rainfall > 50 mm in 6hrs Rainfall > 100 mm in 24hrs	Alert
Rainfall > 150 mm in 24hrs	Warning

Determine the thresholds or QPE (Quantitative Precipitation Estimation) is a challenging task ???

Sl. No	SIGN	ALERT STATUS	DESCRIPTION	ACTION REQUIRED
1		Information	Likelihood of Moderate Rainfall <100 mm	Effects of rainfall will vary from place to place according to local conditions. Act according to the relevant official instructions
2		Alert	Likelihood of Heavy Rainfall 100- 150 mm	Effects of rainfall will vary from place to place according to local conditions. Act according to the relevant official instructions
3		Warning	Likelihood of Very Heavy Rainfall > 150 mm	Effects of rainfall will vary from place to place according to local conditions. Act according to the relevant official instructions
4		Threat is over	Threat of heavy rainfall is over however light to moderate rainfall can be experienced[1]	Effects of rainfall will vary from place to place according to local conditions. Act according to the relevant official instructions

1.disturbances/low pressure systems /cyclones in the Bay of Bengal / Typhoons in Pacific ocean
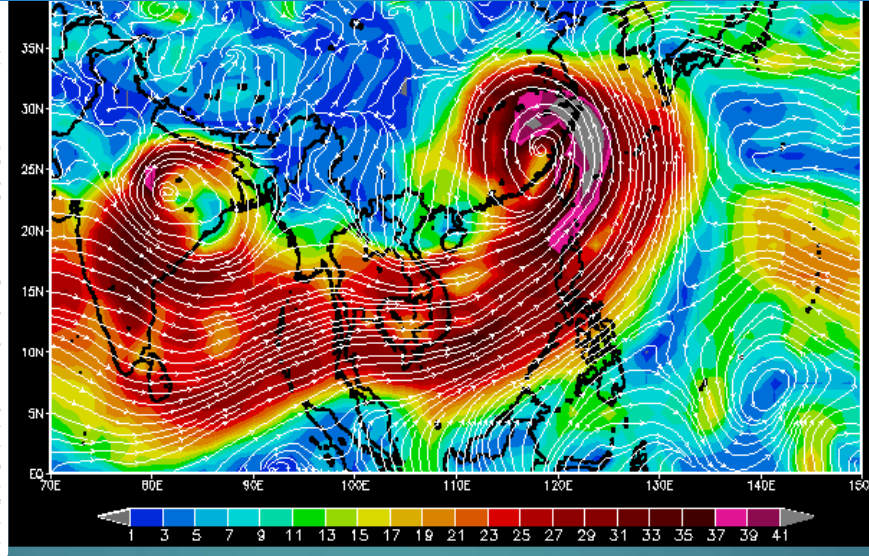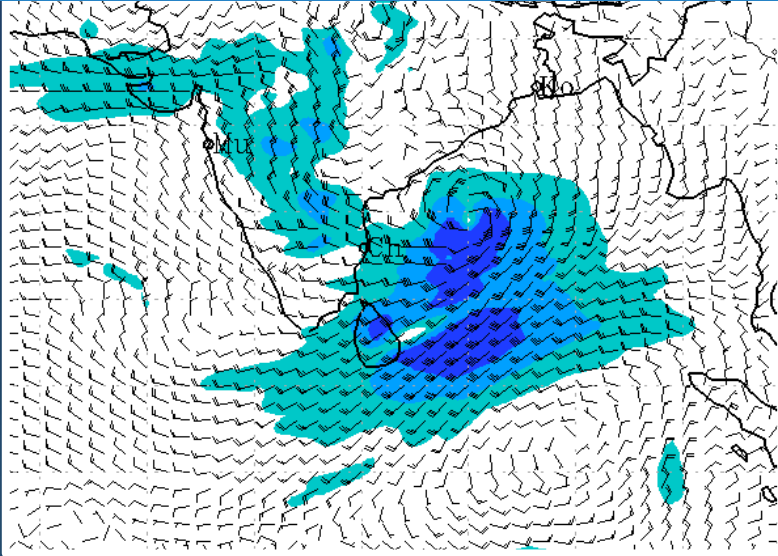
2.wind convergence /trough to the west/southwest
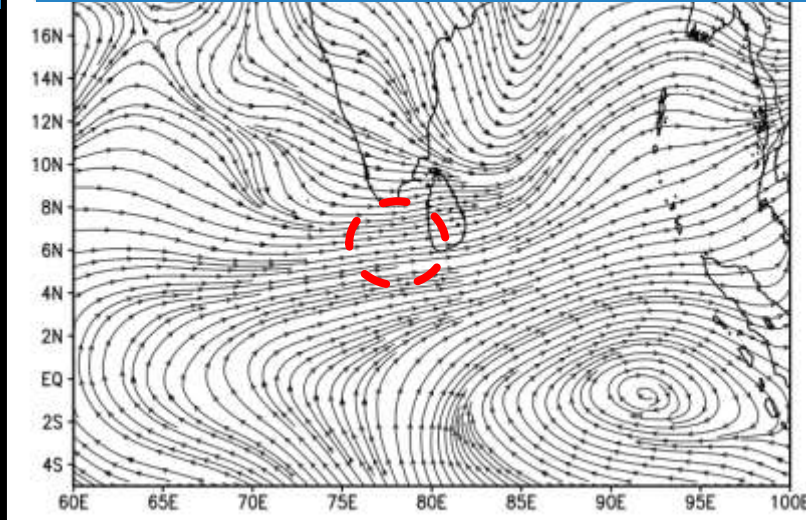
3.Monsoon trough(ITCZ) close/over SL
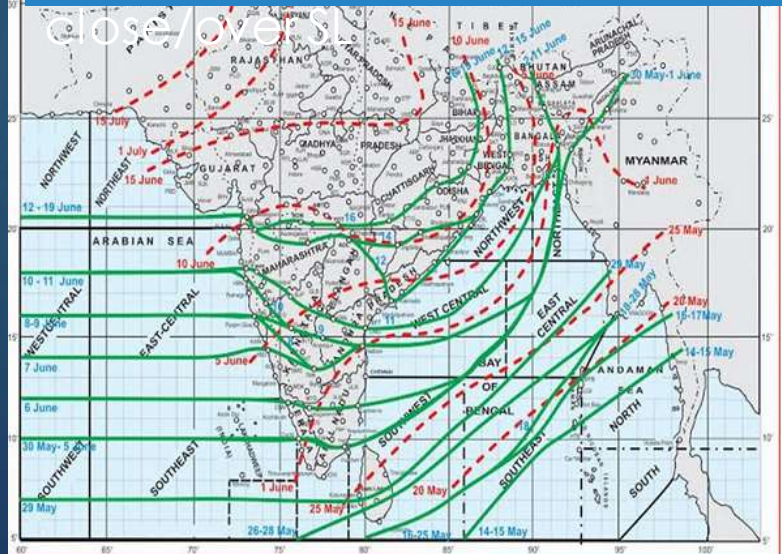
4. Madden- Julian
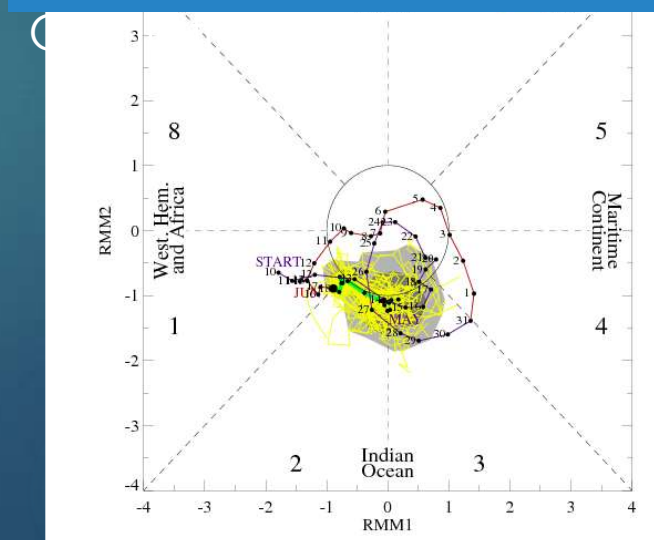
Hydrological Aspect

Mandated Organizations

- Weather Forecasting   :   Department of Meteorology

- Flood Forecasting and Early Warning   :   Hydrology Division of Irrigation Dept.

- Disaster Management :   Disaster Management Center

Flood Types

- Riverine Floods
  : Nearly 25 rivers vulnerable for flooding
- Reservoir Induced Flooding
  : around 100 major/medium reservoirs (due to spillage or dam breach)
- Urban Flooding
  :(mainly due to intense rainfall)

Daily Reports Issued to Public

▶ River Stages at crucial locations

▶ Rainfalls (Catchment Based)

▶ Reservoir Status

(Through the Irrigation Dept. Website, e-mail and Fax)

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RIVER
WATER LEVEL

RAINFALL

GRIEVANCES

REGIONS

MAJOR
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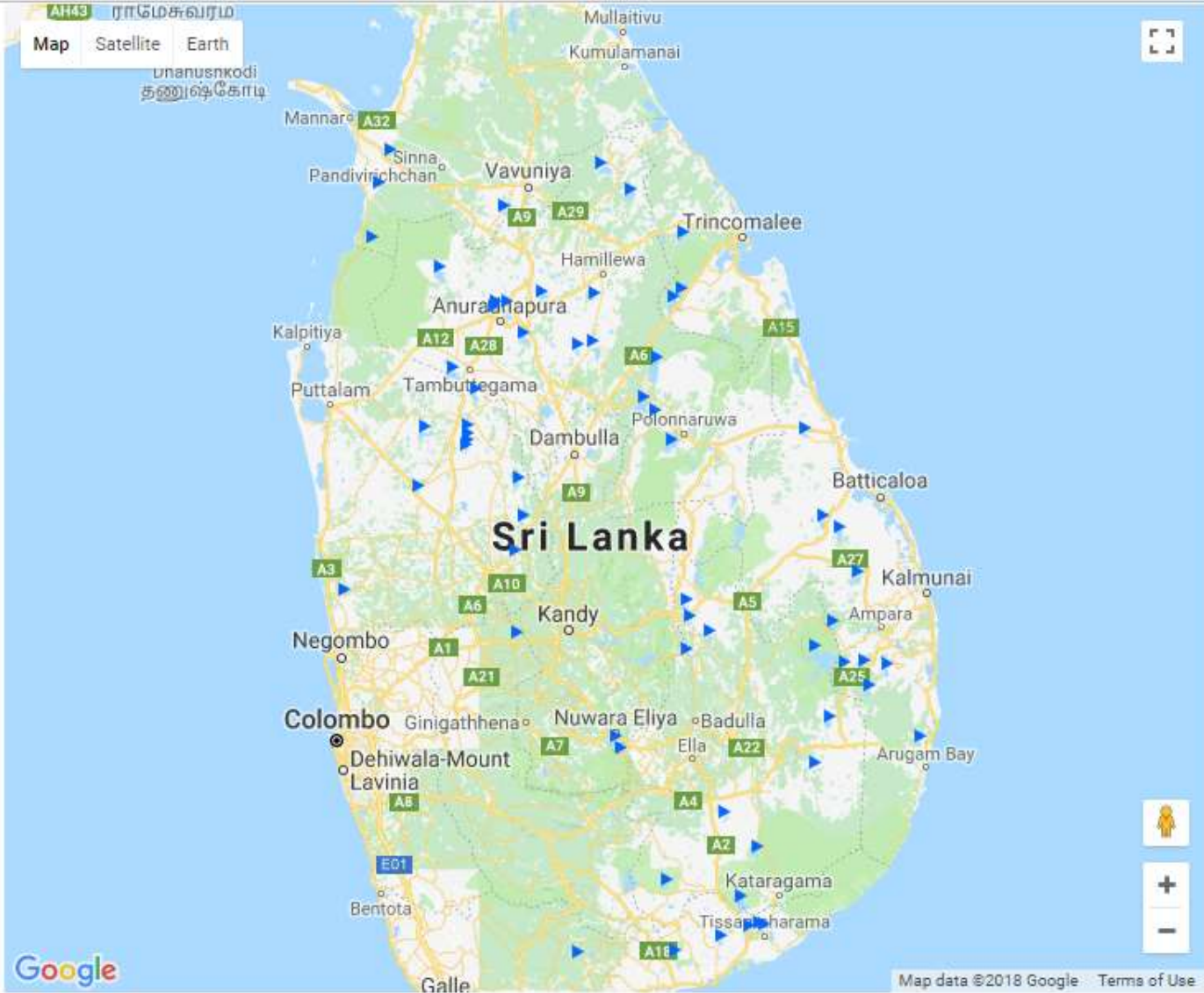
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River Status

- RESERVOIR STATUS
- RIVER WATER LEVEL
- RAINFALL
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- REGIONS
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- PROGRESS MONITORING

Select a Date | 2018-03-11 | VIEW RESET

River Station Data on 2018-03-11

Note: Click on the Station Name to view water level variation and move the mouse pointer on the Station Name to view updated time

Basin	Station Name	Catchment Area (km2)	Alert Level (m)	Minor Flood Level (m)	Major Flood Level (m)	Recorded Highest Water Level (m)	Current Water Level (m)	Condition
Attanagalu Oya	Dunamale	153	3.30	4.40	5.50	5.93	0.44	Normal
Gin Ganga	Tawalama	377	4.27	4.57	6.05	14.78	1.26	Normal
Gin Ganga	Baddegama	681	3.50	4.50	5.00	6.00	1.23	Normal
Heda Oya	Siyambalanduwa	295	4.50	5.00	5.60		0.50	Normal
Kalu Ganga	Ellagawa	1393	10.00	10.66	12.00	14.52	4.05	Normal
Kalu Ganga	Putupaula	2598	3.0	4.00	5.00	6.34	0.48	Normal
Kalu Ganga	Rathnapura	603	5.2	7.5	9.5	11.28	0.85	Normal

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RIVER WATER LEVEL

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Rainfall Status

Search...

Select a Date 2018-03-12 [calendar] VIEW RESET

Rainfall Station Data on 2018-03-12

Note: Click on the Station Name to view rainfall variation and move the mouse pointer on the Station Name to view updated time

Basin	Station Name	River Basin	Rainfall for Last 24 (mm)
Attanagalu Oya	Attanagalla		0.00
Attanagalu Oya	Dunamale		0.00
Gin Ganga	Baddegama		22.20
Gin Ganga	Tawalama		4.60
Heda Oya	Siyambalanduwa		62.10
Kalu Ganga	Putupaula		0.00
Kalu Ganga	Millakanda		0.00
Kalu Ganga	Ellagawa		0.80
Kalu Ganga	Rathnapura		3.80

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Reservoir Status

RESERVOIR STATUS

RIVER WATER LEVEL

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Select a Date   2018-03-08   [📅]   VIEW   RESET

Reservoir Data on 2018-03-08

Note: Click on the Reservoir Name to view storage variation and move the mouse pointer on the Reseroir Name to view updated time

Range	Reservoir Name	Full Supply Depth (M)	Capacity (MCM)	Water Depth above Sluice (M)	Current Storage (MCM)	Dead Storage (MCM)	Effective Storage (MCM)	Spilling	Gate Opening
Ampara	Ambalan Oya	7.77	44.22	2.13	10.32	4.31	6.01	No	No
Ampara	Rambukkan Oya	11.7	56	9.76	45.80	3.08	42.72	No	No
Ampara	Senanayaka Samudraya	33.54	947.10	16.31	126.51	0.01	126.5	No	No
Ampara	Rottikulama	4.73	6.27	3.38	2.98	0.01	2.97	No	No
Ampara	Pannalgama	12.50	33.95	2.56	6.32	3.08	3.24	No	No
Ampara	Pallan Oya	16.77	114.39	6.19	21.76	2.77	18.99	No	No

103 river basins
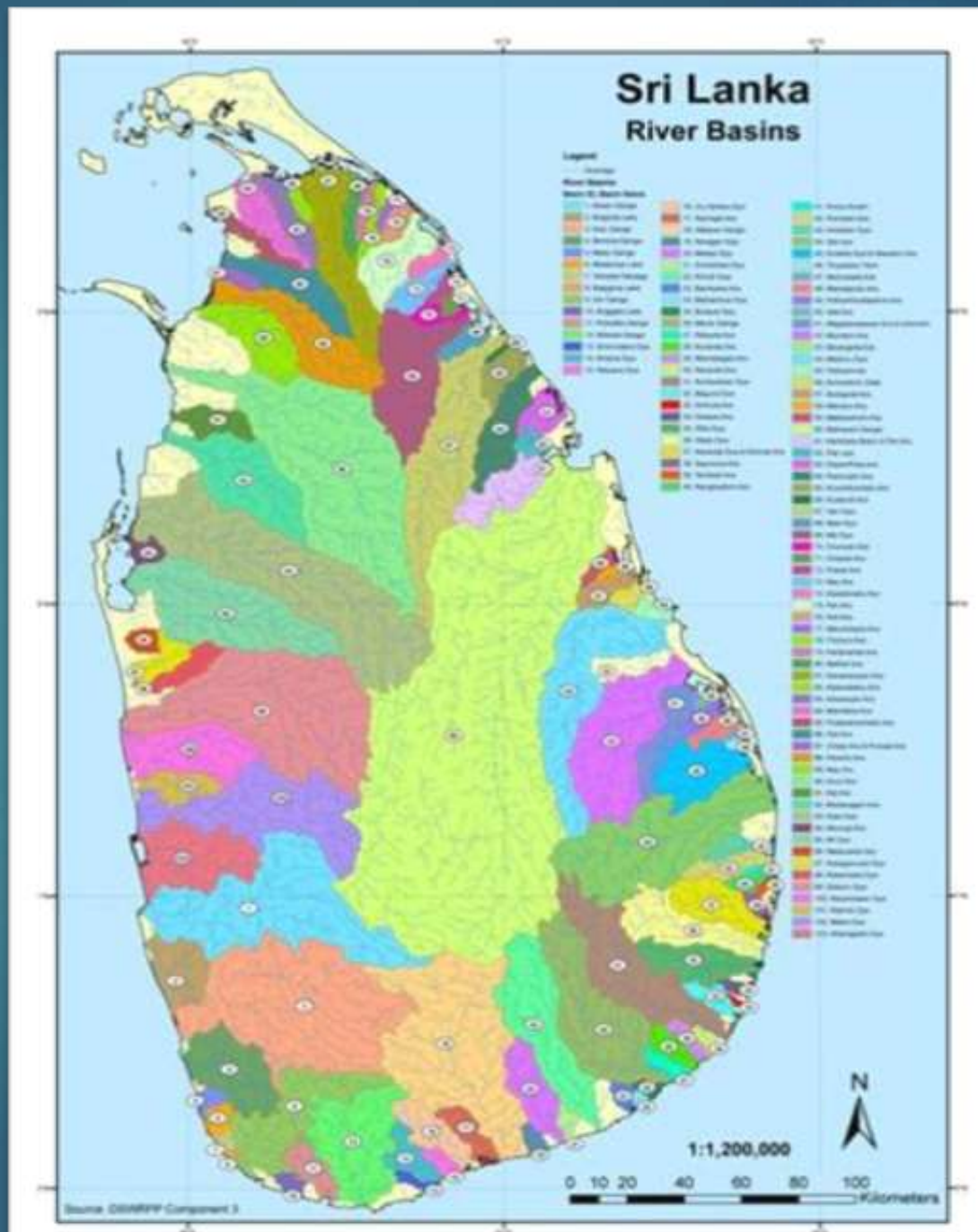
Hydro-meteorological Network

Station Type	Number of Stations	Interval of Record	Data Availability
Manual System	35	1 hour	Some of the stations were inundated.
Automated System	160	10 minute	Recently Installed

Station Distribution…

Irrigation Department

Mahaweli Authority

C. E. B.

Total   160

River Station with WL (Radar) Sensor

Reservoir Station with WL & Rainfall Sensors

Forecasting Methods

▶ Input Data : Observed rainfalls in the upper catchments and the discharges at upstream river gauging stations.

▶ Mathematical Models used

: MIKE 11,

HEC HMS,

Flood Routing Methods

Flood Levels have been classified for Rivers (Hydrometric Stations)

River Basin	Station Name	Flood Level Classification			
		Alert	Minor	Major	Danger
Kelani River	Nagalagam Street	1.22 m	1.52 m	2.13 m	2.74 m
	Hanwella	7 m MSL	8 m MSL	10 m MSL	11 m MSL
	Glencourse	15 m MSL	16.5 m MSL	19 m MSL	22 m MSL
Kalu River	Ratnapura	5 m	5.75 m	6.5 m	
	Ellegawa	2 m	3 m	5 m	
	Millakanda)	3 m	3.5 m	4.5 m	

Hydrometric Network (Kelani River)
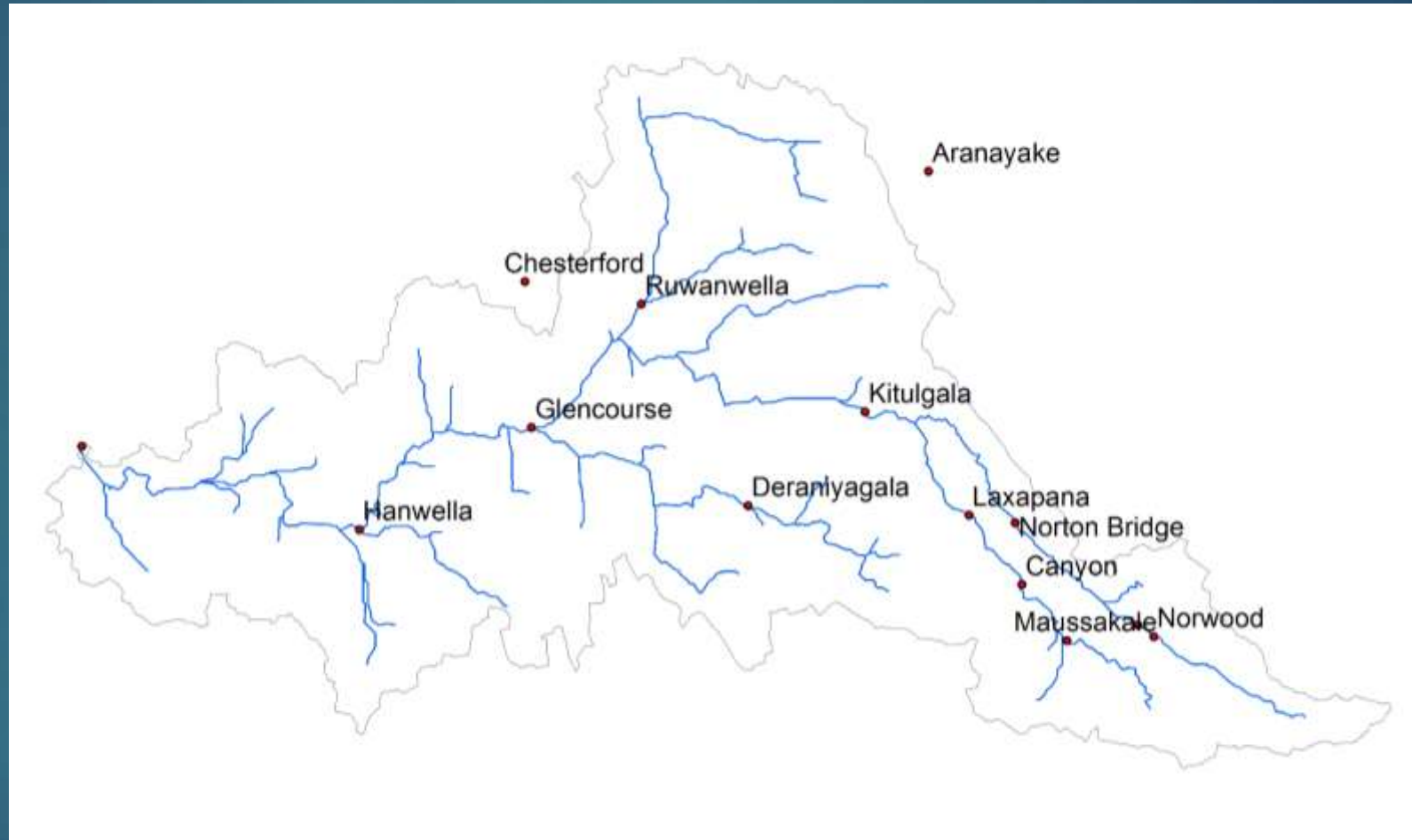
Kelani Basin Model with HEC HMS
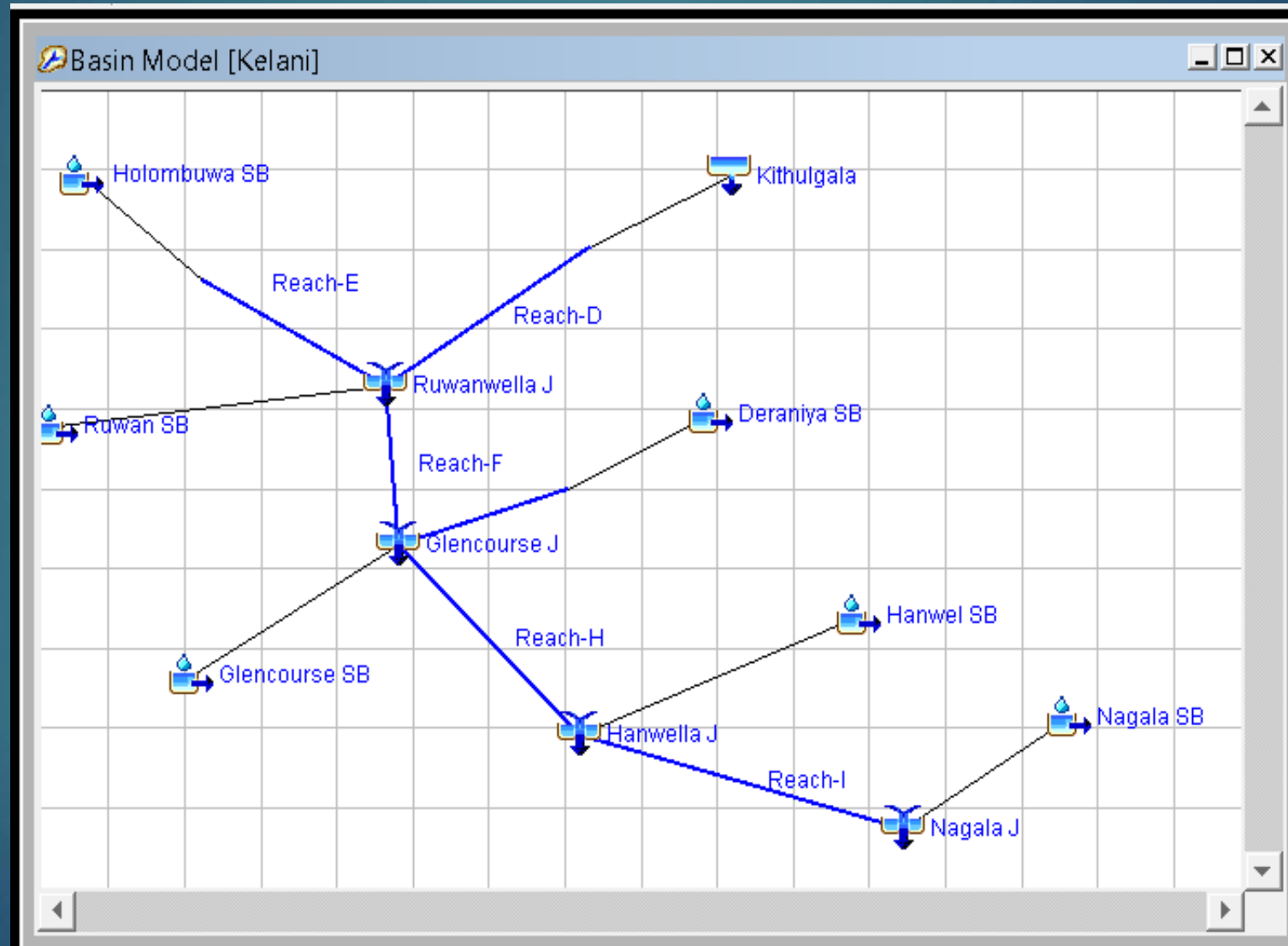
HMIS Rainfall Gauges in Kelani River Basin

Thiessen Weights to Represent Rainfall

| Components | Compute | Results |

| Gage Selections | Gage Weights |

Element Name: Glencourse SB

Gage Name	Depth Weight
Deraniyagala	0.475
Glencourse	0.42
Ruwanwella	0.105

Real Time Rainfall Data Input

Theory used in Hydrological Model

RUN OFF VOLUME/DIRECT RUN OFF - SCS CN/SCS UH

BASE FLOW – EXPONENTIAL RECESSION

FLOOD ROUTING - MUSKINGUM METHOD

OUTFLOW HYDROGRAPH
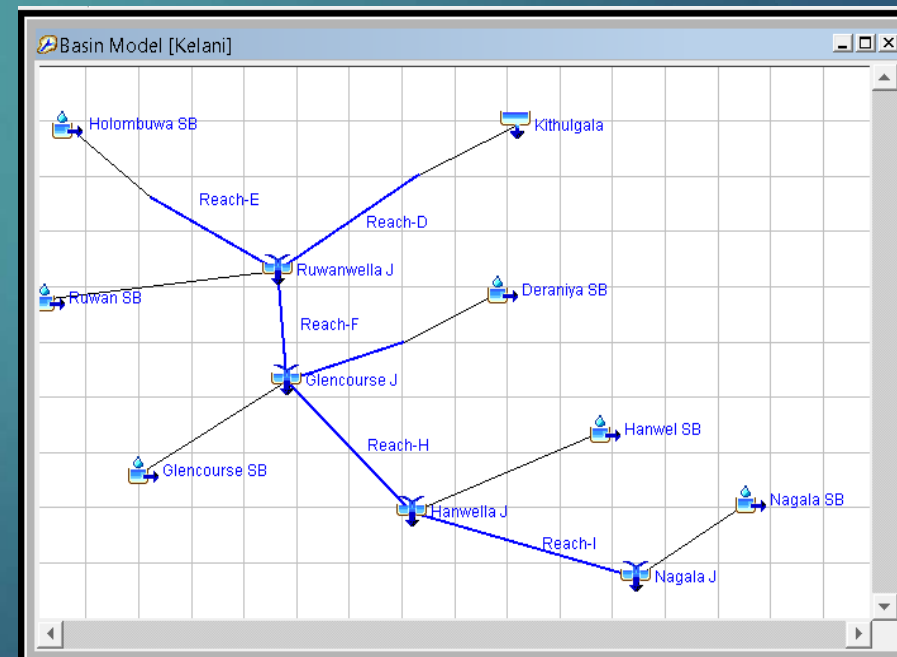
Model Calibration/
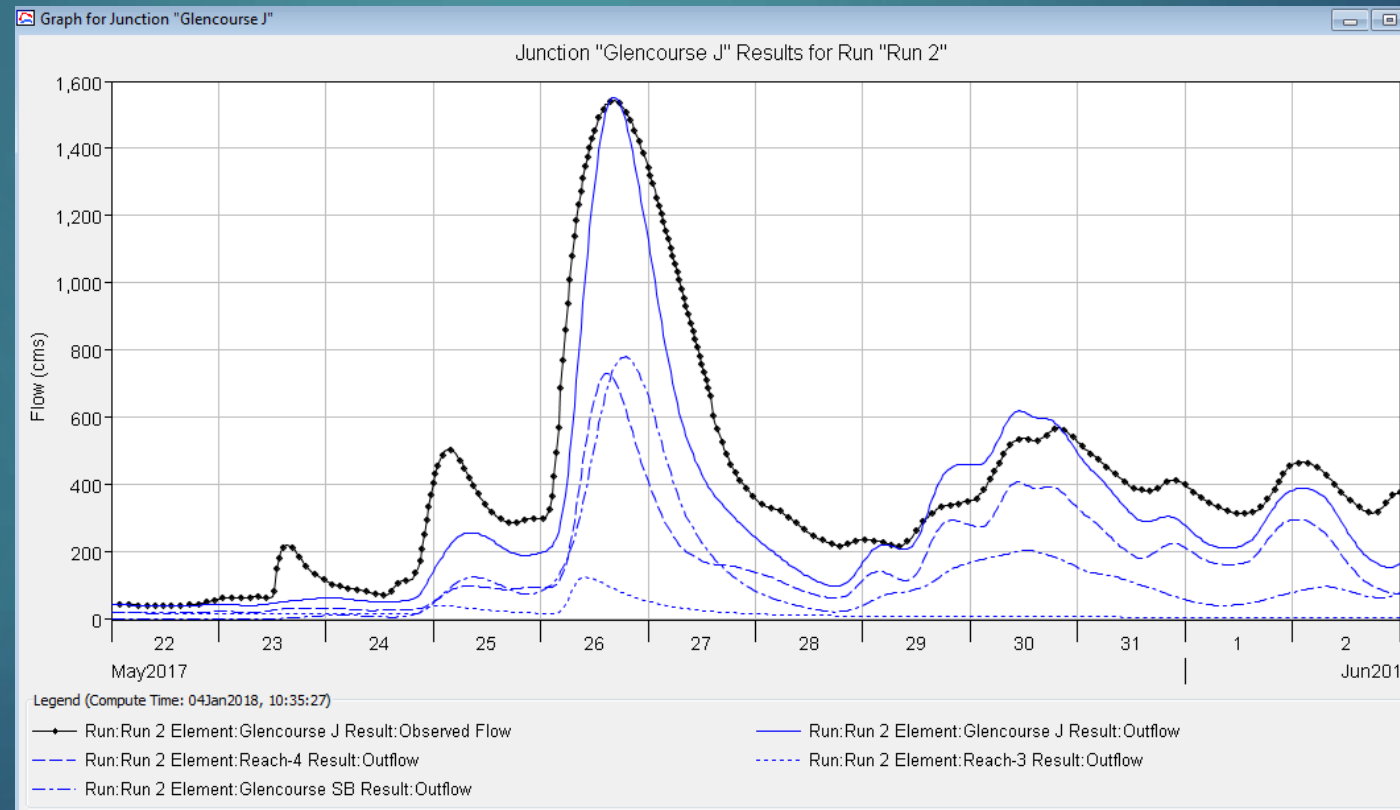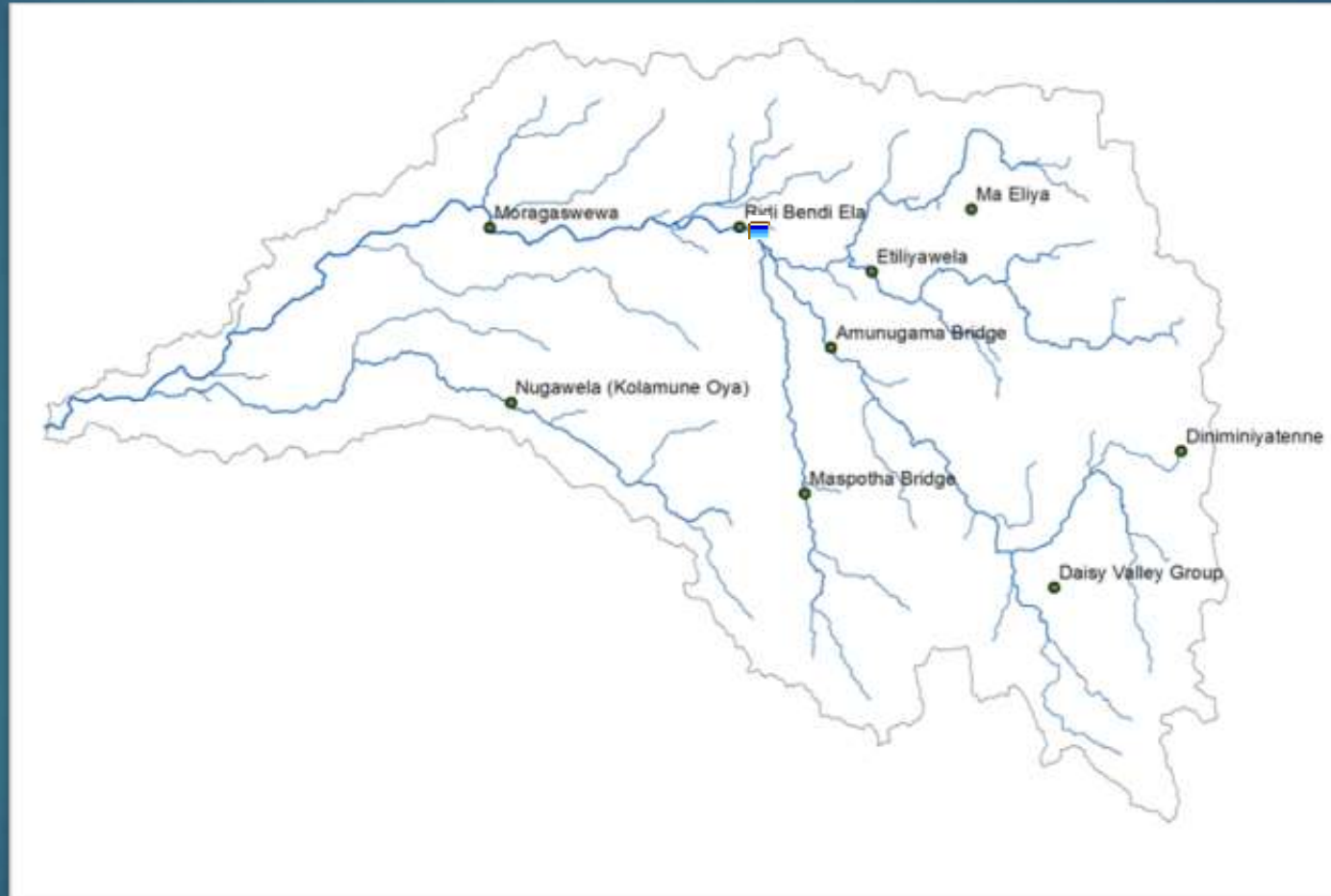## Observed and Simulated hydrographs (2008 Flood)

At Hanwella
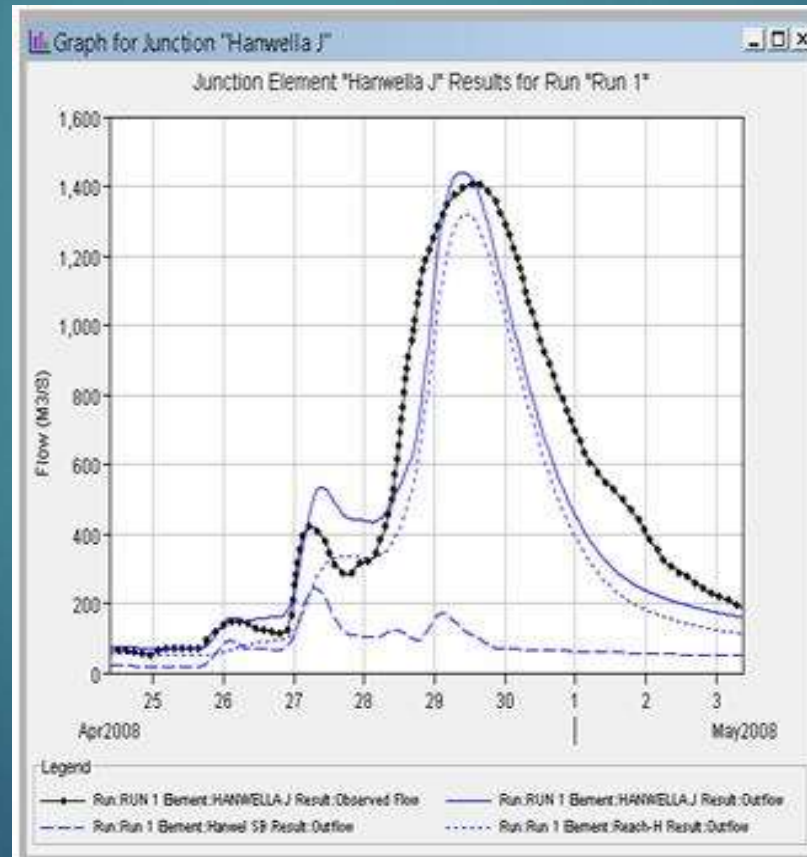
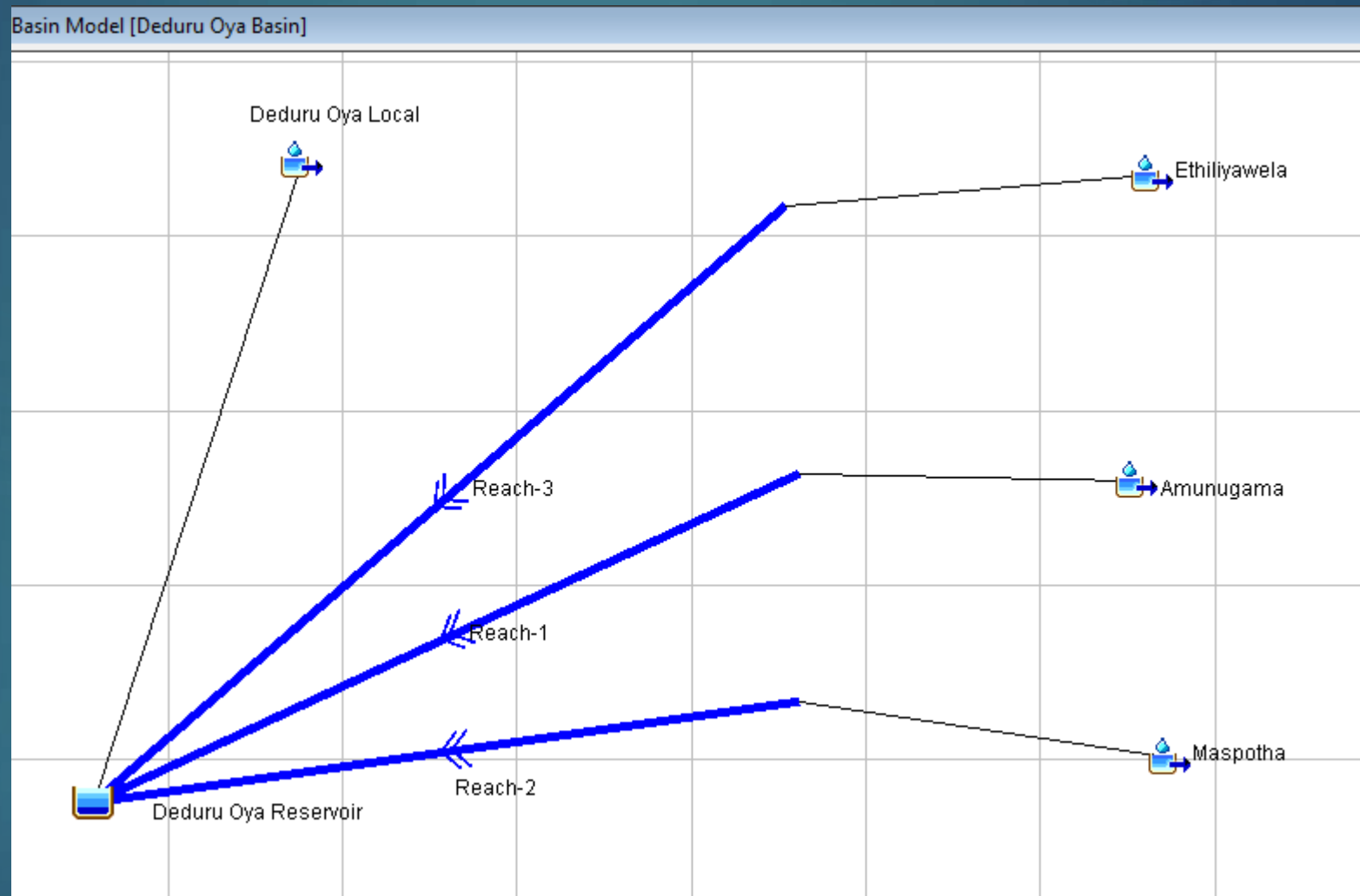# Used for Flood Forecasting - 2017 May
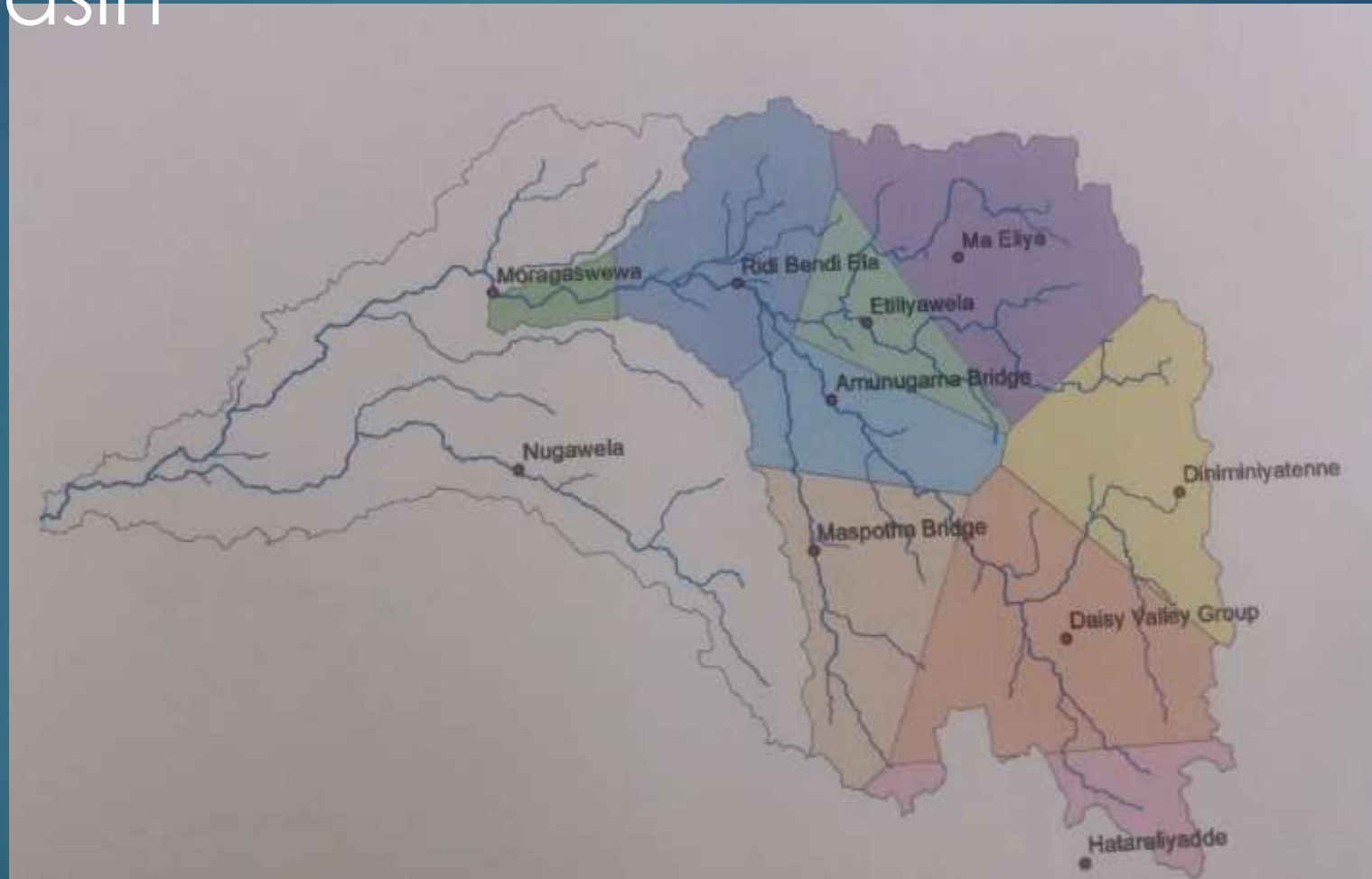
At Glencourse

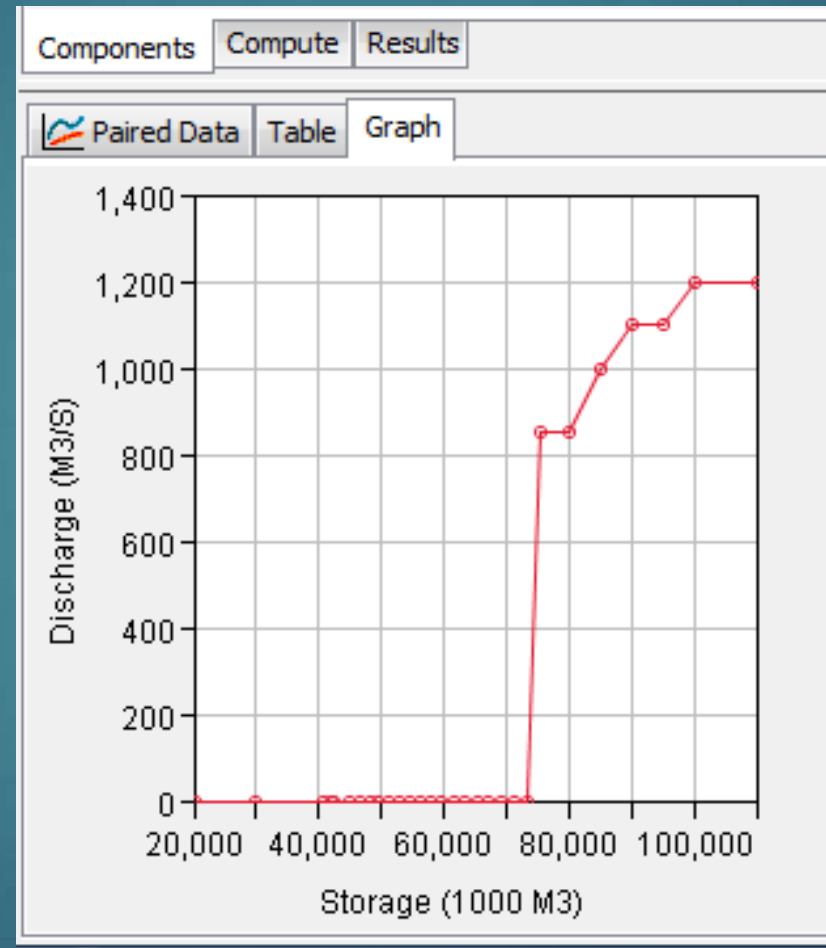# Flood Forecasting/ Reservoir Operation in Deduru Oya River

HEC HMS Model - Deduru Oya River

Rainfall Stations in Deduru Oya Basin

Reservoir Characteristics

Warning Methods

▶ Mainly through the Disaster Management Centre (Publish forecasting levels at gauging stations together with areas of having flood risk)

Warning Methods ctd….

- Directly to the people through the media (television and Radio)

- Issue the level of expected flood (minor, major or critical) with respective levels and the time duration.

- Do not expect evacuation people in cases of minor floods.

- Inundation maps, with respect to major floods and above, have been issued to all authorities including Disaster Management Centre. They will take actions accordingly.

# Flash Floods occur due to…

- Catchment Characteristics (small and steep).
- Rainfall Characteristics (intense rains)
- Sudden opening of spillways.
- Dam Breaches

Inundation Mapping

▶ After each critical flood event, Inundation Area Survey is conducted and prepare a map using Arc GIS to guide flood control authorities and public in future cases of flooding.

Inundation Maps for Kelani Ganga during the previous (2016) major flood
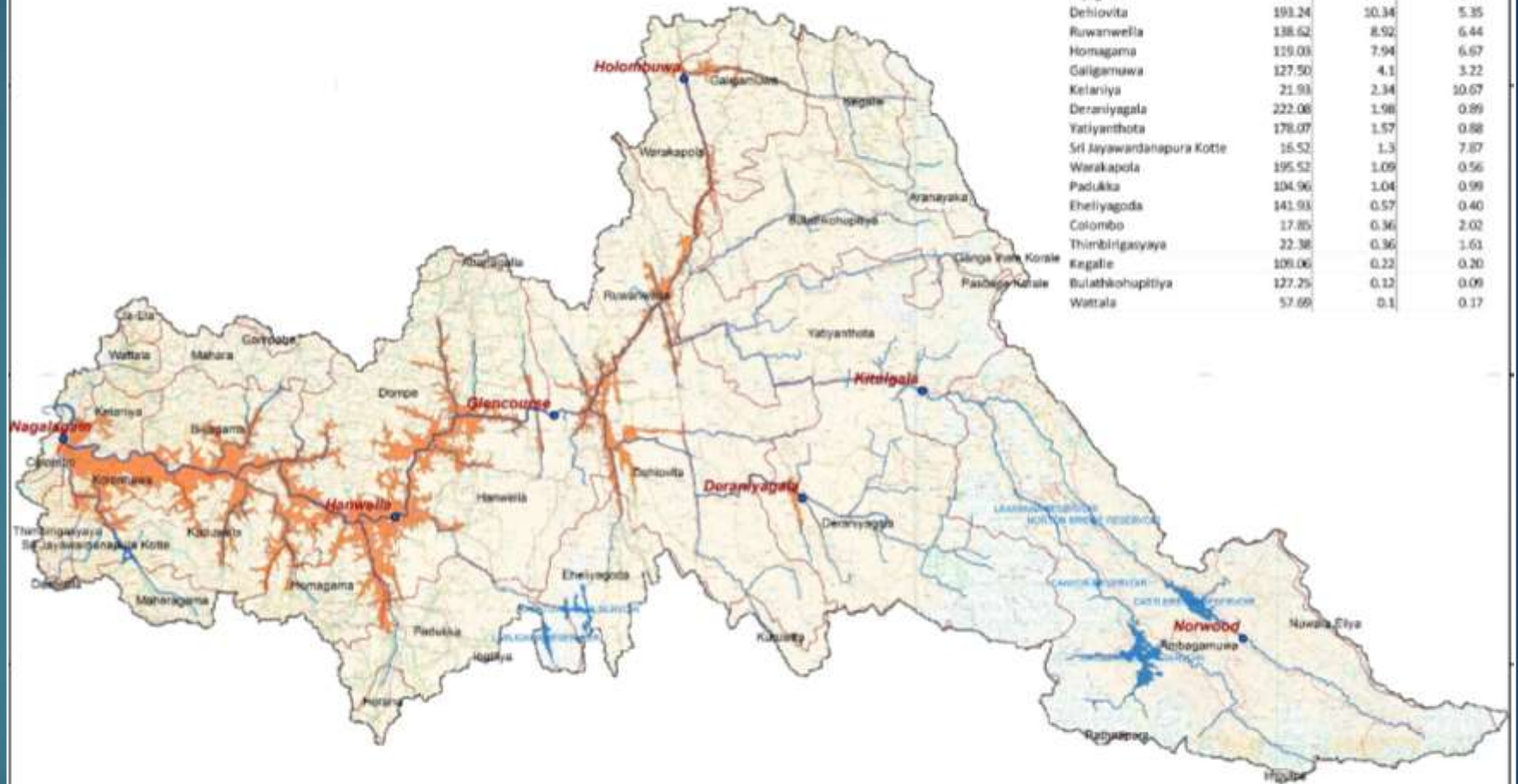
Divisional Secretariat Division	Total Area (Sq.km)	Inundated Area (Sq.km)	Percentage of Inundated Area (%)
Dompe	182.16	24.44	13.42
Hanwella	145.88	23.48	16.10
Kaduwela	87.75	22.65	25.81
Kolonnawa	26.04	16.53	63.48
Biyagama	60.27	11.17	18.53
Dehiovita	193.24	10.34	5.35
Ruwanwella	138.62	8.92	6.44
Homagama	119.03	7.94	6.67
Galigamuwa	127.50	4.1	3.22
Kelaniya	21.93	2.34	10.67
Deraniyagala	222.08	1.98	0.89
Yatiyanthota	178.07	1.57	0.88
Sri Jayawardanapura Kotte	16.52	1.3	7.87
Warakapola	195.52	1.09	0.56
Padukka	104.96	1.04	0.99
Eheliyagoda	141.93	0.57	0.40
Colombo	17.85	0.36	2.02
Thimbirigasyaya	22.38	0.36	1.61
Kegalle	109.06	0.22	0.20
Bulathkohupitiya	127.25	0.12	0.09
Wattala	57.69	0.1	0.17

Inundation Maps for Kalu Ganga in 2003 Flood
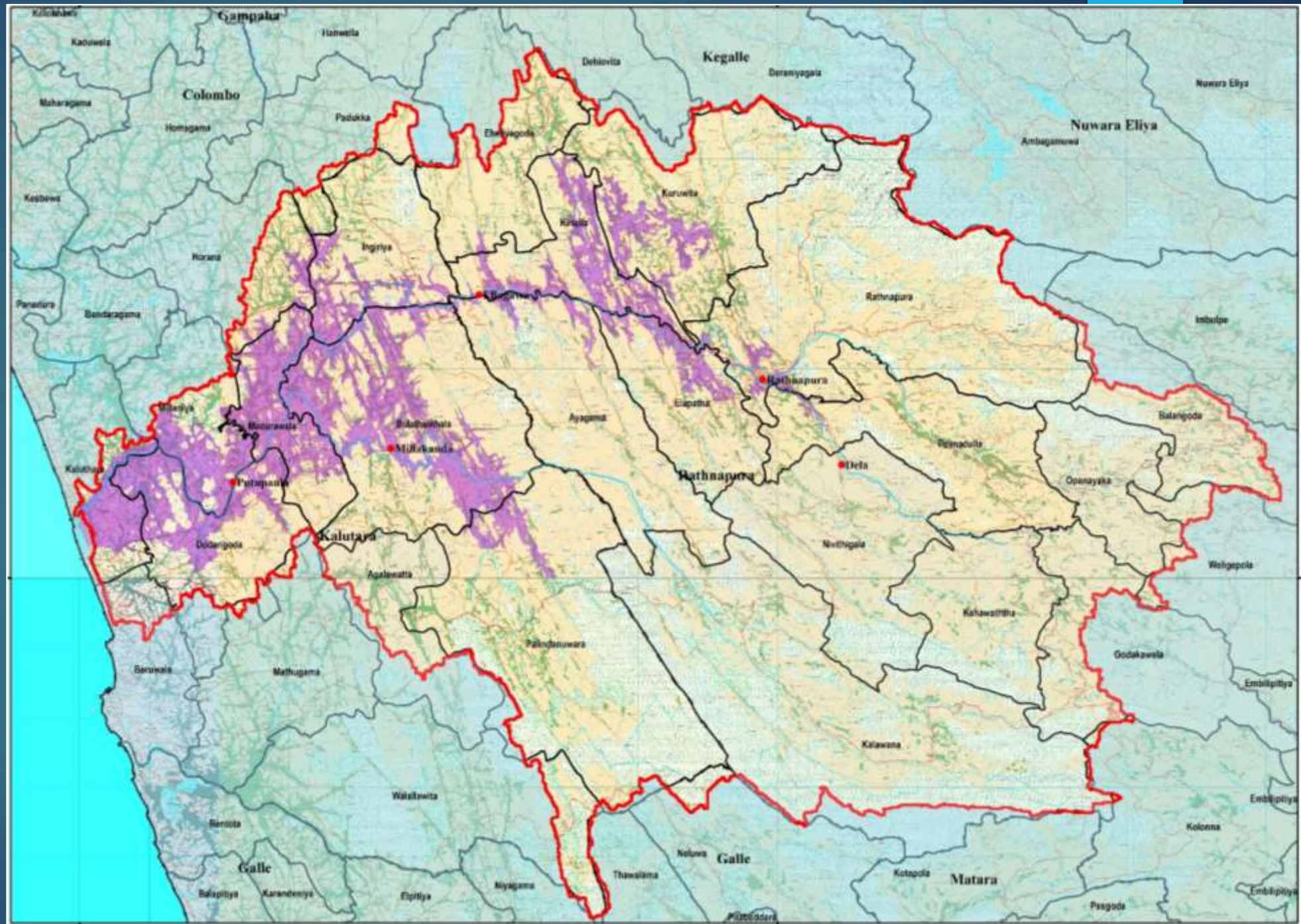
Conclusion

- Flash Flood Guidance will be extremely useful in improving current flood forecasting facilities for Sri Lanka.

- It will save the life of people and reduce the damages and loss of properties.

- Model performance should be further improved with gauged data and local experience.

- Catchment behavior is not only dependent on soil moisture and evaporation but also on reservoir status and the capacities of river channels.

- It is possible to provide all useful data currently available and collect the data, which are currently unavailable, in future.

Thank You !