



Overview of RIMES activities in South Asia

*Short Range Regional Early Warning System
SDMC, Gandhinagar, India
23 June, 2017*

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Hydrologist

Regional Integrated Multi-Hazard Early Warning Systems, Bangkok, Thailand

Presentation Outline



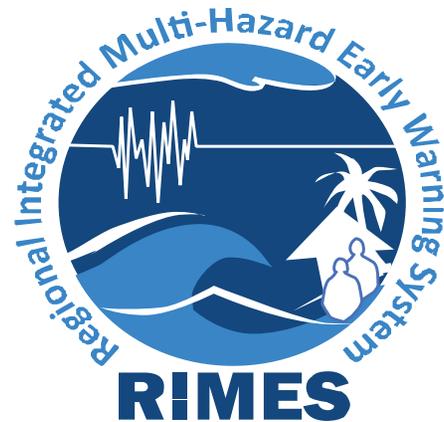
- RIMES Overview
- Key Services
- RIMES Operational Products
- Sector specific Decision Support Systems
- Evaluation of products and application
- Other major activities

About RIMES

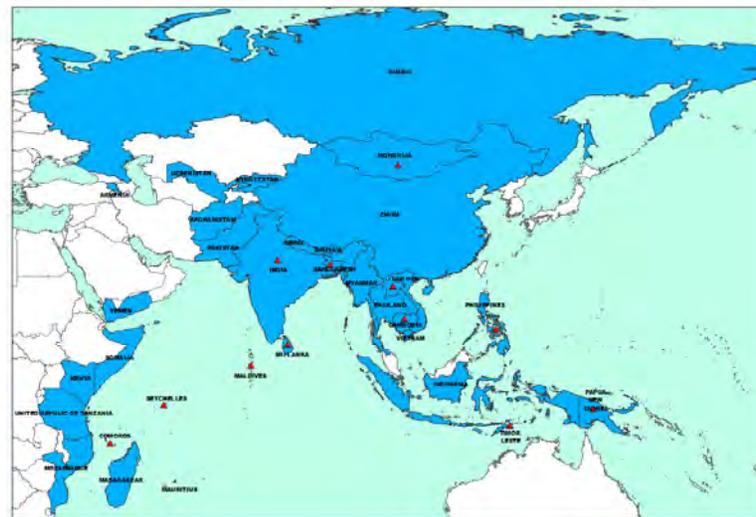
Regional: 33 Member and Collaborating States in Asia and Africa

Integrated: links science with generators and users of early warning information

Multi-hazard: started with tsunami and earthquake, and expanded to include hydro-meteorological hazards



Early warning: with mandate to provide early warning services for enhanced preparedness for, responses to, and mitigation of natural hazards



System: consists of regional technical support unit, connected to national and local systems



About RIMES

- ✧ Established on 30 April 2009
- ✧ Intergovernmental, owned and managed by Member States
- ✧ Registered with the United Nations under Article 102 of UN Charter
- ✧ ESCAP support for RIMES institutional development





RIMES Objectives

- ✧ Facilitate the establishment and maintenance of core regional observation and monitoring networks
- ✧ Provide tsunami warning services in collaboration with India RTSP (INCOIS) under UNESCO/IOC framework
- ✧ Support NMHSs for providing localized hydro-meteorological risk information, in collaboration with ECMWF and NCMRWF, within WMO framework
- ✧ Enhance warning response capacities



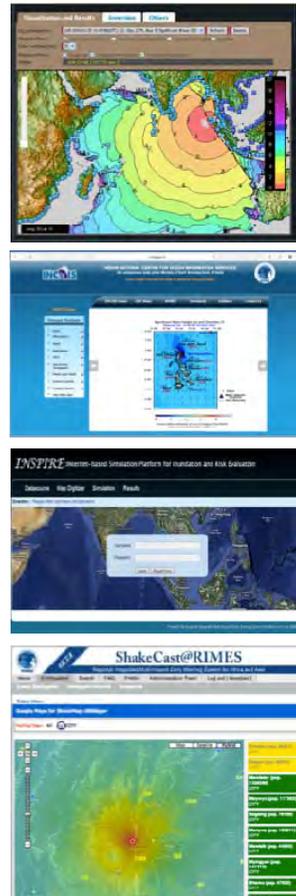
Key services



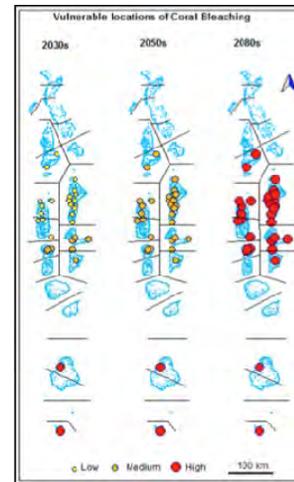
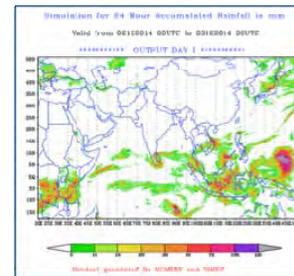
Key Services

Earthquake and tsunami services

Improving data availability



Hydro-met Services

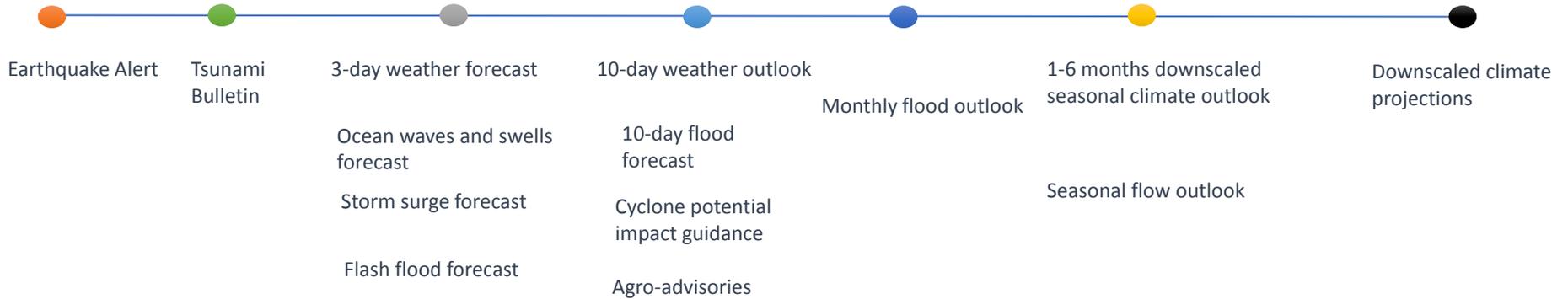


Capacity building





Information Products and Key Partners



IRIS INCOIS	UNESCO/IOC INCOIS	NCAR NCMRWF INCOIS Danida	ECMWF	ECMWF	ECMWF	IPRC IITM-CORDEX-SA NEX-NASA
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ESCAP

ESCAP

MOES Gov of India

ESCAP
USAID
ESCAP
MOES Gov of India

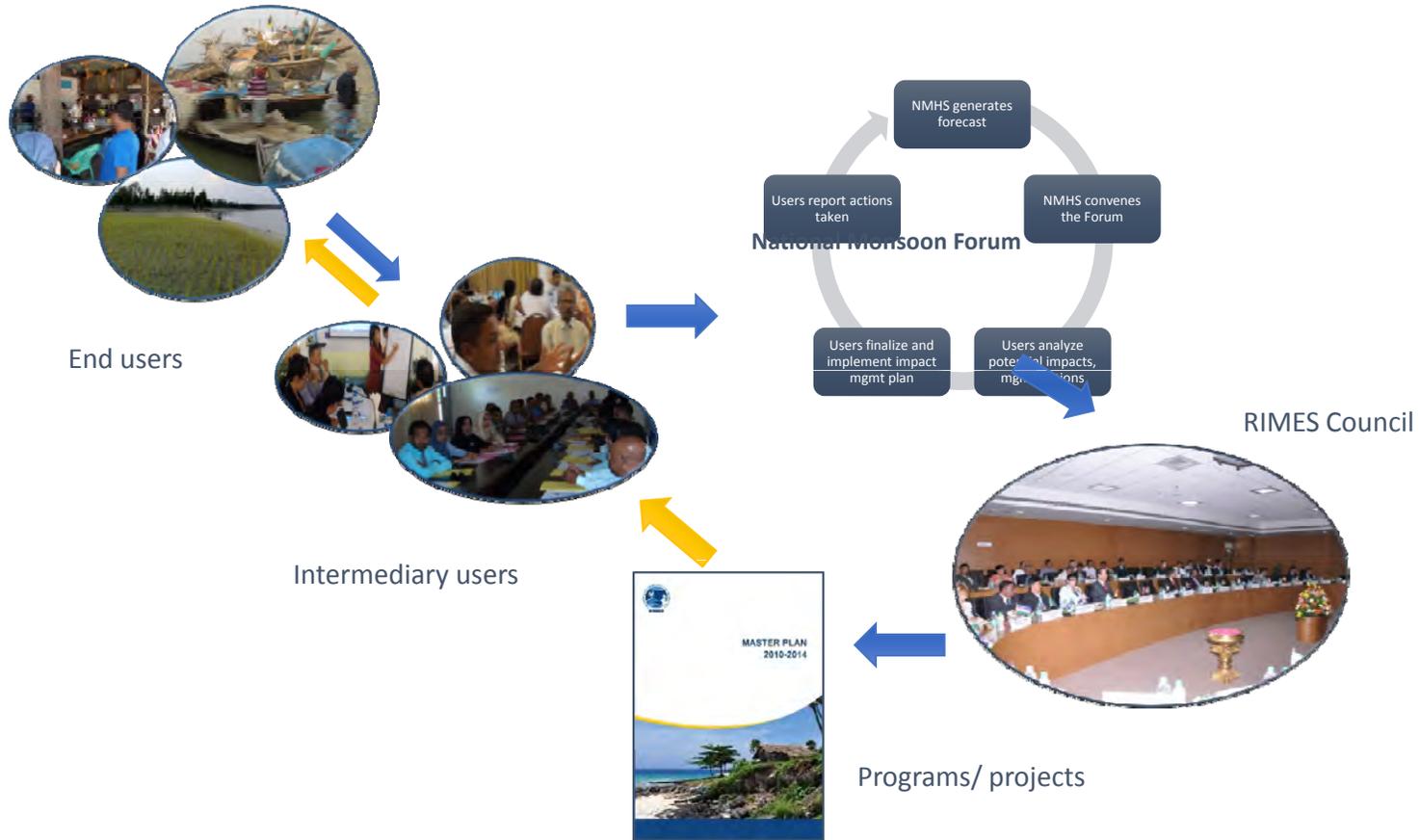
USAID
MOES Gov of India

ESCAP

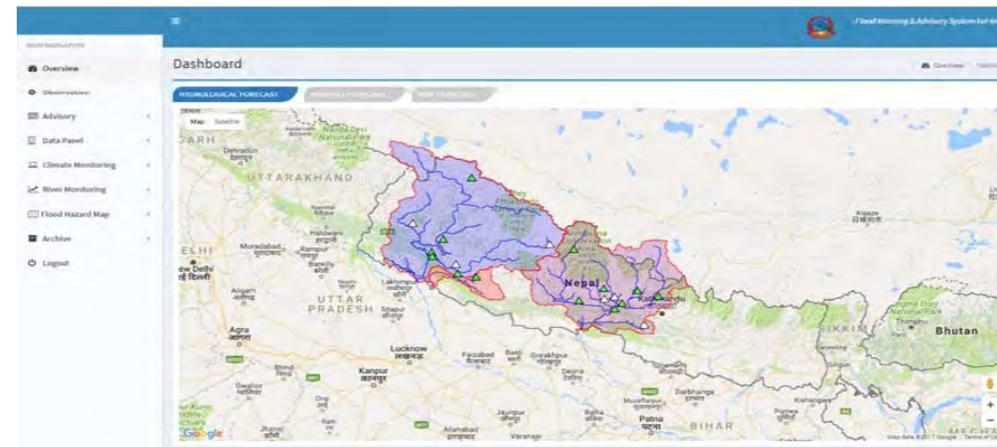
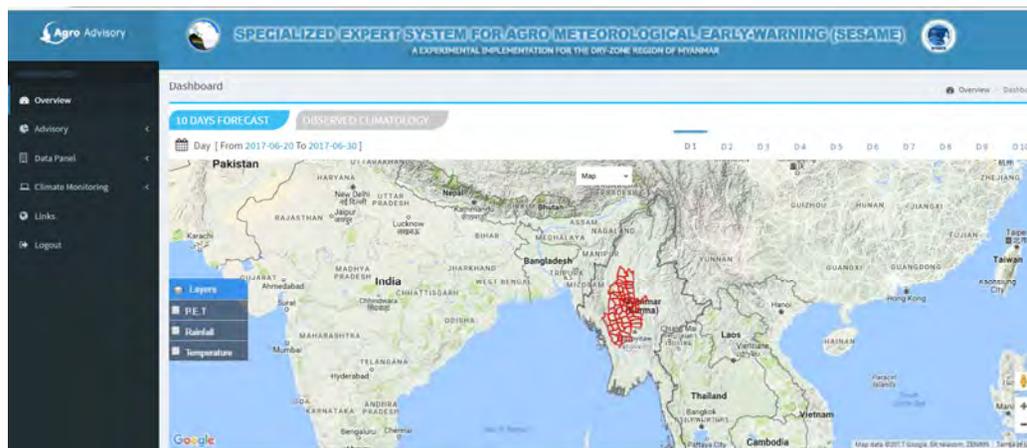
ESCAP



Member State Demand Management



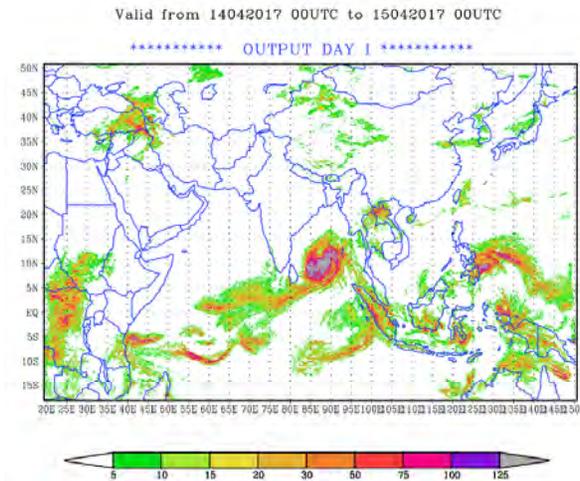
RIMES Operational Products



Weather and Climate Forecasts

Short range Forecast 3-days lead

- Daily weather forecast products
 - Rainfall, temperature, Seal Level Pressure, Wind Speed and Direction
- Severe weather warnings
 - Heavy rainfall events
 - Storm Tracks and intensity
- Delivered to 18 countries daily



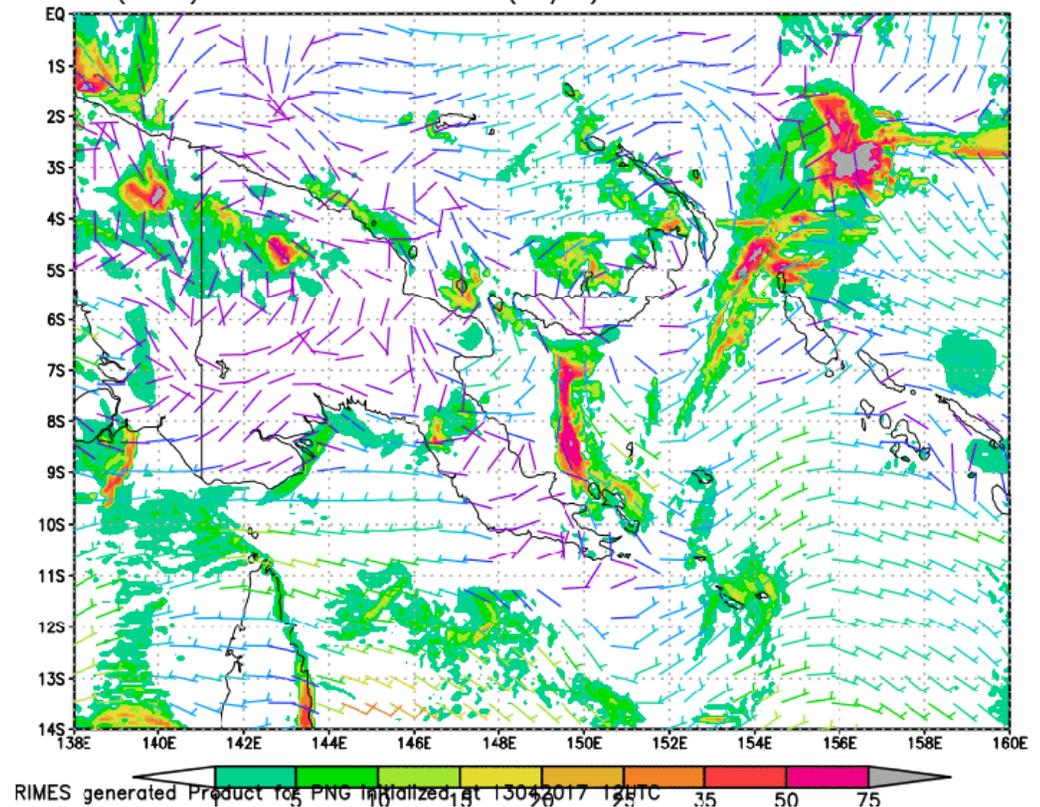
1. **Afghanistan**
2. **Bangladesh**
3. **Bhutan**
4. Cambodia
5. Comoros
6. East Timor
7. Lao PDR
8. **Myanmar**
9. **Maldives**
10. **Nepal**
11. Philippines
12. **Pakistan**
13. PNG
14. **Sri Lanka**
15. Yemen
16. Somaliland
17. Seychelles
18. Tanzania



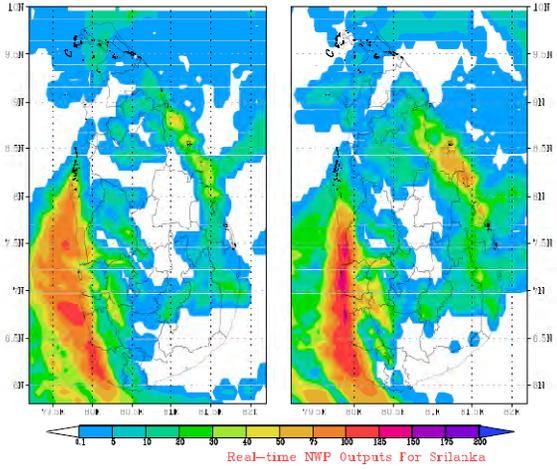
Medium Range Forecast 10-days lead

- High resolution 9km model downscaled using WRF
- 12 hourly accumulated rainfall and wind speed and direction
- Updated daily for next 10 days
- Operational for Tamil Nadu, Sri Lanka, Myanmar, Nepal and Pakistan in South Asia

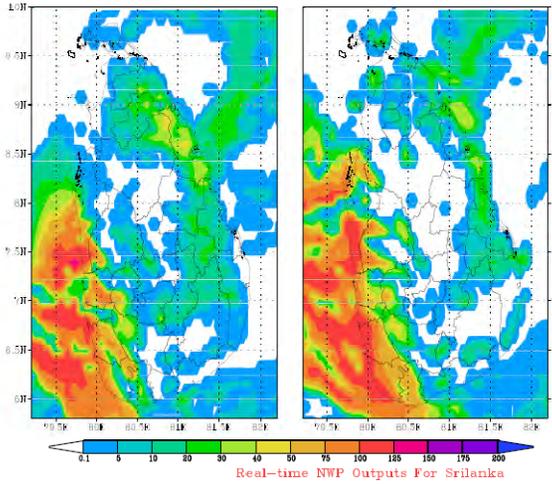
Rainfall(mm) and surface wind(m/s) valid at Wed 12Z12APR2017



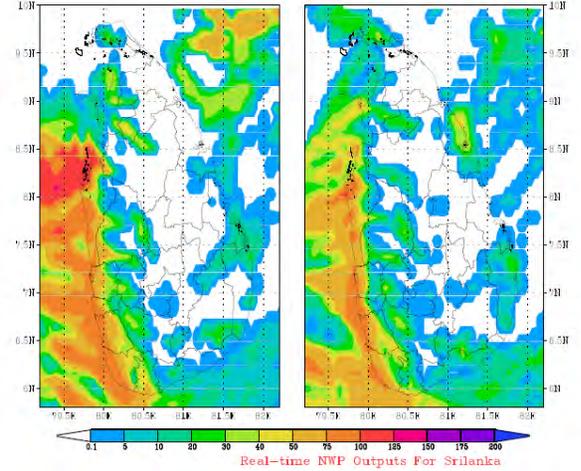
16082014 00UTC to 17082014 00UTC 17082014 12UTC to 18082014 00UTC
- DAY 1 - - DAY 2 -



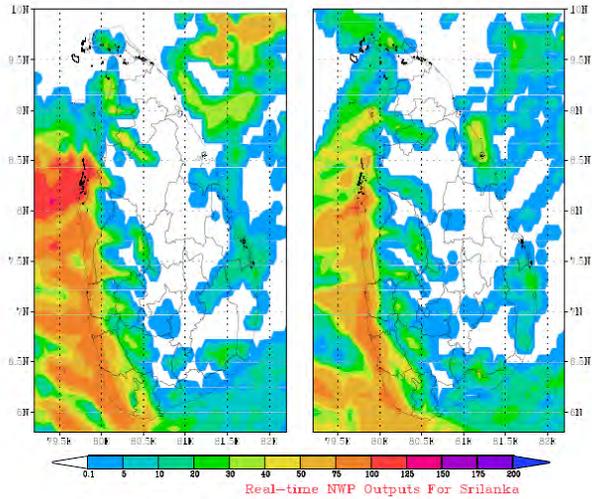
18082014 00UTC to 19082014 00UTC 19082014 12UTC to 20082014 00UTC
- DAY 3 - - DAY 4 -



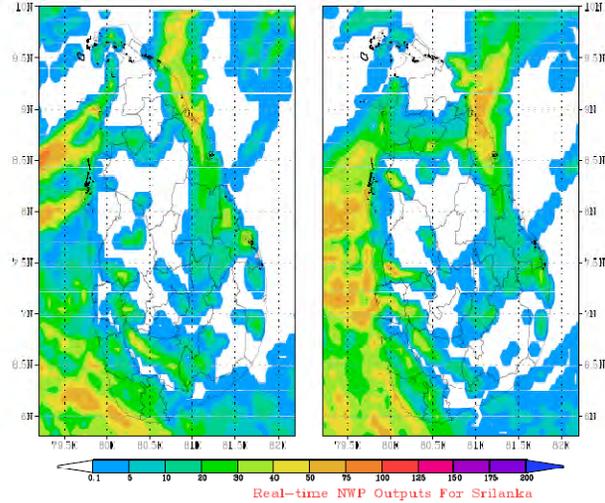
20082014 00UTC to 21082014 00UTC 21082014 12UTC to 22082014 00UTC
- DAY 5 - - DAY 6 -



20082014 00UTC to 21082014 00UTC 21082014 12UTC to 22082014 00UTC
- DAY 5 - - DAY 6 -



24082014 00UTC to 25082014 00UTC 25082014 12UTC to 26082014 00UTC
- DAY 9 - - DAY 10 -

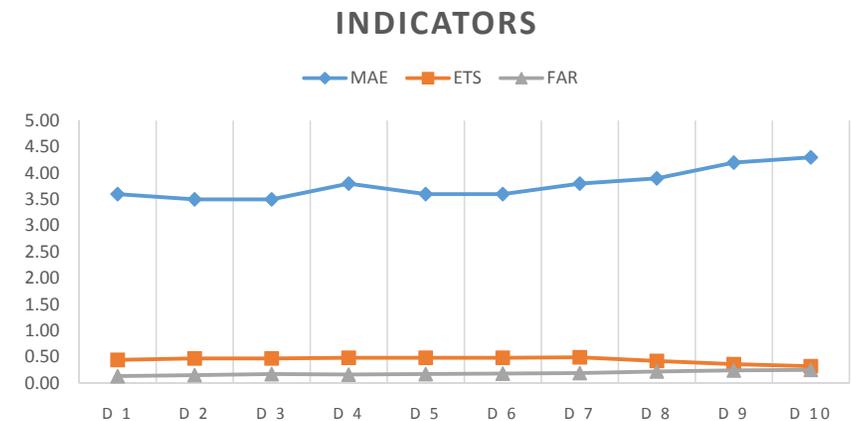
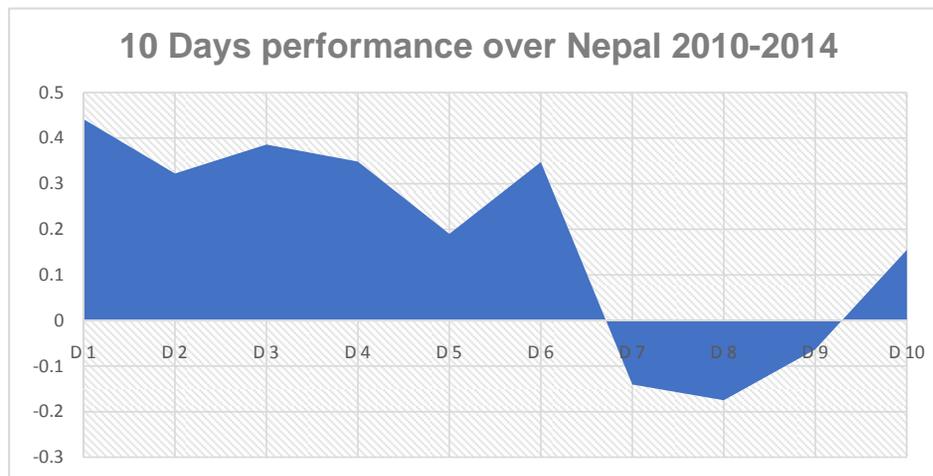
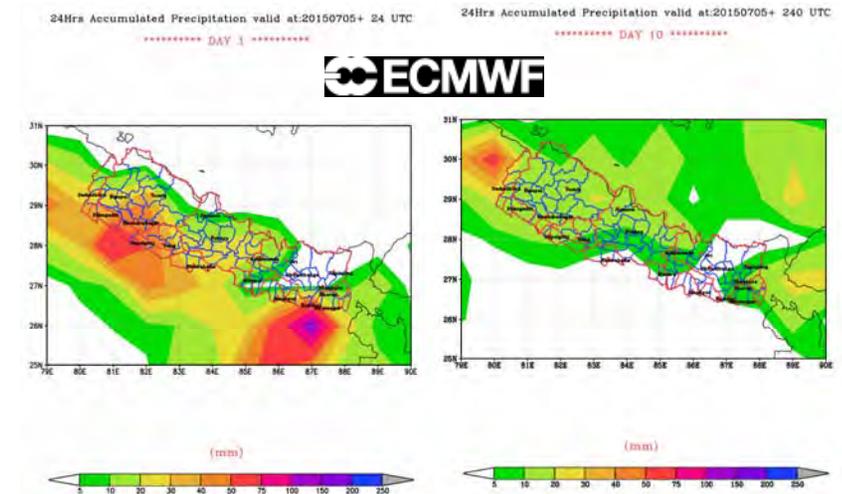


Sri Lanka



Medium Range Forecast

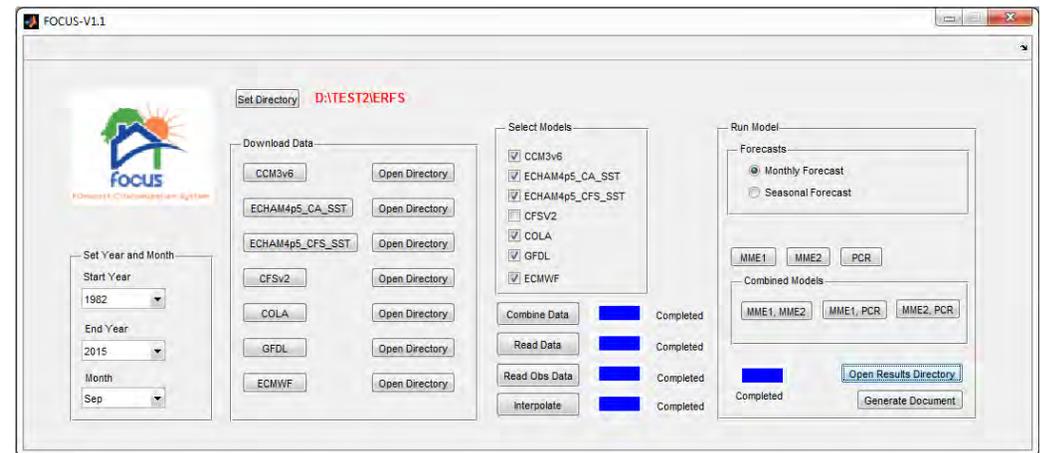
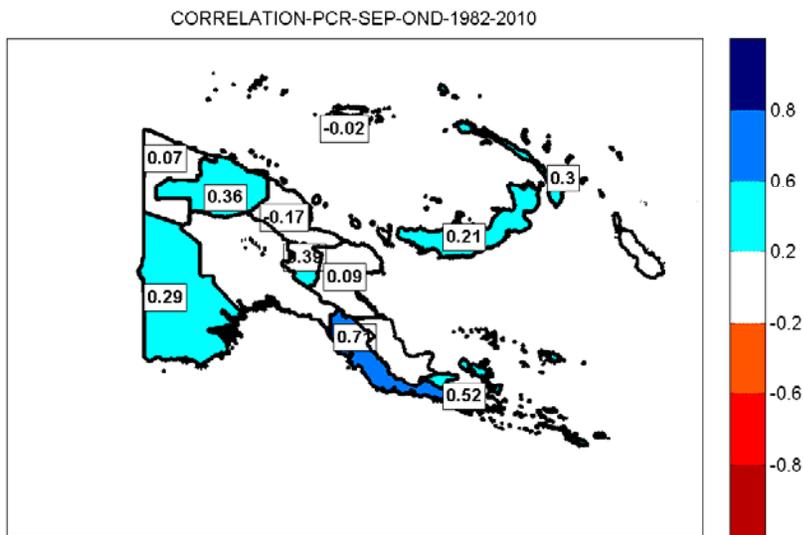
- Deterministic rainfall forecast for 10 days
- Customized from ECMWF data for Tamil Nadu, Afghanistan, Nepal, Sri Lanka





Long Range weather outlooks

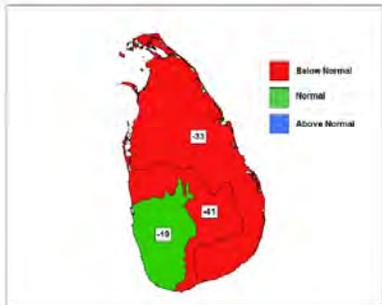
- Model customized for selected countries based on a number of Global models
- User interface developed for easy of use by climatologist



- Outlook provided at province level with one month and three month lead time

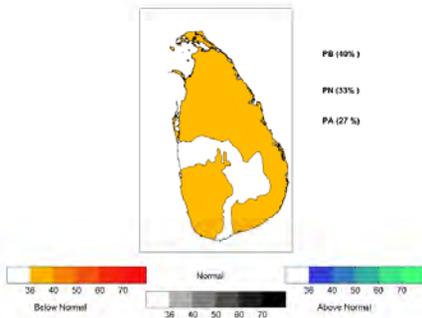
Sri Lanka

Deterministic Precipitation Forecast
for
March 2015 (lead-1) February start



The forecast over Sri Lanka for the month of March is expected to be in the **Below normal category**. The forecast for individual zones fall in the **Below normal category for Dry Zone and Intermediate Zone, normal category for the Wet Zone**.

Probabilistic Precipitation Forecast
for
March 2015 (lead-1) February start

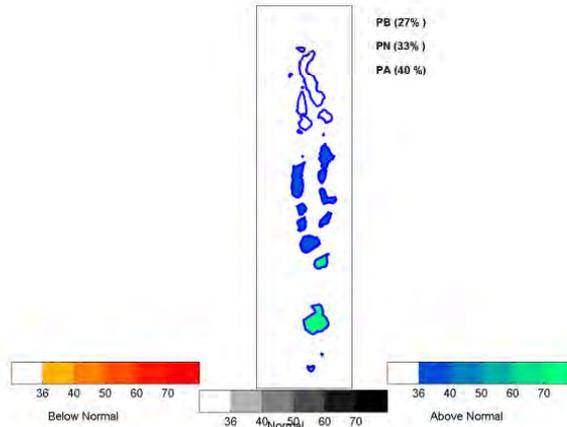


The probabilistic forecast for the month of March 2015 for SRI LANKA signals more chance of **Below normal precipitation over the dry and wet Zones**. There is no clear signal for precipitation over the intermediate zone.

Maldives

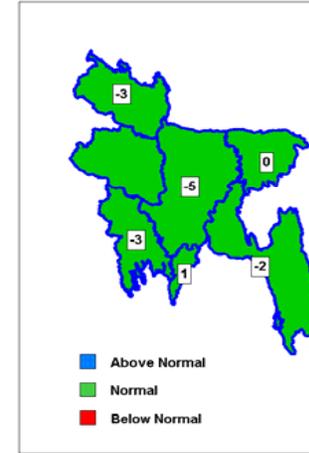


PB (27%)
PN (33%)
PA (40%)

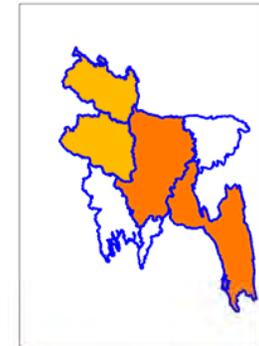


Bangladesh

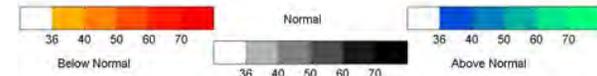
% DEPARTURE-COMB-MAR-AMJ-2015-135



PROBABILISTIC-FORECAST-MAR-AMJ-2015-135



PB (33%)
PN (34%)
PA (33%)



Flood Advisory Systems



RIMES Flood Advisory Systems

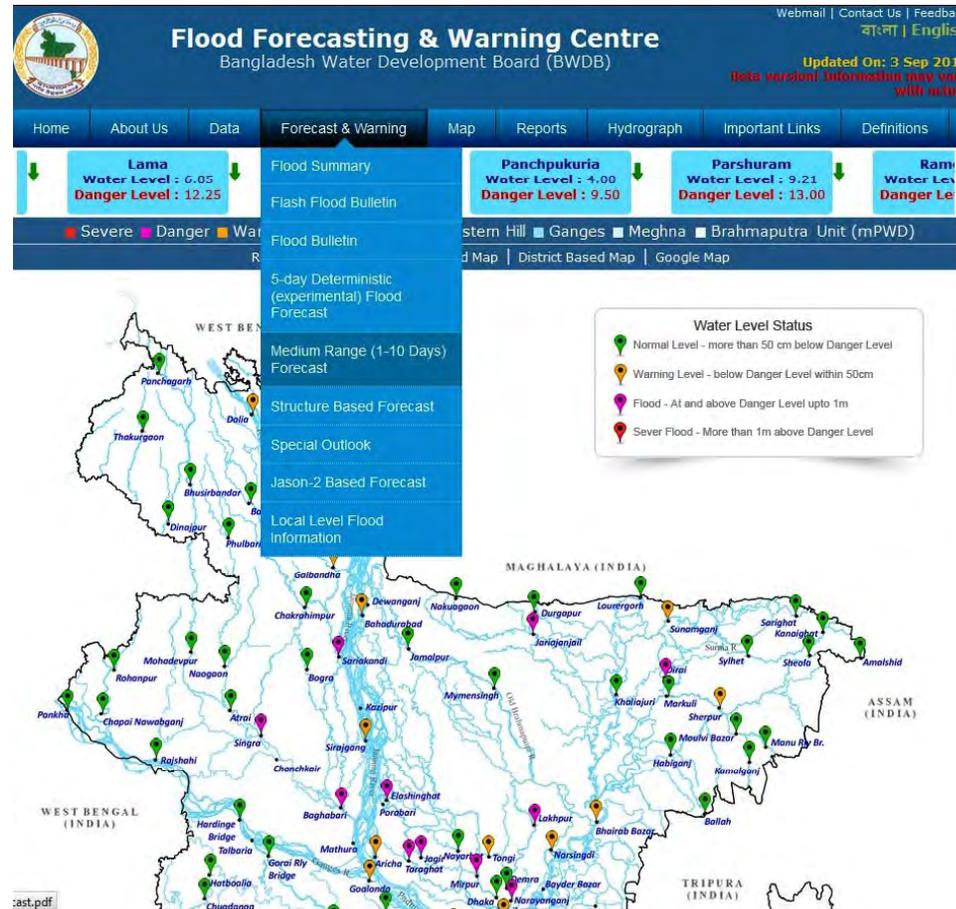
RIMES support member countries to develop and enhance:

- Medium range (1-10 days) flood forecast
- Flash Flood Guidance System
- Long range (1-3 month) hydrological outlook



10-Days Flood Forecast System

uses ECMWF EPS rainfall forecast, CFAB-FFS model and MIKE11 model





Flash Flood Warning and advisory System

- 1) Based on 3 days downscaled WRF Forecast
- 2) 10 Days Deterministic ECMWF forecast
- 3) Threshold based approach

Climate Advisory

Name: P.H. Jharkar
 Email: jharkar@imr.gov.bd
 Phone: 00217464222
 Station: 144

Weather Metadata
 Rainfall: mm
 Temperature Min: °C
 Temperature Max: °C
 Source: Bangladesh Meteorological Department

Advisory
 No Flash Flood on 27-08-2014 to 29-08-2014 based on ECMWF Forecast.
 No Flash Flood on 29-08-2014 to 31-08-2014 based on WRF Forecast.

Send Email Send SMS Update Information

Bangladesh Flash Flood Advisory

Select Rainfall Type: over 3 days forecast | Select Stations: 144 | Date of Forecast: 18 August 2014

Accumulated RainFall (in mm)
 Forecast Length in Hours: 20140817:12+72 Hours.

Duration (hr)	18-08-2014	19-08-2014	20-08-2014
18	10	11.01	12.02
48	34	35.04	36.07
72	58	60.12	62.14
144	76	77.51	79.03
240	94	95.51	97.03
Advisory	101	102	103

Flash Flood Advisory
 Flash Flood Warning on 19-08-2014 to 20-08-2014

Flash Flood Alert
 No Flash Flood on 18-08-2014

Create Advisory



Seasonal Flow Outlook

- uses ECMWF seasonal ensemble (41) forecast of rainfall and temperature for the Ganges and Brahmaputra basins and lumped conceptual rainfall-runoff model
- ARIMA error correction applied for model output

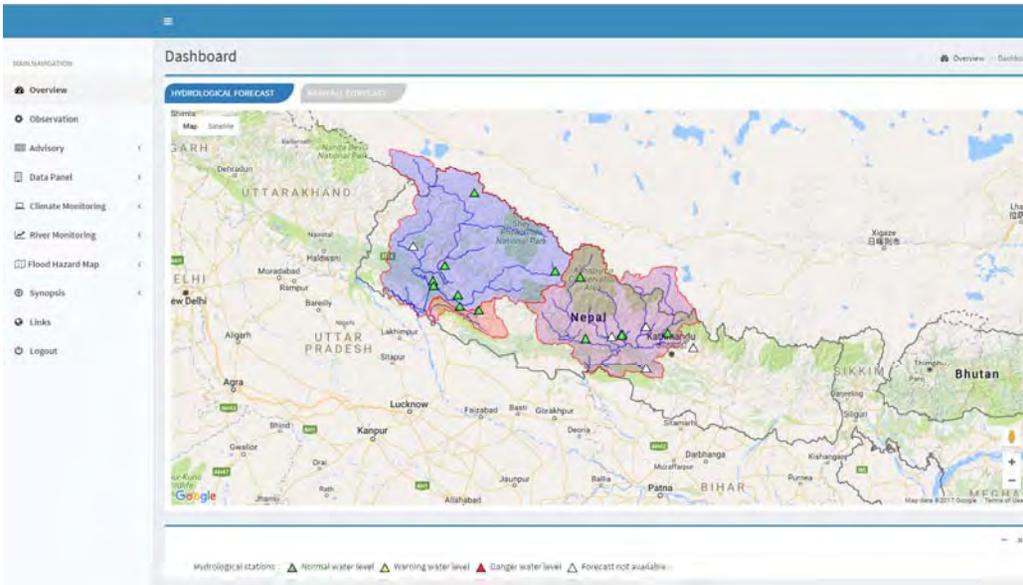




Nepal Flood Advisory System

http://203.159.16.215/nepal_flood/index.php/home

Dashboard



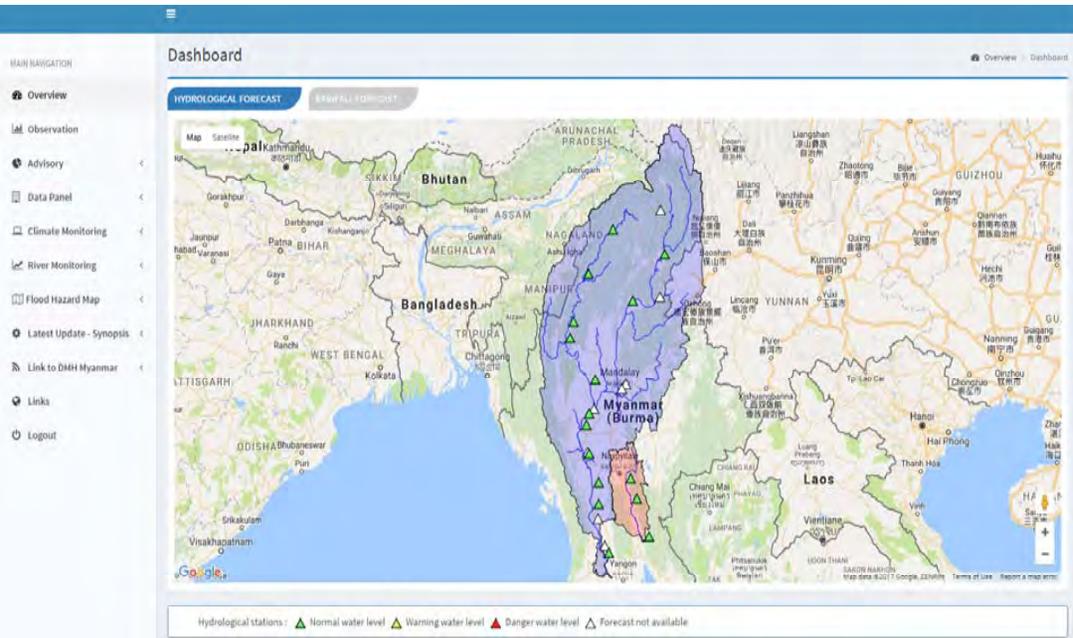
Hydrological stations : ▲ Normal gage height ▲ Warning gage height ▲ Danger gage height ▲ Forecast not available

Information							
Day [From 31-Mar-2017 To 02-Apr-2017]							
Station	Day 1	Day 2	Day 3	Estimated Discharge Q (m ³ /s)	Estimated Gage Height H (m)	Warning Gage Height (H)	Danger Gage Height (H)
Botrawoti	▲ Below Warning Level	▲	▲	55.00	1.18	4.50	4.90
Devghat	▲ Below Warning Level	▲	▲	249.00	0.95	7.70	8.70
Jomsom	▲ Below Warning Level	▲	▲	11.00	1.18	4.10	5.10
Kumalgauin	▲ Below Warning Level	▲	▲	77.00	1.17	7.80	8.80
Asaraghat	▲ Below Warning Level	▲	▲	427.00	2.23	6.10	6.50
Chisapani	▲ Below Warning Level	▲	▲	482.00	3.60	11.90	12.90
Samajjighat	▲ Below Warning Level	▲	▲	41.00	1.35	7.30	7.80
Jumlakarnali	▲ Below Warning Level	▲	▲	398.00	2.91	4.60	5.60
Thulabheri	▲ Below Warning Level	▲	▲	41.00	1.37	5.80	6.80
Bheri	▲ Below Warning Level	▲	▲	482.00	3.34	5.50	6.50
Chepanang	▲ Below Warning Level	▲	▲	15.00	1.07	5.50	6.10
Daredhunga	▲ Below Warning Level	▲	▲	1.00	0.68	5.50	6.10



Myanmar Flood Advisory System

http://203.159.16.215/myanmar_flood/index.php/home



Hydrological Stations: ▲ Normal water level ▲ Warning water level ▲ Danger water level ▲ Forecast not available

Information

Ayeyarwady Basin Sittoung Basin

Day [From 31-Mar-2017 To 02-Apr-2017]

Hydrology Station	Status	Forecasted Flow (Q m ³ /s)	Forecasted Water Level (H m)	Warning Water Level (H m)	Danger Water Level (H m)
Hkamh	▲	52.00	1.47	13.60	13.60
Homalin	▲	52.00	18.56	28.00	28.00
Mawlaik	▲	99.00	0.28	11.30	12.30
Kalewa	▲	158.00	0.63	14.50	15.50
Manywa	▲	201.00	0.50	9.00	10.00
Myitkyna	▲	1942.00	2.26	11.00	12.00
Kotha	▲	2040.00	3.04	9.40	10.40
Nyaung Oe	▲	2480.00	0.82	20.20	21.20
Chauk	▲	2480.00	4.82	13.50	14.50
Mogway	▲	2483.00	4.23	16.00	17.00
Aunglan	▲	2484.00	13.45	24.50	25.50
Plyay	▲	2485.00	17.59	28.00	29.00
Zalam	▲	2487.00	1.74	10.60	11.60



Capacity building and Feedback mechanism

- 1) Continuous engagement
 - 1) with technical team with series of training
 - 2) Technology transferred
 - 3) Backup support to all activities irrespective of project period
- 2) Feedback on the model performance



Agro Advisory Systems

SESAME – Specialized Expert System for Agro-Meteorological Early Warning for Climate Resilient Agriculture

- Forecast Component of different lead time

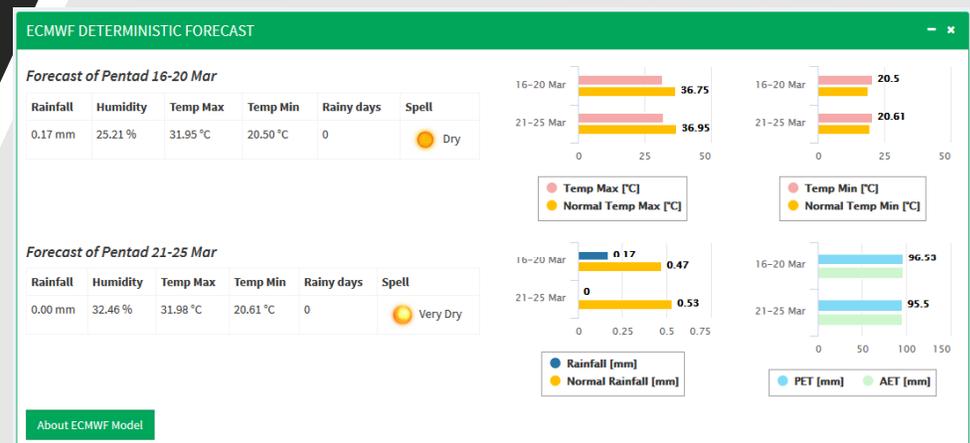
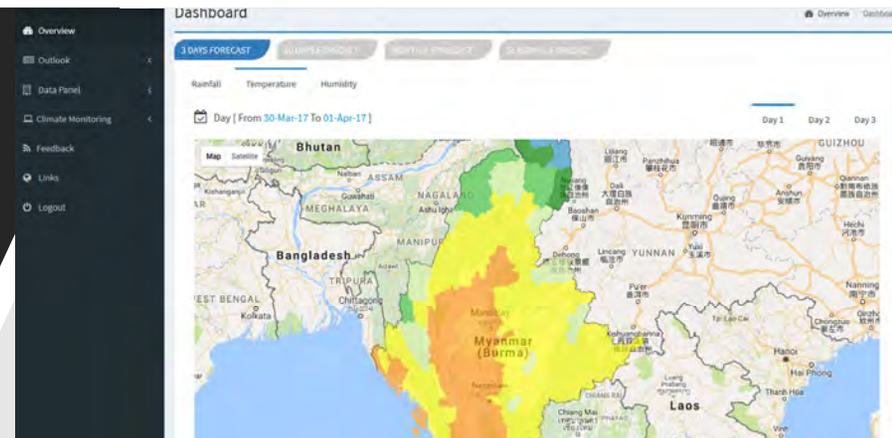
- **ECMWF**

- Seasonal and Monthly outlooks
- Monthly update
- 10 days – Pentad (averaged condition over 5 days)

- **RIMES WRF model**

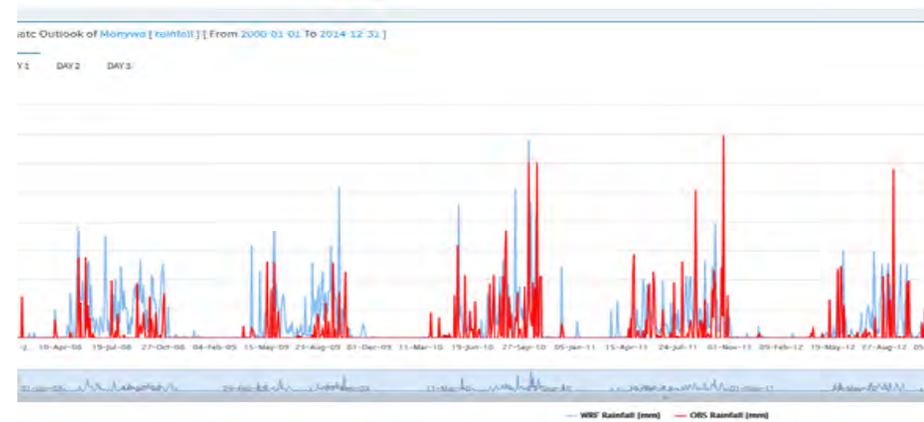
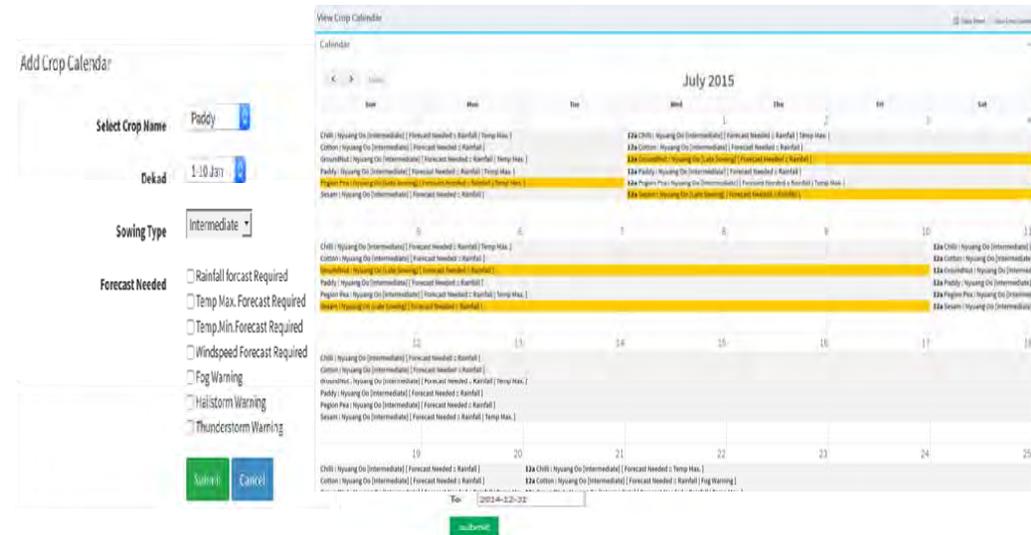
- 3 days High resolution forecast

- Parameters: Rainfall, Temperature (Tmax, Tmin), wind speed and direction, Humidity



SESAME – Specialized Expert System for Agro-Meteorological Early Warning for Climate Resilient Agriculture

- Dynamic Crop information panel for expert users
- Weather bulletins for Pentads, monthly and seasonal outlooks
- Real time verification of forecast products
- Validation of information at different levels
 - NHMS → Agro met staff → Extension Worker –farmer



SESAME – Specialized Expert System for Agro-Meteorological Early Warning for Climate Resilient Agriculture

- Dissemination of information
 - Email service
 - SMS service, through gateways
 - Fax service
- Mobile application
 - Android version - Beta



SMS Alert!

Temp will rise by 3 deg C above Threshold in next 24 hrs.

“PROTECT YOUR GRAPES FROM EXCESSIVE HEAT”

The image displays two versions of the Agro Advisory system. On the left is the Android mobile application interface, and on the right is the web-based interface.

Mobile Application Screenshot (Left):

- Header: Agro Advisory
- Location: Monywa
- Forecast: RAIN, 2017-03-01
- Weather Data:

Pentad 1	Pentad 2
Rain: 0.00 mm	Rain: 0.00 mm
Tmin: 19.42 °C	Tmin: 22.37 °C
Tmax: 32.73 °C	Tmax: 34.64 °C
Humidity: 22.37 %	Humidity: 22.41 %
PET: 97.76 mm/day	PET: 100.38 mm/day
Spell: Very Dry	Spell: Very Dry
- Map: Shows Myanmar (Burma) and surrounding regions (Thailand, Laos, Vietnam, India, Bangladesh, Nepal, Sri Lanka).
- Legend: 0-5, 6-10, 11-25, 26-50, 51-75, 76-100, >100
- Navigation: 3 DAYS, 10 DAYS, MONTH, SEASON

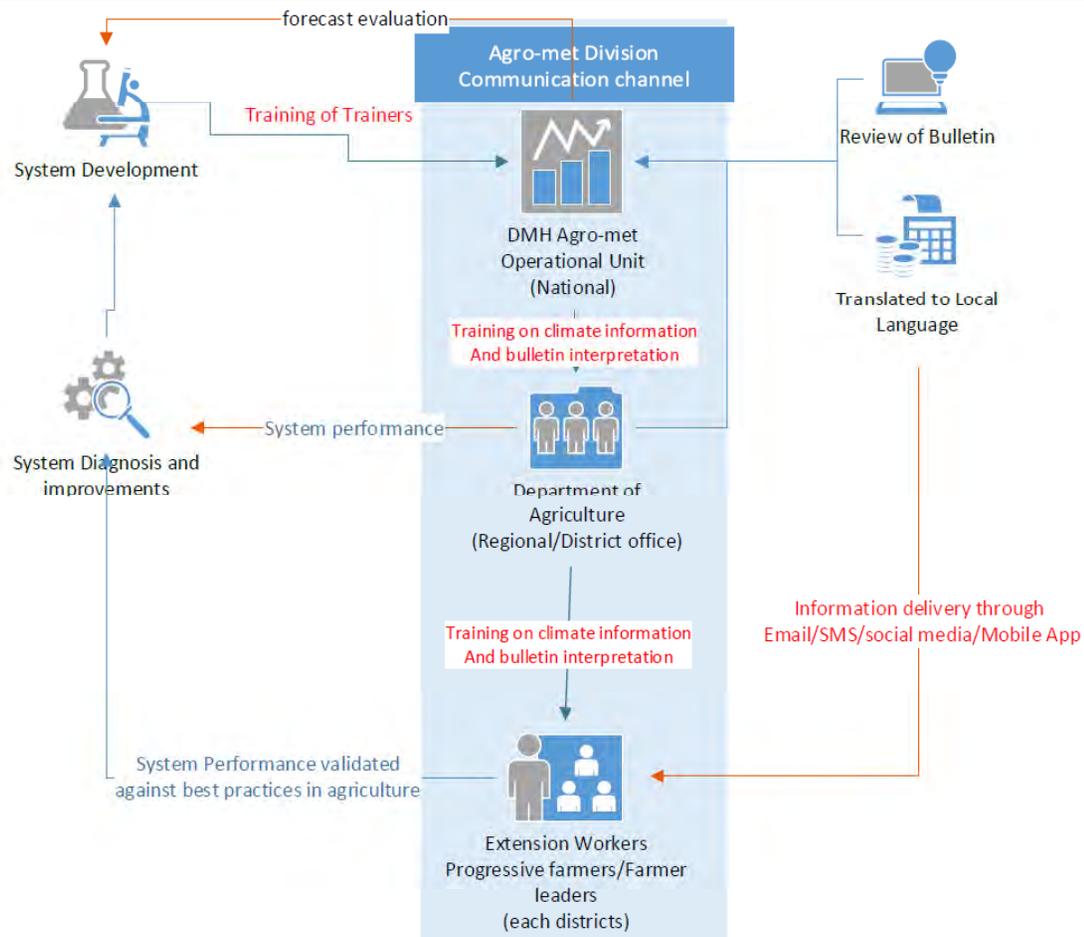
Web Interface Screenshot (Right):

- Header: Department of Meteorology and Hydrology, DMH, Myanmar
- Section: Agro-Climatic Bulletin for Dry-Zone
- Section: Weather Outlook and Advisory (Forecast for Pentad [26-31 Mar])
- Location: MONywa
- Text: "Expected accumulated rainfall for pentad 26-31 Mar 2017 is 0.00 mm. The spell is expected to be mostly Very Dry."

Soil Moisture	PET	Spell Type	Rainy Days	Humidity
deficit	104.65	Very Dry	0	23.94%
- Section: Forecast for Pentad [1-5 Apr]

Soil Moisture	PET	Spell Type	Rainy Days	Humidity
deficit	101.07	Dry	0	35.65%
- Section: Month outlook of April: "The rainfall outlook for the month of April is expected to be slightly below normal"
- Section: Seasonal Outlook of Apr|May|Jun: "The rainfall outlook for the months of Apr|May|Jun is expected to be slightly below normal"
- Section: Previous Month outlook of March: "The rainfall outlook for the month of March is expected to be slightly above normal"

Dissemination Process



Standard procedure of flow of information from DMH to farmers and feedback mechanism (Technical assistance: RIMES) through a continuous engagement process

Capacity Building on using the tool (Myanmar)



Training on development of tool at RIMES Office



Training to DMH Officers at DMH office



Training to stakeholders at Nyuang Oo on 7th September 2015

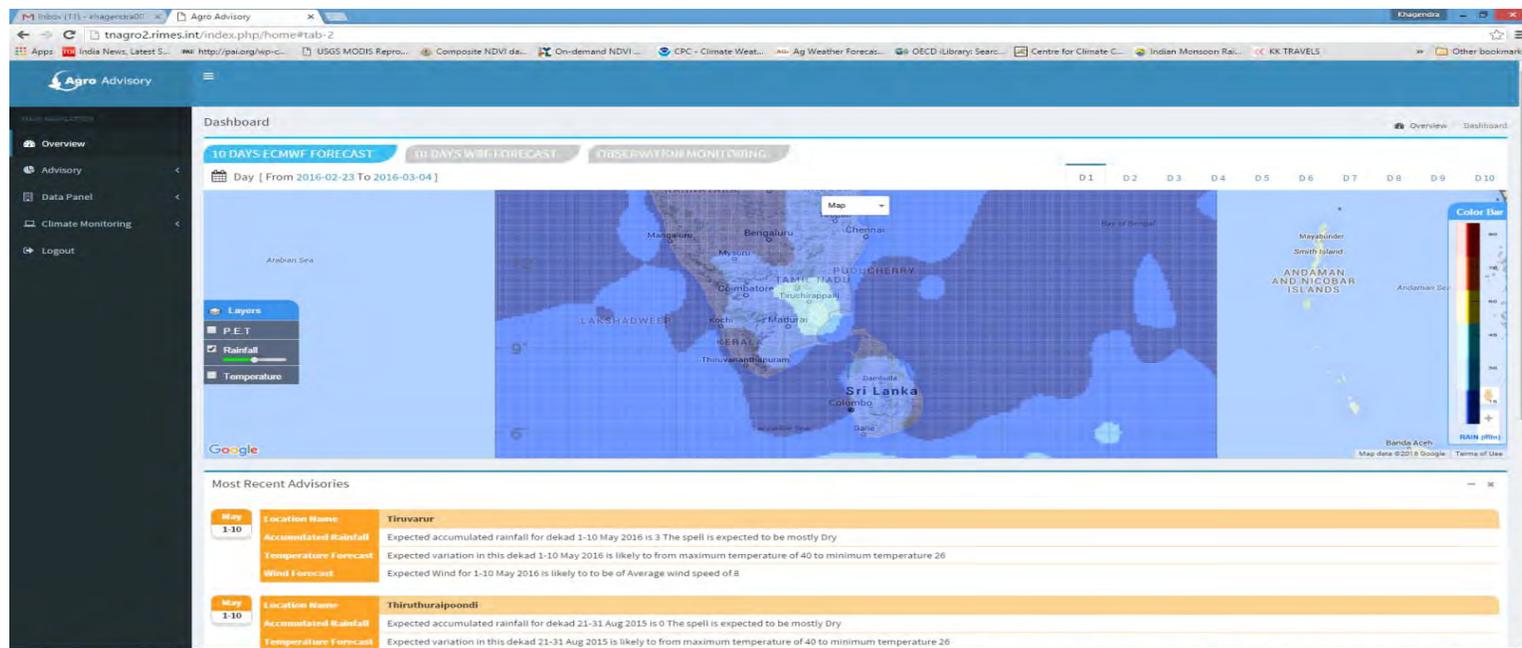


Training to stakeholder at Monywa on 8th September 2015

Tamil Nadu AGRO advisory System



<http://tnagro.rimes.int/>



- In collaboration with Tamil Nadu State Planning Commission (TNSPC) and Department of Agriculture
- Interface system to use 3-days and 10-days weather forecast from India Meteorological Department (IMD) after testing of prototype; and other sources for agriculture planning

Capacity Building on using the tool

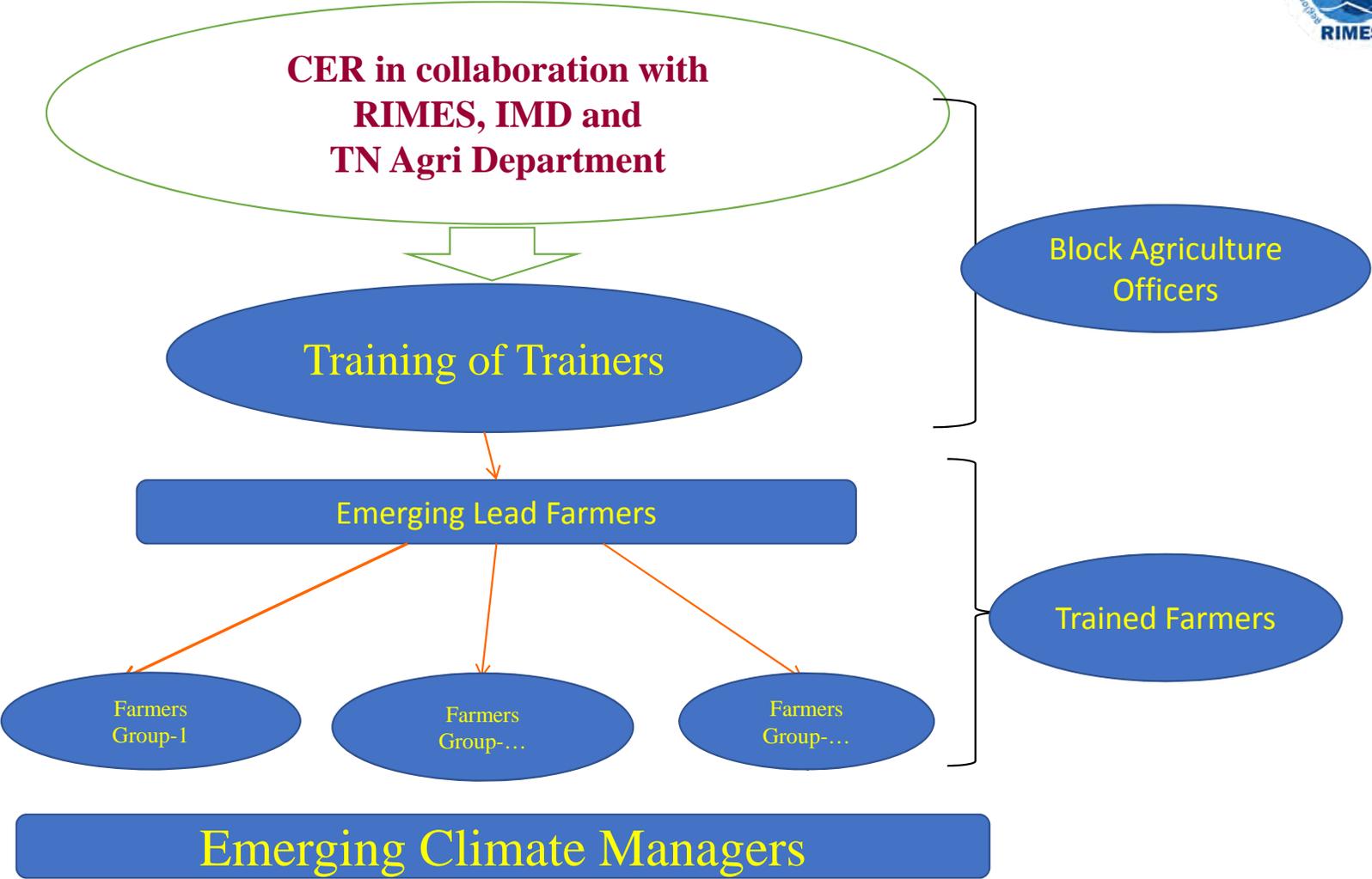


The whole process of learning is divided in **four** major parts:

- I) The Human and Institutional Dimension of Learning Process,
- II) Climate Information, Weather and Climate Forecasts,
- III) Application of Climate Information and Weather/Climate Forecasts to Farming Operations and
- IV) Support Programs to Facilitate Broader Adoption.

These four modules are thought through 12 modules

Multi Cycle Training Approach



Capacity Building on using the tool (Tamil Nadu, India)



Indian AGRO-met System



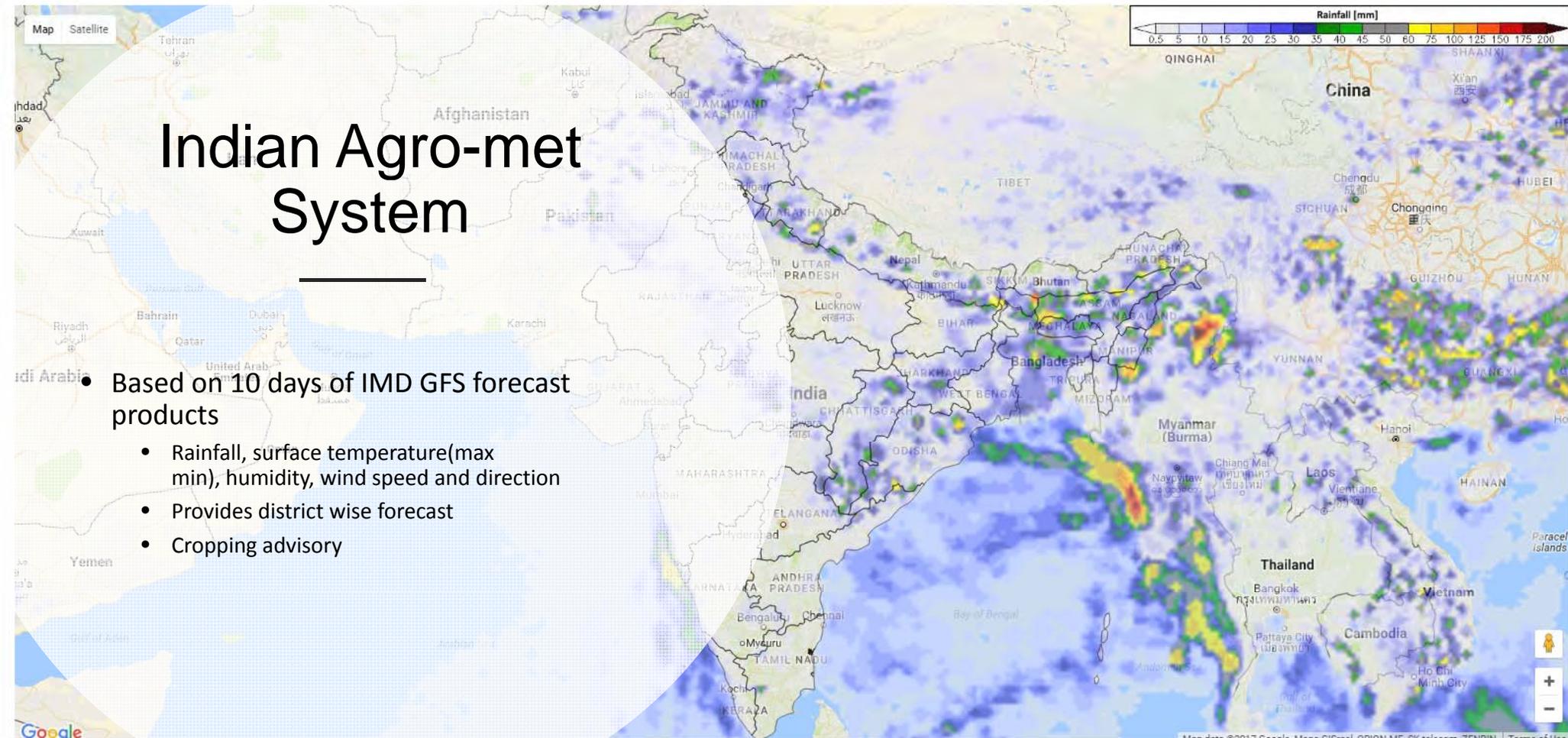
Rainfall Temp Max Temp Min Humidity

Day [From 2017-06-22 To 2017-07-01] **** Click on State to view District Wise Map.**

Day 1 Day 2 Day 3 Day 4 Day 5 Day 6 Day 7 Day 8 Day 9 Day 10

Indian Agro-met System

- Based on 10 days of IMD GFS forecast products
 - Rainfall, surface temperature(max min), humidity, wind speed and direction
 - Provides district wise forecast
 - Cropping advisory





Indian AGRO-met System

Select District:

STATE **Gujarat** DISTRICT **Ahmedabad**

Date	Rainfall	Humidity	Temp Min	Temp Max
2017-06-22	0.81 mm	72.65 %	29.37 °C	34.44 °C
2017-06-23	3.14 mm	74.23 %	29.15 °C	35.47 °C
2017-06-24	7.80 mm	73.92 %	29.05 °C	36.37 °C
2017-06-25	2.23 mm	74.86 %	29.47 °C	37.07 °C
2017-06-26	1.67 mm	71.40 %	29.29 °C	37.82 °C
2017-06-27	0.91 mm	70.19 %	29.48 °C	37.02 °C
2017-06-28	10.90 mm	74.62 %	28.66 °C	35.26 °C
2017-06-29	11.27 mm	78.25 %	28.19 °C	34.88 °C
2017-06-30	14.09 mm	79.06 %	28.06 °C	34.57 °C
2017-07-01	NA	NA	NA	NA

Forecast of Pentad (FIRST)

Rainfall	Humidity	Temp Max	Temp Min	Rainy days	Spell
15.26 mm	73.10 %	35.84 °C	29.35 °C	3	Normal

Forecast of Pentad (SECOND)

Rainfall	Humidity	Temp Max	Temp Min	Rainy days	Spell
38.63 mm	74.70 %	35.91 °C	28.73 °C	3	Normal

Line graph showing Rainfall, Humidity, and Temperature from 22-Jun to 30-Jun. Legend: Forecast (blue line), Observed (grey line).

Rainfall Temp Max Temp Min Humidity

Day [From 2017-06-22 To 2017-07-01]

Day 1 Day 2 Day 3 Day 4 Day 5 Day 6 Day 7 Day 8 Day 9 Day 10

District: Anand
Date: 2017-06-22
Humidity: 80.26 %

District Wise Map

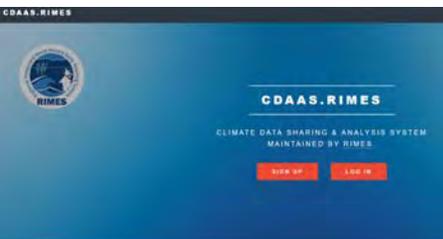
10 DAYS FORECAST

Rainfall Temp Max Temp Min Humidity

Day [From 2017-06-22 To 2017-07-01]

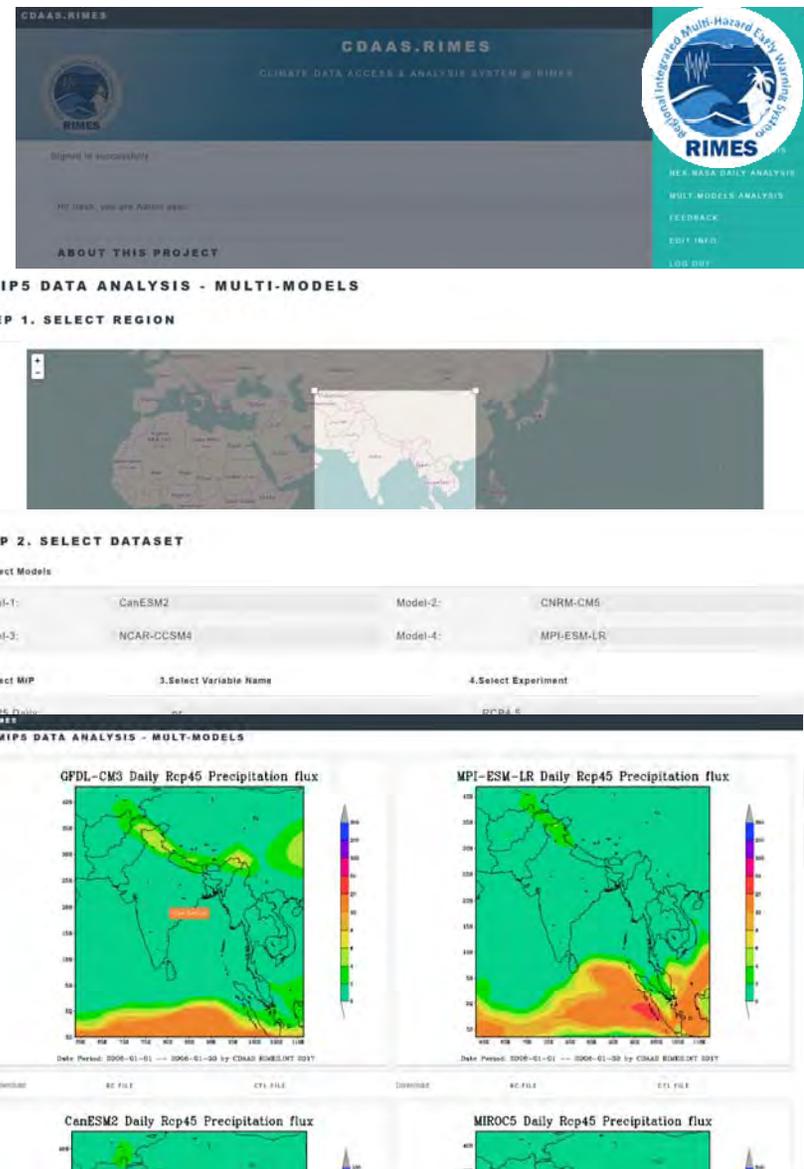
Day 1 Day 2 Day 3 Day 4 Day 5 Day 6 Day 7 Day 8 Day 9 Day 10

District: Kutch
Date: 2017-06-22
Rainfall: 2.67 mm

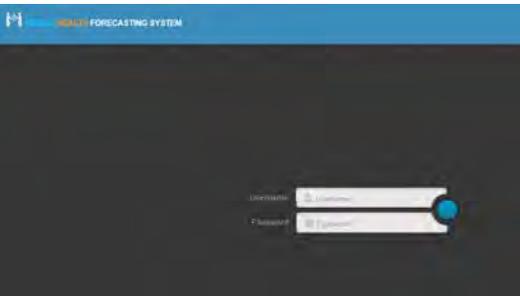


CDAAS – Climate Data Access and Analysis System

- Once stop Portal for accessing different global climate model outputs
- Simple and easy-to-use interface
- Lists out a number of CMIP5, CORDEX and NEX-NASA models
- Different access levels, with expert users are allowed to perform analysis on the datasets
- Background operations are handled with Climate Data Operator(CDO) and graphics with GrADS
- Perform multi model analysis on selected location or region



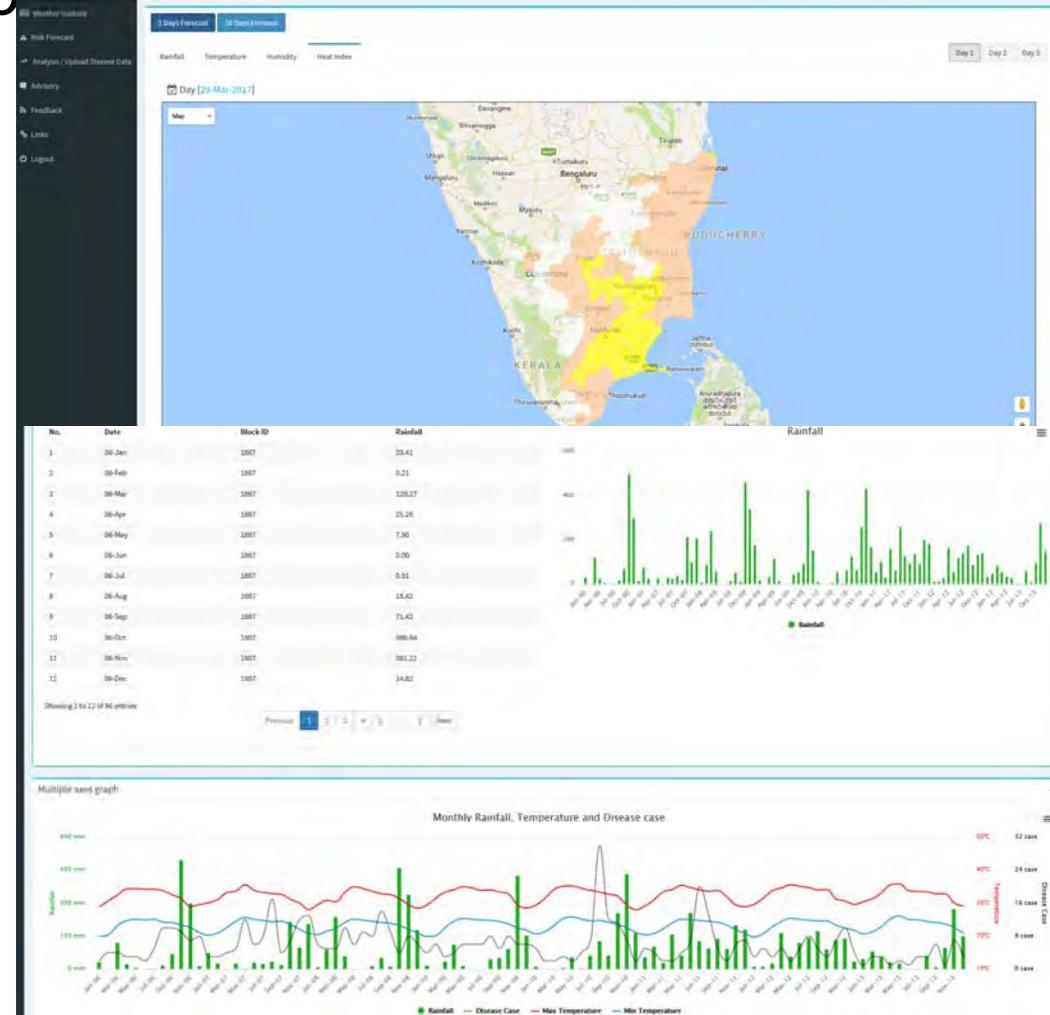
Development of Sector Specific DSS



CRISH – Climate Risk Information System for public Health

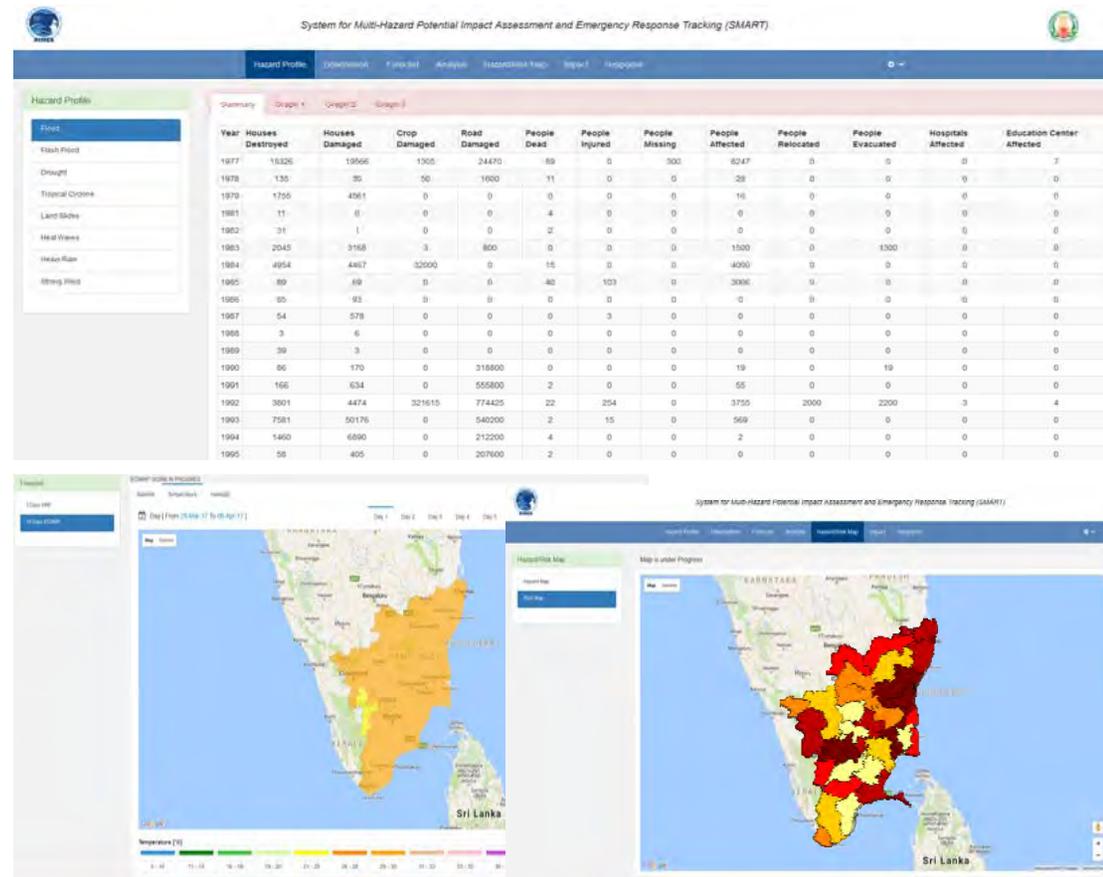


- Portal for public health warning information
- Weather condition for three days and 10 days lead time
- Extreme heat indicators,
- Building Correlation disease pattern and weather conditions
- Risk based information for Malaria and Dengue spreading
 - piloted in two districts in Tamil Nadu, India
 - At taluk level
- Generation of health Advisories



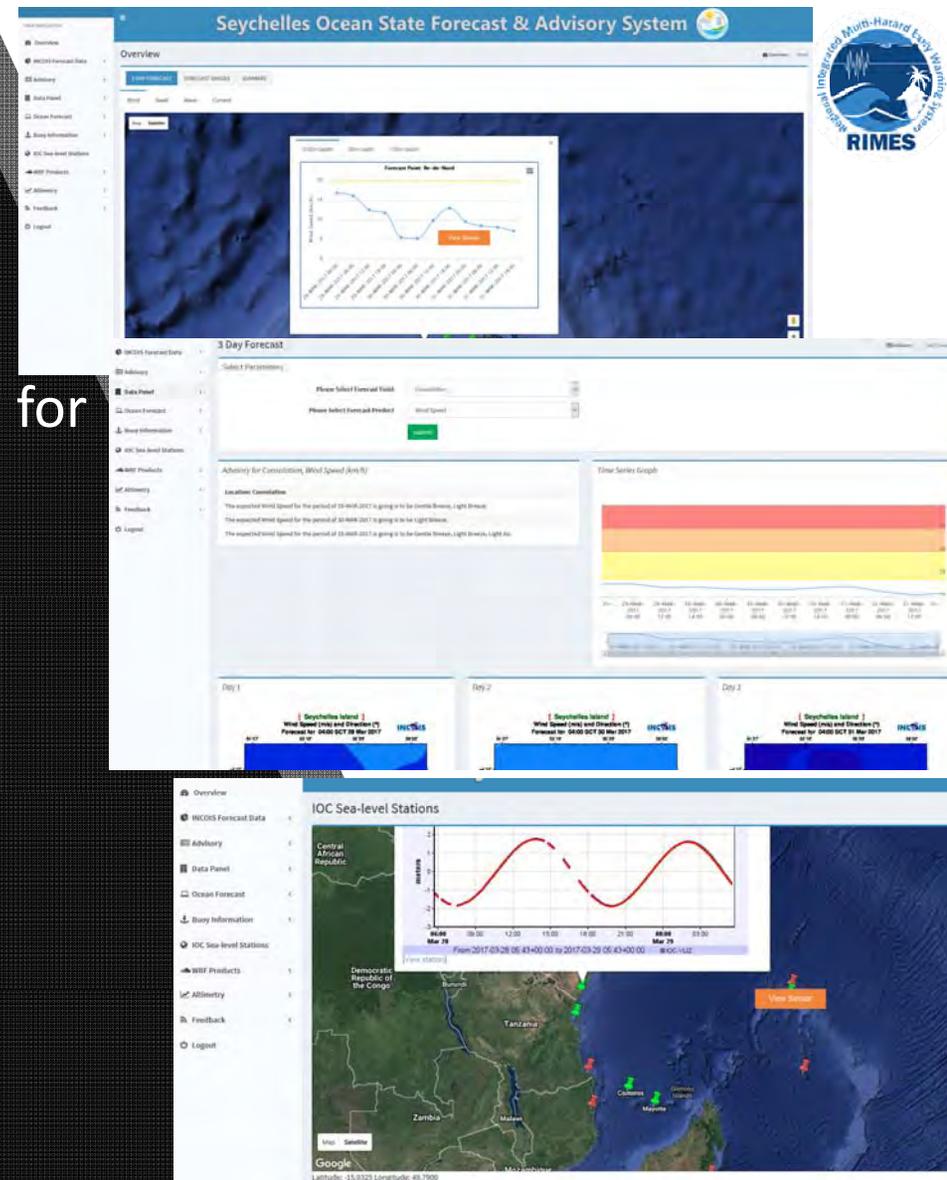
SMART – System for Multi-Hazard potential impact Assessment and Emergency Response Tracking

- Integrated platform for Disaster response
- Block level Disaster profiles
- Assessment of historical disaster events
- Real time monitoring of weather parameters
- Short- medium range forecast and extreme event alerting
- Analysis – Evaluation of forecast performance
- Generation of risk based information on the basis of the weather forecast at different time scales
- Integration of EDEN SAHANA for response and resource allocation – **work under progress**



Ocean state forecast and Information System

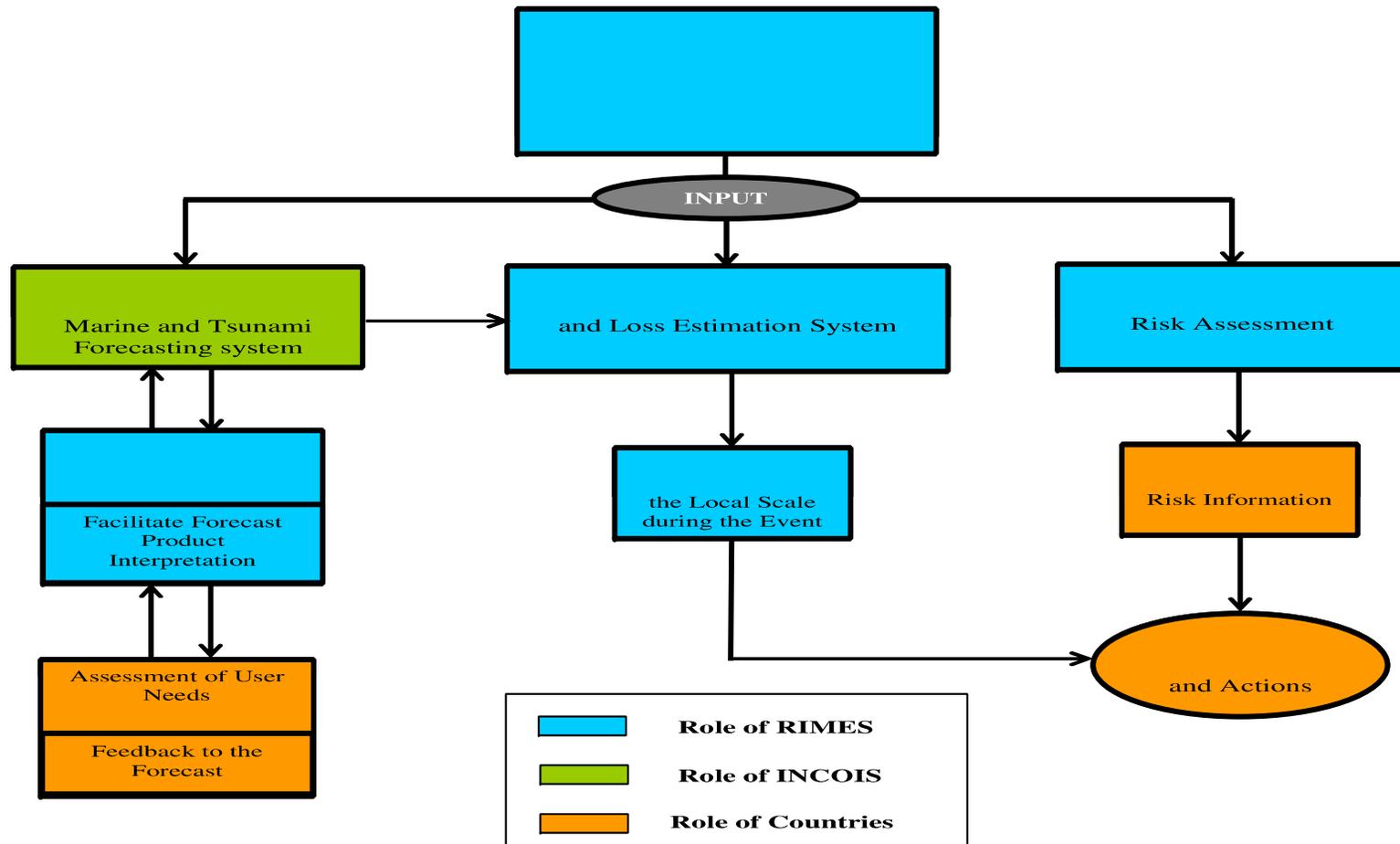
- Web based tool developed and customized for Seychelles
 - ocean state forecast at three days lead time
 - Collaboration with INCOIS, India
 - forecast for wind, current, swell wave period information
- Alert and warning messages based on thresholds for selected forecast points
- Real time Buoy data and drift alert
- IOC sea level stations – monitoring





INCOIS RIMES Collaborative Framework

INTEGRATED OCEAN SERVICES: Development and customization of country-relevant ocean information





INCOIS RIMES Collaborative Framework

INTEGRATED OCEAN SERVICES: Development and customization of country-relevant ocean information

The screenshot displays the INCOIS Maldives website interface. At the top, the INCOIS logo (with ESSO) and the RIMES logo are visible, along with the text "Integrated Ocean Information and Forecast System" and "Maldives". A navigation menu includes "INCOIS Home", "OSF Home", "RIMES", "Downloads", "Feedback", and "Contact Us".

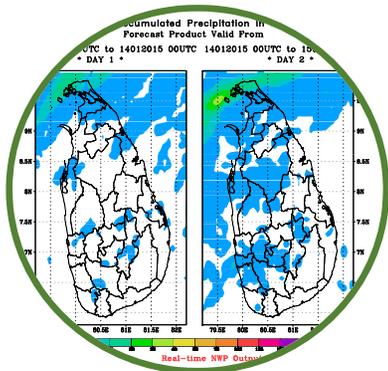
The main content area is titled "Indian Ocean Forecast System (INDOFOS)". It contains a paragraph describing the Maldives' coastline and the risks of coastal inundation. Below this, it states that the Ministry of Earth Sciences, Government of India developed an integrated high resolution ocean forecasting system for Maldives, available three days in advance.

Location specific forecast products are available for the following locations:

- Northern Maldives**
 1. Baa
 2. Haaalifu
 3. Hanimadhoo
 4. Lhaviyani
 5. Noonu
 6. Ra
 7. Shaviyani
- Central Maldives**
 1. Aif
 2. Aif Dhaalu
 3. Dhaalu
 4. Hulhule
 5. Kaafu
 6. Kadhdhoo
 7. Meemu
 8. Thaa
 9. Vaavu

A sidebar on the left lists "Forecast Products" with expandable options: Wave, Wave period, Swell, Swell period, Wind, Sea Surface Temperature, Mixed Layer Depth, Surface Currents, Location Specific, High Wave Alert, and Oil Spill Advisory.

Evolution of products and Application



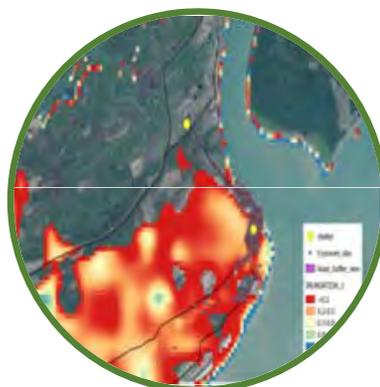
RESPONSE TO DEMANDS



NEEDS-BASED DEMAND ARTICULATION



UPTAKE OF SEASONAL INFORMATION



INTEGRATION OF GEO-HAZARD INFORMATION



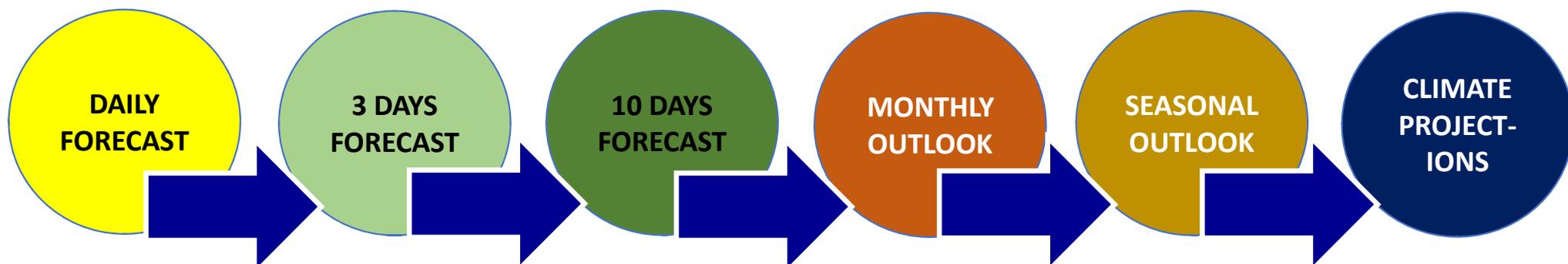
UPTAKE OF MULTI-TIMESCALES INFORMATION FOR RESOURCES AND RISKS MANAGEMENT

SEASONAL FORUM EVOLUTION



RESPONDING TO USER REQUIREMENTS

Forecast of various timescales



DEVELOPMENT OF FORECAST OF DIFFERENT TIMESCALES IN SRI LANKA BASED ON MONSOON FORUM STAKEHOLDER DEMANDS

ENHANCEMENTS IN SPATIAL FORECAST RESOLUTION WERE ALSO INTRODUCED BY DOM; FORECAST FOR SPECIFIC SECTORS EVOLVED

INFORMED RESOURCES AND RISKS MANAGEMENT

Circumventing forecast information into economic gains – examples from Sri Lanka

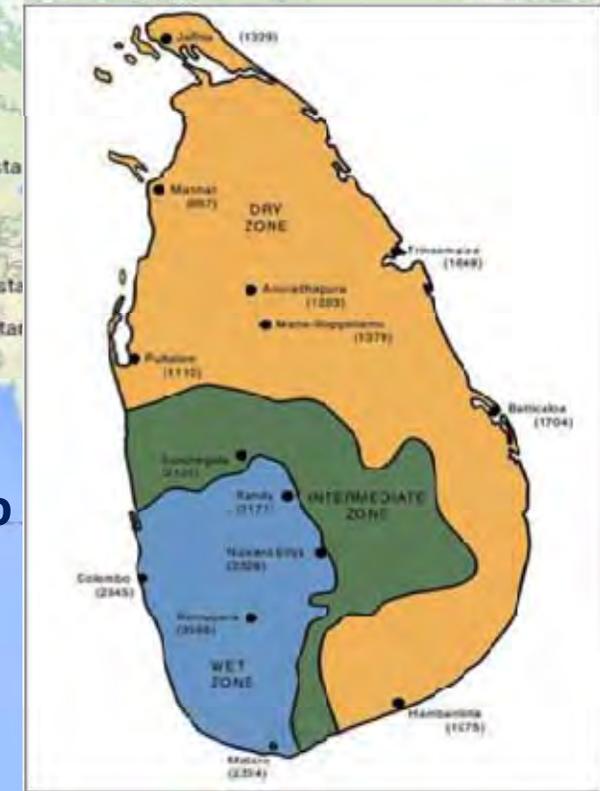
◆ **2014 Yala Season: productivity in Sri Lanka's Batticaloa District (dry zone) despite 2 consecutive seasons of suppressed rainfall**

◆ **2015 Yala Season: 96% cultivation rate despite extended dry spells and suppressed rainfall**

◆ **23% increase against 5-year Yala season average**

◆ **Increase in cultivation of other field crops compared to 2014 Yala Season**

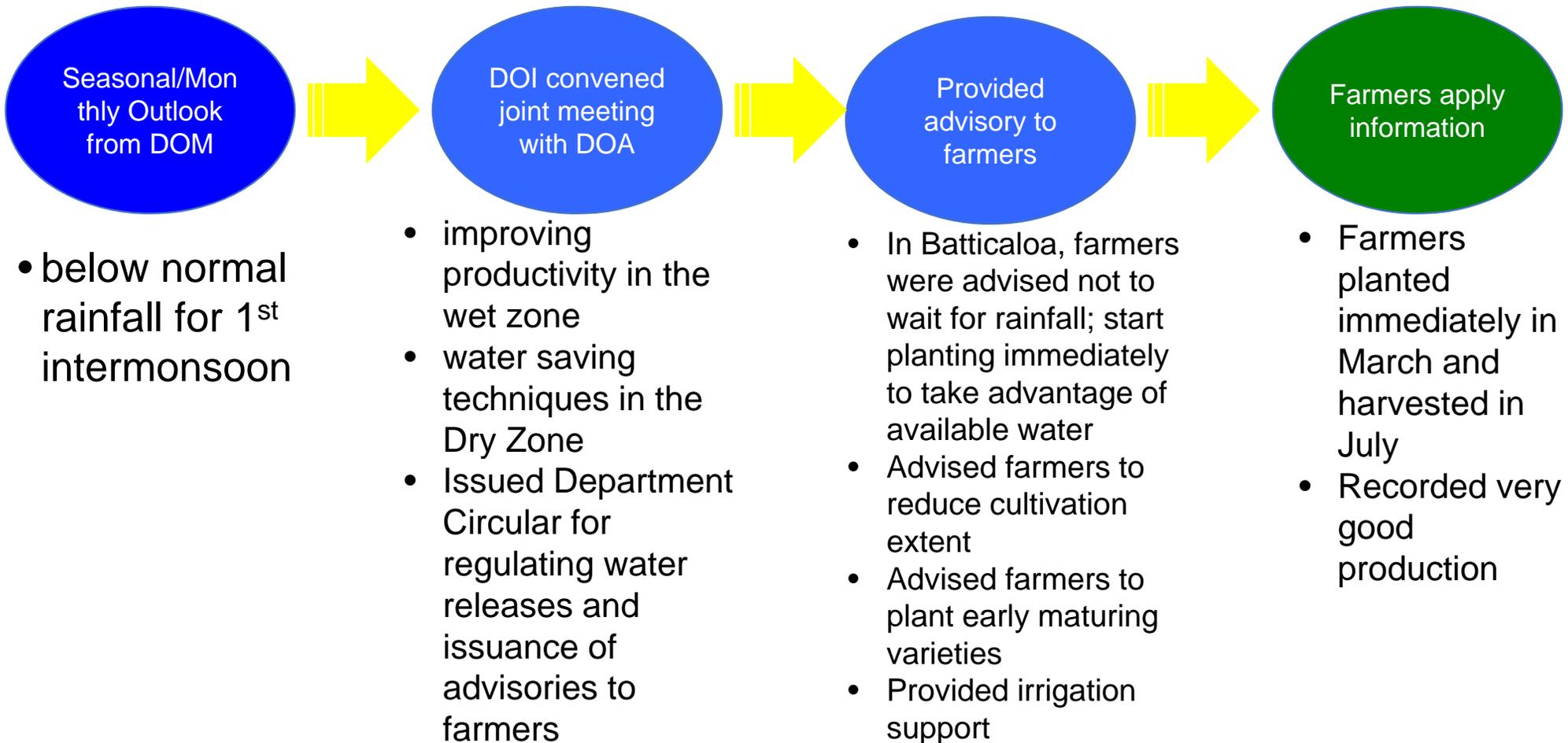
◆ **October 2015 – February 2016: managing reservoirs for reducing flood events – savings of USD 41 Million**

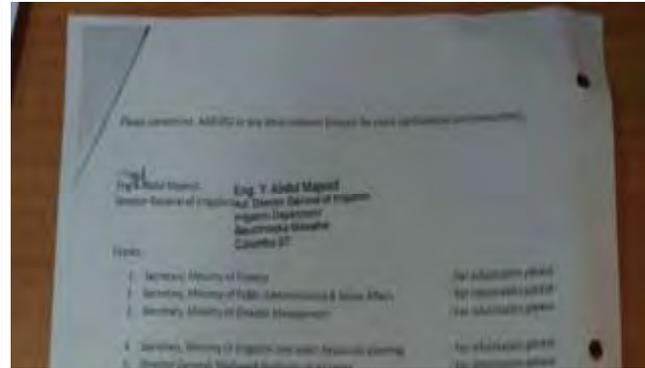
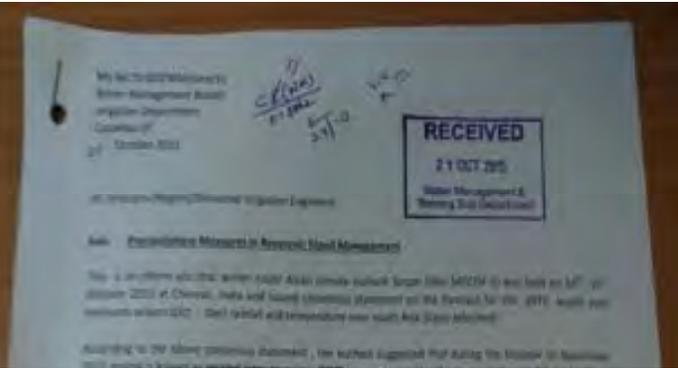




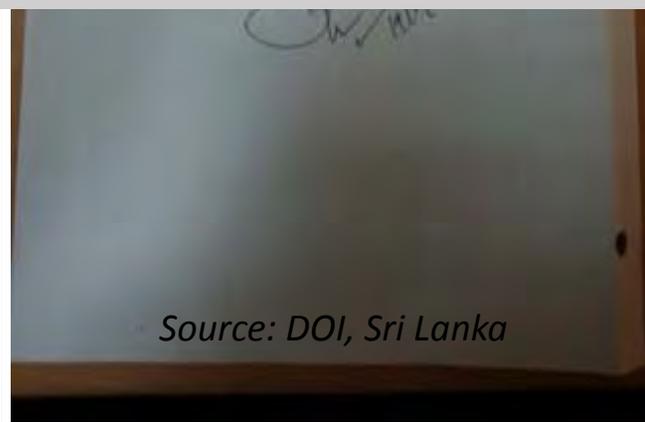
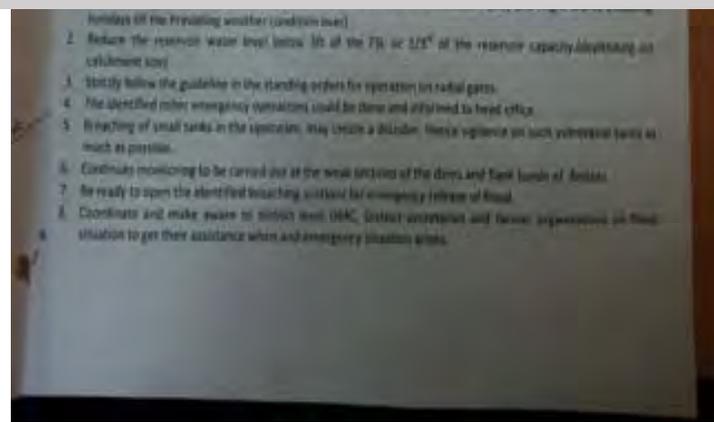
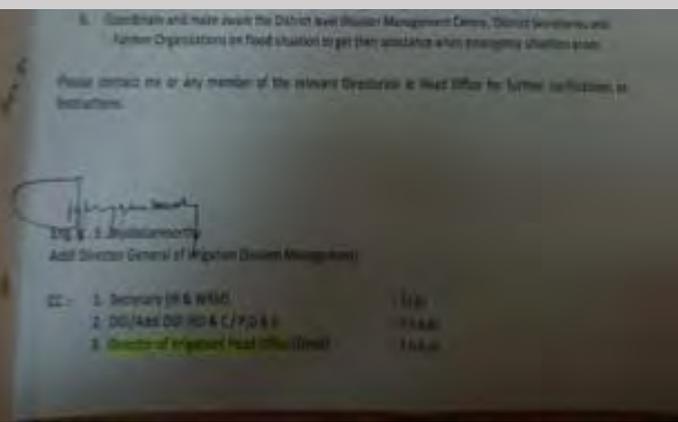
SRI LANKA: Water Management for Agriculture

Department of Irrigation



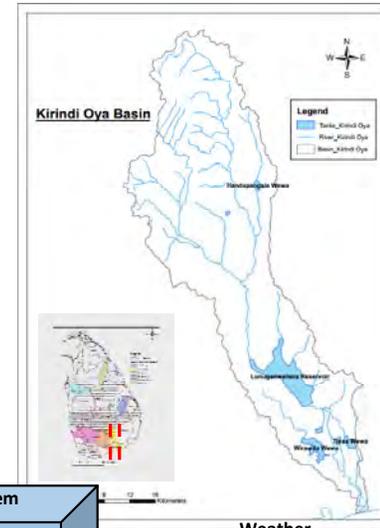


Institutional decision for regulating the release of water in reservoirs for reducing probability of flooding, guided by information of potential for above normal rainfall for October 2015 – February 2016





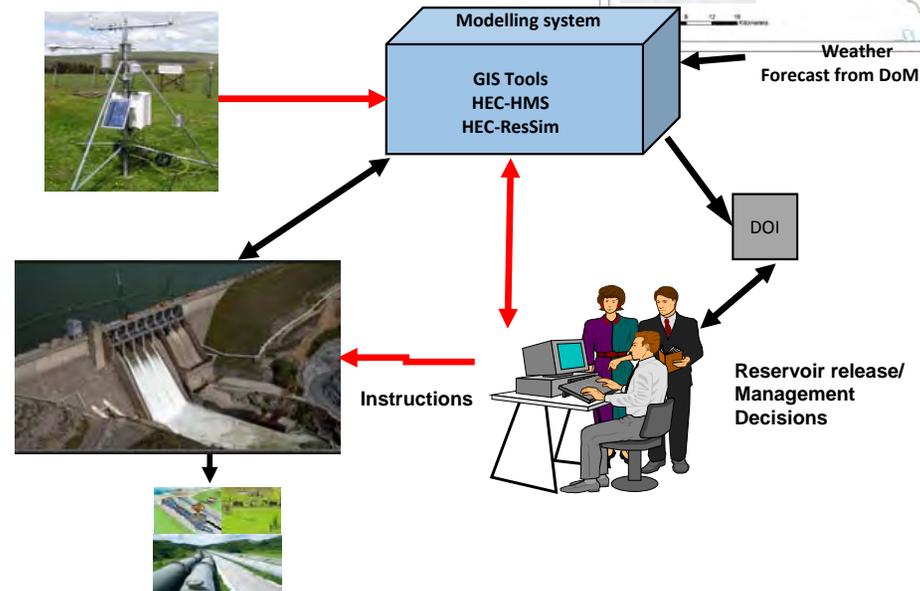
DSS for Water Sector



Development of decision support system to connect seasonal climate information with irrigation and agriculture: Case study in Kirindi Oya basin, Sri Lanka

Objectives:

- To develop, a mechanism to issue timely flood warning and, a suitable institutional/coordination arrangement to manage floods
- To establish an improved reservoir operation and management plans, which incorporate and synchronize the role of large, medium and small water storages, to mitigate the impact of floods
- To build the capacity of Irrigation Department to operate reservoirs and manage the river basin with a flood management objective



Funded by World Meteorological Organization (WMO) under Global Framework for Climate Services (GFCS) for South Asia

System Components



- A DSS that is capable of integrating rainfall outlook and forecast information and provide probable inflow to Lunugamwehera reservoir based on seasonal, 10 days and 3 days forecast
- A hydrological model as per the requirement of DoI and link DoM rainfall forecast at different time scales to generate hydrological forecasts
- A reservoir simulation model

Other Activities



National Climate Outlook Forum (NCOF)
Nepal, Bhutan, Sri Lanka, Pakistan, Maldives, Myanmar, Bangladesh, India (Uttar Pradesh)



South Asia Seasonal Climate Outlook Forum (SASCOF)



Regional Training for Flood Forecasting in Transboundary River Basins



Thank you