Satellite Data Based
Operational Geo-spatial Services and Applications

under
National Hydrology Project

30th July 2019

Dr. V. Venkateshwar Rao
Project Director, NHP
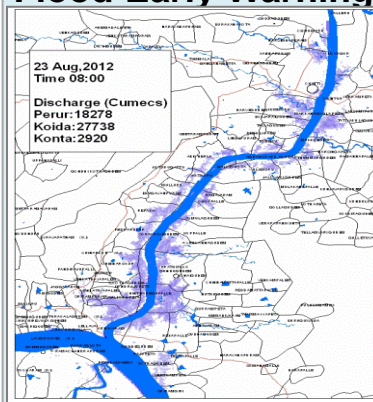**Group Director, WRG**

Satellite Data Based Geo-spatial Products, Services and Applications
Under National Hydrology Project

- National Hydrology Project (NHP) is being executed by Ministry of Water Resources, Govt. of India
- NRSC is signatory to NHP as one of the Implementing Agency
- NRSC to support NHP through geo-spatial data products, services, customized applications development
- RS. 79.437 Crore, 2017-18 to 2023-24
- 7 Major study components
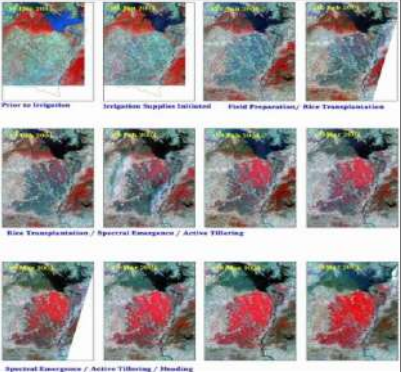- Capacity building & Training to the stake holders

Salient Features

- Hydro-Informatics (*Snowmelt, Evapotranspiration, Soil Moisture, Surface Runoff, Reservoir Inflows, Hydrological Drought*)
- Development of Spatial Flood Early Warning for Two (Tapi & Godavari) river basins
- GLOF Modelling for high risk lakes (15 No's)
- Real-time DSS for Irrigation Water Management (Narayanpur Command Area)
- Hydro-conditioned DTM (ALTM and Satellite) for Flood and GLOF modelling
- Capacity building for Central & State water resources departments personnel (4 Trainings & 100 Officials/year)
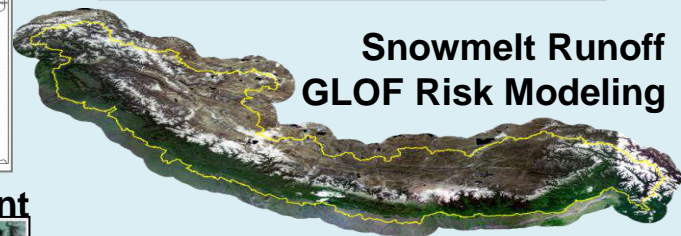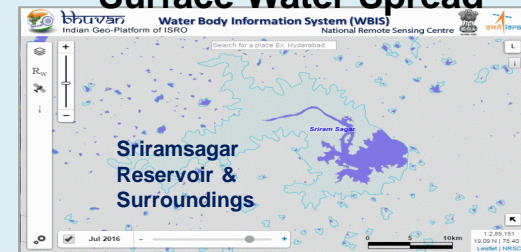- Web services through NWIC & Bhuvan

Flood Early Warning

23 Aug,2012
Time 08:00

Discharge (Cumecs)
Perur:18278
Koida:27738
Konta:2920

Surface Water Spread

Water Body Information System (WBIS)

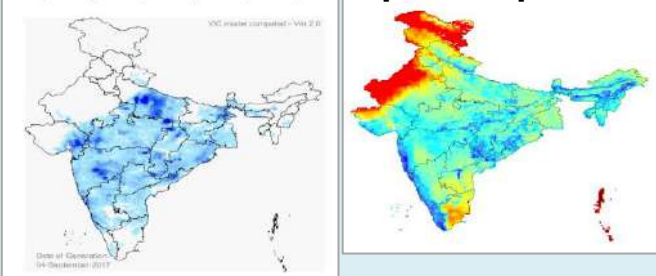Sriramsagar Reservoir & Surroundings

Snowmelt Runoff
GLOF Risk Modeling

Irrigation Management

Surface Runoff   Evapotranspiration

Proposed National Remote Sensing Centre Activities under National Hydrology Project

1. Real-time Operational Spatial Flood Early Warning System Development

2. Development of Satellite-based Regional Evaporative Flux Monitoring System for India

3. Glacial Lake Outburst Flood (GLOF) Risk Assessment

4. Development of spatial snowmelt runoff product   in the Indian Himalayas

5. Operational National Hydrological Modelling System for the entire Country

6. Satellite data based inputs for Irrigation Scheduling for a selected Irrigation Project command area

7. Operational hydrological drought services using remote sensing data

8. Customized RS & GIS Training and Capacity Building

Development of Satellite-based Regional Evaporative Flux Monitoring System for India

Objectives

1. Daily actual evapotranspiration (mm/day) estimate at 5.5 km spatial resolution in near real time
2. Satellite data based regional ET estimates for India at spatial scales of watershed/sub-basin/basin and at temporal scales of daily, fortnightly, monthly and annually
3. Long term ET database
4. Web based (India-WRIS/NWIC/Bhuvan) regional ET monitoring system

Deliverables
Satellite Derived Products

1. **Net Radiation R_n**
2. **Soil heat Flux G**
3. **Actual Evapotranspiration (AET)**
4. **Sensible Heat Flux**

Achievements till date

- Computation of surface energy balance equation components like Net radiation (R_n) and Soil heat flux (G) for Modified PT method
- Development of methodology for satellite based Modified PT parameter (ϕ) using NDVI-LST triangle
- Evaporative Flux estimation from Modified PT parameter (ϕ) and surface energy balance equation components
- Model frame work development for deriving near real time AET estimation using INSAT3D, NPPS and CDAS, NOAA (meteorological datasets)
- Communicated with agricultural universities and other research institutes across India for setting up ET sensors instrumentation

2019-2020 Work Plan

Experimental AET product generation & Validation

- Development of architecture of the AET product generation and Computation of near real time product generation
- Web hosting of experimental actual ET product
- Validation of experimental AET product with global AET products
- Development of water balanced based ET
- Establishment of field ET observation network across country Phase 1
- Validation of satellite based AET with field measurement will be initiated

Details of sample products

Spatial Extent: Indian Region

Latitude 5° to 38° and longitude 66° to 104°

Spatial Resolution: 375 metre

Temporal Resolution: Daily

Input data sets

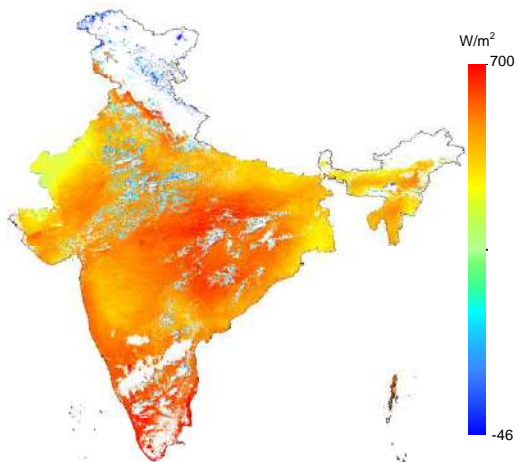**NPP Suomi**: Albedo, NDVI, LST

INSAT3D: Insolation, ,OLR

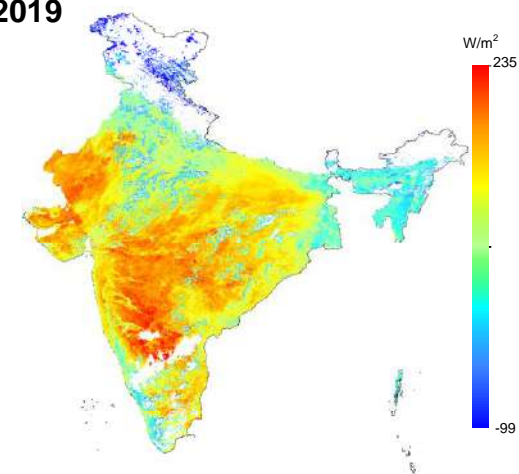**Meteorological data**: Air temperature, Dewpoint temperature

Fixed Inputs: CARTO DEM, Region of interest (Indian region)
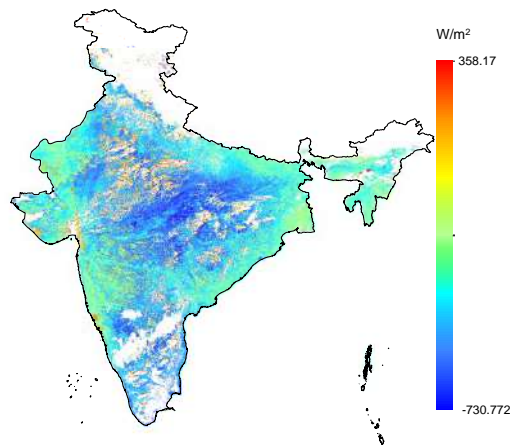
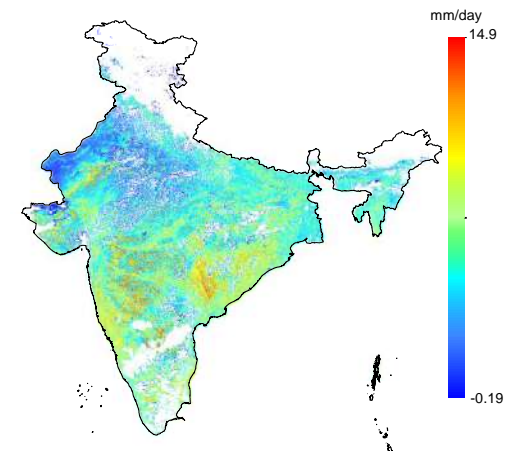Database availability: 25-Mar-2018 onwards

Date: 18.04.2019

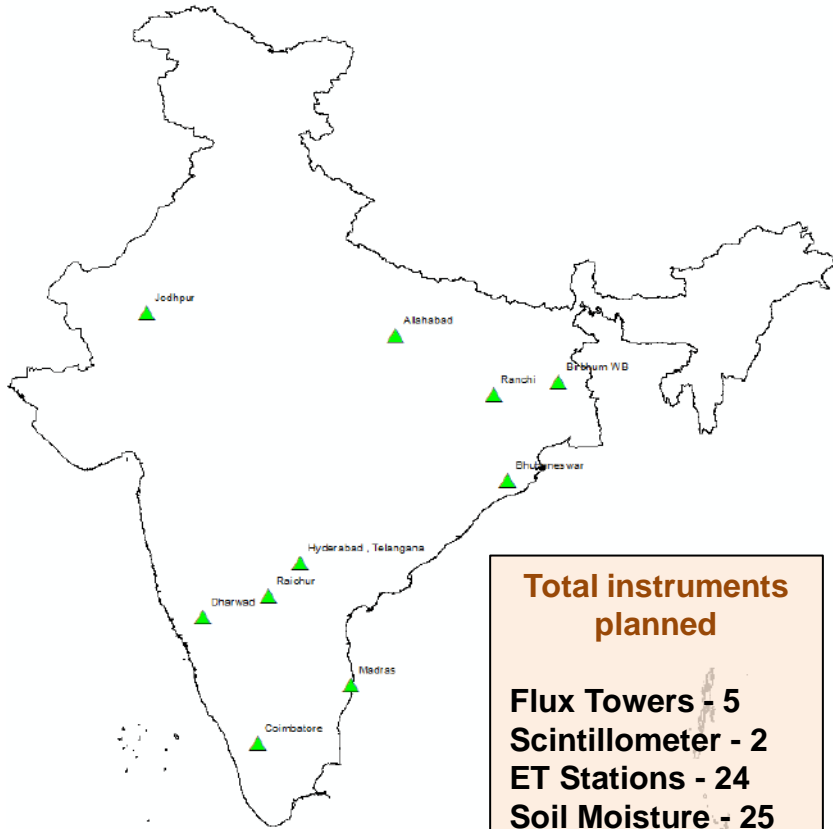**Daily Average Net Radiation flux**

Daily Average Soil Heat flux

Daily Average Sensible Heat flux

Daily Actual Evapotranspiration

Ground based instrumentation network related to ET and Soil moisture measurement for calibration and validation of Satellite derived Products

Selected and communicated locations for ET measurement sensors installation in Phase 1
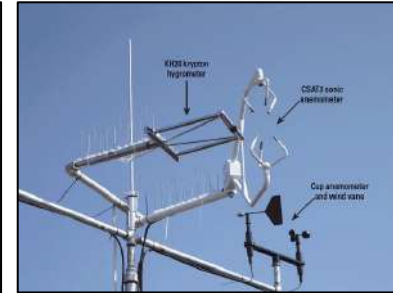**(Apart from already existing instrumentation setup)**

ET Station

Flux Tower

Scintillometers

Soil Moisture Measuring Probe
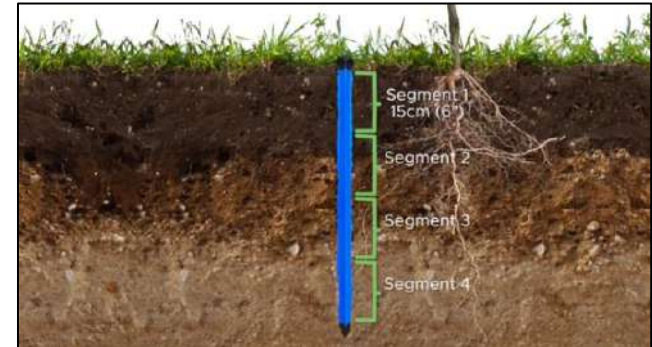
Soil Moisture probes will measure soil moisture at 6 different depth along the soil column (1 m) at 10, 30, 50, 60, 80, 100 cm depths.

Map of India showing locations: Jodhpur, Allahabad, Ranchi, Birbhum WB, Bhubaneswar, Hyderabad, Telangana, Raichur, Dharwad, Madras, Coimbatore

Total instruments planned

Flux Towers - 5
Scintillometer - 2
ET Stations - 24
Soil Moisture - 25

Operational Web-based
National Hydrological Modeling System

Salient Features

- *National level hydrological modeling framework*
- *Near-real-time water balance components estimation*
- *Field experimentation setup for calibration and validation*
- *Reservoir inflow forecast*
- *Web-enabling to India-WRIS/ Bhu...*

2019-20 Planned Activities

- *Forecast of Inflows (91 Major Reservoirs)*
- *Crop Specific Irrigation Requirement*
- *River Discharge at selected locations*
- *Field Experimentation setup for calibration and validation of SM*
- *Snow Melt Runoff estimation using Energy Balance Mode*

National level Spatial Water Balance Components
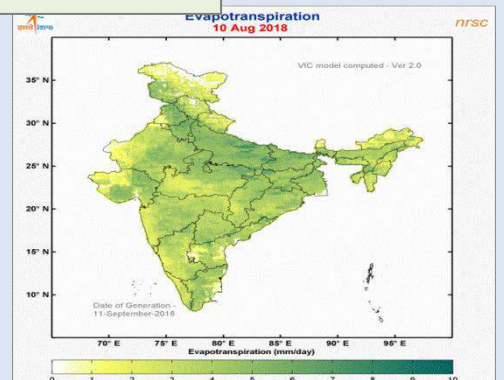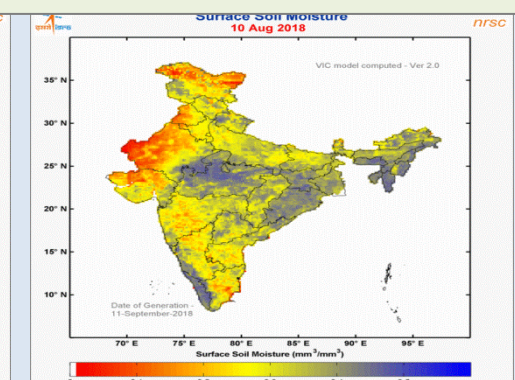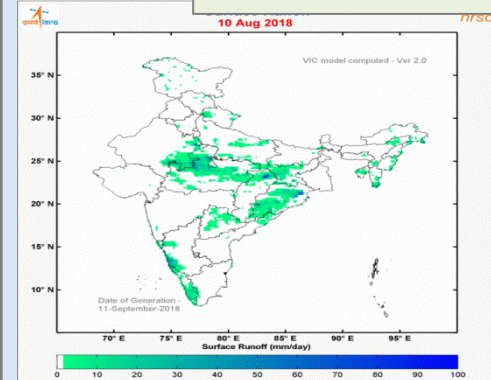
Soil Moisture Adequacy Index

3 min (~5.5 km) Grid-wise Products

Operational Web-based
National Hydrological Modeling System

Soil Moisture Validation
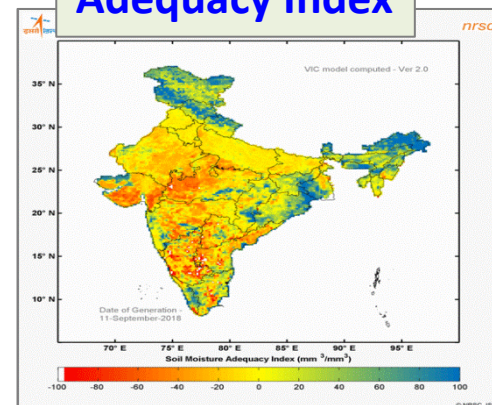
SDI-12

PR2/4
40 cm

- 25 Permanent probes to measure soil moisture along the soil column
- 10 Mobile probes up to 15 – 30cm soil moisture measurement

Technology Transfer

The near-real-time hydrological model outputs (surface runoff, evapotranspiration, layer wise soil moisture data, min_temp, max_temp and rainfall) are shared with NPMU on a daily basis

Training of NWIC Officials is scheduled from 13th May, 2019 on VIC model development and execution.

Reservoir Inflow forecast

Tungabadra Reservoir — Inflow, Forecast Inflow

Nagarjunsagar Reservoir — Inflow, Forecast Inflow

Satellite data based inputs for Irrigation Scheduling for a Selected Irrigation Project command area

Salient Features

- Geo-spatial database
- In-season cropping pattern
- in-season irrigation water demand at weekly/fortnightly time-step
- Performance of irrigation system.
- Decision Support System

08-November-2018
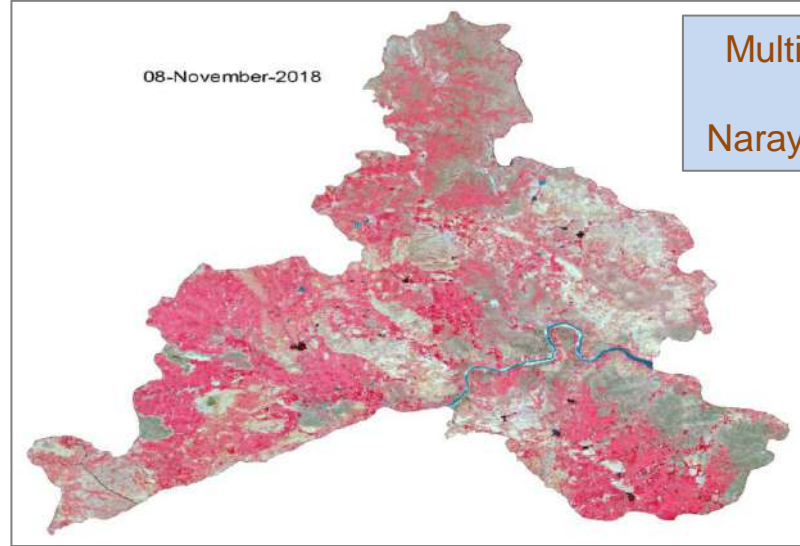
Multi-date satellite data of 2018-19 Narayanpur Command area

Crop Map : Kharif 2018

COTTON
CHILLIES
KHARIF PADDY
KHARIF REDGRAM
KHARIF JOWAR
SUGARCANE

Crop Map : Rabi 2018-19

SUGARCANE
RABI JOWAR
RABI PADDY
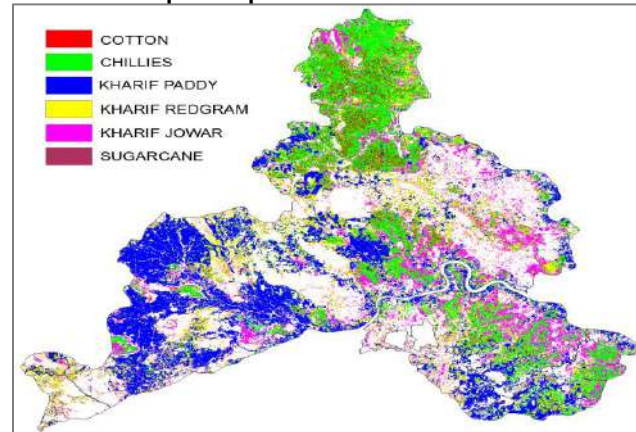
Satellite data based inputs for Irrigation Scheduling for a Selected Irrigation Project command area
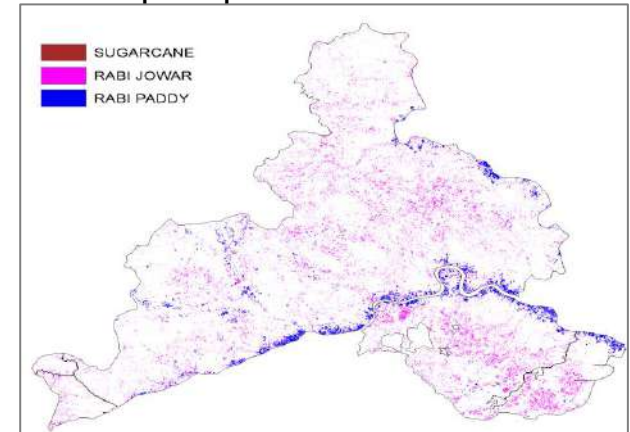
Canal Releases Estimation and Scheduling Module

Canal network with node connectivity
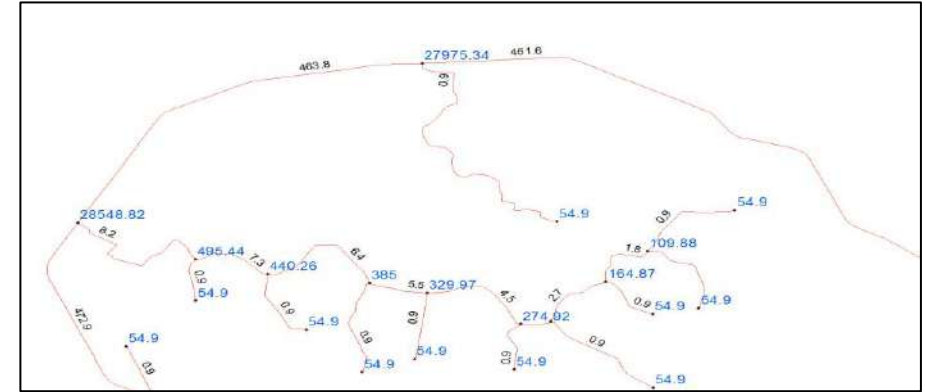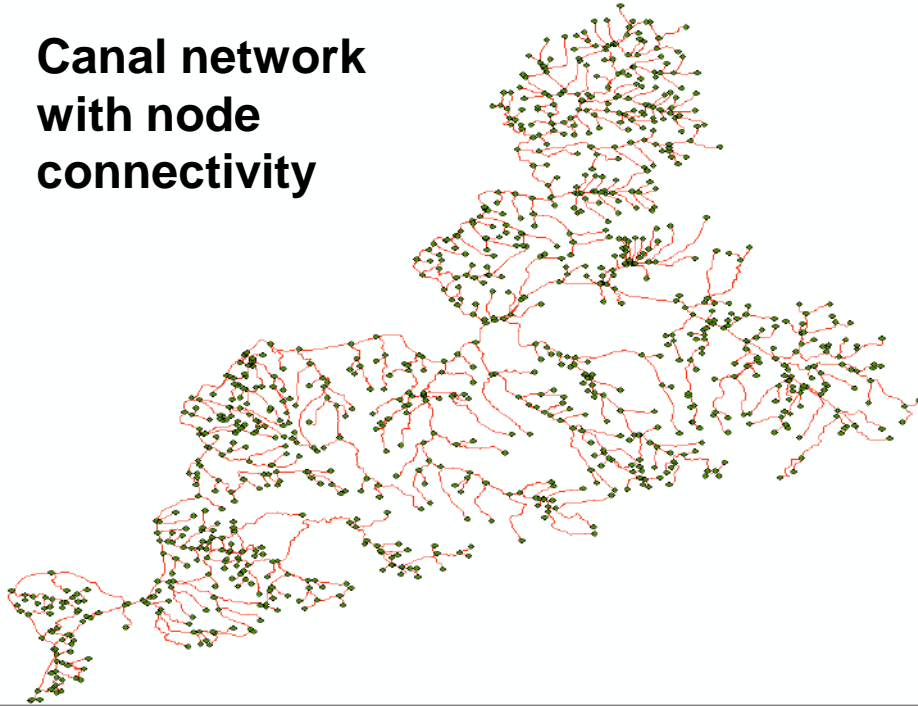
- Volume required at each junction(ha.m)
- Volume to be diverted to each off-taking canal(ha.m)
- Discharge in each canal to meet the requirement for defined release time (m³/s)

Real-time Operational Spatial Flood Early Warning System Development for Tapi and Godavari Basins

Objectives

- ✓ To develop medium-range flood early warning models for the major floodplains of Godavari and Tapi river basins using space based inputs through hydrological modelling approach.

- ✓ To develop spatial flood inundation simulation models using high resolution ALTM DTM in the major floodplains of the rivers. Carto 10 m DEM for other prominent flood plains.

- ✓ To develop web-enabled real-time spatial flood early warning system.

- ✓ To develop workflow mechanism for issuing flood advisory to the concerned disaster management authorities during the flood event.

- ✓ Generation of flood inundation scenarios in the main flood-plains of the rivers under different flood return periods

What is new ?

- ❑ To develop fully automated web-enabled flood early warning system to give flood advisories
- ❑ To consider complete basin area for flood early warning
- ❑ To cover maximum extent of floodplains for inundation simulations (ALTM + CARTO 10m)
- ❑ Scientific assessment of flood-prone areas under different flood return periods
- ❑ Complete 2-D flood inundation simulations in delta areas

Milestones and Status (as on today)

S.No	Activity	Proposed	Status (as on today)
1	Collection of field data and establishing gauge sites by CWC/IMD (if required)	Mar 2019	In progress
2	Preparation of spatial and non-spatial database	Mar 2019	In progress
3	Flood forecast model development	June 2019	Completed
4	FF Model calibration and validation	Dec 2019	In progress
5	Development of spatial Inundation simulation models	Mar 2021	Initiated, ALTM DEM acquisition is in progress
6	Inundation simulation models calibration and validation	Sep 2021	
7	Inundation simulations for different flood return periods	Dec 2022	
8	Development of web-enabled flood forecast system	Mar 2023	
9	Establishing linkages with user organisations	Dec 2022	
10	Implementation of the activity in real-time at NRSC	June 2023	
11	Transfer of technology and models to CWC	Sep 2023	
12	Compilation & report preparation	Mar 2024	

Activities Planned for 2019-2020

S.No	Activity	2019-20 (Apr-Jun)	2019-20 (Jul-Sep)	2019-20 (Oct-Dec)	2019-20 (Jan-Mar)
1.	MIKE Hydro River HD Model calibration and validation.				
2.	Development of spatial Inundation simulation models				
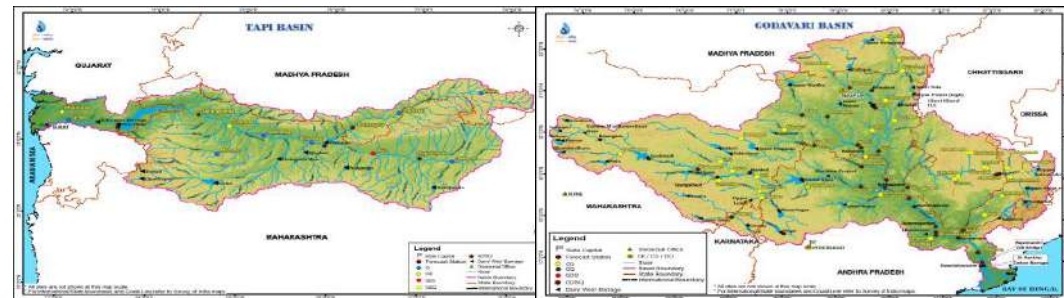
Tapi Basin   **Godavari Basin**

Development of Spatial Snowmelt Runoff product in Indian Himalayas (NHP)

Study Objectives

- To develop a short-term snowmelt runoff forecasting model using satellite derived products and field data
- To generate a spatial daily/3-day gridded snowmelt forecast product
- To provide short term snowmelt runoff forecast at selected basin outlets in snowmelt season

Study Area

Indian Himalayas covering Major river systems (Indus, Ganga and Brahmaputra) including outside Indian boundary

Present Status

- Suomi-NPP satellite derived products such as daily SCA, Snow Albedo and LST generated for 2015 to 2018 for April to June months.
- Established of process chain for NRT generation of NPP products on daily basis
- Developed short term spatial snowmelt forecast model. Calibration and validation to be done
- Experimental spatial snowmelt forecast products being generated
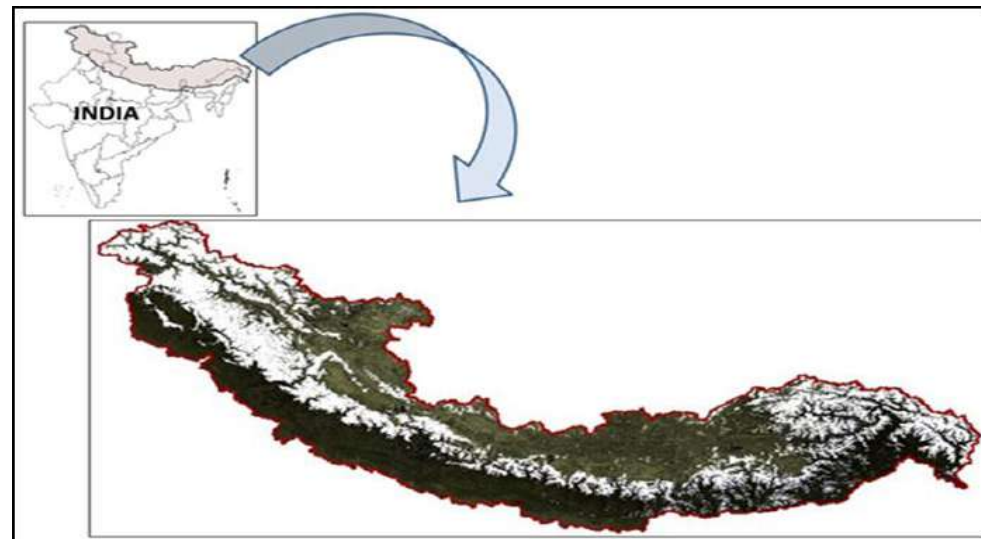
Development of Spatial Snowmelt Runoff product in Indian Himalayas (NHP)
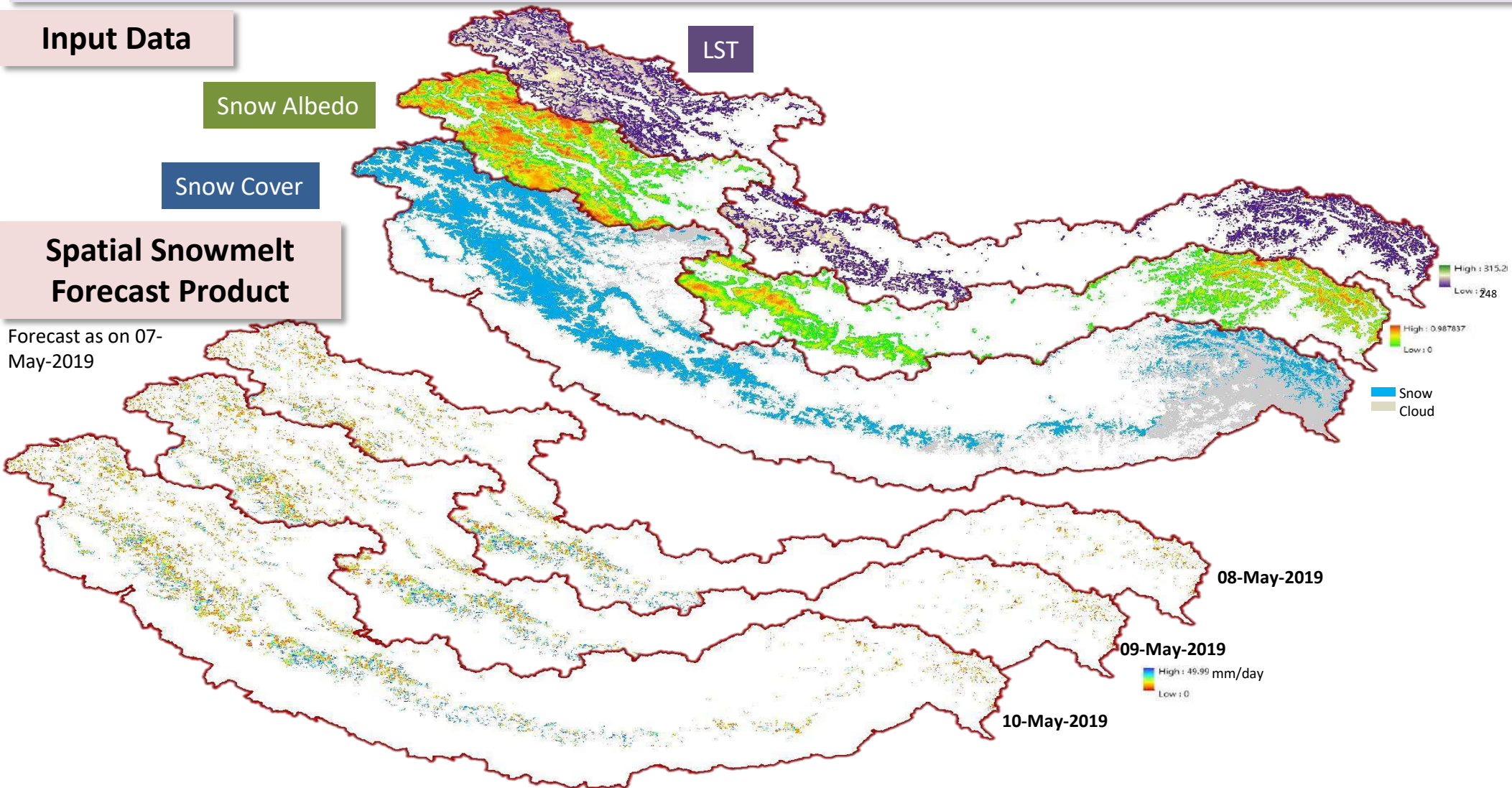

Input Data

LST

Snow Albedo

Snow Cover

Spatial Snowmelt Forecast Product

Forecast as on 07-May-2019

High : 315.2
Low : 248

High : 0.987837
Low : 0

Snow
Cloud

08-May-2019

09-May-2019

High : 49.99 mm/day
Low : 0

10-May-2019

Glacial Lake Outburst Flood Risk Assessment of Glacial Lakes in Indian Himalayas

Study Objectives

- Inventory of Glacial lakes using high resolution satellite data
- Selection and Prioritisation of critical glacial lakes
- Generation of high resolution DEM for d/s of prioritized critical lakes (15)
- Investigation of prioritized critical lakes and their surroundings based on high resolution DEM and data
- GLOF modelling and inundation mapping using high resolution DEM

Study Area

Indian Himalayas covering Major river systems (Indus, Ganga and Brahmaputra) including outside Indian boundary

Present Status

- RS-2 LISS-IV data (450 Sub-scenes) were procured
- Cartosat DEM of 10 m resolution for study area procured
- Inventory of Glacial lakes and water bodies (> 0.25 ha) along 21 attributes being generated
- Methodology for ranking is finalised
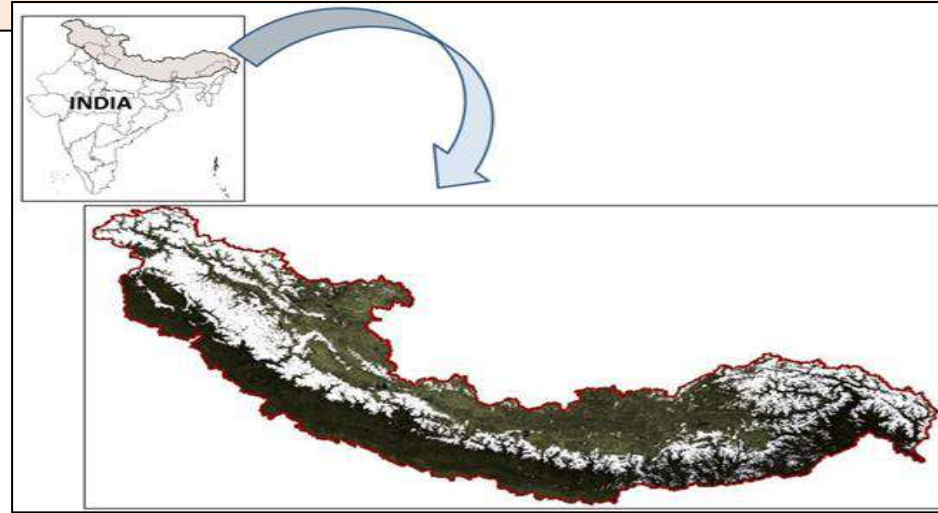
Glacial Lake Outburst Flood Risk Assessment of Glacial Lakes in Indian Himalayas

Glacial lakes and Water bodies (> 0.25 ha)

Indus

Ganga

Brahmaputra

As on 08-May-2019

Indus: 6,669
Ganga: 6,015
Brahmaputra: 19,931

Total: 32,615

Glaciers

Indus

Ganga

Brahmaputra

As on 08-May-2019: 17,711
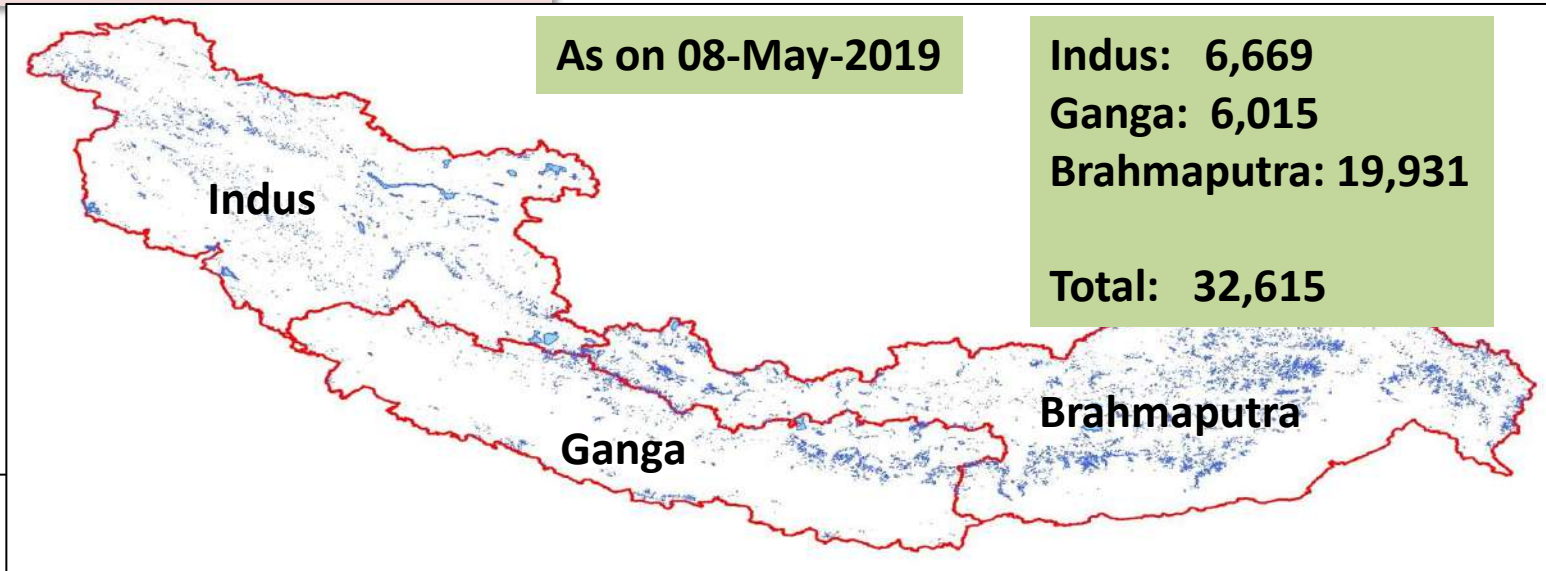
Customized RS & GIS Training and Capacity Building (NHP)

Objectives

- To conduct 2 training programs (one week) per year on RS & GIS fundamentals with 25 participants per batch (2017-18 to 2023-24)
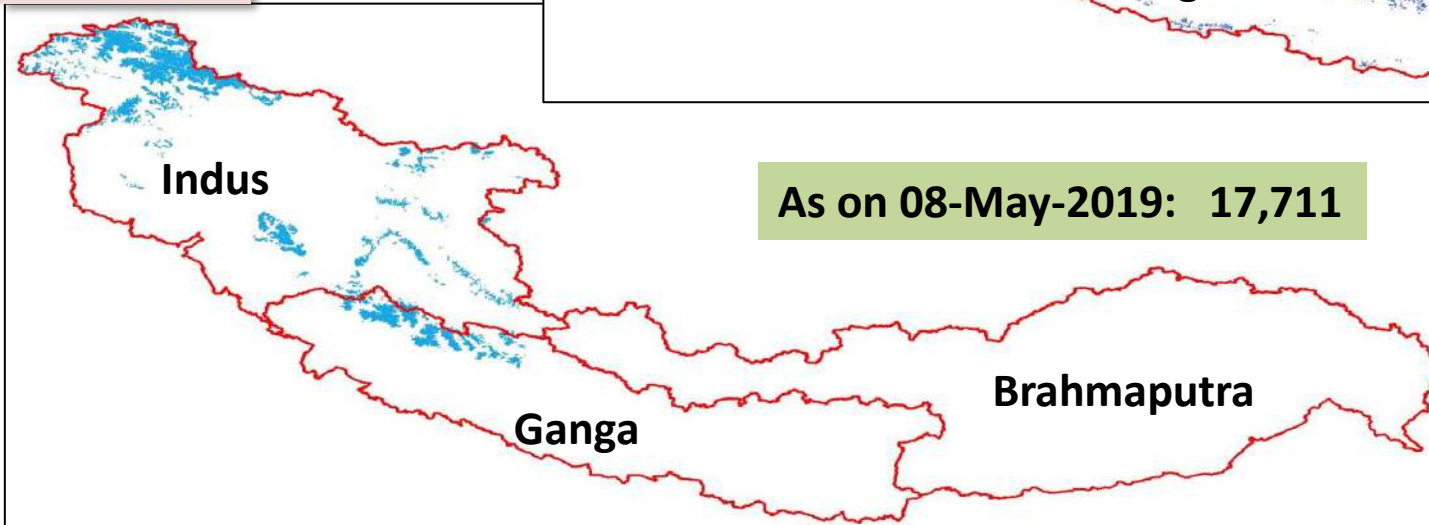- To conduct 2 customized training programs (two weeks) per year on "RS & GIS applications in water resources management" with 25 participants per batch (2017-18 to 2023-24).

Training Programmes conducted till date

Year	Training Programmes	Duration	No. of Participants	No. of IAs
2017-18	2 training programs (1 week) per year on "RS & GIS fundamentals"	31-Jul-17 to 04-Aug-17 09-Oct-17 to 13-Oct-17	23 19	12 9
	2 training programs (2weeks) per year on "RS & GIS applications in water resources management"	18-Sep-17 to 29-Sep-17 05-Feb-18 to 16-Feb-18	21 8	11 5
			Total- 71	
2018-19	2 training programs (1 week) per year on "RS & GIS fundamentals"	09-Apr-18 to 13-Apr-18 29-Oct-18 to 02-Nov-18	17 13	5 4
	2 training programs (2weeks) per year on "RS & GIS applications in water resources management"	30-Jul-18 to 10-Aug-18 11-Feb-19 to 22-Feb-19	29 23	10 8
			Total- 82	

Timelines/Milestones of NRSC activities under NHP

Activity	2017-18	2018-19	2019-20	2020-21	2021-22	2022-23	2023-24
Flood Early Warning	FF Model Dev.		Cal & Val of FF Model & Dev. Of SISM's	Dev. of web-enabled FF system	Spatial Simulations for different RI	Real-time Implementation	Real-time Implementation. Transfer to CWC
ET	Dev. of Net Radiation and Soil Heat Flux Products. Meth. Dev.for ET estimation		Dev. of A ET product and Est. field obser. network	ET validation & Long term database generation and analysis	Operational AET product & web-enabled ET monitoring system	Near real time AET, PET	Real-time Implementation. Transfer to CWC
GLOF	Inv. of GL & glaciers Prelim. selection and Ranking of GL		Gen. of High res. DEM & Hydr. Invest.	GLOF modelling	Assessment of GLOF Risk & Dev. of visualizn.sys.		
Snowmelt	Parameter retrieval and Model development		Experimental forecast	R T forecast and refinement	Real-time forecast and refinement of model		
Hydrological Fluxes	Model Framework Developed	Field Expn . & Valid.	Forecast of inflows into major reservoirs	Real-time run, dissemination, and Web hosting			
Irrigation	GIS data prep.& DSS conceptualis ation	FIR for in season Cropping Pattern	Weekly canal –wise IR estimates	Val. Of IR with canal releases	Dev. Of DSS for canal advisories	Exp. run	Operationalisatio n

Significant Achievements under NHP

Component	Activities
Flood EW	• Flood Forecasting model (Tapi and Godavari) set up is in progress • ALTM DEM for Tapi is acquired and DEM generation is in progress
ET	• Net radiation product & soil heat flux products are being generated • Methodology for derivation of AET product is in progress
GLOF	• RS-2 LISS-IV data (450 Sub-scenes) & 10 m Cartosat DEM procured • Inventory of Glacial lakes and water bodies (> 0.25 ha)is in progress • Methodology for prioritisation of ranking of critical glacial lakes is finalised
Snowmelt	• Process chain for near-real-time generation of Suomi-NPP Daily maximum possible snow cover data products • Parameter retrieval and model development is in progress
Hydrological Fluxes	• National level HM framework at 3' grid resolution in VIC model established • Runoff calibration is in progress & forecast of inflows into 48 major reservoirs completed
Irrigation	• Historical cropping pattern derived for Narayanpur command area • VIC-CROPSYST frame work developed for estimation of FIR & Development of Hydraulic model simulating uniform flow in an irrigation channel is under progress
Hydrological Drought	• Developed methodology for composite Hydrological Drought Index • Developed methodology and implemented standardised Runoff Index at grid level

THANK YOU