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BMD's (Bangladesh Meteorological Department) expectations of new-generation satellites for hazard monitoring

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- **Location: South Asia (20.57N-26.63N & 88.02E-92.68E)**
- **Area: 147570 km²**
- **Population: 160 million (Approx.)**
- **Land elevation of 50% of the country is within 5 m of MSL**
- **About 68% of the country is vulnerable to flood**
- **20-25% of the area is inundated during normal flood**

CLIMATE OF BANGLADESH

Seasons	Period	Weather Events	Rainfall
Summer (Pre-monsoon)	March - May	Thunder storm, Tornado, Hail, Cyclone, Heat Wave	19%
Rainy Season (Southwest Monsoon)	June – September	Heavy rain, Monsoon Depression, Flood	71%
Autumn (Post-monsoon)	October – November	Cyclone, Tornado	8%
Winter (Northeast Monsoon)	December – February	Abnormal Dryness (Drought), Cold Wave	2%

Disaster Calendar
(Extreme Meteorological Events)

~ Bangladesh is one of the most disaster prone coutries in the world. ~

Lowest Temp.	Highest Temp.	Strongest Wind	Highest Rainfall
2.8 deg Celsius 04 Feb 1968 Srimongal	45.1 deg Celsius 18 Mar 1972 Rajshahi	225 km/h 29 Apr 1991 Sandwip	590 mm/day 15 Jun 2001 Sandwip

1 2 3 4 5 6 7 8 9 10 11 12 (Month)

Tropical Cyclone | Monsoon Depression | Tropical Cyclone

Thunderstorm /Nor'wester | Heavy rain & Thunder | Thunderstorm

Fog | Drought | Flood | Fog

Cold wave | Heat wave | Cold wave

1 2 3 4 5 6 7 8 9 10 11 12 (Month)

Major Severe Weather and Natural Disasters in Bangladesh:

Tropical cyclone, SevereThunder Storm/ Tornadoes, Heavy rainfall, Floods , Storm surge, Flash flood, Landslides, Tidal bores , Droughts, River erosion, Earth quakes , Heat waves, Cold waves

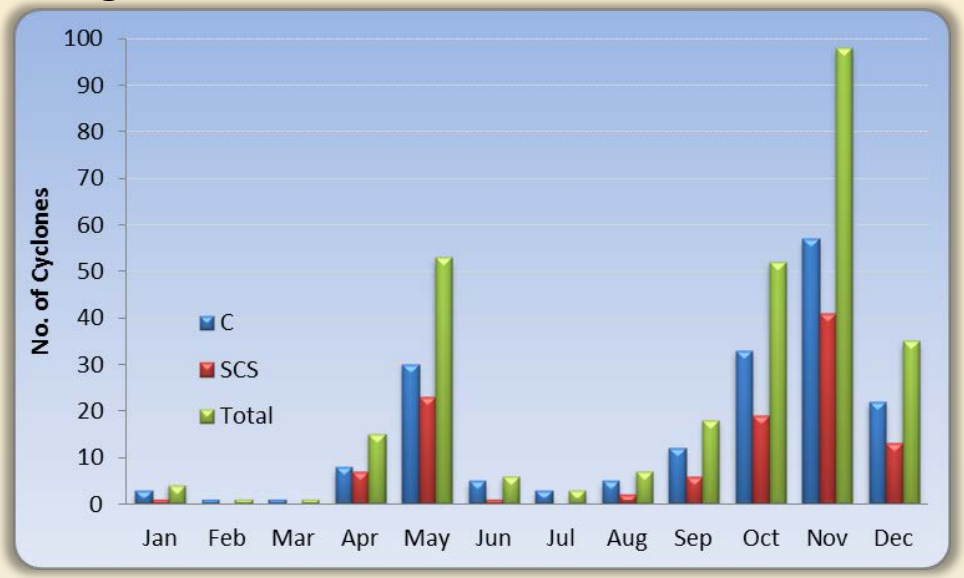
BMD's Top three hazards of concern that can be monitored by satellite :

1. Tropical Cyclone
2. Severe Thunder Storm
3. Monsoon Activity (Heavy Rainfall, Flood)

Hazard 1: Tropical cyclone

Bangladesh has a complex coast line (Funnel shape of the Bay) of about 710 kms and long continental shelf with shallow bathymetry.

About 5% of the global tropical cyclones form over the Bay of Bengal. On an average, 5 to 6 storms form in this region every year. But casualties, here, is 80% of the global casualties. Loss of life and property is mainly attributed to the storm surge as well as strong wind.



Frequency of cyclone over Bay of Bengal during 1895-2013

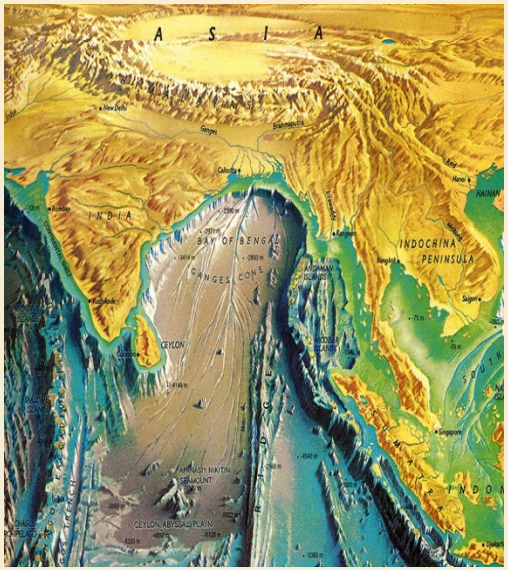
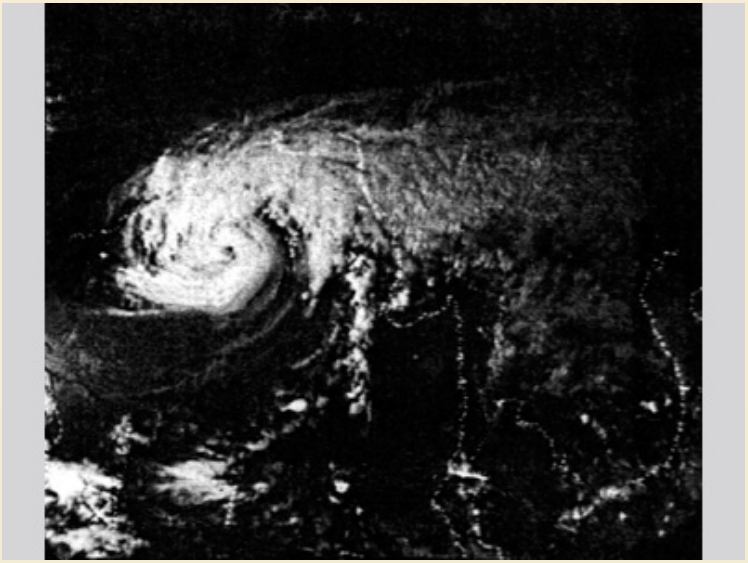


Fig: Bathymetry of Bangladesh

Case-1:

- The November 11, **1970 "Bhola** (Formed 03 November 1970; Dissipated 13 November 1970) struck Bangladesh and produced devastating storm surge flooding.
- The storm surge was estimated to be 20-30 feet high and average winds in excess of 225.3 km/h (140 mph).
- At least 300,000 – 500,000 people in the low-lying region near the Bangladesh coast were killed by massive flooding from the powerful cyclone is the **world deadliest known tropical cyclone** in history.



An image of the Bhola Cyclone as it formed on 11 November, 1970.
Source: NOAA

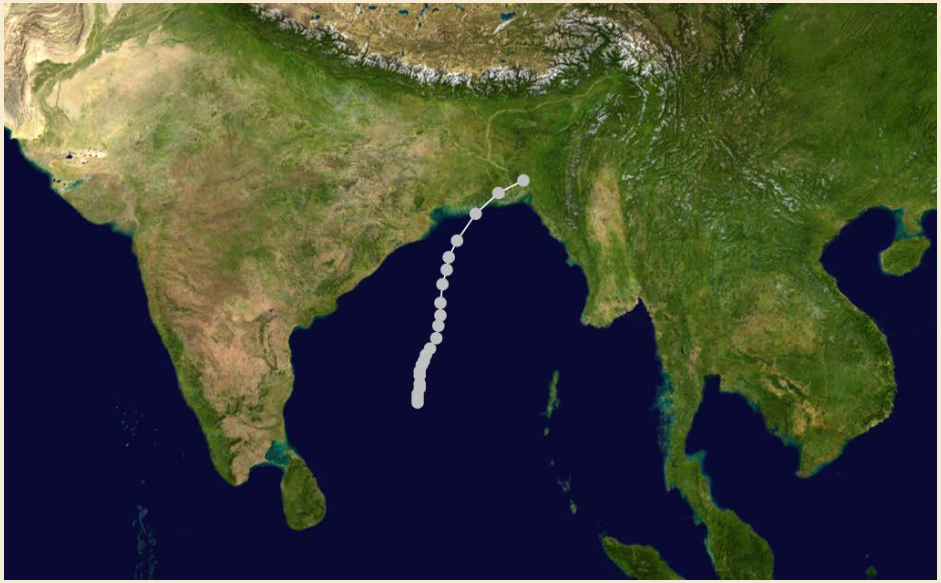
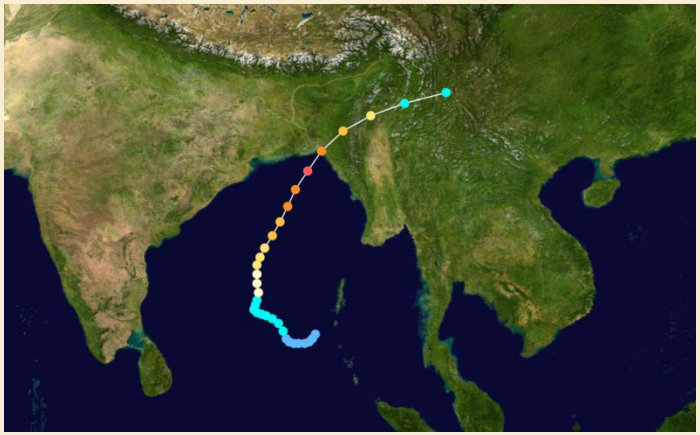


Fig : Map plotting the track of the cyclone

Case-2:

- The **1991 Bangladesh cyclone** [Super cyclonic storm, Formed April 24 , 1991; Dissipated 29 April, 1991] was one of the deadliest tropical cyclones on record.
- On the night of 29 April 1991 the powerful tropical cyclone struck the Chittagong district of southeastern Bangladesh with winds of around 250 km/h (155 mph).
- The storm forced a 6 metre (20 ft) storm surge inland over a wide area, killing at least 138,000 people and leaving as many as 10 million homeless and caused huge loss of lives and damage to properties in Bangladesh.

Visible satellite image from 06:23 UTC on April 29, 1991

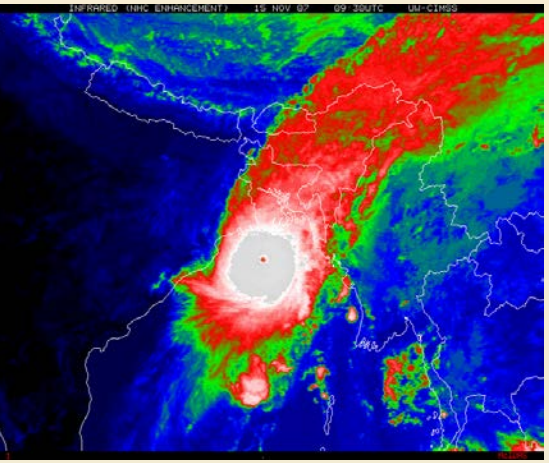


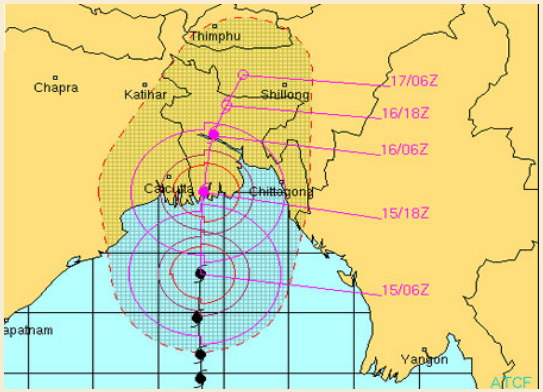
Flooding around the Karnaphuli River in Bangladesh Due to Cyclone 1991

Case-3:

- **Cyclone Sidr** [Extremely severe cyclonic storm (IMD scale), Formed 11 November 2007; Dissipated 16 November 2007] was one of the worst natural disasters in Bangladesh.
- The storm struck on November 15, 2007 with winds of around 250 km/h (155 mph) and triggering a 5-metre (15-foot) tidal surge and killed some 3,500, injured tens of thousands and displaced 2 million.
- **The devastation also includes:**

- Over 1.4 million homes destroyed or damaged ; At least 1.25 million livestock killed
- 2 million acres of cropland damaged ; Roads and coastal embankments destroyed





Cyclone Sidr in the Bay of Bengal near peak intensity

Hazard 2: Severe Thunderstorm/ Tornado

- The geographic location of Bangladesh, with the Bay of Bengal to the south and the Himalayan Mountains to the north, makes a tornado a natural phenomenon for Bangladesh.

- During the hot weather period, predominantly during the pre-monsoon season from March to May thunderstorms with great destructive potential occur.

- Bangladesh is the world's worst place for deadliest tornadoes. Bangladesh is considered the only other part of the world outside the United States where strong and violent tornadoes are prevalent.

06 out of 10 world's worst tornadoes ever recorded in terms of fatalities have occurred in Bangladesh:

Nmae of the Hazards	Location	Date/Year	Death Toll
Daulatpur-Saturia Tornado	Manikganj, Bangladesh	26 April 1989	1300
Jamalpur-Tangail Tornado	Madarganj and Mirzapur, Bangladesh	13 May 1996	700
Manikganj, Singair and Nawabganj Tornado	Manikganj, Bangladesh	17 April 1973	681
Northeast suburbs of Dhaka Tornado	Dhaka, Bangladesh	14 April 1969	660
Magura and Narail Tornado	Magura , bangladesh	11 April 1964	500
Madaripur and Shibchar Tornado	Madaripur , bangladesh	1 April 1977	500

Fig: April 30, 1989, in Saturia, the houses were reduced to scraps during a severe tornado

Fig:Damage left by a tornado at in Mymensingh district, April 15, 2004, north of the capital Dhaka.

Fig: At least 20 people were killed and more than 300 others injured when a tornado ripped through scores of villages in Brahmanbaria district on 22 March , 2013

Hazard 3: Monsoon activity (Heavy rainfall and flood)

Heavy Rainfall:

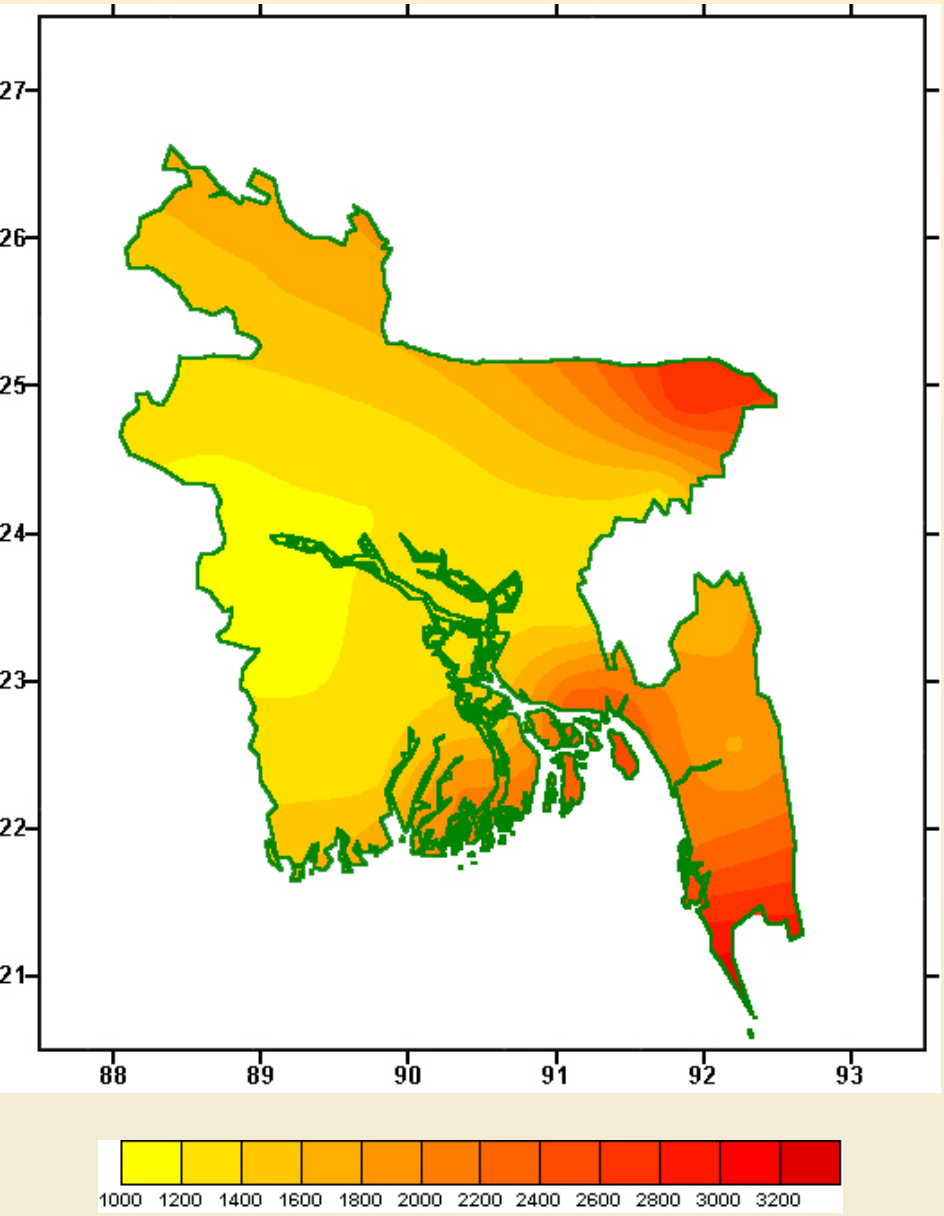
Bangladesh's unique geographic location, with the Indian Ocean to the south, the Himalayas to the North and the prevailing monsoons, has made it one of the wettest countries of the world.

- While the mean annual rainfall over the country is about 2320 mm, there are places with a mean annual rainfall of 6000mm or more (Hossain et al., 1987).

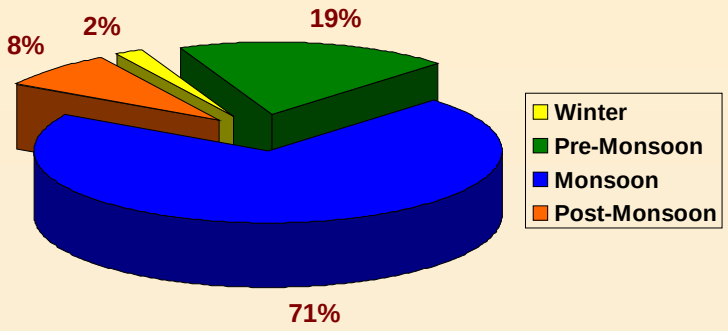
- In September 2004, 341mm rainfall occurred in 8 hours in Dhaka which led to severe urban flooding . Serious urban floods also took place in Dhaka city due to 333mm rainfall on 28 July, 2009.

- On 11 June, 2007 around 408 mm rainfall was measured in Chittagong, which resulted in urban flooding and landslide killing at least 124 people

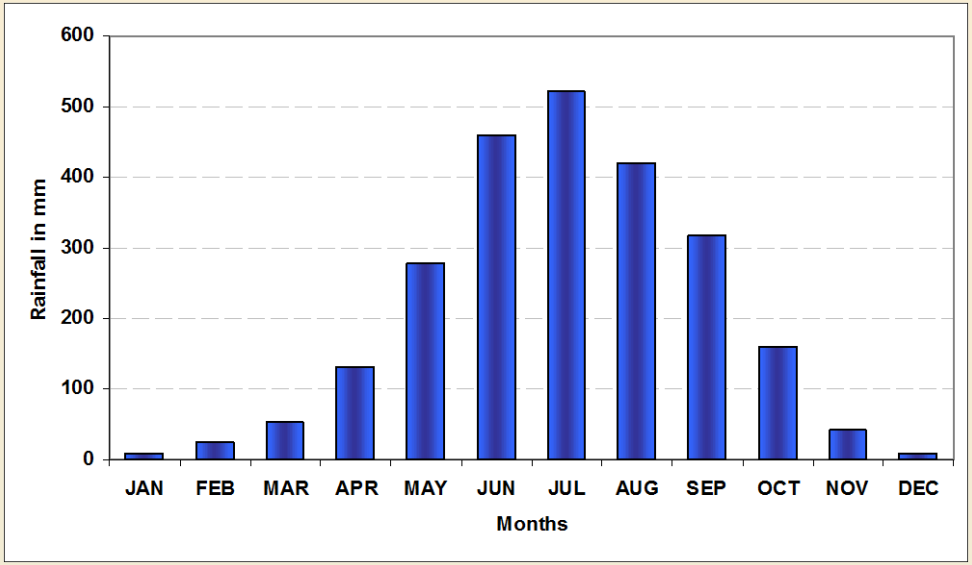
- Very recently, the seasonal monsoon rain showers have set off severe floods and landslides, since June 24, 2015 in Cox' Bazar, Bandarban and Chittagong. Hundreds of villages have submerged under swelling waters, over 200 000 people have been stranded, and at least 19 people died.



RAINFALL DISTRIBUTION OVER BANGLADESH IN MONSOON



Season wise Rainfall



MONTHLY RAINFALL DISTRIBUTION OVER BANGLADESH

Fig: Heavy Rainfall as well as flooding condition due to active Monsoon June, 2015

Flood:

Bangladesh is prone to flooding due to being situated on the Ganges Delta and the many distributaries flowing into the Bay of Bengal.

- The floods have caused devastation in Bangladesh throughout history, especially during the years 1966, 1987, 1988 , 1998, 2004 , 2010 and 2015. The 2007 South Asian floods also affected a large portion of Bangladesh.

- The catastrophic floods of 1987 occurred throughout July and August and affected 57,300 km^2 of land, (about 40% of the total area of the country)

- The flood of 1988, which was also of catastrophic consequence, occurred throughout August and September. The waters inundated about 82,000 km^2 of land, (about 60% of the area)

- In 1998, over 75% of the total area of the country was flooded, including half of the capital city Dhaka. 30 million people were made homeless and the death toll reached over a thousand. 700,000 hectares of crops were destroyed and there was a 20% decrease in economic production.






Fig: Flood Condition

BMD's expectations of new series of satellites for hazard monitoring

Major hazard	Features of new generation GEO met. satellite
Hazard 1: **Tropical cyclones**	**Multi-spectral bands:** Images derived from multi-spectral-band observations will more effective for giving better warnings and prediction. **Rapid scanning:** Rapid scanning observations will also more effective for giving better warnings. **High spatial resolution:** Images of high special observations will more effective for monitoring the formation and track of the tropical cyclone.
Hazard 2: **Severe Thunderstorms**	**Rapid scanning:** Rapid scanning observations will enable to early detection of convective activities which is very helpful for nowcasting. **Multi-spectral bands:** New quantitative products will be derived from multi-spectral band observation data. **High spatial resolution:**

BMD's expectations of new series of satellites for hazard monitoring

Major hazard	Features of new generation GEO met. satellite
Hazard 3: Monsoon Activity	**Multi-spectral bands:** Images derived from multi-spectral-band observations will more effective for giving better heavy rainfall warnings and prediction. **Rapid scanning:** Rapid scanning observations will also more effective for giving better heavy rainfall warnings. **High spatial resolution:** Images of high special observations will more effective for monitoring the potential Rainfall zone.

BMD's plans/requirements for utilization of new-generation geostationary meteorological satellite data

- BMD plans to utilize high spatial and temporal resolution images and products for severe weather forecasting and warning to support very-short range forecasting, as well as nowcasting.
- BMD will ensure to increase the internet bandwidth in order to receive new-generation satellites products capable for high spatial resolution and multi-spectral bands reception and processing system.
- BMD plans to acquire software for processing different types of satellite products and more training in imagery analysis.
- BMD will install HimawariCast to all BMD Regional Meteorological Services.

For utilization of new-generation geostationary meteorological satellite data BMD's requirements are also given below:

- High Computing Power (PC Cluster)
- Comprehensive Training on NWP.
- Training on NWP development.
- Interpretation of NWP products.
- COMS (Communication, Ocean and Meteorological Satellite) data receiving and analysis system.
- Marine Meteorology and Hydrology related training is needed.
- Training in Satellite imagery analysis (home and dabroad)
- Training on Programme language of NWP is needed
- Rainfall estimation from cloud imageries
- Fog Monitoring and prediction using Satellite products
- Satellite Radiance Data assimilation
- Satellite SST analysis

Thank you