

# The Past and Present History of Earth Science Applications Using the NASA Database Regarding Bangladesh Tropical Cyclone Forecast Advancement

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# Motivation and Purpose of this Study

Personal Experiences

1985 and 1991

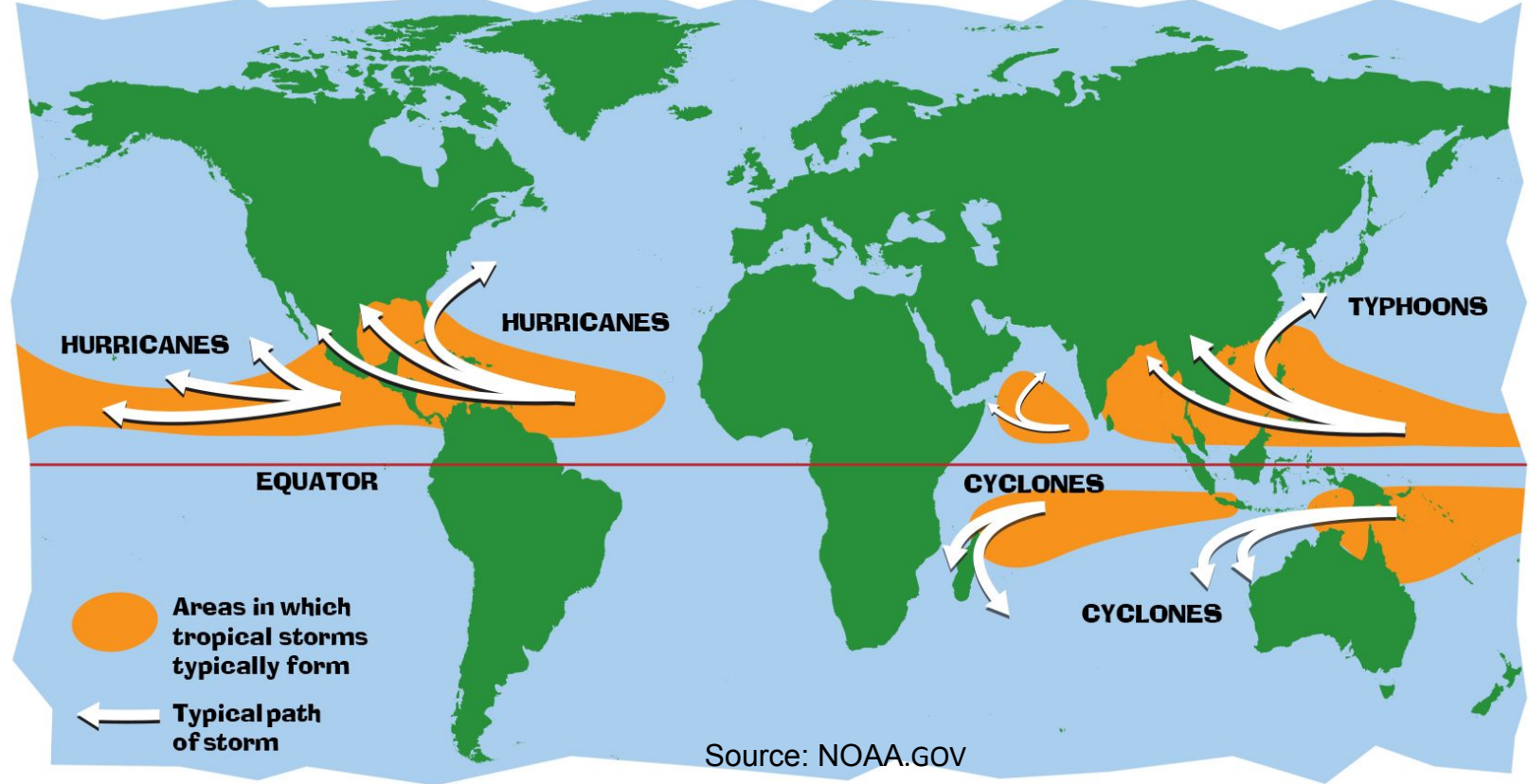
To identify Bangladesh's severe tropical cyclones

The cyclone monitoring system

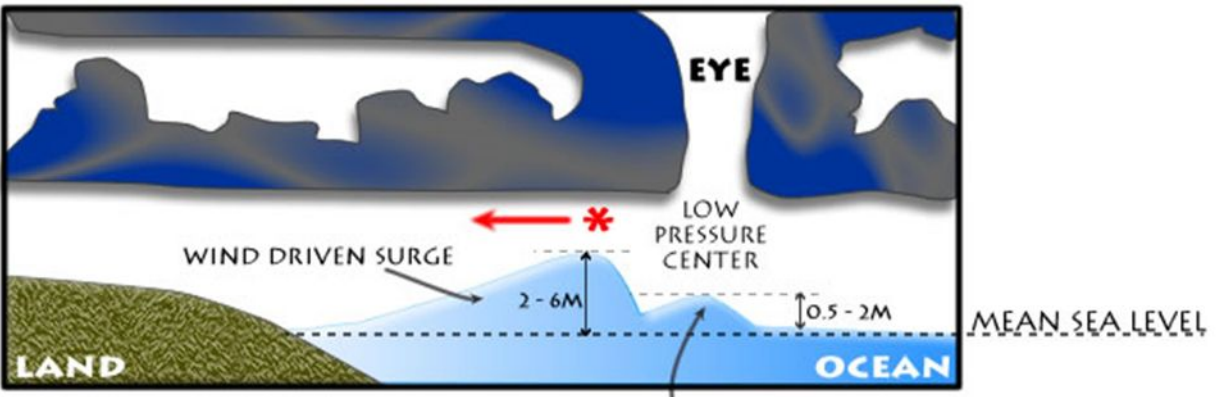
Using NASA database in the Earth Science Applications

The effectiveness of NASA database

# Tropical Cyclones and Their Formation



← DIRECTION OF TROPICAL CYCLONE MOVEMENT



\* High on-shore winds on the right (left) side of the storm in the Northern Hemisphere (Southern Hemisphere)

SEA LEVEL RISES DUE TO THE LOW PRESSURE IN THE EYE

## Tropical Cyclones

Low pressure system, Hurricanes, Typhoons, Cyclones

## Four Stages

Tropical Disturbance, Tropical Depression, Tropical Storm, and Cyclone

## Formation

- Tropical regions
- Ocean temperature 80 degrees Fahrenheit
- Develop over Africa and blow westward where waters are warm
- It begins to cool creates anvil-shaped clouds
- Winds begin blowing in a circle
- Spinning winds reach 74 miles per hour become a cyclone





# Monitoring Tropical Cyclones

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- GOES satellites
- Built by NASA and operated by NOAA
- Currently NOAA maintains
  - GOES-S, GOES-17, GOES-16, GOES-15, GOES-14, GOES-13



Cyclone  
Categories

Category	Wind Speed (mph)	Damage at Landfall	Storm Surge (feet)
1	74-95	Minimal	4-5
2	96-110	Moderate	6-8
3	111-129	Extensive	9-12
4	130-156	Extreme	13-18
5	157 or higher	Catastrophic	19+

Source: NASA <https://spaceplace.nasa.gov/hurricanes/en/>



# Physical Characteristics of Bangladesh Coastline

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- Highly diverse
- Western section: active delta
- Coastline: floodplains
- Slope:
  - low 1.5 inches/miles west
  - 1 inches/mile central, and
  - east coast much steeper



# Indian Continent Cyclone Monitoring System Progress



Image Source: IMD

- 17<sup>th</sup> century
- Thermometer
- Barometer
  
- British scientist Halley published article in 1636
  
- British East India Company established meteorological stations
- 1785 in Calcutta and 1796 in Madras

# NASA Achievements and Progress Global Weather Forecast

## **TIROS 1**

1<sup>st</sup> weather satellite 1960

## **ECHO 1**

1<sup>st</sup> communications passive satellite  
reflected radio and radar signals; early  
60s

## **Telstar 1**

A private company built and operated by  
AT&T; 1<sup>st</sup> publicly available transatlantic  
TV signals

## **Nimbus**

launched in 1964; 1<sup>st</sup> images of  
hurricanes from space; contributed to  
improved long-term weather forecasts

## **Apollo 8; Dubbed GOES, POES**

More than 30 satellites have been  
observing Earth

## **Landsat Satellite Series**

### **Landsat 1**

1<sup>st</sup> launched 1972

### **Landsat 9**

Launching in September 2021

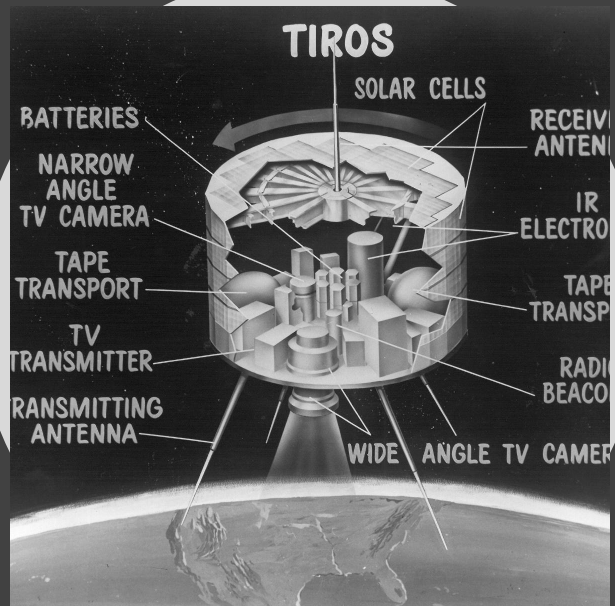
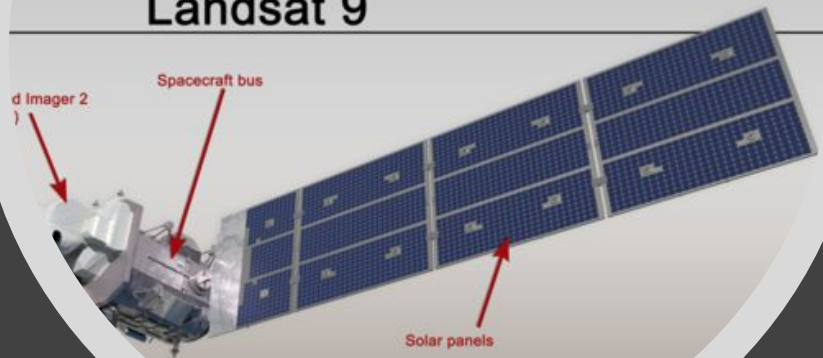
Jointly NASA and the U.S. Geological  
Survey (USGS) operating and observing  
Earth's land surfaces, oceans, and  
atmosphere

## **International Space Station**

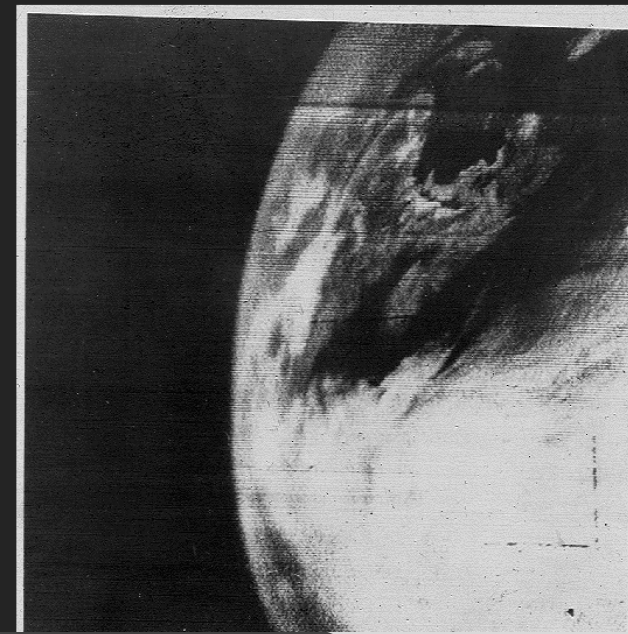
Established in 1993



# Landsat 9



FIRST TELEVISION PICTURE FROM SPACE  
TIROS I SATELLITE  
APRIL 1, 1960



Sources: NASA; NOAA; USGS



# Cyclone Forecasting and Time Periods

# Pre-colonial-era & Major Cyclones

Cyclone Name	Location	Date/Year	Death	Application
Backerijang	Bangladesh	1584	200,000	Animal and plant observations, weather almanacks, rain God Hindus, statistical weather forecasting, dark cloud observation
Sunderbans	Bangladesh	1699	50,000	
Hooghly River	India & BD	1737	300,000	
Backer Barisal	Bangladesh	1767	30,000	
Barisal	Bangladesh	1831	22,000	



# Colonial-era and Major Cyclones

Cyclone Name	Location	Date/Year	Death	Applications
Barisal	Bangladesh	1822	50,000	Indian Meteorology Department-IMD 1875  IMD produced 1 <sup>st</sup> monsoon forecast 1886 using the melting snow  IMD has been using statistical methods weather forecasting under British colony 1920s
Great Backerganj	Bangladesh	1876	200,000	
Chittagong	Bangladesh	1897	175,000	
Bangladesh	Bay of Bengal	1912	40,000	
Bangladesh	Bay of Bengal	1919	40,000	
Bengal Cyclone	India & Bangladesh	October14, 1942	101,000	

# Post-colonial-era (East Pakistan) & Major Cyclones

Cyclone Name	Location	Date/Year	Death	Applications
Chittagong	Bangladesh	May 28, 1963	22,000	Strom gauge, barometer, radars screen, ground observation, telephone, maps, lighthouse, cyclone centers, cargos, ships, watermark, radiosonde network, Singapore forecast center, reconnaissance aircraft, aerial photograph, ITOS 1 weather satellite
Bangladesh	Bay of Bengal	May 11, 1965	36,000	
Bangladesh	Bay of Bengal	May 31, 1965	15,000	
Great Bhola	Bangladesh	November 12, 1970	300,000-500,000	

# Bangladesh-era (After 1971) & Major Cyclones

Cyclone Name	Location	Date/Year	Death	Applications
Urir Cyclone	Bangladesh	May 28, 1985	15,000	Teleprinters & SSB, BMD Radars, observatories, ships, cyclone E-Atlas, SYNOP chart, NWP modelling, synoptic observations, MODIS on NASA's Terra satellite, Climate Booklet, Himawari-8 satellite, CYGNSS satellites, SAR, TIROS-3, Sentinel-1, RADARSAT-2,
Cyclone 02B	Bay of Bengal	May 5, 1991	175,000	
Sidr	Bangladesh	November 15, 2007	3,363	
Nargis	Bangladesh	May 8, 2008	3500	
Aila	Bangladesh	May 25, 2009	150	
Mora	Bay of Bengal	May 30, 2017	7	
Amphan	Bangladesh & India	May 20, 2020	80	



# Tropical Cyclones & Related Impact

Hazards associated with tropical cyclones

Storm surge

Coastal inland flooding

River flooding

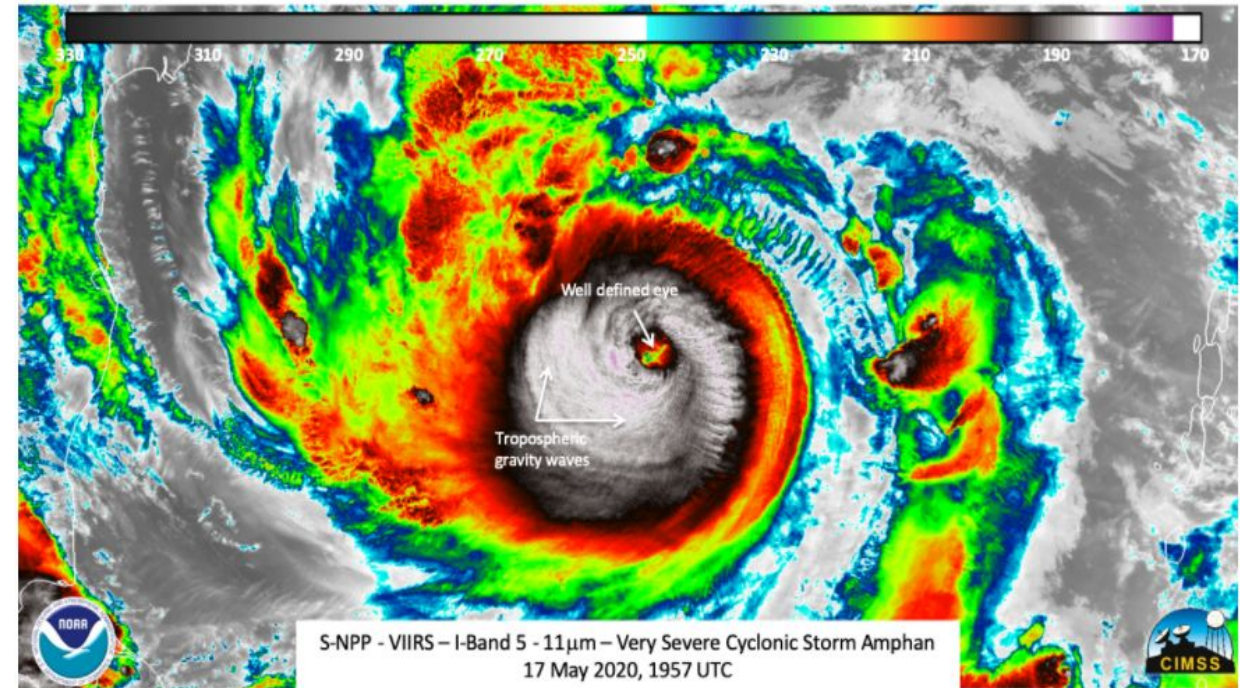
Heavy rains

Extreme winds

High surf & rip currents

Tornadoes

Lighting



Imagery via the Suomi-NPP satellite on May 17, 2020.

[Cyclone Amphan](#)





Cyclone Amphan Source: NASA

Himawari-8 satellite caught this imagery of Tropical Cyclone Amphan



# Bangladesh Cyclone Forecast and Earth Science Application

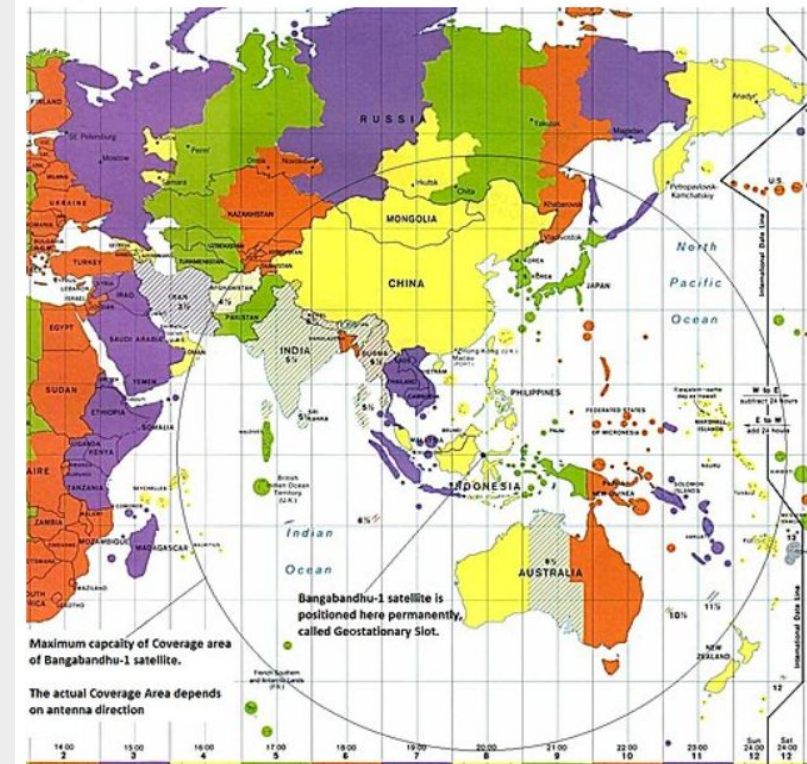
Bangladesh Meteorological Department (BMD)

Bangladesh Airforce MET



Bangabandhu Satellite-1

Map of satellite's position



<https://www.bsf.org.bd/bangladesh-an-overview/bangabandhu-satellite-1/>,  
[https://met.baf.mil.bd/history\\_of\\_met](https://met.baf.mil.bd/history_of_met).



# Southeast Asia & Nearby Nations Weather Satellites

India: INSAT series-Cyclones

Bangladesh: Bangabandhu Satellite-1

Pakistan: Pakistan Remote Sensing Satellites

Sri Lanka: SupremeSAT-Communication

Japan: Himawari-Meteorological Satellite

China: Fengyun 3E satellite-Weather

Myanmar: Himawari-8; RealVue™ Satellite

Indonesia: Palapa-communication

Cambodia: 1<sup>st</sup> satellite will launch in October 2021

Singapore: X-Sat

Philippines: Diwata-Weather observation microsatellite

Thailand: THEOS-Earth Observation

Laos: LaoSat 1-Telecommunication

Malaysia: TiungSAT-1 Meteorological

Vietnam: VNREDSAT-1 Earth Observation

# Looking Forward to the Future Technologies

Landsat 9

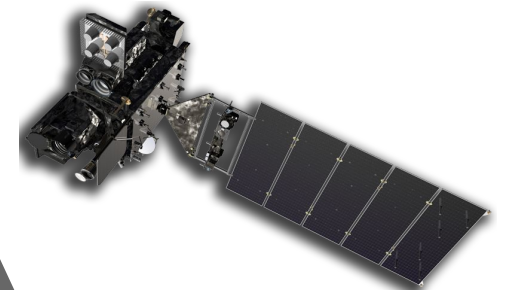
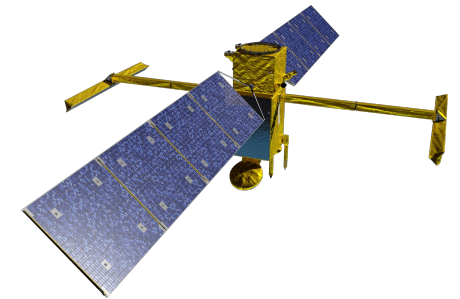
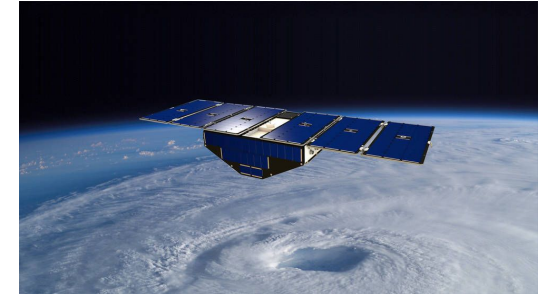
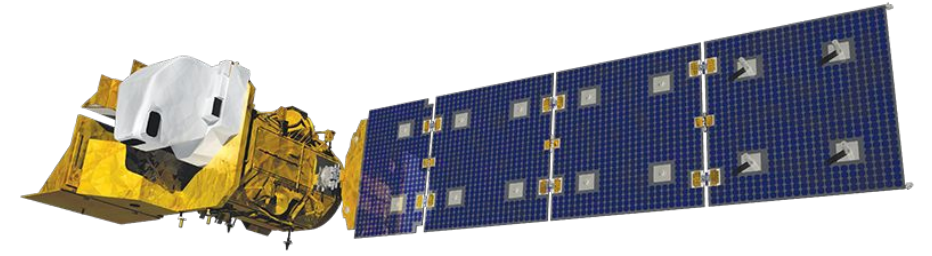
CYGNSS

Cyclone Global Navigation Satellite System

SWOT

Surface Water and Ocean Topography

GOES-R series



Possible Future  
Research  
Recommendation  
Relates to Earth  
Science Application

Coastal ecosystem mangrove forests destruction from the cyclones and storm surge

Landcover change in the coastal regions due to cyclones

Why climate change triggers sea level rise in coastal Bangladesh?

Cyclone intensification aided by Climate change

Risk assessment and infrastructure damage from cyclones

Monsoon flood, riverbank erosions, and human migration

Floods and Vulnerability

Earth Science Application monitoring agriculture

Crop damages from drought

Crop damages from monsoon river floods

Disaster Management System, policy, and mitigation effort



# Key Sources

The National Aeronautics and Space Administration-NASA.GOV

Indian Space Research Organization-ISRO.GOV

Japan Aerospace Exploration Agency-JAXA

Pakistan Space and Upper Atmosphere Research Commission-SUPARCO.GOV

Asia-Pacific Space Cooperation Organization-APSCO.INT

Bangladesh Space Research and Remote Sensing Organization-SPARSO.GOV

Bangladesh Meteorological Department-BMD.GOV

India Meteorological Department-IMD.GOV

National Ocean and Atmospheric Administration-NOAA.GOV

National Hurricane Center and Central Pacific Hurricane Center-NHC.NOAA.GOV

World Meteorological Organization-PUBLIC.WMO.INT

Pakistan Meteorological Department-PMD.GOV

United States Geological Survey-USGS.GOV

The Asia Foundation-ASIAFOUNDATION.ORG

Meteorological Branch Bangladesh Airforce-MET.BAF.MIL.BD

Naval Meteorology & Oceanography Command (NMOC)-METOC.NAVY.MIL

Joint Typhoon Warning Center-JTWC

Asia-Pacific Regional Space Agency Forum (APRSAF)

Asian Disaster Reduction Center (ADRC)

Sentinel Asia

United Nations Economic and Social Commission for Asia and Pacific-UNESCAP.ORG

United Nations Development Programme-UNDP.ORG

Paul, Bimal Kanti, and Harun Rashid. "Climatic Hazards in Coastal Bangladesh." *Salinity Intrusion and Impacts* (2017).

# Acknowledgement

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Dr. Gregory Vandenberg: UND Mentor








**Asian tops worst cyclones**

prone to some of the worst cyclones in the world.

Deadly tropical cyclones, deaths in thousands

Bangladesh (1970)	300
Bangladesh (1991)	139
China (1922)	100
Bangladesh (1942)	61
India (1935)	60
China (1912)	50
India (1942)	40
Bangladesh (1965)	36
Honduras (1998)	15

Bangladesh, 1970, six days after cyclone



# Questions?

