

# **Hindu Kush Himalayan Hydrological Cycle Observing System (HKH-HYCOS)**

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WMO Global Hydrological Status and Outlook System (HydroSOS)  
September 26-28, Entebbe, Uganda

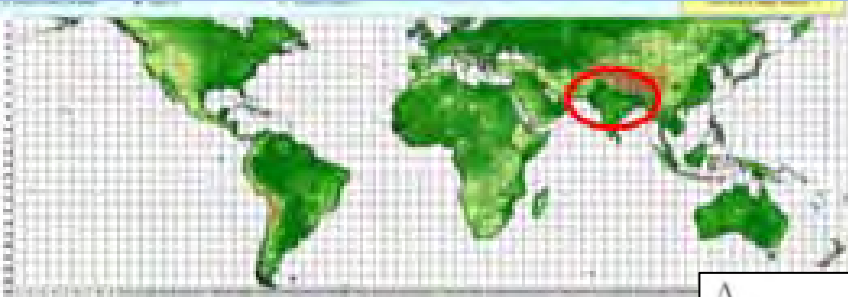
# Outline

## The HKH-Region: Flood issues

### HKH-HYCOS Programme:

- Pilot Real Time Observation System
- Regional Flood Information System
- Regional Flood Outlook
- Transboundary Flood Outlook-Koshi R.

# The HKH region: flood issues

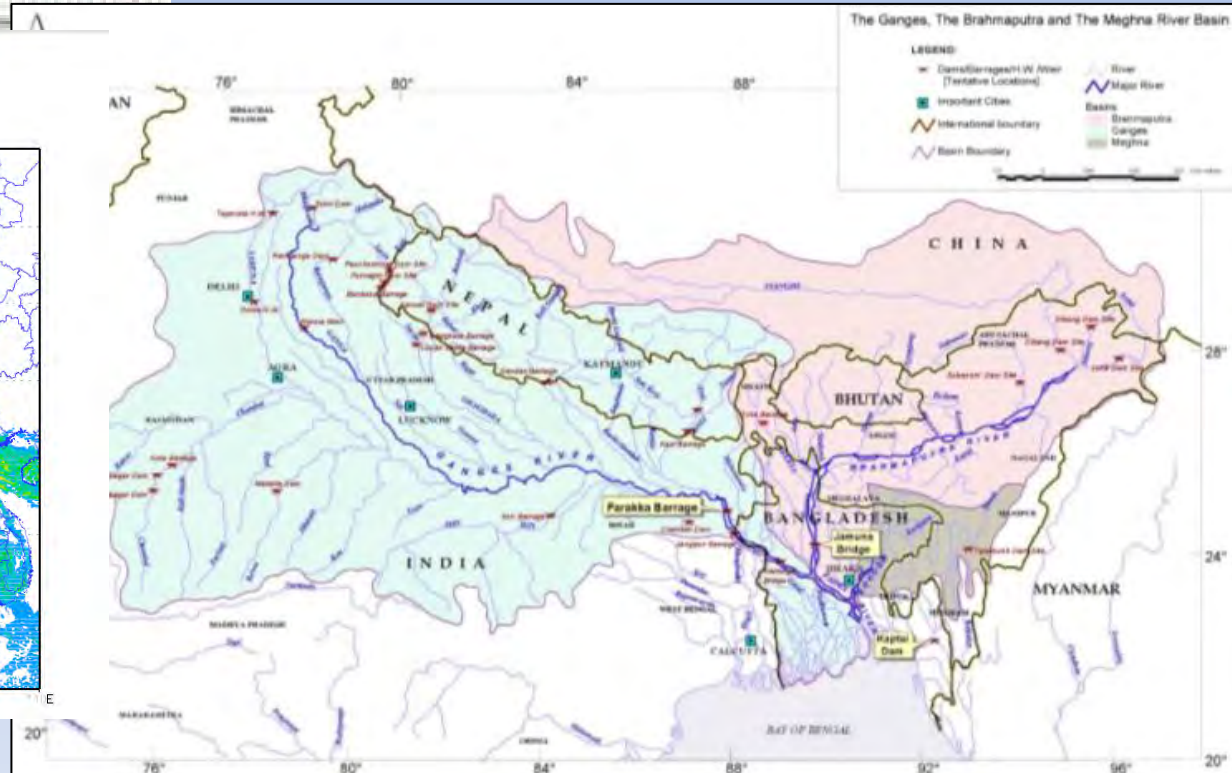
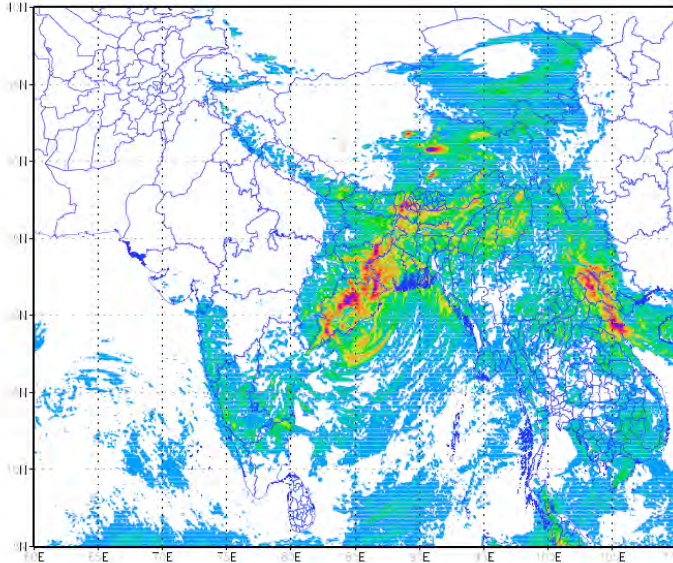


The HKH region consists of large river basins of China (Tibet), Afghanistan, Pakistan, Nepal, Bhutan, India & Bangladesh

Simulation for 24 Hour Accumulated Rainfall in mm

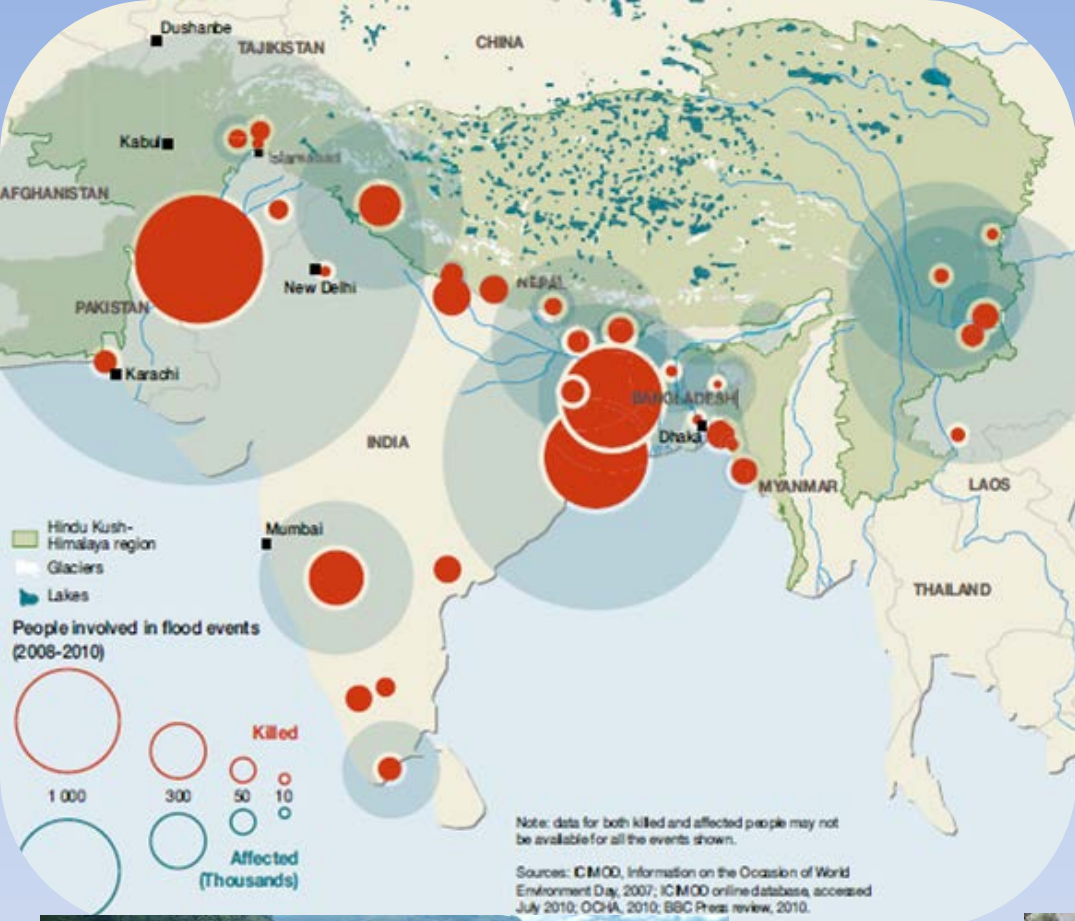
Valid from 20092014 00UTC to 21092014 00UTC

\*\*\*\*\* OUTPUT DAY I \*\*\*\*\*



The Ganges and Brahmaputra are two very large river systems of South Asia with a catchment area of 1.5 million sq. km .





Out of a total population of over 1 billion in HKH region, 500 million are poor and disadvantaged.

Millions of people suffer from annual floods which are widespread and of transboundary in nature, thousands losing lives.

Damages to infrastructure in billion dollars

Alarming significant loss of livelihoods



The recent Floods of 2017 were devastating in South Asia: 800 people killed , 240 million affected,

National Governments & International agencies have spent billions of dollars in structural flood mitigation, but with limited success.

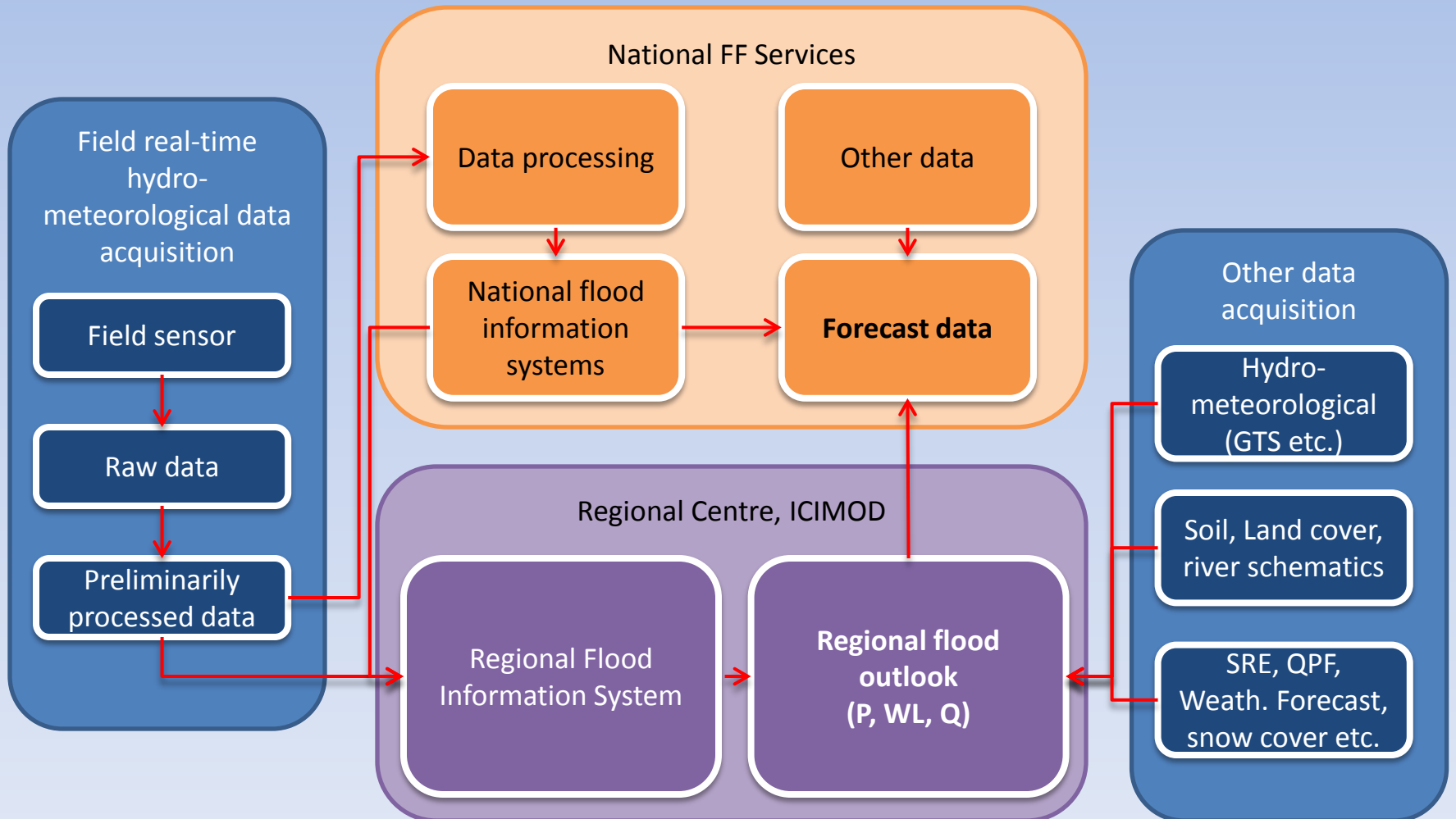
It has now been realized that monitoring of hydro-met events and providing forecasts and early warning can play an effective role in reducing the impacts of flood disasters.

=> HKH-HYCOS Programme initiated in 2012 by the International Center for Mountain Development (ICIMOD) with cooperation from WMO.

## Five major components: HKH-HYCOS programme:

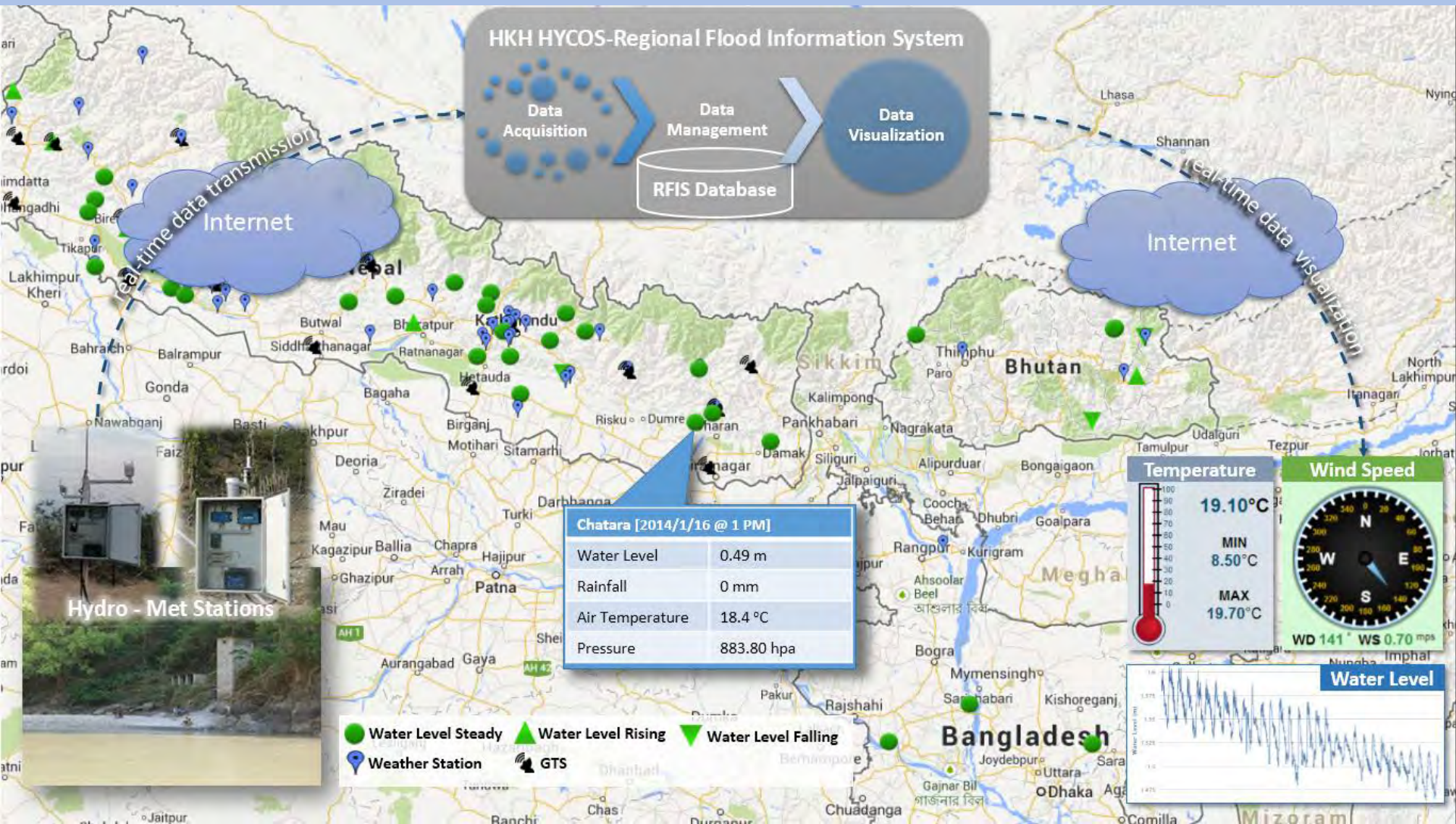
1. Framework for cooperation
2. Establishment of Regional flood observation network
3. Development of Regional flood information system
4. Development of Transboundary Flood Outlook
5. Creating Public awareness & capacity building

# The overall process

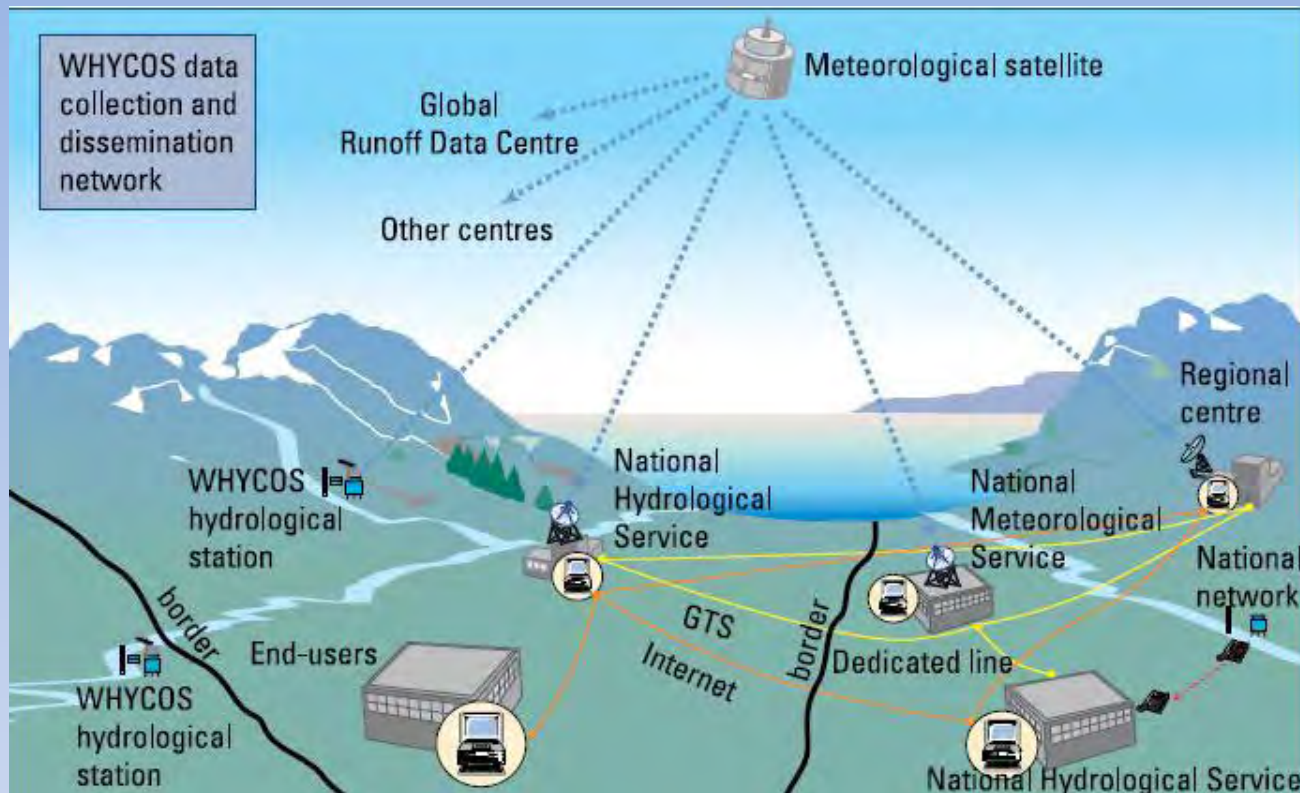




# HKH-HYCOS







## Overall Objectives of The HKH – HYCOS:

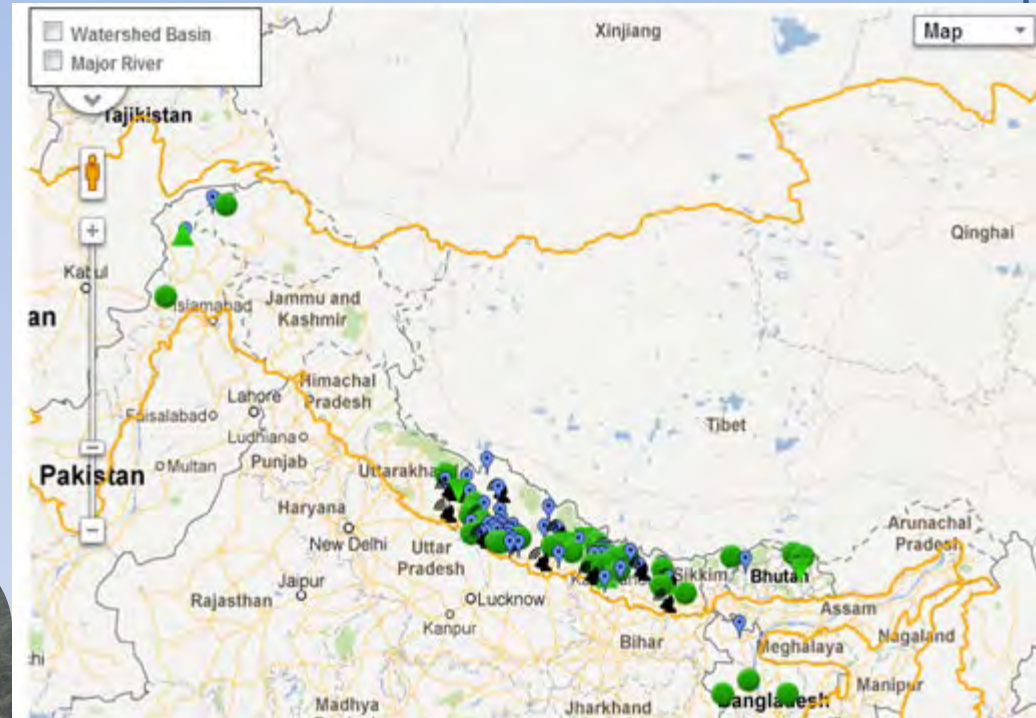
to minimise the loss of lives and property by reducing flood vulnerability in the HKH region



**‘Making Information Travel Faster than Flood Waters’**

# Observation network

- 33 real time hydro-met stations and data sharing installed in four countries (Bangladesh, Bhutan, Nepal & Pakistan)







Old manual gauge



HYCOS Real Time Radar WL



# HKH HYCOS

## Regional Flood Information System

ICIMOD

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### HKH HYCOS

#### About

Bangladesh

[Kurigram](#)

[Sirajganj](#)

[Lalon Shah Bridge](#)

[Bhairab Bazar](#)

Bhutan

[Korilla](#)

[Sumpa](#)

[Uzorong](#)

[Trashi Yantshe](#)

[Hongtsho](#)

[Gunitsawa](#)

Nepal (Hycos)

[Jiri](#)

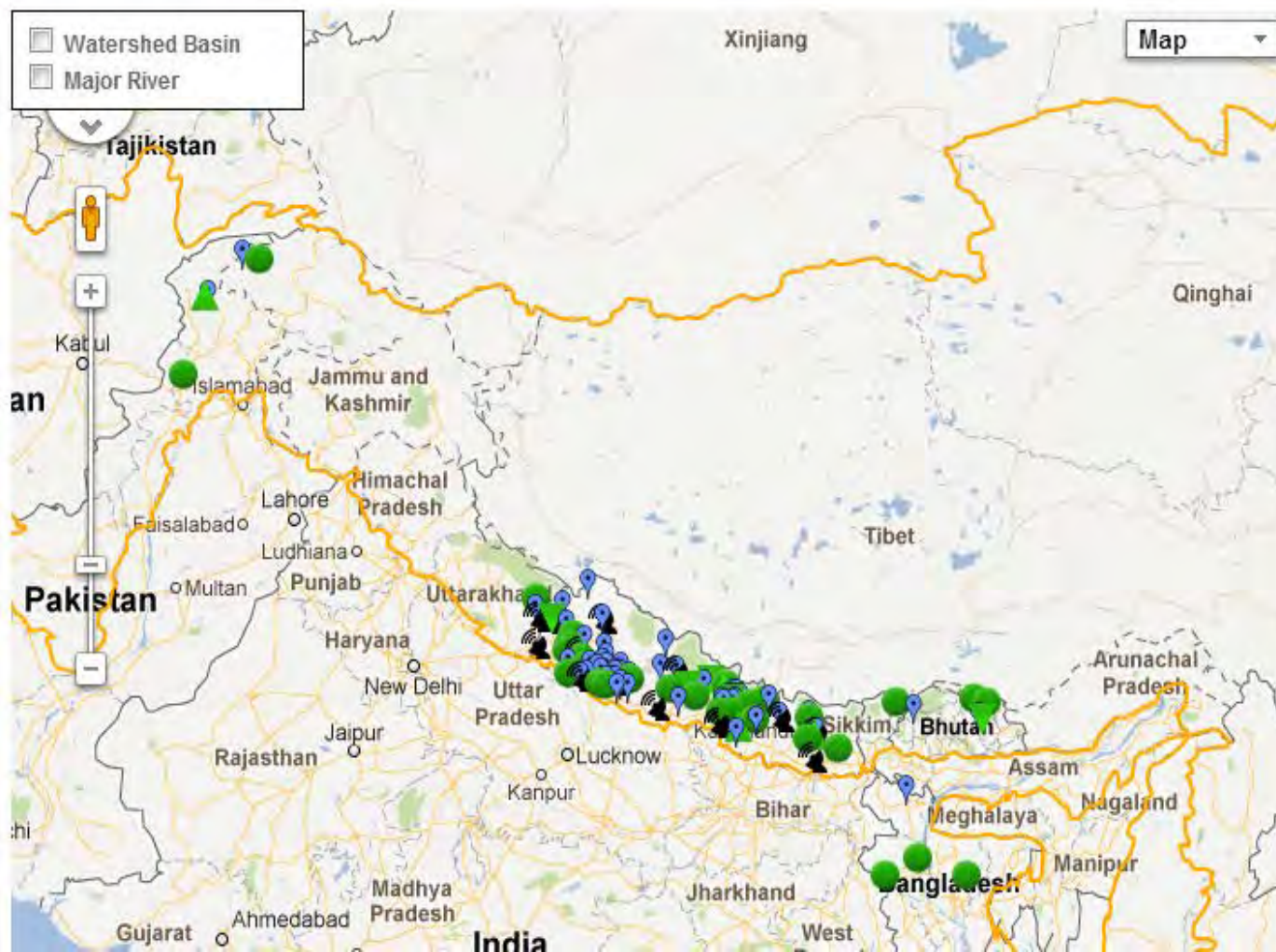
[Pachuwarghat](#)

[Mulghat](#)

[Dhankuta](#)

[Busti](#)

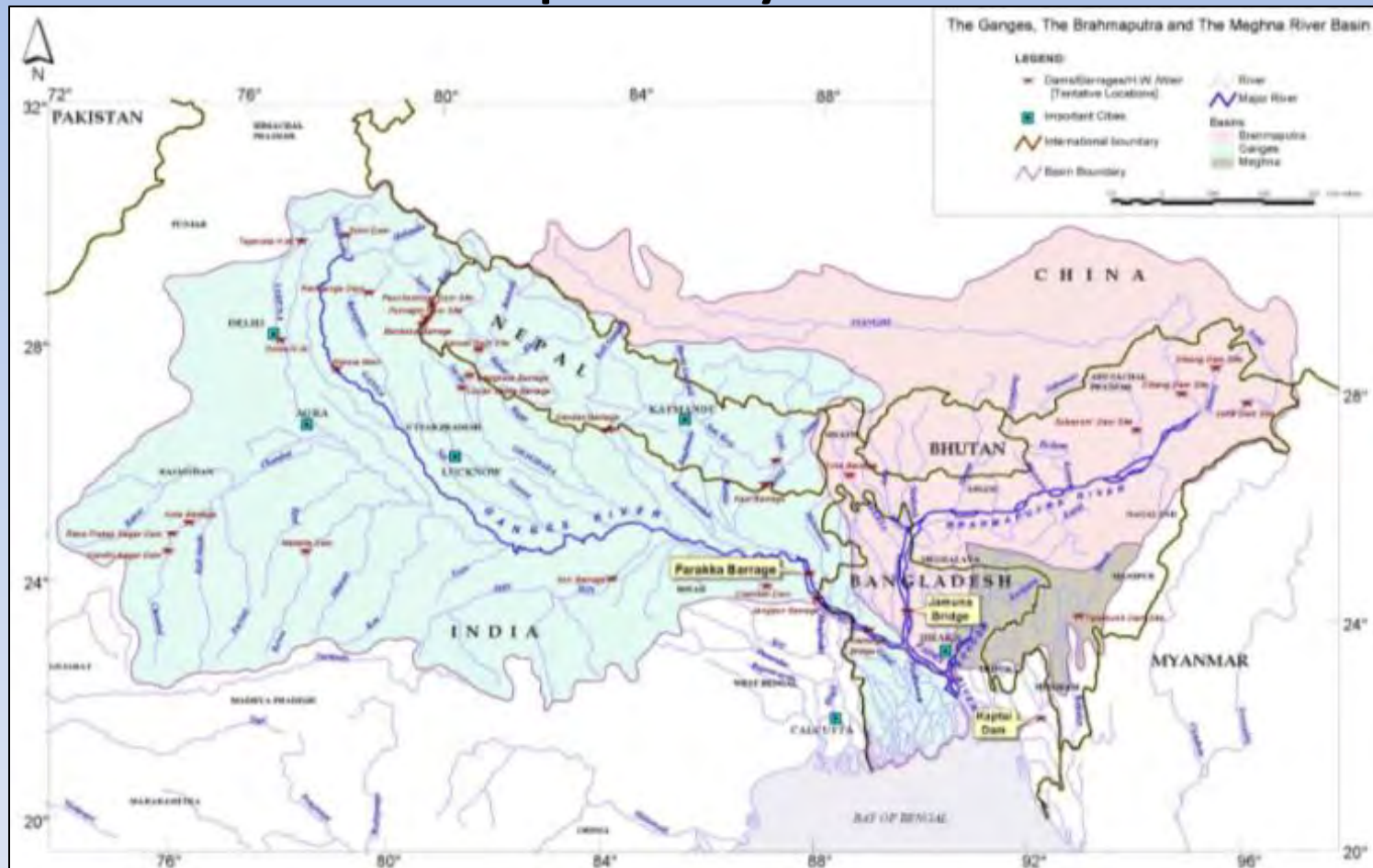
[Tumlingtar](#)



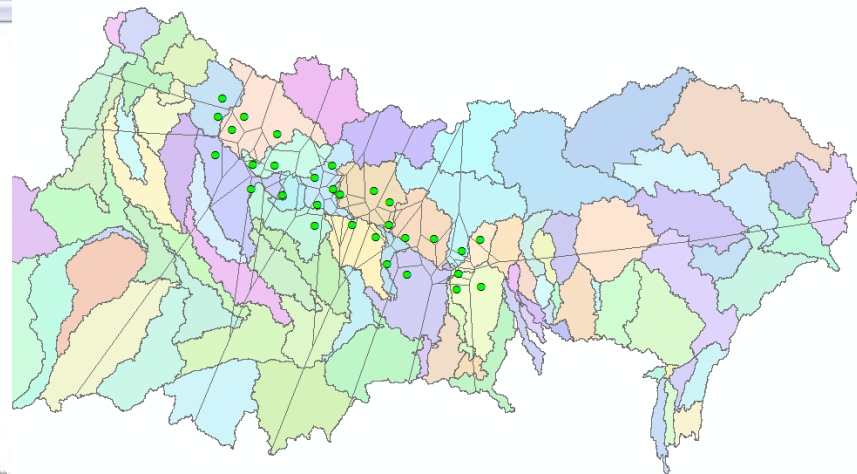
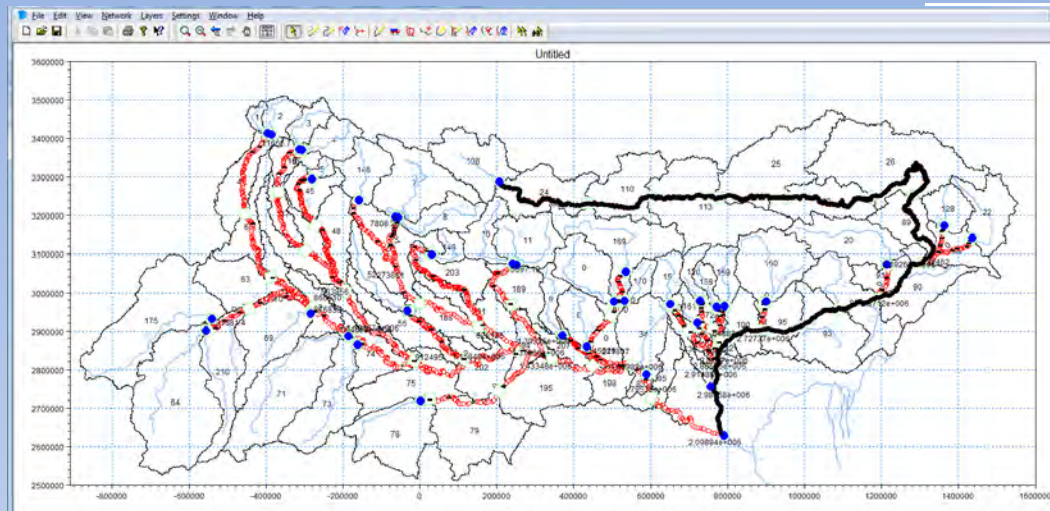


# Regional flood Outlook

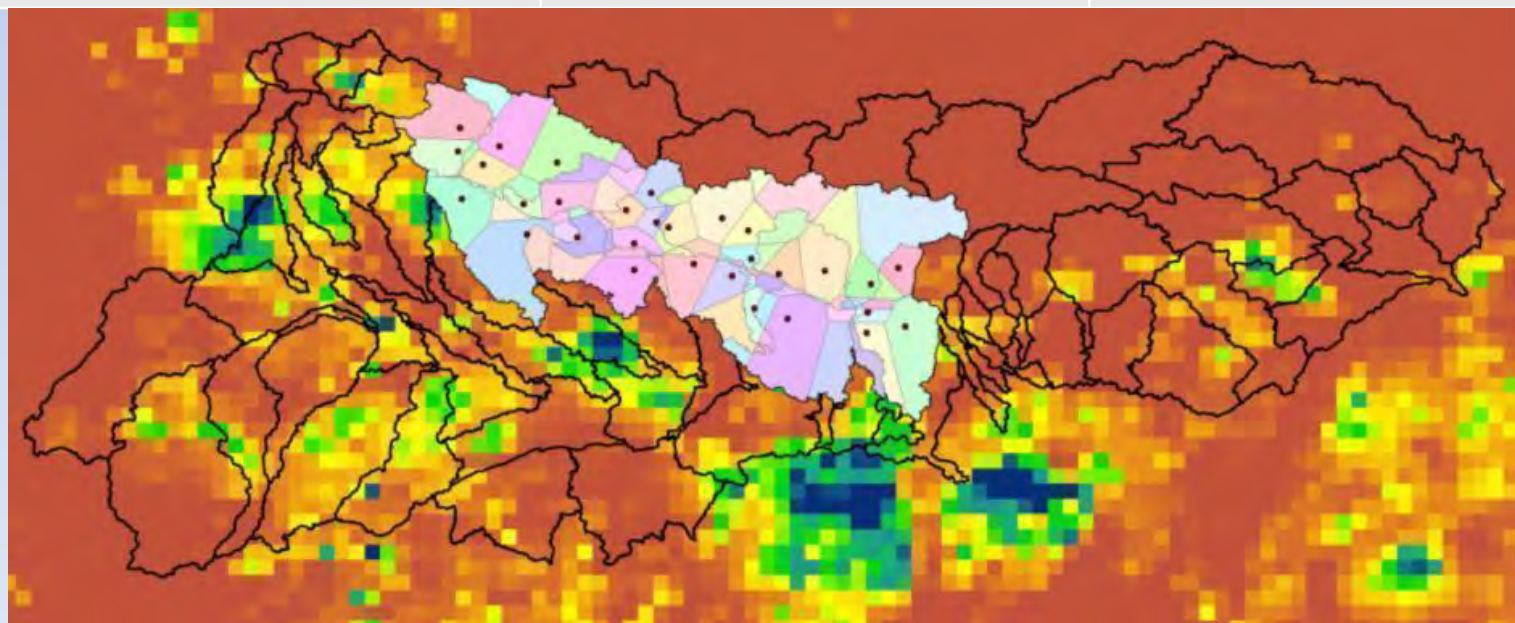
## The Ganges- Brahmaputra Basin (G-B) as a pilot system



1.50 million sq.km



<b>Rivers</b>	<b>31</b>	<b>15</b>
<b>Catchments</b>	<b>53</b>	<b>33</b>



Combination of real time observations and Satellite rainfall estimates



# The Overall Regional Flood Outlook system

National  
RTDAS

HKH HYCOS

DATA BASE  
Historical Data  
Real Time Data

WEB data

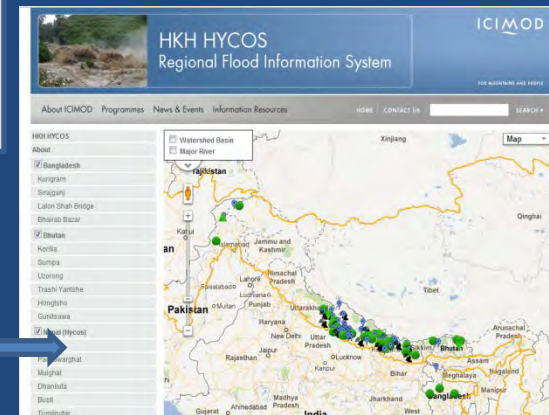
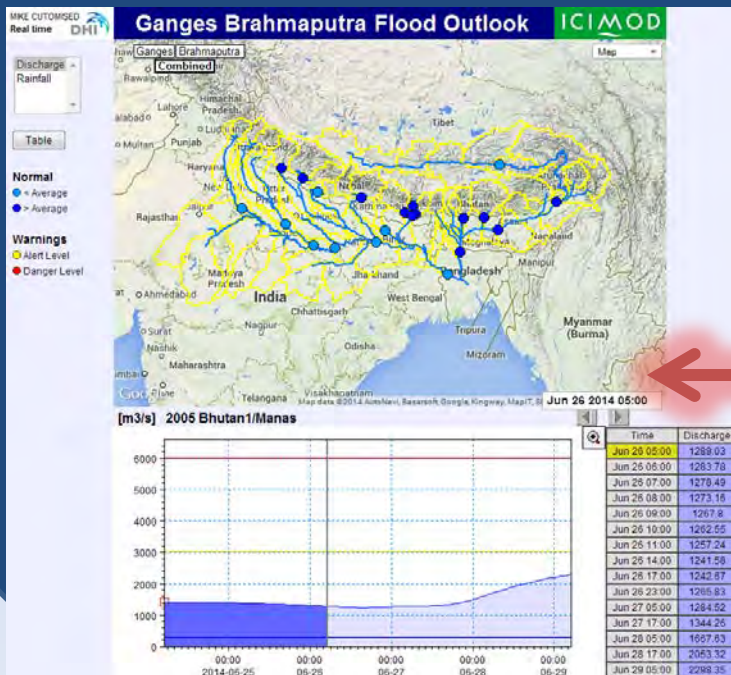
QPF  
Met-  
forecasts

Calibrated Flood  
Model

Forecasting  
Model

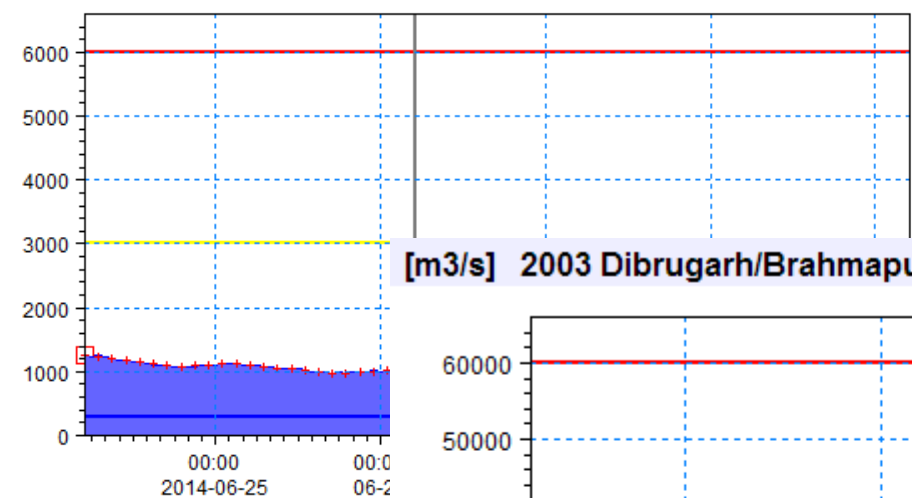
COMMUNICATION  
Real-time  
Flood Information

National & regional flood  
information portals

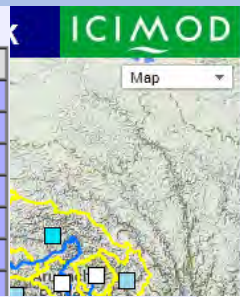


The outlook which, in essence, is a regional flood forecast based on a mathematical model describing the precipitation-runoff process in the catchments and hydrodynamic flood routing along the river system.

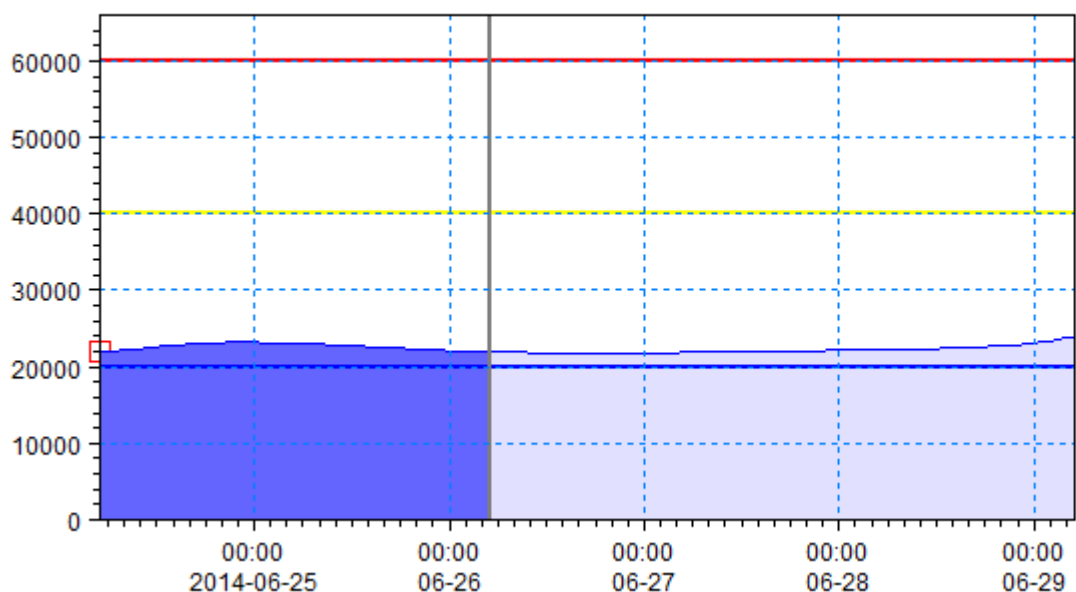
m<sup>3</sup>/s] 1006 Chisapani/Karnali



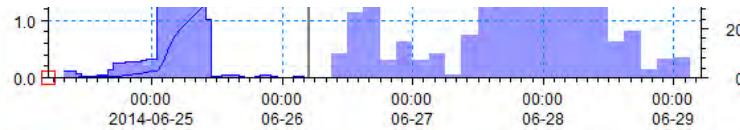
Time	Discharge
Jun 26 05:00	1017.19
Jun 26 06:00	1006.74
Jun 26 07:00	1007.03
Jun 26 08:00	985.36
Jun 26 09:00	981.74
Jun 26 10:00	973.16
Jun 26 11:00	968.87



[m<sup>3</sup>/s] 2003 Dibrugarh/Brahmaputra



Time	Discharge
Jun 26 05:00	22035.01
Jun 26 06:00	22004.85
Jun 26 07:00	21966.7
Jun 26 08:00	21931.14
Jun 26 09:00	21896.52
Jun 26 10:00	21863.05
Jun 26 11:00	21831.28
Jun 26 14:00	21718.61
Jun 26 17:00	21635.43
Jun 26 23:00	21654.96
Jun 27 05:00	21886.22
Jun 27 17:00	22104.71
Jun 28 05:00	22217.57
Jun 28 17:00	22592.21
Jun 29 05:00	23927.57

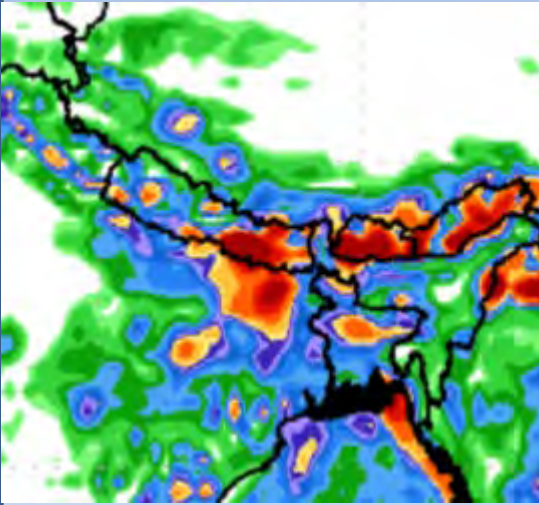




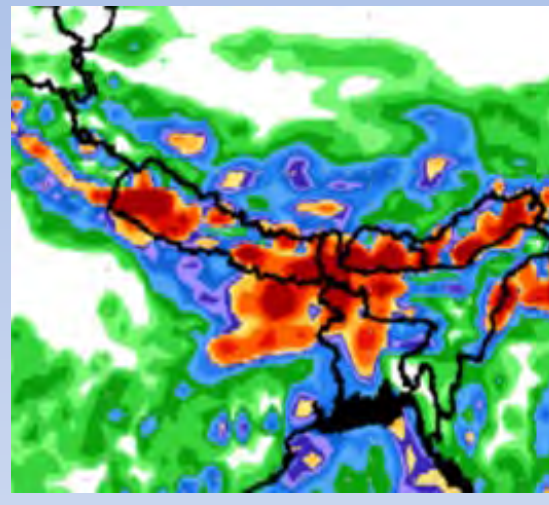
# Case study: 14 -16 August 2014

GFS rainfall forecast on 12<sup>th</sup> Aug 2014 07:00

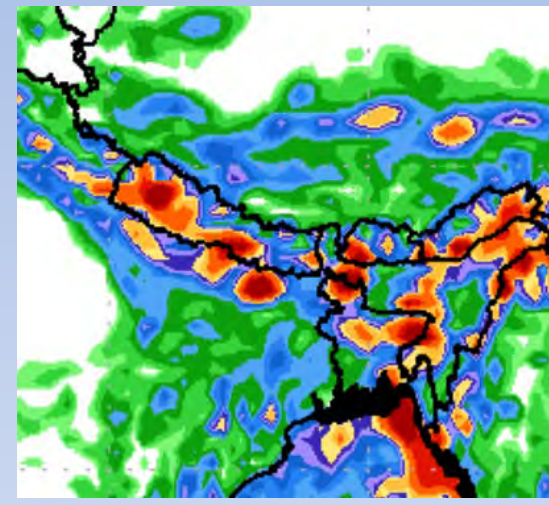
14 Aug



15 Aug

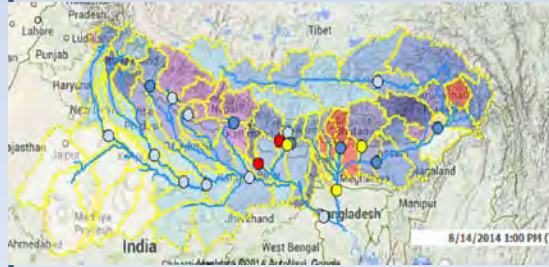


16 Aug



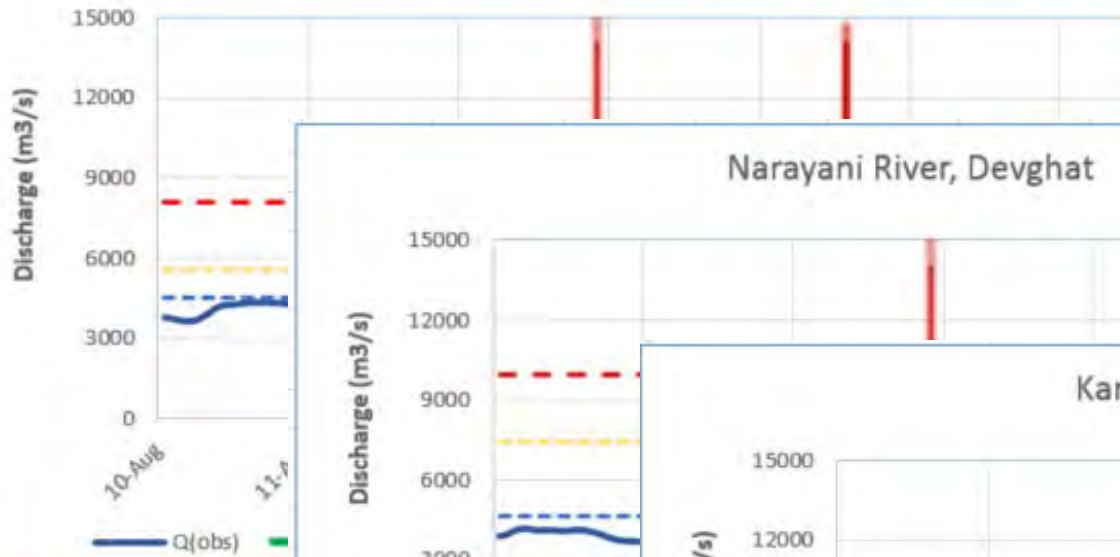
## Pilot regional flood outlook results 2014

- Legend**
- Danger Level
  - Alert Level
  - Monthly average Level

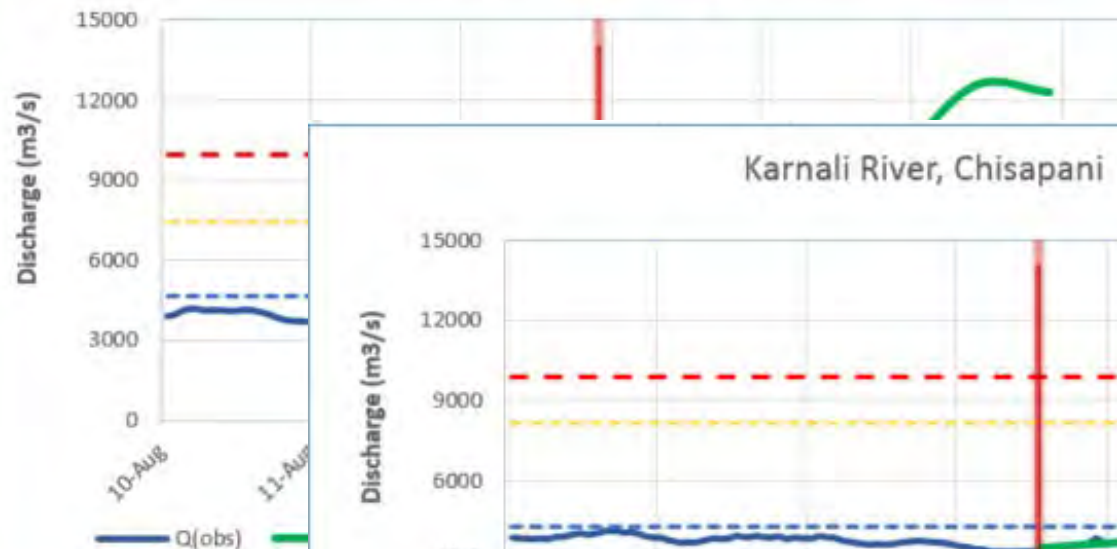


# Operational forecasts : 2014 (major river basins of Nepal)

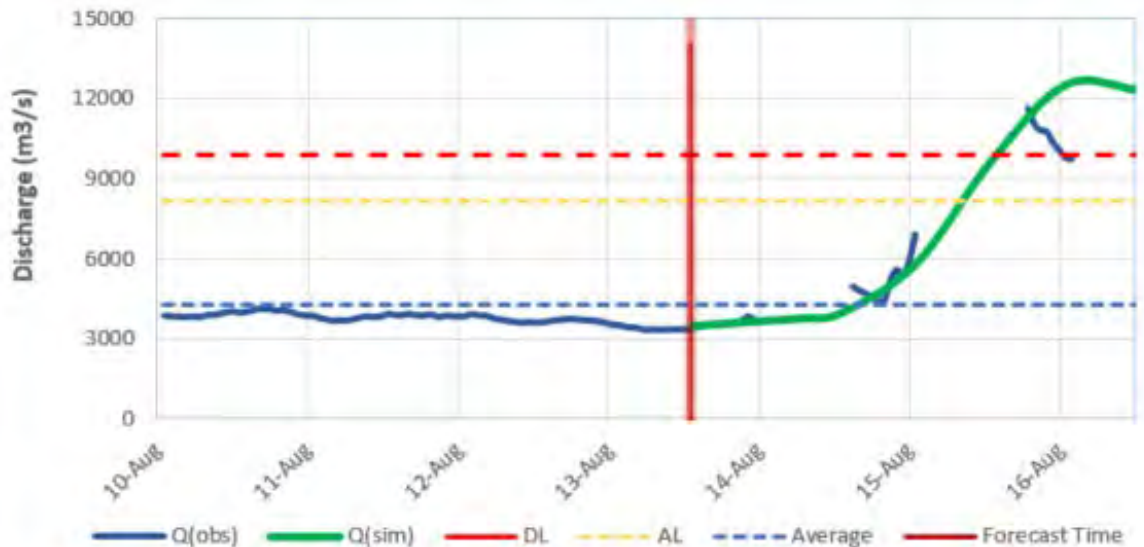
Koshi River, Chatra



Narayani River, Devghat



Karnali River, Chisapani





# Dissemination of Flood Outlook

Browser: http://www.icimod... Regional FI... New tab

File Edit View Favorites Tools Help

HKH HYCOS  
Regional Flood Information System

ICIMOD 30  
THREE DECADES FOR MOUNTAINS AND PEOPLE

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- HYCOS RFIS Home
- About RFIS
- Stations Metadata
- Stations - Bangladesh
- Stations - Bhutan
- Stations - Nepal (HYCOS)
- Stations - Pakistan
- Stations - KSL Project
- Stations - GTS
- Satellite Rainfall Estimation
- Comparison of SRE Products
- Map of GTS Stations
- Regional Flood Outlook**

Discharge Rainfall Combined

**Rainfall [mm per Day]**

- > 100
- 80 - 100
- 60 - 70
- 40 - 50
- 30 - 40
- 25 - 30
- 20 - 25
- 15 - 20
- 10 - 15
- 5 - 10
- 2 - 5
- 1 - 2
- < 1

Jul 13 2014 13:00

**[mm/h] 1046 Tamor**

Time	Rainfall	Total
Jul 13 13:00	3.4	3.4
Jul 14 13:00	5.5	8.9
Jul 15 13:00	8.6	17.5
Jul 16 13:00	19.2	36.7

75%

Browser: http://www.icimod... Regional FI... New tab

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Regional Flood Information System

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Discharge Rainfall Combined

**Normal**

- < Average
- > Average

**Warnings**

- Alert Level
- Danger Level

Jul 13 2014 13:00

**[m3/s] 1006 Chisapani/Karnali**

Time	Discharge
Jul 13 13:00	9598.66
Jul 13 14:00	9629.81
Jul 13 15:00	9681.22
Jul 13 16:00	9692.97
Jul 13 17:00	9725.56
Jul 13 18:00	9758.76
Jul 13 19:00	9792.57
Jul 13 22:00	9903.46
Jul 14 01:00	10024.66
Jul 14 07:00	10254.03
Jul 14 13:00	10468.91
Jul 14 19:00	11048.77
Jul 15 13:00	11658.62
Jul 16 01:00	12365.5
Jul 16 13:00	13068.72

75%

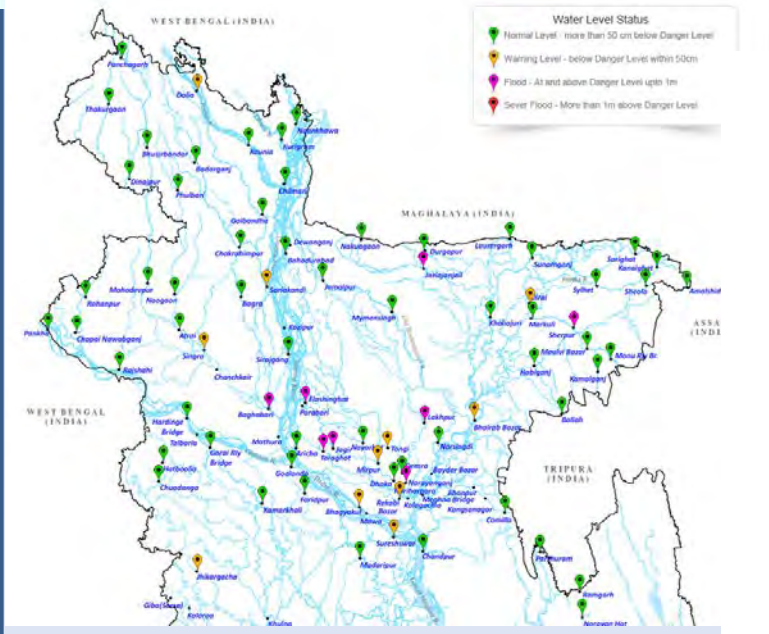
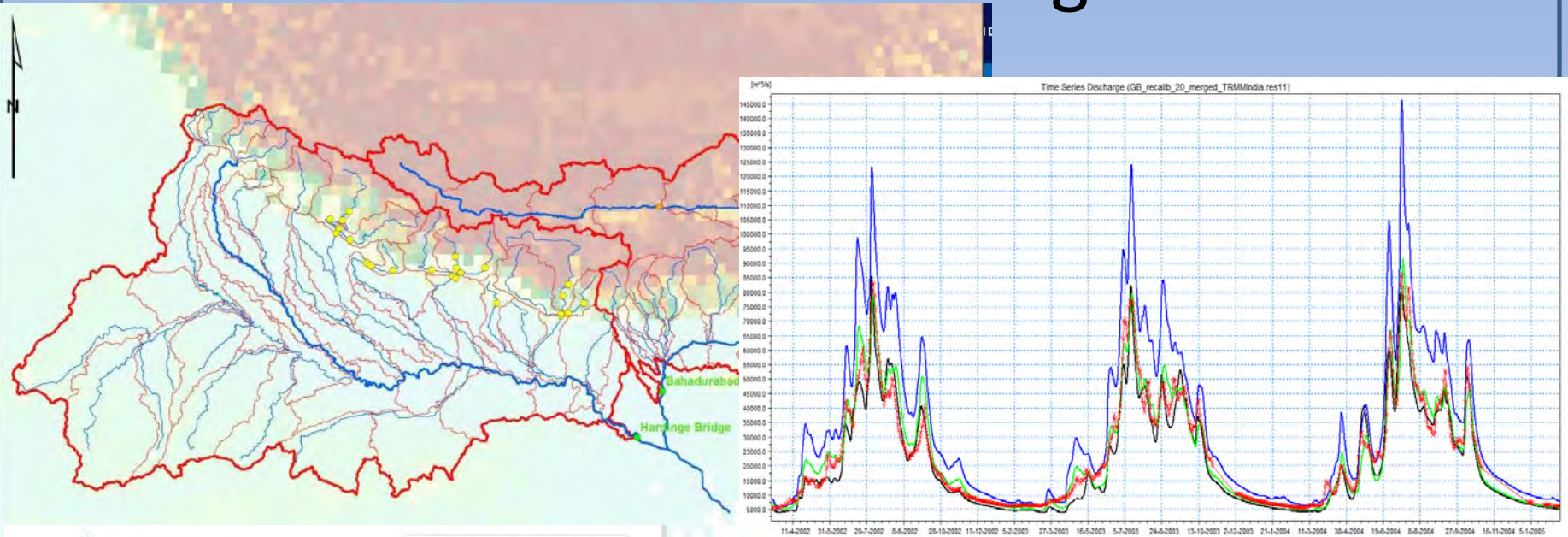


# Tabular view of forecast

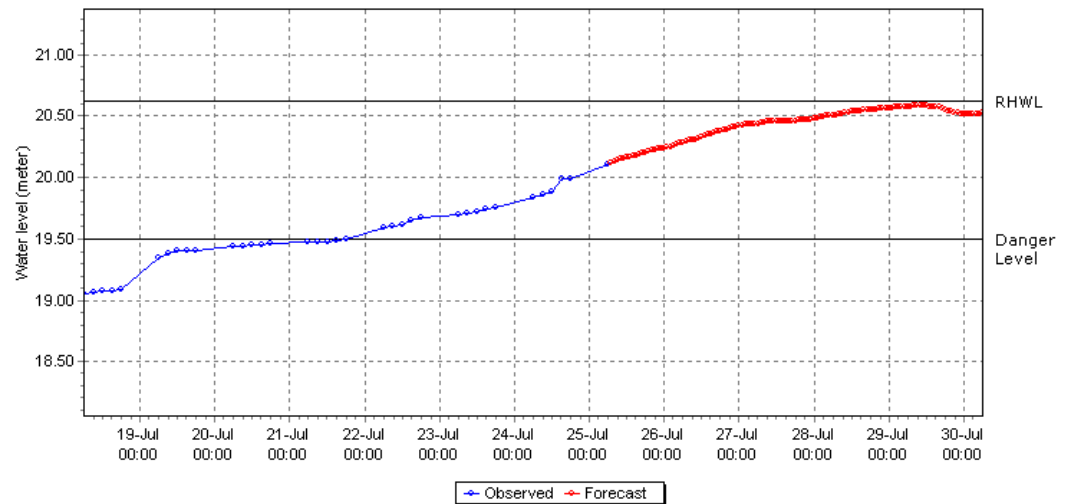
Station / River	Average	Warning Level		Hours after Time of Forecast - 2014/08/13 15:00														Maximum		
		Alert	Dange	0	1	2	3	4	5	6	9	12	18	24	36	48	60	72	Time	Max
1001 Hardinge Br /Ganges	20000	40000	60000	9673.29	9709.89	9750.9	9794.01	9837.85	9881.92	9926.64	10074.1	10221.2	10540.4	10967.8	12036.1	13395.1	16708.7	23427.7	8/16/2014 3:00 PM	23427.7
1002 Turkeghat/Arun	1230	3000	4000	736.51	748.27	761.09	774.83	788.63	801.4	813.44	852.97	895.23	1008.96	1142.16	1397.22	1611.8	1733.51	1752.96	8/16/2014 12:00 PM	1755.4
1003 Rabuwabazar/Sunkoshi	603	1900	2900	1464.13	1482.76	1503.24	1524.56	1548.79	1574.3	1600.77	1782.41	2017.25	2766.25	3657.01	5315.35	8997.2	6909.55	6174.91	8/15/2014 7:00 PM	710.55
1004 Mulghat/Tamor	1050	3200	4500	626.69	627.46	629.06	630.89	632.71	634.66	636.82	656.74	677.96	782.83	1029.9	2074.31	3166.53	3462.99	3202.73	8/15/2014 1:00 AM	3467.69
1005 Chatarai/Koshi	4530	5567	8100	4543.23	4562.07	4592.71	4626.26	4661.43	4699.67	4739.86	4953.13	5244.55	6207.83	7486.86	10618.5	13792.2	14307.8	13338	8/15/2014 11:00 PM	14384.9
1006 Chisapani/Kamali	4270	6173	9900	3520.19	3504.32	3494.86	3497.66	3504.84	3506.35	3504.79	3623.26	3537.31	3560.55	3625.2	4464.78	7007.7	11060.8	12262.8	8/16/2014 3:00 PM	12262.8
1007 Kusum/West Rapti	371	1531	1972	20.2	20.43	21.21	22.77	25.04	27.78	30.64	37.7	40.87	41.95	51.34	160.32	232.27	308.89	343.88	8/16/2014 3:00 PM	343.88
1008 Narayangaht/Narayani	4650	7443	9992	4935.7	4959.21	4983.25	5007.9	5031.38	5053.61	5076.05	5221.57	5399.92	5910.97	8547.73	8043.86	8686.04	8924.54	8317.86	8/16/2014 2:00 AM	8941.76
1009 Tanakpur/Sarada	300	1300	1600	317.74	319.84	323.31	327.39	331.39	334.83	338.13	353.6	366.28	387.22	408.5	556.96	754.6	1066.65	1248.43	8/16/2014 3:00 PM	1248.43
1010 Benibad/Bagmati	300	3000	6000	242.49	256.4	281.11	314.86	358.3	410.48	470.1	1097.44	3138.01	9184.49	7377.91	5041.68	3819.14	2087.45	1380.19	8/14/2014 9:00 AM	3184.49
1011 Patna/Ganges	10000	20000	30000	4831.77	4900.07	4972.09	5046.12	5120.06	5191.47	5262.32	5473.36	5666.51	5974.51	6194.08	6828.14	7922.43	9473.31	11541.8	8/16/2014 3:00 PM	11541.8
1012 Varanasi/Ganges	10000	20000	30000	334.04	333.74	333.54	333.33	332.99	332.46	331.92	330.39	328.59	325.02	321.73	315.4	309.55	305.79	302.85	8/13/2014 3:00 PM	334.04
1014 Allahabad/Yamuna	10000	20000	30000	65.33	64.94	64.53	64.14	63.82	63.56	63.25	62.35	61.3	59.34	57.35	52.17	38.36	3.68	-24.68	8/13/2014 3:00 PM	65.33
1015 Agra/Yamuna	10000	20000	30000	1568.53	1574.52	1579.79	1584.4	1588.38	1591.81	1594.78	1601.65	1605.93	1608.42	1602.59	1571.25	1522.03	1481.39	1476.02	8/14/2014 8:00 AM	1608.58
1016 Kanpur/Ganges	10000	20000	30000	472.98	483.35	493.49	503.38	513.21	522.81	532.04	558.39	579.95	613.13	634.58	658.67	673.79	685.01	695.7	8/16/2014 3:00 PM	695.7
2001 Bahadurabad/Brahmaputra	20000	40000	60000	36646.7	36813.4	36979.7	37145.2	37310.3	37475.4	37641.1	38148.5	38681.2	39845.5	41173.5	45164.6	51819.3	61135.2	73369.4	8/16/2014 3:00 PM	73369.4
2002 Shanon/Brahmaputra	10000	20000	30000	5368.06	5411.39	5455.01	5498.88	5542.87	5586.9	5631.09	5766.79	5903.93	6174.21	6420.31	6933.26	7654.9	8585.59	9439.57	8/16/2014 3:00 PM	9439.57
2003 Dibrugarh/Brahmaputra	20000	40000	60000	29666.5	29877	30065.7	30240.1	30422.6	30514.7	30799.5	31260.2	31656.6	32893.1	34841.5	39472	44779	47528	48523.5	8/16/2014 1:00 PM	48546.3
2004 Guwahati/Brahmaputra	20000	40000	60000	34431.2	34525.4	34627.5	34731.6	34834	34930.8	35029.5	35361.3	35695.5	36403.8	37235.3	39592.4	43417.4	48444.3	53487.4	8/16/2014 3:00 PM	53487.4
2005 Bhuban/Manas	300	3000	6000	2696.82	2792.38	2908.34	3043.77	3180.5	3295.85	3389.63	3721.68	4141.66	5225.48	6127.05	7273.84	9136.56	9386.23	7974.96	8/15/2014 9:00 PM	9626.82
2006 Bhuban/Dudkumar	300	3000	6000	2200.69	2248.95	2299.92	2354.19	2411.19	2473.11	2538.43	2891.78	3414.69	4807.38	5771.04	6505.94	9528.2	10643.3	7945.69	8/15/2014 9:00 PM	11448.7



# Forecast lead time for Bangladesh



Jamuna River at Bahadurabad (Year 2016)



# Impact of The HKH-HYCOS programme:

- National Governments inspired to install over 500 real time hydro-met stations in Nepal, Bhutan, Pakistan, Bangladesh (World Bank and UNDP actively supporting)
- Development of National Flood Information systems including real time flood forecasting and early warning systems
- Benefits of Regional Data sharing and transboundary flood information being realized by the riparian countries.
- Regional Transboundary flood outlooks used in flood disaster management
- Lower riparian countries using the regional flood outlooks in increasing lead time of flood forecasts.
- Regional and National capacities improved in flood monitoring, modelling & in dissemination of community based early warning
- Improved awareness, reduced loss of lives during heavy floods (2017)

Thank you