Surat City: Experience developing the Resilience Capacity towards Flood Risk

Training Workshop on Building Resilient Cities: Strategies for Effective Urban Flood Management

SAARC Disaster Management Centre, Gujarat
Virtual Mode
January 27 2025

SMC

ResilienceStrata
towards connecting habitats

Surat City Profile

- Surat is situated on the western coast of India 21.17°N, 72.83°E
- Area of city: 462 sq.km, population: 8.0 million
- Average Annual rainfall in Surat: 55 inch
- Length of river Tapi passing through Surat City: 31.69 km
- The tidal effect of the sea is felt up to the city area
- Topography of Surat: The western part of the city is low-lying
- Length of main Creeks passing through the city: 61.17 km

8th Largest Indian City

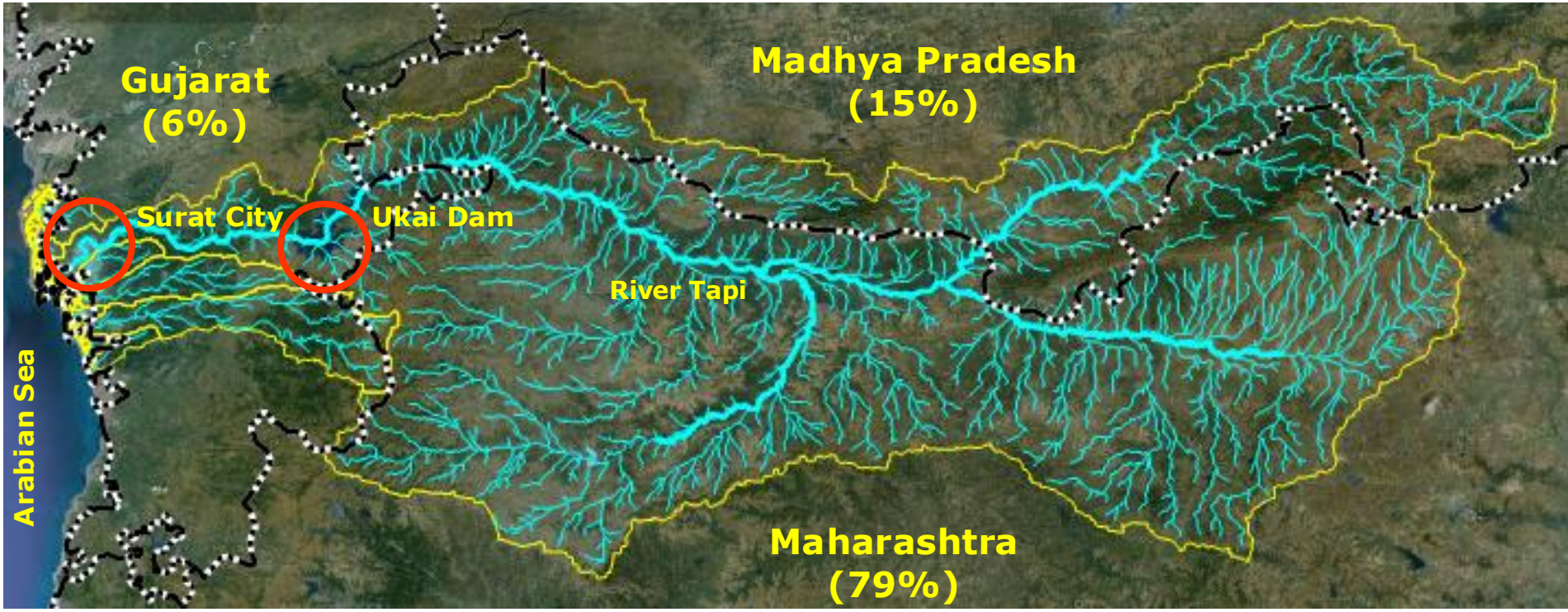
4th fastest growing Global City

Economic Capital of Gujarat

90% Diamonds in world are cut and polished

India's 60% man-made fabric , per day 40 million mts

Tapi River Basin & Ukai Reservoir



River Length	724 Km before falling in the Arabian Ocean
Reservoir Type	Earthen & masonry dam
Distance from Surat	90 Km (Upstream of Surat)
Total Catchment	65,145 Sq. km
Command Area	4.11 Lac Ha. (2007-08)

Flood History of Surat

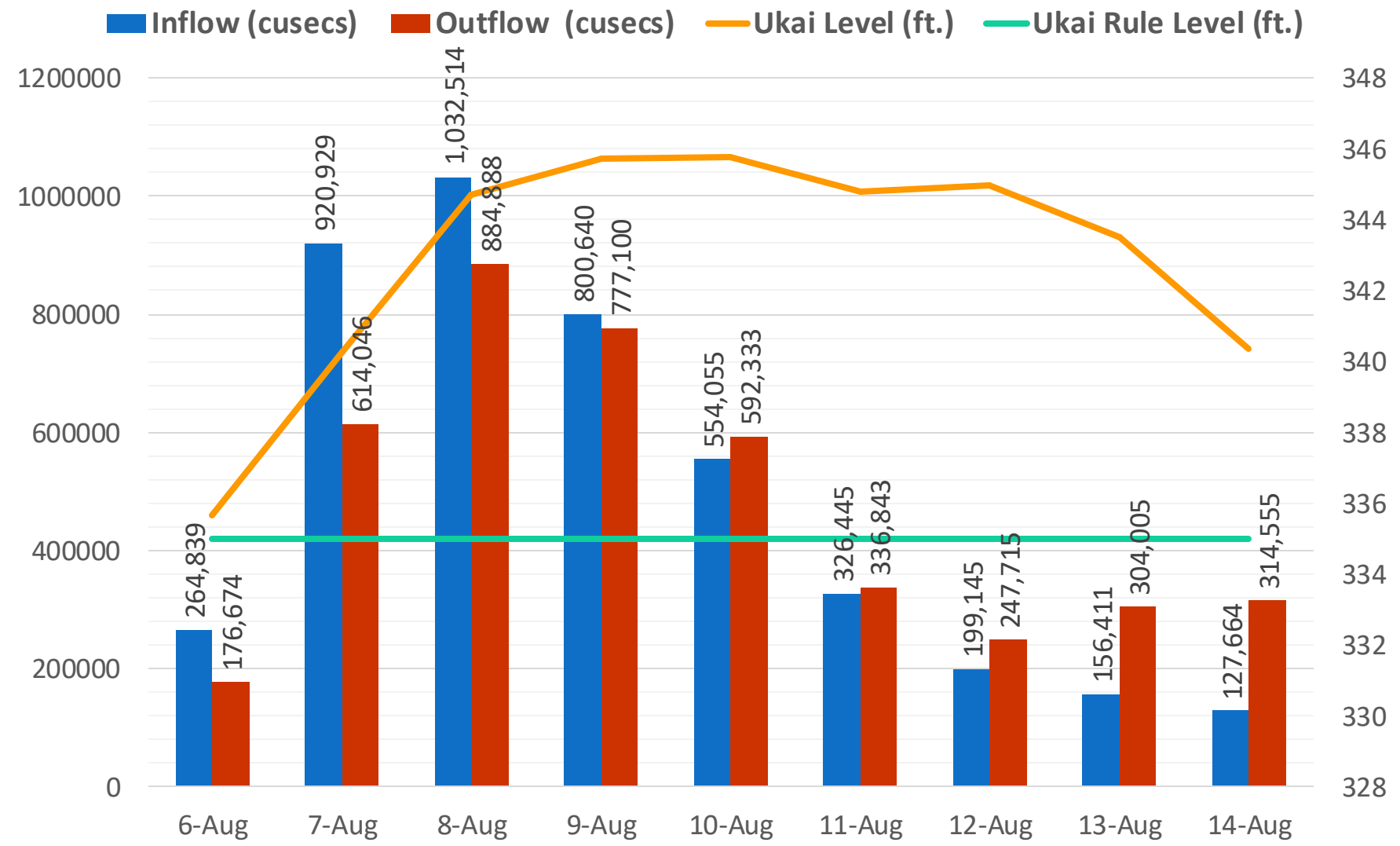
Before Ukai Dam (1972)

Flood Events	Discharge (lac Cusec)	Hope Bridge Water Level (m)	Month
1883	10.05	11.05	July
1884	8.46	10.05	Sept
1894	8.01	10.33	July
1942	8.60	10.56	August
1944	11.84	11.32	August
1945	10.24	11.09	August
1949	8.42	10.49	Sept
1959	12.94	11.55	Sept
1968	15.50	12.08	August

After Ukai Dam(1972)

Flood Events	Discharge (lac Cusec)	Hope Bridge Water Level (m)	Month
1978	4.11	8.59	August
1994	5.25	10.10	Sept
1998	7.00	11.40	Sept
2002	3.25	8.20	Sept
2006	9.10	12.70	August
2013	4.39	9.80	Sept

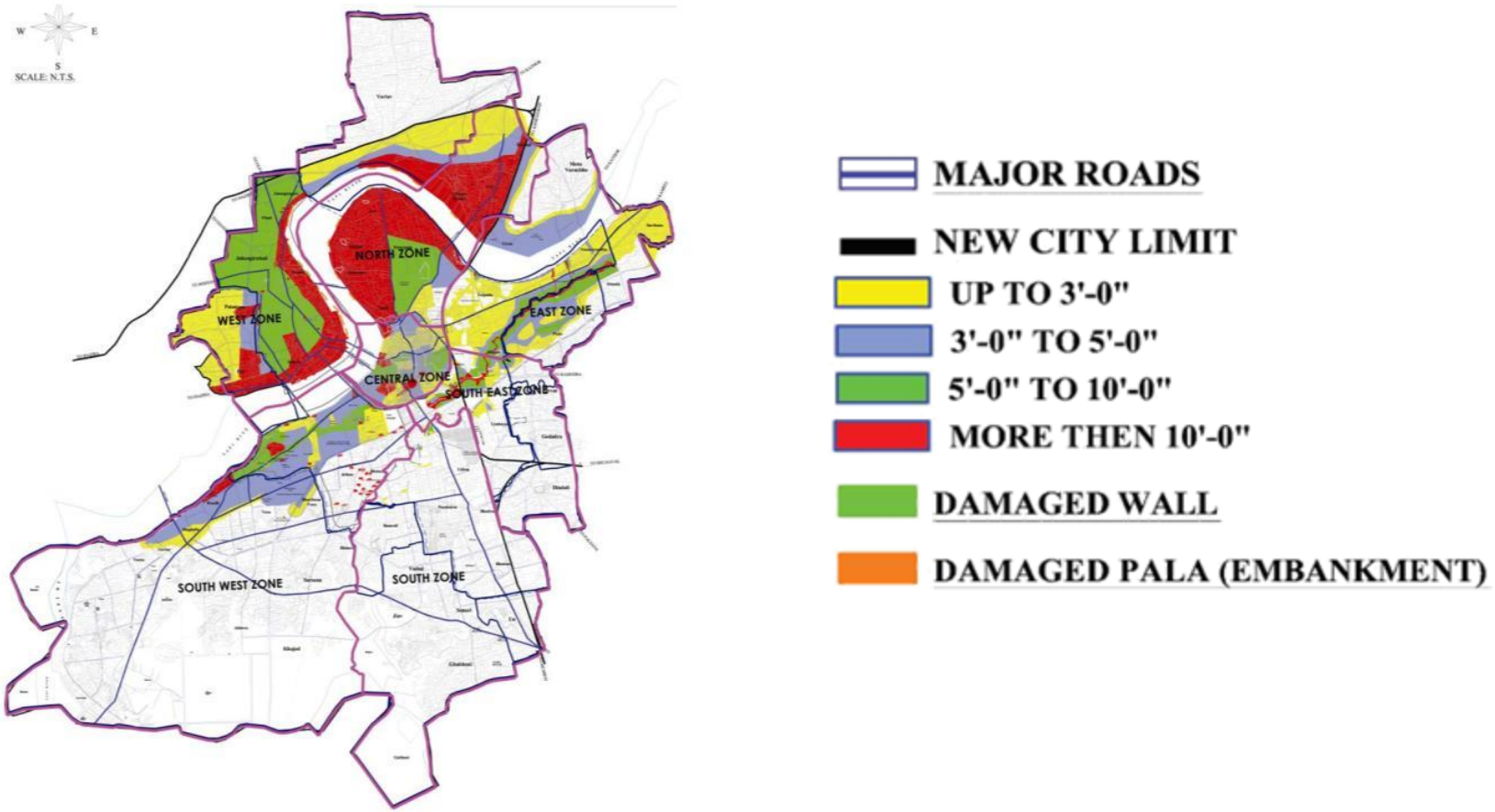
Ukai Dam in 2006
Avg. Inflow – Avg. Outflow – Level – Rule Level



Flood Level Aug. 2006

6.00 to 7.5 lakh Cusecs for 13 hrs. and 8.00 to 9.5 lakh Cusecs for 42 hrs.

Total of 128 Sq.Km. area of city limit under submergence

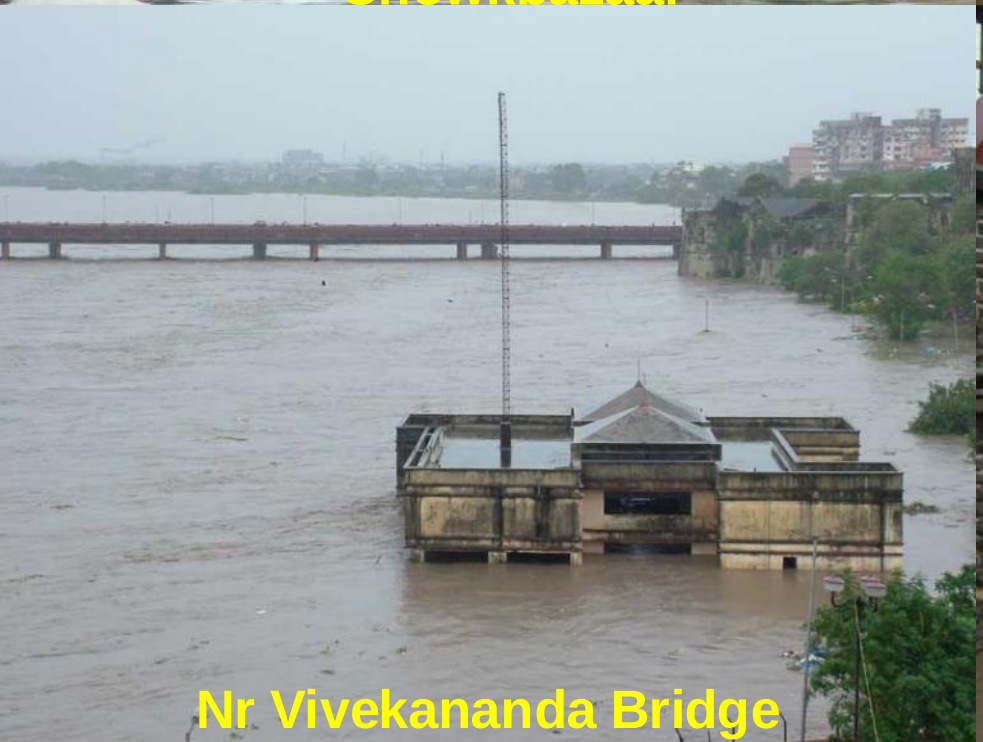


Impact of Flood-2006

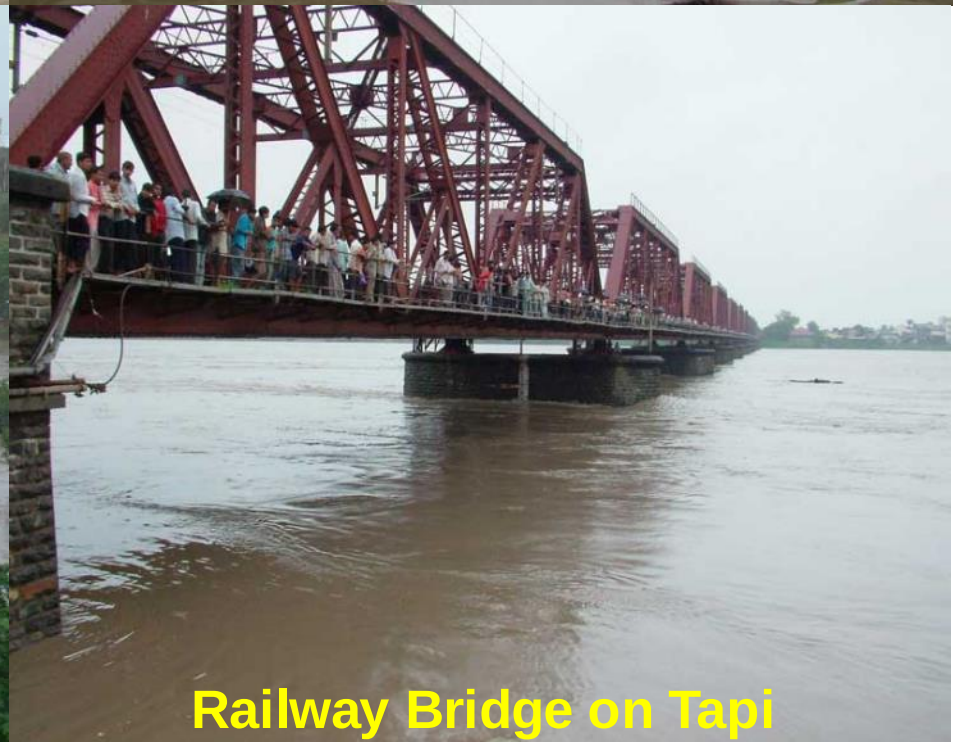
- 157 deaths
- Total affected population : 25 lakhs (Urban) + 2 lakhs (Rural) = 27 lakhs
- Economic loss estimated at Rs. 15890 crore due to damage to public and private property and disruption of normal economic activity
- Total cost to SMC : Losses Rs. 178.24 crore
  : Expenses Rs. 14 crore
- Expenditure on immediate relief
  - Compensation paid : Rs. 0.26 crore
  - Cash doles paid : Rs. 9.55 crore
  - House-hold paid : Rs. 40.52 crore

Flood in 2006

Chowkbazaar



Nr Vivekananda Bridge



Railway Bridge on Tapi

Flood in 2006

Chowk

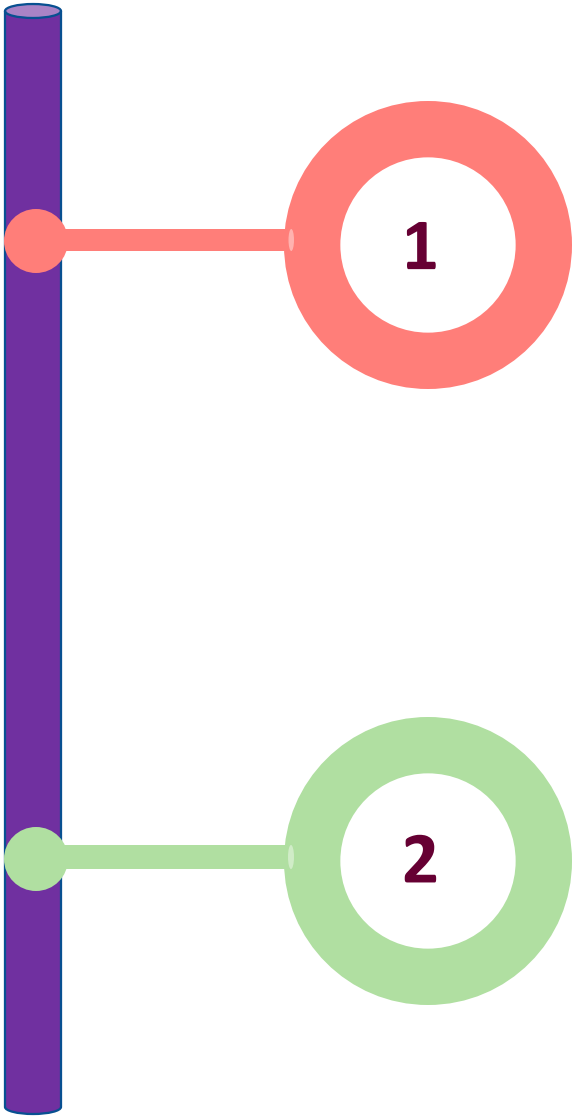
Gujarat Samachar Press

Nr Surat Old RTO Office

Gujarat Gas Circle

Flood in 2006

Improving Flood Resilience Capacity ; Adaptation and Mitigation strategies



1. River Bank Encroachment removed
2. Embankment constructed by State & Local Govt.
3. Storm water network upgradation
4. Revision of Rule Level
5. Early Warning System Established
6. End User communication system

1. Ward wise micro level planning with Ward Disaster Management Plan
2. Revamped City Disaster Management Plan under the guidance of GSDMA
3. AWS system installed
4. Color Poles marked
5. De-watering pump installed

Removal of Encroachment
Relocation of slums to EWS houses

Nehru Nagar Slum
After shifting

Strengthening of River Embankment

- The Flood Protection works are being carried out by the Irrigation Department.
- SMC has completed flood protection work along the river bank at Rander, Bharimata and Singanpor location in a stretch of 4.25 k.m.

Strengthening of River Embankment

- Flood protection retaining walls for garden embankments of weir(Length-240.00 Mts)
- Heights of both flood gates on either side of cause-way had been raised up to R.L.16.00 mts.

Storm Drainage Network improvement for water Logging

- Total storm drain in the city is 892 km.
- Identification of Water Logging Pockets
- Study of existing network
- Study of demography & contour
- Considering current &future development

Revision Ukai Reservoir Rule Level

Date	Previous Level	Revised Level
1st July	321 ft.	321 ft.
1st August	333 ft.	333 ft.
1st September	340 ft.	335 ft.
15th September	340 ft.	340 ft.
1st October	345 ft.	345 ft.

5. Risk Assessment

IIT,Delhi

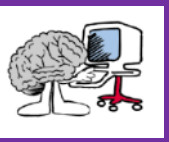
Hydrological & Hydraulic Modeling

4. Reservoir Management

NWRWS

- Historical Data
- Real Time Dam Release Data

3. Observation and Monitoring



CWC & NWRWS

- Stream Gauge Data (Historical & Real-time)

2. Catchment Rainfall Monitoring

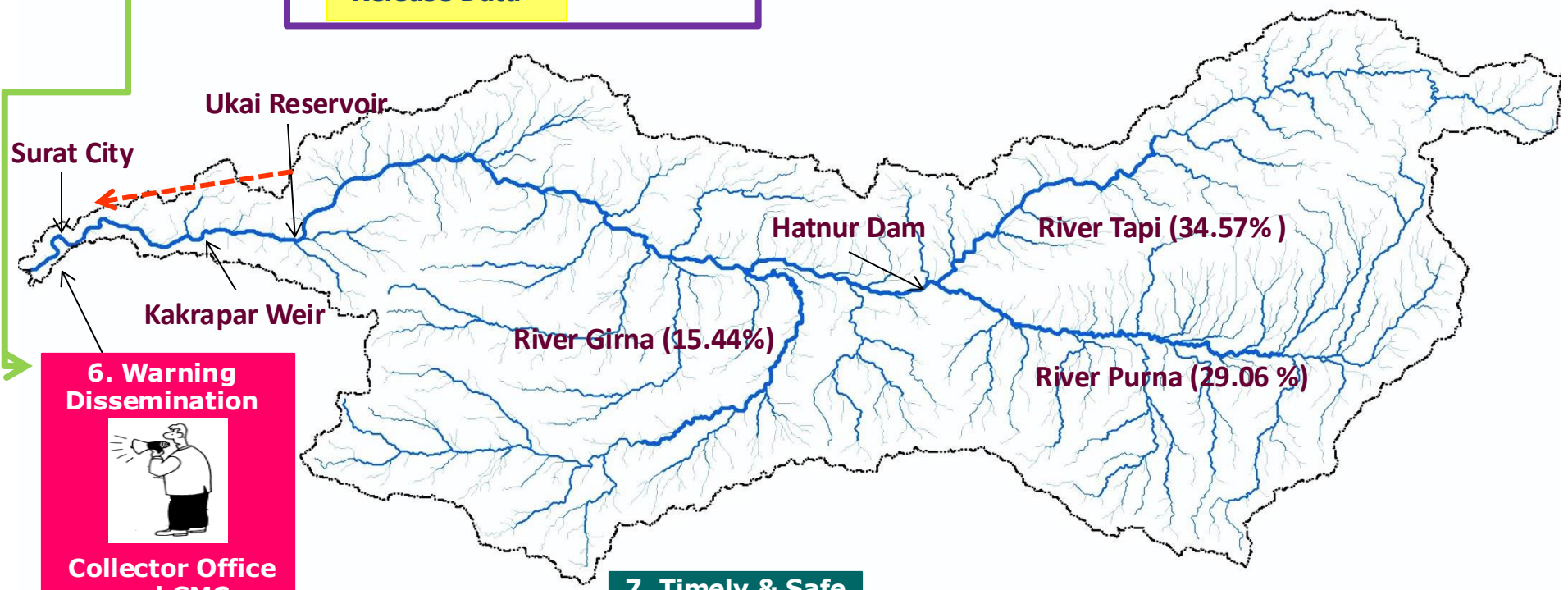
CWC & NWRWS

- Historical Data
- Real Time Rainfall Monitoring Data

1. Prediction

IMD

River Tapi Basin Rainfall Prediction Data* (6 to1 Days)



6. Warning Dissemination

Collector Office and SMC

7. Timely & Safe Evacuation

SMC

Increase in Respite Time to 3 to 5 Days

Rainfall and Inflow Forecast

IMD 3 models rainfall forecast is used for running the hydrological model for generating inflow forecast for UKAI.

- **MME (Multi Model Ensemble model)- Run by IMD for Agriculture purpose**
  - District level
  - 5 days forecast (including current day)
  - Daily rainfall
- **WRF (Weather Research and Forecasting model)- Operated by European Country**
  - 9 km resolution
  - 3 days forecast (including current day)
  - Daily rainfall
- **GFS (Global Forecast System)- NASA-US-presently run By IMD**
  - 37.5 km resolution
  - 7 days forecast (including current day)
  - Daily rainfall

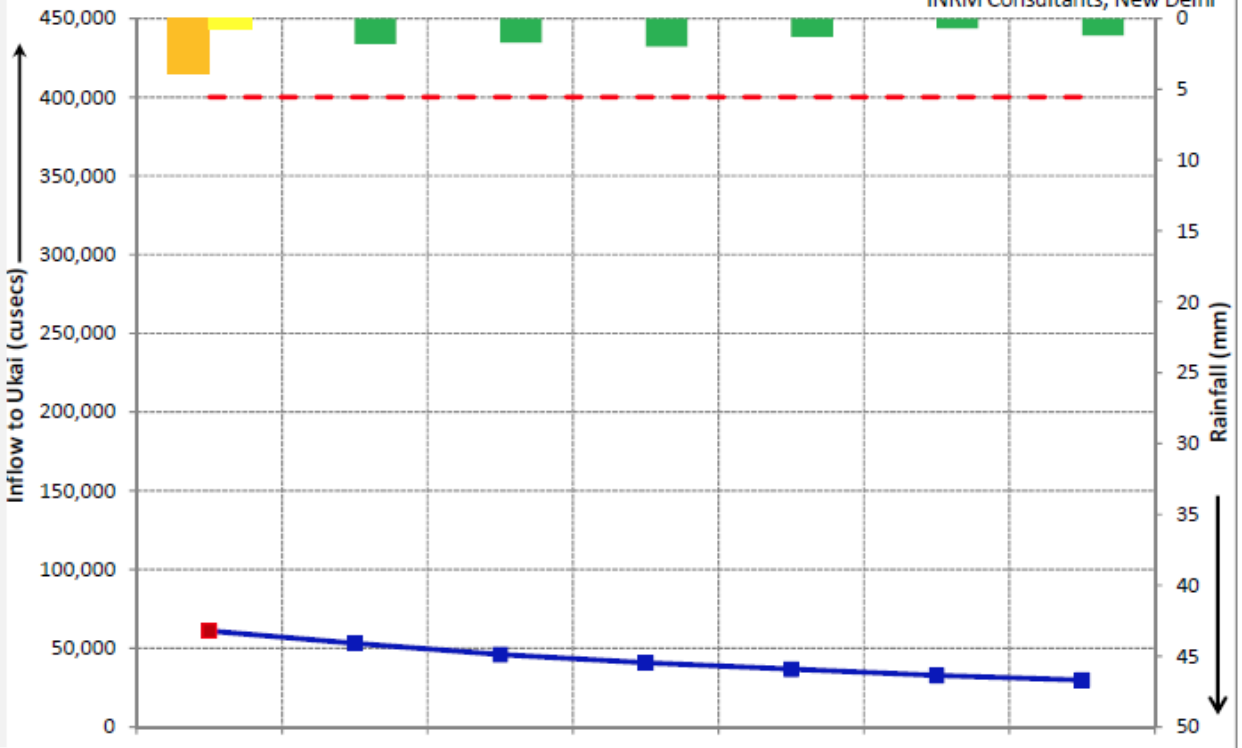
Global Forecasting System

Ukai Inflow (cusecs) Forecast using Global Forecast System (GFS) Valid till 20 September 2014

Developed for SCCT Surat
INRM Consultants, New Delhi

Forecast released on experimental basis

- Caveat
  - Simulated using SWAT Hydrological Model
  - Using Rainfall forecast from Global Forecast System (GFS) forecast precipitation data at 37.5km resolution
  - (ftp://ftp.cpc.ncep.noaa.gov/GIS/gfs)
- **Limitations in Model calibration:**
  - Observed Rainfall data from Maharashtra stations (Maha HP) is not updated consistently.
  - Observed rainfall is from 3 sources (Telemetry, Maha HP and TRMM gridded data)
  - There will be discrepancy between observed and forecast rainfall data in magnitude and timing
  - Calibration at Morane (on river Panjara) and Gidhade (Middle Tapi) could not be achieved for lack of /erroneous observed gauge data
  - Daily Calibration was not done for Inflows to Ukai .
  - U/s reservoirs operations are not included (as operation policy is unknown)
  - Latest upstream intervention (if any) has not been incorporated.



	14-Sep-14	15-Sep-14	16-Sep-14	17-Sep-14	18-Sep-14	19-Sep-14	20-Sep-14
Average Catchment observed rainfall upto Ukai on 14-09-2014 Forecast							
Average Catchment Forecasted rainfall upto Ukai on 14-09-2014	3.9						
Average Catchment Rainfall upto Ukai (Global Forecast System (GFS) forecast precipitation data at 37.5km resolution)	0.7	1.8	1.7	2.0	1.3	0.7	1.2
Inflow Forecast in cusecs using Global Forecast System (GFS) Valid till 20 September 2014	60,953.1 61,023.7	53,148.6	46,050.3	40,788.4	36,762.6	32,779.1	29,819.7
4 Lakhs cusecs Dischage Mark	400,000.0	400,000.0	400,000.0	400,000.0	400,000.0	400,000.0	400,000.0

Simulated using SWAT Hydrological Model

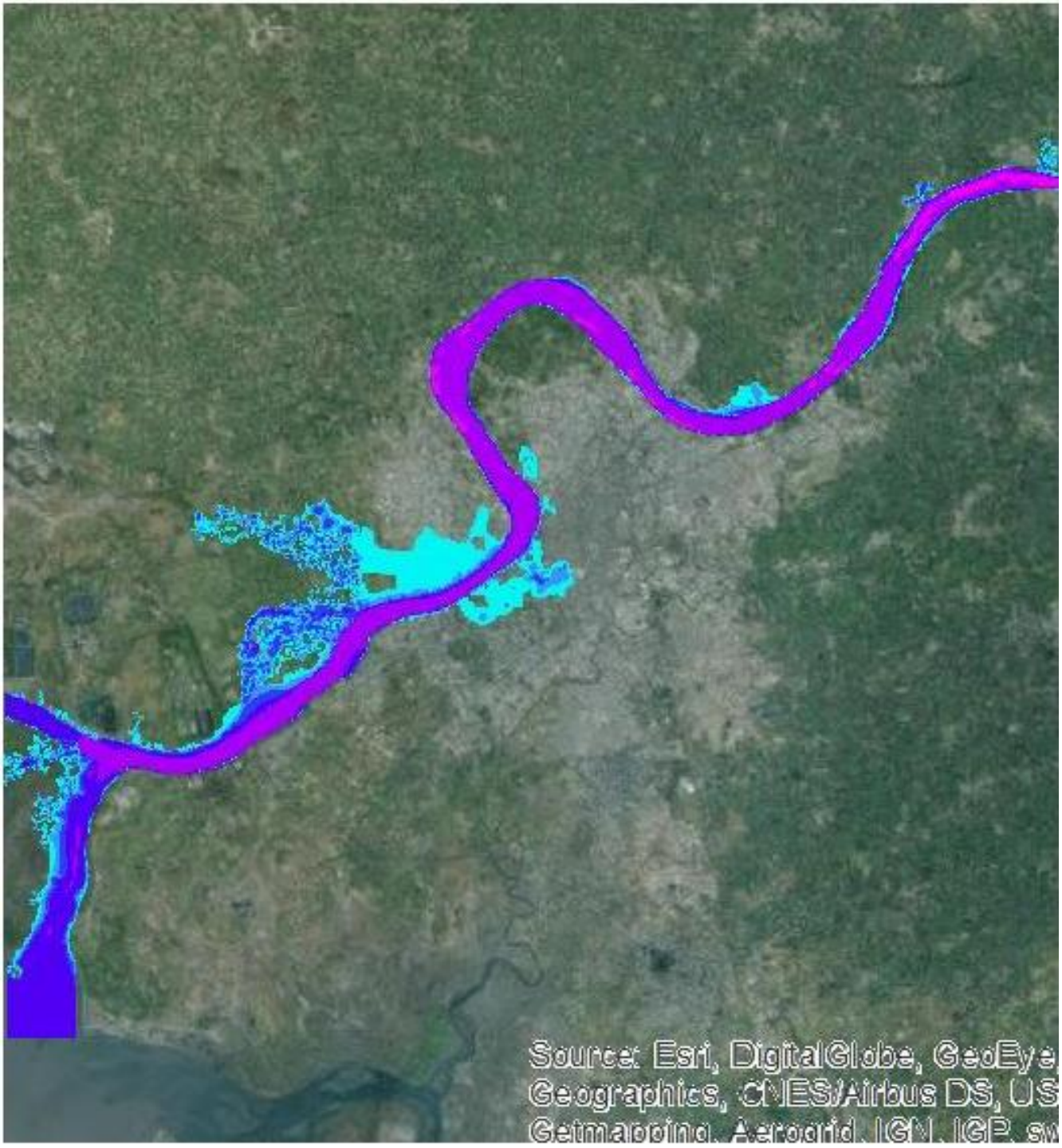
Global Forecast System (GFS) forecast precipitation data at 37.5km resolution

4

Lac Cusec

Water depth (m)

- 0 - 1
- 1 - 2
- 2 - 4
- 4 - 8
- 8 - 16
- 16 - 26



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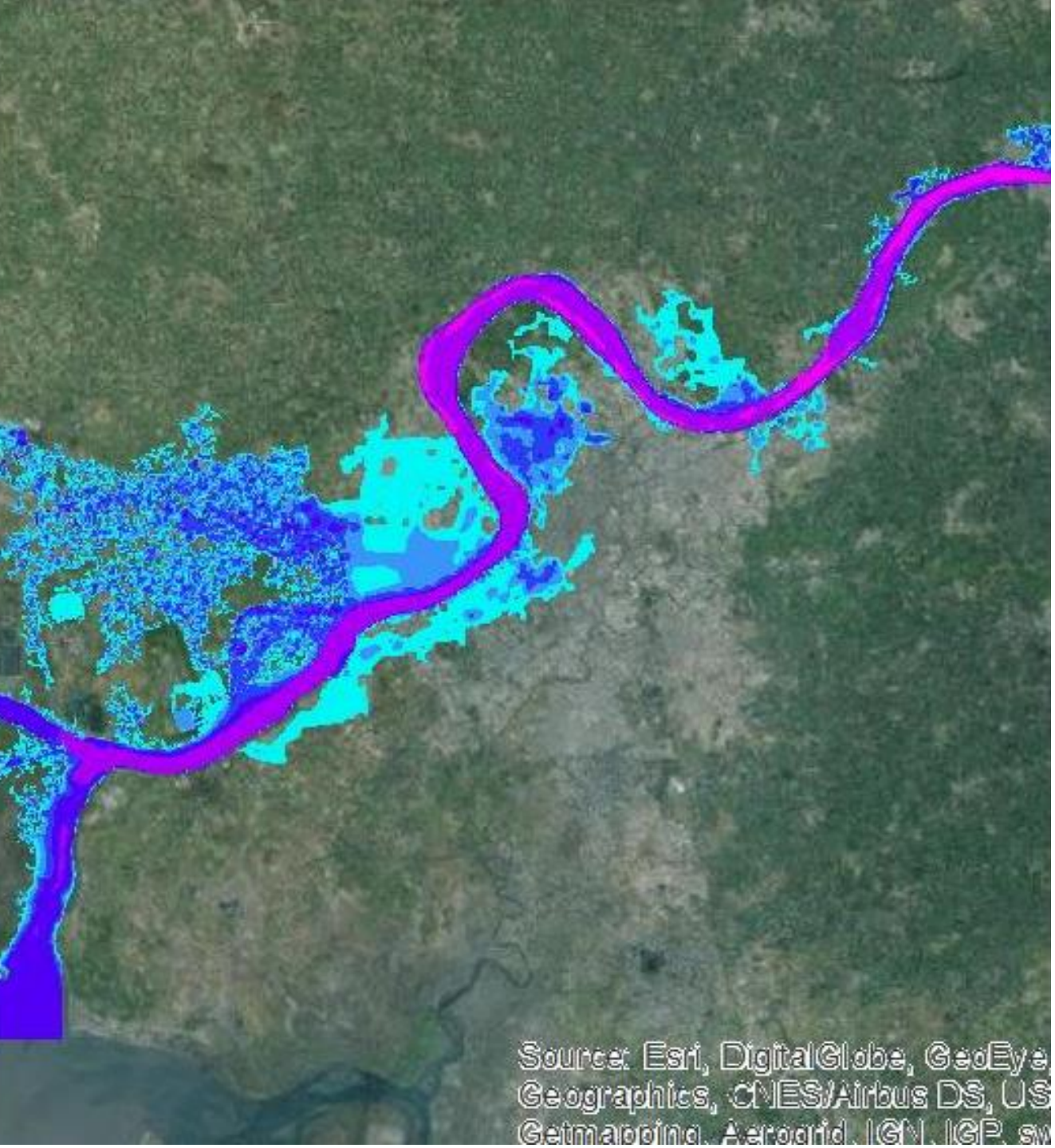
Lac Cusec

Water depth (m)

- 0 - 1
- 1 - 2
- 2 - 4
- 4 - 8
- 8 - 16
- 16 - 26



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Lac Cusec

Water depth (m)

- 0 - 1
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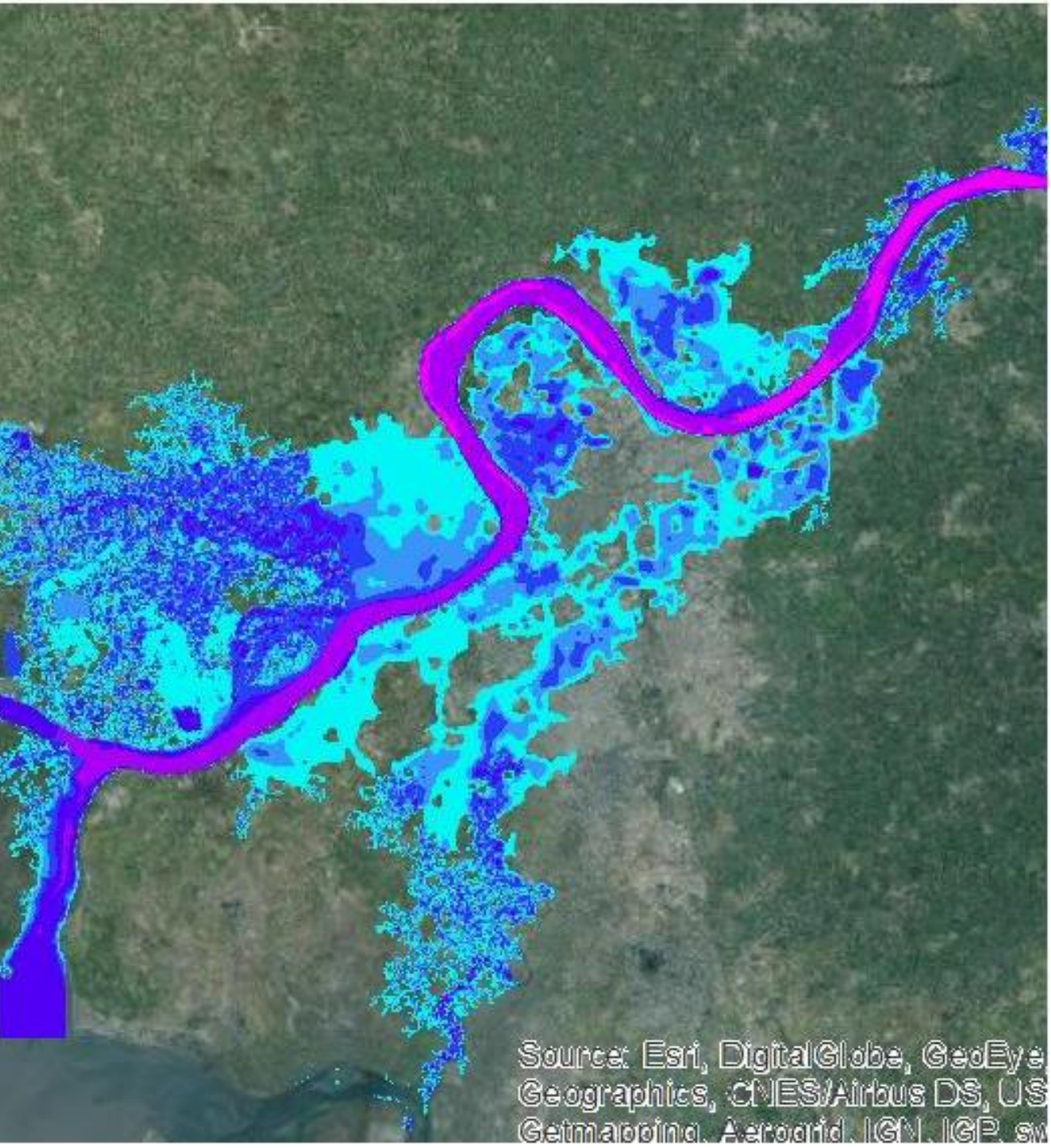
- 4 - 8
- 8 - 16
- 16 - 26



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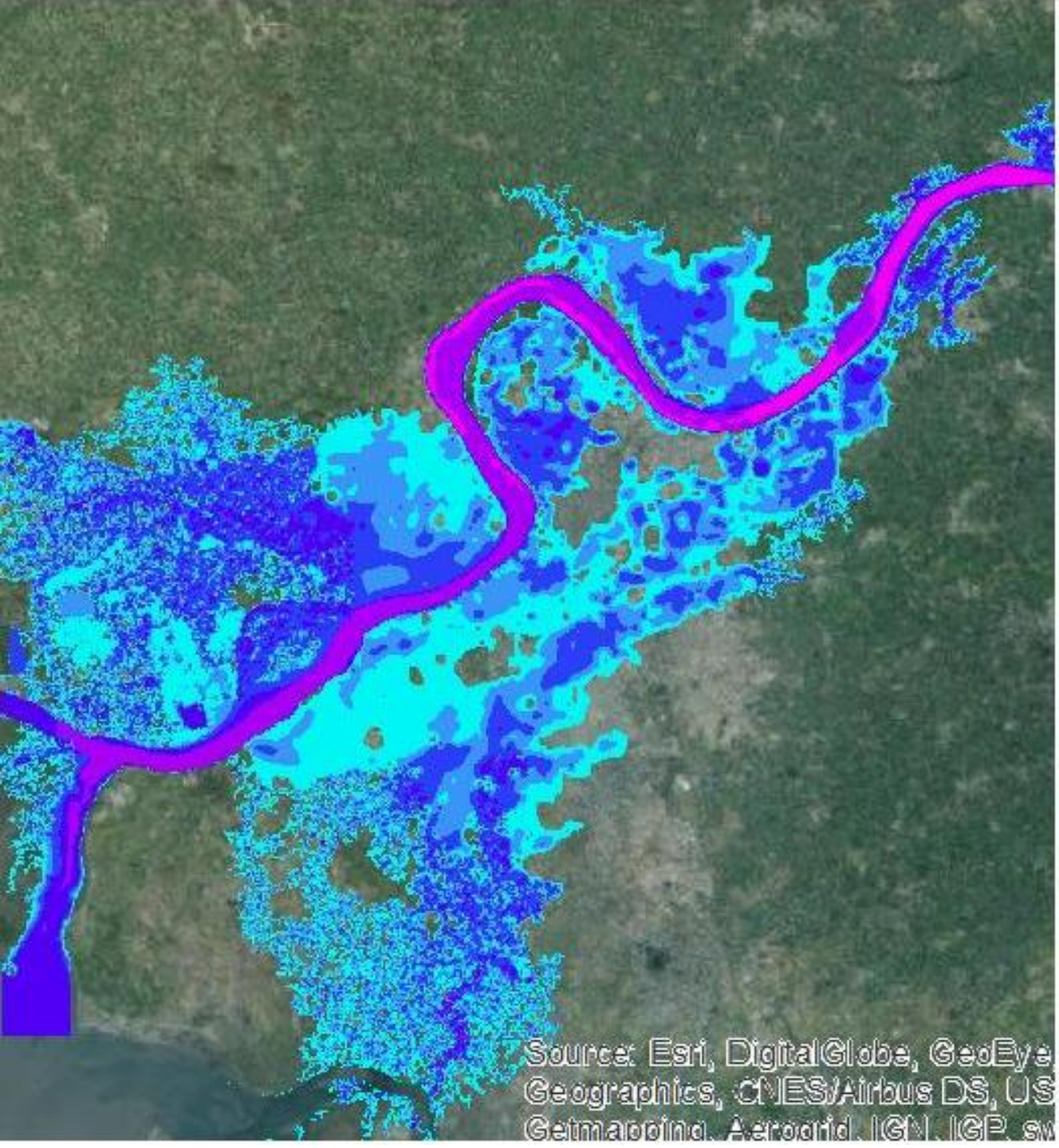
Lac Cusec

Water depth (m)

- 0 - 1
- 1 - 2
- 2 - 4
- 4 - 8
- 8 - 16
- 16 - 26



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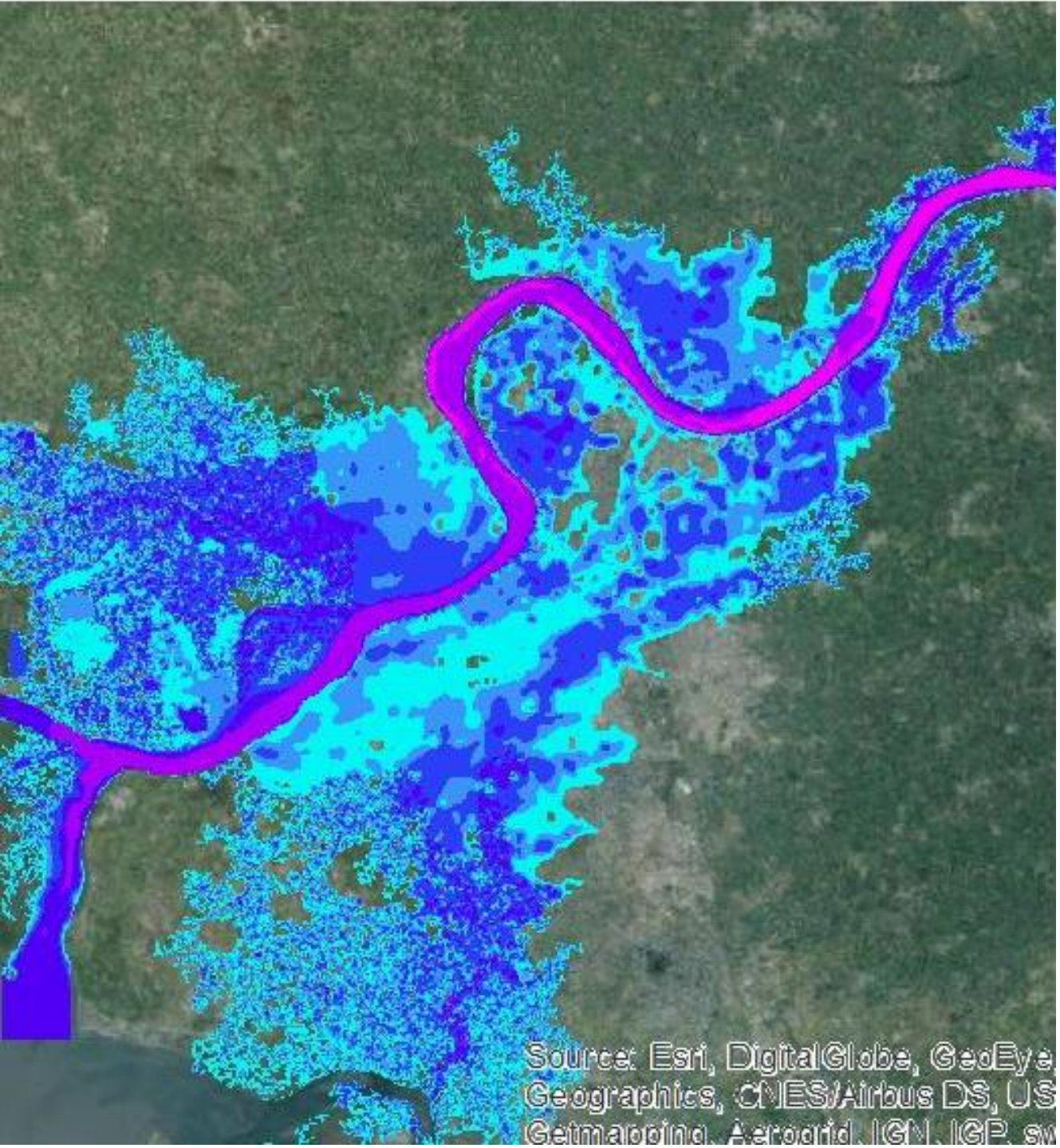
Lac Cusec

Water depth (m)

- 0 - 1
- 1 - 2
- 2 - 4
- 4 - 8
- 8 - 16
- 16 - 26



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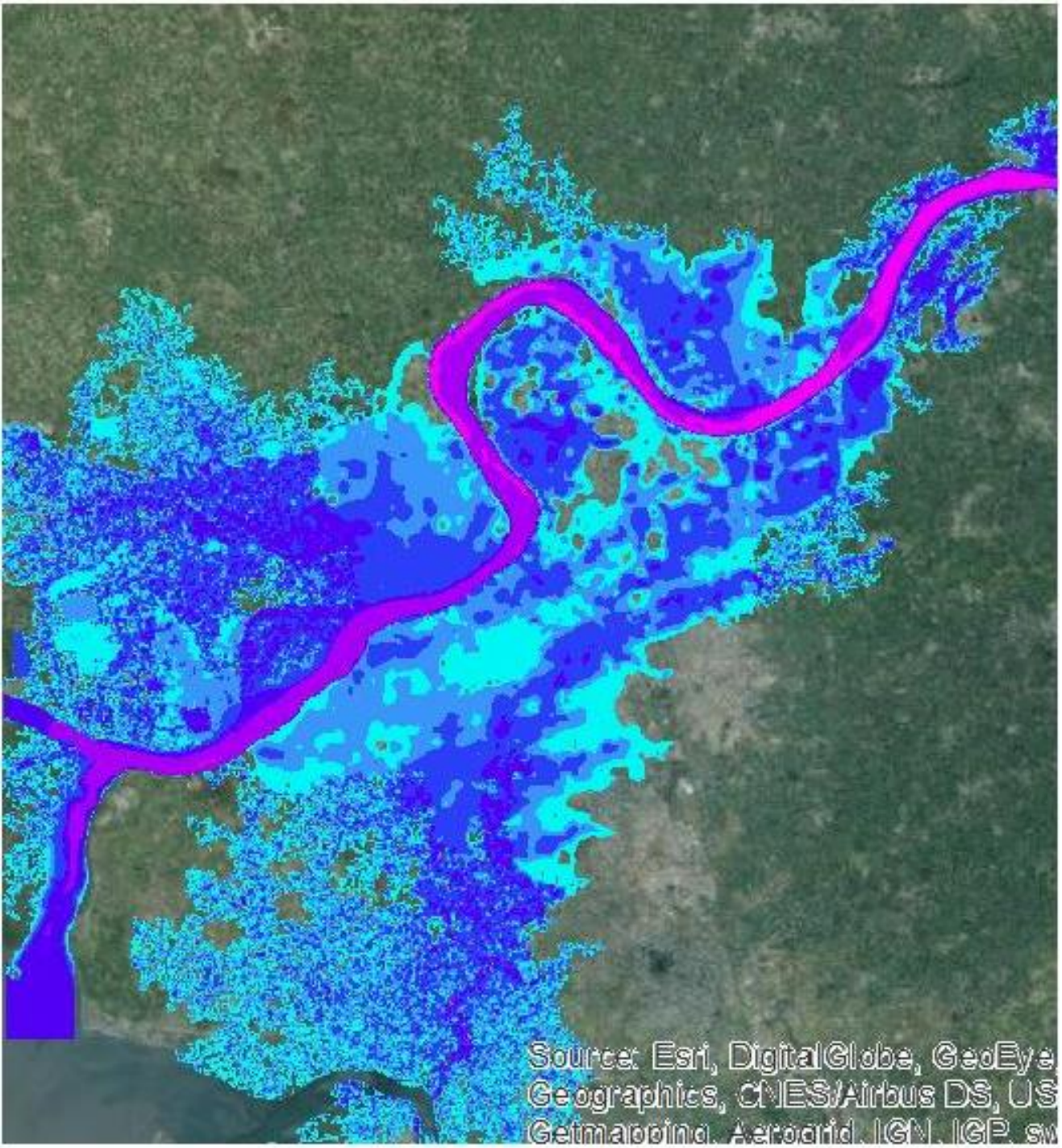
Lac Cusec

Water depth (m)

- 0 - 1
- 1 - 2
- 2 - 4
- 4 - 8
- 8 - 16
- 16 - 26

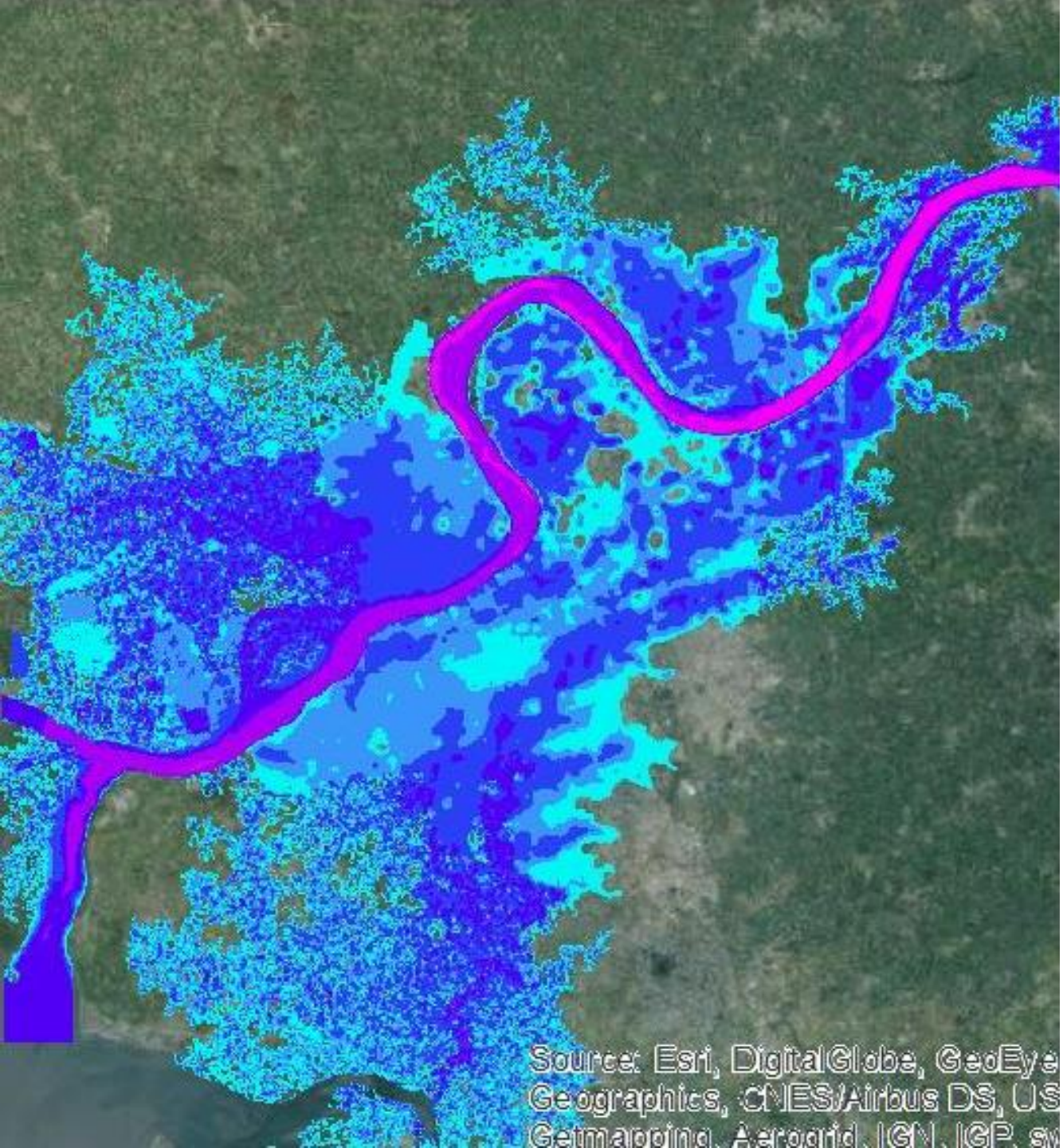


10

Lac Cusec

Water depth (m)

- 0 - 1
- 1 - 2
- 2 - 4
- 4 - 8
- 8 - 16
- 16 - 26

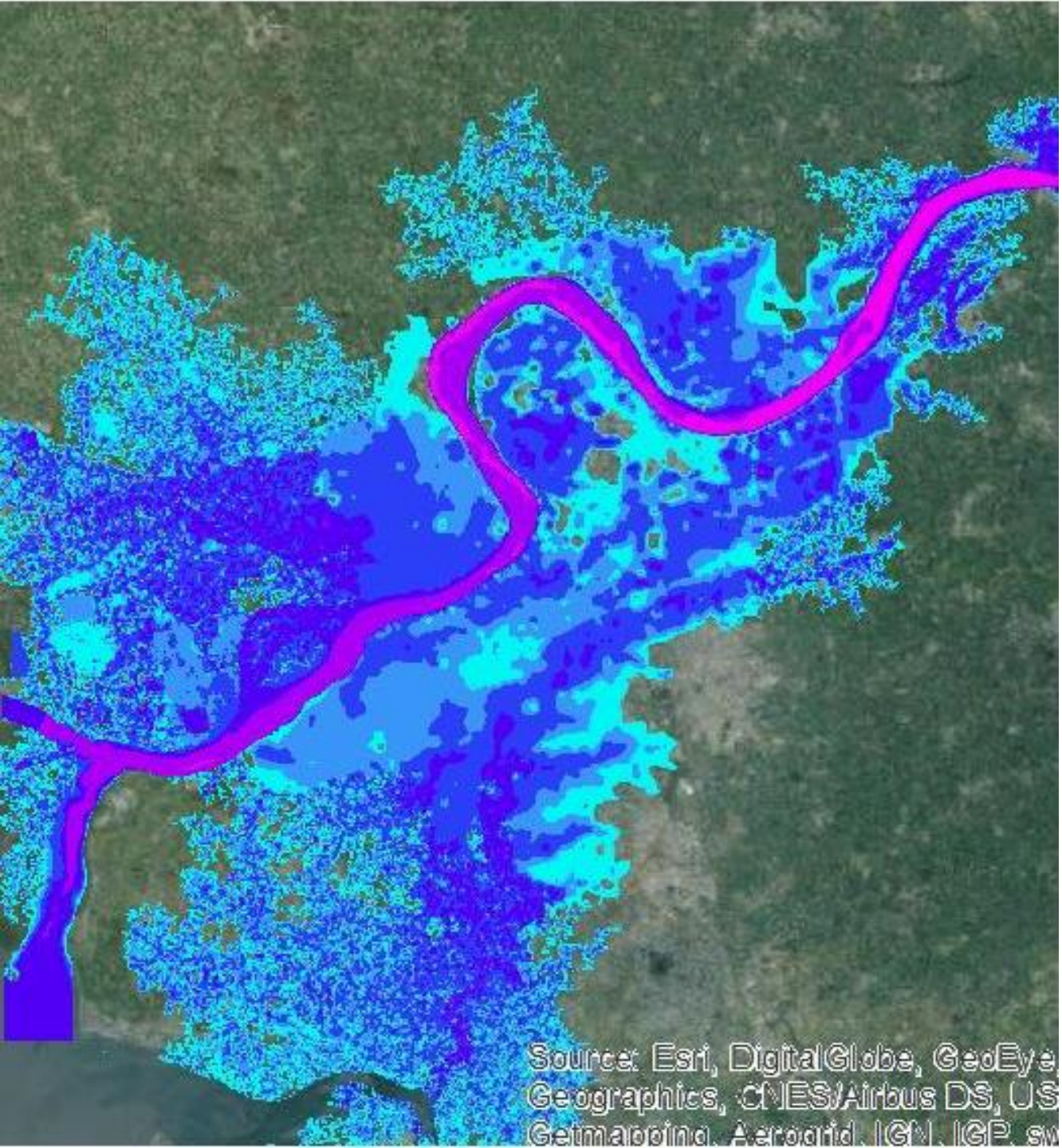


11

Lac Cusec

Water depth (m)

- 0 - 1
- 1 - 2
- 2 - 4
- 4 - 8
- 8 - 16
- 16 - 26



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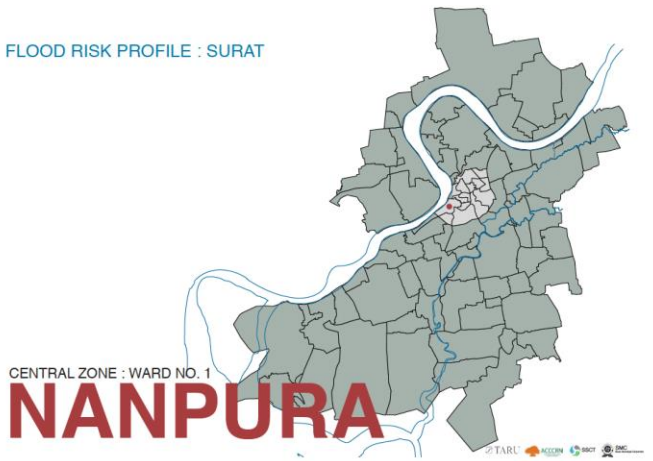
Lac Cusec

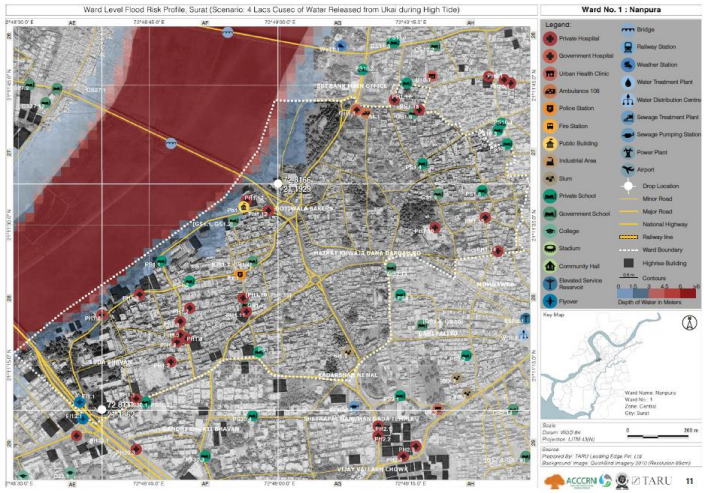
Water depth (m)

- 0 - 1
- 1 - 2
- 2 - 4
- 4 - 8
- 8 - 16
- 16 - 26

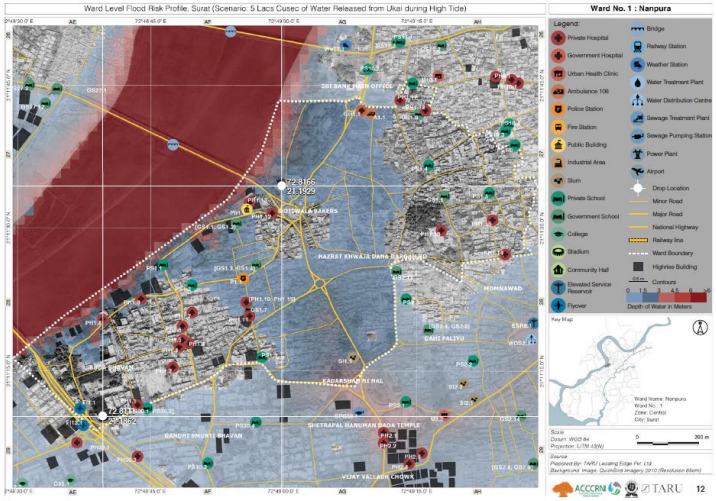
Ward Wise Flood Scenario With Critical Infrastructure



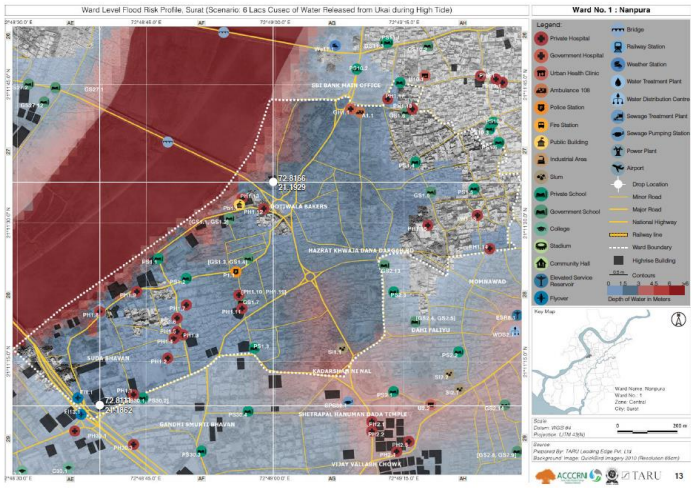
Surat Ward Map



4 lakh cusec

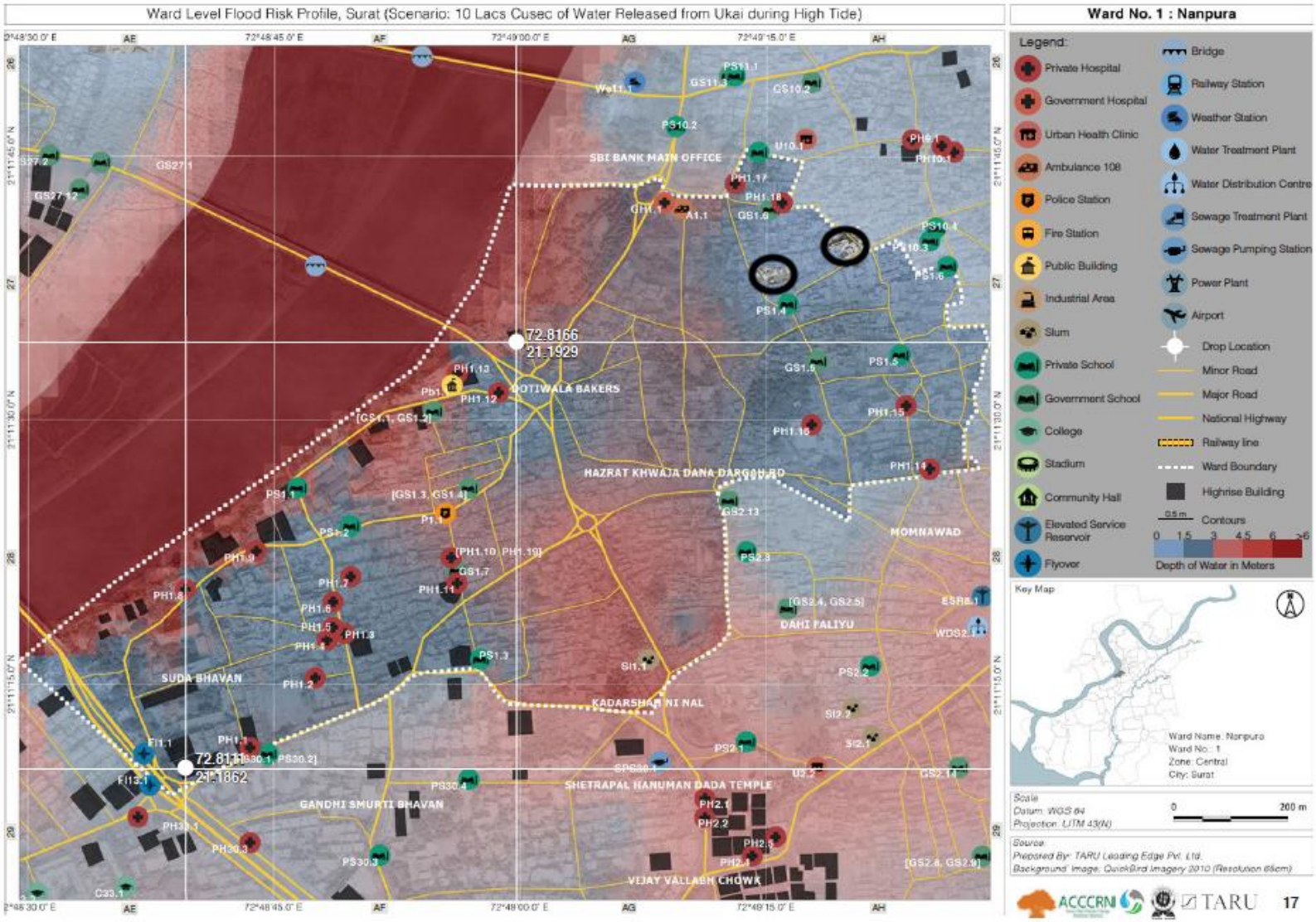


5 lakh cusec



6 lakh cusec

Topography and Critical Infrastructure Details:



10 lakh cusec

Critical Infra. Details

Private Hospitals

Map ID	Locator ID	Name	Area	Address	Type of Hospital	Contact Person	Mobile	Landline	Email	No. of Beds	No. of Doctors	No. of Nurses	No. of Paramedical Staff	Longitude	Latitude
PH1.8	AE28	Me and Mummy Hospital-1	Bahumali, Nanapura	Jalnidhi Complex, 3rd Floor front of Bahumali Building nanpura, Surat	Maternity Home	Dr. Praful B.Doshi Dr.MitsuP.Doshi	9824134253	2472222	-	20	9	5	15	72.811	21.189
PH1.9	AE28	Praver Hospital	Bahumali, Nanapura	Front Navdi Ovara Niva Appt. Nanpura, Surat	Kidney	Dr. Prashant Patel Dr. Vatsal Patel	9879759964	2460202	-	24	5	4	10	72.8122	21.1896
PH1.10	AF28	Rails Orthopedic Hospital	Timaliyawad, Nanapura	1-1037-Chowki Sheri Nanpura Surat	Orthopedic	Dr. Harjeetpal Singh	9825116977	2461239	-	15	1	2	3	72.8155	21.1895
PH1.11	AF28	Shreyas Hospital	Timaliyawad, Nanapura	Chowki Sheri, Frontof Handloom House, Nanpura, Surat	Maternity Home	Dr. Dasrath V. Patel	-	-	-	10	3	4	2	72.8156	21.1891
PH1.12	AF27	Nupur General Hospital	Nanapura, Makkai Bridge	Makkai pool frontof Swimming pool Nanpura, Surat	Surgical	Dr. Mukesh K. Vaghela	9825115154	2474899	-	17	2	2	12	72.8163	21.1921
PH1.13	AF27	Parth Eye Hospital	Nanapura, Makkai Bridge	Westan Plaza appt.Shopping, Bhulka bhavan School, Adajan Road	Private	Dr. S.K. Varma	-	2735619	-	17	1	2	4	72.8156	21.1924
PH1.18	AH27	Rupal Eye Hospital	Gopipura	Modi Desai Pole ,Gopipura, Surat	Prastrulgruh	Dr. Maltiben Shah	-	-	-	0	5	20	16	72.8211	21.1951

Government Hospital

Map ID	Locator ID	Name	Area	Address	Type of Hospital	Contact Person	Mobile	Landline	Email	No. of Beds	No. of Doctors	No. of Nurses	No. of Paramedical Staff	Longitude	Latitude
GH1.1	AG27	Old Civil Hospital	Chok Bazar	Chowk Bazar, Surat	General	Medical Suprintendon	-	-	-	50	3	13	0	72.8191	21.1951

Ambulance 108

Map ID	Locator ID	Base Location	Longitude	Latitude
A1.1	AG27	CHC Zhankhwaw	72.8194	21.195

Police Station

Map ID	Locator ID	Name	Longitude	Latitude
P1.1	AF28	Nanpura Police Station	72.8154	21.1902

Public Building

Map ID	Locator ID	Name	Area	Longitude	Latitude
Pb1.1	AF27	Southern Gujarat Chamber of Commerce & Industry office	Nanapura, makkai Bridge	72.8155	21.1922

Slum

Map ID	Locator ID	Slum Code	Slum Name	Slum Name in RAY	Area (sqm)	Ownership of Land	Total No. of Huts	Longitude	Latitude
Sl1.1	AG28	SMC/C008	C-1,Subedar Street-Jamalesha Street	SUBEDAR STREET,JAMALSHA STREET	12747.42	Private	325	72.8188	21.1879

Disaster Management Plan

- SMC has been preparing annual DMP since 2002.
- DMP is updated every year with improvements based on experience and fresh information.
- Each zone reviews its own ZDLP (Zonal Disaster Management Plan)
  - Information of this is given to
  - MLAs and Municipal Councilors
  - UCD and Anganwadi Staff
  - Medical Practitioners of each zone
  - Entire staff of the zone administration
  - NGOs, Voluntary Organization and Swimmers
- Every member of staff is trained in his /her role in the event of flood.

Automatic Weather Station

- **Under Asian Cities Climate Change Resilience Network - Surat Climate Change Trust has installed Automatic Weather Stations at various locations.**
- **Features:**
  - Wireless GSM / GPRS enable automatic weather station
  - Useful for collection and transmission of data in real-time through internet
  - Easy availability of information
  - Energy efficient instrument.
- **Parameters :**
  - Temperature
  - Relative Humidity
  - Wind speed
  - Wind Direction
  - Rainfall

Surat AWS map

AWS online information

Site ID ✓ AWSBAMROLI, AWSBHESAN, AWSCAUSEWAY, AWSDUMAS, AWSHOPE, AWSKARANJ, AWSKOSAD, AWSLIMBAYAT, AWSSARATHANA, AWSSC

Start Date 2017-6-9 End Date 2017-6-9 Get Record

Export to E

Citizen can access the information from
http://virtualinfocenter.com
Login ID: scct2013
Password: ews2014

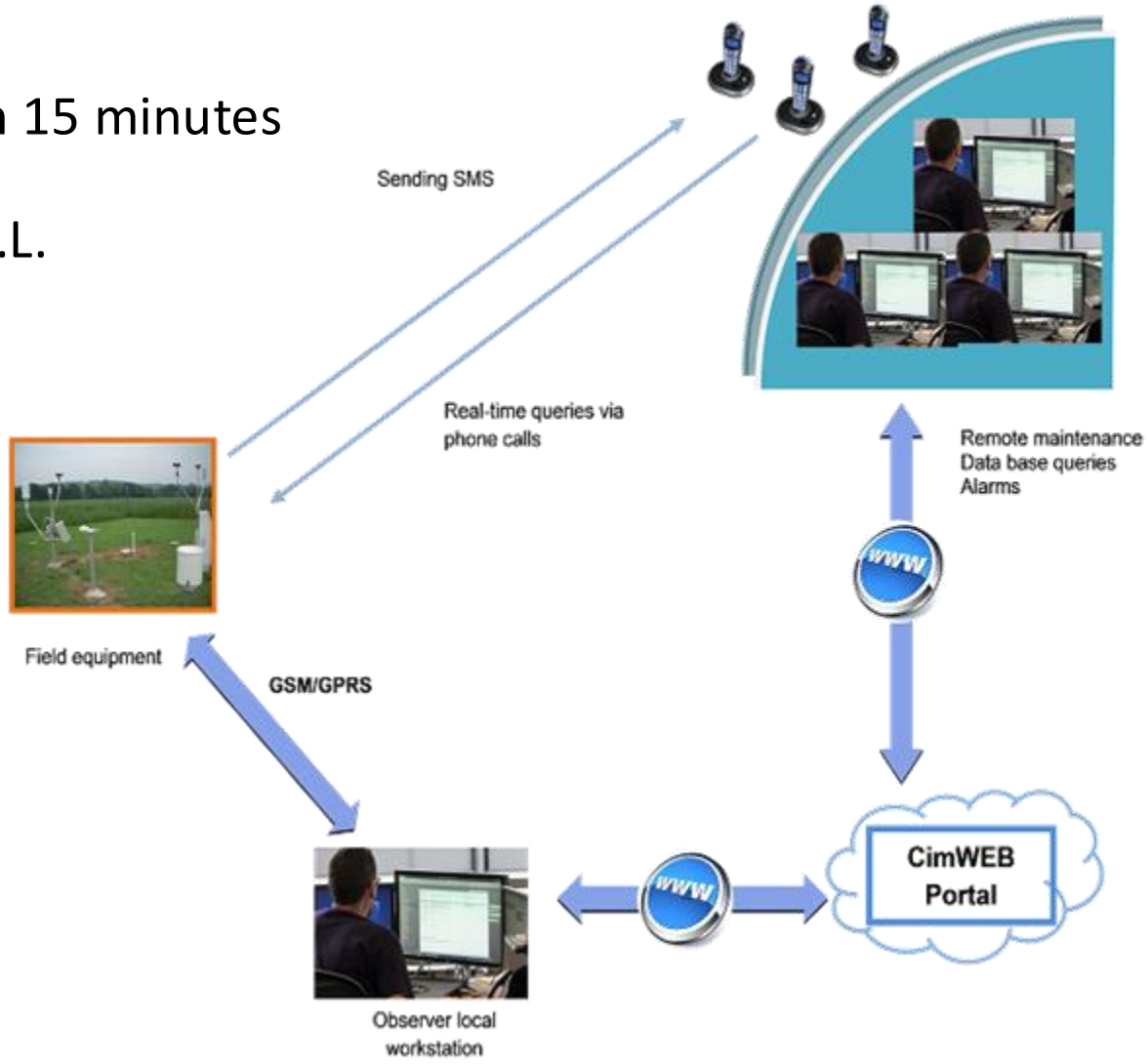
<< < 1 2

Site ID	Date & Time	Temp.	Max. Temp.	Min. Temp.	RH	Max. RH	Min. RH	Wind Speed	Avg. Wind Speed	Max. Win Speed
(X)	(DD/MM/YYYY - HH:MM:S)	(°C)	(°C)	(°C)	(%)	(%)	(%)	(mtrs/sec)	(mtrs/sec)	(mtrs/sec
I	09 / 06 / 2017 - 12:32:00	34.91	34.91	34.05	73.09	74.39	72.11	0.9	1	3.7
I	09 / 06 / 2017 - 12:47:00	35.2	35.2	34.9	71.71	73.33	69.8	0.5	0.9	3.2
I	09 / 06 / 2017 - 13:02:00	34.43	35.4	34.42	72.02	72.23	69.59	0.8	0.9	2.3
I	09 / 06 / 2017 - 13:17:00	33.8	34.47	33.72	74.98	75.07	71.85	1.3	1.2	3.4
I	09 / 06 / 2017 - 13:32:00	33.82	34.05	33.7	74.68	75.26	73.08	0.9	1.4	4.4
I	09 / 06 / 2017 - 13:47:00	34.38	34.45	33.81	72.73	75.03	72.24	1.5	1	3.3
I	09 / 06 / 2017 - 14:02:00	33.95	34.37	33.94	73.5	73.81	71.65	0.7	1	2.3
I	09 / 06 / 2017 - 14:17:00	34.02	34.03	33.76	73.8	74.62	72.19	1.4	1.2	3.4
I	09 / 06 / 2017 - 14:32:00	34.4	34.53	33.96	70.79	74.35	70.76	1.1	1.2	3
I	09 / 06 / 2017 - 14:47:00	34.53	34.68	34.39	71.98	72.56	70.42	0.9	1.4	4
I	09 / 06 / 2017 - 15:02:00	34.17	34.74	34.13	74.45	74.97	71.16	2.5	1.8	4.3
I	09 / 06 / 2017 - 15:17:00	33.52	34.23	33.51	77.51	78.59	74.27	2.5	2.3	5.3

Automatic Weather station

- **SMS Alert for**

- If it rains above 50 mm in 15 minutes
- If level at causeway is
  above 12 meters R.L.



Observed Inundation level ; Different Discharges

Community can easily understand inundation level

Need for Flood Forecasting & Reservoir Management

- Provides timely and effective information on flood hazard,
- Can reduce hazard intensity (by controlled release from dam),
- Can stop hazard convert into disaster,
- Reduce magnitude of disaster (timely evacuation, preparedness),
- Support city administration to prepare for effective last mile response well in advance.
- End-to-End Early Warning System to reduce the intensity of floods and resultant flood damage to Surat city.
- Improve reservoir operations to minimize peak floods caused by extreme precipitation events in Upper and Middle Tapi basin.
- Better prepare institutions and society to handle flood emergencies (including tidal creeks floods).

Linkage of System for Floods Early Warning and Disaster Management System

Early Warning & DM System provide near-real time modeling results in the following way:

- Safe Evacuation Routes (including vehicle) Marking in flood affected areas,
- Communicate through various channels using multiple modes to reach the communities at risk including Radio, TV, automated mobile SMS ,What's App, as well as voice calls, public address system
- Linkage with City DMP and Ward DMP

Thank you!

SURAT MUNICIPAL CORPORATION