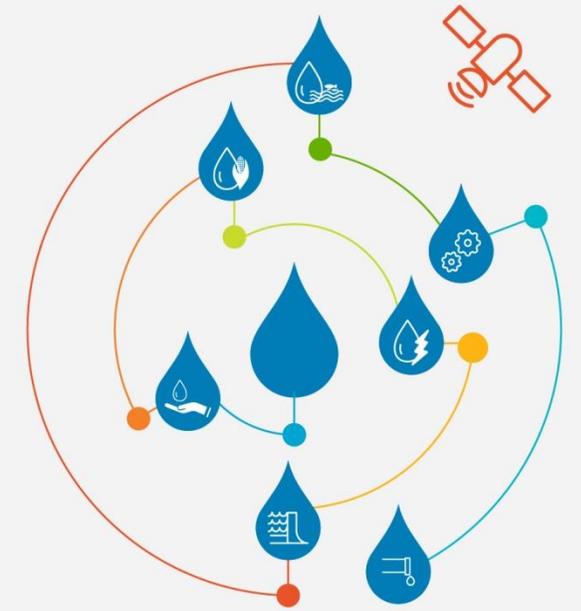


Potential of remote sensing tools to establish indices for surface water and groundwater resource assessment, monitoring and management



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October 3, 2018



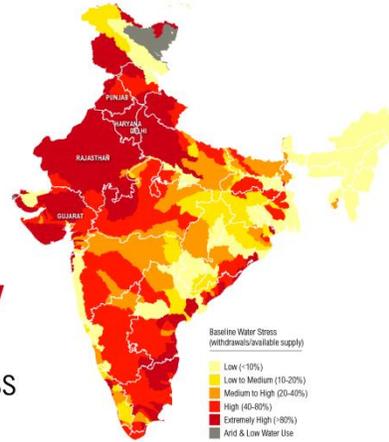
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Introduction

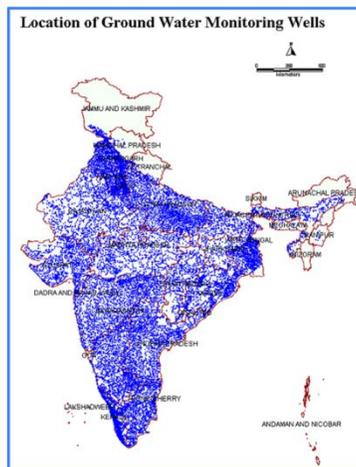
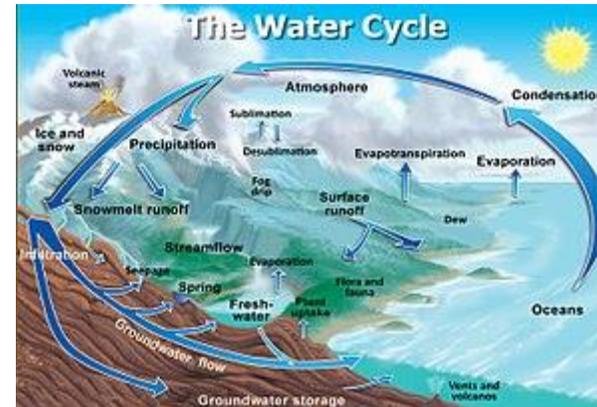
- Water resources - scarce
- Management - lacks capacity
- Water management - quantity but not quality?
- Lack of holistic view
- Limited observations

54%
of India
Faces
**High to
Extremely
High**
Water Stress



www.indiawatertool.in

WORLD RESOURCES INSTITUTE



(CGWB 2015; WRI 2015; TOI 2016; USGS)



Introduction – Groundwater

- Climate Change buffer
- Highest groundwater extractor (estimated 230 -245 km³ per year)
- Disconnect (rainfall/deep aquifers)

80% of India's drinking water needs dependent on groundwater

2/3 of water for irrigation supplied by groundwater

84% of the total addition to irrigation over the last four decades has come from groundwater

60% of India's districts face groundwater over-exploitation and/or serious quality issues

WELLS IN BAD HEALTH

A comparison of 2017 pre-monsoon water levels with the 10-year average presents a grim picture



State	% of wells with water below 10-year avg (2007-16)*	
	Total	≤2m below avg
Tamil Nadu	86.8	51.9
Punjab	84.6	35.5
Andhra	75	21.8
UP	70.6	13.3
Kerala	70.1	8.7
Karnataka	69.3	26.7
Haryana	68.5	31.1
Delhi	64.9	36.2
Chhattisgarh	61.1	16.6
Odisha	60.2	7
Gujarat	59.2	23.9
Jharkhand	58.7	11.5
Maharashtra	56.8	18.1

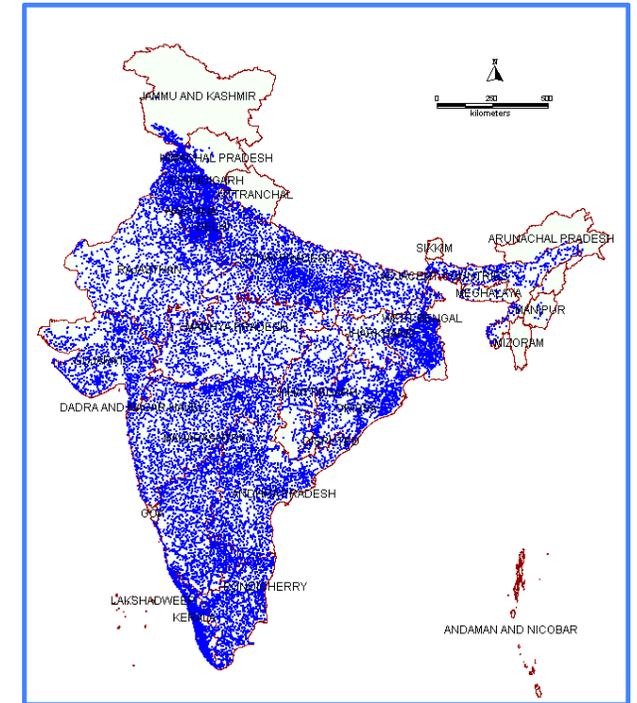
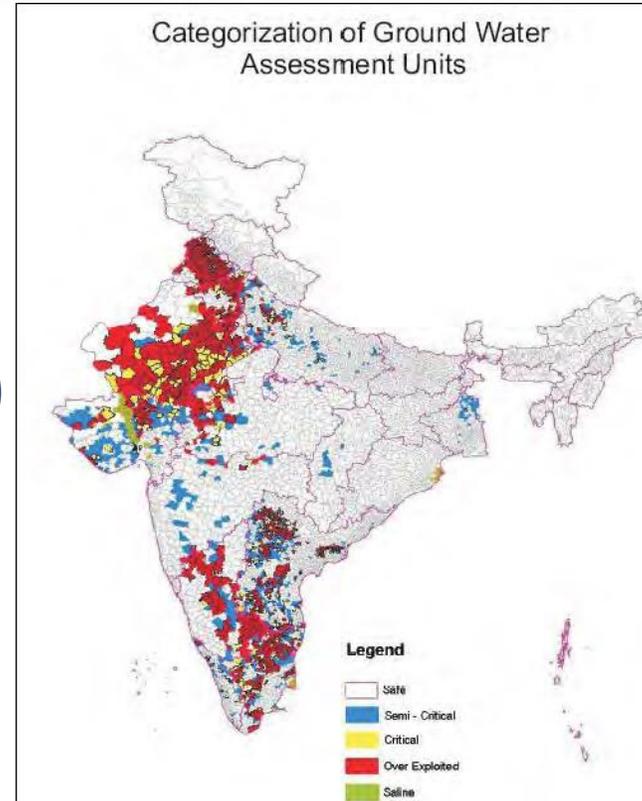
17.5% of these below avg by 2m or more

*States covered in a Central Ground Water Board survey

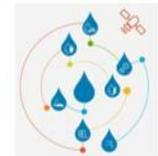
Sinking Cities?

Lucknow: Under threat of massive subsidence (land sinking) from over-exploitation of groundwater resources in the next 15 to 20 years

Kolkata: Estimated avg land subsidence rate of 13.5mm/year. For every 1m drop in groundwater, avg subsidence is 33mm



(World Bank 2013; CGWB 2017; TOI 2018)



Objectives – Ways forward

- Develop physically based holistic frameworks

- Mass balances
- Socio—economic drivers
- Anthropogenic stressors

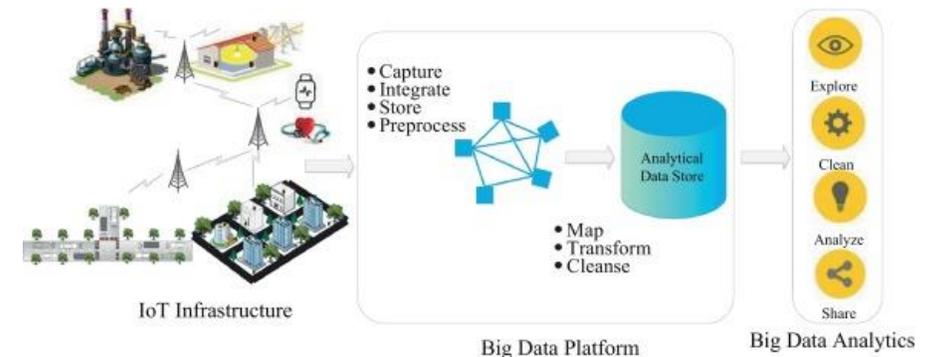


- Holistic approach

- Big Data Analysis

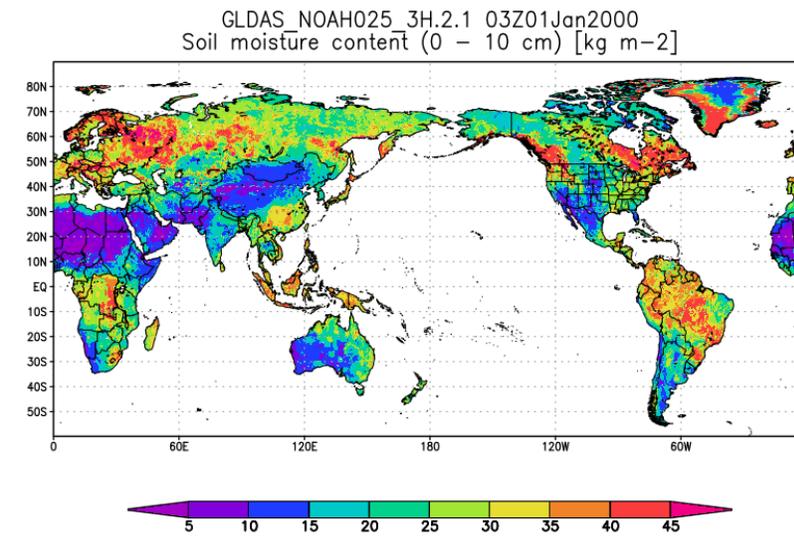
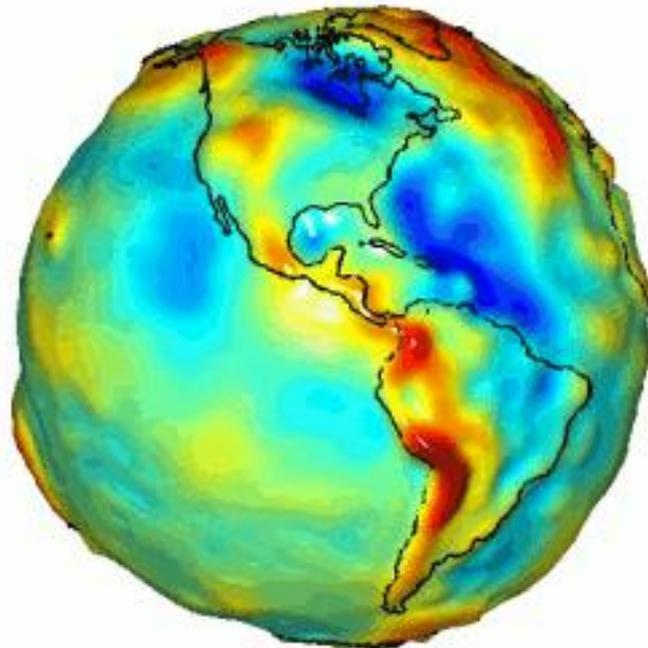
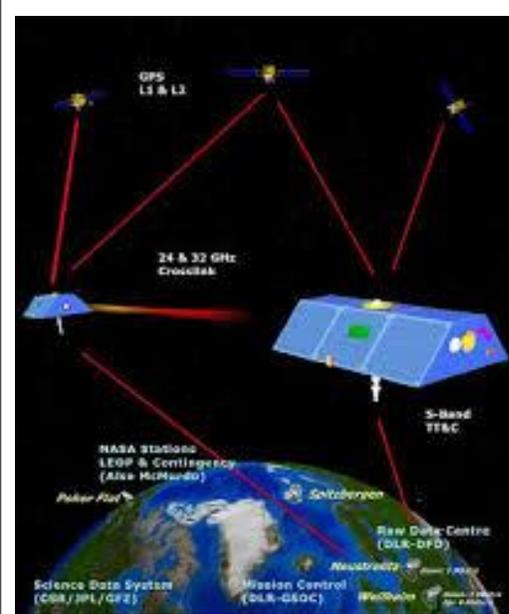
- higher Spatial and temporal resolution

- Satellite data augmenting observation data



Remote Sensing Data Platforms

- Gravity Recovery And Climate Experiment (GRACE)
- Global Land Data Assimilation Systems – GLDAS Archives
- Bhuvan GIS (RS/Observed data)



(NASA, BhuvanGIS)



Case Study 1 – Initial: Sensitization and Seeking Capacity

Comparing groundwater level trends between Observed and Remote Sensing

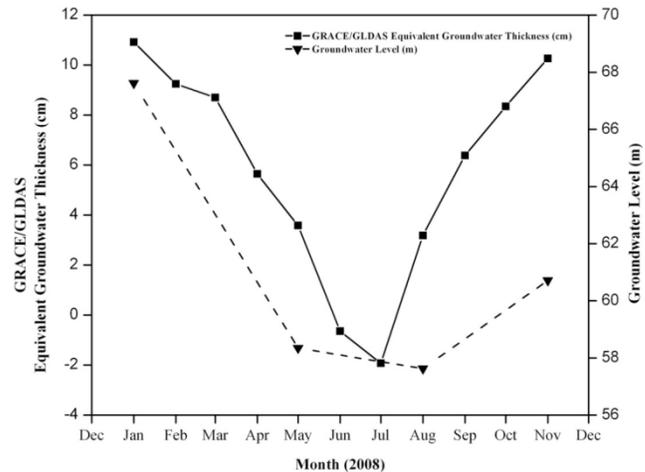


Figure 5. Comparison between GRACE/GLDAS-derived groundwater thickness (cm) and observed groundwater level (m) at Gandhinagar district in Gujarat for the calendar year 2008 (Central Groundwater Board 2010).

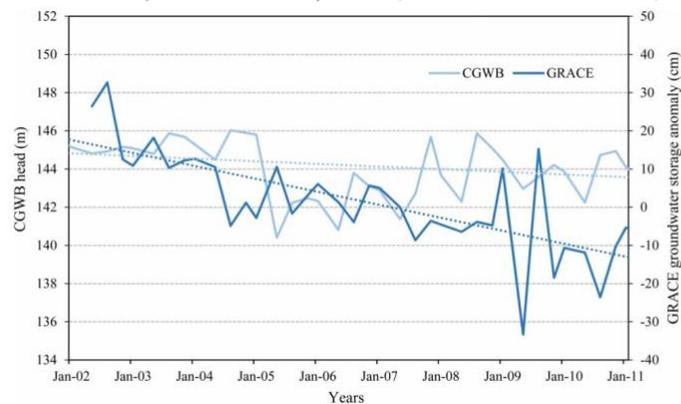


Figure 3 | Comparison between CGWB-derived groundwater head and GRACE-derived groundwater storage anomaly for the Ramganga basin.

Monthly Estimates

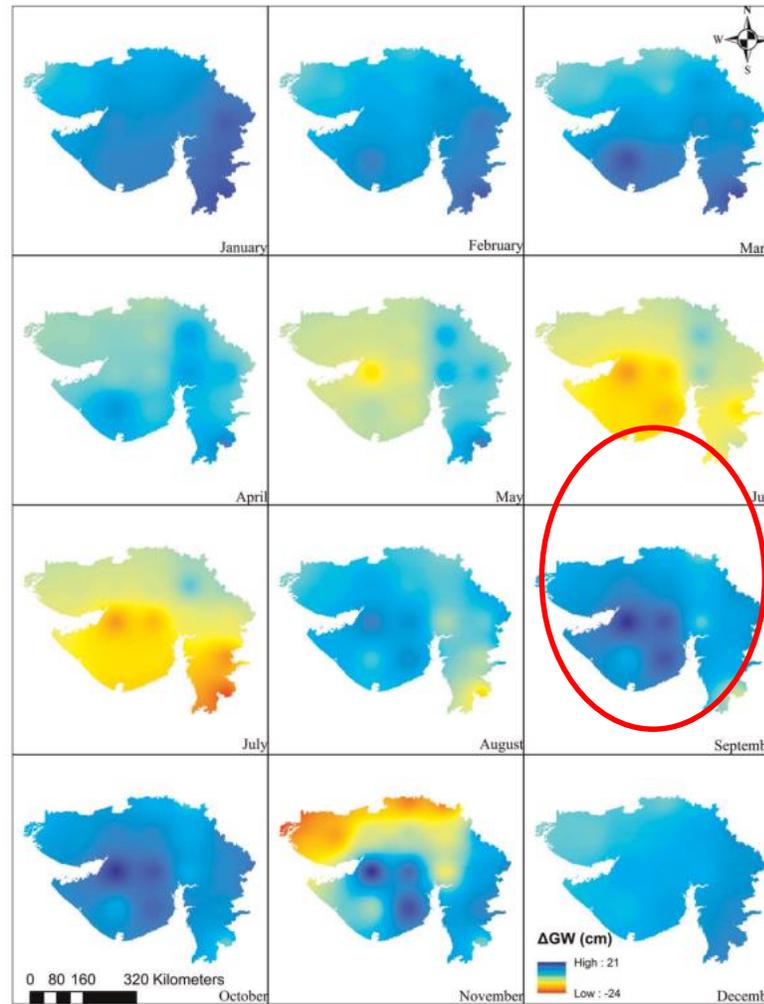


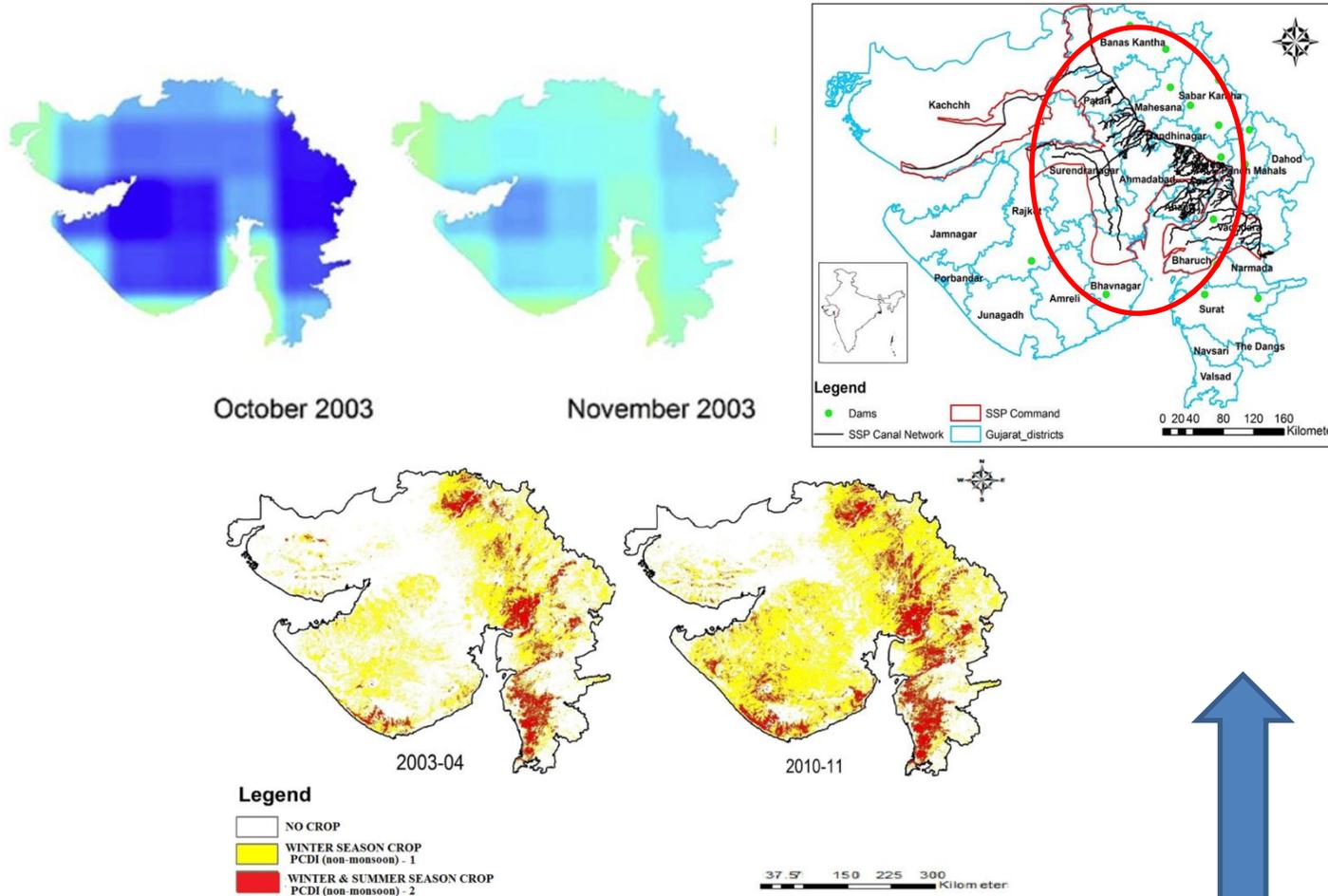
Figure 2. Monthly GRACE/GLDAS gravity solution for total groundwater storage for 2008 in Gujarat, India.

First ever monthly estimates of groundwater storage change



Case Study 2: Identifying Physical and Anthropogenic Stressors

Increased groundwater recharge and use in winter



Impact of Groundwater liberalization in West Bengal

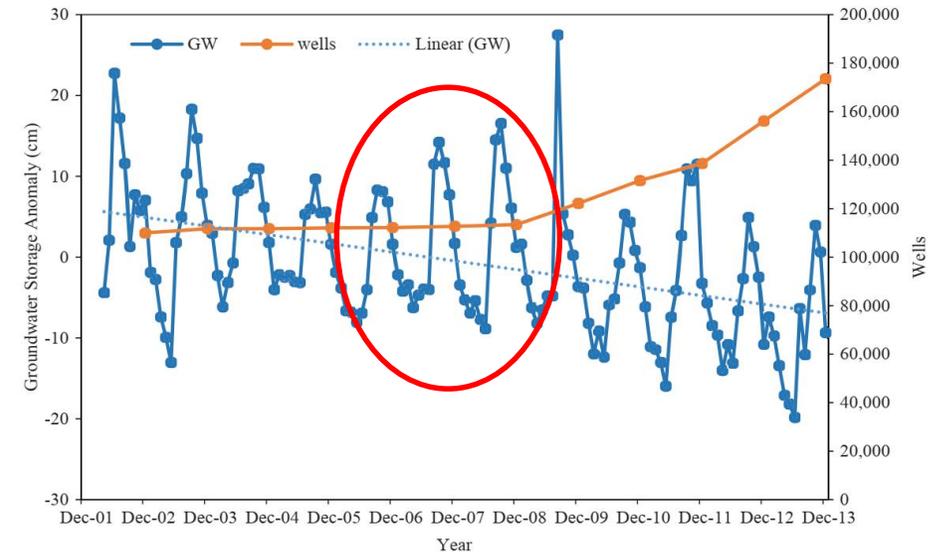


Figure 3. GRACE estimated GW storage anomaly and total number of wells trends for West Bengal, India, from 2002 to 2013.

(Chinnasamy and Agoramoothy 2015; Chinnasamy et al 2017)



Case Study 3: Identifying Long Term Trends and Storage

Long term rainfall and groundwater storage change in Rajasthan

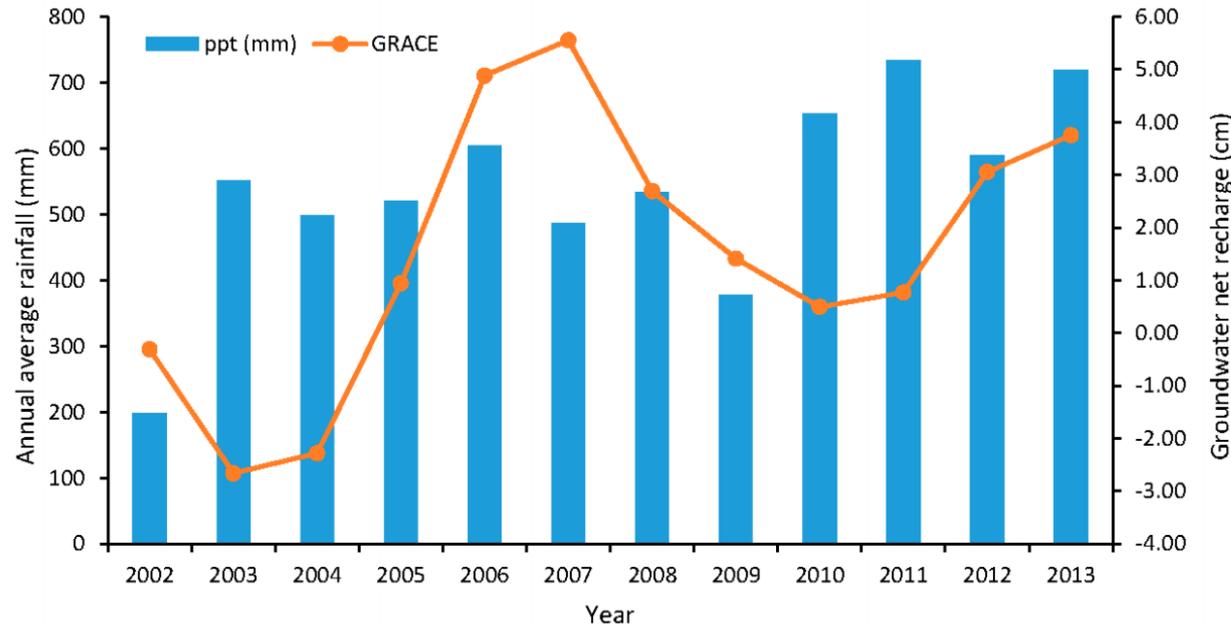
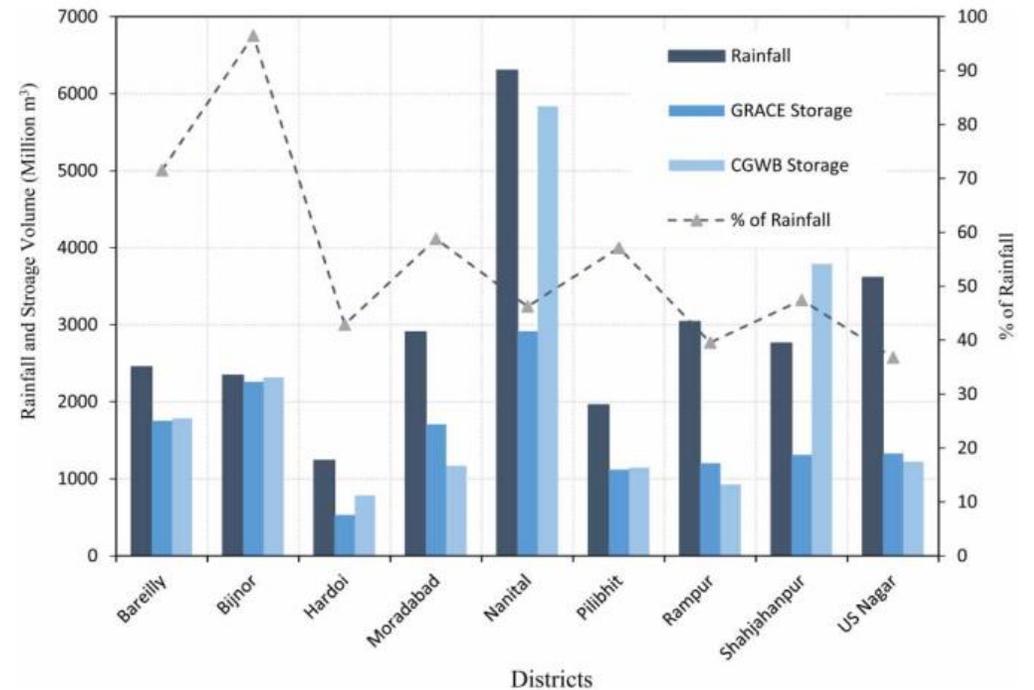


Figure 7. Comparison between annual average rainfall and GRACE net estimated groundwater recharge.

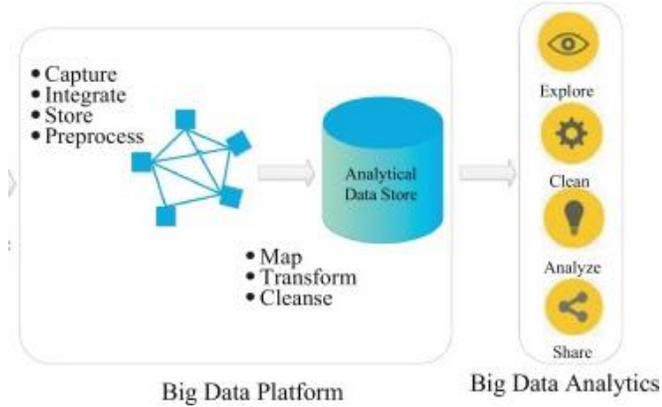
Potential of groundwater storage to store floods in Ganges



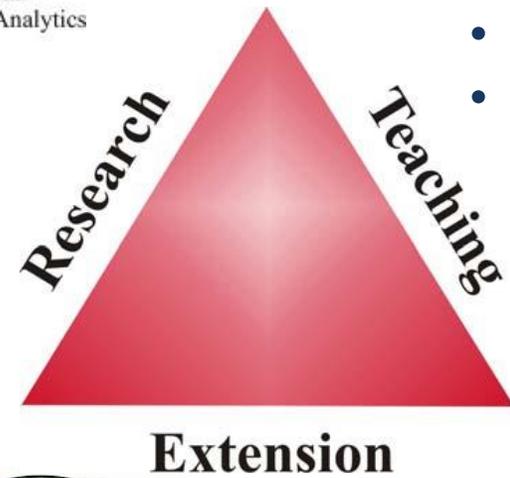
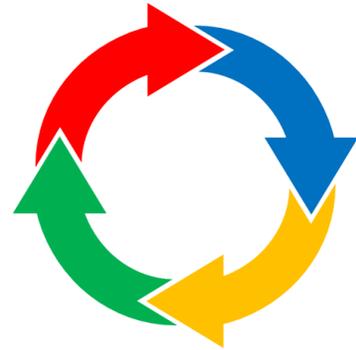
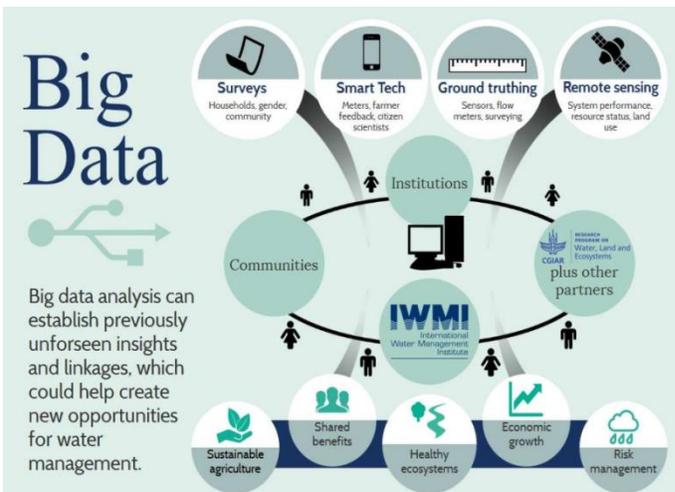
(Chinnasamy et al 2015; Chinnasamy et al 2017)



Future work: Developing Framework



- Define problem/issue
- Big Data methods
- **3Cs-**
Collect/Clean/Collaborate
- Research/dissemination
- Policy and Banks
- Dynamic and cyclic process



(IWMI, Ahmed et al 2017)



Conclusion

- Remote Sensing, Satellite and Big Data has high potential for water resources measurements, monitoring and modeling
- Opportunity for holistic management
- Better spatial and temporal resolution and products
- Opportunity for trans-boundary water management

Acknowledgements

- Funders – ADB, EPA, WB, CSIRO, USAID, Government of India
- International Water Management Institute (IWMI)
- NASA team
 - GRACE, GLDAS products
- Central Groundwater Board (CGWB), Gov. of. India

