National Remote Sensing Centre

Project Proposal – TDP

Date: 24.07.2020

1. Project Title:	**Ground Water Resources Assessment & Management (GRAM)**		
2. Group/Division:	**Hydrogeology Division / Geosciences Group**	**3. Principal Investigator:**	**4. PI: Dr. I.C. Das Co-PI: Ritwik Majumdar Rajarshi Saha, Tushar Wankhede**

5. Introduction:

a. Background & scope of the project – Reference to similar earlier projects / pilot study:

The challenge of ensuring sustainable water in sufficient quantities to meet the needs of humans and ecosystems has emerged as one of the major issues of the 21st century. This resource is unevenly distributed and not properly managed in India. Groundwater is an indispensable resource to sustain livelihoods in situations where the extension of the public water supply does not keep up with unregulated urbanization fueled by population growth. The groundwater assets in India are diversely distributed both spatially and temporally. Heterogeneous hydro-geological conditions along with uneven rainfall of the seasonal monsoon type give rise to uneven distribution of groundwater quality depending upon its lithological variations. The ever-increasing dependence on groundwater as a major source of water has resulted in indiscriminate extraction without considering the recharging capabilities of aquifers and other geo-environmental factors and health factors. The nature of the geological formations influences the quantityof groundwater. On the other hand, the availability of supplied pipe drinking water in rural areas is very limited. A comprehensive understanding of the groundwater system is necessary, therefore, for a sustainable development of this key resource, with a particular focus on nine major hydrogeological provinces.

b. Need for study:

Any strategy for scientific management of ground water resources should involve a combination of supply side and demand side measures depending on the geo-hydrological settings. In view of the marked difference in stage of development of ground water in India, there is a need to critically analyse the underlying factors responsible for the imbalances at micro level in terms of technical and socio-economic considerations. In this regard, a detailed scientific understanding is required to address the micro level groundwater variation in different hydro-geological provinces of the country.

6.

a. Scope of Work

Ground water is the major source for all purposes of water requirement in India. More than 90% of rural and 30% of urban population is dependent on it for drinking purposes. Ground water is dynamic

in terms of time and space which greatly depends on the recharge and exploitation conditions along with geological conditions. Different hydro-geological provinces behave differently in holding water as well as in its discharge. To characterize such aquifers at micro level a detail understanding of the factors governing groundwater occurrence is very much required.

b. Objectives:

Geo-hydrological model for micro level ground water assessment and recharge in different hydro geological provinces using EO based services.

7. Scientific /Technical rationale

Indian landmass is covered by 42 aquifers belonging to 14 aquifer systems (CGWB 2012). Of these the alluvium is the most dominant aquifer, occupying about 31%, whereas Basalts and Banded Gneissic Complex occupy about 17% and 15% respectively. In the alluvial areas, the main parameter that influences the ground water availability is the recharge into the system through rain or from rivers, canals etc. In addition, the alluvial tracts are mostly the agricultural belts and over-exploitation of the ground water with reference to the recharge into the system, is of primary concern. This can be observed in states like Punjab, Haryana, Bihar etc. where the stage of ground water development is more than 100%. Intra-formational variability in the areas occupied by alluvium (fluvial or aeolian origin) is considerably less compared to hard-rock terrains where primary porosity is negligible and geological structures and morphology influence occurrence, movement and recharge. Due to this diverse hydro-geological setup and variability of groundwater exploitation in the country, province wise development of detailed geo-hydrological model through geo-spatial integration of EO based thematic layers and ground observations is being proposed in the present study to understand the ground water scenario at village level for sustainable groundwater management practices with lesser uncertainty.

8. Review of Literature

The water resources of India, in general, are unevenly distributed both spatially and temporally (Mathai, et al., 2015). Variation in lithology, geomorphology along with inconsistent monsoon gives rise to heterogeneous distribution of groundwater in India (Saha et al. 2018). Around 90% of Indian rural population is dependent on groundwater for drinking purposes (Shankar et al. 2011). The demand of groundwater has drastically increased with swift population growth, urban and industrial development (Vaidyanadhan and Kumar 2015). This has resulted a huge increase in groundwater abstraction quantity without thinking the aquifer capacity and recharge capabilities (Jha and Sinha 2009). This has resulted drastic lowering of groundwater table [12-15 meter (m) on average; upto 25 m or more] in last four decades (Subramanyam et al. 2000). The science of groundwater is inter-disciplinary and very dynamic in nature (Ahmed et al. 2008; Lawrie et al. 2017). Groundwater recharge is an integrated effect of surface and subsurface features (Jasrotia et al. 2007; Chung et al. 2010; Kumar et al. 2020). It takes into account lithology, geomorphology, lineament, drainage,

landuse, soil, slope and elevation into account as surface and subsurface variables to access the recharge condition (Ellyett and Pratt 1975; Singhal and Gupta 1999; Gupta 2003; Chesnaux et al. 2011). Over the last few decades groundwater quantity has become an important subject for water security related subject. Many studies have been conducted to understand groundwater occurrences and distributions. In National Rural Drinking Water Programme (2000-2014) major focus was given on the groundwater prospects in a meso-scale, but not on the micro-level impact of intra and inter lithological, geomorphological variations along with similar geological formations which affecting the groundwater quantity.

9. Statutory & Regulatory Requirement

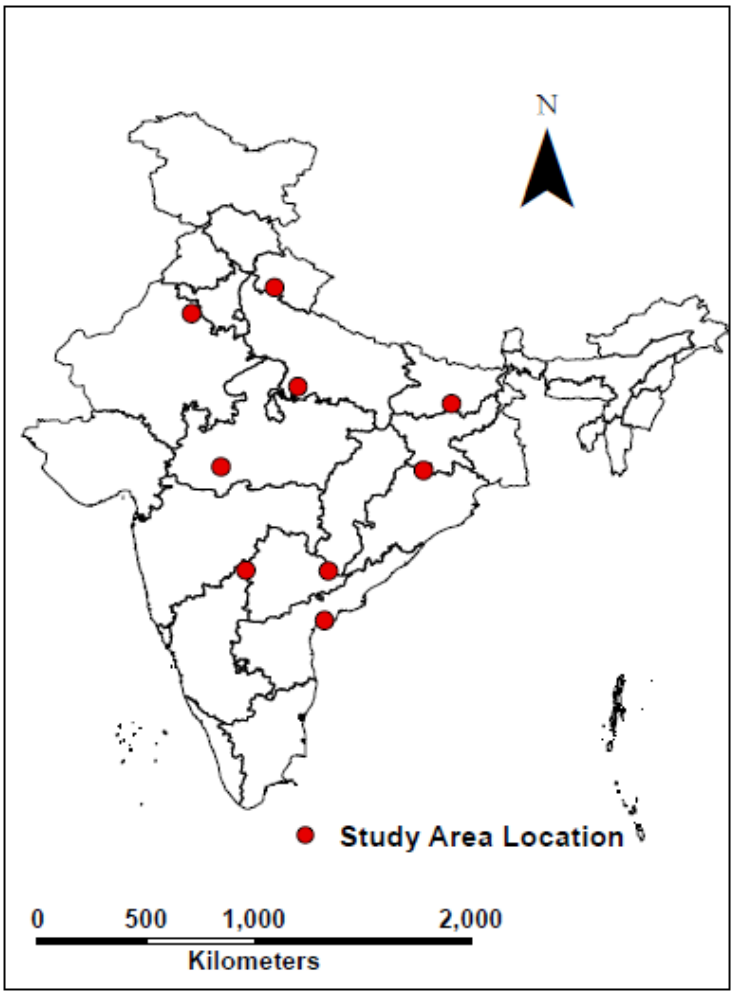
As per Govt. of India guidelines

10. Relevant Standards

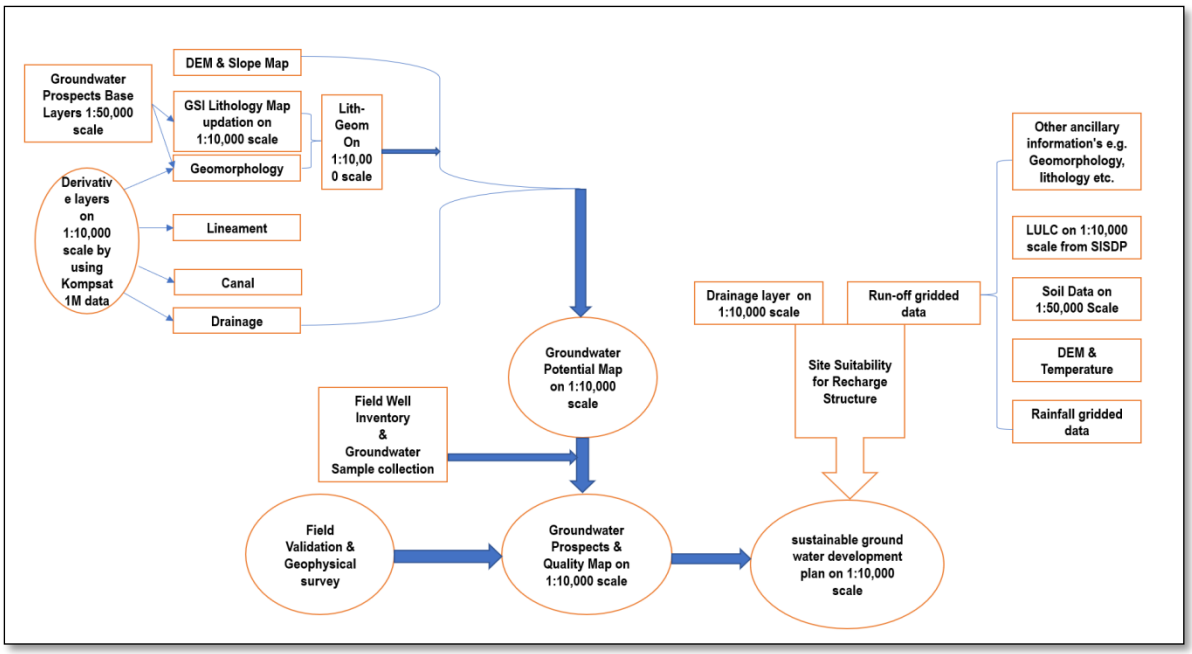
As per NRSC RSA standard

11. Study area

Nine sites in nine major hydro-geological provinces in the state of Karnataka, Telangana, M.P. Rajasthan, Odisha, Bihar, U.P, A.P. and Uttarakhand (Shown in Figure 1)



12. Approach & brief Methodology



13. Risk factors & Mitigation plan

Risk factor: Travel to field and data collection; Mitigation: In collaboration with state Remote sensing centre and PHED, we will able to get historical field data as well as partial information on the present condition, that they collect during their routine activity.

14. Expected Results

a) Province* wise micro level groundwater assessment model. (9 provinces)

b) Province* wise site-suitability for groundwater recharge. (9 provinces)

(Study area: Nine sites in nine major hydro-geological provinces in the state of Karnataka, Telangana, M.P. Rajasthan, Odisha, Bihar, U.P, A.P. and Uttarakhand.

15. Expected Outputs with Key Performance Indicators

- To create a detail database on 1:10K in Q1
- Field data collection during Pre and Post- monsoon period and updating the database in Q2
- GIS based Hydrogeological modelling for understanding the aquifer system in Q3
- Final model and output generation in Q4.

16. Suggested Action Plan for utilisation of Expected outputs

Model and outputs will be shared with State Remote Sensing Centres and state PHED for implementation.

17. Linkages to on-going/planned programmes & relevance to ISRO

NRSC has completed preparation of GWP and GWQ maps for the country under National Rural Drinking Water Mission Program (NRDWP) for Ministry of Drinking Water & Sanitation (MoDWS). This map has been extensively used in the field from last two decades and a success of

85-90% has been achieved for source finding of groundwater. But in recent years due to the over exploitation in many parts of the country coupled with infrequent monsoon has resulted in depletion of groundwater. To address this critical problem, it is envisaged to carry out a detailed province wise hydro-geological assessment and to understand the minute details of factors controlling groundwater occurrence. This will help in source finding and sustainability. The methodology as well as the results developed in the proposed study will cater the overall objective of supplying safe and sustainable drinking water in the country.

It is linked with ISRO's 2030 vision of providing safe & sustainable drinking water to the country for water security management.

It is linked with completed National Rural Drinking Water Programme where NRSC mapped on 1: 50,000 scale ground water quality assessment in entire country which I carried by NRSC.

NRSC is known for its satellite application related capabilities, here in this TDP 1:10,000 scale

18. Resource Requirements & their availability

a. **Satellite data:** KOMPSAT, Cartosat 2S/3, Landsat, ASTER, Cartosat DEM 10m, LISS-IV
b. **Ancillary data:** 50k GSI lithological Map, Water level data, Gridded Rainfall data.
c. **Rest of things:** Available with PI

19. Project Team Details with responsibilities & Authority

Name	Designation	Role
Dr. K. Vinod Kumar	Group Director, GSG, Scientist'G'	Overall Guidance
Dr. I.C. Das	Head, HGD, Scientist'SG'	Methodology Development
Ritwik Majumdar	Scientist 'SE'	Team
Rajarshi Saha	Scientist 'SE'	Team
Tushar Wankhade	Scientist 'SD'	Team

20. Time Schedule & Milestone Targets

a. Start Date: 1.04.2021

b. Expected Date of Completion: 31.3.2024

Year/ Month / Milestone target	1st		2nd		3rd	
Methodology/Schema Development						
Thematic data interpretation for micro						

level hydro-geological feature extraction						
Field survey & well inventory, Ground water Data collection & Analysis						
Geo-spatial integration for micro level hydrogeological assessment and site suitability model for Artificial groundwater recharge (9* provinces)		3*		3*		3*

21. **Budget Details**

Sl No.	Item Description	Justification	Total Cost (values in Rs lakhs)	BE 2021-22 (values in Rs lakhs)	BE 2022-23 (values in Rs lakhs)	BE2023-24 (values in Rs lakhs)
a	Data Cost Satellite data/Collateral Data		3	1	1	1
b	Travel-local conveyance (Object code:500)		Nil	Nil	Nil	Nil
c	Travel- to & at Field Work (Object code:400)		9	3	3	3
d	Instrumentation (Sub system towards R&D)		Nil	Nil	Nil	NIl
e	Miscellaneous		3	1	1	1
	Total		15	5	5	5

Total Budget: 15 Lakhs

22. Change Management(w.r.t scope outcome, schedule budget etc)

N. A. (scope, outcome, schedule and budget remains constant)

23. Knowledge Management

Systematic and clear work sharing will lead to knowledge sharing and knowledge management.

24. Relevance to IPR Management

Work will be documented and published

25. Bibliography

- Mathai, J, Das, I.C., Subramanian, S.K., Lenin, K.S. and Dadhwal, V.K (2015) Coupling geomorphology parameters with lithology for microlevel ground water assessment: a case study from semi-arid hard rock terrain Tamil Nadu, India, Arabian Journal of Geoscience, 8(10), 8077-8087.

- Saha, R., Kumar, G. P., Pandiri, M., Das, I. C., Rao, P. N., Reddy, K. S. N., & Kumar K, V. (2018). Knowledge Guided Integrated Geo-Hydrological, Geo-Mathematical and GIS based Groundwater Draft Estimation Modelling in Budhan Pochampalli Watershed, Nalgonda District, Telangana State, India. Earth Science India, 11(4)

- Shankar, P. V., Kulkarni, H., & Krishnan, S. (2011). India's groundwater challenge and the way forward. Economic and Political Weekly, 37-45.

- Vaidyanadhan, R., & Kumar, K. A. (2015). Tale of a watershed: vision for tomorrow's India. Journal of the Geological Society of India, 85(5), 632.

- Jha, B. M., & Sinha, S. K. (2009). Towards better management of ground water resources in India. QJ, 24(4), 1-20.

- Subramanyam K, Ahmed S, and Dhar RL (2000) Geological and hydrogeological investigations in the Maheshwaram watershed, A.P., Technical Report No. NGRI 2000 – GW-292, Hyderabad, India

- Lawrie, K., Murray, T., Brodie, R.S., Gibson, D., Halas, L., Symington, N., Christensen, N.B., Grunewald, E. and Sandiford, M., 2017, March. An inter-disciplinary, multi-physics approach for rapid mapping and hydrogeological characterisation of neogene intra-plate fault systems in depositional landscapes. In Symposium on the Application of Geophysics to Engineering and Environmental Problems 2017 (pp. 387-390). Society of Exploration Geophysicists and Environment and Engineering Geophysical Society.

- Ahmed, S., Jayakumar, R., & Salih, A. (Eds.). (2008). Groundwater dynamics in hard rock aquifers: sustainable management and optimal monitoring network design. Springer Science & Business Media.

- Jasrotia, A. S., Kumar, R., & Saraf, A. K. (2007). Delineation of groundwater recharge sites using integrated remote sensing and GIS in Jammu district, India. International Journal of Remote Sensing, 28(22), 5019-5036.

- Kumar, V. A., Mondal, N. C., & Ahmed, S. (2020). Identification of Groundwater Potential Zones Using RS, GIS and AHP Techniques: A Case Study in a Part of Deccan Volcanic Province (DVP), Maharashtra, India. Journal of the Indian Society of Remote Sensing, 1-15.

- Chung, I. M., Kim, N. W., Lee, J., & Sophocleous, M. (2010). Assessing distributed groundwater recharge rate using integrated surface water-groundwater modelling: application to Mihocheon watershed, South Korea. Hydrogeology Journal, 18(5), 1253-1264.

- Ellyett CD, CD E, DA P (1975) A Review of the potential applications of remote sensing techniques to hydrogeological studies in Australia

- Singhal BB, Gupta RP (2010) Applied hydrogeology of fractured rocks

- Gupta RP (2003) Remote Sens Geol. Heidelberg: Springer-Verlag 10:978-3

- Chesnaux, R., Lambert, M., Walter, J., Fillastre, U., Hay, M., Rouleau, A., ... & Germaneau, D. (2011). Building a geodatabase for mapping hydrogeological features and 3D modeling of

groundwater systems: Application to the Saguenay–Lac-St.-Jean region, Canada. Computers & Geosciences, 37(11), 1870-1882

26. Signature (signature of PI, through proper channel*)

27. Date