Composite Land Assessment & Restoration Tool (CLART)

Composite Land Assessment & Restoration Tool (CLART) is a geographic information system (GIS) based tool to help in the planning of soil and water conservation measures. There are levels of complexity to understanding the nature of recharge potentiality of a specific area where rock type, slope and landuse/landcover varies. The treatment plan for the area therefore needs to be made after assessing the different physical properties of the land. To aid in this process, a composite approach has been identified with the help of spatial data of different resolutions but at a uniform scale under the GIS umbrella and made available through an android application (GIS enabled) for informed decision making on the field.

1. **Rationale of the tool:**

- Typical water enhancement measures do not consider geohydrology, slope, landuse/land-cover, evapotranspiration.
- Variability in local ecological and climatic conditions impacting water availability is usually not considered.
- Access to granular data on soil and water restricts use of data analytics for decision making.
- Knowledge and insights is not accessible to layman in a user friendly/ demystified manner.
- Huge investments (Annually 59% of 69000 crores (2018-19)) are made on on intuitive knowledge leading to injudicious use of public funds.
- Limited availability of trained technical staff further adds to planning and implementation gaps.

2. Objectives: CLART is a decision support tool which provides location specific information in a user friendly manner to enable village communities to plan and develop estimates of the soil and water conservation interventions without help of Engineers and Internet at field.

3. Data and process of generating CLART:

Layers	Source	Scale/Resolution
Geology	Bhukosh (Geological Survey of India)	1:50K
Geomorphology	Geological Survey of India-NRSC	1:50K
Drainage	Generated from SRTM/ASTER-DEM	30 meter (approx 1:60K)
Slope	Generated from SRTM/ASTER-DEM	30 meter (approx 1:60K)
Slope	Generated from Cartosat DEM	5 meter (approx 1:10K)
Micro Watershed	Central Ground Water Board & Bhuvan	1:10K
Landuse-Landcover	LISS IV (2018) Bhuvan	5.8 meter (approx 1:11K)
Landuse-Landcover	Sentinel -2 (few places)	10 meter (approx. 1:20K)
Lineament	NRSC-Bhuvan	1:50K
Ground water level	CGWB - WRIS	15,000 wells (approx)
Ground water table	FES GWMT (available for 450 blocks only)	
Village boundary	Survey of India	

3.1 The algorithm built on

3.1.1. Recharge potential of rocks (according to GEC 97 norm -mentioned below)

3.1.2. REPORT OF THE GROUND WATER RESOURCE ESTIMATION COMMITTEE (Page no 24)

3.1.3. www.angelfire.com/nh/cpkumar/publication/Lgwa.pdf

Slope class (FAO)	
Slope (%)	**Slope Code**
0-3	1
3-5	2
5-7	3
7-10	4
10-15	5
15-25	6
25-30	7
>30	8

Table 4. NORMS FOR RAINFALL INFILTRATION FACTOR AS RECOMMENDED BY GEC 1997

S.No	Formation	Recommended Value (%)	Minimum Value (%)	Maximum Value (%)
(a)	Alluvial areas			
	Indo-Gangetic and inland areas	22	20	25
	East coast	16	14	18
	West coast	10	8	12
(b)	Hard rock areas			
	Weathered granite, gneiss and schist with low clay content	11	10	12
	Weathered granite, gneiss and schist with significant clay content	8	5	9
	Granulite facies like charnockite etc.	5	4	6
	Vesicular and jointed basalt	13	12	14
	Weathered basalt	7	6	8
	Laterite	7	6	8
	Semi-consolidated sandstone	12	10	14
	Consolidated sandstone, quartzite ,limestone (except cavernous limestone)	6	5	7
	Phyllites, shales	4	3	5
	Massive poorly fractured rock	1	1	3

3.2 The methodology adopted to generate recharge potential

- Morphometric analysis of drainage (watershed wise classification)
- Landform/Geomorphology wise classification – GEC norm
- Rock type wise classification – GEC norm
- Lineament wise classification – 2 meter buffers has been considered
- Aquifer wise classification (for limited locations only)

Recharge Potentilaity	RCP based on comparative analysis of micro watershed & Drainage Density	RCP based on Lithology	RCP based on Lineaments buffer	Score Matrix (multiplication of 3 parameters)
High	1	1	10	1,2,10,20,30
Moderate	2	2	1	3,4
Low	3	3	1	6,9

All the layers have been classified in 3 categories (1 is high, 2 is moderate and 3 is low) and multiplying them generating 9 numbers where 1,2,10,20 and 30 are high recharge area, 3,4 are moderate and 6 and 9 are low recharge area.

The final recharge potential layer then integrated with slope and landuse-landcover layer as stated below in the GIS platform. The entire exercise has been automated using python.

Firstly, recharge potentiality has been combined with different slope categories and then that layer has been combined with the land use /land cover of the area. With these combinations, the optimum location for water harvesting structure creation has been identified based on the recharge potentiality, slope and landuse. Mainly five types of area have been identified which are

1. High recharge area,
2. Moderate recharge area,
3. Low recharge area,
4. Area suitable for regeneration
5. High surface runoff zone The whole combination has been evaluated as follows:

The identification matrix of interventions:

Recommended Treatment Code	Recommended Treatment Type	Recharge Potentiality	Slope	Land Use/Land Cover
1	Good Recharge structure (Percolation tank, WHS, CCT etc)	Very High (5) High (4)	3-20%	Current fallow (5), Other Waste land (9), Gullied (10), Scrubland (11)
2	Moderate Recharge structure (WAT, GP, LBCD etc)	Moderate (3)	5-25%	Current fallow (5), Other Waste land (9), Gullied (10), Scrubland (11)
3	Surface water Harvesting structure (WHS, FP, FB etc)	Low (2) Very Low (1)	0-20%	Current fallow (5), Other Waste land (9), Gullied (10), Scrubland (11) Agriculture (2,3,4)
4	Regeneration (Plantation, Veg Int, Grass seeding, stone bunding, bench terracing, trenching etc)	Very Low (1), Low (2), Moderate (3)	25 -30%	Current fallow (5), Other Waste land (9), Gullied (10), Scrubland (11), Mixed, degraded forest, Deciduous forest
5	High Runoff zone (Trenching, stone bunding)	Very Low (1), Low (2), Moderate (3) High (4) Very High (5)	Slope >30	Current fallow (5), Other Waste land (9), Gullied (10), Scrubland (11), Mixed, degraded forest, Deciduous forest

On the basis of the recommended treatment code treatment code 1 indicates high recharge area. In treatment code 2, moderate recharge structure can be constructed and surface storage structure can be created in treatment code 3. Treatment code 1 is actually indicating an area of very high to high recharge potential with 3-20% of slope, and varied land-use types (Current fallow, Other Waste land, Gullied, Scrubland). Therefore, the structures in this area will help maximum recharge to ground water where in the intervention would be concentrated in common land. Further, the recommended treatment plans are percolation tank, contour trench, water harvesting structure for recharge.

Similarly, treatment code 2 indicates moderate recharge in ground water (some parts can be used for surface usages) with 5-25% of slope and the intervention would be in the same type common land of Current fallow, Other Waste land, Gullied or

Scrubland. Here, the recommended treatment plans are water arresting trench, loose boulder check dam, gully plug etc.

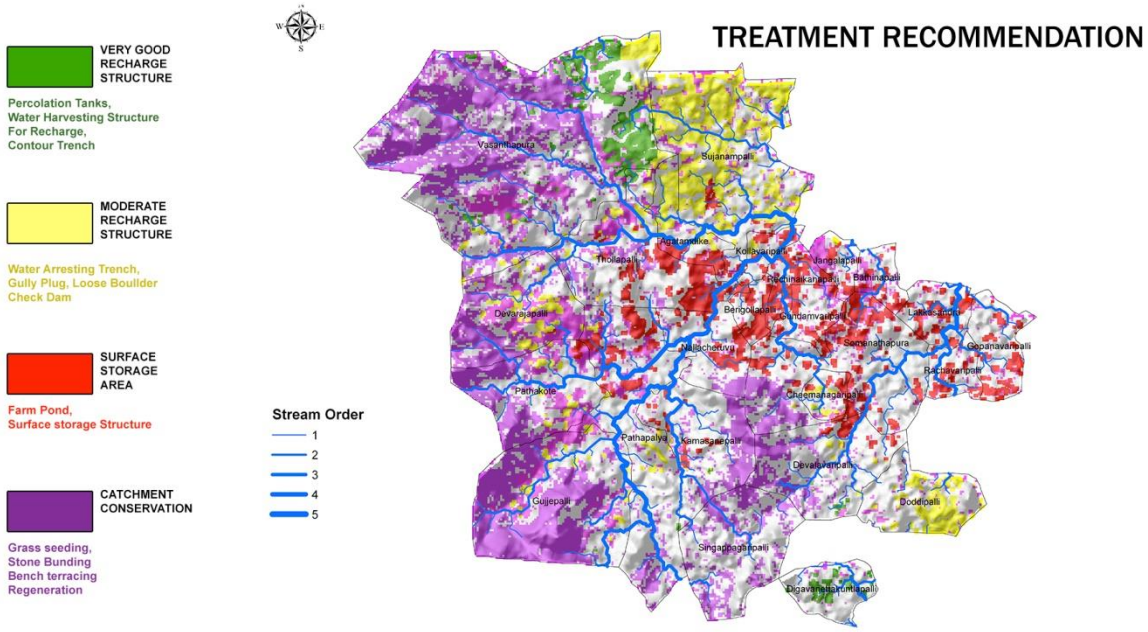
Treatment code 3 indicates the area with less chance of recharge but suitable for the creation of water harvesting structures (0-20% of slope, common land and agriculture land) which help store water in the submergence area of the structure. This harvested water can be used for direct irrigation (lift irrigation), domestic use or for livestock, critical irrigation for agriculture (farm pond). This will also reduce non beneficial Evapotranspiration (ET) and transfer non beneficial ET to beneficial ET. The recommended treatment plans are farm bund, farm pond, water harvesting structures (for surface storage) to use as lift irrigation, cattle drinking, and domestic uses.

Treatment code 4 indicates the area of higher slope (25-30%) with forest land, barren land, waste land, scrubland on which regeneration, grass seeding, stone bunding, bench terracing are recommended.

Treatment code 5 indicates the area with more than 30% of slope which is majorly high surface runoff zone where no recommendation for constructing any engineering structure is recommended.

4. Translating scientific recommendations in an easily accessible manner

In the CLART map, the colour coding for recommended treatment has been set (as seen in the figure below) to ensure uniformity across areas. Good Recharge Structure construction which will be strictly for recharge of ground water without any other uses (norms/rule & regulation need to be formed at village institution) is indicated as Green. Yellow indicates the area of moderate recharge where recharge is possible but to a certain extent and hence the structures constructed in these zones can be used for other purposes after few days of water holding. Red indicates the zones where the chance of recharge of ground water is very less and the water harvested in these structures need to be used as much as possible as the water does not go into the subsurface. Violet is designated for areas of regeneration, plantation, seeding etc. So with these colour coded maps, planning can be done based on scientific recommendations that are translated graphically to facilitate ease of use.



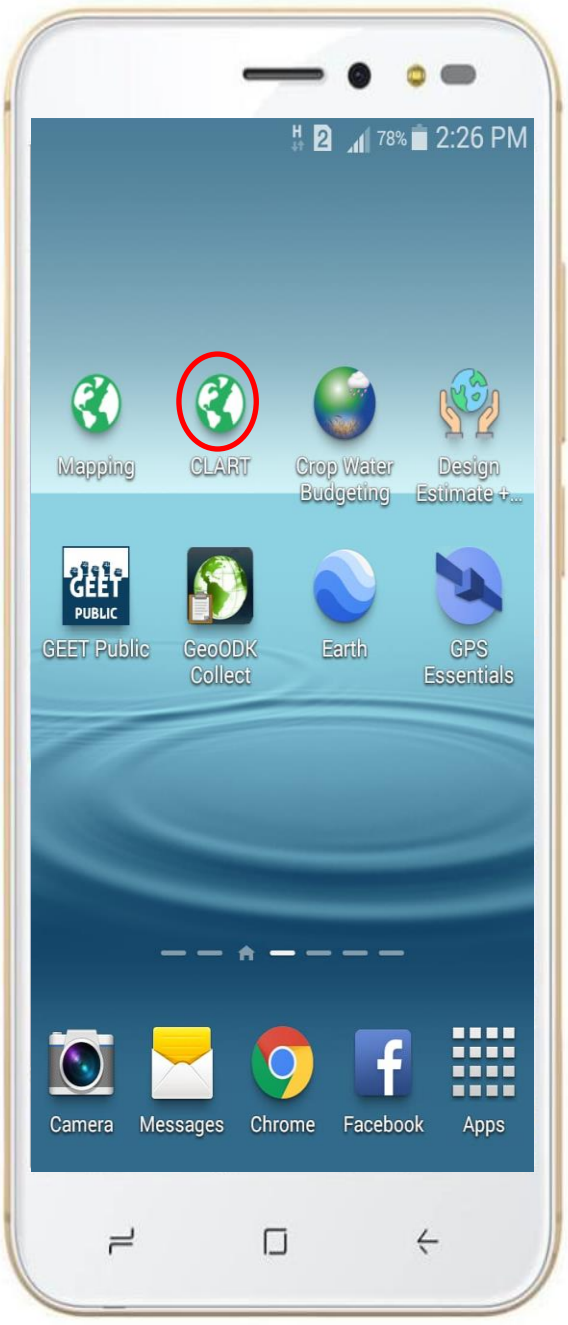
Treatment recommendation Map

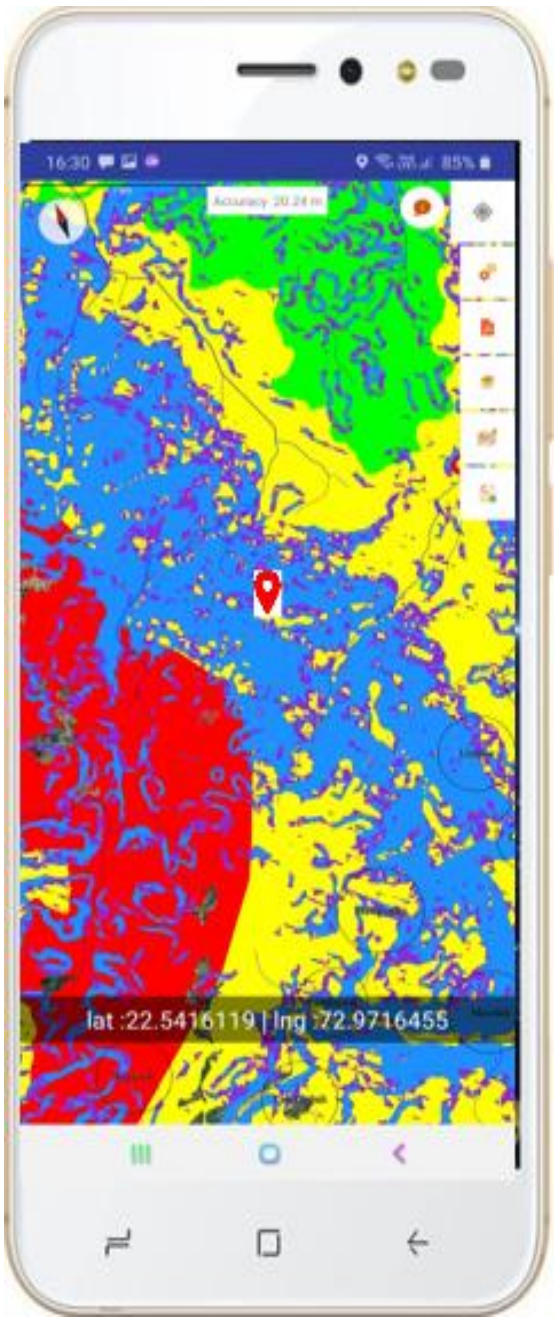
5. **How does the CLART Tool help end users in the field?**

This map data is then fed into android application (CLART app). The android app is available as an open source tool (available here).

After installing the application in mobile device, the tool helps the user to locate them on the map (CLART map which is geo-enabled) by using inbuilt GPS signal of the device (with or without internet). Based on the location identified on the colour of the map, user can immediate understand about the feasibility of a treatment plan or purpose of the treatment plan (for ground water recharge/surface storage/regeneration). Once the purpose is decided or the feasibility is checked, user can also take the possible measurement (length, breadth and width) of the planned intervention which helps the user to create the design and estimate of the same in the device. The design and estimate has been automatically generated based on the engineering aspects through application and considering the rate and technical specification of the district which is available in the device. The application is also

having the facility to capture the photographs and screenshot of the screen for capturing the map view on the site and location data.





In this manner, the user in the field can directly check the recommendation for that particular location, and make informed plans based on the recommendation made by recharge potentiality, slope and landuse landcover.

6. The design and estimate can be prepared for the following interventions:

No.	Structure Name	No.	Structure Name
1	Contour Trench	36	Bush Clerance
2	Stone Bund	37	Grass & Tree Seeding
3	Bench Terracing	38	Thor Fencing
4	LBCD	39	Forestry Block Plantation
5	Farm Pond	40	Forestry Line Horticulture
6	Jalkund	41	Horticulture Block Plantation
7	Dugout Pond	42	Horticulture Line Plantation
8	Earthen WHS	43	Revegetation Measures
9	Pond Deepining	44	Pastureland Development
10	Open Circular Dug Well	45	Earthen Farm Bund
11	Gabion Wall	46	Stone Farm Bund
12	Gabion Check Dam	47	Underground Dyke
13	Spring Chamber	48	Slope type Farm Pond
14	Retaining Wall	49	Slope type Dugout Pond
15	Irrigation Channel	50	Slope Type Recharge Pit
16	CC Check Dam	51	Slope Type Fishreies Pond
17	Forestry Plantation	52	Earthen WHS
18	Horticulture Plantation	53	Pond Deepening
19	Trench	54	CC Check Dam
20	RCC Check Dam	55	RCC Check Dam
21	Open Rectangular Dug Well	56	MasonryCheck Dam
22	Horticulture Plantation Work	57	Gabion Check Dam
23	Peripheral Bund	58	Open Circular Dug Well
24	Flood Embankement	59	Open rectangular Dug Well
25	ContourTrench/(Trench cum Bund)	60	Gabion Retaining Wall
26	Water Arresting Trench	61	Spring Chamber
27	Earthen Contour Bund	62	Retaning Wall
28	Stone Contour Bund	63	Irrigation Channel
29	Earthen graded Bund	64	Strep Type Farm Pond
30	Stone graded Bund	65	Step Type Dugout Pond
31	Bench Terracing	66	Step Type Recharge Pit
32	LBCD	67	Fishries Pond
33	Earthen Gully Plug	68	Repair of Masonry WHS
34	Cattle Protection Trench	69	Repair of Earthen WHS
35	Stone Wall Fencing	70	Nala Revertment
		71	Field Bund With Different Sections

7. **CLART platform:** While the tool works offline in field, the user needs to synchronize all the data in the portal using internet connection after coming back from field. Once the data is synchronized, the data can be visualized in the portal (https://det.indiaobservatory.org.in). The program manager and coordinator can visualize the data on screen with various filters (such as village/block/district/state date wise/type of structure etc) and compare the data with maps, field picture, location on google earth, design and estimate in excel etc, and vet the plan. They can approve or reject with the reasoning which reflect it in the portal for the enumerator to rectify the plan if needed. The rates and specification from district to district may vary and therefore the facility has been provided to be customized in the portal (by program manager) and immediately the same would reflect in the app (in online zone). The roles of the various levels are as follows:

Organization Admin:

- Assign program manager and other system users
- Can visualize all the plans and status

Program Manager:

- Assign program coordinator and other system users
- Can visualize all the plans and status
- Responsible for configuration of BSR/TS
- All the roles of Program coordinator

Program coordinator:

- Can visualize all the plans and status
- Approve/Reject the plans

Field functionary

- Can make the plan using the app
- Can visualize the plans made by them only
- Notified of the approval or rejection of the plans

At the end, the user can download the plans (single or multiple based on the filtering criteria) in pdf and excel which can be used as the planning document (such as Detailed project report etc) for further processing. A customized widget is also available for quick visualization of all the plans on a GIS dashboard

8. **Output of the CLART:**

- Location specific suggestion on field using app – enable villagers/resource persons for easy decision making based on scientific information on the site.
- Preparing Design and Estimate on field without help of technical staff.
- Automatic SoR/TS updation in app (district wise) – enable district specific plans preparation with actual rates and specification of that district.
- Visualization of data/plans/evidences in the portal.
- Different level of users (admin, coordinator, data enumerator, visitors) with different roles.
- Onscreen vetting with field evidences (such as photograph, location on google map, screenshot of CLART maps and structure data).
- Data filtering by village/block/district level and generating report in pdf and excel.
- Widget for visualization.
- API connection for integrating with other platforms.

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