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Case study JoGE

Sustainable Rural Development through Geospatial Technology – A Case of Keonjhar District of Odisha

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Abstract

The 2030 Agenda for Sustainable Development emphasizes that sustainability encompasses three dimensions: economic, social, and environmental. Monitoring society's impact on natural resources involves identifying activities that affect ecosystem processes. Geospatial technology plays a key role in detecting community-level development projects and evaluating sustainable development outcomes at the district level. The main objective of the study is to show the impact of implementation of SDGs on the development of community livelihood and overall infrastructure Development. The study focuses on Keonjhar district in Odisha, one of the vulnerable districts in the state. Public works under the MGNREGA program have made significant progress across all 13 blocks of the district. According to the 2019 dashboard, 2267 village clusters actively participated in the initiative, with 575,708 workers involved in the program. The study area encompasses more than 26,389 assets, covering an expanse of 653,900 hectares of land. From 2009 to 2019, these assets have been developed, primarily focusing on projects related to irrigation, water conservation, water harvesting, and drought-proofing efforts. From the year 2017 and 2018, there is demand and increase in rural sanitation works in the study area

Keywords: SDG, MGNREGA, Geospatial, conservation, ecosystem

INTRODUCTION

The UN Millennium Summit on September 8, 2000, established the Millennium Development Goals (MDGs), marking the first global agreement to end poverty and improve humankind's lot. The MDGs were implemented until December 31, 2015, after which the SDGs took effect on January 1, 2016. Sustainable development (SD) tackles the underlying causes of poverty, societal demands, and environmental security while preserving resources for future generations. The 2030 Agenda for Sustainable Development emphasizes the economic, social, and environmental dimensions of sustainability. Societal impacts on natural resources can be assessed by identifying activities that influence ecosystem processes. Earth Observation (EO) systems collect data on the lithosphere, hydrosphere, biosphere, and atmosphere, and their interactions through Remote Sensing technologies, enhanced by in-situ measurements and survey data. Geospatial technologies, which combine EO data with tools like Global Positioning Systems (GPS), Geographic Information Systems (GIS), and the Internet, facilitate the online mapping and analysis of the Earth and human activities (AAAS, 2018). These technologies are instrumental in identifying community development projects and aggregating sustainable development outputs at the district level. The study has taken advantage of the regulations regarding openness by retrieving data about the assets (home and rural community infrastructure) built under the MGNREGA program through the use of ICTs. This article is predicated on the

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rationale that the economy gives society the push it needs in order for it to advance successfully in the environmental domain and, as a result, for proactive preservation of natural resources [1-7].

Figure 1 shows the dividend discussion amongst the three sustainability pillars as a result of initiatives like MGNREGA. Because society controls the economy and the environment depends on society, SD can arise from the balanced integration of the environment, society, and economy. Under MGNREGA, 260 combinations of works are allowed. The majority of these works are in the areas of infrastructure development, agriculture, natural resource management, water facilitation, rural connection and sanitation, and other related activities. [8-12].

The main objective of the study is to show the impact of implementation of SDGs on the development of community livelihood and overall infrastructure Development.

The identification of ICT as a technology capable of facilitating transparency in the MGNREGA process was based on the program's massive scale, geographical reach, financial implications, beneficiaries, and stakeholders. ICT enables online monitoring and program evaluation, validates transparency, and aids in the transmission of information [14-17]. A specialized website is available to facilitate social reporting on project activities and to uphold the 'Right to Information' legislation. The webpage provides essential details on active and completed works, as well as asset expansion under the NREGA program. Benefit reporting is simplified through the backend Management Information System (MIS) [18-20].

Public access to geotagged assets is now available via the GeoMGNREGA portal, hosted on the Bhuvan platform, which was developed by the Indian Space Research Organisation (ISRO). Bhuvan provides crucial online geospatial support to the MGNREGA project by offering an integrated view of asset information. GeoMGNREGA allows users to visualize assets at block, district, and state levels, with categorization by work type. Data on the geotagged assets are displayed in the GeoMGNREGA dashboard [21-25]. Figure 2 presents a preview of the Geo-portal, which offers the public access to geo-tagged asset information as part of the MGNREGA initiative.

Study Area

The MGNREGA program covers the entire country, excluding urban populations. Phase I was launched in 2006, focusing on 200 of India’s most underdeveloped districts, identified by the Planning Commission based on their backward status.

Kendujhar District is an administrative district in Odisha, situated within the state's Fifth Scheduled Area. The district's headquarters are located in the town of Kendujhar, also referred to as Kendujhargarh.

Anandapur, Champua, and Kendujhar are the three subdivisions that make up the district. The Anandapur plains lie on the eastern side of the district. A series of hills to the west is home to summits like Thakurani (3003 feet), Gonasika (3219 feet), Mankadnacha (3639 feet), and Gandhamardan (3477 feet). Forests of Northern tropical deciduous type trees, such as Sal, Asan, Jamu, Arjuna, Kusum, Kangada, Mahua, Mango, and Kendu, cover over half of this district. Clusters of rocky crags can be seen in the highlands, and the peak of the mountains has a steeply ridged or peaked appearance tables on the peaks of them. While isolated hills occasionally rise sharply from the plains, most places have an overall elevation of more than 600 meters. The Baitarani River is one of the rivers whose watershed is formed by the highlands. The Anandapur plains lie on the eastern side of the district. A series of hills to the west is home to summits like Thakurani (3003 feet), Gonasika (3219 feet), Mankadnacha (3639 feet), and Gandhamardan (3477 feet) (Figures 1-3) [26-28].

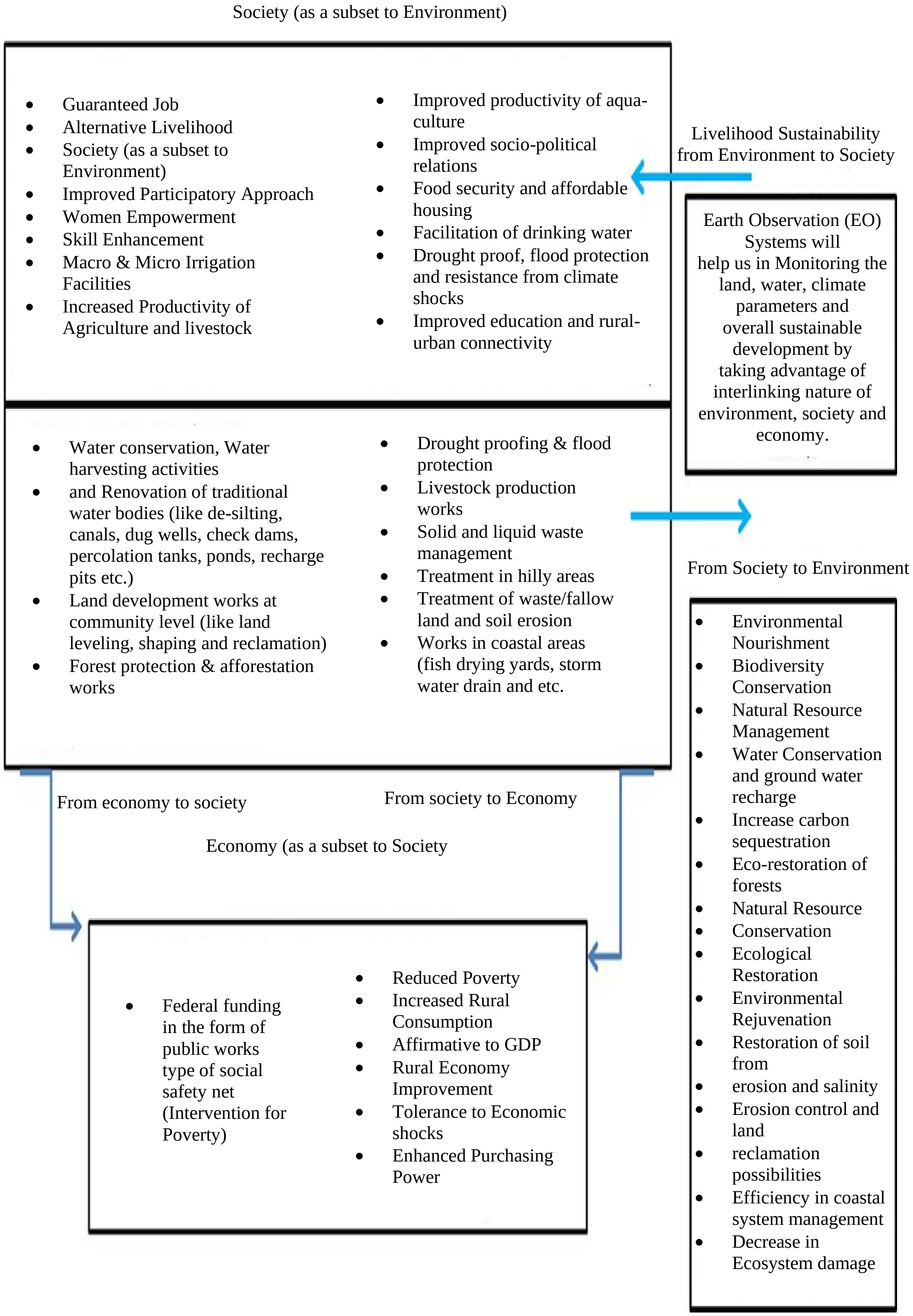


Figure 1. A depiction of interactions between the three pillars of Sustainable Development due to the interventions like public works on Natural Resources.

Figure 2. A screenshot of GeoMGNREGA web-portal, which facilitates the MGNREGA with evidence of a geo-tagged photograph of the asset. (Citizen view mode from GeoMGNREGA web portal).

The district's geographic area is 8,303 km^�. The district lies between latitudes 21° 0'46.44"N and 22° 9'34.61"N and longitudes 85°11'3.49"E and 86°21'30.93"E. Forests of Northern tropical deciduous type trees, such as Sal, Asan, Jamu, Arjuna, Kusum, Kangada, Mahua, Mango, and Kendu, cover over half of this district.The tops of the mountains seem to be steeply ridged or peaked, and the highlands are composed of groups of rocky crags. Large tablelands are present on their peaks. While isolated hills occasionally rise sharply from the plains, most places have an overall elevation of more than 600 meters. The Baitarani River is one of the rivers whose watershed is formed by the highlands. In the spring, the district experiences a sharp increase in temperature, with May typically recording the highest readings of up to 38 °C. However, the highest temperature ever recorded was 43.3 °C. During the June monsoon, the temperature drops, and it stays that way until the end of October. December is when the lowest possible temperature is 7°C. 1°C was the lowest temperature that was noted. Rainfall totals for the year average 1910.1 mm. The population of the Kendujhar district is 1,801,733, as per the 2011 census. In India, it is the 264th most populated district. The population density of the district is 217 people per square kilometer (560 people per square mile). The Keonjhar subdivision has the greatest concentration of Scheduled Tribes, and lowest in the subdivision of Anandapur. Most members of Scheduled Tribes work in mining, quarrying, or agriculture.

DATABASE AND METHODOLOGY

With the use of a web-based geographic information system, EO systems enable the collection, storage, management, and distribution of remotely sensed data. According to the current trend in EO technology has the potential to raise human living standards, advance the social economy, and support the Sustainable Development Goals. In order to address agricultural, ecological, and socioeconomic issues, as well as to assess the state of ecosystems, monitor biodiversity, and provide insights into social problems, EO satellites gather Very High Spatial Resolution (VHSR) images, which are widely used to create land cover maps. Various activities such as rural connectivity (new roads), rural sanitation infrastructure (toilets), irrigation systems, drought-proofing efforts like afforestation and tree planting, land development, water conservation, and harvesting can be effectively analyzed through high-resolution Remote Sensing (RS) data. One valuable outcome of using Earth Observation (EO) data is the generation of Land Use and Land Cover (LULC) change maps. These maps, produced at regular intervals, offer a broad overview of land cover changes and serve as important tools for planning, monitoring, and evaluation [25].

Additionally, environmental interactions related to initiatives like MGNREGA (Mahatma Gandhi National Rural Employment Guarantee Act) can be geographically assessed through such data. A detailed analysis of the environmental impacts of MGNREGA activities is presented in Table 1, showcasing their geographical evaluation.

A key measure for assessing Social Safety Nets (SSNs) is tracking challenges related to food security and agricultural activities.

A improved agricultural productivity will come from soil conservation techniques, land development projects, drought proofing measures, and irrigation facilitation. Measuring vegetation signatures with RS sources has turned into a risky method of assessing the impacts of agricultural output at the regional and global levels. The Normalized Difference Vegetation Index (NDVI) is one of the most widely used methods for monitoring vegetation. NDVI captures how vegetation interacts with light, particularly its ability to absorb visible light while reflecting near-infrared light. The index indicates the influence of climate and water availability on vegetation, with photosynthetically active plants showing a distinct difference in reflectance between visible and near-infrared wavelengths.

An index of vegetation is created by recycling this data. The vegetation index's lower value denotes moisture pressure in the vegetation, which results from a protracted water shortage. If the NDVI levels are higher than those observed in previous years, it could indicate optimal growing conditions. The highest NDVI indicates the peak photosynthetic activity of the vegetation and provides the greatest NDVI value of the rising season For long-term studies, the maximum NDVI is useful for identifying trends in vegetation health over multiple years. This method helps to track changes and assess the overall condition of vegetation across different seasons. Plans for managing and conserving water resources can greatly benefit from the employment of contemporary RS and GIS methodologies (Shakoor, Shehzad, & Asghar, 2006). Water spread area data and other associated data are promptly provided by satellite-based Water Body Information Systems (WBIS). Common types of water bodies include reservoirs, ponds, rivers, lakes, irrigation systems (such as wells, tanks, etc.), aquaculture and pisciculture-based natural or artificial water bodies (WBIS, 2019In rural areas, most of the water from local water bodies is utilized for agriculture, drinking water, small-scale industries, and livestock production.

Table 1. Public works of MGNREGA that interact with natural resources and related geospatial evaluator.

Activity under public works of MGNREGA	Interaction with Natural Resources	Geospatial Evaluator
• Works related to water conservation and water harvesting. (Construction of check dams, boulder check, underground dyke, farm bunds, earthen dam, mini percolation tanks, sub surface dam, sunken pond, water absorption trench, and etc.). • Watershed management works. (Construction of contour trench, contour bund, terracing, boulder check, gabion structures, sunken pond, spring-shed treatment etc.). • Renovation of traditional water bodies. (De-silting of the water-bodies, removing/cleaning of encroachments, removal of aquatic weeds, etc.).	• Augments and improves groundwater recharge. • Reduces, arrests soil erosion. • Improves soil moisture profile. • Controls the runoffs and reduces rate of siltation. • Improves facilitation of drinking water. • Improves water facility for livestock. • Improves bio-mass production. • Reduces the impact of low rainfall events on agriculture, livestock and drinking water. • Increases the storage capacity of water bodies. • Increases the water spread area. • Increases the flow of water to downstream.	• During the construction phase these activities can be monitored using high resolution satellite data. Geoportals will enable to upload geo-tagged photographs during the construction from the field, and in turn will provide status of the work. • The effects of water conservation and water harvesting structures on groundwater recharge and soil erosion can be studies using RS methods. • Soil erosion studies can be done using RS methods. Microwave RS studies have proven to be predicting realistic estimations of soil moisture. • The effects of soil moisture can be correlated with vegetation growth and hence this phenomenon can be monitored using NDVI techniques. • National Remote Sensing Centre (NRSC) • monitors the status of all water bodies (nearly two lakh in count) in the country using multi-resolution satellite images. The estimated water spread area on the date of image is published in dedicated Water Body Information System (WBIS, 2019).
• Construction and renovation of micro and minor irrigation works (like canals, distributary and minor routing canals, lining of canals, correction of water conveyance system, correction of system deficiencies about outlet upto distributaries, and etc.).	• Facilitates water to agriculture purpose. • Reduces the impact of low rainfall events on the agriculture.	• Before and during the construction phase these activities can be monitored using high resolution satellite data. • Studies related to water stress on agriculture can be done using RS.
• Drought proofing works. Examples include eco-restoration of forest, reforestation, tree plantation, block plantation, avenue plantation, afforestation, grass land	• Local natural and human production resource base should able to provide a certain desirable amount of food, fuel, fodder, drinking water and livelihood resources during a drought.	• Impacts of these studies can be done using RS • Indices along with drought prediction models. • Studies related to eco-restoration of forest, afforestation, grass land development can be done using

development, bio-drainage, plantation in government lands, and etc.		RS data along with socio-economic data.
• Spring shed development (in mountain regions) like trenching, planting of trees, fodder grasses or hedges and gull plugging.	• To create source of water supply systems, enhance rainfall infiltration, recharge springs, revive dysfunctional traditional water harvesting systems.	• In the mountainous regions, most of the consumable water originates from springs. The uncertainty can be monitored using RS methods along with digital elevation models. • Climatic factors, anthropogenic causes and the topography, vegetation cover, soil and geology of an area also affects the water availability in a region. These factors control the rainfall runoff and groundwater recharge and storage. Hence RS data can be used to monitor spring shed management along with other in-situ data.
• Construction of Poultry shelter, goat shelter, fodder trough. • Construction of buildings (like houses, food grain storage and etc.).	• Accrue of community level infrastructure. • Housing facility for marginal and vulnerable groups and etc. • Food storage, security and other need based infrastructure.	• Can be seen in high resolution RS data using change detection techniques. Information systems will able to accumulate the filed photographs using controlled crowd sourcing methods.
• Fisheries (tanks, water harvesting ponds, landscaping of the bed and fish drying yards.	• Helps in boosting fisheries occupation.	• Can be monitored using RS data with high resolution and multi resolution data for coastal area development applications.
• Rural drinking water (soak pits, recharge pits), rural sanitation, solid and liquid waste management, flood management related, irrigation related (like canal, channel).	• To solve drinking water problems, facilitate irrigation facilities, and control the flood like events.	• Can be monitored using high resolution RS data. Water spread areas can be detected and mapped in RS data using multispectral data.
• Pro-forest activities like tree plantation, grass lands, nursery, afforestation activities, and etc.	• Increases forest cover and aids in conversion of wastelands to cultivable lands.	• Can be mapped using RS data. Portal titled Global Forest Watch can be used to monitor the forest lost and gain events.

The outputs of the trees and forests in their area are often utilized by the rural people for a variety of purposes, including direct household usage (food and fuel), inputs into the agricultural system (protection and feed), and sources of revenue and employment (Wackernagel & Rees, 1998). The program of this SSN includes work related to soil protection, afforestation, tree planting, boundary planting, agro-forestry, block planting, and agro-horticulture. By removing reliance on forest resources and immediately providing sufficient purchasing power, they have a positive impact on the conservation of forests. As a result, forest area monitoring suggests what the peri-rural population needs from the forest. Figure 4 displays the "Global Forest Watch" web-GIS site, which has a forest theme. These portals are quite helpful for tracking changes in the forested areas.

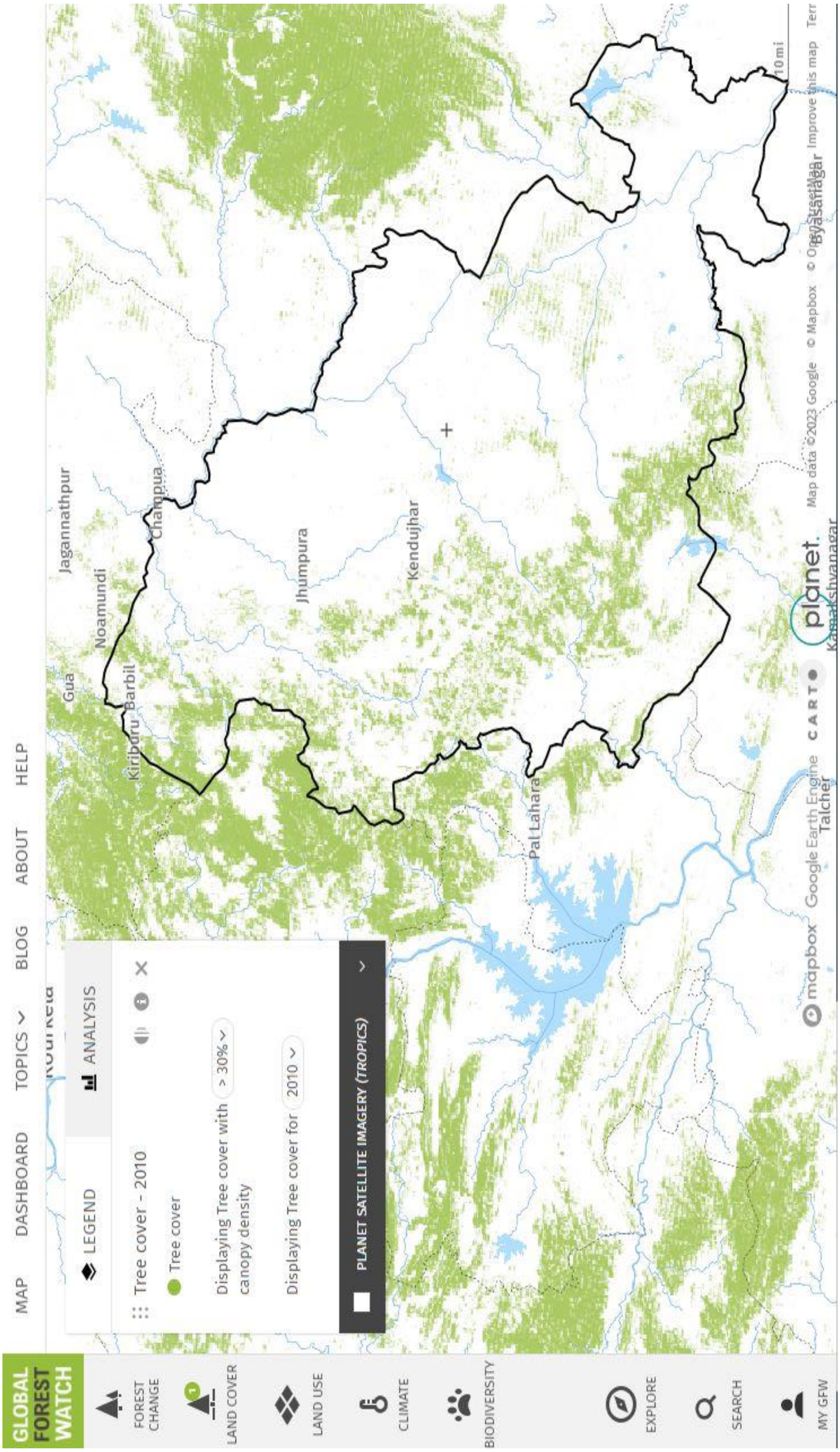


Figure 4. A screenshot showing Keonjhar district and surroundings in Global Forest Watch geo-portal Methodology.

Methodology

- The maximum NDVI (Max-NDVI) has been calculated for agricultural fields using RS images from 2009 to 2019 throughout cropping seasons. In these areas, asset density appears to be a hotspot and is highly significant.
- From 2009 to 2019, water bodies in the research region were analyzed to look for signs of change brought on by water harvesting and conservation efforts that have funded higher ground water levels and more water disposal for agriculture.
- Maps of land deterioration were created in 2009 and 2019.
- The global forest watch geo-portal's forestry component was measured using the forest loss/gain as an indicator.

DISCUSSION

In all 13 blocks of the Keonjhar district, public works projects funded by the MGNREGA have advanced satisfactorily. According to Dashboard (2019), 2267 village clusters have taken involved in the initiative in a meaningful way. In this district, a total of 5,75,708 workers were involved in the MGNREGA program. The research area spans 653900 Ha of land and includes more than 26389 assets. the total number of assets developed from 2009 to 2019 is presented in Table 2. It shows that the majority of these assets were dedicated to drought-proofing, water harvesting, irrigation, and conservation. Furthermore, there has been a notable increase in the demand for rural sanitation projects starting in 2017 and 2018 within the study area (Figure 5).

Table 2. Year-wise MGNREGA assets details in the Keonjhar district.

Year	No. of Assets	Dominant Asset Type
2009-10	1646	Water Conservation and Water Harvesting, Renovation of traditional water bodies
2010-11	2832	Farm Pond, Renovation of traditional water bodies, Bharat Nirman Sewa Kendra
2011-12	3725	Works on Individuals Land (Category IV),Bharat Nirman Sewa Kendra, Water Conservation and Water Harvesting
2012-13	2901	Works on Individuals Land (Category IV),Water Conservation and Water Harvesting, Renovation of traditional water bodies
2013-14	4697	Works on Individuals Land (Category IV),Water Conservation and Water Harvesting, Renovation of traditional water bodies
2014-15	1135	Works on Individuals Land (Category IV),Water Conservation and Water Harvesting
2015-16	15466	Works on Individuals Land (Category IV),Land Development, Drought Proofing
2016-17	9587	Works on Individuals Land (Category IV),Drought Proofing, Renovation of traditional water bodies
2017-18	34103	Works on Individuals Land (Category IV),Drought Proofing, Renovation of traditional water bodies
2018-19	24600	Works on Individuals Land (Category IV), Drought Proofing, Water Conservation and Water Harvesting

Source: MGNREGA Dashboard 2018; GeoMGNREGA dashboard, 2018

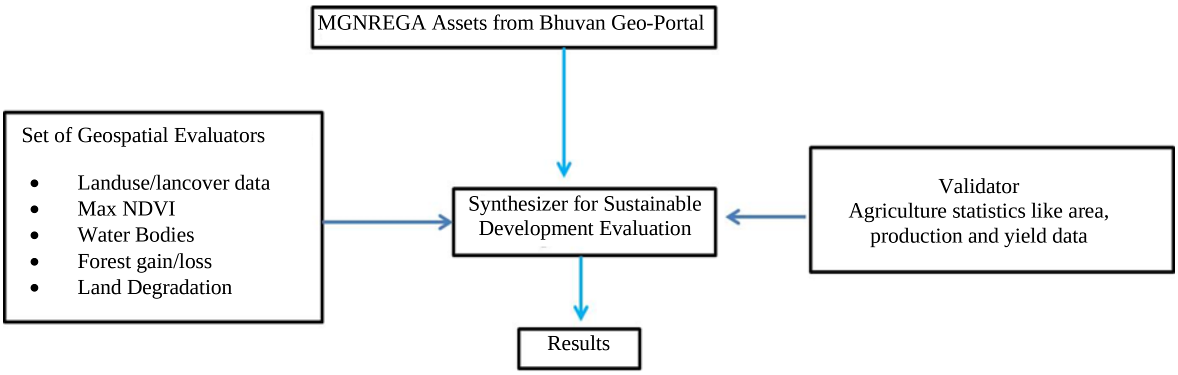
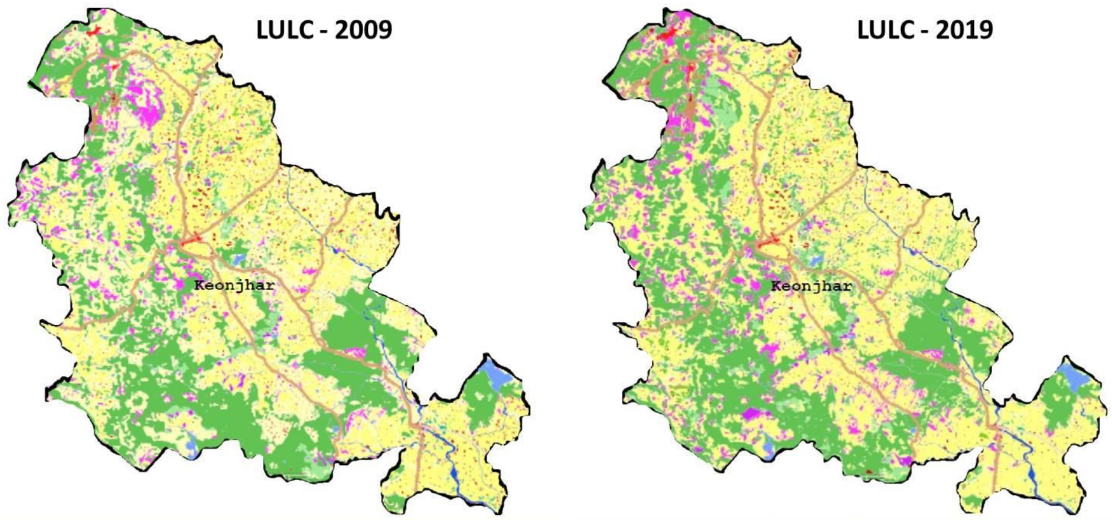


Figure 5. Methodology for rapid evaluation of sustainable development using Geospatial evaluators and agriculture outputs parameters as validators.

Figure 6 presents the Land Use and Land Cover (LULC) maps for 2009 and 2019. A comparison of these maps confirms the transformation of wasteland areas into agricultural land. Figure 7 shows the Max-NDVI values from sampled areas at hotspots where land development, irrigation projects, and soil fertility enhancement activities have been most intense. The research area's vegetation is showing steep progress, as indicated by the Max-NDVI values over 250 samples. Over a ten-year period, the Max-NDVI readings have improved from 0.40 to 0.52. In the study region, about 150 water bodies were examined. The snapshot of the GeoMGNREGA site used to obtain the hotspot data for the MGNREGA-assigned works is shown in Figure 7. Figure 7 represents the category wise hotspots for various assets at block level.

Table 3. Observation of changes from the geospatial evaluators in Keonjhar district from 2009 till 2019.

Indicator	Observation
Satellite based LULC maps for the year 2009 and 2019	From LULC derived through satellite data there is indication of changing wastelands regions into agriculture.
Max NDVI at peak cropping season	Max NDVI values over 250 sample points indications steep improvement in the vegetation. The values NDVI has improved from 0.40 to 0.52 over the span of 10 years.
Interpretation of water bodies	Approximately 150 water bodies in the study area where analyzed. The reflection is that majority of water bodies' exhibits excellent recharge and water spread area.
Interpretation of Forest cover from Global forest watch portal	There is no change in the forest cover. For the year 2009 the area of the forest cover is 2420 Ha and the figure is 2545 same for 2019 also.
Land degradation and erosion	Traces of enhancement in land degradation and erosion were detected in the temporal analysis of land degradation data.
Agriculture Productivity	From the statistics of agriculture productivity it is detected that there is significant growth in total cropped area, net area irrigated (through canals and tanks). There is growth in total area for food grain and also its productions. The area of principal crop (rice), production and yield were also improved significantly.



LULC Class	Area (Sq.Km)	LULC Class	Area (Sq.Km)
Builtup,Urban	30.96	Builtup,Rural	384.56
Builtup,Mining	36.71	Agriculture,Crop land	2643.28
Agriculture,Plantation	42.64	Agriculture,Fallow	1980.5
Agriculture, Current Shifting Cultivation	6.32	Forest,Deciduous	2419.57
Forest,Forest Plantation	35.13	Forest,Scrub Forest	144.99
Barren/unculturable/ Wastelands, Gullied/Ravinous Land	66.21	Barren/unculturable/ Wastelands, Scrub land	299.88
Barren/unculturable/ Wastelands, Barren rocky	22.01	Wetlands/Water Bodies, Inland Wetland	11.46
Wetlands/Water Bodies, River/Stream/canals	117.33	Wetlands/Water Bodies, Reservoir/Lakes/Ponds	61.46
Total			**8303.00**

LULC Class	Area (Sq.Km)	LULC Class	Area (Sq.Km)
Builtup,Urban	393.15	Builtup,Rural	64.85
Builtup,Mining	39.95	Agriculture,Crop land	3756.68
Agriculture,Plantation	47.82	Agriculture,Fallow	208.54
Agriculture, Current Shifting Cultivation	22.82	Forest,Deciduous	2544.9
Forest,Forest Plantation	79.09	Forest,Scrub Forest	252.6
Barren/unculturable/ Wastelands, Gullied/Ravinous Land	80.21	Barren/unculturable/ Wastelands, Scrub land	582.5
Barren/unculturable/ Wastelands, Barren rocky	37.68	Wetlands/Water Bodies, CoastalWetland	11.49
Wetlands/Water Bodies, River/Stream/canals	118.3	Wetlands/Water Bodies, Reservoir/Lakes/Ponds	62.41

Figure 6. Land Use / Land Cover (LULC) maps of Keonjhar district for the years 2009 and 2019.

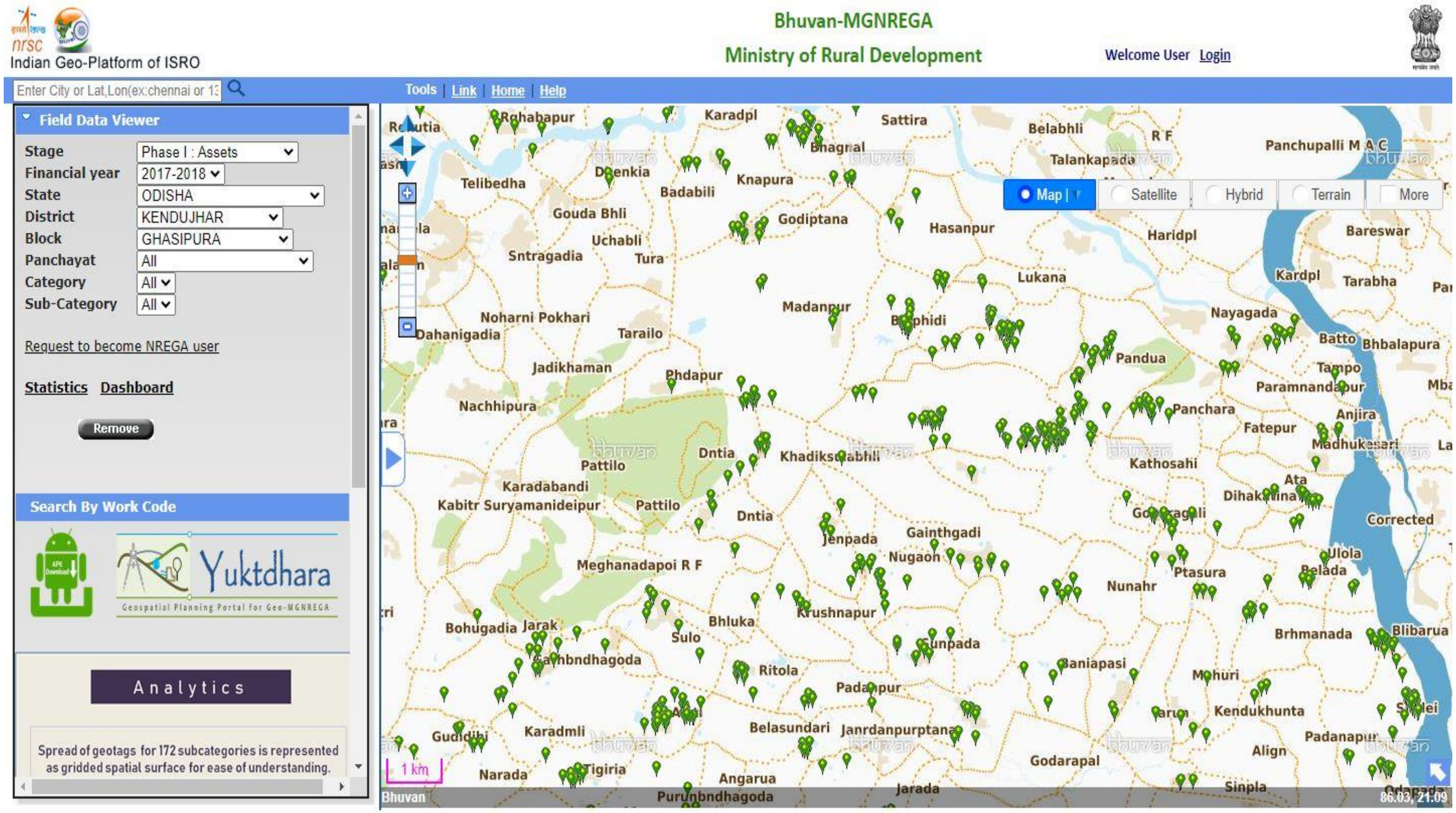
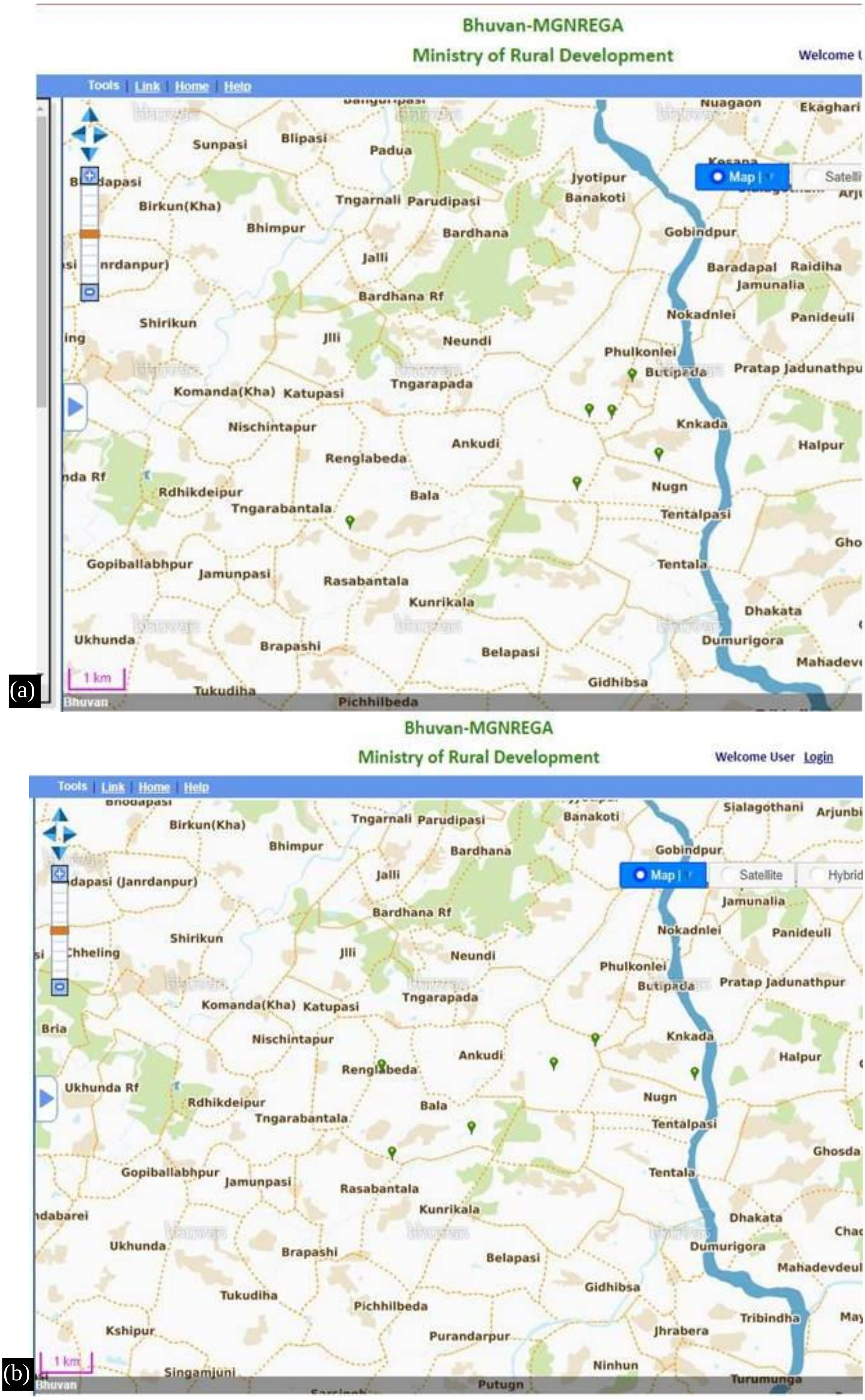


Figure 7. Spatial distribution of assets in the study areafor the year 2017-2018 in block Ghasipura (figure captured in citizen view mode).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Tentalpasi
Ghosda
Gopiballabhpur
Jamunpasi
Tentala
Rasabantala
Kunrikala
Dhakata
Ukhunda
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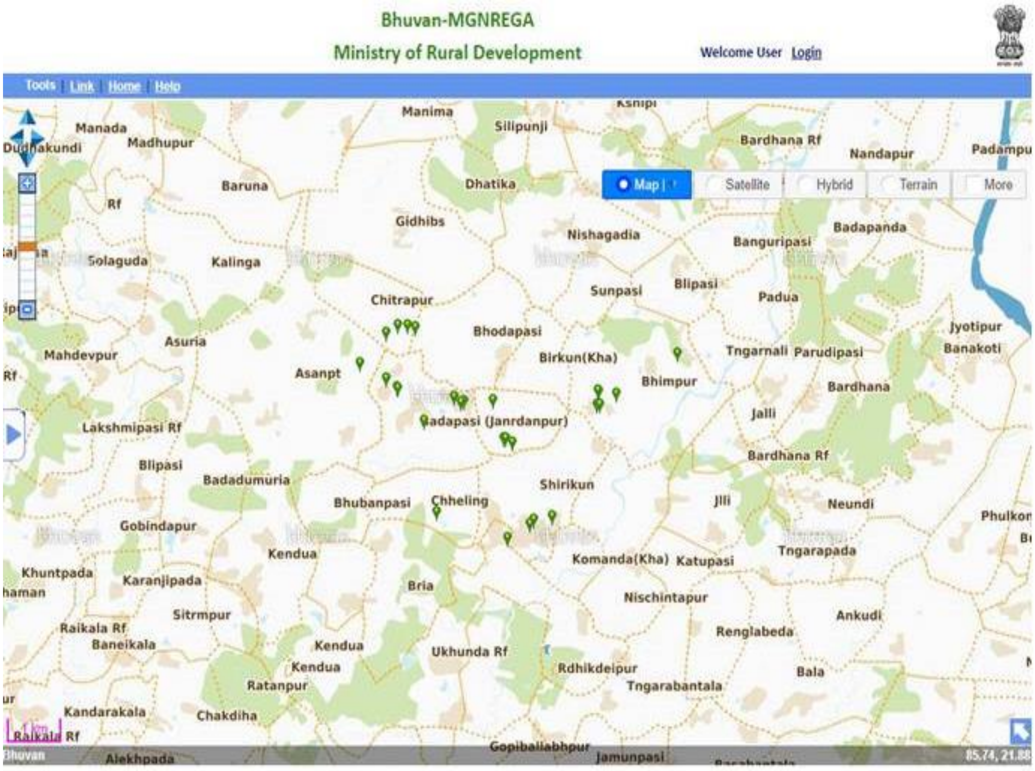

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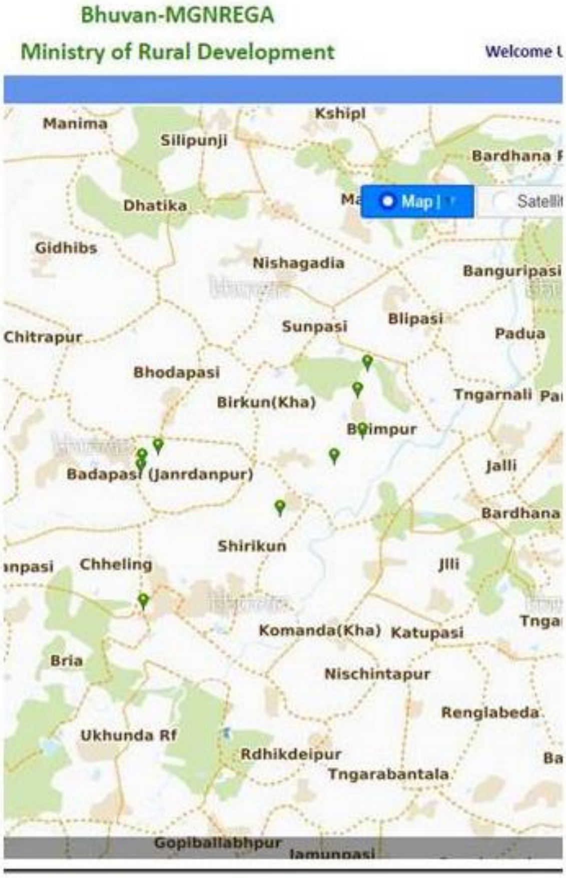

(d)

Figure 8. Hotspots of MGNREGA assets in Ghasipura block of Keonjhar district. A - Assets pertaining to Rural drinking water work. B - Assets pertaining to Drought proofing. C - Renovation of traditional water bodies. D-Water conservation and water harvesting.

The study's results are displayed in Table 3. It has been observed that land development is improving in terms of agricultural productivity. The findings additionally validate that the implementation of water collecting practices has a favorable effect on the provision of irrigation and drinking water in the studied area. After excavating farm ponds in this area, the farmers who previously had a shortage of water during dry spells are now content (Figure 8). In addition to raising the surrounding ground water level, the agricultural ponds helped to store rainwater. All year round, the fields have access to the necessary moisture. Despite being aware of the idea, many farmers were unable to put it into practice because of the upfront costs associated with excavating ponds; however, MGNREGA made this feasible. High-resolution satellite data can be visually interpreted to show improvements in the restoration of eroded and degraded areas. In the Keonjhar district, numerous water rehabilitation projects were carried out under the MGNREGA initiative. The VHSR Remote Sensing data clearly illustrates the consequences; Figure 9 provides one example of how the restoration efforts have affected the water spread area. In a similar vein, it depicts a region where land development operations have triumphed over sustainable land use patterns.

Table 4. Agriculture statistics (2009 – 2019) for Keonjhar district.

Year	Gross Cropped Area '000 Ha.	Gross Area Irrigated ' 000 Ha.	Gross Area used for food grains '000 ha.	Production in '000 Tonnes	Food grain-Yield Kg per Ha.	Gross area for Rice '000 ha.	Production of Rice in '000 tonnes	Rice - Yield Kg per Ha.
2009-10	426.26	73.86	299.74	360.17	1202	195.51	282.17	1443
2010-11	414.28	96.26	211.32	245.41	1161	181.38	191.57	1052
2011-12	394.63	74.37	269.63	331.74	1675	171.46	293.73	1713
2012-13	426.26	114.23	275.14	333.01	1675	170.65	283.99	1664
2013-14	393.33	123.55	275.6	375.84	1364	175.37	272.65	1664
2014-15	400.27	138.33	277.89	510.62	1837	175.8	412.75	2348
2015-16	391.92	135.55	277.29	312.06	1125	182.9	206.98	1132
2016-17	407.43	178.22	291.6	530.67	1820	192.84	422.25	2190
2017-18	400.29	136.62	283.35	503.44	1777	188.36	395.04	2097
2018-19	363.68	185.55	251.36	473.69	1885	160.69	367.34	2286

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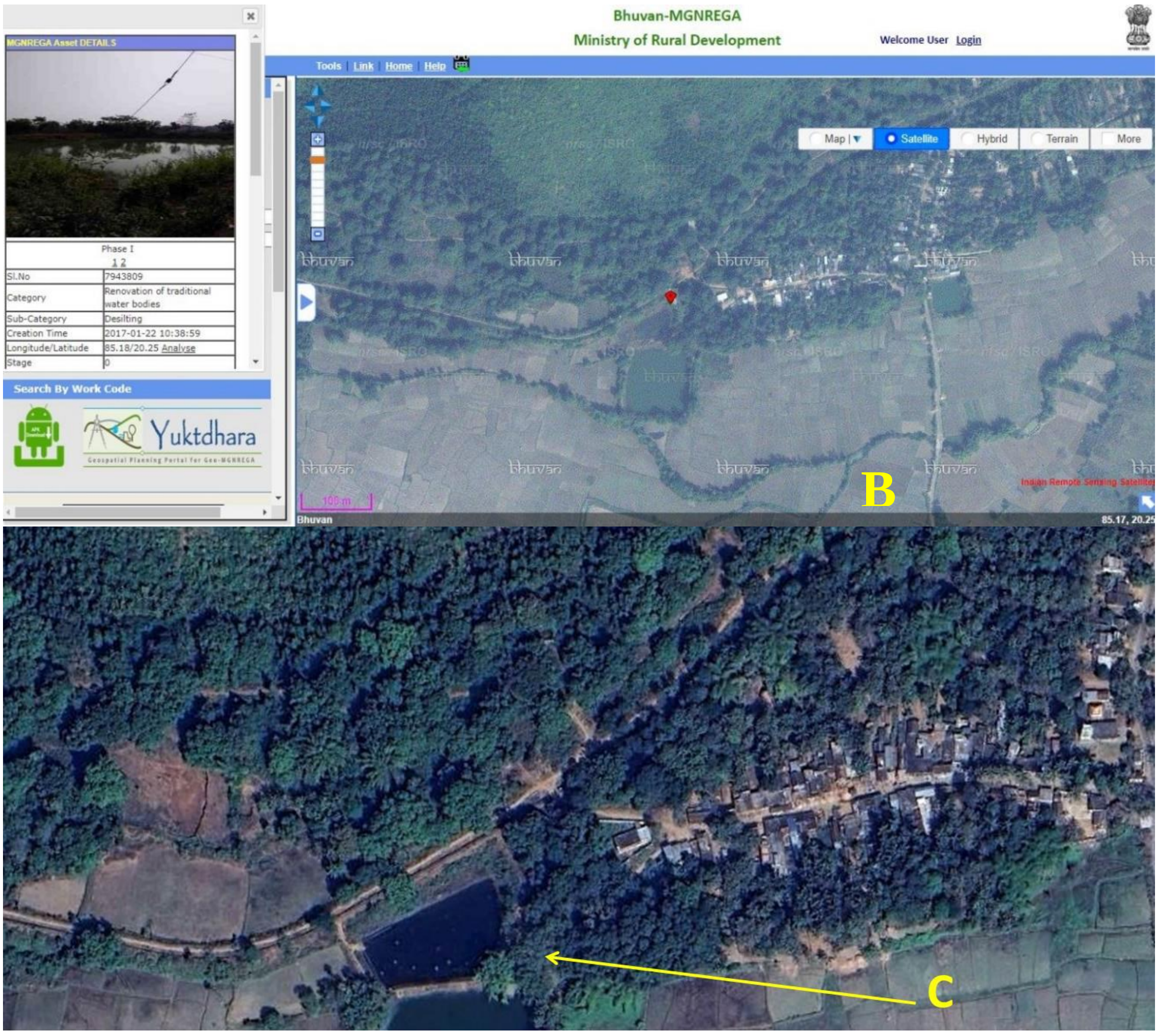

Figure 9. Restoration of minor irrigation tank through MGNREGA public work in Keonjhar District.
(A) Satellite data of date March 2017 showing the reservoir with less water spread area.
(B) GeoMGNREGA application showing details of assets at the reservoir.
(C) Satellite data of date March 2018 showing the reservoir with more water spread area.

CONCLUSION

The analysis concludes that the public works assets created under MGNREGA lead to significant benefits.The findings confirm that MGNREGA resources positively impact natural resources and successfully support the promotion of sustainable living. The research region now has easier access to drinking water and irrigation because to initiatives like water collection and conservation. The process of renovating historic water features and water harvesting infrastructure has increased the amount of land used for irrigated crop production by improving water availability.

Most of the smaller irrigation tanks have been fully restored to their original capacity. The outcomes of this innovative program have aided the blue and green revolutions in this region of the study. According to the study, the public works implemented under the MGNREGA have a substantial positive impact on all three SD dimensions. For example, the social dimension benefits from the creation of durable rural infrastructure, the environmental dimension benefits from improved sustainable eco-restoration practices, and the national economy benefits from increased spendability in rural areas. The study validated the application of geographic information technology in quantifying the environmental and socioeconomic gains resulting from MGNREGA public works.

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