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Dynamics in Land Use and Land Cover of Konam reservoir, Visakhapatnam, India by Geo-Spatial Technique

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Abstract: -
Satellite images and a geographic information system serve as a tool to identify, monitor and analyse changes in the basin and its management. Interactions and relationships between human activities and natural phenomena are important for the estimation of surface elements using change analysis, which improves better resource management and decision-making in watershed hydrology assessment. Satellite data serves as an important monitoring system of the earth's surface with different spatial and temporal resolutions. Spatially consistent data provide remote sensing suites that cover large areas with high spatial detail and high temporal frequency. Land is becoming a scarce resource due to enormous agricultural and demographic pressure. Information on land use / land cover and the possibilities of their optimal use is therefore necessary for the selection, planning and implementation of land use schemes to meet the increasing demands for basic human needs and well-being. Land use and land cover changes have become a central component of contemporary strategies for managing natural resources and monitoring environmental change. Land-use changes Land cover is a dynamic process occurring at the surface and is becoming a central component of contemporary strategies for managing natural resources and monitoring environmental change. LULC change detection is a process that helps in determining changes related to land use and land cover with reference to georectified remote sensing data.

The objective of this paper is to analyse the dynamics of land cover changes in Konam dam, Konam village, Chedikada mandal, Visakhapatnam district and Andhra Pradesh, India using multi-temporal remote sensing data (LANDSAT from 2010-11 and 2020-21) changes in land use have been made soil. Five LULC classes were established as Forest area, Agricultural land, Wasteland, water bodies and Built-up area. LULC changes were highest in Built-up area, Forest area and Agricultural land from 2010-11 to 2020-21.

Keywords: - Geo-Spatial Techniques, LULC Changes, LANDSAT data, Konam reservoir etc.,

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1. Introduction: -

Changes in land use/land cover (LULC) are major issues of global environmental change. Satellite Earth Remote Sensing data, with its repetitive nature, has proven to be quite useful in mapping land use/land cover patterns and changes over time. Quantification of such changes is possible using GIS techniques, even if the resulting spatial data sets are at different scales/resolutions. Change detection is the process of identifying differences in the state of an element or phenomenon by observing them at different times. Change detection is useful in many applications related to land use and land cover change (LULC), such as cultivation change and landscape change, land degradation and desertification, coastal change and urban sprawl Image pre-processing, urban landscape pattern change, deforestation, mining, and landscape and habitat fragmentation and other cumulative changes. Land use change directly affects the amount of evapotranspiration, groundwater infiltration, and runoff from land. Land use change is an important issue with respect to global dynamics and its response to environmental and socioeconomic factors (Hurni et al., 2005). Land-cover land-use changes negatively affect climate patterns, natural hazards, and socioeconomic dynamics at global and local scales (Hegazy & Kaloop, 2015). Information on uses/covers and potentials for their best use is essential for the selection, planning, sustainable management of land resources and understanding changes in hydrological processes to meet the increasing demands for basic human needs and well-being Human activities are one of the main driving forces. forces of land use and land cover changes and in the natural environment in general.

Changes in land use affect the nature of climate, cause natural hazards and socio-economic dynamics at global and local scales. Therefore, defining land-use change is an important issue with respect to global dynamics and its response to water flow, forest, soil, and rainfall and runoff characteristics of a basin or watershed. In addition to land use research, land cover change is important for effective sustainable natural resource management, efficient use of natural resources, and use as a tool for policy makers and understanding changes in hydrological processes. Therefore, this study is an important tip for decision makers to understand the dynamic nature of the watershed in recent decades and take action based on the findings.

Change detection is valuable in many applications related to land use and land cover (LULC) change detection, including cultivation, urban expansion, and landscape change (Solaimani et al., 2010). Understanding landscape patterns, changes and interactions between human activities and natural phenomena are essential for good land management and improved decision-making (Rawat & Kumar, 2015). Geographic Information Systems (GIS) and Remote Sensing (RS) are powerful and cost-effective tools for assessing spatial and temporal changes in LULC. Nowadays, remote sensing data are applicable and valuable for land use and land cover change detection studies. Remote sensing data is the most common source for detecting, quantifying, and mapping LULC patterns due to its repetitive data acquisition, convenient processing, and accurate georeferencing.

2. Material and Methods: -

2.1. Study Area: Konam Reservoir

The Bodderu River, a tributary of the Sarada, originates in the Eastern Ghats of Andhra Pradesh. The Konam reservoir project was constructed across the Bodderu River near Konam village in Visakhapatnam district (Figure 1). There is no upper use due to the hilliness and the forest. The dam can be divided into two parts, an earth dam and a concrete spillway. The earthen levee is made

of impermeable soil and the embankment is lined with heavy rubble stones to protect the upper slope of the levee. The slope downstream is equipped with high-quality turf and drainage chutes for the drainage of rainwater.

This is a medium sized tank. The total length of the dam is 930 m, of which 300 m is a constructed earthen embankment and the rest is a natural earthen embankment. The maximum height of the dam from the deepest foundation is 26.65 m. The top width of the earthen dam is 5.0 m and the top level of the dam is 104.25 m. The gross storage capacity of the reservoir is 48.14 MCum at full reservoir level (101.25 m) (Table 1). The spillway is of the Ogee type with a crest of 95.25 m and has 3 vents of size 12.20 m x 6.00 m each. The total length of the spillway crest is 36.60 m with a discharge capacity of 1260 cubic meters. Konam project irrigates 12,638 acres of ayacut spread over 39 villages through two vents of high level river sluice, low level river sluice in spillway and one vent high level channel on earthen embankment. The project was constructed across the Bodderu River (a tributary of the SARADA River) near Konam village in Chedikada Mandal of Visakhapatnam District (Figure 2). The project is 40 km from Anakapalli Road. This tank was designed to irrigate an ayacut of 12,638 acres of 39 villages in Chedikada, Madugula, Devarapalli, Butchayyapeta, Chodavaram Mandals of Visakhapatnam District. This project was started in 1977 and completed in 1980 with an expenditure of Rs.469 Lakhs.

Figure 1: - Location Map of Konam Reservoir

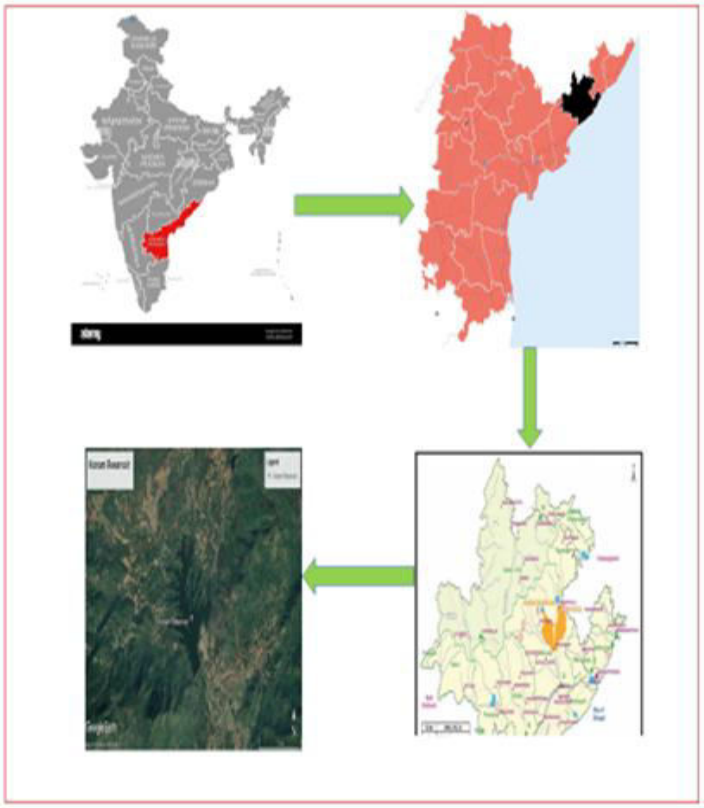

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Figure 2: - Satellite view of Konam Reservoir

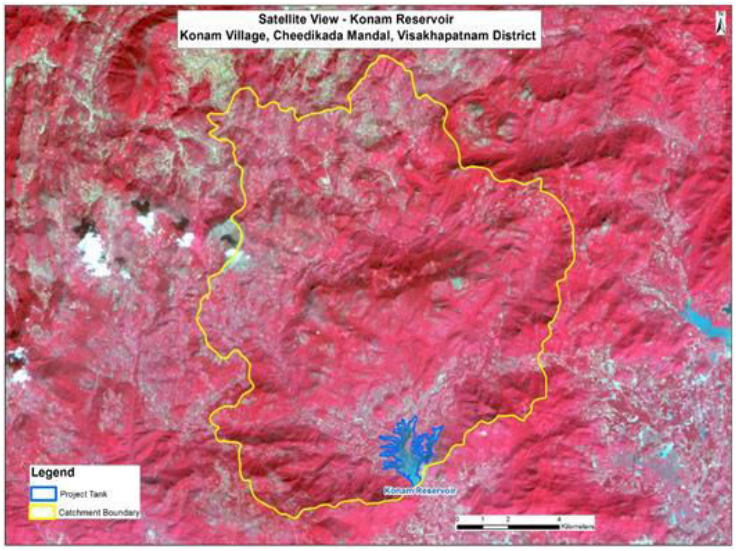

Table 1: Details of Konam Reservoir

Project details		
Location	:	On River Bodderu near Konam (V) Chedikada (M) of Visakhapatnam
Longitude	:	82° 50' 0"
Latitude	:	18° 52' 0"
Ayacut	:	12,638 Acres
Canal details		
Total Length	:	300mts
Ayacut	:	12,638 Acres
Cropping Pattern	:	Paddy, Sugarcane and others
Villages Benefitted	:	39
Utilisation	:	0.7 TMC (2013-14 khariff & Rabi)
Spillway Details:		
Type	:	Ogee spillway
Crest level	:	+95.25 Mts.
Vents	:	3 Nos. (12.20m x 6.00m)
Discharge capacity	:	44,500 Cusecs
Length	:	36.60 m

2.2. LULC Classification

Land cover modification acts as one of the most important factors of ecological and hydrological processes. Remote sensing data with different spatial and temporal resolutions allow LULC classification (Table 2). However, the best classification technique used for classification was evaluated by classifying the study area using different classification techniques.

Table 2: - Land Use and Land Cover Classification

S.No	Major LULC Class	Sub Classes
1	Agriculture land	Agricultural land-crop land-cropped more in 2 seasons Agricultural land-crop land-cropped in 2 seasons Agricultural land-fallow Agricultural land-crop Land-Rabi crop Agricultural land-crop Land-Zaid crop Agricultural land-crop land-kharif crop Agricultural land-plantation
2	Forest area	Forest-deciduous (dry/moist/thorn)-dense/closed Forest-deciduous (dry/moist/thorn)-open/closed Forest-scrub Forest Forest-forest plantation Vegetated / open Area
3	Built up area	Built up (rural) Built up-quarry Built up-industrial Built up - compact (continuous) Built up - sparse (discontinuous)
4	Wastelands	Wastelands-scrub land-dense scrub Wastelands-scrub land-open scrub Wastelands-gullied/ravenous land-gullied Wastelands-gullied/ravenous land-ravenous Wastelands-barren rocky/stony waste
5	Waterbodies	Waterbodies-reservoir/tanks-seasonal Waterbodies-river/stream-non perennial Waterbodies-reservoir/tanks-permanent

2.3. LULC Change detection:

The LULC maps were prepared using LISS-III and LISS-IV satellite images for the years 201-11 and 2020-21 of three crop seasons i.e. kharif, rabi and zaid. Various image enhancement techniques have been adapted to make the images more interpretable. ArcGIS software was used to delineate the vector data, on-screen digitization using the visual interpretation method was used for mapping. LULC classes were delineated from both images using visual interpretation methods to finally generate LULC datasets and maps for the two reference years. Subsequently, an accuracy assessment was carried out to assess the degree of correctness of the map after the preparation of the LULC maps. To perform the subsequent change analysis, a copy of the 2020.21 LULC map of the study area was overlaid on the 2010-11 satellite image and polygons were adjusted wherever changes occurred and a LULC change map was obtained. The visual interpretation was accompanied by supporting information (Figure 3).

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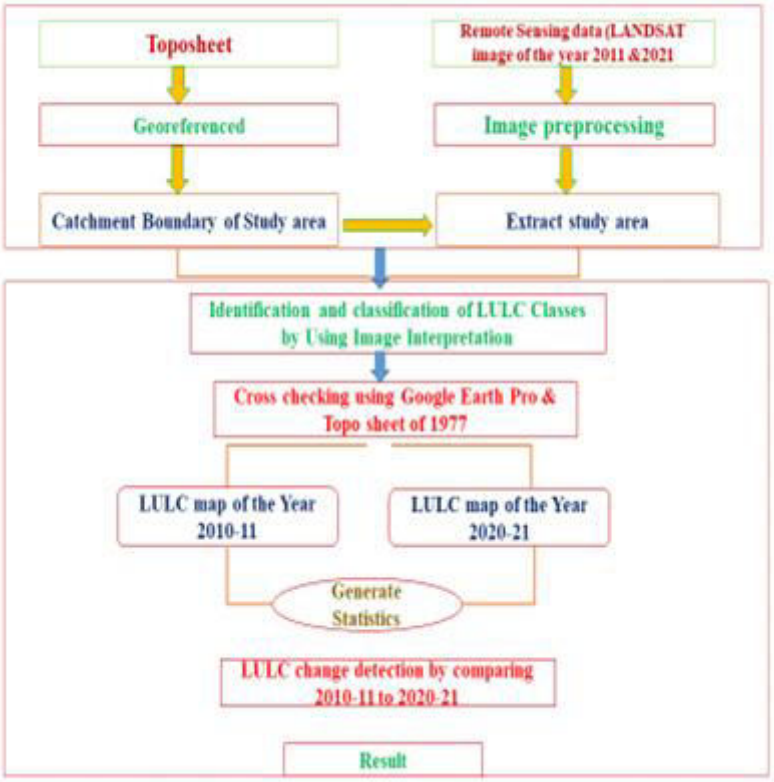
Figure 3: - Process of Land use and Land Cover Change detection



2.4. Software's used: Arc GIS 10.3.1, ERDAS IMAGINE 2015 and MS Office.

2.5. Image rectification & Processing:

Georeferenced topo sheet values were applied to satellite data for georeferencing. Geometrically corrected satellite data were processed with the ERDAS 2015 software and a false color composition (FCC) was created, followed by a digital analysis of land-use/land-cover changes in selected water bodies.

3. Results & Discussion: -

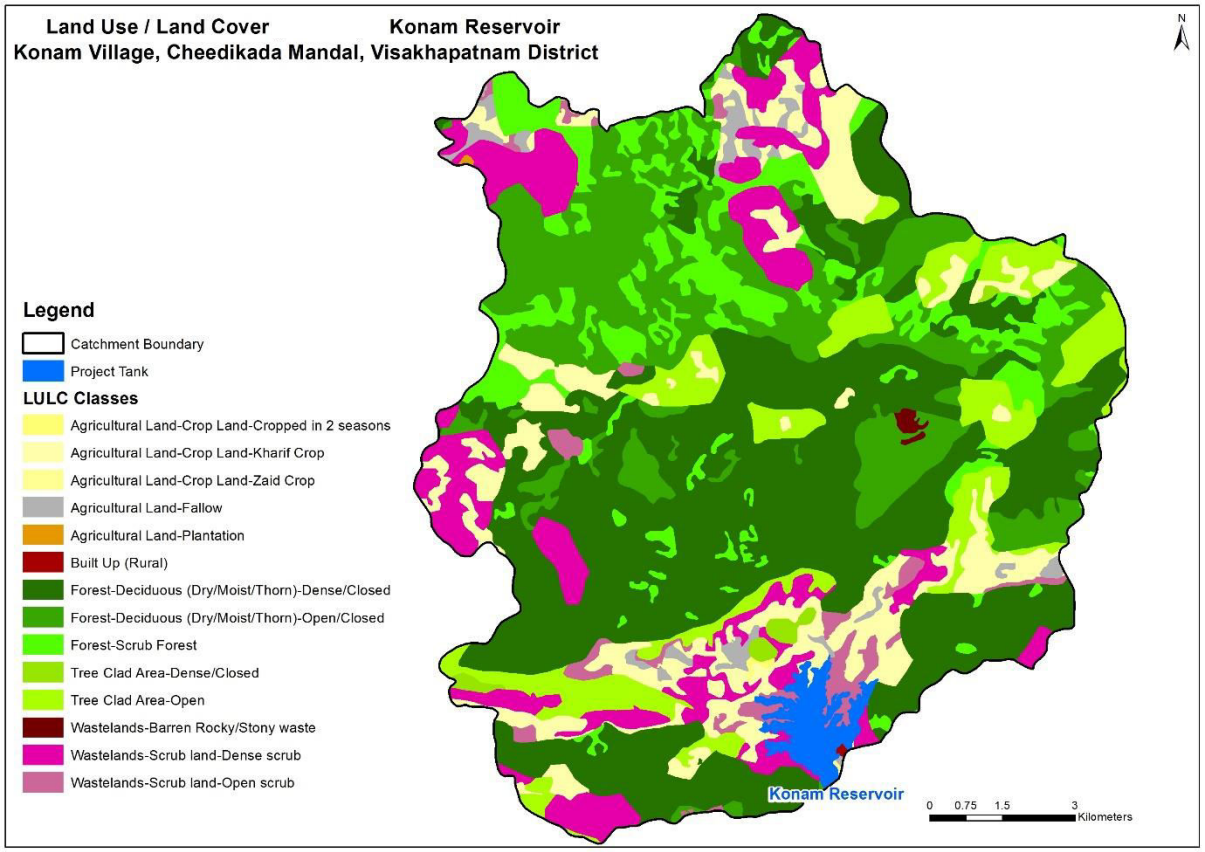
3.1. LULC Classification: -

The Konam reservoir is spread over an area of 41293.01 acres. The LULC of the reservoir basin was classified into 5 major classes and 15 subclasses. The main catchment LULC classes monitored during the study period included forest areas (73%), agriculture (12.83%), wastelands (12.65%), water bodies (1.49%) and built-up areas (0.03%) to Total Geographical area (TGA), shown in Table 4 and Figure 4.

Table 4: - LULC Classes of Konam Reservoir

S.No	LULC Classes	Percentage to TGA
1	Forest area	73.00
2	Agricultural area	12.83
3	Wastelands	12.65
4	Waterbodies	1.49
5	Build up area	0.03

Figure 4. LULC of Konam Reservoir 2010-11



The catchment forest area class covers a total of 73% with 5 subclasses (Table 5), which include deciduous (dry/humid/thorny) dense/closed (36.50%), tree cover-dense/closed (0.56). %), deciduous (dry/humid/thorny) class open/closed (17.40%), scrub forest (10.04%) and Tree cover area-open (8.50%).

In the agriculture class, 5 subclasses were identified. These were kharif crop (11.21%), fallow land (1.51%), kharif and rabi season crop (0.06%), plantation (0.03%) and zaid crop (0.02 %) (Table 5).

Wasteland covers 12.65% of the total watershed, in which 3 subclasses have been identified. They included dense scrub (10.25%), open scrub (2.23%) and barren rocky/stony wasteland (0.17%) shown in Table 5.

The catchment area covers a total of 1.49% of the total catchment area. Includes only one subclass (seasonal) reservoir/reservoir. Meanwhile, the Built-up area also has one built-up sub-class (rural) with 0.03% of the total geographical area.

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Table 5: - LULC with Sub classes and their percentage to TGA

S.No	LULC Class	LULC Sub Class	Area in Acres	Percentage to TGA
1	Forest area	Forest-deciduous (dry/moist/thorn)-dense/closed	15073.04	36.50
2		Forest-deciduous (dry/moist/thorn)-open/closed	7183.73	17.40
3		Forest-scrub forest	4145.32	10.04
4		Tree clad area-dense/closed	231.33	0.56
5		Tree clad area-open	3510.28	8.50
6	Agriculture land	Agricultural land-crop land-cropped in 2 seasons	24.34	0.06
7		Agricultural land-crop land-kharif crop	4629.04	11.21
8		Agricultural land-crop land-zaid crop	7.48	0.02
9		Agricultural land-fallow	623.76	1.51
10		Agricultural land-plantation	11.69	0.03
11	Wastelands	Wastelands-barren rocky/stony waste	68.87	0.17
12		Wastelands-scrub land-dense scrub	4233.27	10.25
13		Wastelands-scrub land-open scrub	921.98	2.23
14	Water bodies	Waterbodies-reservoir/tanks-seasonal	617.25	1.49
15	Built-up area	Built up (rural)	11.62	0.03

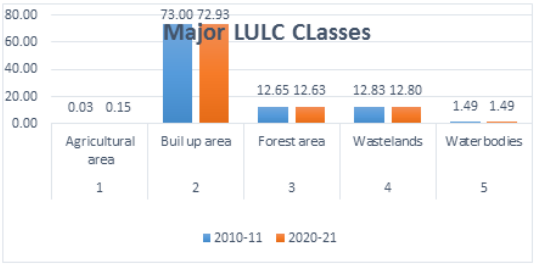
3.2. Dynamics of LULC classes: -

From the LULC study of Konam reservoir from 2010-11 to 2020-21, it was observed that the built-up area increased by 0.0118% (48.94 acres) from 11.62 acres to 60.56 acres and the forest area decreased by 0. 06% (28.84 acres) from 30,143.7 acres to 30,114.86 acres, wastelands decreased by 0.023% (9.72 acres) from 5224.12 acres to 5214.4 acres to 2.7 hectares and 7, 8 acres, 8 acres of agricultural land decreased by 0.022% (9.72 acres) decreased by 0.003% (1.37%) from 617.25 acres to 615.88 acres as shown in Table 6 and Figure 5.

Table 6. Dynamics in Major LULC Classes from 2010-11 to 2020-21.

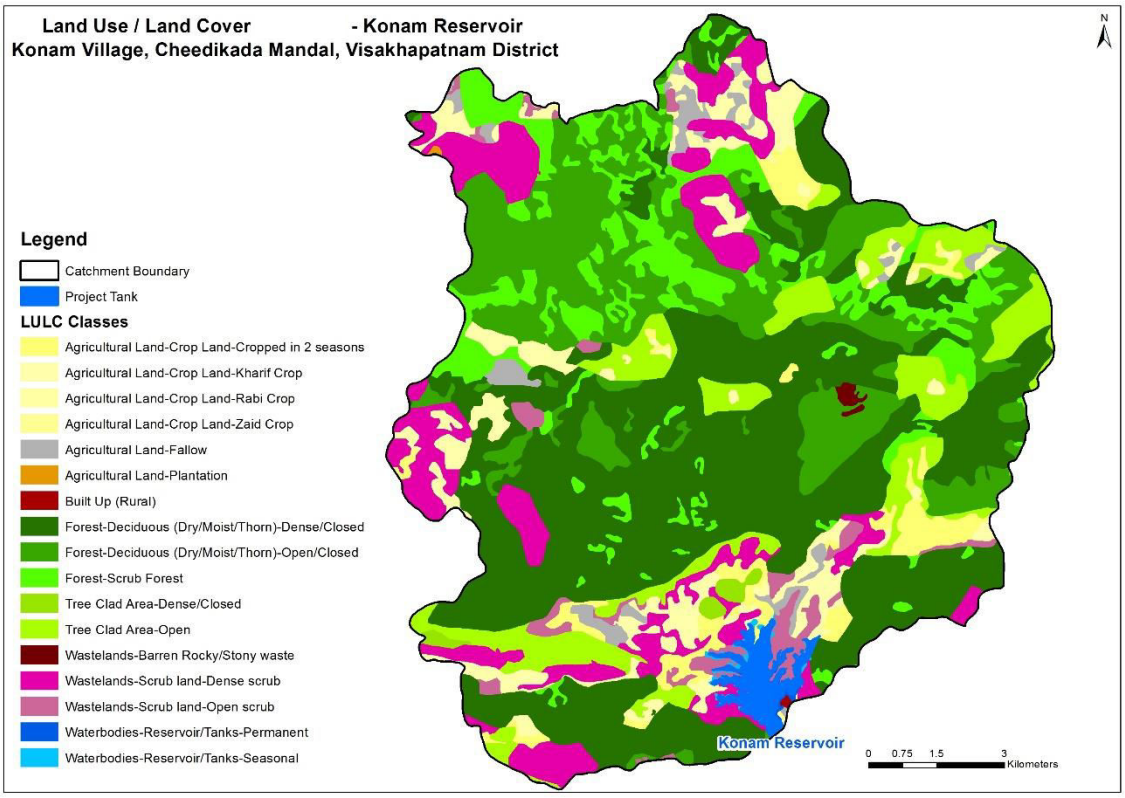
S.No	LULC Major Classes	2010-11	2020-21	Changes (Acres)	Changes (%)
1	Built up area	11.62	60.56	48.94	0.118519
2	Forest area	30143.7	30114.86	-28.84	-0.069842
3	Wastelands	5224.12	5214.4	-9.72	-0.023539
4	Agricultural area	5296.32	5286.87	-9.45	-0.022885
5	Waterbodies	617.25	615.88	-1.37	-0.003318

Figure 5. Dynamics in Major LULC Classes from 2010-11 to 2020-21.



From the study, it was observed that the net area of built-up area was increased by 0.11 % (48.94 acres) with 1 sub class which is built up rural (48.94 acres) from 11.62 acres to 60.56 acres respectively as shown in table 7 and figure 6.

Figure 6. Dynamics of LULC in Konam Reservoir from 2010-11 to 2020-21



The net area of forest area has decreased by 0.069% (28.84 acres), which includes 5 sub-classes. Four classes have been reduced in 5 sub-classes which include Forest-Deciduous (Dry/Moist/Spiny)-Open/Closed (-63.64 acres) has been reduced from 7183.23 acres to 7120.09 acres, Forest-Scrub Forest (7.089 acres) which was reduced from 4145.32 acres to 4137 acres, open tree covered area (6.66 acres) was reduced from 3510.282 acres to 3503.61 acres followed by dense/closed tree covered area (0 .44 acres) from 231.32 acres to 232.32 acres Another one class has been increased in net area which is forest-deciduous (dry/moist/thorny)-dense/closed (49.78 acres) has been increased from 15073 .04 acres to 15122.81 acres.

In the wasteland category, the net area decreased by 0.023% (9.72 acres) and three sub-classes were reduced from 3 which include dense scrub (7.84 acres) from 4233.27 acres to 4225.43 acres, open scrub (1, 75 acres) from 92 acres to 920.23 acres followed by barren stony/stony waste has slightly decreased by 0.13 acres as shown in Table 7 and Figure 6.

The net agricultural land area decreased by 0.22% (9.45 acres) with 6 sub-classes. Of the 6 sub-classes, agricultural land-cultivated land increased from 24.34 acres to 1526.209 acres in 2 seasons and fallow increased from 623.761 acres to 751.65 acres and agricultural land appeared as a rabi crop. new grade in 2020-21 on 2.04 acres. The three sub-classes showed a decline in terms of net area, which includes agricultural land, crops, kharif crops (1,641.82 acres) from 4,629.04 acres to 2,987.22 acres, followed by plantations (0.02 acres) from 11 .69 acres to 11.67 acres and zaid zaid -crop (0.01 acres) from 7.48 acres to 7.47 acres as shown in Table 7.

The net area of water bodies has been slightly reduced by 0.003% (1.37 acres),

which include 2 subclasses. Of the 2 sub-classes, one class reservoir/tank-permanent which emerged as a new class in 2020-21 (316.74 acres) and reservoir/tank-seasonal was reduced by 318.11 acres from 617.25 acres to 299, 13 acres as shown in Table 7.

Table 7. Dynamics in LULC sub-Classes of Konam reservoir from 2010-11 to 2020-21.

S.No	LULC Class	LULC Sub Class	2010-11	2020-21	Changes (Acres)	Changes (%)
1	Forest area	Forest-Deciduous (Dry/Moist/Thorn)-Dense/Closed	15073.04	15122.82	49.78	0.33
2		Forest-Deciduous (Dry/Moist/Thorn)-Open/Closed	7183.73	7120.09	-63.64	-0.89
3		Forest-Scrub Forest	4145.32	4137.45	-7.87	-0.19
4		Tree Clad Area-Dense/Closed	231.33	230.89	-0.44	-0.19
5		Tree Clad Area-Open	3510.28	3503.62	-6.66	-0.19
6	Agriculture Land	Agricultural Land-Crop Land-Cropped In 2 Seasons	24.34	1526.21	1501.87	98.41
7		Agricultural Land-Crop Land-Kharif Crop	4629.04	2987.22	-1641.82	-35.47
8		Agricultural Land-Crop Land-Rabi Crop	0.00	2.04	2.04	100.00
9		Agricultural Land-Crop Land-Zaid Crop	7.48	7.47	-0.01	-0.19
10		Agricultural Land-Fallow	623.76	751.66	127.90	17.02
11		Agricultural Land-Plantation	11.69	11.67	-0.02	-0.19
12	Wastelands	Wastelands-Barren Rocky/Stony Waste	68.87	68.74	-0.13	-0.19
13		Wastelands-Scrub Land-Dense Scrub	4233.27	4225.44	-7.84	-0.19
14		Wastelands-Scrub Land-Open Scrub	921.98	920.23	-1.75	-0.19
15	Water Bodies	Waterbodies-Reservoir/Tanks-Permanent	0.00	316.74	316.74	100.00
16		Waterbodies-Reservoir/Tanks-Seasonal	617.25	299.13	-318.11	-51.54
17	Built-Up area	Built Up (Rural)	11.62	60.56	48.94	80.81

4. Conclusion: -

Land use is a continuous process; its change depends on time and place. Information about the existing use of landscape cover, its spatial distribution and changes are essential for planning. In some cases, land use/land cover information in the form of thematic maps, records and statistical data is insufficient and does not provide up-to-date information on changing land use patterns and processes (Paul and Meyer 2001). The time lag between reporting, collection and availability of data is usually longer and in effect the data becomes out of date. Land use study/land cover analysis is a very important tool for holistic urban development in a sustainable manner.

Land use study/land cover analysis is very essential for sustainable development. Land cover analysis is very important for predicting land requirements and assigning proper use to land resources. LULC classification is the most important scientific view that helps to understand human intervention in the environment. Any slight changes in LULC will affect various

phenomena of precipitation patterns and hydrological processes such as evapotranspiration and groundwater recharge (Mustard et al., 2004; Chase et al., 2000; DeFries and Eshleman, 2004). Factors that can attribute changes in LULC can be socio-economic, demographic, physical and or a combination of all these factors, these factors can act independently at different levels or simultaneously and can vary in temporal and spatial scales (Lambin et al., 2001).

In the Konam Dam catchment, LULC patterns during 2010-11 and 2020-21 were classified into 5 major classes to assess changes. The 5 main classes include farmland, forest area, wasteland, water areas and built-up area. Changes in these LULC classes were further classified into 15 subclasses.

Built-up main class which represents 1 sub-class namely built-up (rural) has increased by 80.81% from 2010-11 to 2020-21. The forest area represented 5 subclasses, namely deciduous (dry/moist/thorny) dense/closed, deciduous (dry/moist/thorny) open/closed, tree cover-dense/closed, scrub forest, and open area. Of this, the deciduous (dry/moist/thorny)-dense/closed area increased to 0.33, while the deciduous (dry/moist/thorny)-open/closed area decreased to 0.89%, and the scrub forest, tree-covered area- dense/enclosed and open area to the extent of 0.19% from 2010-11 to 2020-21.

Wasteland is another main class that features 3 subclasses namely rocky/stony waste, thick scrub and open scrub. The area of rocky/stony waste sub-class decreased by 0.19%, dense scrub by 0.19% and open scrub by 0.19% from 2010-11 to 2020-21.

Agricultural land is the main class which represents 6 sub-classes namely arable land cultivated in more than 2 seasons, arable land harvested in 2 seasons, arable land kharif crop, arable land rabi crop, arable land Zaid crop, fallow land and plantations. Sub-class agricultural land - 2 season crop increased to 98.41% followed by fallow increased to 17.02% from 2010-11 to 2020-21. Agricultural land-crop land-rabi is not present in 2010-11, but these sub-classes appeared in 2020-2021. The next three classes, agricultural land-crop-soil-kharif crop decreased to 35.47% followed by agricultural land-plantation and rabi crop decreased to 0.19%.

Water bodies represented 2 sub-classes, reservoir/reservoirs-permanent & reservoir/reservoirs-seasonal. Of these, reservoir/tanks-seasonal decreased to 51.51% while reservoir/tanks-permanent did not appear in 2010-11 but emerged as a new sub-class with an extent of 316.74 acres in 2020-21.

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