



Land Use Land Cover Classification and Decadal Analysis of Wular Lake Catchment

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Introduction

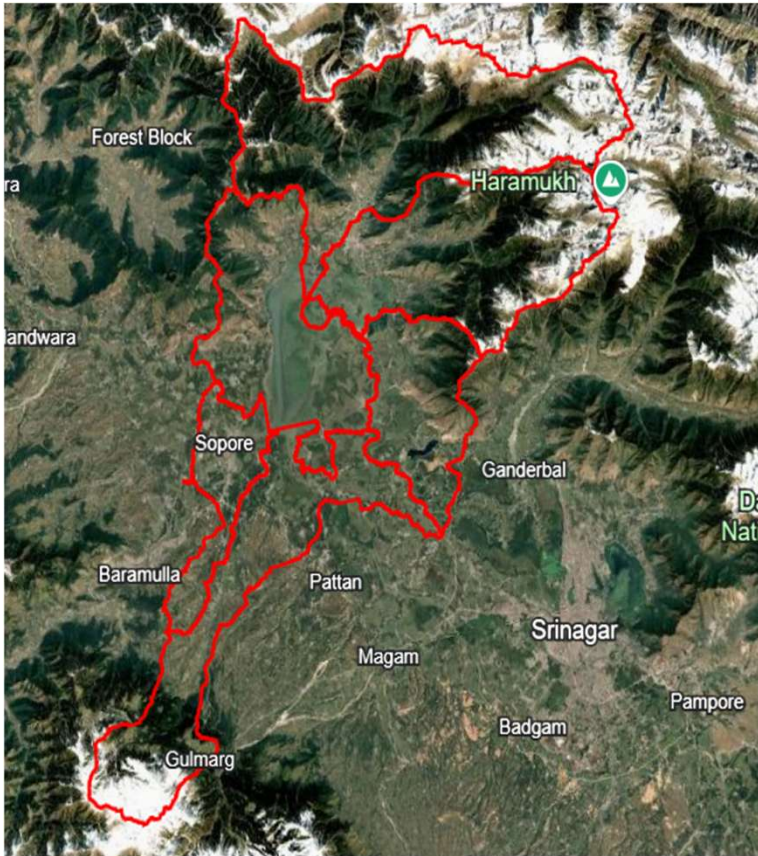
- This project analyzes Land Use Land Cover (LULC) changes in the Wular Lake catchment, Jammu & Kashmir, India, from 1991 to 2020.
- Using Google Earth Engine and Landsat imagery, six land cover classes were monitored i.e, agriculture, snow , barren land, water, built-up and forest cover ,to understand landscape dynamics and human impact over nearly three decades.
- The study highlights significant ecological changes affecting Wular Lake's hydrology and biodiversity, emphasizing the need for sustainable land management.

Wular Lake

- Located in Bandipora district, Jammu & Kashmir.
- One of South Asia's largest freshwater lakes.
- Natural lake formed by tectonic activity.
- Vital for flood control, biodiversity, and livelihoods.
- Part of the Jhelum River Basin; receives inflow from Erin & Madhumati streams.
- Size vary from 30 sq.km to 189 sq.km .
- Almost the entire west of kashmir valley finds its way through river Jhelum into Wular lake.
- It contributes 60% of entire fish yield of Kashmir valley.
- Around 6000 fisherman are dependent on it for their livelihood.
- In 1990 it was declared as wetland of international importance under Ramsar convention.



Study Area

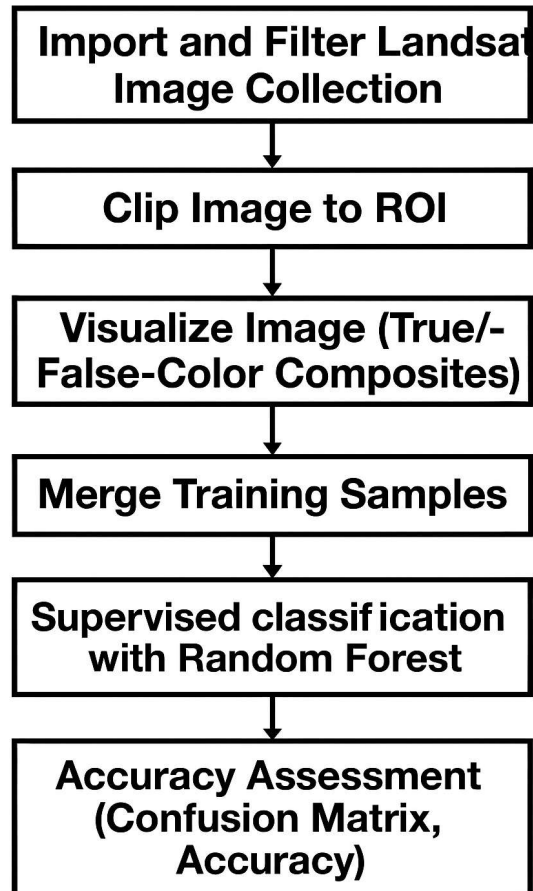


Study region spans 6 direct sub-catchments of Wular Lake :
(i) Wular 1 (ii) Madhumati (iii) Erin (iv) Wular 2 (v) Ningli (vi) Gundar

Area: ~1454 sq. km.

Contains forests, pastures, agriculture, snow, and urban zones.

Six sub-watersheds with diverse land covers, facing degradation from deforestation and unregulated development.



Dataset and Classification Approach

Satellite Data

Landsat 5, 7, and 8 images from 1991 to 2020, focusing on spring season cloud-free images.

Classification Method

Supervised classification using Random Forest algorithm with training samples digitized manually.

LULC Classes

Water, Snow, Barren, Built-up, Forest, Agriculture.

Platform and Output

Google Earth Engine used for processing; results exported for further analysis in Excel.

Methodology Details



True colour composites



False colour composites

Image Preprocessing

Filtered cloud-free Landsat images clipped to study area; visualized with true and false color composites for interpretation.

Training Data

Manual digitization of training points for each land cover class based on color and spectral features.

Classification and Accuracy

Random Forest classifier applied; accuracy assessed via confusion matrix, ranging from 79% to 94%.

Area Calculation

Pixel area function used to quantify spatial extent of each land cover class for change analysis.

Land Cover Change Results (1991-2020)

Year	Forest (km²)	Water (km²)	Built (km²)	Agriculture (km²)	Snow (km²)	Barren (km²)	Accuracy (%)
1991	407.25	173.05	29.45	307.84	354.84	182.71	82
1994	400.43	107.65	28.34	468.08	315.86	133.98	81
1996	468.6	153.06	29.98	378.76	323.29	101.45	81
2000	511.64	106.07	90.03	340.96	277.25	129.19	79
2003	392.27	112.33	86.52	406.57	360.89	96.57	85
2005	439.35	21.74	93.42	360.37	289.22	158.09	83
2008	457.75	90.14	89.55	471.24	313.3	33.17	93
2010	444.04	79.48	60.84	514.93	306.49	23.3	86
2013	417.45	94.84	64.84	485.95	305.57	21.9	84
2015	364.58	167.21	89.2	393.93	324.95	115.27	94
2017	417.68	167.44	96.89	328.6	319.39	125.05	93
2020	404.41	114.99	127.99	388.65	329.45	90.99	92

Built-up Area

Increased from 29.45 km² to 127.99 km², indicating rapid urban growth.

Agriculture

Expanded from 307.84 km² to 388.65 km², peaking at 514.93 km² in 2010.

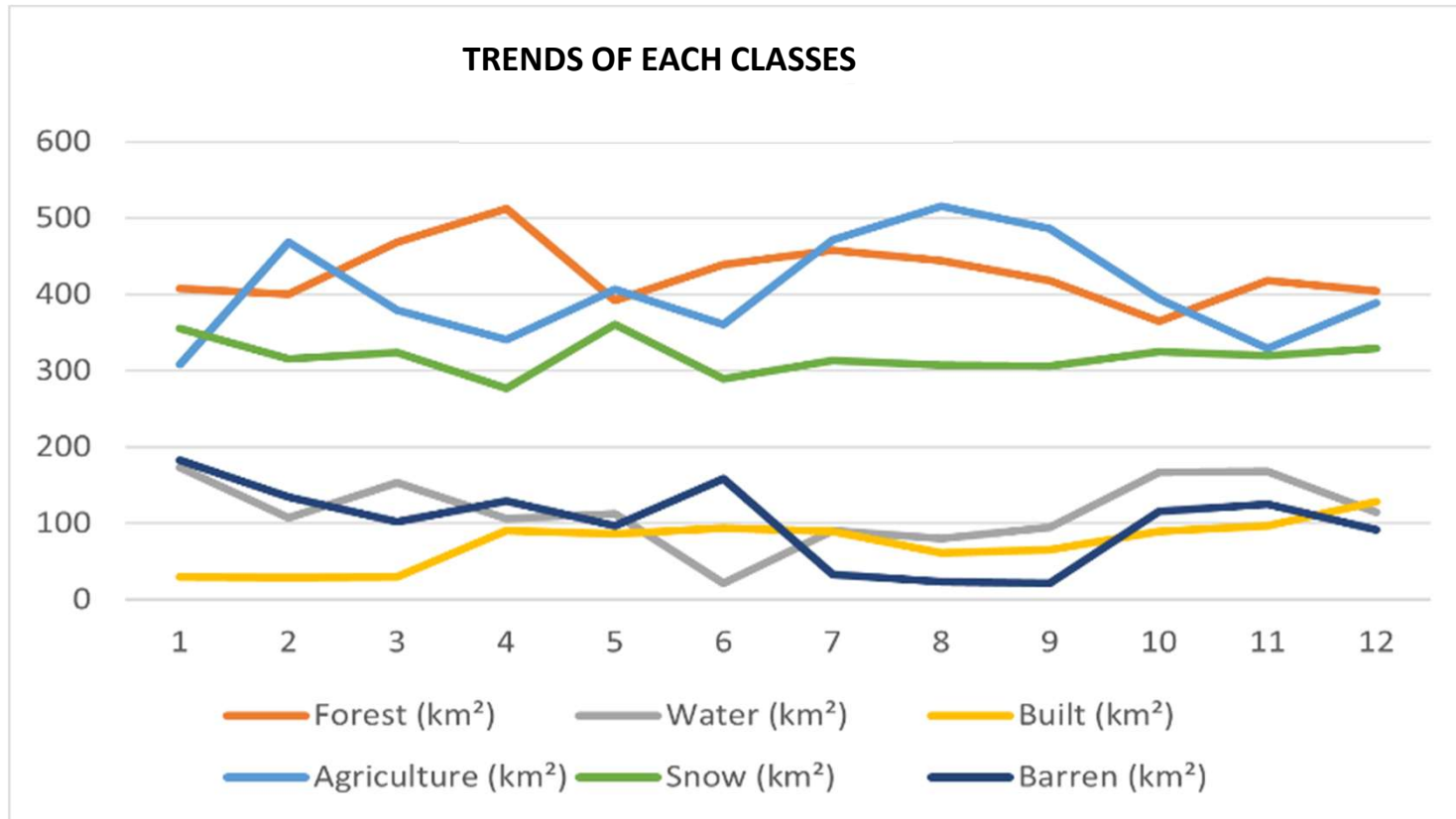
Water and Barren Land

Water bodies declined by about 58 km²; barren land decreased significantly, reflecting land conversion.

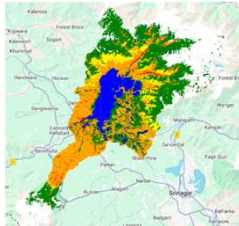
Forest and Snow

Forest cover remained relatively stable; snow area slightly decreased, possibly due to climate effects.

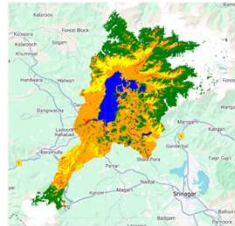
Graph :



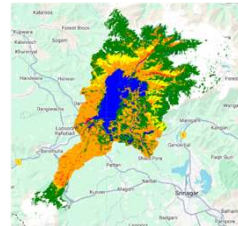
Catchment Analysis



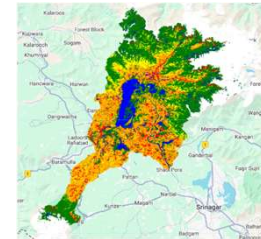
1991



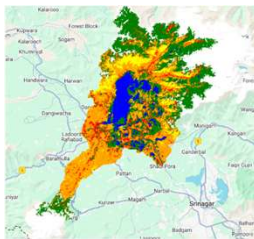
1994



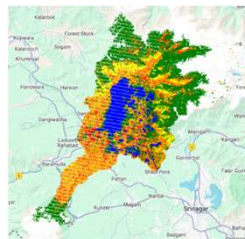
1996



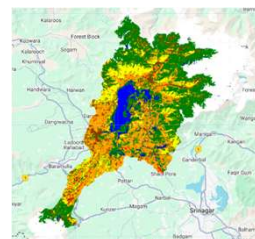
2000



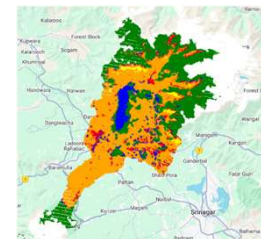
2003



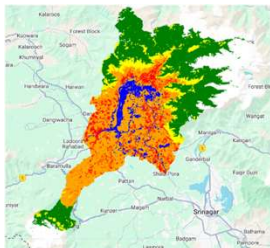
2005



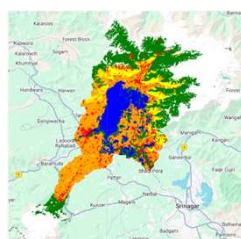
2008



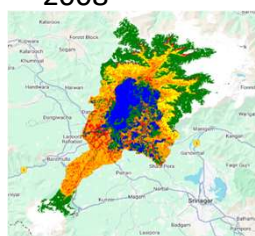
2010



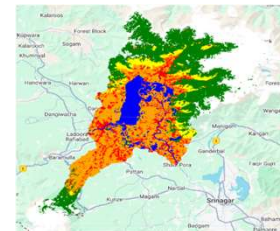
2013



2015

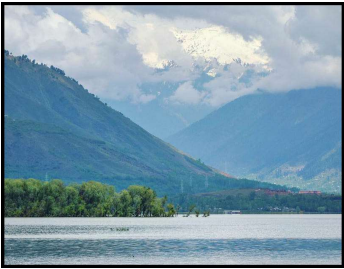


2017



2020

Sub-Catchment Descriptions



Sub1 (Wular 1)

Critical for sediment and nutrient inflow into the lake ecosystem.



Sub2 (Erin)

Moderately forested, supplies freshwater via Erin stream.



Sub3 (Wular 2)

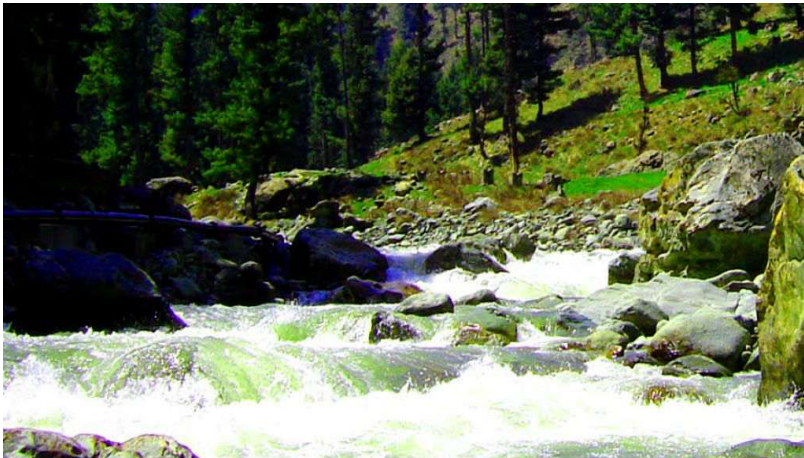
Influences lake's land and water interactions from the south.



Sub4 (Gundar)

Mix of vegetation, fields, and limited habitation.

Sub-Catchment Descriptions Continued



Sub5 (Ningli)

Known for dynamic land use changes due to agriculture and flooding.



Sub6 (Madhumati)

Key for hydrology and sediment transport to the lake.

Sub-Catchment Level Analysis

Sub-Catchment 1 (WULAR 1)

- **Agriculture:** Large **increase** from 71.7 → 98.8 km² (peaked at 131 km² in 2010).
 - **Forest:** Noticeable **decline**, 47.9 → 31.6 km².
 - **Built-up:** **Increased** from 5.7 → 24 km².
 - **Barren land:** **Decreased** significantly from 32.9 → 21.5 km².
 - **Water:** Moderate **decrease**, 82.1 → 63 km².
 - **Snow:** Fluctuating, with **low and inconsistent values**—may reflect seasonal variability.
- Observation:** Urbanization and agriculture expansion at the cost of forest and water.

Sub-Catchment 2 (ERIN)

- **Forest:** **Increased** from 85.5 → 107 km² (peaked at 132 km² in 2013).
 - **Agriculture:** Fluctuated, ending at **~33 km²**, lower than 1991.
 - **Built-up:** **Increased** to 16.9 km² from 6.9 km².
 - **Water:** Generally **declined**, from 24.2 → 15.8 km².
 - **Barren land:** Slight **decline** overall.
 - **Snow:** Remained consistently **high**, slightly declining in later years.
- Observation:** Forest increased significantly; agriculture reduced, possibly due to reforestation or shifting use.

Sub-Catchment 3 (WULAR2)

- **Agriculture:** Slight **decrease**, 61.9 → 49.8 km².
- **Forest:** Relatively **stable**, slight gain from 39.6 → 37 km².
- **Built-up:** Sharp **rise** from 4.6 → 22.1 km².
- **Barren:** Slight **decrease** overall.
- **Snow:** Remained **low**, with sporadic spikes.
- **Water: Declined**, 18.9 → 14.7 km².

Observation: Urban expansion with slight agricultural loss and moderate forest retention.

Sub-Catchment 4 (GUNDAR)

- **Agriculture:** Substantial **increase**, 92.4 → 111 km² (peaked at 131 km²).
- **Forest: Decreased**, from 58.6 → 37.3 km².
- **Built-up:** Tripled, 9.8 → 35.9 km².
- **Barren land:** Dropped drastically from 15.6 → **~1.3 km²**.
- **Snow:** Fairly **stable** with small fluctuations.
- **Water:** Decreased from 27.0 → 13.9 km².

Observation: Strong agricultural and urban growth; forest and water sacrificed

Sub-Catchment 5 (NINGLI)

- **Agriculture:** Moderate **increase**, 56.4 → 60.1 km².
- **Forest:** massive **decrease**, 8.4 → 2.2 km².
- **Built-up:** **Almost tripled**, 7.1 → 19.3 km².
- **Barren:** Steep **drop**, 8.3 → ~0.03 km².
- **Water:** Decreased slightly overall.
- **Snow:** Minimal values; nearly absent by 2020.

Observation: Urbanization and agriculture expanded significantly, almost eliminating barren land and forest.

Sub-Catchment 6 (MADHUMATI)

- **Forest:** Strong **increase**, 156.7 → 189 km² (peaked at 246 km² in 2013).
- **Snow:** Stayed **consistently high**, ending at 189 km².
- **Agriculture:** Clear **decline**, 37.7 → 16.5 km².
- **Built-up:** Slight **rise**, 6.2 → 9.99 km².
- **Barren:** Declined a bit, ends at 19.3 km².
- **Water:** **Significant drop**, 9.8 → 2.3 km².

Observation: Dominated by forest and snow cover, with sharp reduction in agriculture and water.

Summary of Land Cover Trends by Sub-Catchment



Water Bodies

Water bodies declined overall; sharpest drop observed in Sub6 since 1991.



Forest Cover

Forest cover increased in Sub2 and Sub6; declined notably in Sub1 and Sub4.



Agriculture and Built-up

Agriculture showed increased in Sub1, Sub4; declined in Sub2, Sub6 after 2010 due to urbanization while Built-up increased steadily across all catchments, showing significant land conversion and urban growth trends.



Snow and Barren Land

Snow showed variability; barren lands slightly decreased, indicating land conversion.

Conclusion and Implications

- This study reveals significant LULC changes from 1991 to 2020 driven by human activities and climate factors. Water bodies fluctuated but increased in some sub-catchments, while forest cover declined notably, especially in Sub3.
- Agricultural expansion peaked by 2010 but later declined due to urbanization. Built-up areas grew rapidly, reflecting increasing anthropogenic pressure. These trends highlight the need for sustainable land use planning and conservation efforts to protect Wular Lake's ecological and hydrological health.

