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Land use land cover dynamics in Ribb watershed and its implication to the sustainability of Ribb dam, North Western Ethiopia.

Yidnekachew Jember (MSc)

Woldia University, School of Land Administration

E-mail: yjember5@gmail.com, 0918195147

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INTRODUCTION

- Our use of land has a profound effect and results in an observable pattern in the land use land cover (LULC) over time (Opeyemi, 2006).
- The mix of landforms of the country have contributed to the formation of various sizes of a watershed in the country.
- Ribb is one of the largest watersheds that discharge to Lake Tana.
- It has a total area of 1972 km^2.
- The essentiality of a watershed for existence can be explained in many ways.
- Land use and land cover dynamicity affect the ecosystem and development in a different way.

- Analysis of LULC dynamics helps us to understand the characteristics and interdependencies of the components that constitute spatial systems.
- This research used
  - (GIS) and(RS) techniques
  - in conjunction with a socio-economic and historical assessment to analyze the dynamics of Ribb watershed LULC and its implication to the sustainability of Ribb dam.

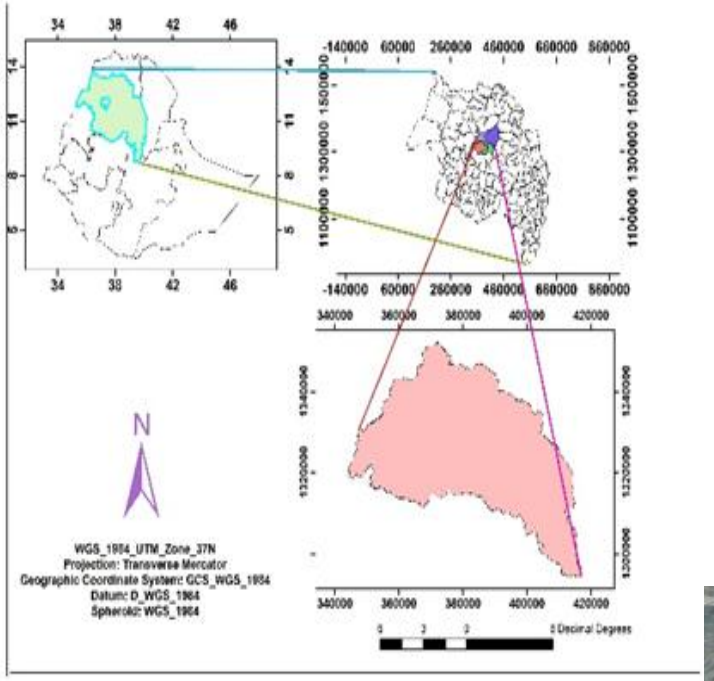
- This study attempted to gain a better understanding of LULC changes in Ribb watershed.
- This is because Ribb watershed is an area with many development activities which includes Ribb dam construction.
- The irrigation scheme is planned to irrigate about 14,460 hectares of land and benefits about 11,500 households.
- There are also wetlands in the watershed, which made the research very important.

- The accurate information on
  - LULC dynamicity,
  - the cause, and consequence,
  - perception of households on LULC and
  - the implication of LULC change on the sustainability of Ribb dam is essential to advance and support development interventions and
- it is also important to decision makers in terms of developing strategies for natural resource management and monitoring of environmental changes in the study area and areas that have a similar geographic setting.

STUDY AREA AND METHODOLOGY

Ribb watershed

- part of Lake Tana sub-basin (1972 km^2)
- The watershed boundary is with in Farta, Ebnat, Libokemkem, Debre Tabor and Fogra woreda's of south Gondar
- Ribb Dam
- Proposed irrigate up to 14,460ha of land
- 11,500 HH expected to benefited
- Has 10 major tributaries



Data Source and Method of data analysis

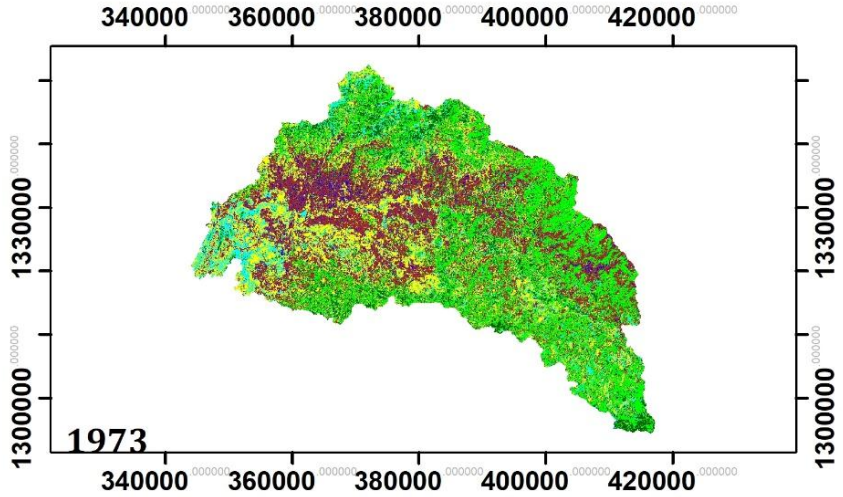
Data Source

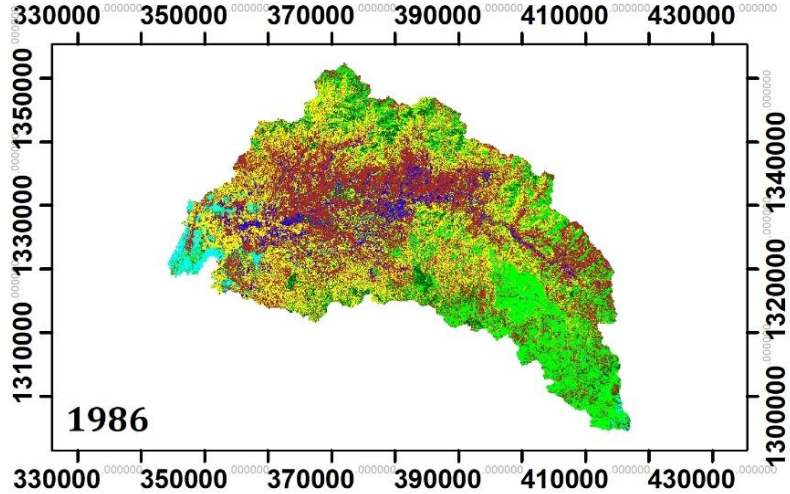
- Rural households
- The Kebele administrator
- Key informants
- Government and non-government staff working at different levels.
- Land sat MSS, TM, ETM+ and OLI satellite data during 1973, 1986, 2001 and 2016
- Ground survey
- Published and unpublished documents and reports

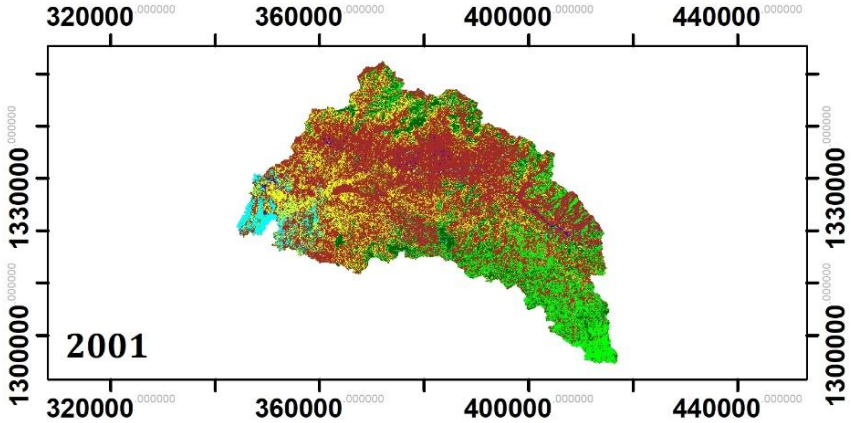
- The justification for the selection of this years is to relate the history of government intervention on the land with socio-economic data and analyze the land use land cover dynamics using longer time period with the large time difference between the selected year.

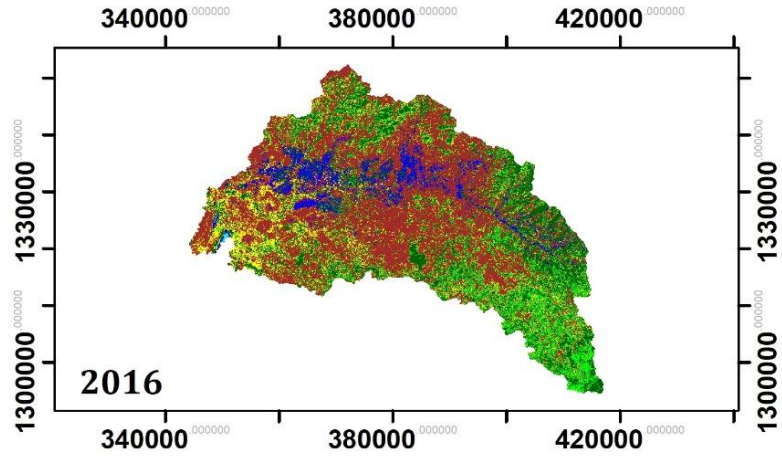
RESULT

Spatio-temporal watershed changes between1973 and 2016









Legend

- Bush Land
- Cultivated and Settlemnt Land
- Forest Cover
- Grazing Land
- Water Body
- Wetlands

N

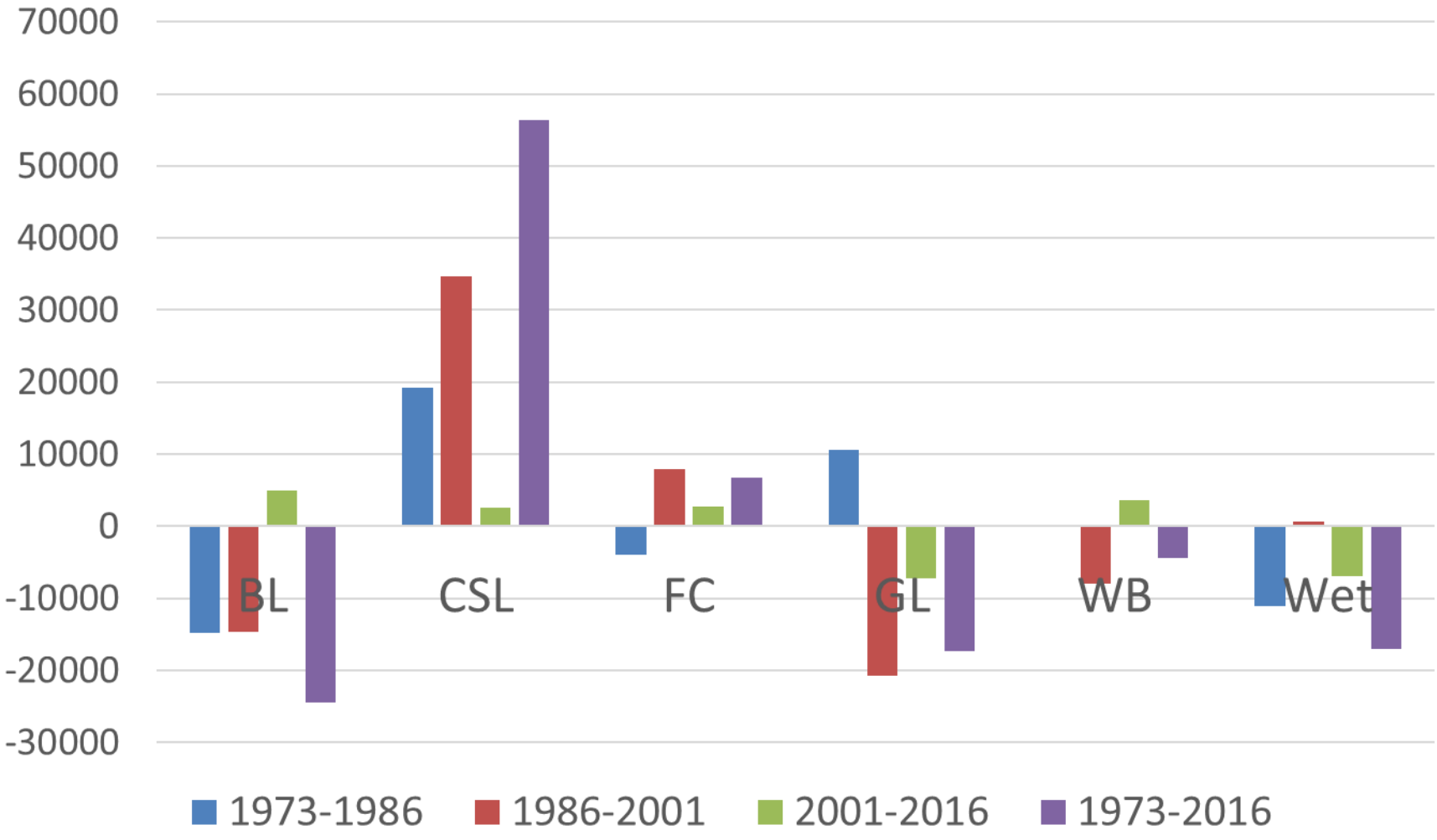
WGS_1984_UTM_Zone_37N
Projection: Transverse_Mercator
Geographic Coordinate System: GCS_WGS_1984
Datum: D_WGS_1984
Spheroid: WGS_1984

3,900,000 1,950,000 0 3,900,000 Centimeters

Summary of land use land cover change between 1973 and 2016

class	Area (ha)				Net gain/ Loss (ha)
	1973	1986	2001	2016	1973-2016
BL	58133.50	43389.60	28800.7	33709.70	-24423.80
C&S	51843.60	70998.90	105645	108234	56390.40
FC	18626.40	14695.60	22653.1	25352.80	6726.40
GL	42296.80	52929.57	32209.6	25036.86	-17259.94
WB	9144.36	9091.98	1159.99	4715.89	-4428.47
WL	17155.30	6094.35	6731.56	150.75	-17004.55
Total	197200	197200	197200	197200	

Land use land cover dynamics in Ribb watershed between 1973-2016



- The improvement in coverage of bushland found during the third period of analysis (2001-2016) more likely related to the introduction and expansion of area closure introduced by the government.
- These dynamicity were attributed to population growth which forced the farmers to till and expand their lands to a greater extent than before to cope up with the conditions and to sustain their life.
- The increasing change of cultivated and settlement land between the year 1973 and 1986 is more likely related to historical land reform proclamation of March 1975 by Derg's regime.
-

- The proclamation declares land as a collective property of people, redistributed land to farmers and abolishes the system of tenancy.
- Peasant Association was created and charged to distribute communal land to the farmers.
- The expansion of farmland is directly related to population growth, weak environmental conservation policy.
- Between the year 1973 and 2016 forest cover showed great dynamics of increasing and decreasing.
- Forest cover showed a decrement in size between 1973 and 1986 study year

- The relative decrement in forest cover and bushland is more likely related to the restriction posed by the government on farmer not to cut their trees unless approved by peasant association committee.
- This restriction seems to have a positive effect on the protection of forest and bushlands.
- But this restriction and others discouraged private tree planting activities.
- After 1986 the area coverage of forest showed relative increment.
- The main reason for this related to private tree plantation for commercial purpose and forest conservation area closure practice by government and different NGOs in the watershed.

- Grazing land showed a decrement between 1973 and 2016 study year.
- This result shows us the scarcity of farmland and illegal cultivation of grazing land related to population growth and lack of well-planned management in the area.
- The main driving forces for change in grazing land is
  - illegal encroachment for agriculture,
  - overgrazing leads to barren land,
  - distributing grazing land to landless and
  - construction of infrastructure on communal grazing lands.

- Even if water body showed a considerable amount of increment in the year between 2001 and 2016 its area is decreasing in the study year between 1973 and 2016
- There were farm ponds made by the farmers. Constructing an embankment across a water resource and excavation of a pit and conserving rainwater using geomembrane technology is the recent phenomenon practiced in the watershed.
- This is more likely the main reason for the increase of water body between 2001 and 2016

- Wetland showed the dramatic change between the study year of 1973-2016.
- The efforts of the government at Derg's regime to improve agricultural sector through the establishment of cooperatives and the cultivation of cash crops contribute to the increment of cultivated and settlement land in the watershed and decrease of wetlands found in Fogera plains.
- Generally, in the course of the study year cultivated and settlement land, and forest cover showed increment. While bushland, grazing land, water body and wetland showed a relative decrement in the course of the study year from 1973-2016

Responsible cause for watershed land use land cover dynamics

- **Population pressure**
- It was observed that to get agricultural land the local community is encroaching into the grazing and bushland.
- Due to the high rate of population pressure and encouragement of government to expand agricultural production farmland expands.
- Every year a considerable amount of new farmland was created.

- Based on the key informant interview and observation irrigation agriculture is increasing through time due to the introduction of water pumping technology and more farmers tend to irrigate using the streams found in the watershed.

- **Poverty**
- Poverty is linked to land use land cover change is that the poor overuse the natural resource to escape from poverty.
- The amount of income generated by individual households ranged between the US $150 and the US $800/annum with a mean income of US $460 which is less than the US $2 a day.
- Additional income mostly generated by young farmers by working on commercial farms outsides the watershed during agricultural off-season.
- Overexploitation of natural resource without using proper management techniques cause depletion of natural resources. Therefore, poverty is one of the major reasons that caused land use land cover change in the watershed.

- **Policy and Institutional factor**
- Access to land, labor, capital, technology, and information is structured by local and national policies and institutions.
- Three different governments have been in power in Ethiopia since 1972, and the policies implemented by each have directly affected land use land cover.
- Before 1974, the relationship between land users and owners was based on a feudal system (Desta *et al*., 2000).
- Under which the ownership of land was limited to a few individuals, and most inhabitants could access farmland only through sharecropping.
- The population density was relatively low, and the fallow land was common. Likely the classification result of 1973 land use land cover status of the watershed related to the system of the regime followed before the study year.

- Much of the expansion of cultivated and settlement land and loss of forest cover and bushlands took place during the 1970s and 1980s.
- This is more likely related to the reform of 1975 which confiscated all rural lands and distributes to the rural tenants.
- At the time the arable communal land was abundant in most place of the watershed and the population pressure was low as a result of which poorly drained soils and hilly areas were not turned to cultivation.
- However, as result of frequent redistribution and the later land reform act of 1997 particularly enacted in Amhara region, more fragile land areas were converted to cultivation.

- The land redistribution of 1997 was mainly from communal grazing lands.
- From the empirical evidence, farmer lack access to credit and most of the credit goes to buy agricultural input not to expand off-farm activities.
- Inaccessibility to market and road facilities coupled with the insecurity of tenure identified as the major institutional factor that causes land use land cover change.
- Many land use land cover change is due to ill-defined policies and weak institutional enforcement, as explained by household respondents and focus group discussants in the Ribb watershed.

- Even if the current government enacted different policies and regulations to conserve the natural resource, their implementation is in the infant stage.
- Discussion with government officials revealed weak implementation of land administration and use policies.
- Among ill-defined policies in agricultural sector raised by the discussant is that the state policy which tends to encourage converting bush lands, grazing land and wetlands found in the watershed to attain food sufficiency.
- This policy implemented by concerned agricultural sector especially in the watershed by converting bushlands, grazing land and wetlands found in the watershed.

- **Tenure Insecurity**
- Land tenure policy has a significant impact on the change of LULC for a specific area.
- The dynamics of land management has been aggravated by land tenure systems and the governmental agricultural policy that banned the sale and purchase of land.
- Farmers only have usufruct land rights. The present government allows access to the land only by lease, sharecropping, and borrowing.
- At present, the main way to gain access to land in the watershed is by inheritance and sharecropping.
- Because the land is owned by the state, farmers have feared to invest in long-term SWC measures, as the land might be taken by the government and redistributed to others.
- Even if all respondents confirmed having land holding certificate only 63% of them acknowledged holding of the certificate as an incentive for the management of their land.

Consequences of LULC dynamics on the socioeconomic setting and the environment

- **Soil erosion**
- The rate and severity of soil erosion and land degradation in the watershed depend on the pattern of land use. There is the removal of bushlands for the various purpose by the community.
- In Ribb watershed, the majority of the cultivated land is used for the production of cereal crops.
- Unsustainable land use practices and improper management systems prevailed in the watershed create the dynamic change of land cover in the watershed and this, in turn, have played a significant role in causing high soil erosion rates, sediment transport and loss of agricultural nutrients.

- **Lack of fuelwood**
- As population increases household energy consumption also increases.
- In the study area fuelwood is not only a source of energy but a means of income generation too.
- Without adequate alternative sources of energy, population growth increases the demand for fuelwood, which in turn leads to the destruction of forests.
- It also contributes to the use of crop residues and dung for fuel rather than using them as sources of organic fertilizer to improve the already poor soils.

- **Impact on livelihood**
- Major environmental problem and livelihood change are the result of land use land cover change.
- The survey result revealed that the household livestock holding is low and more concentrated in sheep and goats.
- The existing livestock population is beyond the carrying capacity of the poorly managed communal resource pool.
- Agriculture which is the mainstay of the society is being largely practiced in garden and plot lands.
- Highly intensive farming is clearly observed in all part of the watershed.
- Reduction of cropland per capita and insecurity have led to a reduction in activities such as fallowing, planting trees and investing in conservation structures

• Implications of Watershed LULC dynamics to the sustainability of Ribb dam

- Watersheds are sensitive to LULC dynamics induced by human activities.
- This dynamic change will have strong implication on the sustainability of the dam by affecting river flow and sediment yield if the trend continued in this way.
- It is well known that deforestation causes changes in soil properties and infiltration rates, which ultimately affects the soil erosion processes and hydrological cycle of the catchment.
- Average annual sediment deposition estimated by Tensay (2011) and Estifanos (2014) to the Ribb dam is 72.79 ton/Km and 39.8 tonnes/ha/year.

- There was extreme sedimentation case in Ethiopia such as Borkena Dam in wollo, which cost $35 million US dollar in 1991 and Adrako Dam (Ebnat) South Gondar where the dead storage volume of the reservoir silted up before their construction ended (Nigussie *et al*., 2006).
- This effect will not be only stopped in the watershed immediately affected by water shortage but also extends to Lake Tana.

- CONCLUSIONS
- The identification of Spatiotemporal watershed land use land cover change showed that Ribb watershed had experienced significant land use land cover dynamics over the past 44-years.
- Among the class of land use land covers, which show a large alteration is cultivated and settlement land that has increased dramatically.
- This tells to conclude that there is a high trend of changing bushlands, grazing lands, and wetlands into cultivated and settlement land by farmers and government.
- The growing population in the watershed put high pressure on the existing land use land cover of the watershed.

- Reinforced by the
  - underlying cause of poverty,
  - weak policy and institutional enforcement and,
  - tenure insecurity
- result in the problem of
- soil erosion,
- lack of fuelwood and deterioration of livelihood through time.
- Land use practices and improper management systems have played a significant role in causing high soil erosion rates, sediment transport and loss of agricultural nutrients.

- If not managed and monitored properly, the problem of land use land cover change in the watershed will have a great impact on the sustainability of Ribb dam.
- Based on the study it is recommended the land use land cover dataset to monitor the change should be developed.
- Policies related to population, agricultural productivity, and environment with the aim of sustainability should be devised to address the environmental, social and economic problem in the watershed.

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