Land Cover Classification in Rural Area of Koya District Using Remote Sensing and GIS

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ABSTRACT

Land values are well recognized broadly by the scientific community, as they are associated with economy and food security, but yet land degradation is a global issue. Land use and land cover is one of the main fields of geographical studies. Geographers endeavour to understand the human activities which occur in a certain area and demonstrate an appropriate direction for optimum use of lands from both environmental and economic aspects. The objectives of this study is to make a land cover classification of Koya District Rural area with depending on the (ERDAS Imaging 2017) data and using GIS (ArcGIS 10.5) software. The Landsat8 satellite images and Thermal Infrared Sensor (TIRS) instrument were used according to Operational Land Imager of May 2015. In order to classify the study area land cover accurately, the Normalized Difference Vegetation Index (NDVI) formula was used and the results accuracy were confirmed by field surveys at 260 sites and interviews with farmers.. This study classified and mapped Koya District rural area lands for six types of the main land covers (Cropland 21%, Arable Land 7.5%, Forest 9%, Orchards 1%, Rangelands 60.5 % and Water Bodies 1%).

KEY WORDS: Koya District Rural Area, Classification, NDVI, RS and GIS.

1. INTRODUCTION

There Land is a precious resource of the Earth and connected with food security. Land degradation is already a global issue environmentally, economically and security related [1]. Because of human population expansion and increasing of individual demands on the commodities driven from lands and using land for different purposes, global land cover has been affected and deteriorated [2]. The term of land use and cover are slightly different; land use means using the available land by human for multiple purposes, whereas land cover refers to what actually covers the land surface and includes both features natural as forests, and manmade as cities and dams [3][4][5]. Understanding and classifying land cover can cooperate with enhancing regional planning and development, it can find out the most dominating land cover and determine area of improvement [6]. To figure out land cover types and their area sizes, using remote sensing techniques is more efficient and effective to describe the earth surface, when compared to traditional methods of land survey which could be more costly [7]. Using remote sensing techniques and GIS for land cover survey and classification is well recognized and used globally [8][9][10] especially Landsat images and data. Within a certain area, various types of land cover can be perceived, as being of minor to high significance of land value. In the area of study only six features of main land covers have been considered, including Cropland, Arable Land, Forest, Orchards, Rangelands and Water Bodies.

National mapping for tree resources and forest area improvement have been recommended worldwide, therefore, countries have set up and developed specific classifications and mapping, as conducted by USA

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[11][12] and china [13]. Forest means natural native trees, but in past centuries, forests were in danger, as they were converted to other types of land use such as to croplands or orchard [2][14] it is also true in the research area, as forest been vanished in some areas of Koya District. Orchard is also forest but planted and covered with introduced trees for commercial purposes, usually fruit as a source of food [15]. Most orchards are covered with a single type of fruit tree, but sometimes they can be mixed. This type of land cover in arid and semi-arid regions is paralleled with availability of surface water such as rivers and lakes.

Croplands are the lands devoted to plants of any type of crop. Over the past 40 to 50 years, agricultural intensification was achieved by 'Green Revolution' technologies and increased the cropland area [16]. This increase of cropland has reduced other types of land cover, such as forest and rangeland. Rangelands, generally, are characterized by low erratic precipitation, rough topography and often low soil fertility [17]. It includes grasslands, desert grassland, pampas, tall grass and short grass prairies, tundra, chaparrals, savannas, steppes [18]. This land is usually used for domestic livestock farming and wildlife areas. Some developed countries, introduced methods to manage their rangelands and animal grazing areas, by seeding new and crucial plants and apply fertilizers and measures to protect soil from erosion.

Arable land is another well understood type of land cover, considered as a fundamental resource related to food security [19]. Arable land refers to planting temporary agricultural crops as a part of crop rotation. Countries with wide area of arable lands are defined as rich countries because arable lands can be used for agriculture and any other type of land use. Unfortunately, arable lands have been degraded because of extensive conversion to industrial use and urbanization [16] [2]. Finally, water covers most of the earth surface as ocean and sea, and within land water covers is found in the form of lakes, ponds and rivers. Water bodies are usually natural such as rivers but also manmade such as reservoir and channels. Availability and reliability of water resources is a decision element of 'applied agriculture', especially in arid and semi-arid areas [20]. Therefore, rainwater collection is important subject to study and development of arid and semi-arid regions [21].

This study will make a land cover classification in rural area of Koya District for 2015 using remote sensing techniques and satellite data images including GIS for mapping. The Landsat8 satellite images and Thermal Infrared Sensor (TIRS) instrument used according to Operational Land Imager of May 2015.

2. STUDY AREA

Koya is one of the Erbil governorate districts. It is located in southeast of Erbil and borders with Sulaymany governorate in the east and Kirkuk governorate in the south. The longitudes (44'34° - 44'17°) East and latitudes (36'18° - 35'- 47°) North hemisphere are passing through the district. The administrative district of Koya consists of 6 smaller administrative units (see Fig. 1) and 130 villages (see Fig. 2). The topography of the study area plays a key role of land cover patterns; Haibatsultan and Bawajy are extending from west to east and they form two areas of different characteristics, namely mountainous and plain areas (see Fig 3). The mountainous areas represent about 26 % of the study area, facing the Mediterranean Sea cyclones, which results in lower temperature and higher amount of annual precipitation. The second area is the plains region and encompassed the largest percentage of Koya district (74 %). This region is located on the southern and western slopes of the mountainous area. Therefore, it receives less precipitation when compared to mountainous area, which then can reflect in the range of land cover patterns.

Fig. 1. Location of study area

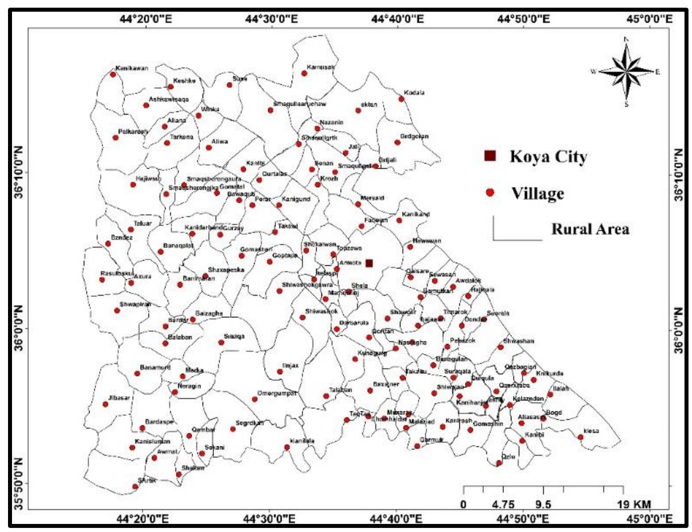


Fig. 2. Villages of the Study Area

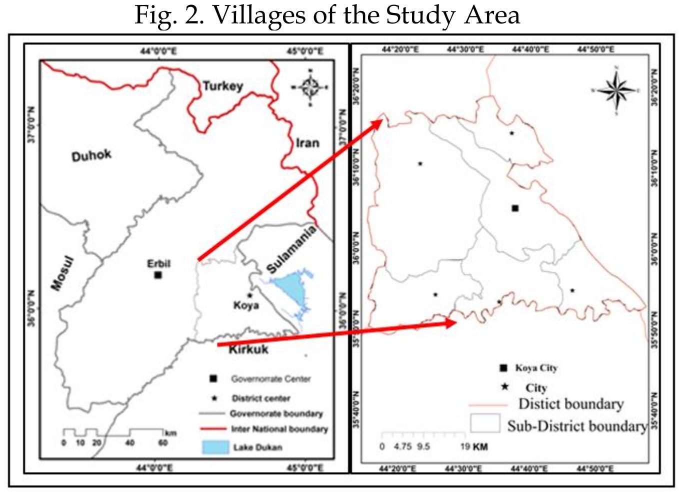
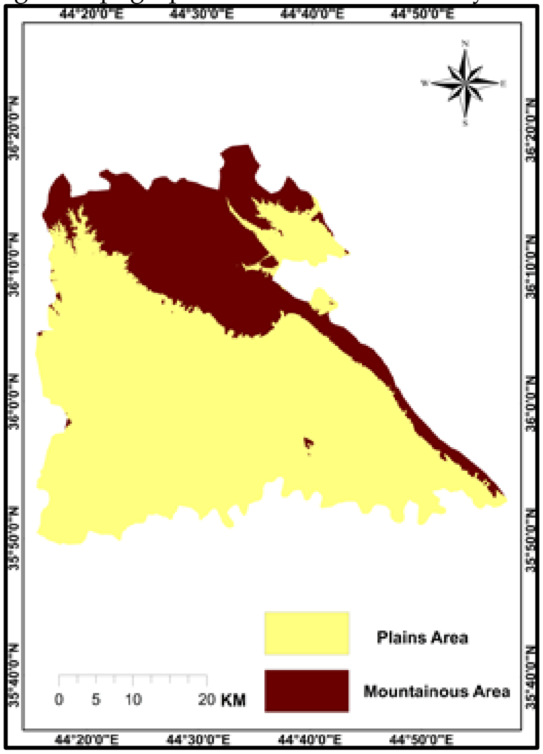


Fig. 3. Topographic Variation in the Study Area



3. MATERIAL AND METHODS

For data gathering and analysis, this research project followed a methodology using associated technical software programs as detailed below;

1. Data sources

The research data originated from scientific digital satellite images, then confirmed by interviewing and field surveys as follows;

- Importing digital satellite image of LANDSAT 8 – 2015
- Earth Resources Date Analysis System (ERDAS Imagine 2015)
- DEM map of the study area
- Arc GIS 10.5 used for mapping and data classification
- Field survey conducted during land cover mapping to confirm accuracy of the collected data from satellite images. The survey team visited 260 sites that were documented with GPS coordinates.
- Farmers interviewed to determine the planted crop types of 2015 to assist with analysis of the preliminary satellite images

2. Digital Image Processing

In order to achieve reliable results, the remote sensing techniques required some data processing to rectify distortions and identify the accuracy level;

- Radiometric Correction

It is to reduce the contrast between the spatial and visual properties of the satellite due to the different angle of sun fall and distance.

- Topographic Correction

The amount of sun light a particular region receives varies according to its different topographical features. Therefore, this technique was used to correct the impacts of different elevation and land features in receiving equal amounts of radiation at the determined level.

- Spatial Filtration

The LANDSAT images resolution is 30m by 30m, but to increase the ability of visual interpretation the images resolution was converted from 30m to 15m.

- Image Enhancement

It is the process of improving data in satellite imagery by increasing differences among reflection types and colour tone to obtain spectral classes that increase the level of visibility and interpretability.

3. NDVI Formula

Finally Normalized Difference Vegetative Index (NDVI) formula [NDVI = (NIR-RED) / (NIR + RED)] was used to qualify and quantify vegetation covers of the study area. It is based on the substance reflectance level to the sense, and varies between near-infrared (NIR) which vegetation strongly reflects and red light (RED) which vegetation absorbs. The result of this formula generate a value between -1 and +1. The higher positive value reflects the greater vegetation and density of the plant, and vice versa.

4. RESULT AND DISCUSSION

In the area of study only six features of main land covers been considered to discuss. Topography and climate condition influence spatial distribution of land covers of the study area. Fig. 3. Shows that study area elevation above sea level varies from 260m in the south west up to 1500m in the north of the district. Most of the land cover types are in relation with topography, as topographic variation results in climatic variation, such as precipitation and temperature. In this district, normally the mountainous area do not experience less than 500mm rainfall annually, whereas the plains area occasionally drop down to less than 300mm [22]. Therefore, both topography and climate play the key role in creating various land cover features of study area as presented in Fig.4.

Fig. 4. Shows All Landcover Typs of the Study Area

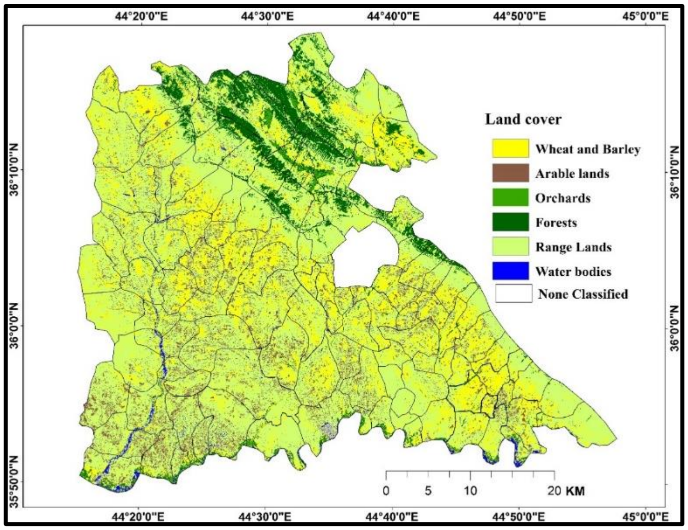
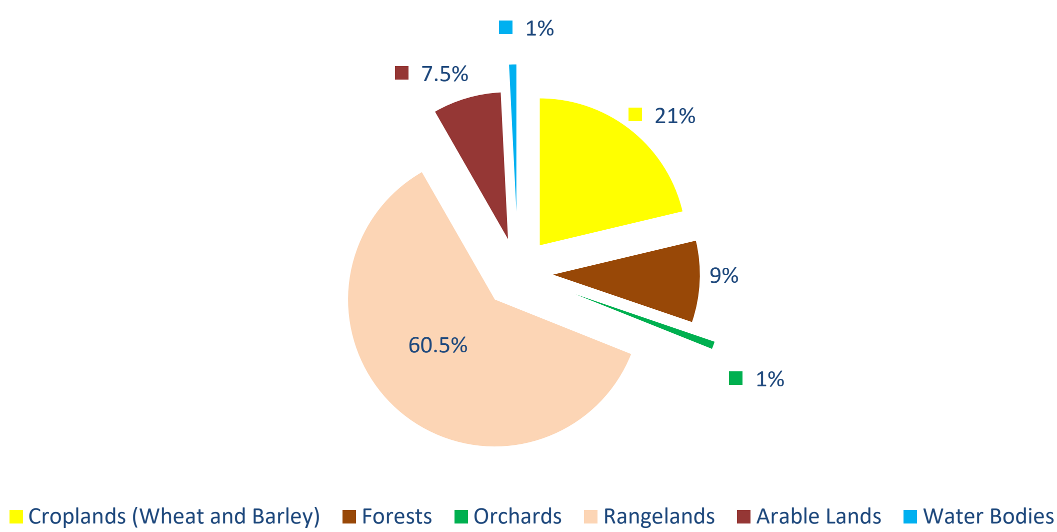


Table 1. Land Covers Types Proportion of the Total Study Area

Land cover	Area (ha)	Percentage %
Croplands (Wheat and Barley)	46451.3	21
Arable lands	16346.2	7.5
Forests	19514.8	9
Orchards	1785.7	1
Rangelands	132359.1	60.5
Water Bodies	1737.9	1
Total	218195	100



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5. CROPLAND (WHEAT AND BARLEY)

In this research, croplands are defined as the cultivated land only with wheat and barley. The area cropland covers is 46451.3 ha which is 21% of the total district area. Fig. 5. Shows that the highlands were not employed by wheat and barley because of the topographic obstacles and road access for machinery. With further going away from the highlands and going in to the plain areas cropland cover increases, especially in Siktan village in the North East, Qulqula, Sarqalla, Banagulan and Kanihanjir in south East, Palkarash and Hajywsu villages in North West, Shawpiran and Banamurd in the West and Shiwashokgawra, Smaqa, Omergumpat and Segrtkan villages in central of the study area Cropland gets its highest density (Fig. 1 and 5).

There are more crops being grown in the region, for example with lentil and chick pea, but because the area covered with these crops is minimal, therefore they are not discussed further here.

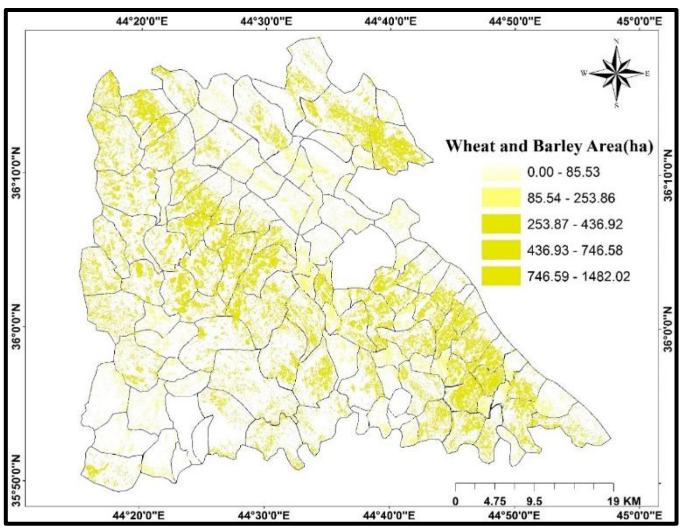

Fig. 5 the Lands Covered by Wheat and Barley

6. ARABLE LANDS

These lands are capable of being ploughed and used for growing crops, but they are left for a year as a part of crop rotation. This land has Near Infrared reflection and appears as bare lands and covers 16346.2 ha which consists of 7.5% of the study area. However, its location changes year to year, as it depends on crop rotation decided by the farmers (farmer's interview confirms that). Fig. 6. Show that Arable land appear all over the study area (except in the highlands) particularly in the centre (e.g. Shaxapiska, Gomashin, Sewashok, Ilinjax, and Smaqa), and south west (e.g. Qamaber, Bardaspy, Sekani, Awmar, Jlbasar and Kanisulaiman) of Koya district.

Arable land and cropland yearly rotating with each other, both together cover 28 % of the study area, but the portion of croplands is always larger than arable lands because croplands turn to arable lands once every four years.

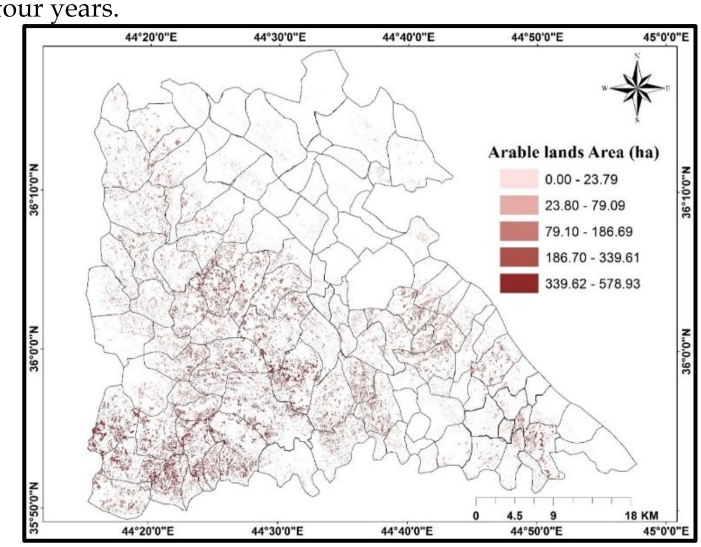

Fig. 6 the Arable Land Cover in Koya District

7. FORESTS

The natural forests are found in the mountainous area in the north of the district, for example in Kamusak, Naznin, Jali, the thtree Smaquly, Suske, Aliawa, Kanibi, Qurtalias and Kanigund, together with a small portion of land alongside the Lower Zab towards the south of the study area. The natural forests also exist where other water bodes are available, for example, in Basty Shrgha where there are more shrubs than trees (see Fig. 2. and 7). The total area of natural forest cover is 19514.8 ha or 9 % of the study area.

In the past Natural forests were denser and covered more land, but in the 1990s significant numbers of trees were cut down and to use as fuel [23] especially in the south east of Koya District. However, the altitude in this region is near 1000m above sea level and remains poor with tree cover as it has not recovered that well from the previous deforestation.

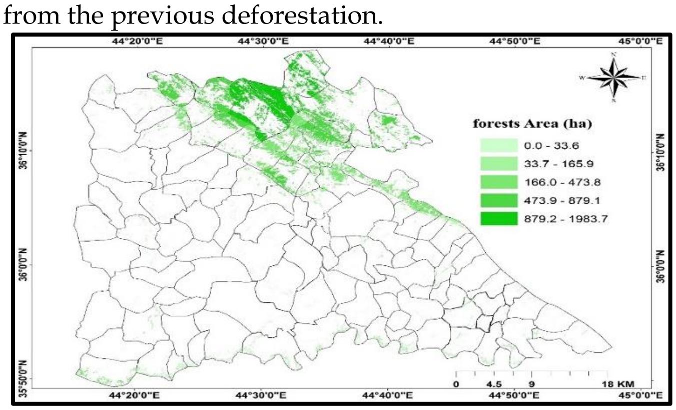

Fig. 7. The Lands Natural Forest Covers in the Study Area

8. ORCHARD

Orchard land cover is defined as enclosed land planted with fruit trees typically which have been introduced. Geographical location of orchard is similar to natural forest (see Fig. 8.) and located in Kamusak, Smaqulysarwchaw, Smaqulygtrk, Senan and Krozh among the mountain valleys where water available. Orchards cover 1785.7 ha that represents approximately 1 % of land in the study area. Natural forest and orchard sometime mix with each other because existing orchards lands were once covered with natural forest, but the trees were removed by farmers to plant fruit and use for other purposes.

In the study area Orchard is directly related to availability of surface water in dry seasons and explains why orchards are found in the north and south of the district alongside of Lower Zab particularly in these villages Chomhaider, Kanilala, Shiatan and Sartk.

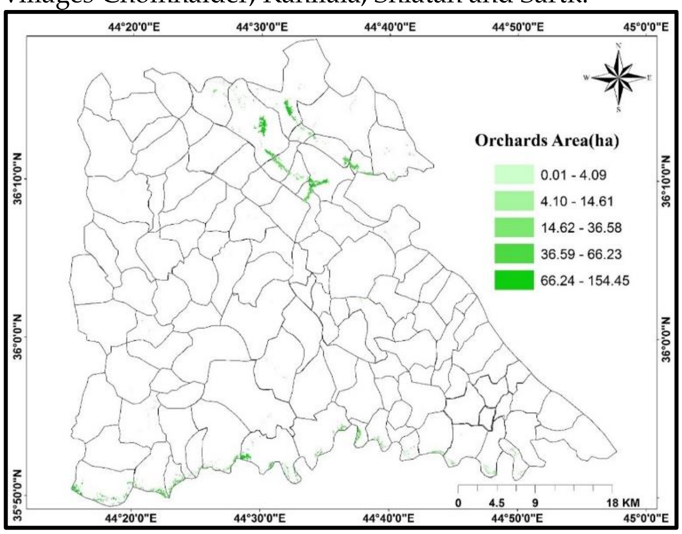

Fig. 8 Land Cover of Orchard

9. RANGELANDS

In this study, rangeland refers to those lands that are used for animal grazing. It represents the vast majority of land cover of the district area of 132359.1 ha or 60.5 % of the total study area. Fig. 9. shows that rangeland are more densely found Palkarash, Hajiwsu, Shiwapiran, Banamurd and Jlbasar villages in west and Smaqa, Omergumpat, Segrtkan and Kanilala villages south east of the study area. Although can be found almost everywhere of the district it is notably less dense, for example, in Kodala village in the north east and Bogdklesa in the south east of the study area.

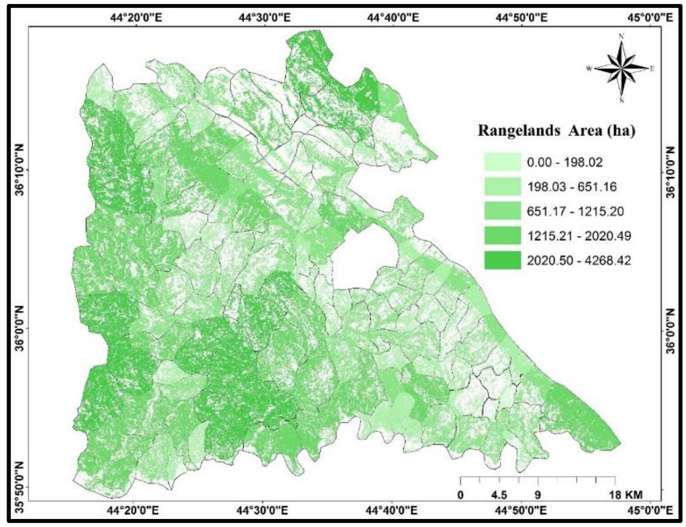

Fig. 9 Rangelands Area in Koya District

Some geographical factors play an important role to make rangelands to be so widespread in Koya district. For instance, the landscape has hillocks, valleys and rocky lands those are not suitable for cultivating because of soil properties and topography, but allows the growth of short grass for grazing. Secondly, animal grazing fields are also found among the other types of land use, such as forests and on the mountains, even in the small urban areas where livestock farms exist. Moreover, the arable lands are used for animal grazing as part of crop rotation and also when the crops are harvested allowing the grazing animals to moves in. Finally, there are some lands that local people have agreed to be occupied only for animal grazing when they are also suitable for cultivation.

10. WATER BODIES

This land cover includes all forms of available surface water such as rivers, streams, lakes and ponds. The study area has more water available during wet season, but it is very dry in the dry season as most of the rivers and streams are seasonal [23] and some rivers already polluted are unsafe to use such as Koya River [24]. Data of this research was collected in the month of May, which is transition period from wet seasons to dry seasons, to be reasonable and close to the annual mean data.

Fig. 10. Presents availability of surface water, Lower Zab is located in the south of Koya district which is the natural border with other neighbouring districts. The Lower Zab is the largest permanent water body, but passes from the edge of the study area and only one of its sides is in contact with the study area - therefore this river area is not added to the Koya district land cover.

So, it can say that the main water body of the district is called Basty Shrga where the catchment starts from North West to a south west direction of the study area; while the Krozh River is in the north associated with ponds and some small and slow flowing streams. Water bodies cover around 1 % or 1737.9 ha of study area land.

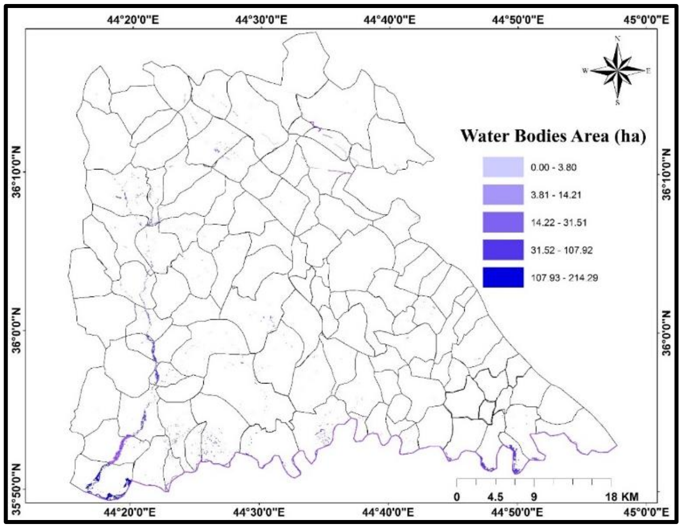

Fig. 10 Water Bodies of the study area

11. CONCLUSION

This study reveals that Koya rural area consist of six main types of land cover, including Rangelands (60.5 %), Cropland (21%), Forest (9%), Arable Land (7.5%), Orchards (1%), and Water Bodies 1%. The most dominate land cover in Koya district is rangeland, and the least cover are water bodies.

12. Recommendations

As more than half of the researched study area is suitable for animal grazing, it would be economically beneficial for the government to encourage improvement with this sector, such as seeding native plants and introducing plants of high nutritional value in developing rangelands of the Koya district area.

To enrich the district with water resources and increase areas of planted forest, rainwater harvesting is recommended by constructing ponds and dams, and directing channels as the topography allows.

We recommend a government strategy to prevent further deforestation and plan for reforestation, where natural forests been destroyed.

Moreover, Governmental monitoring is required to control unplanned land cover changes by villagers.

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