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Analysis of Land Use and Vegetation Coverage Change: A case study in the Yaxi Watershed Area, China

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Content

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Abstract

Land use change is one of the important aspects of the regional ecological restoration research. With remote sensing (RS) image in 2007 and 2015, using geographic information system (GIS) technologies, the land use pattern changes in Yaxi watershed area in China and its driving force factors were studied. Normalized difference vegetation index (NDVI) was used to detect the changes of vegetated land and non-vegetated land. The watershed was classified into six major land use classes viz. water area, town and mining land, grass land, garden plots, forest land and cultivated lands. Results showed that: (1) cultivated land constituted the largest area during 8 years, and followed by water area and town and mining, forest land, garden plots and grass land. Garden plots, grass land, forest land, cultivated land and water area were reduced during the study period, whereas only town and mining land was increased. (2) During 2007-2015, grass land change rate showed the largest, followed by town and mining land, garden plots and forest land. (3) International slow city project can change in the land use distribution and vegetation coverage and; is the main driving force factor of the land use pattern change in this watershed area. These land use land cover transformations can be posed a threat to watershed resources. Hence, proper management of the watershed is required or else these resources will soon be lost and no longer be able to play their role in socioeconomic development of the area.

Keywords; Land use change, Normalized difference vegetation index, Driving force, Geographic information system

Analysis of Land Use and Vegetation Coverage Change: A case study in the Yaxi Watershed Area, China

ခိုင်ရည်မွန်လင်း၊ ဒုတိယညွှန်ကြားရေးမှူး
ပတ်ဝန်းကျင်ထိန်းသိမ်းရေးဦးစီးဌာန

စာတမ်းအကျဉ်း

မြေအသုံးချမှုပြောင်းလဲခြင်းကို လေ့လာခြင်းသည် ဒေသတွင်းဂေဟစနစ် ပြန်လည် ထူထောင်ရေး သုတေသနလုပ်ငန်း၏ အရေးကြီးသော ကဏ္ဍများထဲမှတစ်ခုဖြစ်သည်။ စာတမ်းတွင် တရုတ်နိုင်ငံ၊ ဂျင်းစုပြည်နယ်ရှိ ယရှီးရေဝေရေလဲဒေသ၏ ၂၀၀၇နှင့် ၂၀၁၅ ခုနှစ်များတွင် ဖြစ်ပေါ်နေသည့် မြေအသုံးချမှု ပြောင်းလဲမှု၊ရွက်အုပ်များပြောင်းလဲမှုနှင့် မြေအသုံးချမှုကို ပြောင်းလဲစေသောအကြောင်း အရင်းများကို ပထဝီဝင်အချက်အလက်စနစ် နည်းပညာများကို အသုံးပြု၍လေ့လာခဲ့သည်ကို ရေးသား ထားခြင်းဖြစ်ပါသည်။ ရွက်အုပ်များပြောင်းလဲမှုအညွှန်းကိန်းနှင့် စပ်လျဉ်း၍ရွက်အုပ်ရှိသည့် မြေဧရိယာနှင့် ရွက်အုပ် မရှိသည့် မြေဧရိယာ ပြောင်းလဲမှုကိုလေ့လာခဲ့ပါသည်။ အဆိုပါ ရေဝေရေလဲဒေသ တွင် အဓိက မြေအသုံးချမှုအမျိုးအစား ၆ မျိုးဖြစ်သည့် ရေဧရိယာ၊ မြို့ပြနှင့်သတ္တုတွင်းမြေ၊ မြက်ခင်း မြေ၊ ဥယျာဉ်ခြံမြေ၊ သစ်တောမြေနှင့် စိုက်ပျိုးမြေများ ဟူ၍ ခွဲခြားလေ့လာခဲ့ပါသည်။ ထွက်ရှိလာသည့် ရလဒ်များအရ လေ့လာသည့် ခုနှစ်များ(၂၀၀၇-၂၀၁၅ ခုနှစ်)အတွင်း စိုက်ပျိုးမြေ ဧရိယာသည်အများ ဆုံး၊ ၎င်းနောက်တွင် ရေဧရိယာ၊ မြို့ပြနှင့် သတ္တုတွင်းမြေ၊ သစ်တောမြေ၊ ဥယျာဉ်ခြံမြေ များနှင့် မြက် ခင်းမြေများ ဖြစ်ကြပါသည်။ လေ့လာမှုပြုလုပ်ခဲ့သည့် ကာလအတွင်း ဥယျာဉ်ခြံမြေများ၊ မြက်ခင်းမြေများ၊ သစ်တောမြေ၊ စိုက်ပျိုးမြေများနှင့် ရေဧရိယာများ လျော့နည်းလာသည်ကို တွေ့ရှိရပြီး မြို့ပြနှင့် သတ္တုတွင်းမြေဧရိယာများသာ များပြားလာသည်ကိုတွေ့ရှိခဲ့ရပါသည်။၂၀၀၇-၂၀၁၅ ခုနှစ်အတွင်း မြက်ခင်းမြေဧရိယာပြောင်းလဲမှုနှုန်းသည် အကြီးဆုံးဖြစ်ပြီး ၎င်းနောက်တွင် မြို့ပြနှင့် သတ္တုတွင်းမြေ၊ ဥယျာဉ်ခြံမြေများနှင့် သစ်တောမြေများဖြစ်ပါသည်။ ယရှီး ရေဝေရေလဲဒေသတွင် မြို့ပြစီမံကိန်း လုပ်ငန်းသည် မြေအသုံးချမှုနှင့် ရွက်အုပ်များပြောင်းလဲမှု၏ အဓိကအကြောင်းအရင်း ဖြစ်သည်ကို လေ့လာတွေ့ရှိရပြီး ထိုသို့မြေအသုံးချမှု ပြောင်းလဲခြင်းသည် ရေဝေရေလဲဒေသအတွက် ခြိမ်းခြောက်မှု တစ်ခု ဖြစ်စေနိုင်သည်။ သို့ဖြစ်ပါ၍ ရေဝေရေလဲဒေသများကို စနစ်တကျ စီမံခန့်ခွဲရန်လိုအပ်ပြီး သို့မဟုတ်ပါက အဆိုပါ အရင်းအမြစ်များသည် ပျက်စီးဆုံးရှုံးသွားနိုင်ပြီး လူမှုစီးပွားဘဝဖွံ့ဖြိုး တိုးတက်ရေးအတွက် အထောက်အကူပြုနိုင်မည် မဟုတ်တော့ပေ။

Analysis of Land Use and Vegetation Coverage Change: A case study in the Yaxi Watershed Area, China

1. Introduction

It is well understood that clean water is one of the important elements of sustainable development. The watershed is one of the natural resources units widely recognized as a fundamental geographic unit for measuring and analyzing the relative health and condition of the landscape [1, 2]. From the ecological point view, watersheds are important because water flows along the rivers by picking up nutrients, sediment, and other pollutants, which are transported to the outlet of the basin. These pollutants can degrade ecological progresses within the watershed, as well as the receiving water body. Therefore, scientific watershed management is essential to conserve water resources and ecosystems [3].

Watershed deterioration is caused all over the world. There are several factors for this deterioration, such as improper utilization of watershed resources, among which land use practice is the most important. Land use practice can impact watershed and land degradation [4]. The changes of land use and land cover patterns within the watershed have negative impacts on the soil and water quality of rivers by increasing human activities [5, 6, 9]. Land use change is known in the influence of the biogeochemistry of watersheds [10–12].

When land has been changed from the natural uses to agricultural and urban land uses, it makes forests and watersheds lost; surface runoff changed; and man-made chemicals and wastewater inputs increased [12–14]. Impaired watersheds contain more agricultural and developed land cover and less forest land cover when it is compared with unimpaired watersheds [15]. Land cover changes and land use management factors have been regarded as the key important factors behind the alteration of the hydrological system which led to the change in runoff as well as the water quality [7, 8, 9]. Physical alteration of the landscape also occurs as a result of land use change, affecting the hydrogeological dynamics of watersheds [16, 17].

Land use change has generally been considered a local environmental issue, but it is becoming a force of global importance [18]. Changes in land and their implications for global environmental change and sustainability are a major research challenge for the human environmental sciences [19]. Global changes in land use and climate also have highlighted the role of ecosystems in food, water, and energy security and in climate change mitigation and adaption [20].

Land use change has played a role in changing the global carbon cycle and accounts for roughly 35% of anthropogenic carbon dioxide emissions resulted [18]. Much of this change is a direct consequence of land uses: 40% of land surface is in agriculture [19]. Currently, in many parts of the world, human activity is the major force in shaping land use and land cover although the underlying physical structure of landscape may constrain land use and land cover [21]. Anthropogenic nutrient inputs to the biosphere from fertilizers and atmospheric pollutants now exceed natural sources and have widespread effects on water quality and coastal and freshwater ecosystems.

Land use changes can also have an important impact on the water and energy balance, directly affecting climatic conditions. The impacts of these land use changes become globally significant through their accumulative effects [22]. The intense human utilization of land resources has resulted in significant changes of the land use and land cover [23]. Since the era of industrialization and rapid population growth, land use change phenomena have strongly accelerated in many developing countries [24]. Land use and land cover changes are the result of the interplay between socio-economic, institutional and environmental factors [25]. Deforestation, urban development, agriculture, and other human activities have substantially altered the Earth's landscape. Farmland provides open space and valuable habitat for many wildlife species. However, intensive agriculture has potentially severe ecosystem consequences. For example, it has long been recognized that agricultural land use and practices can cause water pollution. Runoff from agricultural lands is a leading source of water pollution both in inland and coastal waters [26].

So, understanding the causes and consequences of land use change is one of the prime goals of global change research [27]. As a consequence, information about land use change is necessary for effective management and planning of the resources for sustainable development [28]. Accurate and up-to-date land cover change information is necessary to understand and assess the environmental consequences of such changes [29]. It can be inferred that examining land use and land cover change should be fundamental first step for improving the water quality and ecological environment of a watershed.

Land use and land cover change (LULCC) may significantly affect the ecological environment and sustainable development. LULCC is receiving an increasing amount of attention from scholars, and there were numerous studies on LULCC have been reported around the world at various scales. So far, the research contents mainly included described land use change, explored the relationship between LULCC and driving forces, simulated land use change, and analyzed the impacts of land use change [30]. Meanwhile, developing countries are undergoing rapid urbanization and industrialization, which leads to more rapid LULCC than in developed countries. Over the past several decades, China has been the World's most populous country, as well as one of the most rapidly developing countries, and along with its continuous urbanization and population increase, China has been undergoing an increasingly significant landscape changes [31–37]. China has experienced obvious land use change since last century. Regional land use changes in the eastern developed regions of China have received great attention; comparatively, land use changes in its western undeveloped regions have attracted little attention [38].

Land use has been considered one of the most important factors influencing livelihood of people. The change in farming system, such as land use change on the hydrology of the rivers, can affect local people's livelihoods strategies. As far as I study, most previous studies examine the impacts of land use change in the watershed level all over the world. In China, the previous studies have only focused on the land use change effects on the lakes and rivers mainly. In southern part of China, it hasn't been done the land use change analysis. So, in this paper, I will mainly focus on the land use and land cover change rate and its driving forces in Yaxi town.

The study area, Yaxi watershed, is located in Gaochun District, the East of Nanjing. It is located in the north subtropical climate zone. It has four seasons and abundant rainfall. Yaxi town is the first International Slow City of China. Ecological tourism is a feature of this watershed. According to meteorological data shows, the annual average temperature is 15.9

℃ and the annual different temperature change is bigger. The extreme maximum temperature is 40 ℃ and the extreme minimum temperature is -8 ℃. The average annual rainfall of this area is 1157 mm. The altitude ranges from 21m to 101m above sea level.

There are two main events in Yaxi, namely Golden Rape Flowers Tourism Festival and Land Art Festival which are held annually. The former is held in late March when rape flowers blossom and the latter is held in September. The beautiful natural scenery of land art and farms beside lush bamboos form a pastoral picture, attracting hundreds of people to come there. Tourists can take part in various agricultural activities, escape from the busy life in the city, relax themselves and enjoy the harmony of human and nature.

2. Objectives

The objectives of the study are;

(i) To examine land use change and vegetation coverage change in the Yaxi watershed area from 2007 to 2015.

(ii) To identify the driving forces of land use change in the study area.

3. Material and Method

Different methods of data collections are used in this study. The ground visit approach was done to get the reference data for this research. Interview with township officers was also conducted to supplement the information obtained from the satellite images. Images such as topographic maps and aerial photos and Landsat images for 2007 and 2015 were obtained from the Land and Resources Bureau, Jiangsu Province, China Government. Data from primary sources include satellite imagery and field data. Secondary data such as census records and unpublished official documents and reports were gathered from offices of Agricultural Development and Land and Resources Bureau, Jiangsu Province, China Government respectively.

A primary ground visit was conducted in the Yaxi watershed area. This was benefited because aerial photos with high resolutions were not reliable and the good accuracy assessment for this study area can be performed. The current situation of this watershed area and the general idea of the physical characteristics of the area were obtained. Visual observations were made for the identification of surface features and land use types. However, fieldwork was conducted for ground truth verification of mapped features.

Data were imported into ArcGIS 10.2. The ArcGIS 10.2 software was used for the analysis of land use area change and vegetation coverage change. Remote sensing technique provides useful information on land use dynamics. Adopting the "Classification and Implications of Land Use Status", the plan was formulated by the "Technical Regulations for Investigation of Land Use Status" promulgated by the National Agricultural Zoning Commission in September 1984. Taking into account the situation in the study area, the land use types are finally divided into six categories: cultivated land, forest land, grass land, town and mining land, water area and garden plots.

The analysis of land use change maps involved technical procedures of integration using the ArcGIS software technique and the Excel 2016 was used for the report. The detection of the changes provided an understanding of human interference on the sub-catchment over years. The land use in percentage will be calculated as:

$$\text{Percentage} = \text{Observed Area} / \text{Sum of Area} \times 100$$

The patterns and processes of land use change will be described by land use change rate and transition rate in the study. Land use change rate for a single land use type during different periods will be assessed by the following formula [84, 85]:

$$K= (Ub - Ua/Ua) \times \frac{1}{T} \times 100\%$$

Where K is land use change rate for a single land use type (percent) per year, U_a and U_b are the areas of the land use type at the beginning and at the end for a period, respectively. T is time intervals (years).

Vegetation indices allow us to delineate the distribution of vegetation and soil based on the characteristic reflectance patterns of green vegetation. The NDVI is a simple numerical indicator that can be used to analyze the remote sensing measurements, from a remote platform and assess whether the target or object being observed contains live green vegetation or not. The NDVI is calculated as;

NDVI= NIR – RED/ NIR + RED

Very low value of NDVI (0.1 and below) correspond to barren areas of rock, sand, or snow. Moderate values represent shrub and grassland (0.2 to 0.3), while high value indicates temperate and tropical rainforests (0.6 to 0.8). Bare soil is represented with NDVI values, which are closest to 0 and water bodies are represented with negative NDVI values.

4. Results

According to the data resulted from the classified images of 2007 and 2015, there were land use changes in this study. Yaxi watershed area is characterized into six land use classes, namely water area, town and mining land, grass land, garden plot, forest land and cultivated land. Water bodies include rivers, ditches, ponds and reservoirs. According to the Nanjing Municipal Hydrological Bureau, the reservoir water quality is Class II water standards and the pond water quality is Class III water standards. Town and mining land include mining areas, roads, villages, residents, scenic spots and sightseeing areas. Garden plots includes tea garden and orchard. In forest land, there are pines, maple, poplar and camphor trees. Cultivated land can be found into irrigated land and paddy fields. The crops grown in this area consist of maize, rice, beans, chili, peanut, tomatoes, vegetables and different kinds of fruits. In the agricultural sector of this area, the per capita net income of farmers increased from 597 yuan in 1985 to 17693 yuan in 2014. The agricultural production conditions improved significantly and the residents' income increased steadily.

The actual percentages covered by different land use and land cover types in the years 2007 and 2015 are presented in tables 1 and 2. During the 2007 and 2015 periods, cultivated land and water areas were the dominant land use land cover types in the Yaxi watershed area. And then followed by town and mining land, forest land, garden plots and grass land. Analysis of the 2007 image reveals that cultivated land covered 60.07 % of the study area. The classification result also shows that 16.80% of the area was covered by water area. 12.85%, 5.49% and 3.71% of the total area are covered by town and mining, forest land and garden land respectively.

Table 1: Land use and land cover distribution in 2007

Land use types	2007	
	Area(hectare)	%
Cultivated land	9128.413891	60.07%
Forest land	833.6974812	5.49%
Garden land	563.3174934	3.71%
Grass land	164.5340738	1.08%
Town and mining	1952.508732	12.85%
Water area	2553.032793	16.80%

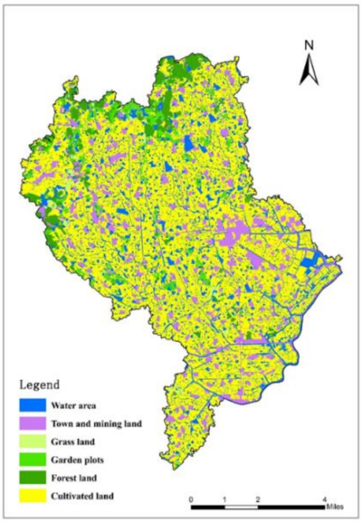

Figure 1: Classified land use and land cover map of Yaxi town in 2007

The 2015 image analysis result indicated that cultivated land closure size decreased to 9091.1295 hectares which was 9128.414 hectares in 2007. The forest land cover of the study area also decreased from 5.5% to 5.4%, in the year 2015, as compared to the 2007 image classification result. The garden land covered which was 3.7% in 2007 it decreased slightly to 3.6% of the study area. Whereas grass land and water area decreased from 1.08% to 0.8% and from 16.8% to 16.6% respectively**.** Only town and mining land increases from 12.8% to 13.4%.

Table 2: Land use and land cover distribution in 2015

Land use types	2015	
	Area(hectare)	%
Cultivated land	9091.129543	60.18%
Forest land	812.6289504	5.38%
Garden land	548.7287837	3.63%
Grass land	120.8847882	0.80%
Town and mining	2018.542869	13.36%
Water area	2514.809081	16.65%

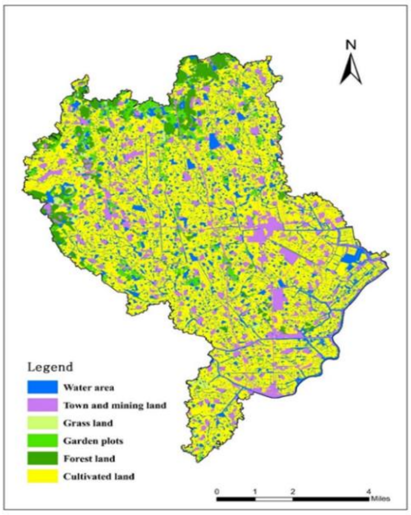

Figure 2: Classified land use and land cover map of Yaxi town in 2015

Table 3: Change rate of land use and land cover distribution in 2007 and 2015

Land use types	2007		2015		changed area(hectare)	Change %
	Area (hectare)	%	Area (hectare)	%		
Cultivated land	9128.413891	60.073	9091.129543	60.179	-37.284348	-0.408
Forest land	833.6974812	5.486	812.6289504	5.379	-21.0685308	-2.527
Garden land	563.3174934	3.707	548.7287837	3.632	-14.5887097	-2.589
Grass land	164.5340738	1.082	120.8847882	0.800	-43.6492856	-26.529
Town and mining	195.2508732	12.849	2018.542869	13.361	66.034137	3.382
Water area	2553.032793	16.801	2514.809081	16.646	-38.223712	-1.497

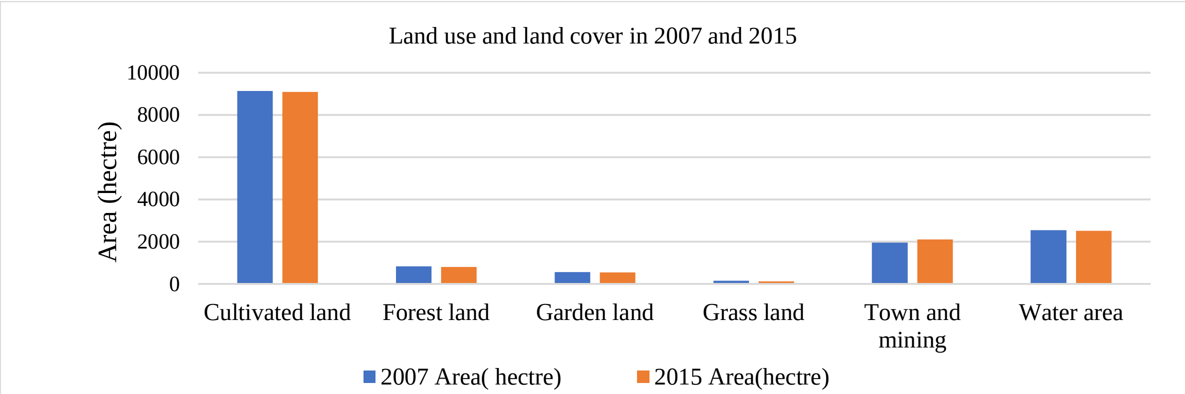

Figure 3: Comparison of land use and land cover of 2007 and 2015

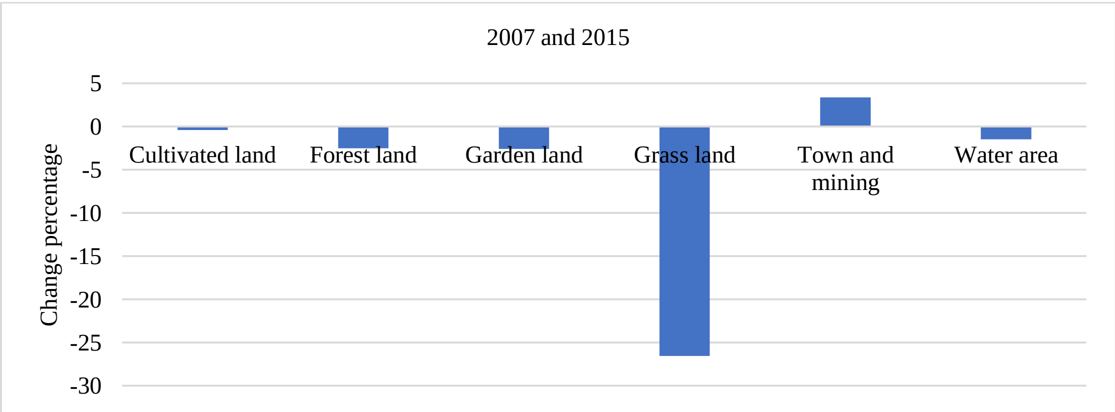

Figure 4: Change rate % of land use and land cover of 2007 and 2015

From the Table 3, during 2007-2015, the change rate of grass land was the largest, accounting for -26.53% of the change in total land use, and it indicated that the change amplitude of grass land was the biggest, followed by those of town and mining land, garden plots and forest land, accounting for 3.38%, -2.6% and -2.53% of the change in total land use, respectively; water areas and cultivated land changed relatively less, accounting for -1.5% and -0.41% of the change in total land use, respectively.

The grass land shows the largest declined average change rate of 5.5 ha/yr of the total grass land area during the 8 years study period. And then this was followed by garden plots which was losing an estimated 1.8 ha/yr of the total garden plots. Only town and mining land showed the inclined rate by an estimated 8.8ha/yr in the period from 2007 to 2015.

5. Discussion

For water body, this area was 2553.033 hectares in 2007 and reduced to 2514.809 hectares in 2015. There was a decrease change rate -1.5% during the study period.

Town and mining land area accounted 1952.508 hectares which was 12.85% of the total land use area in 2007. In 2015, this type of land use occupied into 2018.543 hectares which was a 3.38% increase rate for the period on this study. Among all land use types in the study, only this land use type was increased. In this area, provincial highways and recreation buildings are constructed for the development of rural tourism which can attract more tourists.

In 2007, grass land occupied 164.534 hectares and then declined to 120.885 hectares in 2015. This land use change rate percentage is the biggest amount during the study period. On the other hand, during the entire study period from 2007 to 2015 the smallest portion of the land in the study area was covered by the grass land. The cultivated lands were 9128.414 hectares in 2007 and then declined to 9091.130 hectares in 2015. Among all land use types, this land use type area was the biggest amount. In this area, their income depends mainly on the agriculture. But among all types of land use, the cultivated land change rate was the least amount during the study period. The cultivated lands were spread all over the places of this study area.

The area covered by the garden plots was 563.318 hectares which was 3.71% of the total land use areas in 2007 and decreased into 548.729 hectares that was 3.61% of the total land areas in 2015. In 2007, forest land area was 833.697 hectares. This area was decreased to 812.629 hectares by the year 2015. The change rate percentage is -2.53% during the study period. In this area, garden plots and forest land were located mostly in the northern part. They also scattered in the middle part of the study area**.**

The values of NDVI were divided into two categories: non-vegetated land and vegetated land. In the results of NDVI, the negative values and zero value represent non-vegetated land while positive values represent vegetated land. The NDVI have been used widely to examine the relation between Spectral variability and the changes in vegetation growth rate. Figure 5 and 6 illustrate the continuous images of NDVI results of 2007 and 2015 to display the distribution of NDVI values. It is also useful to determine the production of green vegetation as well as detect vegetation changes. After the analysis of first image [Fig 5], it has been found that the multispectral images are giving result for all the features at NDVI value of 0.64 in the year 2007, whereas second image [Fig 6], giving the result for all the features at NDVI value of 0.67 with changes of year 2015. In 2007, NDVI value range is from -0.60 to 0.91 and in 2015 from -0.97 to 0.95. The lowest values are found on the town and mining area, water area and on the less vegetated soils and presumably because reflection from the soil is high, and produce low values in NIR band and high values in red band; hence the NDVI values are low. The highest values of NIR can be found in the forest area.

When soil water availability decreases, due to any environmental reason (stress by water deficit); the green vegetation tends to disappear, then the values of NDVI can decrease. Empirical study implies in 2007, the percentage of forest land is found to be 5.5% at NDVI threshold of 0.64, water areas are found to be 16.8%, cultivated land is found to be 60.1% and remaining areas are found to be 17.6%. In the year 2015, the percentage of forest land in the given study area is found to be 5.4% at NDVI threshold of 0.67, water areas are found to be 16.6%, cultivated land found to be 60.2% and the remaining areas are found to be 17.8%. The NDVI method gives superior results for vegetation varying in densities and also for scattered vegetation from a multispectral remote sensing image.

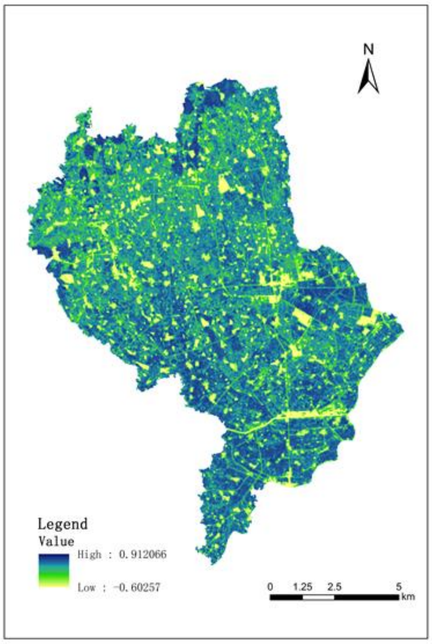

Figure 5: NDVI in 2007

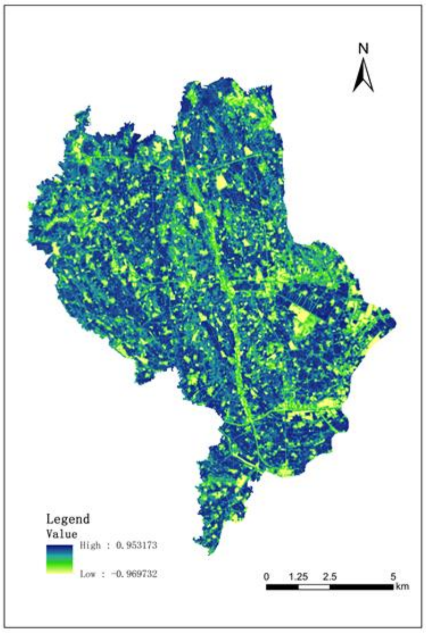

Figure 6: NDVI in 2015

Land use change is a direct manifestation of human effects on the natural environment, whose development is mainly affected by natural and human factor. Natural factors are fundamental to the land use distribution of the ecological environment, which include altitude, landform, gradient, slope direction, soil, vegetation, etc. and human factors include population, economy, system policy, technical measures, etc.

To know the driving forces in the study area, the interviews are conducted with experienced township officers, agricultural department officers and educated local people. Their experiences and knowledge were taken into consideration to get the reasonably confident information.

In this study, the effects of human activities on the spatial distribution of land use are the main driving force factors of the land use pattern change, which can lead to land use changes over a short period, especially the implementation of the International Slow City Project, which is the developmental activity in this area. There is the construction of provincial highways and five major projects in the slow city project around the watershed area. They can change the micro topography, reduce the surface slope, and then induce land use changes distribution in the Yaxi watershed area.

According to the information revealed by classification results, the town and mining area showed the increase rate from 2007 to 2015. Reasons were a number of new housing schemes, farmhouses and recreational pursuits that have been developed in and around area in the past 10 years. Along with the development, there is an incline toward the construction of new pavements, highways, roads and other structures to access these areas. For the non-point source pollution control project around the slow city, there are the construction of garbage collection pool and the construction of sewage treatment which can carry out the daily processing capacity.

According to the standards of the international slow city, it must have a population of less than 50,000, pursuing a green lifestyle, anti-pollution, anti-noise, supporting urban greening, supporting traditional manual methods, no fast-food area, no large supermarkets and so on. Therefore, the "slow city" contains a sustainable economy, the original culture and harmonious environment. To implement one of these standards, it had to spread over forests in this area. But the forest coverage rate decreased from 5.49% in 2007 to 5.38% in 2015, and not significantly decreased during the 8 years. The ecological function was also not destroyed significantly. This small watershed's average annual rainfall, humid climate and more abundant rainfall can lead to the forest growth to bring more favorable conditions later. So, the structure of forest and tree species can be optimized, and the proportion of broad-leaved forest and mixed forest will be higher.

The area covered by Water class has also witnessed a decrease from 2007 to 2015. Easy accessibility of water resulted in the depletion of water and ended in dried up tributaries. Another reason for the shrinkage was an increased rate of surface runoff. As the runoff exceeded recharge capacity of ground water, it resulted in the lowering of water table. Deforestation rate also contributed to the increase in surface runoff and is responsible for down flow of nutrients and sediments. The reservoir in this area not only supplies water to ever the population of this area but also supplies it for irrigation purposes. Along with the loss due to agriculture and urbanization demands, evaporation, seepage and percolation are also leading causes of quantitative decline of water in the reservoir.

In this area, grass land degradation was mainly resulted from anthropogenic factors. In this predominantly grazing region, excessive reliance on animal husbandry has exerted great pressure on the land. Tourism is also developed in this area and it can destroy not only the grassland but also biodiversity.

6. Conclusion

This study has demonstrated the use and application of remote sensing and GIS techniques as powerful tools to extract meaningful information for using thematic maps of the area for two different dates. Land use change analysis indicated that magnitude of the land use and land cover in Yaxi watershed was generally low; the percentage of the change of various land types relative to the total area was also small amount.

The result showed that cultivated area was the dominant land use in the study area throughout the study period covering about 60% of the entire study area. This is followed by water covering about 17% of the study area, town and mining land 13% of the entire study area, forest land 5%, garden plots 4% and grass land 1% of the entire study area. The study indicated that in the international slow city project of the study area, mainly construction of farm-houses for ecotourism and of provincial highways are major driving factors of land use change. So, Land use planning should be considered from the outset of construction. Soil protection and erosion control measures should also be encouraged. Riparian buffer vegetation using appropriate plant species should be established. It will increase infiltration and water storage and reduce sediment loading.

In 2007, the percentage of forest land is found to be 5.5% at NDVI threshold of 0.64, water areas are found to be 16.8%, cultivated land is found to be 60.1% and remaining areas are found to be 17.6%. In the year 2015, the percentage of forest land in the given study area is found to be 5.4% at NDVI threshold of 0.67, water areas are found to be 16.6%, cultivated land found to be 60.2% and the remaining areas are found to be 17.8%.

On that way developing and implementing regional land use strategies that recognize both short- and long-term needs, balance a full portfolio of ecosystem services, and increase the resilience of managed landscapes will require much more cross-disciplinary research on human-dominated ecosystems. However, it will also benefit from closer collaboration between scientists and practitioners—linking, for example, ecologists and land-use planners, hydrologists and farmers, climatologists and architects, and entomologists and physicians. A wide array of skills will be needed to better manage our planet's landscapes and balance human needs, the integrity of ecological infrastructure, the continued flow of ecosystem services, and the long-term health of people and the biosphere. Sustainable land use policies must also assess and enhance the resilience of different land use practices.

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