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Impacts of Urbanization of Mountainous Areas on Resources and Environment: Based on Ecological Footprint Model

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Abstract: The rapid urbanization has exerted tremendous pressure on natural systems in mountains. As a measure of sustainable use of natural resources, ecological footprint is an important basis for judging whether the development of a country or region is within the biocapacity. Taking Dali Bai Autonomous Prefecture as an example, this study comprehensively analyzes the impact of human activities on mountain resources and environment from the three aspects of urbanization, land use and ecological carrying capacity. The results show that Dali Prefecture with the urbanization rate of 33% is still in the accelerated stage of urbanization. The urban space presents the core-periphery feature, and the central city is the focus of human existence and living activities. The per capita ecological footprint is 1.14 hm2/person higher than the ecological carrying capacity, meaning Dali Prefecture is in an ecological deficit state. This indicates that there is an uncoordinated state between urbanization and environment. Arable land is the main source of per capita ecological footprint in the prefecture. However, the urban expansion overly occupies the arable land in the plain sub-region, leading the arable land to an ecological deficit state. In the future, the development of the mountainous area should focus on the protection of arable land and choose a new sustainable path.

Keywords: mountainous areas; urbanization; ecological footprint; Dali Bai Autonomous Prefecture

1. Introduction

Urbanization is a worldwide phenomenon after the industrial revolution and a product of the development of modern industry and technological progress [1,2]. Industrialization represents a fundamental shift in the ways in which resources and environment are exploited and utilized, and its typical modes of social production and operation are: production mechanization, organization intensification, and mass consumption. Industrialization is precisely the economic connotation of the development of modern cities. Meanwhile, the emergence and development of cities are also a long-term endeavor and inevitable result of our continuous deepening development of earth's resources and the environment. Therefore, the modern city is not only an important node with gathering elements of population and consumption, but also plays a leading role in social production and environmental pollution through the agglomeration [3,4]. With the acceleration of industrialization and urbanization, the impact of human beings on natural resources has been gradually enhanced. The global crisis such as the shortage of resources and the deterioration of the environment has become a problem mankind has to face. If these problems are ignored and unsolved, they will further restrict the progress of human civilization. As China is a country of large

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population with relatively fragile resources and environment, it's important to coordinate the relationship between urban development and the utilization of environment.

Mountains are home to one tenth of the world's population and cover 25 percent of the earth's land surface[5]. The mountains are the resource of water, food, energy. They shelter nearly half of the world's biodiversity[6]. In response to the challenge of urbanization, studying, protecting, and developing mountainous areas have become a major issue for the sustainable development of all countries[7]. Since 1998, in order to promote sustainable development of mountainous areas, the UNFAO as the responsible agency has done a great deal of work in cooperation with the UNESCO, UNDP, UNEP and some governmental and non-governmental organizations. They prepared several reports on Sustainable Mountain Development and policy advice in the field of urbanization, economy and livelihoods, energy and infrastructure, education and capacity building[8,9].

China is one of the most mountainous country in the world. The mountainous areas (including hills and plateaus) of which account for about 70% of the country's territory, and the population in mountainous areas accounts for about half of the country's population. Mountainous areas are important spatial carriers for the sustainable supply of people's activities, and also an important space for economic and social development in the future. The mountain topography in China is complex and diverse. The proportion of mountainous areas in the western region is generally large, where the extensive exploitation of resources, the large amount of traditional industries and the backward production methods lead to the waste of land resources and serious environmental pollution. There is a sharp decline in the service functions of mountain ecosystems[10]. Since the 1990s, Chinese Academy of Sciences, Chongqing University, Northwestern University, etc. have carried out researches on the sustainable development of mountainous areas and achieved fruitful results. For example, Professor Guangyu Huang with Chongqing University established mountain urban science based on the planning and practical experience from 1959 to 2002[11]. After a long period of studies on mountainous systems, Guojie Chen et al. (2010) found that China not only has differences in economic development among the eastern, central and western regions, but also shows differences in the internal development of the mountainous areas, which is mainly due to the development of the secondary industry[12]. Yuluan Zhao et al. (2016) analysed Spatial Correlation between Type of Mountain Area and Land Use Degree in Guizhou Province[13]. Yang Yi et al. (2016) analysed Effects of Urbanization on Landscape Patterns in a Mountainous Area, and found urban development in mountainous areas should focus on the protection of croplandarable land[14] .

In 2016, the urbanization rate in China reached 57.35%, while the urbanization rate in the western region was 48.7%, which was 10% below the national average. Among 31 provinces in China, there were 18 provinces whose urbanization rates were below the national average, 11 of which were in the western region. Although the level of urbanization in the western region is 5 to 10 years behind the national average, half of the population in the western region now lives in cities. With the advancing of the rapid urbanization process in the western region, the space to the surrounding areas continue to spread. It has created obvious restrictive effects and is unsustainable. Based on the carrying capacity of resources and the environment, it is of great significance to coordinate the economic development in the mountainous areas with the environmental protection.

Ecological carrying capacity refers to the capacity of the ecosystem under the influence of various natural factors, social and cultural factors and their relations. At present, the evaluation method of ecological carrying capacity widely applied at home and abroad is the ecological footprint method, which was first proposed by Canada William E. Rees and his student Mathis Wachernagel in 1992, and was further improved by the latter in 1996[15]. The ecological footprint measures human biospheric demand by calculating the area of bio-productive land needed by mankind, including biological production land areas required for consumption of renewable resources, infrastructure construction, and the absorption of carbon dioxide emissions (excluding marine absorption) from the burning of fossil energy sources[16,17,18]. The ecological footprint can be compared to biocapacity, i.e., the area ofbio-production land that the earth uses for resource regeneration. Both of the ecological footprint and biocapacity are expressed in "Global Hectare",

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where 1 global hectare represents 1 hectare of land use area at the global average bio-productivity level[19]. KB Bicknell et al. (1998) proposed the use of a modified form of input-output analysis to calculate the ecological footprint[20]. H Haberl et al. (2001) presented calculations of the ecological footprint (EF) for Austria 1926–1995, based upon three different methodological approaches[21]. Yung-Jaan Lee et al. (2016) also reveal that Taiwan's ecological footprint from 2008–2011 exceeded that from 1997–2007[22]. E Verhofstadt et al. (2016) investigated the relation between the ecological footprint and the subjective well-being at the individual level, using a questionnaire carried out in Flanders (Belgium)[23].Since the mid-1970s, China began to experience ecological deficits, the scale of which has been expanding[24]. China's mountainous areas are complex, and researches on the carrying capacity of mountainous areas are rare. Scholars such as Yingmei Wu et al. (2006), Xudong Li (2013) and Yi Zhang et al. (2016) studied the resource and environment carrying process of mountainous areas in different spatial scales respectively and evaluated the supporting capacity of the resources and environment in mountainous areas using the PSR concept model, the system dynamics model and the 3S technology[25,26,27]. After the Wenchuan Earthquake on May 12, 2008, many scholars analyzed the particularity of mountain carrying capacity and proposed that the size and spatial pattern of mountainous areas should be adjusted. In general, China has not yet conducted an in-depth study on the ecological carrying capacity of mountainous areas.

2. Materials and Methods

2.1. Study area

In order to understand the impact of mountain urbanization on resources and environment, Dali Prefecture of Yunnan Province was selected for observation. Established in 1956, the Prefecture is the only Bai Autonomous Prefecture in China, located in the central west of Yunnan Province, 398km away from the provincial capital of Kunming. The Prefecture is located at the junction of Yunnan-Guizhou Plateau and the Hengduan Mountains, with an average elevation of 1974m. It is under a subtropical low latitude plateau monsoon climate, with the average annual rainfall of about 1000mm and the average annual sunshine time of 2345 hours. Due to the complex topography and vast elevation difference, the vertical difference of climate is significant. Dali Prefecture has a land area of 29459 square kilometers, with mountain areas accounting for 93.4%. The land area of steep slopes with the inclination above 25 degrees and the gentle slopes with the inclination of 8-25 degrees occupies 41% and 51% of the total area respectively. The plain sub-region area with the inclination between 0 and 8 degrees occupies only 6.6% of the total area. The plain sub-region area has 57.8% of the settlements and is the land carrying area with relatively concentrated population, relatively active economy, and urban development.

Due to the influences of the topography and the conditions of multi-ethnic areas, the urbanization of the western region of China has long been characterized by its special status and its own development. Dali Prefecture as a typical mountain city in the west of China located in the hinterland and far away from the sea is relatively backwardness and poverty. The urbanization has an increasing demand for land resources, and there is an urgent need to further study the relationship between urbanization, resources and environment.

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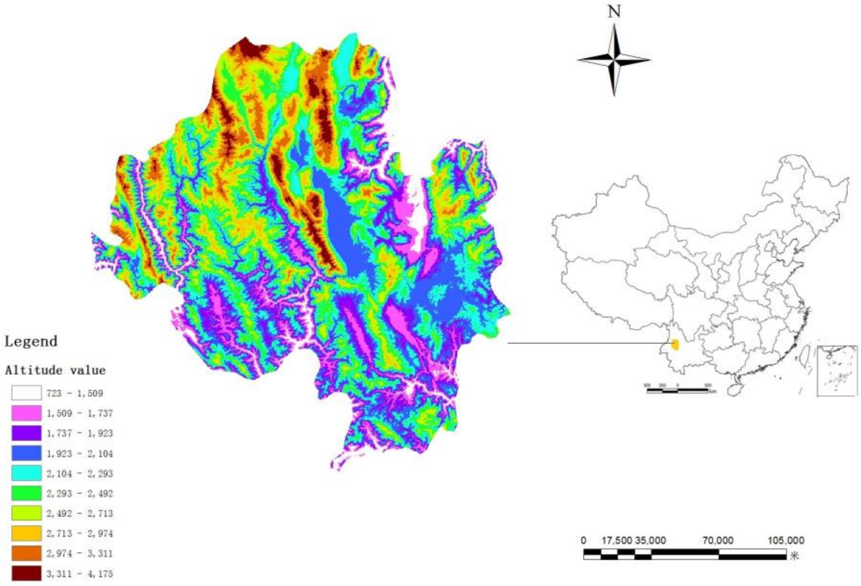

Figure 1. Study area.

2.2. Study Methods

The ecological footprint as an effective tool to measure human demand and consumption of natural resources can quantify the supply and demand of renewable resources in a region and provide a reference for the formulation of environmental economic policies and the selection of production modes[28,29].

$$ECC = N * ecc = N * \sum_{j=1}^{6} a_j * r_j * y_j \qquad (1)$$

In Formula (1), where ECC is the total ecological carrying capacity in the region in hm²; N is the total population; ecc is the per capita ecological carrying capacity in hm²/person; a_j in hm²/person is the actual per capita possession of biological production of land area in class j; r_j is the equivalence factor of class j land, and y_j is the yield factor of class j land. The "equivalence factor" and "yield factor" are based on the values published by Wachernagel in report of *Ecological Footprints of Nations*.

The gap between demand and supply of ecological carrying capacity in the region is identified. The ecological carrying capacity is represented by the ecological deficit or surplus, and the former refers to the state of ecological footprint (ecological footprint) exceeding the ecological supply (ecological carrying capacity), while latter is the opposite. The calculation formula is as follows:

$$ED(ER) = EF - ECC = N \times (ef - ecc) \qquad (2)$$

$$EF = N * ef = N * \sum_{j=1}^{n} c_j / p_j \qquad (3)$$

In Formula (2) and (3), ED is the ecological deficit in hm²; ER is the ecological surplus in hm²; EF is the total ecological footprint in hm²; and ECC is the total ecological carrying capacity in the region, expressed in the unit of hm²; N is the total population; ef is the ecological footprint per capita, expressed in hm²/person; ecc is the ecological carrying capacity per capita, hm²/person; c_j is per capita consumption of goods of class j, expressed in kg/person; p_j is the average production capacity of class j consumption goods per unit area, expressed in the unit of kg/hm².

2.3. Data sources

Data for urbanization and ecological footprint studies conducted in this paper are from the Dali Statistical Yearbook. The land use data are interpreted from Landsat ETM + high-quality image data in 2000 and 2010 and converted to a vector format for manual correction against Google Earth. Land use is divided into 8 kinds of land, namely, arable land, woodland, grassland, construction land, water, snow and ice covered land, unused land and other types.

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3. Results

3.1. Urbanization

From 1956 to 2010, the urban population increased from 112,100 to 114,180, and the urbanization rate grew from 6% to 33% with an average annual increase of 0.51 percentage point. Figure 2 shows that since the 1990s, the urbanization in Dali Prefecture has entered a period of rapid development, with a net increase of about 90,000 urban population per year, keeping a gradual increase in pace with the average level in Yunnan Province. Its urbanization has entered a period of accelerated development. However, the level of urbanization in Dali Prefecture is rather low in China. In 2010, the urbanization rate of Dali Prefecture was equivalent to the average level of China in 1998, and its urbanization rate lagged behind that of the whole country for about 12 years.

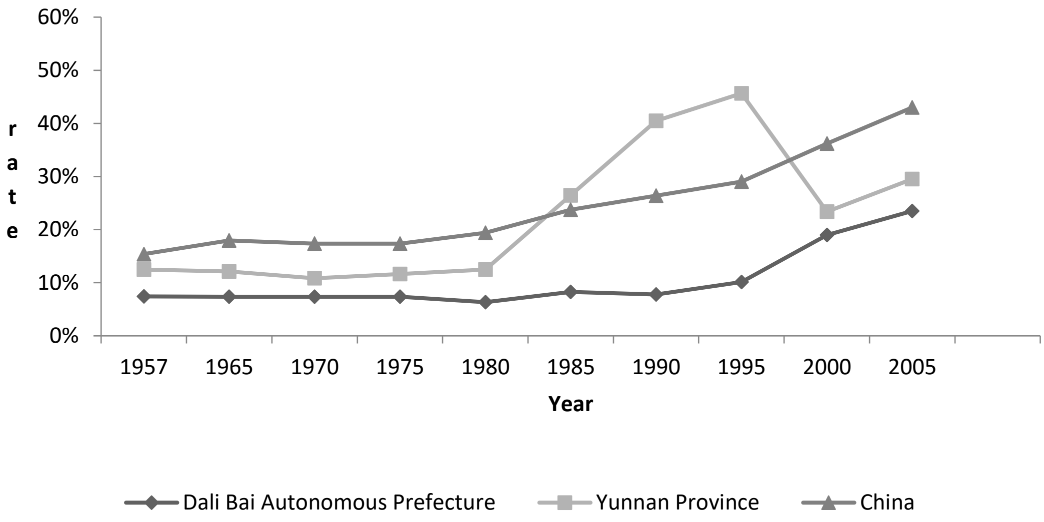

Figure 2. Urbanization rate comparison from 1957-2005.

The development of urban system in Dali Prefecture was not balanced. There were 70 towns in Dali Prefecture with the urban density of 39 people/km². The size of the urban population can be divided into the 3 grades of 200,000 or more, 150,000-200,000, 1-50,000 (Table 1), the ratio of the number of towns at each grade is 1:17:50. Only one city has a population of more than 200,000, and the number of cities with the population of about 100,000 is scarce, while cities with a population of 50,000 or less account for 73.5%. The central urban area depending on the location and environmental advantages of the Cangshan Mountain and the Erhai Lake has always been the center of Dali's economic and social activities. In 2010, the population of the central urban area reached 241,000 with an urbanization rate of 60%, while the size of non-agricultural population and urban GDP accounted for 54% and 38% of the entire region respectively, taking the lead in the steady development of urbanization. With the Cangshan Mountain and the Erhai Lake as the boundary, the development of the eastern region and the western region differed greatly. There are many plain sub-regions in the east, enabling high accessibility to transportation and rapid economic development. In 2010, the land area and cultivated area of the eastern region were 47% and 56% of that of Dali Prefecture respectively. GDP, retail sales of social consumer goods and urban population account for nearly 80% of Dali Prefecture respectively. The economic linkage between the eastern and western regions was not prominent, resulting in the fact that the organic development of the region had not yet taken shape.

Table 1. Urban hierarchical structure in 2010.

City Scale Grad	Number of cities	population（ten thousand）
> 200 thousand people	1	24.1

50-200 thousand people	17	117.9
10-50 thousand people	50	152.3

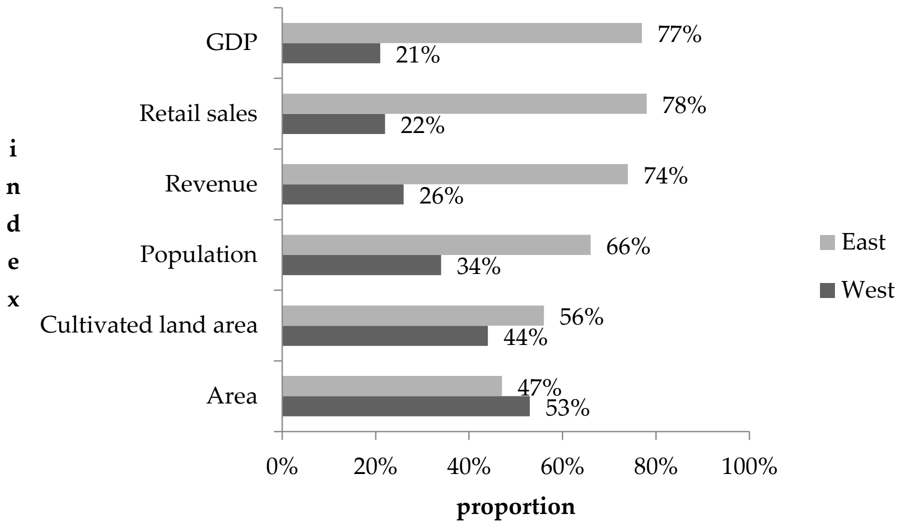

Figure 3. The spatial difference in input and output effects of urbanization in 2010.

3.2. Land use

Land use change is an important reflection of the evolution of the ecological environment. Table 2 shows that non-agricultural construction land in Dali Prefecture increased by 23,000 hm^2, with an average annual increase of 5.4%. In recent years, with the rapid economic and social development and the progress of urbanization, the growth of non-agricultural construction land will also be substantially increased. In 2010, the woodland and grassland accounted for 82.32% of the total area, and other types of land 17.68%. Compared with 2000, the woodland and grassland remained the major types of land use, and the area of arable land decreased significantly, with a decrease of 2.3%.

The land use change matrix is an important tool for analyzing the change relationship between land use types of the same area in different periods. Table 3 shows that the arable land area was reduced mainly because it was changed to woodland, grassland, unused land and construction land, and excluding the influence of the spectral content of the image interpretation, the construction land occupation and the conversion of cropland to forestland are the most important factors for the reduction of arable land. The increase of woodland was mainly attributed to the increase of vegetation coverage of arable land and grassland, and the reduction of grassland area was mainly because it was changed to woodland, reflecting that the returning grain plots to forestry in Dali Prefecture achieved remarkable results and vegetation restoration was in good condition. The increase of construction land was mainly from occupying arable land and grassland, mostly of which were in the gentle terrain, reflecting the prominent demand of Dali Prefecture for economic development. The area of water bodies reduced mainly because it was deteriorated to arable land and grassland, indicating the severe situation of wetland protection.

Table 2. Land use status change between2000 to2010.

Land type	Area(Hectare)
Arable land	-64969.2
Woodland	144066.3

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Grassland	-75598.7
Built-up land	308.9
Water	-4347.0
Ice and snow cover	-16211.4
Unoccupied land	26089.7
Other land	-9348.4

Table 3. Land use status transfer matrix between 2000-2010.

	Arable land	**Woodland**	**Grassland**	**Built-up land**	**Water**	**Ice and snow cover**	**Unoccupied land**	**Other land**
Arable land	159398.19	69883.92	42567.48	3651.21	1177.65	9503.73	18343.08	855.9
Woodland	103690.35	1423682.55	227007.63	2310.21	1767.87	7299.45	22534.56	10047.42
Grassland	69573.51	142829.1	251010.27	8220.42	2457.54	397.98	42784.47	4360.5
Built-up land	4569.03	2737.35	6838.65	9865.08	1613.43	35.55	1557.54	223.65
Water	319.68	1247.94	734.4	817.83	30701.79	15.48	59.13	364.32
Ice and snow cover	2.43	369.99	558.81	29.25	4.05	397.98	2.07	57.6
Unoccupied land	22143.24	13428.09	73389.51	1998	391.5	46.89	22451.94	302.58
Other land	1198.62	2334.69	2037.96	253.89	497.88	312.75	327.69	2118151.44

3.2. Ecological carrying capacity

The per capita ecological carrying capacity of Dali Prefecture is generally high, and the types of land with low carrying capacity are scattered across the whole area. The per capita ecological carrying capacity of various types of land varies greatly (Table 4). Among them, the per capita ecological carrying capacity of arable land is the highest, i.e., 0.583hectare/person, accounting for 44.02% of the total; the second is woodland, which is 0.490hectare/person; the lowest is the unused land, and both of its equivalence factor and yield factor are 0; in addition, that of the water area is 0.003 hectare per person, mainly due to the small area of water and the relatively low equivalence factor. The total ecological carrying capacity of each town is calculated based on the per capita ecological carrying capacity. It can be seen from Figure 4 that the spatial distribution is obviously different. In other words, the overall ecological carrying capacity in the western region is lower than that in the eastern region, mainly due to the large population accumulation in the eastern region, which is significantly more than that in the western region.

Table 4. Ecological carrying capacity per capita.

Land Use Category	**Equivalence factor**	**Yield factors**	**Land area(gha/per)**	**Carrying Capacity (gha/per)**

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Grassland	0.5	6.5	0.054	0.176
Arable land	2.8	1.49	0.140	0.583
Built-up land	2.8	1.49	0.017	0.07
Woodland	1.1	0.8	0.558	0.490
Water	0.2	1	0.014	0.003
Unoccupied land	0	0	0.005	0
Total				1.324
Total（Deduct 12% biological diversity）				1.165

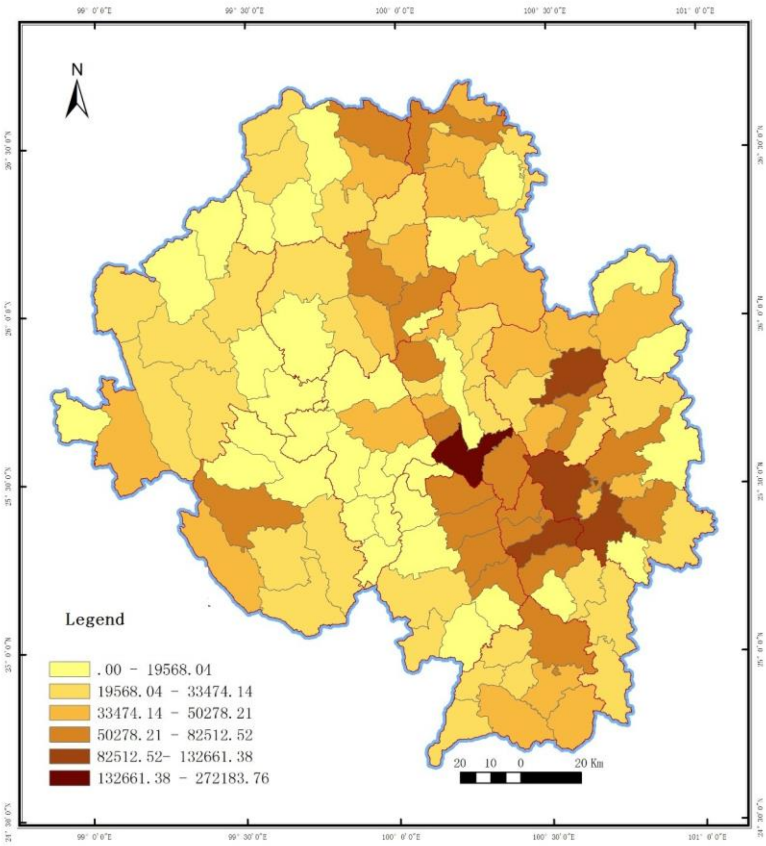

Figure 4. Distribution of ecological carrying capacity.

Per capita ecological footprint, including the footprint of bio-resources and energy consumption footprint in two parts, the calculation results are shown in the table 5 and table 6. The per capita ecological footprint of arable land is dominant in the composition of biological resources

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account. In fossil energy and construction land accounts, fossil fuel land is the main ecological occupancy. It shows that Dali's economic development is still in a continuous expansion stage. The accelerated process of industrialization has shown outstanding performance.

Table 5. Ecological footprint of biological resources consumption

	Global output (kg/gha)	Average consumption of residents (kg)	Average consumption of rural residents (kg)	Total average consumption (kg)	Ecological footprint (gha/per)	Land Use
Cereals	2744	76.33	38.17	114.495	0.042	Arable land
Starchy roots	12607	13.7	6.85	20.550	0.002	Arable land
Pulses and oilseeds	1856	6	3.00	9.000	0.005	Arable land
Meats	431	7.87	3.94	11.805	0.027	Arable land
Vegetables and fruit	18000	137.58	68.79	206.370	0.011	Arable land
Sugars and honey	4997	5.80	2.90	8.700	0.002	Arable land
Tobacco	1548	45.16	22.58	67.740	0.044	Arable land
non-staple food	3500	47.57	23.79	71.355	0.020	Arable land
Pork	74	21.29	10.65	31.935	0.432	Grassland
Beef and mutton	33	5.66	2.83	8.490	0.257	Grassland
Chickens	764	6.64	3.32	9.960	0.013	Grassland
Eggs	400	7.24	3.62	10.860	0.027	Grassland
Milk	502	24.27	12.14	36.405	0.073	Grassland
Fish and seafood	29	7.68	3.84	11.520	0.397	Water
Log	1.99	-	-	0.04	0.018	woodland

Table 6. Ecological footprint of energy consumption

	Energy consumption equivalent (SCE)	Coefficient (GJ/t)	Consumption per capita (GJ/per)	Energy footprint GJ/ (gha)	Ecological footprint (gha /per)	Land Use

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Power	40402	11.84	0.132905	1000	0.000133	Built-up land
Heating	4140.1	29.34	0.033749	1000	0.000034	Built-up land
Coal	3314886	20.93	19.27628	55	0.350478	Fossil energy land
Oil	6811.09	41.87	0.079233	93	0.000852	Fossil energy land
Natural gas	2356.54	39.98	0.026176	71	0.000369	Fossil energy land

Table 7 shows that the per capita ecological footprint is 1.143 hectare/person higher than the ecological carrying capacity, meaning Dali Prefecture is in an ecological deficit state. The comparison between the ecological footprint per capita and the ecological carrying capacity per capita of various types of land is shown in Figure 3. Among them, the per capita ecological footprint is the largest source of arable land, reaching1.637 hectares per person, which is the main source of per capita ecological footprint in the prefecture, accounting for 70.91% of the total. The least is the land for construction, which is 0.001 hectare per person. In terms of supply and demand, among the six types of land, the construction land and woodland which are 0.072ha/person and 0.471 ha/person respectively are in surplus; and ecological deficits occur in the arable land, grassland, water area and fossil fuel land. According to the results of the distribution of the ecological footprint deficit(Figure 5), the largest proportion of Dali's deficit accounts for 16.94%, followed by Xiangyun county accounting for 13.11%, while the central Yangbi county is at least 2.93%. The difference of the ecological deficit between East and West is obvious, which is high in the East and low in the West..

Table 7. Ecological carrying capacity evaluation

Land Use Category	Carrying capacity（supply）				Ecological footprint（demand）			The difference of carrying capacity (gha/per)	Carrying capacity per capita
	Equivalence factor	Yield factors	Land area(gha/per)	Carrying capacity (gha/per)	Equivalence factor	Land area(gha/per)	Ecological footprint (gha/per)		
Grassland	0.5	6.5	0.05	0.17	0.50	0.37	0.18	0.01	deficit
Arable land	2.8	1.5	0.14	0.58	2.80	0.58	1.64	1.05	deficit
Built-up land	2.8	1.5	0.02	0.07	2.80	0.00	0.00	-0.07	surplus
Woodland	1.1	0.8	0.56	0.49	1.10	0.02	0.02	-0.47	surplus
Water	0.2	1	0.01	0.003	0.20	0.40	0.08	0.08	deficit
Fossil energy land	1.1	0	0	0	1.100000	0.35	0.39	0.39	deficit

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Unoccupied land	0	0	0.005	0	0	0	0	0.00	-
Total				1.32			2.31	-	-
Total（Deduct 12% biological diversity）				1.16525				1.14	deficit

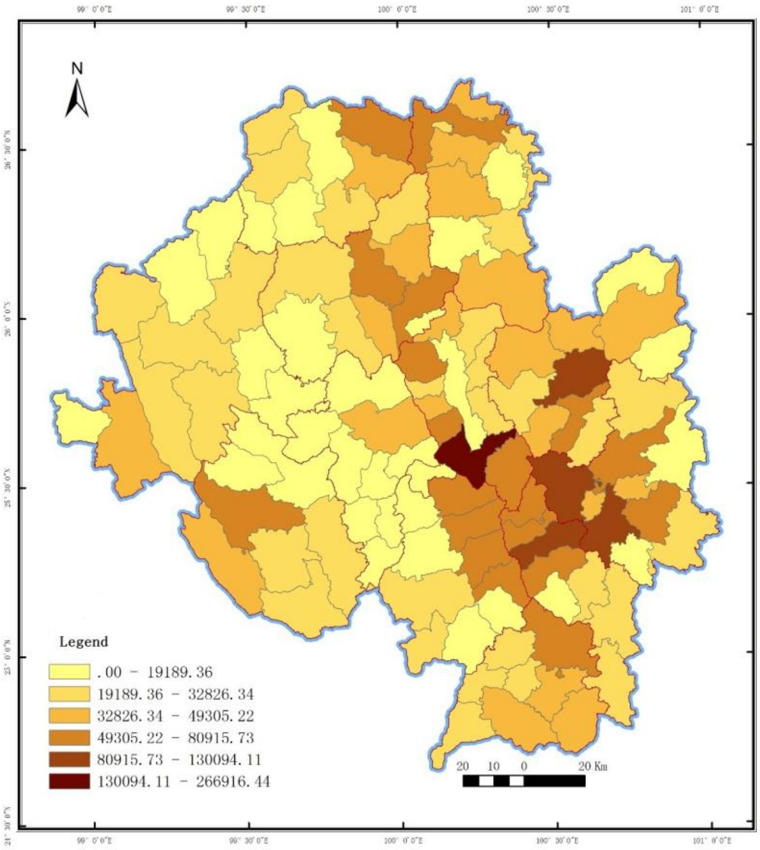

Figure 5. Distribution of ecological footprint ecological deficit.

4. Discussion and conclusions

The generation, development and evolution of cities depend entirely on the extent to which mankind uses and develops natural resources and the environment. Urban agglomeration of space does not only make the city become the strongest engine of economic development, but also changes the natural ecosystem. China, which is rapidly developing, is still at an accelerated stage of industrialization and urbanization. Industrialization and urbanization often lead to greater ecological footprint challenges, which are also the stage that developed countries have experienced. The stability of the mountain ecosystem is related to the sustainable development of China in the future[30]. In the meantime, due to the limitation of mountainous terrain in western China, the economic development of the region has lagged behind in China for a long time. The development of mountain cities faces the same problem that many underdeveloped mountain areas in the world are experiencing in their development, namely, how to achieve sustainable growth under unfavorable natural conditions.

Dali Prefecture is a typical mountain city in China. Researches show that urban development in the Prefecture presents a single center phenomenon. At present, the central urban area lack of enough attraction has limited spillover to its hinterland. The mountainous terrain has led to the unbalanced distribution of urban system in the prefecture. Therefore, the strategy of balanced spatial development is unrealistic in mountainous areas, meaning the polarization of single center will not change for a long time. With the accelerated development of urbanization and the continuous expansion of urban areas, the resources and environment per capita will grow, resulting the increasingly prominent scarcity of land resources. The spatial expansion of construction land will have a profound impact on the evolution of the ecological environment.

The ecological footprint of the prefecture has exceeded the biocapacity, and the sustainability of resources is facing increasingly serious challenges. The lack of resources for construction land arable land has the strongest impact on the economic and social development in Dali. From 2000 to 2010, the reduction of arable land was mostly due to the occupation of construction land and the conversion of cropland to forestland in the prefecture. The arable land was over-reclaimed as urban construction land, the slope arable land over 15° accounting for 29.47% of arable land had been reclaimed to the degree that it surpassed the objective conditions of topography, land form and ecological environment. Owing to the excessive and unreasonable development, the degradation of farmland ecosystem, the accelerated occurrence of debris flow, and drought disasters in some areas, have posed severe challenges to the protection of ecologically sensitive spaces.

The mountain topography determines that the future urban expansion cannot continue to occupy a large amount of arable land, and this also determines that Dali Prefecture should choose a new sustainable path, instead of following the traditional extensive urban expansion mode. It is proposed from the following three aspects. First, increase the speed and quality of urbanization. According to the growth pole theory, we should foster a reasonable urban system to strengthen the construction of a central city, improve urban functions, and increase its spillover capacity. Second, limit the ecological footprint within the renewable capability of resources. In addition to controlling the ecological footprint, it is also an important means to increasing biocapacity. The development of mountain cities cannot be separated from the natural ecosystem supporting all lives. It needed to protect the arable land in the plain sub-region and the mountain ecological environment to enhance the supply capacity of mountain ecosystems to provide human with resources such as food, water and energy, and leave sufficient space for the survival and multiplication of other species. Third, improve production efficiency. The utilization of resources in Dali Prefecture which is mainly in primary processing has low added value of resource products. In the future, it can draw lessons from the mode of "small and fine economic mode" of Switzerland in the economy of mountainous areas to guarantee the development of resource products from the aspects of capital, technology and human resources, increase the processing depth of resources, and turn resource advantages into competitive advantages, especially deep processing of biological resources.

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