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A Comparative Study on the Coevolution and Drivers of Environmental Risks and Man–Land Relationship between China and the United States from the Perspective of LUCC

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Abstract: The study of geography is centered on the regional system of the human-land relationship, and the core of the study of the geographical system of the human-land relationship is land use change. Land use is the most direct manifestation of human activities, accompanied by changes in land cover. This is the most appropriate entry point to reveal the evolution of human-land relationships. The past 300 years have been the most intense period of social change in China and the United States. In this study, we investigated the differences and evolution of human-land relations between China and the United States from the perspective of land cover change. We found: (1) Cultivated land, forest land, and grassland areas in China and the United States have changed significantly in the past 300 years. The cultivated land area has generally increased, and the extent of forest land and grassland has declined. According to the speed of land cover change, it can be roughly divided into three different stages. The change in cultivated land in China is mainly based on the enhancement of cultivation intensity. The change in cultivated land in the United States is mainly based on expansion of cultivated land. (2) The difference in land cover change between China and the United States in the past 300 years is mainly caused by the difference in social development, interpreting human-land relationships with honest feedback and social feedback. In general, with the continuous development of land, environmental issues have become increasingly prominent, and people's awareness of environmental protection has also increased. (3) The evolution of human-land relations in China and the United States has been influenced by natural and social factors for nearly 300 years. China is dominated by population, whereas the United States is dominated by technology. The relationship between humans and land differs between the two countries in some respects, with similarities in other areas. In both countries, this relationship can be characterized by the stages of relying on the environment, understanding the environment, transforming the environment, and protecting the environment. This evolution is in line with the law of social development, according to which human beings constantly recognize, utilize, and adapt to nature.

Keywords: China and the United States; the past 300 years; LUCC; man–land relationship; environmental risks

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1. Introduction

The territorial system of human–environment interaction is the core of geography research. Land use, as a direct expression of human activities, is the most concentrated reflection of the man–land relationship. Land use status in different regions reflects different characteristics of the man–land relationship [1,2]. The evolution of the man–land relationship can be revealed through the study of land cover change and its impact [3,4]. In the process of the development of man–land relations, human beings have always played a

leading role. Human activities have promoted the deepening of land cover. Meanwhile, land cover has also restricted the development of human society [5]. In 1995, the International Geosphere-Biosphere Program (IGBP) and the Global Environmental Change Humanities Program (IHDP) launched the Land Use and Land Cover Changes (LUCC) research program. Furthermore, the Global Land Project (GLP) was established in 2005. It is integral to revealing the coupling mechanism between human development and land use and its development laws [6–8]. Purposeful activities for human expansion affect the rate, intensity, and direction of natural processes. Thus, social laws influence the natural laws of environmental evolution. In the process of man–land interaction, regional differences in land use and natural rules of dynamic development imply social laws. In this process, the land is a complex of nature and society, and policymakers realize their aspirations by changing the land use structure, reflecting the state of the man–land relationship.

Throughout history, the emergence and development of man–land relationship theory have gone through stages of environmental determinism, probabilism, ecological and landscape view, etc. [9,10]. With increasing global environmental problems and the proposal of Sustainable Development Goals (SDGs) advocated by the United Nations in 2015, it is essential to explore the evolution law of the international man–land relationship. In recent years, many studies related to this topic have been carried out. Through these studies, on the spatial scale, theoretical discussions have occurred about the global man–land relationship [11–14] and the specific relationship between humans and land in small areas [15,16]. However, there is a need for more comparison of distinct regions in existing research. In addition, on the time scale, theoretical interpretations of the role of the man–land relationship in the development of human history have been posited for thousands of years [17,18], as well as quantitative demonstrations of the rapid evolution of the man–land relationship in the process of urbanization in recent decades [19,20]. However, research on the past few hundred years of human development is relatively scarce. The ability of humanity to transform nature in the early days was limited, and the relationship between man and land was relatively stable and coordinated. However, in the later period, with the development of technology, the direction and speed of the evolution of the man–land relationship changed, causing a continuous transition between man and land and a reciprocal contradiction of tension and ease [21].

China and the United States have similar latitudes and national land areas, and differences in land cover change as a result of various social development processes. Therefore, differences in changes in land cover between the two countries can inform the study of the evolution of the relationship between people and land in other societies. From the perspective of the time dimension, the past 300 years have been the most dramatic period of worldwide change and the most significant period of development in China and the United States. The project "BIOME 300" developed by PAGES in cooperation with LUCC and GAIM also emphasizes the historical evolution and driving mechanism of LUCC since the industrial revolution [22]. During this period, the United States experienced colonial expansion, national independence, and development, becoming a world power. China experienced the process of the Qing Dynasty transforming from prosperity to decline, re-establishment of the country, and development into an economic power. In this study, we selected two other social developments in China and the United States. The land cover changes in the past 300 years were comparatively studied, and the evolution of the human-land relationship was interpreted. We hope that studying the relationship between humans and complex land systems in different regions can help to elucidate global human-land relations. The law of evolution provides a reference for the sustainable development of humanity.

2. Materials and Methods

2.1. Study Area

China and the United States are the world's largest developing and developed country, respectively. The former is a traditional agricultural power, and the latter is a modern

industrial power. The difference between the two countries' natural environment and social development leads to differences in land use during different periods. The relationship between people and land is foreign. The natural environment is the internal foundation of the evolution of a human-land relationship, and the social environment is the external driving force for the development of the human-land relationship. Due to the repeated changes in the history of China and the United States, to facilitate comparative research, the scope of this study was selected as China's current mainland (excluding Hong Kong, Macao, Taiwan, and other places) and the US mainland (excluding Alaska and the Hawaiian Islands).

Regarding the natural environment, China and the United States have many similarities and differences in topography, climate, hydrology, vegetation, and soil. Regarding topography, China is a high–low ladder from west to east, and the United States also has a high–low terrain from west to east. China's climate is greatly affected by monsoons and topography, with continental monsoon climates, whereas temperate and subtropical climates dominate the United States. In terms of hydrology, China's rivers and lakes are mainly distributed in the eastern and southern regions, and most rivers flow from west to east; the American rivers and lakes are distributed primarily in the central and northeastern areas, and the main rivers run from north to south. Vegetation types are mainly affected by climate types. There are temperate evergreen broad-leaf forests, temperate grasslands, and temperate deserts in China; the vegetation types in the United States and China are similar, but the distribution of vegetation types differs as a result of topographic factors. Soil is an essential factor in the interaction of atmospheric, water, and biological circulation. The soil types in the two countries are diverse, but the soil in the United States is relatively fertile, whereas China has more desert soil and saline–alkaline soil [23].

In terms of the social environment, the social settings of China and the United States are very different. On the one hand, the differences in geographical backgrounds lead to different initial social cultures. China is in the eastern part of the Eurasian continent and has formed a continental civilization dominated by a farming society. Industrial and commercial civilizations between the Pacific and the Atlantic Oceans dominate a maritime culture. On the other hand, over time, the cultural differences caused by the initial geographical environment further expand with the social development within the region. The story of social development in China and the United States is remarkable. The United States is a developed country that has risen rapidly with the industrial revolution and represents Western social culture. China has followed the development of agriculture for thousands of years with a traditional oriental social culture [24,25].

2.2. Data Sources

The main manifestations of the past 300 years of human land use are changes in the land cover area of various types of land. Land cover types such as cultivated land, forest land, and grassland are dominant, although construction land, industrial and mining land, etc., are disturbed by humans. However, the total area of these land types is relatively small. In this study, we investigated land cover change data on cultivated land, forest land, and grassland in China and the United States for a period of nearly 300 years. The data mainly come from the research results of relevant scholars and "Global Historical Environment Data (HYDE3.2)" and "Global Land Use Data Set (SAGE2010)" [26,27].

China's nearly 300 years of arable land data were re-established based on data from Ge et al. (1661–1949) [28] and Feng et al. (1949–2003) [29]; forest land data were quoted from He. et al. [30]. Grassland data were derived from reconstruction data from Ramankutty et al. [31]. The past 300 years of arable land data in the United States were derived from HYDE 3.2 [32]. US woodland and grassland data (grassland data included in the HYDE dataset) were derived from the 1700–1992 data reconstructed by Ramankutty et al. [31]. Some scholars have evaluated multiple datasets, with the most evaluations of the SAGE2010 cultivated land data is significantly higher. Chinese regional information is more accurate and based on the revised historical data, with some such data adopted in the HYDE3.2 dataset.

Historical population data and environmental change data are essential for interpreting human-land relationships. Chinese population data were quoted from Cao et al. [33], whereas US population data were derived from the HYDE 3.2 dataset. China's environmental change data were mainly derived from China's environmental statistics, "China Local History Document Database" (http://dfwx.datahistory.cn/pc/, accessed on 10 May 2022), "People's Land System Theme Database" (http://www.data.ac.cn/, accessed on 10 May 2022), and other related data. US environmental change data were mainly obtained from the Environmental Science Database (NOAA) (https://www.noaa.gov/, accessed on 10 May 2022), the "Global Integrated Disaster Database" (https://www.emdat.be/, accessed on 10 May 2022), US Environmental History, and other information.

2.3. Research Method

In this paper, we focus on the changes in land system properties caused by human activities and in the human-land relationship territorial system has both natural and social properties, with initially strong natural properties. With the strengthening of external human disturbances, the natural properties of the land weaken, and the social properties gradually strengthen [34,35]. The representation of "land" in the territorial system of the human-land relationship is based on natural attributes. In contrast, the representation of "people" is based on social attributes, decreasing natural attributes and increasing social attributes of land: forest ecosystem, grassland ecosystem, arable agricultural system, urban settlement system, etc. Due to data limitations when considering long time scales, in this study, we focus on analyzing the natural and social attributes of three land systems: forest, grassland, and arable land. Because the natural and social attribute intensities differ depending on land cover type, they are corrected by the natural and social attribute intensity indices for each type of land. In this study, we use the unit land natural attribute index to reflect the resource and environmental carrying capacity of the land system represented by "land" and the unit land social attribute index to reflect the dynamics of human activities represented by "people". The state of the human-land relationship is described by the ratio of the social attribute index to the natural attribute index of the land. The higher the ratio, the greater the relative tension between humans and land.

(1) Unit land natural property index:

$$In = \sum_{i=1}^{n} \lambda_i \times s_i / S \quad (1)$$

where I_n indicates the natural attribute index of land use, and $0 < I_n \leq 1$; the larger the I_n value, the stronger the natural attributes of the land and the smaller the external human interference, with a relatively gentle human-land relationship; λ_i is the intensity index of natural attributes for different land use types; and S is the total area of regional land use.

(2) Social attribute index per unit of land:

$$Is = \sum_{j=1}^{n} \lambda_j \times s_j / S \quad (2)$$

where I_s indicates the social attribute index of land use, and $0 < I_s$ 1; the larger the value of I_s, the stronger the social attributes of the land and the greater the external human interference, with relative tension in the human-land relationship; λ_j is the social attribute intensity index of different land use types; s_j is the area of each land use type with social attribute characteristics; and S is the total area of regional land use.

(3) Human-land relationship intensity index.

$$R = I_s / I_n \quad (3)$$

where R is the characteristic value of the evolutionary state of the regional human-land relationship; the larger the value of R, the stronger the social attributes of the unit of land and the weaker the natural attributes, with a gradual tension of the human-land relationship.

The spatial and temporal characteristics of land cover change are explored by analyzing the changes in natural and social attribute indices per unit of land in the last 300 years in China and the United States and comparing the changes in land cover of the same species in the two countries. Combined with the interpretation of typical environmental events in the past 300 years in China and the United States, the evolutionary state of the human-land relationship is explored.

From the perspective of a regional system, land use structure is the plane projection of the regional system of human-land relationships. As far as people and land are concerned, the performance of human beings is mainly the change in cultivated land area caused by maintaining consumption. The performance of the land is primarily the change to forest land and grassland area accompanying land reclamation [36,37]. Owing to the use of different land use methods such as farming, grazing, logging, settlement, and urban land use, various land cover types have been implemented. In response to these land cover changes, nature and society provide specific feedback, which can reveal the characteristics of human-land relationships. Natural feedback is mainly related to environmental problems such as soil erosion, land desertification, and environmental pollution, whereas social feedback is primarily reflected in relevant social conditions such as policy systems, population change, and ecological awareness [38,39]. The direct effect of natural and social feedback on stress tolerance is difficult to measure quantitatively, but there is a correlation between these types of feedback when analyzed in conjunction with related factors. Although the abovementioned natural and social changes are also affected by other factors, land cover change is one of the critical factors.

In studying the land cover changes in China and the United States for nearly 300 years, analyzing environmental problems such as environmental pollution and ecological damage is conducive to evaluating the relationship between humans and land. Moreover, exploring the social environment in terms of population, policy, and technology is conducive to interpreting the differences and evolution of human-land relationships [40]. In addition, China and the United States have vast territories, and the characteristics of human-land relations also differ between regions within a country. The features and evolution of the relationship between China and the United States are studied by combining specific regions with the whole (Figure 1).

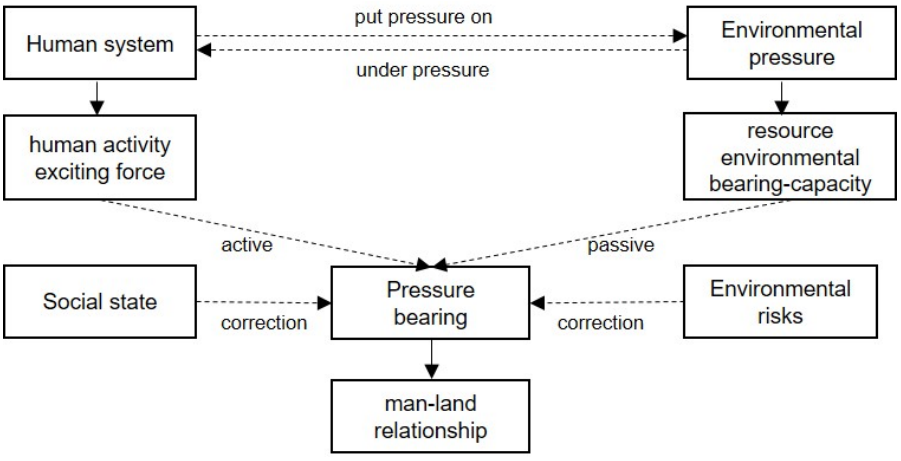

Figure 1. Man–land relationship evaluation framework based on resource and environmental carrying capacity.

3. Results

Land is one of the most important natural resources, and the suitability and restriction of land resources lead to differences in the development of land complexes. The relationship between humans and land is essentially restricted by land carrying capacity. By analyzing the characteristics of land use changes in China and the United States in the past 300 years and classifying the stages of land use change, in this paper, we examines the natural and

social impacts of land use based on demographic and environmental changes. Furthermore, we interpret the relationship between people and land in different periods.

As shown in Figures 2 and 3, the cultivated land area of China and the United States has generally increased in the past 300 years, but the latter has changed more markedly. As a long-standing agricultural country, China's traditional agrarian area was deeply reclaimed 300 years ago. In 1700, the size of cultivated land in China reached nearly 62 $\times$ 10^4 km^2 compared 107 $\times$ 10^4 km^2 in 2000, an increase of 0.72 times. In contrast, for the United States, the cultivated land area was only 0.63 $\times$ 10^4 km^2 in 1700, whereas in 2000, it was 178 $\times$ 10^4 km^2, which is an increase of 282 times. It is noteworthy that the United States has covered the entire history of its development over the past 300 years because of its short history. Before 1700, there was only a tiny amount of land use.

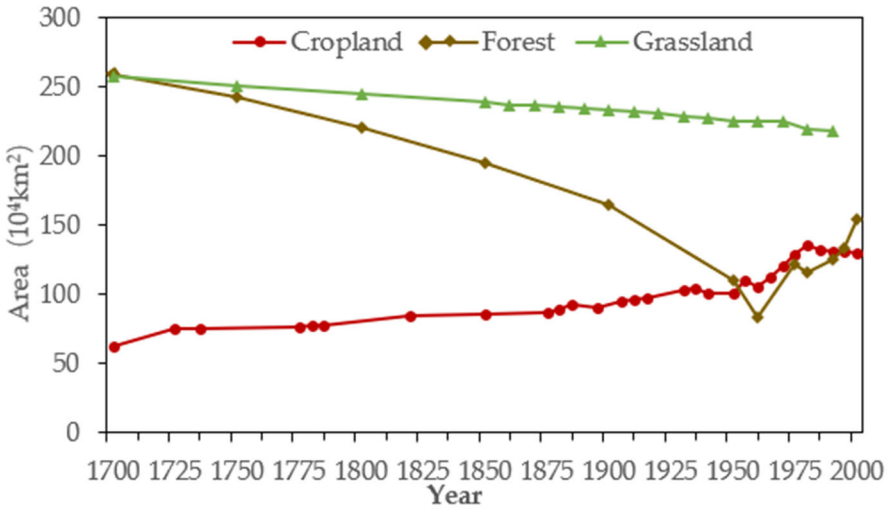

Figure 2. China's cultivated land, forest land, and grassland trends in the past 300 years.

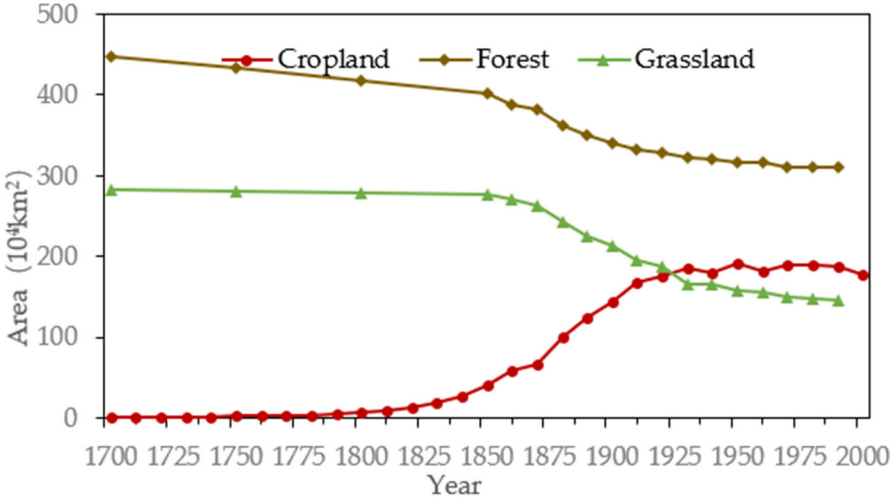

Figure 3. Trends in cultivated land, forest land, and grassland in the USA in the past 300 years.

In the past 300 years, the forest and grassland areas of China and the United States have generally declined. The forest area in China has changed dramatically, with an increasing trend in the recent period. In 1700, China's forest area was 259 $\times$ 10^4 km^2, and the grassland area was 258 $\times$ 10^4 km^2. At the end of the 20th century, the forest and grassland areas were 154 $\times$ 10^4 km^2 and 218 $\times$ 10^4 km^2, respectively, with a more rapid reduction in forest land, mainly because traditional plains have been exploited before, and people can only turn forested areas into mountain developments. However, in the 1970s, forests were restored through ecological projects, e.g., returning farmland to forest. In

1700, the number of forests and grasslands in the United States was large, with areas of 447×10^4 km^2 and 282×10^4 km^2, respectively. However, by the end of the 20th century, the areas of forest and grassland were 310×10^4 km^2 and 145×10^4 km^2, respectively, with a more rapid reduction in grassland, mainly because the vast central plains were subdued and cultivated during the westward movement.

In the past 300 years, the rate of change in land cover area in China and the United States has varied due to different driving factors. From the perspective of the stage characteristics of land development, the trend of land cover area change in China in the past 300 years can be roughly divided into three phases: 1700–1880, 1880–1960, and 1960–2000 (Table 1). The trend of the land cover area in the United States in the past 300 years can be roughly divided into three stages: 1700–1850, 1850–1930, and 1930–2000 (Table 2). To describe land area changes, in this article, we define an average annual growth rate below 1% as a slow growth phase and an average annual growth rate above 1% as a faster growth phase with increasing land area. When the land area decreases, an average annual growth rate above −0.1% is defined as a slow decreasing phase, and an average annual growth rate below −0.1% is defined as faster decreasing phase.

Table 1. Stage characteristics of cultivated land, forest land, and grassland areas have changed in China in the past 300 years.

China	Year	1700–1880	1880–1960	1960–2000
Cultivated land	Average growth rate per annum	0.22 Slow growth	0.17 Slow growth	0.53 Fluctuating growth
Forest land	Average growth rate per annum	−0.23 Decrease	−1.08 Decrease	1.70 Fluctuating growth
Grassland	Average growth rate per annum	−0.05 Slight decrease	−0.06 Slight decrease	−0.11 Decrease

Table 2. Stage characteristics of changes in cultivated land, forest land, and grassland area in the United States in the past 300 years.

USA	Year	1700–1850	1850–1930	1930–2000
Cultivated land	Average growth rate per annum	2.82 Rapid growth	1.91 Rapid growth	−0.06 Fluctuating decrease
Forest land	Average growth rate per annum	−0.07 Slight decrease	−0.28 Decrease	−0.06 Slight decrease
Grassland	Average growth rate per annum	−0.01 Slight decrease	−0.64 Decrease	−0.23 Decrease

As shown in Table 1, the land cover change in China has undergone a long and slow period of transition. In the middle and late 20th century, land use gradually accelerated, and cultivated and forest land fluctuated significantly. China's cultivated land area grew slowly in period of 1700–1880; the forest land and grassland area decreased gradually in the same period, but the forest land decreased faster than the grassland, with a forest land area growth rate of −0.23%. In the period of 1880–1960, the cultivated land area continued to grow gradually; in the same period, the grassland area decreased gradually, and the size of forest land fell rapidly, with a growth rate of forest land area of −1.08%. The reduction in the area of forest land is mainly due to the expansion of newly developed mountain areas. From 1960 to 2000, the cultivated land area in China fluctuated. The area of forest land also fluctuated, and the grassland area decreased rapidly.

As shown in Table 2, land cover changes in the United States started earlier than those in China. In the mid—19th century, land use began to accelerate, but the fluctuation in cultivated land in the later period decreased. The area of cultivated land in the United

States increased rapidly from 1700 to 1850; the area of forest land and grassland decreased slowly during the same period. During the period of 1850–1930, the area of cultivated land maintained rapid growth; in the same period, the area of forest land and grassland decreased rapidly, with a more rapid decrease in forest land and a grassland area growth rate of −0.64%. The reduction in grassland area was mainly due to the expansion of cultivated land to grasslands. From 1930 to 2000, the area of cultivated land fluctuated and stabilized, and the area of forest land and grassland decreased slowly.

As shown in Figures 4 and 5, there have been significant differences in land development between China and the United States in the past 300 years. China's cultivation intensity has mainly been enhanced, and the United States has experienced an expansion of its reclamation space, whereas China's spatial extent of land reclamation has experienced more minor changes. The overall scope of reclamation land has gradually expanded from the eastern to the northeast and northwest regions. The lifting of the Manchurian ban in the late Qing Dynasty prompted the development of land in the northeast and Inner Mongolia. Immigration and real estate policies promoted the development of the northwestern region, such as Xinjiang province. Owing to the large amount of forest land in the region, the area of forest land was reduced faster than the grassland area (Figure 1). The intensity of land reclamation in China has changed dramatically. In the early stage, cultivation intensity increased continuously in the Huabei Plain and the Guanzhong Plain. Later, the intensity of cultivation also increased in the Northeast Plains, the middle and lower reaches of the Yangtze River, and the Sichuan Basin. China's areas with high land reclamation intensity are mainly distributed in the eastern and central regions. They continue strengthening to the south and north under the influence of the political economy. Due to the constraints of topography and hydrothermal conditions, it is only possible to adopt intensive farming practices to support more people, and the cultivation intensity of traditional farming areas is continuously being enhanced.

The scope of land reclamation in the United States has changed dramatically, expanding from east to west. With the early colonial expansion of the United States through "Westward Movement" after the founding of the People's Republic, the spatial changes that led to the colonization of the United States had clear political drivers. Because the first three settlements of the United States were in the northeast, the land development continued with the continued expansion of the territory—Changes in the scope of cultivation. In addition, the "Westward Movement", which began in the late 18th century and lasted for hundreds of years, prompted the living space to expand westward across the Appalachian Mountains. Due to the many grasslands in the central and western regions, the grassland area shown in Figure 2 decreased faster than the forest land area. The intensity of land reclamation in the United States has also significantly changed. The reclamation intensity of the Great Lakes and Central Plains has increased, both of which have flat terrain and abundant hydrothermal resources. The scope of land reclamation and the intensity of reclamation in the United States are simultaneously driven by technology, especially by the outbreak of three industrial revolutions, which have promoted the development of agricultural mechanization in the United States. Agricultural mechanization progressed until the middle of the 20th century. In addition, agricultural breeding, irrigation, and other technologies have promoted the increasing intensity of land reclamation in major grain-producing areas.

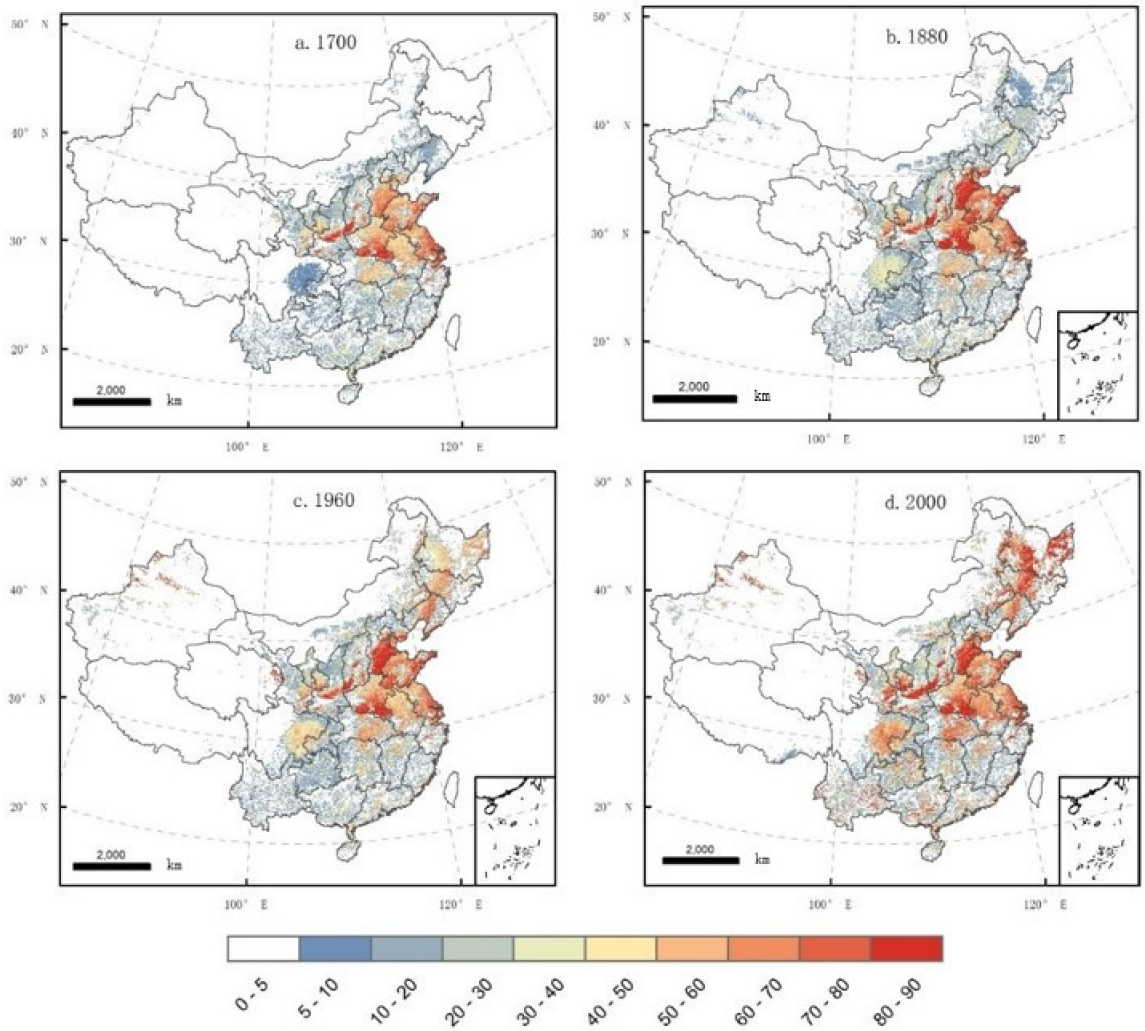

Figure 4. Dynamic map of the reclamation space in China in the past 300 years (**a**–**d**).

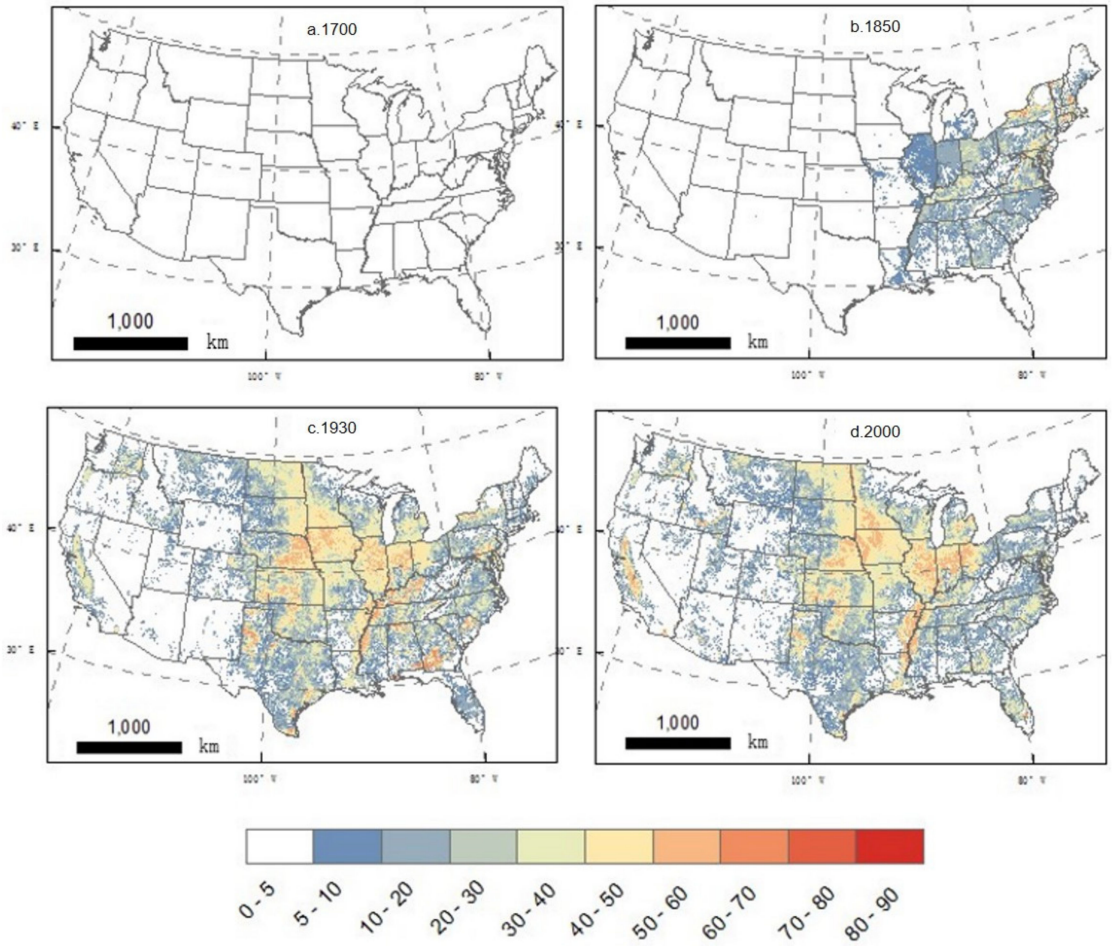

Figure 5. Dynamic map of the reclamation space in the United States in the past 300 years (**a**–**d**).

4. Discussion

4.1. Environmental Risks

The environmental effects of land cover change are most evident in the evolution of natural environmental risks. Land cover change affects atmospheric, soil, water, and biological elements in the region. These changes lead to changes in ecosystem structure and function over a long period, resulting in changes in external environmental conditions such as land productivity, water, heat balance, etc. This series of environmental effects is eventually fed back to affect land cover changes. Ecosystem imbalance and biodiversity reduction caused by land cover change are the main manifestations of ecological problems. Still, given the limitations of the database and measurement methods, a systematic analysis is focused on land cover area change and the more obvious environmental risks. There is specific information about the general applicability of the conclusions; in addition to China and the United States, many countries, including India and countries in Southeast Asia, have seen changes in land cover over the past several hundred years driven primarily by social development, with population increases most directly leading to an increase in the rate of cultivated land settlement, which can result in the area of other land cover being affected. Combining the spatial and temporal characteristics of land use changes in China and the United States over the past 300 years, we analyzed the causes of and responses to typical natural hazard events to explain the synergistic evolution of environmental risk and human-land relations.

The early land development within the borders of China and the United States has affected land use and human-land relations over the past 300 years. China's Yellow River Basin and the Yangtze River Basin are areas of early activity in the Chinese nation.

Traditional farming areas were developed more than 300 years ago. China has experienced a relatively complete process of human social development; from primitive society dominated by hunter–gatherers to slash-and-burn slave society and the feudal society of iron-plowing cattle, the continuous growth of agricultural technology accelerated the process of land use. China's ancient theory of human-land relations has also been enriched in transforming nature. Theories of harmony between man and nature, humans and land, and human beings and human beings have been posited [41]. Since the establishment of the Qing Dynasty in 1636, people have realized a transition from the initial environment-dependent scenario.

Before the discovery of the New World, the development of American civilization was slow. The original inhabitants, i.e., the Indians, were mainly hunter–gatherers, and only the southwestern part of the eastern plains and other areas of agriculture had been initially developed. After the new North American route was opened, the European colonists washed away the Inca and the Mayan civilizations. American culture had been established through European society. Ancient civilization has less connection with modern sophistication. The ideas of the indigenous people on land use and human-land relationships have less influence on the later stage than those of the outsiders [42]. In 1620, the Mayflower opened the way for European immigrants to North America, who created early American civilization in the late 17th century. The opening of new routes and the colonial expansion of European countries in North America accelerated the process of land use in North America from the initial dependence on the environment to an understanding of the environment.

4.1.1. The Emergence of Environmental Problems

From 1700 to 1880, the area of cultivated land in China grew slowly, and the area of forest land and grassland decreased gradually. Since the establishment of the Qing Dynasty, the population has increased rapidly due to social stability and agricultural development, and the contradiction between people and land has become prominent. In 1740, the Qing court ordered the provinces to open up new sporadic land exemptions. This kind of colonial policy was, on one hand, a lifting of an informal ban on the development of mountain and forest areas and, on the other hand, a preferential tax exemption for mountainous areas in order to promote an increase in the area of cultivated land. In addition to wasteland reclamation, agricultural production was expanded during this period through the promotion of new crops such as sweet potato and corn. The characteristics of drought tolerance and low temperature of maize coincide with the demand for mountain agriculture, which prompted more forest land to be converted into cultivated land [43]. In the Kangxi period, the Hu Guang people started the Sichuan movement. They encouraged immigrants from other provinces to enter the Sichuan Province, prompting the rapid disappearance of forest resources in the Sichuan-Yunnan region. Hunan and Hubei provinces also expanded their cultivated land through reclaim the lake regions during this period. In the later period, floods in the Yangtze River Basin were frequently linked to excessive land reclamation [44]. During this period, a significant increase in population caused severe damage to the ecological environment through immigration and reclamation. Cultivation expanded to the northeast, Inner Mongolia, and the northwest, causing many forests and grasslands to be destroyed, resulting in land desertification, soil erosion, drought, and flooding in many areas, with frequent natural disasters. During this period, Chinese society changed from understanding nature to transforming nature, and the relationship between people and land gradually became tense.

From 1700 to 1850, cultivated land in the United States began to proliferate, and the forest land and grassland area decreased slowly. The early 18th century was foundational for the United States, and the number of colonies gradually increased. Early Virginia had formed a tobacco plantation economy based on slave labor, and immigration and trafficking of enslaved people increased the population. In the mid-18th century, the 13 British colonies in North America formed a federal state through the War of Independence; since then, land development has been driven by land policy. The United States then began selling off public lands east of the Mississippi River and west of the Appalachian Mountains, in 1785

with the Northwest Ordinance. In the early 19th century, the United States undertook a massive Westward Movement, with many immigrants crossing the Appalachian Mountains to reclaim land in the West [45]. The first industrial revolution in the late 18th century provided the impetus for the development of productivity and further accelerated the process of land exploitation. During the Westward Movement, the dominant expansionist ideology of "man can conquer nature" seriously damaged the ecological environment. Overcultivation and deforestation contributed to the massive loss of forest in the Tennessee River Basin, with nearly 85% of arable land severely eroded [46]. The prairie region west of the Mississippi River has experienced accelerated sanding and a dramatic decline in vegetation cover of high-quality forage grasses due to overgrazing. The US transitioned from understanding nature to transforming it during that period, and the relationship between man and land became progressively more tense.

4.1.2. The Aggravation of Environmental Problems

From 1880 to 1960, the area of cultivated land in China grew slowly, the area of forest land decreased rapidly, and the area of grassland decreased gradually. After the New Deal in the late Qing Dynasty, the mainland Chinese population immigrated to the frontier regions by liberalizing the "full ban". In the climax of this "immigrant real side", the eastern and western parts of Inner Mongolia had more than 30 million mu of cultivated land, and the forests in the northeast were severely diminished [47]. In the later period, the regime followed the "Montene and Hanization" policy. Comprehensive arbitrage and indiscriminate policies led to severe damage to the grassland ecology of Inner Mongolia and a dramatic reduction in the grassland area. Domestic wars were frequent in the early 20th century, and many originally cultivated lands were abandoned. After the founding of the People's Republic of China, the increase in cultivated land was mainly based on cultivated land reclamation. There was also some newly cultivated land. The "Great Leap Forward" movement, which began in 1958, caused severe ecological damage and environmental pollution in the short term. In addition, the agricultural sector implemented a one-sided "grain-oriented" policy. Under the encouragement of the "war on the natural world", a considerable amount of deforestation took place, as well as the abandonment of grazing and land reclamation, and the ecological environment was seriously damaged [48]. Although the Chinese government began to pay attention to environmental issues in the early days of the founding of the People's Republic of China, environmental awareness was still in its infancy. During this period, people mainly focused on transforming nature, and the contradiction between people and land was prominent.

From 1850 to 1930, the area of cultivated land in the United States increased rapidly, the area of forest land decreased, and the area of grassland quickly decreased. In the middle and late 19th century, the North and South fought fiercely over land in the West. The subsequent Civil War abolished slavery and paved the way for capitalist economic development. In order to promote land reclamation, in 1862, citizens could apply for 160 acres of federal land through the provisions of the Homestead Law [49]. The second industrial revolution, which began in the late 19th and early 20th centuries, significantly promoted the process of agricultural mechanization in the United States and enabled the large-scale reclamation of the western grasslands, in addition to causing severe environmental problems. The most typical incident is the "black storm" disaster in the United States in the 1930s; a large area of grassland reclamation caused sand to form sandstorms. Natural disasters such as persistent droughts, fires, and blizzards erupted, destroying many wheat fields, collectively hailed as "the three major man-made ecological disasters in history" [50]. In addition, biodiversity was destroyed, tens of thousands of bison were hunted, and species such as the western grey wolf became extinct. Subsequently, the United States successively promulgated the "Timber Culture Act" and the "Desert Land Act" to strengthen environmental management. During this period, people mainly focused on transforming nature, and the contradiction between people and land was prominent.

4.1.3. The Mitigation of Environmental Problems

From 1960 to 2000, China's cultivated and forest land area increased rapidly, with a more rapid restoration of grassland area. In the early days of the People's Republic of China, a rapid industrialization process occurred, with a sharp increase in population and severe damage to the ecological environment. Due to the destruction of vegetation, a large amount of soil erosion occurred. From the late 1950s to the early 1970s, the soil erosion area accounted for about 1/4 of the total land area, and ten counties lost more than one million mu. In addition, the 1998, the Yangtze River flooded in association with early upstream vegetation deforestation [51]. To restore the ecological environment, China has successively established environmental protection measures such as the establishment of nature reserves, the "Three North" shelter forest project, and "returning farmland to forests and grasslands" [52]. In addition, China began to experience environmental pollution problems in the 1970s. In the 1980s, urban river and air pollution became more serious. According to statistics, in 1987, nearly 42% of urban drinking water was polluted. The large-scale burning of fossil fuels intensified air pollution and gradually spread to the countryside. The first photochemical pollution incident occurred in the Xigu area of Lanzhou [53]. A massive pollution accident in the Huaihe River in 1994 led to the death of many fish and shrimp in Hongze Lake [54]. China introduced laws and regulations such as the Environmental Protection Law in response to these environmental problems; several ecological restoration projects have been carried out, and in addition to active participation in global environmental protection activities. During this period, people changed from activities transforming nature to protection of nature, and the contradiction between people and land began to ease.

From 1930 to 2000, the fluctuation in cultivated land area in the United States stabilized, the area of forest land decreased slowly, and the area of grassland decreased rapidly. In the middle of the 20th century, the rise of the third industrial revolution further promoted the development of American productive forces and led to a rapid increase in the population. The resource consumption caused by industrial development and population growth led to ecological damage and environmental pollution, including the black dust storms in the Great Plains of the West in the early 1930s, photochemical smog events in Los Angeles in 1943, and the Donovan smog events [55]. The United States has successively issued natural resource protection policies such as the Agricultural Land Protection Law to protect the ecological environment. With the continuous deepening of the concept of environmental protection, the United States has established numerous environmental protection agencies and actively enacted legislation to improve environmental quality. During this stage, the idea of environmental protection has gradually increased from a regional to global concept. International organizations such as the World Environmental Protection Organization (IUCN) and the World Wide Fund for Nature (WWF) emerged during this period. In 1980, the World Conservation Union (IUCN), the United Nations Environment Program, and the sustainable development theory proposed by UNEP were widely recognized by countries around the world [56,57]. During this period, people changed from activities of natural transformation to protection of nature, and the contradiction between people and land began to ease.

4.2. Reasons for Differences in the Man–Land Relationship between China and the United States

Other social developments have resulted in differences in human-land relations between China and the United States. The specific driving factors have evolved with the development of society. As the changes described above occurred, land and political factors remained relatively stable, with active fluctuations in the population and technical factors. In general, the evolution of man–land relations in China is mainly driven by the population. In contrast, the evolution of the relationship between humans and land in the United States is primarily driven by technology. In this paper, we compare the two countries by focusing on land, population, technology, and political selection.

4.2.1. Land

With the turmoil of the Chinese and American regimes, the two countries have also undergone significant changes in their territories, which has led to the evolution of their land resources. During the late Qing Dynasty, through a series of treaties, Russia circumvented large areas of land in northeastern and northwestern China, with a total area of more than 1.5 million square kilometers. In addition, the independence of modern Mongolian countries caused heavy losses in northern China's territory [58]. Losing these territories also intensified the tension between the people and the land. In the same period, with the growing strength of the country and the increasing population, to alleviate the stress of the people, the United States continued to expand westward through purchase and expansion, eventually expanding from the initial 13 states of more than 710,000 square kilometers to the current 50 states covering more than 9.3 million square kilometers. [59]. The rapid expansion of the US territory eased potential human-land conflicts.

4.2.2. Population

The populations of China and the United States have been increasing continuously over the past 300 years, which has driven land development. During the Qing Dynasty, China's population increased continuously. Although the population was reduced as a result of war in the late Qing Dynasty, the population growth rate increased after the founding of the People's Republic, from 170 million in the early Qing Dynasty to 1.3 billion at the end of the 20th century [60]. Because the United States is an immigrant country, the population base was small initially. However, there were many waves of immigration in the 19th century, and the population increased from 0.01 billion in 1700 to 280 million in 2000 [61]. China's per capita arable land has decreased. Since the early days of the United States, with the expansion of territory and mechanization, the per capita arable land has increased. However, due to the increase in population, the per capita arable land has also gradually decreased.

4.2.3. Technology

The three industrial revolutions of the past 300 years have promoted the rapid development of productivity and greatly enhanced the ability of humanity to change nature. China's traditional farming techniques are relatively advanced, but due to the "closed country" in the Qing Dynasty, modern scientific and technological development have been slow [62]. Traditional "intensive cultivation" promoted land to be used as economically as possible, and the degree of agricultural mechanization was improved after the founding of the People's Republic of China. The United States was greatly affected by the three industrial revolutions. In the 1940s, the rate of agricultural mechanization was already high, making up for the shortage of traditional labor resources. In the later period, agricultural management, chemical fertilizers, and pesticides were continuously developed [63].

4.2.4. Policy

The governments of China and the United States directly impact land use by formulating policies related to land, taxation, population, and environmental protection. Since the Qing Dynasty, China has promoted land reclamation in border areas through policies such as "immigrants' real sides" and "bending borders". In addition, lifting of the ruler's "banned" and "full ban" led to the development of Inner Mongolia and the northeast [47]. After the founding of the People's Republic of China, the previous "food as the key" and later "returning farmland to forests and grasslands" and other policies directly affected China's land use change [48].

In the early days of the founding of the People's Republic of China, the "Northwestern Act" and the "Homestead Act" were enacted to carry out "Westward Movement" to accelerate land development. However, due to environmental problems, the "Clean Water Law" and "Soil Protection Law" were also used to supervise the rational use of land [56].

4.3. Evolution of Man–Land Relationship in China and the United States

In the past 300 years, the evolution of the man–land relationship in China and the US has resulted in spatial temporal differences. In addition, the conflict between humans and land was minimal in the early stage and intense later. The evolution of the relationship between Americans and the land was low and slow in the early stage. This evolutionary process is closely related to the social development of the two countries. Through this study, we analyzed the evolution of the relationship between man and land in China and the United States using the environmental Kuznets curve. Kuznets discovered that the per capita income and income distribution evolve in an inverted U-shape over time. The inverted U-shaped curve is called the Kuznets curve (KC). At the end of the 20th century, some scholars found that the relationship between per capita income and the degree of environmental degradation also showed a similar inverted U-shaped feature. Subsequently, a large number of scholars used the "environmental Kuznets curve" (EKC) to analyze the inverse U-shaped relationship between per capita income and environmental degradation [64,65]. Through the comprehensive analysis of economic development and land cover in China and the United States for nearly 300 years, we can interpret the evolution of human-land relations through environmental changes.

Environmental degradation is caused by many factors and has different relationships with economic growth in different periods. The ecological degradation of China and the United States in the past 300 years mainly manifests as ecological damage such as reductions in forests and grasslands. China's environmental degradation, as a developing country, is related to population pressure and low productivity, whereas in the United States, as a developed country, environmental degradation is related to excessive consumption and agricultural mechanization [14]. By interpreting the intrinsic relationship between forest land cover, grassland cover change, and per capita GDP in China and the United States in the past 300 years, combined with the use of the environmental Kuznets curve to study the peaks of Chinese and American environmental curves, we can interpret the evolution process of the human-land relationship in the two countries during different periods (Figures 6 and 7).

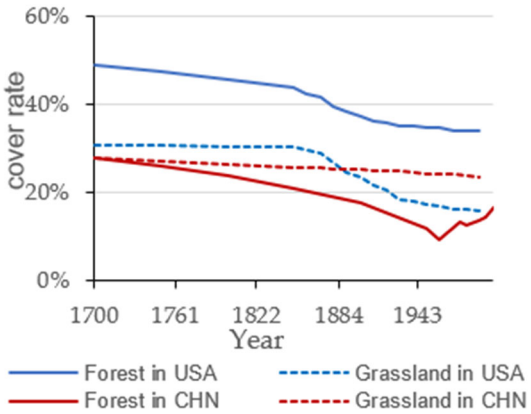

Figure 6. Changes in forest and grassland cover rates in China and the United States for nearly 300 years.

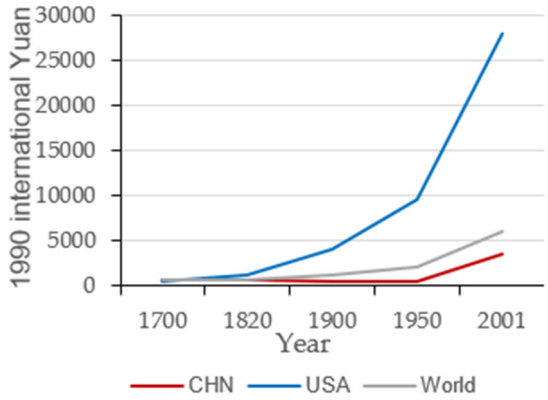

Figure 7. Changes in GDP per capita in China, the United States, and the world.

Combined with the above data analysis, the environmental Kuznets curve law shows a general trend of environmental degradation and economic development in China and the United States (Figure 8). The process of environmental change is differs between the two countries due to differences in social development. At first, China's economic development level was high, and environmental degradation was more severe than that of the United States. However, in the later period, the US economy surpassed China, and the rate of environmental degradation increased. As their economies continue to develop, the United States and China will gradually reach the peak of the environmental degradation and progressively move towards an ecological balance driven by external factors. Still, the economy, policies, and population will affect the specific evolution process. Overall, the environmental degradation rates of both China and the United States have intensified with economic development over the past 300 years, eventually leading to ecological imbalances. However, with environmental problems, the improvement of production efficiency, and people's demands for a better living environment, people began to protect nature. Many factors drove the environmental degradation rate to reach a peak, after which it gradually declined, and the environment returned to equilibrium. However, the relationship between man and land is delayed by land cover change. Many scholars have doubts about the environmental Kuznets curve. They believe that economic development only sometimes leads to environmental improvement. The notion that economic growth will automatically solve ecological problems is too optimistic and requires further investigation. To achieve coordinated development between people and the environment, countries at different action stages must formulate relevant policies to actively promote environmental protection.

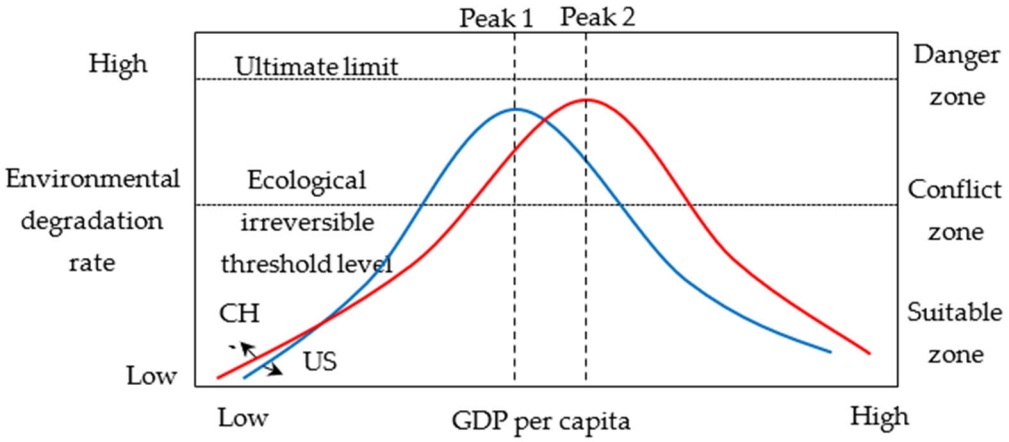

Figure 8. Environmental Kuznets curve for nearly 300 years in China and the United States.

In the past 300 years, China and the United States have constantly been advancing amid twists and turns. With the improvements in productivity and environmental aware-

ness, as well as increasingly close inter-regional exchanges, the man–land relationship in China and the United States advanced from a stage of environmental dependence to understanding of the environment and a process of transforming the environment to protect the environment. The evolution of such human-land relations is in line with the laws of social development. Human society is evolving by constantly recognizing, transforming, utilizing, and adapting to the environment. The historical evolution of human-land relations has moved from coordination to opposition to new coordination [66]. With the emergence of global ecological problems in the late 20th century, countries gradually realized that human development should conform to the laws of nature. Human beings need to make rational use of natural resources and regulate uncoordinated human-land relations. Through the study of the evolution of human-land relations in China and the United States in the past 300 years, we can consider the evolution trend of human-land relationship from the perspective of the destiny of the human community and provide a reference for regional cooperation and the exploration of reasonable human-land relations in the context of global change.

5. Conclusions

The past 300 years have seen many conflicts between humans and the environment, representing the period with the most apparent changes in human-land relations. China and the United States have undergone significant political, economic, and cultural changes during this period, causing dramatic changes in land cover. By analyzing the changes in land cover in China and the United States and interpreting the evolution of human-land relations through environmental changes, the following conclusions are drawn:

(1) On the time scale, China and the United States exhibit similarities in the land development process. The total cultivated land area has shown an upward trend, whereas forests and grassland areas have generally showed a downward trend in both counties. Land cover changes in the two countries can be divided into three different stages according to the speed of change. In this process, the area of forest land in China has been reduced faster than that of grassland, mainly due to the development of mountain land. The area of grassland in the United States has been diminished much faster than that of forest land, mainly due to the migration of the Great Plains in the Midwest. Regarding the spatial scale, the change in cultivated land area in China is primarily based on increased intensity of cultivation. The evolution of cultivated land in the United States is based mainly on expansion of cultivated land. China's land reclamation space has gradually expanded from the east to the northeast and northwest. The US land reclamation space has grown from east to west.

(2) The differences in land cover change between China and the United States are mainly caused by differences in social developments. Land cover change is an external manifestation of the human-land relationship. Natural and social feedback can be used to interpret the characteristics of human-land relationships. Among them, natural feedback is mainly manifested in environmental problems such as ecological damage and environmental pollution. Social feedback is primarily reflected in social conditions such as policy making and demographic changes. As a result of land development, environmental problems have emerged, but ecological awareness still needs to be improved. As productivity increases and environmental issues become more severe, environmental awareness begins to take shape. The productivity level continued to increase in the later period, and environmental problems became more complicated as awareness about environmental protection continued to grow.

(3) Land cover and the relationship between man and land in China and the United States are affected by a combination of natural and social factors. Among them, the land and political elements are relatively stable, whereas the population and technological factors are relatively active. China is dominated by population factors, and the United States is dominated by technological factors. In addition, the evolution of human-land relations differs between the two countries, with some similarities.

China experienced a slow and in-depth understanding of the environment in the early stage, with a rapid and dramatic transformation of the environment in the later stage. The United States experienced a rapid understanding of the environment in the early stage, with advancement to the stage of transforming and protecting the environment. The man–land relationship in the two countries has gone through stages of relying on the environment, understanding the environment, and changing the environment to protect the environment. This evolution is in line with the laws of social development, which state that human beings constantly recognize, utilize, and adapt to nature. As a complex system, human-land relations continue to develop in the unity of opposites.

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