CLIMATE CHANGE AND ITS IMPACTS ON ECO-ENVIRONMENT AND AGRICULTURE IN THE WEST OF NORTHEAST CHINA

Wang Yiyong ∗, Lian Yi and Qiu Shanwen a

(a. Northeast Institute of Geography and Agroecology, CAS, Changchun-130012
(b. Institute of Meteorological Science of Jilin Province, Changchun-130062)

KEYWORDS: Climate Change, Impacts, Eco-environment, Agriculture, West Part of Northeast China.

ABSTRACT:

Based on the literatures and investigation, response characteristics of global change in western Jilin province, its impacts on eco-environment and agriculture are analyzed. The study and prediction of climate change trend, close combination of GIS spatial analysis function and calamitous climate forecast is proposed, and spatial decision support system of climatic disaster is established, in order to rationally allocate water and soil resource and promote scientific process of western ecological restoration construction and land consolidation.

1. INTRODUCTION

Including Heilongjiang, Jilin, Liaoning and some parts of eastern Inner Mongolia, the western region of northeast China is located in 42° 50′ N 117° 125° E, with total area of 320,000 km². It lies in the East Asian temperate monsoon climate area. Affected by solar radiation and monsoon climate, climate of different seasons change obviously: dry windy weather and temperature rose rapidly in spring, hot and rainy weather in summer, sunny weather and temperature decrease rapidly in fall and cold dry weather in winter. Affected by the global climate change, the precipitation has decreased markedly, while temperature and aridity index has increased in recent decades. The aridity index in this region is generally over 1.2, but in Horqin Sandy land where mean annual precipitation is less than 350 mm, the aridity index reach up to 1.5-1.8 and the surface water loss is 90-200 mm (Figure 1), showing a warmer and dryer climate change trend (Li Enze, 2001; Lian yi et al. 2001). In recent 20 years, precipitation in Cherim League reduced by about 50mm while precipitation in Songnen sandy land reduced by 120.3mm. In recent 40 years, precipitation in Baicheng Municipality decreased obviously: precipitation of this area in late 1990’s reduced about 100mm, compared with that in early 1990’s. 120~140 days/ wind speed is over sand rising speed each year in this region, and in spring, the average number of days when the wind speed is greater than eight level is 13.9, while the number in Shuangliao is even as much as 33.7(Lian yi, et al. 2001). This region belongs to typical semi-arid and sub-humid arid climate zone. It is a typical agro-pastoral transitional zone, and also an eco-environmental fragile area.

Figure 1. Distribution of Average Precipitation (a) and Aridity Index from May to September (b) in the Northeast of China

*Wangyiyong@neigae.ac.cn
In recent a hundred years, the eco-environment in the west part of northeast China has been encountered an unprecedented serious damage because of the double effects of natural and human factors. Horqin Grassland, Songnen Grassland and Hulunbeier Grassland, which are famous for high yield per unit area and high quality of palatability, are the three best pastoral areas in the 10 major pastoral areas of China. Due to the warming and drying climate change and the irrational use of grassland, degradation, desertification and salinization of large areas of grassland are caused, which thus leads to rapid expansion of desertification. According to the current study, land desertification in the west of northeast China is increasing at the rate of 1.4%. Currently, desertification area of Horqin sandy land and Songnen sandy land has been reached to 72,000 km² (Qiu, 2008; Qiu et al., 2005; Lian et al., 2001).

According to current study, multiple factors lead to the formation of the desertification of the west of northeast China. Material source is the first factor. The west of Song-Liao Plain has deposited 70~100m loose sediments, espacially in the west Liao River Plain the thickness of loose sediments is 180m. The ground of Song-Liao Plain is composed of fine sand, which provide adequate sand source for desertification (Lian yi et al., 2001). Climate change is the second factor. In recent decades, warming and drying trend of climate is obvious and continental climate increases markedly, which is one of the nature factors of desertification. Human activity is another factor. For example, 40% grasslands become severely degraded grasslands because overgrazing and severe damage of vegetation. Besides, irrational use of water recource is another human factor. For example, the construction of large reservoirs and other projects in the upper reaches of the rivers cuts off the runoff of the middle and downriver, and causes riverbed exposing and spring filled with sand.

In conclusion, adequate sand source, arid climate and excessive damage due to human factors are all causes of desertification in the west of northeast China. Material source is the first factor. The west of Song-Liao Plain has deposited 70~100m loose sediments, espacially in the west Liao River Plain the thickness of loose sediments is 180m. The ground of Song-Liao Plain is composed of fine sand, which provide adequate sand source for desertification (Lian yi et al., 2001). Climate change is the second factor. In recent decades, warming and drying trend of climate is obvious and continental climate increases markedly, which is one of the nature factors of desertification. Human activity is another factor. For example, 40% grasslands become severely degraded grasslands because overgrazing and severe damage of vegetation. Besides, irrational use of water recource is another human factor. For example, the construction of large reservoirs and other projects in the upper reaches of the rivers cuts off the runoff of the middle and downriver, and causes riverbed exposing and spring filled with sand.

According to current study, multiple factors lead to the formation of the desertification of the west of northeast China. Material source is the first factor. The west of Song-Liao Plain has deposited 70~100m loose sediments, espacially in the west Liao River Plain the thickness of loose sediments is 180m. The ground of Song-Liao Plain is composed of fine sand, which provide adequate sand source for desertification (Lian yi et al., 2001). Climate change is the second factor. In recent decades, warming and drying trend of climate is obvious and continental climate increases markedly, which is one of the nature factors of desertification. Human activity is another factor. For example, 40% grasslands become severely degraded grasslands because overgrazing and severe damage of vegetation. Besides, irrational use of water recource is another human factor. For example, the construction of large reservoirs and other projects in the upper reaches of the rivers cuts off the runoff of the middle and downriver, and causes riverbed exposing and spring filled with sand.

In conclusion, adequate sand source, arid climate and excessive damage due to human factors are all causes of desertification in the west of northeast China. Material source is the first factor. The west of Song-Liao Plain has deposited 70~100m loose sediments, espacially in the west Liao River Plain the thickness of loose sediments is 180m. The ground of Song-Liao Plain is composed of fine sand, which provide adequate sand source for desertification (Lian yi et al., 2001). Climate change is the second factor. In recent decades, warming and drying trend of climate is obvious and continental climate increases markedly, which is one of the nature factors of desertification. Human activity is another factor. For example, 40% grasslands become severely degraded grasslands because overgrazing and severe damage of vegetation. Besides, irrational use of water recource is another human factor. For example, the construction of large reservoirs and other projects in the upper reaches of the rivers cuts off the runoff of the middle and downriver, and causes riverbed exposing and spring filled with sand.

In conclusion, adequate sand source, arid climate and excessive damage due to human factors are all causes of desertification in the west of northeast China. Material source is the first factor. The west of Song-Liao Plain has deposited 70~100m loose sediments, espacially in the west Liao River Plain the thickness of loose sediments is 180m. The ground of Song-Liao Plain is composed of fine sand, which provide adequate sand source for desertification (Lian yi et al., 2001). Climate change is the second factor. In recent decades, warming and drying trend of climate is obvious and continental climate increases markedly, which is one of the nature factors of desertification. Human activity is another factor. For example, 40% grasslands become severely degraded grasslands because overgrazing and severe damage of vegetation. Besides, irrational use of water recource is another human factor. For example, the construction of large reservoirs and other projects in the upper reaches of the rivers cuts off the runoff of the middle and downriver, and causes riverbed exposing and spring filled with sand.
2.2 Precipitation Change

Figure 4 is the linear trend rate distribution of annual precipitation from 1961 to 2000 in the northeast of China. It can be seen from figure 4 that the east of 120°E, the south of 45°N in the west of the northeast, including the west of Jilin province (43°-46°N, 122°-124°E), Zhe League of Inner Mongolia, the south of Xinan League, major grain producing areas in central Songliao plain in Jilin province (43°-46°N 124°-126°E) and major regions of Changbai Mountain in the central south of Jilin province except of the east of 128°E in Yanbian, are all areas where the precipitation shows a linear negative trend. These areas together with Liaoning province are composed of areas where precipitation linear trend shows a significant declining trend in the central-west and central-south of the northeast.

Figure 5 is the time series from 1953 to 2000 and its log fitting trend of the anomaly percentage of annual average precipitation of Baicheng and Songyuan. It can be seen from figure 5 that the precipitation of the two cities all show obvious declining trend, which is just opposite with the upward trend of temperature. This shows a remark warmer and dryer trend of climate change (Qiu, 2008; Lian et al., 2003,2007; Sun et al.,2005).
3.2 Effects of Climate Change on Food Production

Food production is a primary production process which under the role of artificial production management and agricultural science and technology, through photosynthesis of crops, transform the climate, soil and other natural resources into food products. From this principle, climate and soil conditions are most basic resources and environmental factors to crop growth and development, compared with relatively stable soil conditions, erratic weather conditions are main factors that affect crop’s yield and quality changes.

Moisture and temperature conditions are main climatic factors that determine the crop’s distribution, structure and yield, drought, flood and low-temperature conditions are common agro-climatic disasters. Latitude is comparatively high in west region of Jilin province, and climate is relatively cold, chilling damage is main meteorological disaster. According to statistics, regression relationship of crop yields and temperature from 1950 to 1975 in Jilin province, from May to September, average temperature increase one degree, the province's total grain output raised by 15%. Average yield of grain and bean in the 20th century in Jilin province hovered at 1000 -2000 kg/hm² until the late 70s, but since 1980’s it jumped into the 4000 - 5000 kg/hm². This change on the one hand has a relationship with agricultural production policy, on the other hand, it relates to the northeast region especially Songliao Plain whose average temperature of agriculture growing season has entered a relatively warm period since 1980’s. The average yield increased to 5000 - 6000 kg/hm² in 1990’s, but inter-annual fluctuations increased (Lian et al., 2007). Climate warming can increase the energy resources, and expand the planting area of thermophilic high-yielding crops (rice, corn), increase growing proportion of high-yielding species with longer growth period to gain a greater harvest of agricultural production. In recent years, with global warming and the continuous advancement of agricultural technology, significant changes have taken place on crop distribution in the western region of Jilin province, namely, the rapid expansion of rice’s cultivation area, and the corresponding shrank of other grain-growing area (Pan Tiefu.1998). Firstly, this change due to global warming, extended frost-free period, advanced sowing date, the original high quality rice varieties which can not grow in the western region can be promote planting; secondly, it is a result of frequent droughts which make yield of dry crop decline.

Meanwhile, aridification is threatening the sustainable development of agriculture. Except for the soaring temperature, precipitation in this region has been lower than multi-year average value for years, which indicates a warming and drying trend of climate change. The decade since the mid-1990’s was not only a time of the highest drought frequency but also a period of the most serious damage in the west of Jilin province. The statistics indicate that, drought area during the decade mentioned above was 2,017,300 hm² on average, disaster area was 1,286,000 hm², zero harvest area was 100,000hm², yield reduction was 2, 971,000 ton, economic crops loss was 367 million Yuan, and the extreme drought occurred in 1997, 2000, 2001, 2002 and 2004. (Hu et al., 2006).

4. DEVELOPMENT STRATEGIES

In order to curb a series of eco-environmental degradation problems caused by climate change and population growth in the western region of Jilin province, party committee and government of Jilin province put forward strategic initiatives timely about eco-protection in 1999, grassland ecology protection, woodland, wetlands and saline-alkali land protection, desertification control, ecological grass building in the western region, and a series of ecological restoration and construction project. Eco-Office of Jilin province invested more than 6800 million yuan ecological province construction special funds on western saline-alkali land management project, relevant departments and local governments invest 100 million yuan which drive the whole society to invest 400 million yuan. Government of Jilin province implement "the western land development major
engineering” project in 2007 whose investment is as high as 6.2 billion. This major project will rebuild and perfect western three important water conservancy projects and transform saline-alkali land to cultivate rice, and strive to eliminate salinization area basically and restore vegetation. Mildly saline-alkali soil will be converted to high-quality resource on the basis of vegetation restoration; moderate region restore vegetation, 80% of which turn into available resources; vegetation be restored basically in severe region, 30% of which turn into available resources and increase cultivated land 270,000 hm², rice annual yield 1.65 billion kg.

High attention should be paid to climate warming induced climate disaster warning and prevention work, besides hydraulic engineering construction, land consolidation, saline-alkali soil improvement and desertification control during ecological environment protection and construction process in west region. Establish climate disaster spatial decision support system, so as to promote ecological restoration construction and land consolidation the management of scientific process actively. Therefore, recommendations and response plans are proposed as follows:

In the background of global warming, it’s necessary to learn and respect the laws of nature, to insist on the principle that we should act according to circumstances and to make reasonable arrangement of farmland, grassland, pasturage and woodland. In order to prevent changing grassland to farmland and over cultivating, it’s necessary to hold the faith that unifying ecology and economy, coordinating production and carrying capability, act according to local conditions and give priority to water, soil and gas under the instruction of regional difference and dominate limiting factor, and try our best to build a harmony environmental friendly society between man and nature in the western region of northeast China.

Increase the intensity of investment in ecological environment monitoring and research in western region, and promote the relevant scientific research capability of scientific and technological innovation to improve the capabilities of the scientific and technological support in the developing process of ecological environment restoration and agricultural. Promote the roles of high-new technologies vigorously such as the Remote Sensing, Geographic Information System, Global Positioning and environmental sensing, Geographic Information System, Global Positioning and Global Positioning and Relevant high-tech research and development agencies to vigorously promote the Remote Sensing. Also, it is necessary to promote the Remote Sensing to vigorously promote the Remote Sensing and enhance the scientific research capability on scientific management and management level of the ecological environment construction and sustainable develop agriculture and animal husbandry in west region.

Water resource is the decisive factor in the process of ecological environment’s protection and restoration, industrial and agricultural and husbandry’s development in the western region of Jilin province. Raising income and reducing expenditure is the fundamental way to resolve the problem of inadequate water resource in the context of climate warming and drying in the west region. The three important water project which is under construction will relieve the tense status of water utilization of industrial, agricultural and urban to some extent, and will help enhance the capacities of flood control and drought resistance. However, overall, the water resource in the western region is still scarce, and should use water scientifically, economically and efficiently, which require managing water resource scientifically in temporal and spatial configuration, implementing total amount control and quota management.

ACKNOWLEDGEMENTS

This study was supported by Chinese Academy of Sciences (KZCX2-YW-425; KZCX2-YW-Q06-03), and we thank Dr. Nie Xiao for translation.

REFERENCES


Hou Qingguo, 2006. Eco-environmental characteristics and rational utilization of water resources in western semi-arid region in Jilin Province, Research of Agricultural Modernization, 27(1), pp. 33-34.


