Effects of Urbanization and Industrialization on Farmland System in Shandong Peninsula

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Abstract [Objective] The aim was to study the effects of urbanization and industrialization on farmland system in Shandong Peninsula. [Method] In Shandong Peninsula, the effects were studied and analyzed using remote sensing and image interpretation with spatial data analysis and statistic data analysis. [Result] During researching periods in Shandong Peninsula, wasteland area changed from decreasing to increasing; farmland area was declining; orchard and forestry areas were increasing, mainly resulting from political policies and benefits maximization of farmers. Meanwhile, chemical fertilizers and agricultural mechanization are more frequently applied with industrialization on farmland system in Shandong Peninsula. [Conclusion] More policies should be formulated to promote harmonious development of society, economy and environment.

Key words Urbanization and industrialization; Shandong Peninsula; Farmland system; Management method of farmland

Since the reform and open-up, China has been under industrialization and urbanization. According to the data of State Statistics Bureau, our country has enhanced from 17% to 41% in urbanization [1], and small cities in China increased from 3 000 to 19 216 during 1978 to 1998, excluding 5 000 developing towns [2]. In addition, GDP in our country has increased at 9.6% yearly since 1978, twice higher than that of global average speed [3]. Globally, GDP of China ranks second, but some ecological changes have been brought by industrialization and urbanization.

Farmland system has also been through changes under the influence. Based on researches conducted by Liu et al. [4], construction lands in cities and countryside in eastern coastal areas in China increased and forest lands decreased with economic development, presenting a pattern of decreasing in south and increasing in north for farmland. Furthermore, farmland has reduced due to urbanization and industrialization, and farmland landscape becomes weaker [5]. Shandong Peninsula is located in coastal areas of Bo River, where farmland system has been through changes under influencing of urbanization and industrialization. However, few researches are available on effects of urbanization on farmland system. In the research, effects of urbanization and industrialization on farmland system in Shandong Peninsula were researched and explored for better economic development by farmland.

Materials and Methods

Survey of study areas
Shandong Peninsula, located in the east of Shandong Province and Jialai River, is dominated by hills and plains (Fig.1), with elevation at 0~1 130 m and area at 33 747 km², totaling 22 counties or cities. The area is continental monsoon climate, warm and moist in summer, and dry and cold in winter. In addition, annual rainfall averages 600~700 mm and annual temperature is at 10 °C. Crops in the area mainly include wheat, corn, peanut and apple. Total population is about 16.66 million and population density is 493 person/km².

Data collection
Spatial data of farmland system in Shandong Peninsula were collected with remote sensing image, and remote sensing data in three stages, from United States Geological Survey, were chosen for exploration of land changes in recent years, as follows: MSS from the 1970s to 1980s, TM in the 1990s and in 2006. The auxiliary data in clude topographic map (1:100 000), vegetation map (1:1000 000), social economic data, photos taken in field study, from a library in research institution in coastal areas of Yantai, Institute of Geographic Science and Natural Resources Research (CAS), statistical yearbook and field study respectively in 2009.

Data analysis
According to classification method proposed by Liu et al., farmland system in Shandong Peninsula is divided into plowland, orchard, forest land, water, city, countryside and wasteland. Visual interpretation bank of remote sensing image was established based on topographic map and field study with remote sensing images pro-
cessed. According to the established bank, images in three terms in Shandong Peninsula were interpreted. In ArcGIS, spatial analysis was conducted on system data of farmland in three terms to obtain changes of farmland system from the 1970s to 2006 and to further analyze effects of urbanization and industrialization on farmland system.

Results and Analysis
Changes of urbanization and industrialization in Shandong Peninsula
As shown in Fig.2, Shandong Peninsula has been through urbanization and industrialization at a rapid speed, for example, urban area increased from 37,469 to 176,257 hm² during 1978 to 2006. The expansion rate was at 3.6% from 1978 to 1999 and at 27% from 1999 to 2006, showing a rapid developing speed. Meanwhile, GDP in Shandong Peninsula improved as well, for example, GDP enhanced from 700 million RMB in 1978 to 23 billion RMB in 1999 and even achieved 69.8 billion RMB in 2006.

Changes of farmland
As shown in Fig.3 and Table 1, wasteland area changed from increasing to decreasing in Shandong Peninsula. For example, wasteland area increased from 527,968 to 199,833 hm² during 1978 to 1999 and achieved 267,468 hm² from 1999 to 2006. In researching period, plowland was declining in Shandong Peninsula, for example, plowland area decreased from 1,387,041 hm² in 1978 to 1,370,834 hm² in 1999. During 1978-1999, plowland decreased by 16,207 hm² and reduced to 1,073,644 hm² in 2006. In contrast, orchard and forest areas were increasing in researching period, for example, orchard and forest land increased to 941,766 hm² in 1978, 1,202,802 hm² in 1999 and 1,325,388 hm² in 2006.

Changes of water
As shown in Fig.3 and Table 1, water area changed from increasing to decreasing. For example, water area was 53,746 hm² in 1978 and achieved 91,384 hm² in 1999, increasing by 37,638 hm² with annual growth rate at 3.4%. However, water area reduced to 81,978 hm² in 2006, decreasing by 9,406 hm² with depletion rate at 1.5%. During 1978-1999, more agricultural water were required due to transformation of wasteland to orchard, and water used in forest lands and urban areas increased with industrial development. Hence, local governments began to expand or establish some reservoirs, such as Gaolin Reservoir in Mouping District in Yantai City, Xiaozhushan Reservoir in Qingdao, Jihong Reservoir in Qingdao and Bahe Reservoir in Rongcheng. Since 1999, water area declined for increase of municipal and agricultural water and some ponds around some cities changed into construction land due to urbanization.

Adjustment of farmland management
As shown in Fig.4, chemical fertilizer was increasing in farmlands in Shandong Peninsula. The applied amounts increased from 3,880 t in 1978 to 85.90 million t in 2006, increasing by 1.2 times. Before 1999, governments mainly aimed at improving local GDP and related policies were few and farmers believed that the
more fertilizers were, the higher the production would be. Hence, more and more chemical fertilizers were applied. After 1999, urban areas developed at high speed, but living standard in countryside was still low. Therefore, much importance was attached to agricultural production to balance development between city and countryside and a series of measurements were issued accordingly, for example, customs duties for import of fertilizer resource production were reduced; more materials of fertilizer could be purchased at low price by fertilizer enterprises; expanse in fertilizer circulation was lowered, which promoted chemical fertilizer application and led to some environmental problems as well, such as N increase of ground water and eutrophication[7-11].

As shown in Fig.4, total mechanical power increased yearly. For example, it increased from 300 000 kw in 1978 to 17.50 million kw in 2006. Before 1978, agricultural production mainly depended on human and animal powers, determining lower mechanical power. In contrast, farmers were encouraged to buy smaller machines after 1978 and the machine oils were at lower price. With development of industrialization and urbanization, some rural population chose to make a living in urban areas, leading to little labor force in countryside. Hence, more and more farmers began to purchase agricultural implements to make up human shortage. With economic development, more measures are proposed to support agricultural production. After 1999, governments even provided subsidies for farmers to promote mechanical power in agriculture.

### Conclusions

Farmland system changes under influence of industrialization and urbanization. With the help of remote sensing images and social statistical data, wasteland, plowland, orchard and farmland change differently by industrialization and urbanization, resulting from policies and benefits maximization. Meanwhile, agricultural management changes accordingly, and more chemical fertilizers and machines are applied. Machine application actually provides more labors for industrial and urban development, but some environmental problems occur. In general, more encouraging policies were implemented in order to promote agricultural production.
坝建立前后, 洞庭湖水体面积在枯水期和丰水期的变化, 同时对汛期和干旱期洞庭湖面积变化与城陵矶水文观测站的相关关系进行研究。

自三峡大坝建立后, 对洞庭湖在枯水期和丰水期的水体面积差有很大影响; 在枯水期, 洞庭湖水体面积与城陵矶水位线性关系较弱, 而在丰水期,

目的

基于MODIS影像序列的三峡截流前后洞庭湖面积变化序列分析

收稿日期

作者简介

基金项目

关键词

摘 要

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