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Population Growth, Ecological Degradation and Construction in the Western Region of China

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China's most serious ecological crisis seems to be in its western region where the ecological environment is the weakest. This paper analyzes the population growth, underdevelopment and ecological degradation in the western China based on a conceptual framework of population, development and ecological system. The existing problems of underdevelopment and ecological degradation are examined. The on-going ecological construction projects in the western China are used to illustrate how the state has attempted to mediate the conflict between survival and ecological conservation.

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Introduction

There have been growing concerns on the ecological and environmental consequences of rapid economic development in China. There is a large literature focusing on the issues of shrinking arable land, water shortage, food supply, environmental pollution, land degradation and desertification in China.[1] Nevertheless, China's western region has the most serious ecological crisis, which poses a major threat not only to the western region itself but also to the ecological security of the whole country. The frequent dust storms to Beijing and the great flooding in Yangtze River in 1998 were found to be a result of deforestation and desertification in the western region. Figure 1 shows its location in China.

The western region has an area of 6.87 million km^2, accounting for 71.54% of China's total.[2] According to the fifth population census in 2000, the western region had a population of 355 million, accounting for 28.1% of the total population in mainland China. In addition to the outstanding ecological problem, two other major

[1]See Robert F. Ash and Richard L. Edmonds, 'China's land resources, environment and agricultural production', *China Quarterly* 156(1998), pp. 836-879; Vaclav Smil, 'China's agricultural land', *China Quarterly* 158 (1999), pp. 414-429; Lester Brown, *Who Will Feed China? Wake-up Call for a Small Planet* (London: Earthscan, 1995); Qu Geping and Li Jinchang, ed., Zhongguo renkou yu huanjing (*Population and Environment in China*) (Beijing: Zhongguo huanjing kexue chubanshe, 1992).

[2] The western region includes Inner Mongolia, Guangxi, Chongqing, Sichuan, Guizhou, Yunnan, Tibet, Shaanxi, Gansu, Qinghai, Ningxia and Xinjiang according to the state's 'strategy of developing western China'. This definition includes two more provincial units than the initial definition of the western region in the 7th five-year plan. The areas included in the eastern and central regions defined in the 7th five-year plan were also adjusted due this change. The eastern region includes Beijing, Tianjin, Hebei, Liaoning, Shanghai, Jiangsu, Zhejiang, Fujian, Shandong and Guangdong. The central region includes Shanxi, Jilin, Heilongjiang, Anhui, Jiangxi, Henan, Hubei and Hunan.

features of the region were the existence of a large poverty population and a large population of minority nationalities.[3]

To overcome poverty and raise the level of development in the western region, Chinese government launched a bold 'strategy of developing western China' (or 'go west strategy') with many financial and policy measures in 1999, on a scale comparable to 'third front' construction in the 1960s-1970s.[4] The Office of the Leading Group for Western Region Development (OLGWRD) was established within the State Council for the implementation of the strategy in January 2000. This is a dramatic reversal of the state's regional development policy that favored the coastal region especially in the period 1978-1992. Key considerations for adopting such a bold strategy include: increasing inequality between the eastern and western regions; surplus production capacity and inadequate domestic demand; a new emphasis on ecological issues; national unity and the development of minority nationalities; national security of resources. Various policies and incentives have been introduced to stimulate the market force to invest in the western region while the state has also begun to invest heavily in the infrastructure, education and ecological construction.[5] Total investment in the fixed capital in the western region reached RMB 611 billion (US$1= RMB 8.28 in 2000) and RMB 734 billion in 2000 and 2001 respectively. The

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[3] Information Office of the State Council of PRC, *National Minorities Policy and Its Practice in China*, Beijing, 1999; C. Mackerras, *China's Minorities: Integration and Modernization in the Twentieth Century* (Hong Kong: Oxford University Press, 1994).

[4] OLGWRD, ed., *The Overall Plan of Western Region Development and Related Policy Measures* (Beijing: China Planning Press, 2002); Yeung Yue-man and Shen Jianfa, ed., *Developing China's West: A Critical Path to Balanced National Development* (Hong Kong: The Chinese University Press, 2004).

[5] Zheng Du (ed), Zhongguo xibu diqu 21 shiji quyu kechixu fazhan (*The Regional Sustainable Development of the West China in the 21st Century*) (Wuhan: Hubei kexue jishu chubanshe, 2001), pp. 13-24.

central government contributed over RMB 140 billion in these two years.[6] One major task of the 'go west strategy' is to stop ecological degradation and foster ecological reconstruction in the western region. Four other major tasks are: constructing infrastructure such as highways, communication and water facilities; developing specialized industries with geographical and resource advantages; developing science, technology and education; further opening to the outside world. Nevertheless, a few scholars argued that the developmental gap between the eastern and western regions was due to natural condition, history and location in addition to the state policy that had been over-emphasized. It was not possible to reduce the absolute gap in the near future, as the central government alone did not have adequate capital and resource to shift the economic construction towards the western region.[7] Thus the 'go west strategy' should be considered as a way to stimulate the development in the western region rather than to catch up the development in the coastal region of China.

The issue of the relationship among population, development and environment has major theoretical and practical significance and has been the focus of many studies.[8] Some important questions surrounding the issue are as follows. Are population growth and underdevelopment the ultimate causes of ecological degradation? Will agricultural and economic development intensify or help fighting against ecological degradation? How can the complicated relationship between the state and peasants be solved to achieve ecological construction? Obviously, there is

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[6] Talks by the OLGWRD officials, 5 March, 2002, on-line news at http://www.chinawest.gov.cn/english/asp/start.html

[7] Lu Dadao, ed., Zhongguo kechixu fazhan yanjiu (*A Study on the Sustainable Development in China*)(Beijing: Qixiang chubanshe, 2000), p. 81.

[8] See Lester R. Brown and Kane Hal, *Full House: Reassessing the Earth's Population Carrying Capacity* (New York: W.W. Norton, 1994); Vaclav Smil, 'How many people can the Earth feed?', *Population and Development Review* 20(2) (1996), pp. 255-292.

no straightforward answer to these questions. Data on environmental degradation are hard to obtain and development in China is often complicated. For example, Chinese government has moved on quickly in enacting various laws of environmental protection but implementation has been problematic especially at the local level and rural areas.[9] Muldavin argued, based on his study in the rural villages in Henan, that the changing social relations of production, subsistence and their articulation with localities had created particular social entitlements, vulnerability and environmental outcomes.[10] Thus it is difficult to assess the mega-trends of ecological degradation, environmental protection and ecological construction reliably.

Despite these complexities and difficulties, this paper attempts to analyze population growth, underdevelopment and ecological degradation in the western China using a conceptual framework of population, development and ecological system. The latest progress in fighting against ecological degradation and fostering ecological reconstruction in the western region is then examined to illustrate how the policy of central government backed up with financial support might be able to initiate large-scale ecological construction in poor rural areas of the western region.

A conceptual framework of population, development and ecological system

Rapid population growth is often considered a major cause of land and ecological degradation in western China and elsewhere.[11] The debate on the relationship between

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[9] See Richard L. Edmonds, *Patterns of China's Lost Harmony: a Survey of the Country's Environmental Degradation and Protection* (London: Routledge, 1994), pp. 228-260; Geoffrey Murray and Ian G. Cook, *Green China: Seeking Ecological Alternatives* (London: RoutledgeCurzon, 2002), pp. 178-209.

[10] Joshua Muldavin, 'The paradoxes of environmental policy and resource management in reform-era China', *Economic Geography* 76(3)(2000), pp. 244-271.

[11] R. D. Hill, 'People, land, and an equilibrium trap: Guizhou province, China', *Pacific Viewpoint* 34(1)(1993), pp. 1-24; D. Preston, M. Mark and W. Jeff, 'Fewer people, less erosion: the twentieth century in southern Bolivia', *The Geographical Journal* 163(2)(1997), pp. 198-205.

population and development in a wider context has been much more controversial.[12] Some scholars regard population growth as a desirable phenomenon and an essential ingredient to stimulate economic development. An extreme view attributes all of the world's economic and social evils to excessive population growth using such phase as population bomb. China's tight family planning policy can be regarded as a response to its immense population pressure.[13] The population control is considered not only necessary to escape the 'Malthusian trap' but also useful to speed up development and modernization.

The issue of population, poverty and ecological degradation in rural areas was also the focus of previous studies. Stevens and Cathy found that agricultural resources available for food production were highly variable in less developed countries.[14] But land and other physical resource constraints were not the major impediments to agricultural production. They used a demand and supply framework to analyze agriculture. A theory of traditional agriculture was developed with four central economic arguments.[15] First, there has been little change in the traditional agriculture

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[12] J.A. Swaney, 'Julian Simon versus the Ehrliches: an institutionalist perspective', *Journal of Economic Issues* XXV(2) (1991), pp. 499-509; Julian L. Simon, *The Ultimate Resource* (Princeton, N.J.: Princeton University Press, 1981); Paul Ehrlich and Anne Ehrlich, *The Population Explosion* (New York: Simon and Schuster, 1990).

[13] For China's population issues, see J. Shen, 'China's future population and development challenges', *The Geographical Journal* 164(1)(1998), pp. 32-40; J. Z. Lee and F. Wang, *One Quarter of Humanity: Malthusian Mythology and Chinese Realities, 1700-2000*(Cambridge: Harvard University Press, 1999); Lester Brown, *Who Will Feed China?: Wake-up Call for a Small Planet*. J. Shen and N. A. Spence, 'Modelling urban-rural population growth in China', *Environment and Planning A* 28 (1996), pp. 1417-1444; J. Shen and N. A. Spence, 'Modelling regional population growth in China', *Mathematical Population Studies* 6(1997), pp. 241-274.

[14]Robert D. Stevens and Cathy L. Jabara, *Agricultural Development Principles: Economic Theory and Empirical Evidence* (Baltimore: Johns Hopkins University Press, 1988), pp. 18-29.

[15] Ibid., pp. 70-82; T.W. Schultz, *Transforming Traditional Agriculture* (New Haven, Conn.: Yale University Press, 1964).

in various aspects such as technology, institution, economy and culture. Second, there is equilibrium in supply and demand. Farmers are trapped in a low-level of equilibrium and have no opportunity to increase their income under the condition of little change. Third, there is efficient allocation of resources and farmers have done their best in maximization of their production and well being under their own circumstance. Fourth, the return to investment in traditional agriculture is low and there is little incentive to invest in the traditional agriculture.

In the case of subsistence agriculture in the poor western China, peasants mainly produce for their own consumption. An explicit analysis of population change and land exploitation would be essential. Thus the above economic model of agricultural demand and supply needs to be extended to include variables on population growth and land exploitation. Figure 2 presents a conceptual framework describing the key indicators and processes in the population, development and ecological system.

Under the condition of stagnant technology, farmers would resort to land exploitation to feed growing population, resulting in land degradation. This process can be summarized as follows. With low agricultural productivity, more and more labor is employed to produce grain for increased population. More often than not, more and more hilly areas and pastures are converted to arable land which is susceptible to soil erosion and ecological degradation.[16] The yield in such arable land is very low usually. The land converted from pastures often becomes desert while slope land becomes bare land very soon. This necessitates the conversion of more

[16] Robert D. Stevens and Cathy L. Jabara, *Agricultural Development Principles: Economic Theory and Empirical Evidence*, pp. 161-175.

land from hilly areas and pastures. Such vicious circle is close to the familiar concept of Malthusian trap or Nelson's concept of the low-level equilibrium trap. [17]

As shown in figure 2, five key indicators are population, farmland, hilly area and pastures (which may be converted to farmland under population pressure), grain and income (GDP per capita may be a good surrogate). Two intermediate indicators are yield and the amount of grain per capita indicating the productivity of farmland and the level of food supply on per capita basis respectively. They are key indicators of the living standards of rural population and have important impact on the strategies taken by the state and the rural households in rural development.

There are seven major processes. Fertility represents the process of population growth. Planting of grain crops is a main activity of rural households. Non-farm activity and the production of cash crops represent two ways of generating cash income for households. Although it is rare, grain import is a possible option for meeting the food needs if households have sufficient cash income. The expansion of non-farm activity via industrialization and urbanization is an alternative way to reduce population pressure on land if sufficient food is produced locally, regionally, nationally or globally. The state's demand for self-sufficiency of grain production regionally or nationally has been a major constraint on industrialization and urbanization in many developing countries especially when their manufacturing sector is largely uncompetitive and unable to generate sufficient income. Thus a strategy often used by rural households is to convert hilly areas, forestry and pastures to farmland to increase grain production.

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[17] See T. R. Malthus, *An Essay on the Principle of Population* (Cambridge: Cambridge University Press, 1989); R. R. Nelson, 'A theory of the low-level equilibrium trap', *American Economic Review* 46(1956), pp. 894-908.

Finally, households make decisions based mainly on their household size, income level, food supply and the state policy. Five main decisions will be made regarding fertility, land conversion, cash crop planting, non-farm activity and the amount of grain to be bought from the market. At the macro level, non-farm activity can be expanded by local industrialization such as township and village enterprises (TVEs) in China or by temporary/permanent migration to cities.[18] Grain import will become necessary if many rural households rely on market for food supply. It is noted that the state policy plays a significant role in rural/agricultural economies especially in China.[19]

In poor rural areas where grain production is at a subsistence level, rural households concentrate all their labor force for grain production and rarely engage in the production of cash crops and non-farm activities. Thus they have a low income and have no fund to import grain. Both the grain per capita and income are low. Poverty is often associated with high fertility forming the vicious circle described above. As the population continues to grow, the rural households are under pressure to convert hilly areas and pasture to farmland resulting in land and ecological degradation.

Based on the study of traditional agriculture mentioned above, following development strategies have been proposed by Stevens and Jabara: [20] providing new and much more productive technology; making more efforts to break out the low-

[18] J. Shen, 'A study of the temporary population in Chinese cities', *Habitat International* 26(2002), pp. 363-377; J. Shen, 'Rural development and rural to urban migration in China 1978-1990', *Geoforum* 26(1995), pp. 395-409; J. Shen, K. Y. Wong and Z. Feng Z, 'State sponsored and spontaneous urbanization in the Pearl River Delta of south China, 1980-1998', *Urban Geography* 23(7)(2002), pp. 674-694.

[19] Liming Wang and John Davis, *China's Grain Economy* (Aldershot: Ashgate, 2000).

[20] Robert D. Stevens and Cathy L. Jabara, *Agricultural Development Principles: Economic Theory and Empirical Evidence*, pp. 83-84.

level trap of equilibrium; developing higher return investments. Their suggestions are largely confined to the agricultural and non-agricultural sectors in the rural areas.[21] More comprehensive strategies would include population control as well as industrialization and urbanization. Indeed, there are potentially three options to break off the vicious circle in poor rural areas.

The first option is to control population growth so that the pressure for more grain output is reduced. Migration to other rural areas with better land resources or to urban areas would also reduce local population pressure.[22] Agricultural production can then concentrate on quality arable land so that both land and labor productivities of grain can increase. This will improve food supply and living standards.

The second option for peasants is to engage in cash crop production, manufacturing or services. If rural households can increase their income, they will be able to buy food. In countries where food production and distribution systems are efficient, this option is possible. But many developing countries do not have sufficient grain output and their rural households do not have adequate skill, capital, technology or market access to engage in cash crop production or non-agricultural activities. Thus it is often hard to take this option.

Low agricultural productivity is often a result of wrong institutions. The third option is to introduce rural reforms to get the institutions right. Collective farming in socialist China before the early 1980s was considered a main cause for poor agricultural production. The introduction of a household responsibility system boosted the grain output in China in the 1980s. Such increase in grain output has released a large amount of surplus rural labor to engage in non-agricultural activities, increasing

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[21] Ibid., pp. 189-195.

[22] Tian Fang and Zhang Dongliang(eds), *Zhongguo renkou qianyi xintan* (*A New Exploration on Population Migration in China*)(Beijing: Zhishi chubanshe, 1989), pp. 156-168.

the income of rural households significantly. This has reduced the pressure on arable land, especially the need to convert land from hilly areas and pastures or reclaim land from lakes and the sea. However, as environment is a common property, Muldavin argued that decollectivization in post reform China had led to resource abuse and environmental degradation in certain rural areas.[23] Similarly, Yi argued that ambiguous property rights, irrational state policy and institutional constraints were the main causes of worsening ecological condition in China. [24]

Since the late 1990s, China has been largely successful in achieving sufficient grain production. The western China lags behind the overall development in the country and its population pressure on the land remains high. There have been severe problems of land and ecological degradation in the western China. Adequate grain production for the country as a whole now means that the western China no longer needs to achieve self-sufficiency in grain production.[25] Through various projects on ecological reconstruction and poverty alleviation supported by the state, much grain and funds have been channeled into the western China since the late 1990s as part of the 'go west strategy'.

The conceptual framework of population, development and ecological system discussed in this section provides a theoretical basis for an empirical examination of the acute population and ecological problems in the western China. This paper adopts a comparative approach by contrasting the population and underdevelopment against

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[23] Joshua Muldavin, 'Environmental degradation in Heilongjiang: policy reform and agrarian dynamics in China's new hybrid economy' , *Annals of the Association of American Geographers* 87(4) (1997), pp. 579-613.

[24] Yi Zheng, Zhongguo jueze: guanyu zhongguo shengcun tiaojian de baogao (*China's Choice: A Report on the Survival Condition of China*) (Beijing: Shiyou gongye chubanshe, 2001), p. 335.

[25] For a different view, see Zheng Du, ed., Zhongguo xibu diqu 21 shiji quyu kechixu fazhan, pp. 136-140.

ecological degradation in the western region in the following two sections. Information for the eastern and central regions is also presented for comparison.

Population growth and underdevelopment

The western region had a population of 355 million in 2000. Contrary to the expectations of some scholars and policy-makers, large-scale migration to the western region was considered an unviable option for the 'go west strategy' according to our previous study, considering the failure of such migration policy in the pre-reform period.[26] Mao also argued that there should be no large-scale migration to the western region even if rapid economic growth takes place in the region.[27] This section focuses on the pressure of population growth within the western region.[28] If there were large-scale migration to the western region, such pressure would be much higher.

To illustrate the regional differences in the natural population increase rate and population growth rate among three regions and the provinces in the western region, three selective years of 1978, 1990 and 1999 and two periods 1978-1990 and 1990-2000 are chosen. The year 1978 marked the beginning of China's economic reform.

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[26] For a thorough assessment of the population and migration issues in the western region, see Shen Jianfa and Wang Guixin, 'Population distribution and growth', in Yeung Yue-man and Shen Jianfa, ed., *Developing China's West: A Critical Path to Balanced National Development*. For views advocating migration to the western region, see Tian Fang and Zhang Dongliang, ed., Zhongguo renkou qianyi xintan, pp. 196-214; Tian Fang and Lin Fatang, ed., Zhongguo renkou qianyi (*Population Migration in China*)(Beijing: Zhishi chubanshe, 1986), pp. 106-33. For studies on migration to the region in the pre-reform period, see G. Clarke, 'The movement of population to the west of China: Tibet and Qinghai', in J. Brown and R. Foot, ed., *Migration: The Asian Experience*, (New York: St. Martin Press, 1994), pp. 221-57.

[27] Mao Feng, 'Lun zhongguo de renkou kongzhi yu kechixu fazhan (On population control and sustainable development in China)', in Bianweihui (Editorial Committee), ed., Mianxiang 21 shiji zhongguo kechixu fazhan zhanlue yanjiu (*A Study on the Strategy of Sustainable Development in China Toward 21st Century*)(Beijing: Qinghua daxue chubanshe, 2001), pp. 134-143.

[28] For discussions on population and environment in China, see Qu Geping and Li Jinchang, ed., Zhongguo renkou yu huanjing.

Two population censuses were conducted in 1990 and 2000 respectively, which provided the best population data on China. However, the latest data on natural population increase rate were from the annual national sample survey on population changes in 1999. Table 1 presents the relative levels of natural increase rates in 1978, 1990 and 1999 and population growth in the period 1978-1990 and 1990-2000.

For China as a whole, the natural population increase rates were 12.00, 14.39 and 8.77 per thousand in 1978, 1990 and 1999 respectively. After an initial rebound to a peak of 16.61 per thousand in 1987, the natural population increase slowed down continuously with the deepening of economic reform and transition towards a market economy.[29] Most interestingly, the natural population increase rate in the western region was always greater than that of eastern region. By 1999, the natural population increase rate in the western region was 28% higher than the national average while that in the eastern region was 22% lower than the national average. It is noted that the natural increase rate of the western region was only 1% below the national average in 1990 due to an extremely high natural increase rate in the central region, resulting in a high national average. For most provincial regions in the west, their natural population increase rates were greater than the national average. For example, the natural population increase rate was 60% higher than the national average in Guizhou, Yunnan and Ningxia in 1978 and in Guizhou, Yunnan, Tibet, Qinghai, Ningxia and Xinjiang in 1999.

The high natural increase rate in the western region is not because of its low population density. It is caused by low level of socio-economic development, high concentration of minority nationalities and a more relaxed family planning policy for

[29] NBS, *China Statistical Yearbook 2001* (Beijing: China Statistics Press, 2001), p. 91.

minority nationalities.[30] The No. 7 document of the central committee of CCP (Chinese Communist Party) suggested in the first time in April 1984 that a suitable family planning policy was needed for the minority nationalities. For minority nationality with a population of more than 10 millions, each couple might be allowed to have two children. Some couples might have three children in special cases but no couple should have four children. The exact regulations were to be articulated by the People's Congress and the government of each province or autonomous region.[31] The regulation was less restrictive in Xinjiang where an urban or rural couple was allowed to have two or three children under normal cases, respectively. Goldstein et al. reported that birth limits were extended to rural Tibet in 1984 and fines and penalties were introduced in the 1990s.[32] They found surprisingly rapid voluntary adoption of birth control methods in Tibet in the 1990s due to poverty as well as two other factors: division of rural land on a one-time basis and competition pressure in migrant labor market.

There has been substantial migration from the western region such as Guangxi and Sichuan to eastern region especially Guangdong province.[33] In addition to labor migration, migration due to marriage is also an important cause for leaving the western region. For example, a net migration of over 100,000 people due to marriage

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[30] According to 2000 population census, the proportion of ethnic population was over 33% in 8 out of 12 provincial units in western China including Guangxi, Sichuan, Guizhou, Yunnan, Tibet, Qinghai, Ningxia and Xinjiang. NBS, *China Statistical Yearbook 2001*, p. 100.

[31] Deng Hongbi, ed., *Zhongguo shaoshu minzu renkou zhengce yanjiu (A Study on the Family Planning Policy on Ethnic Populations in China)* (Chongqing: Chongqing chubanshe, 1998), p.3

[32] M. C. Goldstein, B. Jiao, C. M. Beall and P. Tsering, 'Fertility and family planning in rural Tibet', *The China Journal* 47 (2002), pp. 19-39.

[33] Cindy C. Fan, 'Migration and labour market returns in urban China: results from a recent survey in Guangzhou'. *Environment and Planning A* 33(2001), pp. 479-508.

took place from Sichuan to Jiangsu and Hubei in the period 1985-1990.[34] Such migration continued most likely in the 1990s. Thus the rate of population growth in these areas in the period 1990-2000 was significantly lower than the national average despite a high rate of natural population increase. Chongqing had a low population growth rate due to a low natural population increase rate as a large city and out-migration related to the Three Gorges Project.[35]

The population growth rate in Yunnan, Tibet, Gansu, Qinghai, Ningxia and Xinjiang was substantially greater than the national average in the reform period 1978-2000. Migration contributed to population growth in Xinjiang. Spontaneous migrants dominated the migration to Xinjiang in the reform period and this was in contrast to the migration organized by the state in the pre-reform period. Many spontaneous migrants were tradesmen and members of construction teams from rural areas in the coastal region such as Jiangsu and Zhejiang seeking business and income opportunities in the western region in an emerging market economy in China.[36]

Rapid natural population increase has contributed to an increased population pressure in the western region of China where the agriculture is weak due to harsh natural environment.[37] In addition to population growth, there are other constraints on the development in the western region: inconvenient geographical location and high

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[34] Wang Guixin, Zhongguo renkou fenbu yu quyu jingji fazhan (*Population Distribution and Regional Economic Development in China*) (Shanghai, Huadong shifan daxue chubanshe, 1997), pp. 345-352.

[35] Li Heming and Philip Rees, 'Population displacement in the Three Gorges reservoir area of the Yangtze River, central China: relocation policies and migrant views', *International Journal of Population Geography* 6(6)(2000), pp. 439-462.

[36] See R. Iredale, N. Bilik and W. Su, ed., *Contemporary Minority Migration, Education and Ethnicity in China*(Cheltenham: Edward Elgar, 2001), p. 175.

[37] Liu Jiaqiang, 'Xibu kaifa zhong de renkou huanjing fenxi (An analysis of the population environment in the western development), *Renkou yanjiu* 24(4)(2000), pp. 46-50; R. D. Hill, 'People, land, and an equilibrium trap: Guizhou province, China', pp. 1-24.

transport cost; weak competitiveness of the firms and economy; lack of capital and out-flow of capital and skilled labor; slow in economic and institutional reform.[38] Some scholars have also argued that the population issue is not the ultimate cause of underdevelopment in the western region.[39]

An examination of food production illustrates the issue of population pressure. Table 2 presents the grain output per capita in 1978, 1990 and 2000 respectively. For China as a whole, grain output per capita increased from 317 kg in 1978 to 365kg in 2000. In the western region, grain output per capita was only 299kg and 347kg in 1978 and 1990 respectively, significantly smaller than the national average. It was in the year 2000 that the grain output per capita in the western region reached 363kg, close to the national average. This is a significant improvement in the balance of grain supply and demand in the region. It is clear that China and the western region in particular were struggling for grain production at or below the subsistence level up to the 1980s. Such a situation not only slowed down the process of industrialization and urbanization, but also caused severe land and ecological degradation through deforestation and slope farming.

The differences in the level of grain output per capita, economic diversification, industrialization and urbanization have caused a substantial development gap among the eastern, central and western regions. Table 3 presents some key development indicators for three regions in China in 2000. The data confirm clearly that the western region lagged behind the eastern region in many aspects. In the year 2000, the western region had a low GDP per capita of only RMB 9119, in comparison with the national average of RMB 15435. The level of urbanization and

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[38] See Zheng Du, ed., Zhongguo xibu diqu 21 shiji quyu kechixu fazhan, p. 106.

[39] Chen Yiping, 'Xibu kaifa cunzai renkou wenti ma (Are there any population problems in development of the West of China)?', *Renkou yanjiu* (Population Research) 24(4)(2000), pp. 51-55.

the share of employment in the secondary sector in the western region were much lower than the national average. More importantly, the non-agricultural activities in the rural area of the western region were much weak. Only 25% of its rural labor force was employed in the non-agricultural sector while it was 40.9% in the developed eastern region. Such gap in rural industrialization had an important impact on the income of rural population. According to table 3, the waged income per capita in the rural area was only RMB 437 in the western region, compared with RMB 1279 in the eastern region. It is interesting to note that the central region was no better than the western region in several indicators such as the urban income per capita and the share of non-farm employment. The grain output per capita in the eastern region was smaller than those in the central and western regions due to a much high level of industrialization in 2000 (table 2). Whether the eastern region should be self-efficient in grain production is a separate issue. But its small grain output per capita certainly did not affect its high level of development.

The status of underdevelopment in the western region was not only associated with less advanced level of urbanization and industrialization, but also associated with low labor productivity in three economic sectors. As shown in table 3, the GDP produced per labor in primary, secondary and tertiary sectors in the western region were all significantly lower than other regions in 2000. No economic sector in the western region has any competitive advantage in the nation. The weak competitiveness of the western region poses a serious challenge on its path towards development. Under the condition of underdevelopment and slow industrialization and urbanization, growing population and high dependence on agriculture have resulted in severe ecological degradation in the western region.

Ecological degradation

The recent drive to industrialization and urbanization in China has been considered to produce profound environmental problems. Indeed, China's environmental problem and ecological degradation could be divided into two categories according to their main causes. Table 4 is a comparison of two categories of environmental degradation. The first is the population growth-induced ecological degradation as its main driving force is to feed the growing population. The key cause and process for such ecological degradation are the conversion of forestry, pasture and slope land to farmland.[40] This category can also be called agriculture-induced ecological degradation that has no direct link with industrialization and urbanization. It perhaps has occurred for a long time and is most notable in the western region of China.[41]

The second category is economic growth-induced environmental degradation. The key causes for such environmental degradation are the conversion of farmland for industrial and urban land use and heavy water, air and waste pollution.[42] The modernization factor and mismanagement of environment play an important role.[43]

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[40] Vaclav Smil's 1983 book has much to do with such environmental problems in China during a period that industrialization was much limited. See, Vaclav Smil, *The Bad Earth: Environmental Degradation in China* (Armonk: M.E. Sharpe, 1983).

[41] Dong Shuocheng , ed., Zhongguo bainian ziyuan huanjing yu fazhan baogao (*A Report on a Hundred Years of Resources, Environment and Development*) (Wuhan: Hubei kexue jishu chubanshe, 2002), pp 506-507.

[42] For issues of shrinking of farmland, see Vaclav Smil, 'China's agricultural land'. For debates on water shortage see, James E. Nickum, 'Is China living on the water margin', *China Quarterly* 156 (1998), pp. 880-898. For debates on China's food shortage see, Lester Brown, *Who Will Feed China? Wake-up Call for a Small Planet*; J. Shen, 'Modelling national or regional grain supply and food balance in China', *Environment and Planning A* 32(2000), pp. 539-557.

[43] See for example, Todd M. Johnson, Feng Liu and Richard Newfarmer, *Clear Water Blue Skies: China's Environment in the New Century* (Washington: World Bank, 1997); Vaclav Smil, *China's Environmental Crisis: an Inquiry into the Limits of National Development* (Armonk, N.Y.: M.E. Sharpe, 1993).

This category can also be called industrialization/urbanization-induced environment degradation. The main driving forces are industrialization and urbanization with assumed objectives of job-creation and improvement in the material standards of living. Such kind of environmental degradation has direct link with industrialization and urbanization and has become more and more important after China's economy took off in the 1980s.

Much recent attention has focused on the potential environmental cost of rapid industrialization and urbanization in China. But it is equally important to consider the situation of the agriculture-based population growth-induced ecological degradation especially in the western China where such ecological degradation has been most acute.[44] The economic growth-induced environmental problem has also been serious in the western China but such problem is concentrated in major industrial cities. For example, according to the weekly air pollution report on 42 major cities in China in 1999 and 2000, six cities in the western region including Lanzhou, Hohhot, Urumqi, Xining, Yinchuan and Xian were among the top ten most polluted cities.[45]

This paper focuses on the ecological degradation in the western region, which is induced by population growth and agricultural activities. The data on China's ecological degradation are hard to obtain and have much inconsistency as these data have been collected by various government departments and organizations based on

[44] For a balanced assessment of two kinds of environmental degradation, see Richard L. Edmonds, *Patterns of China's Lost Harmony: a Survey of the Country's Environmental Degradation and Protection.*

[45] Other four cities were Taiyuan, Shijiazhuang, Beijing and Tianjin. See Fu Deyin, ed., Zaizao yige shanchuan yiumei de xibei (*Rebuild a Northwest Region with Green and Beautiful Lands*) (Lanzhou: Lanzhou daxue chubanshe, 2001), p. 239.

different definitions.[46] The paper has attempted to collect the most up-to-date data from most authoritative or official sources. Table 5 presents the land area of various types such as farmland, forestry, pasture and desert for China as a whole and for various provinces in the western region. It shows the current environment in terms of land cover. As an indication of water accessibility for farmland, the data on the share of irrigated land in the total farmland are also included in the table.

China's arable land has been a myth for a long time. The most reliable figure was 130.04 million ha based on the agriculture census in 1996.[47] According to table 5, the farmland accounted for 13.55% of the total territory in China, forestry 13.92%, pasture 32.64% and desert 17.59% in the late 1990s. In the western region, the share of the farmland was only 7.31%. The forestry, pasture and desert accounted for 8.70%, 36.53% and 29.01% of the land in the western region respectively. Among the total farmland, irrigated land only accounted for 30.60% in the western region due to water shortage in comparison to 41.40% for China as a whole. Among 12 provincial regions in the western China, the land situation was quite different. For example, the share of farmland in the total land was over 20% in Chongqing, Guizhou, Shaanxi and Ningxia while below 3% in Tibet, Qinghai and Xinjiang. The coverage of forestry was below 6% in Tibet, Gansu, Qinghai, Ningxia and Xinjiang. On the other hand, desert accounted for over 40% of the land in Inner Mongolia and Xinjiang.

An area with a high proportion of desert and pasture but a low proportion of farmland can only support a low population density. But the population pressure in an area is best measured by indicators related to land use rather than the population

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[46] For an assessment of the environment data in China, see Richard L. Edmonds, *Patterns of China's Lost Harmony: a Survey of the Country's Environmental Degradation and Protection,* p 3.

[47] See NBS, *China Statistical Yearbook 2001*, p. 365. For issues of arable land data, see Vaclav Smil, 'China's agricultural land'.

density. Various indicators related to farming on slope land, soil erosion, pasture degradation and desertification are presented in table 6. Farming on land with a slope of 15 degrees and over is most likely to cause soil erosion and land degradation. Such slope land has been converted from forestry in a bid to increase farmland and grain output in areas with an acute population pressure. As will be discussed in the next section, forestry should be restored in such slope land if sufficient grain can be produced elsewhere. For China as a whole, there were 12.7 million ha and 6.1 million ha of farmland with slopes of 15-25 degrees and over 25 degrees, accounting for 9.7% and 4.7% of the total farmland in China respectively. Farming on slope land was most serious in the western region. For example, the proportion of farmland with a slope of 15-25 degrees was over 30% in Guizhou and Yunnan and the proportion of farmland with a slope of over 25 degrees was over 19% in Guizhou and Shaanxi.

Various estimates have been produced on the extent of land degradation by the 1990s in China.[48] The definition and measurement of various indicators such as areas affected by desertification may be debatable. But table 6 provides the best data currently available for China. According to table 6, 16.98% of the land was affected by soil erosion, 34.55% by desertification, and 19.79% of the pasture was degraded due to overgrazing in China. The soil lost due to erosion amounted to 5190 million tones a year in China. In the western region, 13.88% of the land was affected by soil

[48] Lu Dadao et al., 2000 Zhongguo quyu fazhan baogao --- Xibu kaifa de jichu, zhengce yu taishi fenxi (*China Regional Development Report 2000 --- Foundation, Policy and Situation Analysis of the Development of Western China*) (Beijing: Shangwu Yinshuguan, 2001), pp. 210 and 218; Zhongguo kexueyuan kechixu fazhan yanjiu xiaozu, 2000 Zhongguo kechixu fazhan baogao (*Strategic Report on Sustainable Development in China 2000*) (Beijing: Kexue chubanshe, 2000), p. 171; Zhongguo kexueyuan kechixu fazhan yanjiu xiaozu , 1999 Zhongguo kechixu fazhan baogao (*Strategic Report on Sustainable Development in China 1999*) (Beijing: Kexue chubanshe, 1999), pp. 308-309.

erosion, 46.33% by desertification,[49] and 28.93% of the pasture was degraded. The soil lost due to erosion amounted to 3350 million tones a year in the western region. It was clear that desertification, pasture degradation and soil erosion was very serious in the western region with a weak and sensitive environment. Different areas in the western region had different patterns of environmental degradation, caused by a different combination of natural conditions and human impact.[50] Gansu and Ningxia were affected seriously by three processes of degradation: soil erosion, desertification and pasture degradation. Inner Mongolia, Tibet, Qinghai and Xinjiang were affected seriously by desertification and pasture degradation. Sichuan and Shaanxi were affected seriously by soil erosion and pasture degradation. The problem in Guizhou was serious soil erosion due to widespread farming on slope land. Shaanxi and Gansu also had very serious soil erosion. Each lost over 490 million tones of soil a year due to a high soil erosion intensity, defined as the amount of soil lost per km^2 per year. The Loess Plateau of the Yellow River Valley, a classical erosion area in China, was located in these regions.[51] Only Guangxi had no significant problem of land degradation.

Much information has been made available about the current status of environmental degradation in China. But it is much more difficult to estimate the environmental change over a period which requires reliable environmental data at both the beginning and end of the period. Such data have to be collected

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[49] The area affected by desertication was 27.3% according to *China Desertification Report* cited in Dong Shuocheng, ed., Zhongguo bainian ziyuan huanjing yu fazhan baogao, p. 489.

[50] See Mike Fullen et.al, 'Soil erosion and conservation on subtropical arable soils in Yunnan province, south-west China', in Terry Cannon, ed., *China's Economic Growth: the Impact on Regions, Migration and the Environment* (London: Macmillan Press Ltd, 2000), pp. 279-292.

[51] See Richard L. Edmonds, *Patterns of China's Lost Harmony: a Survey of the Country's Environmental Degradation and Protection*, pp. 63-64.

systematically and consistently. Thus information on the progress and rate of environmental degradation in China especially since 1978 is rare, unsystematic and confusing sometime. The following examines some estimates on the rate of environmental degradation in various dimensions including desertification, pasture degradation, deforestation and farming in slope land in China.

Desertification is a highly contested and the most difficult environmental issue to define as it is still uncertain what extent of human and climatic influence is in the whole process.[52] UNCED (United Nations Conference on Environment and Development) defined desertification as 'land degradation in arid, semi-arid and dry sub-humid areas resulting from various factors including climatic variations and human activities'.[53] According to a study by the Research Center of Environment and Development in the Chinese Academy of Social Science (CASS),[54] desertification in China can be divided into three stages: the 1st stage before the 10th century; the 2nd stage during the 10-19th century and the 3rd stage since the 20th century. The three stages accounted for 14.3%, 23.3% and 62.4% of the total land affected by desertification in China currently. Land desertification speeded up after the 1950s. Many engineering and biology measures were adopted to control desertification in China but these measures were not strong enough to stop desertification. The ratio of new land affected by desertification to the desert area that was brought under control was 1.3:1. The new area affected by desertification each year increased from 1560

[52]See Mike Hulme and Mick Kelly, 'Exploring the links between desertification and climate change', in Lewis A. Owen and Tim Unwin, ed., *Environmental Management: Readings and Case Studies* (Cambridge, MA: Blackwell Publishers, 1997), pp. 213-230.

[53]United Nations, 'Managing fragile ecosystems: combating desertification and drought', chapter 12, Agenda 21 (New York: United Nations, 1992; http://www.un.org/esa/sustdev/agenda21chapter12.htm), section 12.2.

[54] Y. Zhen and S. Wang, ed., *China Environment and Development Review* (Beijing: Social Sciences Documentation Publishing House, 2001), pp. 144-149.

km^2 in the 1960s to 2100km^2 in the 1980s and 2460km^2 in the 1990s. Much desertification took place in the western region. In Xinjiang, desert was expanding by 84200 ha a year in the 1990s. In Qinghai, it was expanding by 0.13-0.22 million ha a year.[55] Another evidence of intensifying desertification was the occurrence of sand storms that took place 12 times in north China in 2000, greater than 0.5-2.5 times per year over the period 1950s-1990s.

Estimating the contributions of climate change and human impact to the problem of desertification was not an easy matter both inside and outside China.[56] Scientists in the Research Center of Sustainable Development of Chinese Academy of Science (CAS) pointed out that the global warming and natural climatic change were the leading force of the ecological problem in the western region while the human factor may have speeded up the process of ecological degradation.[57] On the other hand, scholars in CASS reported that 5.5% of desertification was caused by the advance of sand hill by natural wind while as much as 94.5% was due to human factor such as over-cultivation (25.4%), overgrazing (28.3%), abuse of water resources (8.3%) and mining and road construction (0.7%).[58] For example, four provincial regions of northwest China cultivated about 1.94 million ha of land in the period 1986-1996. But 49% (0.95 million ha) was affected by desertification in the end. The annual loss of desertification in China was estimated to be RMB 54 billion. Each year

[55] See Fu Deyin, ed., Zaizao yige shanchuan yiumei de xibei, pp. 146-147; Zheng Du (ed), Zhongguo xibu diqu 21 shiji quyu kechixu fazhan, p. 481.

[56] One progress is the estimation that changes in rainfall could explain 83% of the yearly variation of the areal extent of Sahara desert. See C. J. Tucker, H. E. Dregne and W. W. Newcomb, 'Expansion and contraction of Sahara desert from 1980 to 1990', *Science* 253 (1991), pp. 229-301.

[57] Zheng Du, ed., Zhongguo xibu diqu 21 shiji quyu kechixu fazhan, p. 198.

[58] Y. Zhen and S. Wang, ed., *China Environment and Development Review*, pp. 144-149.

about 1500 km of railway, 30,000 km of highway and 50,000 km of irrigation channels were damaged by wind-drift sand. [59]

Cultivation over the pasture for grain production was a major cause of the declining pasture in the period 1950-1980. It was estimated that over 13.34 million ha of pasture were converted to farmland in China in that period with three peaks in 1958-1959 (Great Leap Forward), 1960-1962 (Three Years of Disaster) and 1967-1976 (Cultural Revolution) respectively. Such farmland was not stable and 50% ended up as bare land.[60] The degradation of pasture, 2 million ha a year, continued in the 1980s and 1990s.[61] There was a total of 130 million ha of pasture with medium degradation by the mid-1990s. The degradation of pasture was most serious in the western region. For example, in the Gannan prefecture of Gansu province, the area of water-pasture decreased from 80,000 ha in 1982 to just 20,000 ha in the late 1990s. The pasture affected by the desertification along the Yellow River was expanding 10.8% a year. Overgrazing, pulling up of special plants (for Chinese medicine and vegetable) and gold mining were three important reasons for the degradation of pasture. It was estimated that the number of raised animals was 10-50% higher than the carrying capacity of the pasture. The ratio was as high as 100-300% in some areas.

The information available about deforestation was much confusing.[62] No specific data are available for the western region. But the national data are indicative of the situation in the western region. According to the results of four forestry surveys in 1973/76, 1977/81, 1984/88 and 1989/93, the forestry area in China was stable and

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[59] See Fu Deyin, ed., Zaizao yige shanchuan yiumei de xibei, pp. 41 and 169.

[60] Dong Shuocheng, ed., Zhongguo bainian ziyuan huanjing yu fazhan baogao, pp. 261-264.

[61] Ibid. p. 267.

[62] See also Richard L. Edmonds, *Patterns of China's Lost Harmony: a Survey of the Country's Environmental Degradation and Protection*, pp. 40-43.

even increased in the period 1973-1993.[63] The forestry area was 122 million ha in 1973/76, 115 million ha in 1977/81 and 134 million ha in 1989/93. Tree planting formed a forestry of 34.25 million ha, accounting for 26.65% of the whole forestry in China. The percentage of forestry cover of the territory decreased from 12.7% in 1973/76 to 12.0% in 1977/81 and then increased to 13.92% in 1989/93. However, the forestry was under threat of over-felling, fire and disease, damaging 1.5 million ha of forestry each year. Another 0.4 million ha lost due to cultivation each year. The state set up a plan to control the cutting level. But the actual cutting level was 47.4% (42.9 million cubic meters annually) more than the planned cutting level in the period 1993-1996.[64] Large-scale forestation program has been implemented. The survival rate was no more than 30-40% on average for a long time although it increased to over 80% by 1996.[65]

The faming in slope land and deforestation has also resulted in increasing soil erosion in the western region. In Guizhou province, the area with soil erosion increased from 25,000 km^2 in the early 1950s, to 35,000 km^2 in the 1960s, 50,000 km^2 in the late 1970s and 77,000 km^2 in the late 1980s.[66] The soil erosion is clearly associated with the expansion of the farming on slope land to feed the growing population in the province, confirming the theoretical discussion previously.

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[63] Y. Zhen and S. Wang, ed., *China Environment and Development Review*, pp. 134-135; See also Peili Shi and Jintao Xu, 'Deforestation in China', *Discussion Paper*, WP-00-E16, Center for Chinese Agricultural Policy, Chinese Academy of Sciences, 2000.

[64] Dong Shuocheng, ed., Zhongguo bainian ziyuan huanjing yu fazhan baogao, p. 290.

[65] Ibid., pp. 286-288; Lester Ross, 'Obligatory tree planting: the role of campaigns in policy implementation', in David M. Lampton, ed., *Policy Implementation in Post-Mao China* (Los Angeles: University of California Press, 1987), pp. 225-252.

[66] J. Li, L. Lo, J. Geng, W. Lang and X. Yuan, Xibu shengtai jingji jianshe (*Ecological and Economic Construction in Western Region*) (Beijing: Minzu Chubanshe, 2001), P. 48.

Despite the limitation of the available data, it is clear that the ecological degradation in the western region is very serious and dramatic steps have to be taken to stop further environmental degradation and to restore the balance of man and environment for sustainable development.

Ecological reconstruction

Severe flooding in Yangtze River in 1998, the increasing dry days of Yellow River in the 1990s and the increasing occurrence of sand storms in north China especially Beijing, thought to be caused by the ecological degradation in the western region, have sent clear waning messages to the government and public about the seriousness of the environmental crisis and land degradation. The western region has been subsequently identified as an ecological protection belt for the whole country. Stopping ecological degradation has also been considered important to alleviate natural disaster, poverty and social-economic pressure in the western region.[67]

China's grain output was sustained at about 500 million tones a year in the period 1996-1999.[68] Adequate grain supply for the country provided an opportunity to adjust agricultural production. The regional grain self-sufficiency policy under the condition of increasing population pressure has been considered a key cause for the widespread land abuse, degradation, deforestation and desertification.[69] Sufficient grain production for the country as a whole means that some regions can reduce the scale of farming to restore forestry and pasture to conserve the natural environment. The adjustment of land use and distribution of grain production among various

[67] Zheng Du, ed., Zhongguo xibu diqu 21 shiji quyu kechixu fazhan, p. 197.

[68] NBS, *China Statistical Yearbook 2001*, p. 380.

[69] In China, during the time of inadequate food production, regional grain self-sufficiency policy did not resulted in land productivity losses, see Justin Lin and James Wen, 'China's regional grain self-sufficiency policy and its effect on land productivity', *Journal of Comparative Economics* 21(1995), pp. 187-206.

regions in China cannot be achieved easily through the system of market economy. It is difficult for peasants to find alternative and adequate means of economic sustenance if they switch from farming to forestation. Indeed, there would be no problem of ecological degradation at all if forestation or other economic activities were more profitable than farming. The peasants would have opted for such option already. Persisting deforestation, farming and subsequent ecological degradation are actually related to the lack of other profitable opportunities due to a shortage of capital, skills, technology, competitiveness and access to domestic and international markets. TVE-based industrialization and urbanization are the most advanced in China's coastal region but the least advanced in the western region where agricultural condition and ecological degradation are the worst.[70]

Thus the peasants' private interests are not consistent with the state's goal for ecological construction for the benefit of the public at large. To resolve such inherent conflict, the state must initiate the adjustment of agricultural production and ecological construction using various policies and incentives for peasants. This task becomes an essential part of the 'strategy of developing western China'.

A number of ecological construction programs have been introduced since the late 1990s in China.[71] According to China's 'National Construction Plan of Ecological Environment' promulgated by the State Development and Planning Commission in 1999,[72] the national objective is to increase the forestry area by 39 million ha, 46 million ha and 19 million ha by 2010, 2030 and 2050 successively. The percentage of

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[70] See J. Shen, 'Urban and regional development in post-reform China: the case of Zhujiang delta', *Progress in Planning* 57(2) (2002), pp. 91-140.

[71] Lu Dadao ei al, 2000 Zhongguo quyu fazhan baogao --- Xibu kaifa de jichu, zhengce yu taishi fenxi, pp. 221-222.

[72] Liu Jiang, ed., Quanguo shengtai huanjing jianshe guihua (*National Construction Plan of Ecological Environment*) (Beijing: Zhonghua gongshang lianhe chubanshe, 1999); *People's Daily*, Jan. 7, 1999.

forestry cover will be increased to 19.4%, 24.2% and 26.0% by 2010, 2030 and 2050 respectively. The following are two new ecological conservation and construction projects in the western region:

a. ‘Pilot program to convert cultivated land back into forestry and pasture’ organized by the National Forestry Bureau since 2000. The program covers areas in the upper reaches of Yangtze River, and middle and upper reaches of Yellow River.

b. ‘Program to protect against wind and desertification in key areas’ organized by the National Forestry Bureau since 2000.

Indeed, many ecological programs were introduced before 1999 and were listed in the following:

a. ‘Protection program of natural forestry’ organized by the National Forestry Bureau since 1998.

b. ‘Demonstration program of key counties for ecological construction’ organized by the State Development and Planning Commission since 1998.

c. ‘Ecological demonstration areas (154)’ organized by the National Bureau of Environmental Protection since 1996.

d. ‘National program against wind and desertification’ organized by the National Forestry Bureau since 1992.

e. ‘Demonstration counties of ecological agriculture’ organized by Ministry of Agriculture since the early 1990s.

f. ‘Shelter forestry in the middle and upper reaches of Yangtze River’ organized by the National Forestry Bureau since 1989.

g. ‘Fighting against soil erosion in Yangtze River’ organized by the Ministry of Water since 1989.

h. ‘Three norths shelter program’ organized by the National Forestry Bureau since 1978.

i. ‘Construction program of shelter forestry in the western part of northeast China’ organized by the National Forestry Bureau since 1952.

Thus ecological construction is not new in China. But many programs introduced before 1999 have limited outcome due to lack of investment, financial incentives and public support with a few exceptions. For example, the project of ‘Fighting against soil erosion in Yangtze River’ involved an area of 61,652 km^2 in 78 counties in the upper reaches of Yangtze area.[73] Some 56% of the land had a soil erosion problem and was losing a total of 773 million tones of soil a year. The project introduced measures against soil erosion in an area of 32,611 km^2 in the period 1990-1996. In these areas, the area of slope farmland was reduced by 36.57% and the forestry coverage increased from 22.8% to 41.1% in the above period. It was estimated that the amount of soil lost through erosion was reduced by 116 million tones. For another example, the National Bureau of Statistics (NBS) reported that various national key forestation projects planted trees in an area of over two million ha annually in the period 1991-1997, contributing over 40% to the total planted area (over four million ha each year) in the country.[74] The annual planted area via the ‘Three norths shelter program’ was over one million ha each year in the same period.

The new program introduced since 1999 were designed with more state investment and economic incentives to encourage peasants, local governments and state agents to participate actively. The ‘pilot program to convert cultivated land back into forestry and pasture’ is perhaps the most interesting which has been implemented with strong support of top Chinese leaders.[75] As mentioned before, it is impossible to

[73] Zheng Du, ed., Zhongguo xibu diqu 21 shiji quyu kechixu fazhan, pp. 211-214.

[74] Guojia Tongjiju (NBS), 98’ Zhongguo huanjing tongji (98 China Environmental Statistics) (Beijing: Zhongguo tongji chubanshe, 1999), pp. 118 and 123.

[75] Y. Zhen and S. Wang, ed., *China Environment and Development Review*, pp. 135-136.

solely rely on poor peasants to convert cultivated slope land back into forestry and pasture without financial support from the government or other organizations. Poverty prevails in those ecologically weak areas. The idea of this program is to use 'grain' to exchange for 'forestry'. The state provides grain and capital to encourage and compensate peasants to restore forestry on slope farmland to reduce soil erosion. The overall objective of the program is to restore ecological balance in 10 years in Yangtze River watershed and in 20 years in Yellow River watershed.

The program was first tried in Sichuan, Shaanxi and Gansu in 1999. The program was then introduced into 174 counties in the upper reach of Yangtze River (77 counties), upper and middle reaches of Yellow River (84 counties) and Xinjiang (13 counties) in 2000. It was planned to stop farming on an area of 0.34 million ha and restore forestry or pasture on an area of 0.77 million ha. Peasants were encouraged to plant trees and restore pasture on land beyond the former faming land in a ratio of one to two or one to three. The peasants were compensated according to the following criteria. Each ha of farming land that was used to plant trees was compensated with RMB 300 in cash and the seedling worth RMB 750. Each ha was also compensated with 2250 kg of grain worth RMB 3150 in the Yangtze River watershed and 1500 kg of grain worth RMB 2100 in the Yellow River watershed.

The total investment of the central government was RMB 1,867 million in 2000 that consisted of RMB 903 million from the fund for infrastructure construction and RMB 964 million from the state's fiscal subsidy fund. Among the total funding, RMB 103 million were distributed to peasants in cash, RMB 861 million for purchasing grain by the state, mainly locally, to distribute to peasants, RMB 581 million for purchasing the seedling from the forestry sector to distribute to peasants, RMB 296 million as investment in the infrastructure of the forestry sector for

producing seedlings, RMB 26 million as the cost for the planning, management and research support of the program.

Although the cost for tree planting only needs to be supported once, the peasants need to be subsided in cash and grain annually to keep them from cultivation the land again until they can make reasonable income from the forestry or other economic activities. The state plans to provide the grain and cash support for five years for areas planted with economic tress and for eight years for areas planted with ecological trees. Further support will be based on an assessment of the income of peasants then.[76] It can be estimated that the total cost for each ha of land is RMB 19,887 in Yangtze River watershed (a large part was in the western region) and RMB 14,687 in Yellow River watershed respectively if the peasants are subsided for 5 years. The cost for each ha of land is RMB 37,137 in Yangtze River watershed and RMB 26,687 in Yellow River watershed respectively if the peasants are subsided for 10 years. Such investment is necessary to bring real benefit to peasants so that forestry can be restored. The ecological construction and natural conservation are expected to reduce huge economic loss brought by drought and flooding. It has been estimated that the 1998 flooding in the Yangtze River resulted in an economic loss of RMB 300.7 billion, equivalent to 3.8% of GDP in China.[77]

The above example shows the progress in ecological construction in China with direct investment from the state. Nevertheless, a number of issues need to be solved to sustain the ecological construction and its benefit in long term.[78] First, the

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[76] OLGWRD, ed., *The Overall Plan of Western Region Development and Related Policy Measures*, pp. 196-229.

[77] Hu Angang, ed., Diqu yu fazhan: xibu kaifa xinzhanlue *(Regions and Development: New Strategies for Western Region Development*) (Beijing: Zhongguo Jihua Chubanshe, 2001).

[78] Y. Zhen and S. Wang, ed., *China Environment and Development Review*, pp. 152-153; See also Cui Xiaoli, Guanyu Gansu and Nei Mongol liang shengqu tuigeng huanlin(cao) wenti de kaocha baogao (A

state support should be sustained for many years until the peasants are able to generate sufficient income from other economic activities. Otherwise, peasants will cultivate the slope land again to survive and all the efforts of ecological construction will be undermined completely. Similar projects failed in Ningxia and Sichuan in the 1980s due to inadequate grain support to peasants. Second, scientific planning and technical support are needed in various forestation programs so that healthy forestry ecology can be developed. It has been found that over 80% of economic trees of single or few varieties have been planted in some cases. The percentage of economic trees should be reduced to 20% in the long term. Third, strict monitoring of the implementation of the forestation project is necessary. It is essential to prohibit 'model projects' which are designed only for the field investigation of governmental officials with excessive investment. It is also necessary to stop peasants from cultivating slope land elsewhere otherwise all efforts in forestation become vainness. Fourth, it is necessary to continue to control the population growth in the western region via family planning and migration to other areas. The western region has a low population density but its carrying capacity is also low due to harsh environment. Fifth, various government departments involved in the ecological construction projects should be well coordinated.[79] Formal laws and regulations should be enacted to ensure long-term ecological construction taking into account the interests of the state, local areas and the peasants.

Conclusion

The paper argues that there are two kinds of environmental problems. The first is the population growth-induced ecological degradation and the second is economic

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field-survey report on the problem of converting cultivated land back into forestry and pasture in Gansu and Nei Mongol), on-line paper, http://www.usc.cuhk.edu.hk/wk.asp.

[79] Zheng Du, ed., Zhongguo xibu diqu 21 shiji quyu kechixu fazhan, pp. 272-273.

growth-induced environmental degradation. This paper is concerned with the first problem in the western China.

Rapid population growth is often considered a major cause of land and ecological degradation as more and more hilly areas and pastures are converted to arable land which is susceptible to soil erosion and ecological degradation. The theory of traditional agriculture has been developed previously to describe the stagnant agriculture and poverty in rural areas. In the case of subsistence agriculture in the poor western China, peasants mainly produce for their own consumption. An explicit analysis of population change and land exploitation would be essential. Thus the economic model of agricultural demand and supply are extended to form a conceptual framework of population, development and ecological system.

The focus of this paper is the western China where a major government initiative 'the go west strategy' has been introduced since 1999. The paper demonstrates that the western region has growing population pressure, a low level of development, and serious ecological degradation.

The natural population increase rate in most provinces in the western China was higher than other parts of China in the reform period 1978-1999. Such fertility-led rapid population growth contributed to an increased population pressure in the western region. The western region was struggling for grain production at or below the subsistence level up to the 1980s. Such a situation not only slowed down the process of industrialization and urbanization, but also caused severe land and ecological degradation through deforestation and slope farming.

Other than population pressure, weak economic competitiveness also contributed to the substantial development gap among the eastern, central and western regions. It was found that no economic sector in the western region had any

competitive advantage in the nation that poses a serious challenge on its path towards development socially, economically and environmentally.

Under the condition of underdevelopment and slow industrialization and urbanization, the growing population and high dependence on agriculture have resulted in severe ecological degradation in the western region. Farming on slope land with slope of 15 degrees and over was common in the western region, causing significant soil erosion and land degradation. Environmental changes over a period show the impact of growing population pressure. Various estimates suggested that ecological degradation was worsening in the western region.

The ecological degradation is related to rapid population growth as well as inadequate grain production in the western region. Will agricultural and economic development help fighting against ecological degradation? The answer is yes. Adequate grain production in China since the late 1990s has provided a good opportunity for China to address the problem of ecological degradation especially in the western region that is no longer needed to achieve self-sufficiency in grain production.

However, the complicated relationship between the state and peasants has to be solved for implementing ecological construction. The top priority of peasants is to survive and their private interests are not consistent with the state's goal for ecological construction. To resolve such inherent conflict, the state has initiated the adjustment of agricultural production and ecological construction by compensating peasants for restore forestry on slope farmland since the late 1990s. Some quantities of grain and funds have been transferred into the western China to exchange 'grain' for 'forestry'. The long-term results are yet to be assessed but these government-lead projects do show the potential to reverse the trend of ecological degradation in the

poor western region. These projects may also face various problems that have to be dealt with carefully so that the ecological construction can be sustained in long-term.

Table 1 Relative level of natural population increase rate and population growth 1978-2000 (China=100%)

Region	Relative level of natural increase rate (%)			Relative level of population growth (%)	
	1978	1990	1999	1978-1990	1990-2000
China	100	100	100	100	100
East	95	89	78	104	132
Central	103	114	101	102	74
West	103	99	128	96	89
Inner Mongolia	100	98	106	100	92
Guangxi	142	95	117	136	54
Chongqing	[a]	[a]	72	[a]	61
Sichuan	61	80	99	59	54
Guizhou	160	106	208	116	76
Yunnan	161	110	170	110	137
Tibet	107	115	230	128	166
Shaanxi	78	119	89	103	83
Gansu	92	101	134	110	125
Qinghai	147	118	203	124	139
Ningxia	173	132	180	173	178
Xinjiang	112	130	172	129	232

Note:

a: Chongqing was designated as a city with a provincial status in 1997 and its data were included in Sichuan before 1997.

Source: calculated by the author based on the data from NBS, *China Statistical Yearbook 2001*, p. 99; NBS, *China Statistical Yearbook 2000* (Beijing: China Statistics Press, 2000); Department of Comprehensive Statistics of National Bureau of Statistics, *Comprehensive Statistical Data and Materials on 50 Years of New China* (Beijing: China Statistics Press, 1999), p. 112.

Table 2 Grain output per capita in 1978, 1990 and 2000 (kg)

Region	1978	1990	2000
China	317	394	365
East	331	366	308
Central	359	467	438
West	299	347	363
Inner Mongolia	274	453	523
Guangxi	318	323	340
Chongqing	[a]	[a]	358
Sichuan	329	398	405
Guizhou	240	223	329
Yunnan	279	286	342
Tibet	287	253	367
Shaanxi	288	326	302
Gansu	273	309	278
Qinghai	247	256	160
Ningxia	329	408	450
Xinjiang	300	440	407

Note:

a: Chongqing was designated as a city with a provincial status in 1997 and its data were included in Sichuan before 1997.

Source: calculated by the author based on the data from NBS, *China Statistical Yearbook 2001*, pp. 99 and 380; Department of Comprehensive Statistics of National Bureau of Statistics, *Comprehensive Statistical Data and Materials on 50 Years of New China*, pp. 112 and 121.

Table 3 Comparison of development indicators among three regions in China in 2000

Indicator	China	East	Central	West
GDP per capita (RMB)	15435	23466	11850	9119
Urban income per capita (RMB)	6554	7929	5191	5642
Rural net income per capita (RMB)	2367	3200	2071	1691
Rural waged income per capita (RMB)	792	1279	583	437
Level of urbanization (%)	36.2	46.1	33.0	28.7
Share of non-farm employment in rural areas (%)	28.0	40.9	31.6	25.0
Employment share (%)				
Primary	53.0	42.9	56.8	61.7
Secondary	19.8	27.2	17.5	12.9
Tertiary	27.2	30.0	25.8	25.4
GDP per labor (RMB)				
Primary	4450	6268	3997	3289
Secondary	36699	42438	31376	29278
Tertiary	21332	30857	15927	13024

Source: calculated by the author based on the data from NBS, *China Statistical Yearbook 2001*.

Table 4 A comparison of two categories of environmental degradation

Category	**Population growth-induced ecological degradation**	**Economic growth-induced environmental degradation**
Key sector	Agriculture	Manufacturing and urban sector
Objective of development	Feeding growing population	Job-creation and improving materials standards of living
Major causes of environmental degradation	Expansion of agriculture and farmland	Industrialization and urbanization
Key symptoms	Conversion of forestry, pasture and slope land to farmland; Overuse of water resources; Soil erosion; Land degradation; Desertification.	Conversion of farmland to industrial and urban land use; Air, water and waste pollution; Overuse of natural resources; Low environmental quality; Health problem; Global warming.

Table 5 Land resources in the western China

Region	Land area[a]	Proportion of farmland[b]	Proportion of forestry[c]	Proportion of pasture[a]	Proportion of desert[j]	Proportion of irrigated farmland[b]
	1000 ha	%	%	%	%	%
China	960000	13.55	13.92	32.64[f]	17.59	41.40
West	676800[d]	7.32	8.70[d]	36.53[d]	29.01[d]	30.60
Inner Mongolia	110000[i]	7.46	12.14	56.78[g]	64.59[k]	28.90
Guangxi	23000[i]	19.17	25.34	36.80[h]	n.a.	34.10
Chongqing	8234	29.29	[e]	18.75	[e]	25.90
Sichuan	48830	13.84	20.37	43.00	1.66	36.50
Guizhou	17613	27.84	14.75	24.34	0.06	13.30
Yunnan	38204	16.81	24.58	40.17	0.21	21.90
Tibet	122840	0.30	5.84	66.80	17.37	43.30
Shaanxi	20690	24.85	24.15	25.16	7.06	25.40
Gansu	45389	11.07	4.33	39.45	25.69	19.50
Qinghai	72120	0.95	0.35	50.43	16.13	30.70
Ningxia	5180	24.50	1.54	58.19	23.94	31.40
Xinjiang	164700	2.42	0.79	34.77	46.70	77.60

Data sources:

a. Lu Dadao et al., *2000 Zhongguo quyu fazhan baogao --- Xibu kaifa de jichu, zhengce yu taishi fenxi*, p. 210.

b. Calculated by the author from data in NBS, *China Statistical Yearbook 2001*, pp. 365 and 369. Lu Dadao et al., *2000 Zhongguo quyu fazhan baogao --- Xibu kaifa de jichu, zhengce yu taishi fenxi*, p. 210 and Minzheng bu diming yanjiusuo yu zhongguo xingzheng yu diming xuehui (ed), *Zhongguo xingzheng quhua diming shouce* (*Handbook of Place Names of the Administrative Divisions in China*) (Beijing: Zhongguo shehui chubanshe, 1999).

c. Zhongguo senlin bianweihui, Zhongguo senlin diyi quan (*Forestry in China, Vol. 1*) (Beijing, Zhongguo linye chubanshe, 1997), p. 231; Zhongguo kexueyuan kechixu fazhan yanjiu xiaozu , *1999 Zhongguo kechixu fazhan baogao*, pp. 308-309.

d. Calculated by the author using weighted average of the provincial data in this table.

e. Included in Sichuan.

f. Usable pasture from NBS, *China Statistical Yearbook 2001*, p. 6.

g. Calculated by author based on the data on pasture and land area in Zhao Ji and Chen Chuankang, *Zhongguo dili* (*Geography of China*) (Beijing: Gaodeng jiaoyu chubanshe, 1999), p. 455.

h. Ibid., p. 590.

i. Minzheng bu diming yanjiusuo yu zhongguo xingzheng yu diming xuehui, ed., *Zhongguo xingzheng quhua diming shouce*.

j. Calculated by the author from the data in Lu Dadao et al., *2000 Zhongguo quyu fazhan baogao --- Xibu kaifa de jichu, zhengce yu taishi fenxi*, pp. 210-211.

k. Zhao Ji and Chen Chuankang, *Zhongguo dili*, p. 471.

Table 6 Land degradation in the western China

Region	Proportion of farmland with slope 15-25 degree[a]	Proportion of farmland with slope over 25 degree[a]	Proportion of land with soil erosion[b]	Proportion of degraded pasture[a]	Proportion of land affected by desertifi-cation[d]	Soil erosion[d]	Soil erosion intensity[d]
	%	%	%	%	%	million tones per year	tones per square km per year
China	9.70	4.70	16.98	19.79[d]	34.55	5190	541
West	n.a.	n.a.	13.88[c]	28.93[c]	46.33[c]	3350	488[c]
Inner Mongolia	n.a.	n.a.	15.72	20.29[d]	59.27	477	403
Guangxi	n.a.	n.a.	7.56	0[d]	0	238	1006
Chongqing	[e]	[e]	[e]	6.48	[e]	[e]	[e]
Sichuan	26.20	11.50	43.65	29.15	1.09	351	616
Guizhou	30.30	19.50	43.55	4.67	0	131	744
Yunnan	33.70	12.90	12.85	3.40	0.79	366	929
Tibet	11.20	3.60	0	25.59	42.02	99	81
Shaanxi	19.90	23.20	66.87	35.54	15.96	492	2393
Gansu	25.80	5.90	37.95	47.87	50.62	583	1283
Qinghai	19.20	0.80	3.61	29.97	33.06	231	320
Ningxia	12.10	0.70	69.94	86.26	75.98	50	965
Xinjiang	0	0	0.07	46.42	86.07	336	202

a. Lu Dadao et al., *2000 Zhongguo quyu fazhan baogao --- Xibu kaifa de jichu, zhengce yu taishi fenxi*, pp. 210 and 218.

b. Zhongguo kexueyuan kechixu fazhan yanjiu xiaozu , *2000 Zhongguo kechixu fazhan baogao*, p. 171.

c. Calculated by the author using weighted average of the provincial data in this table.

d. Zhongguo kexueyuan kechixu fazhan yanjiu xiaozu , *1999 Zhongguo kechixu fazhan baogao*, pp. 308-309.

e. Included in Sichuan.

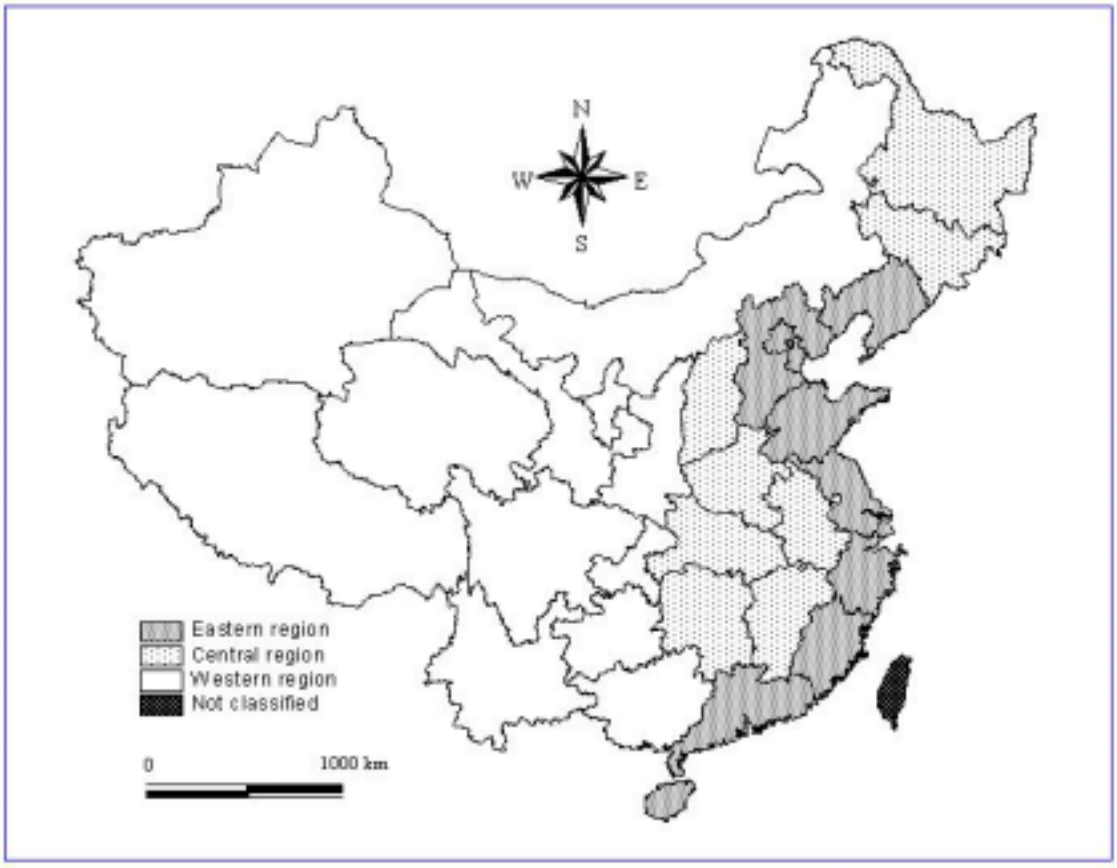

Figure 1 The location of three regions in China

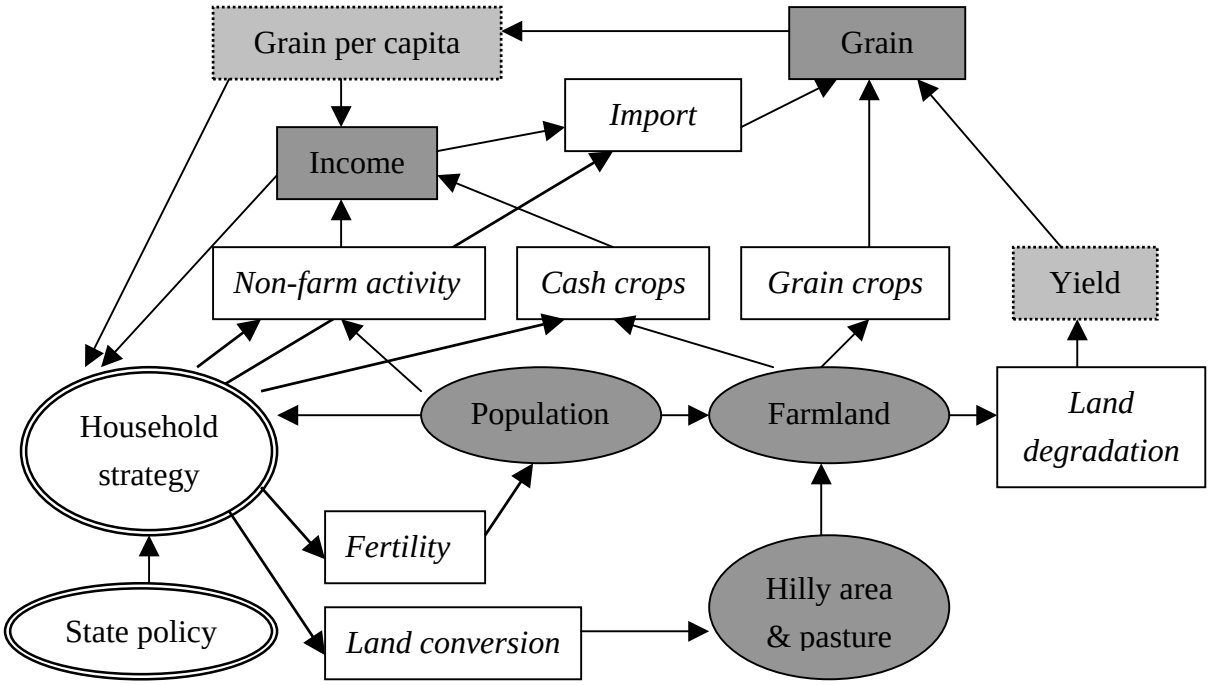

Figure 2 A conceptual framework of population, development and ecological system