LAND DEGRADATION
IN
CHINA:
ITS EXTENT AND IMPACT

L. Berry

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LAND DEGRADATION IN CHINA: IT'S EXTENT AND IMPACT

Preface

This paper is part of a series of case studies, which attempt on a pilot country basis to examine the costs of land degradation. This stage of the work involves a desk analysis of:

- Impacts of land degradation
- Costs of land degradation
- Costs of land improvement measures
- Costs of policy reform and institutional development.

In general there is reasonable, though not comprehensive, information on the impacts of land degradation and a good assessment base of the proximate and root causes. Linkages with poverty are well established and the cost of current remedial programs can be identified.

There is much less information on the impact on the ground of these actions. It is clear that the impact of land degradation is a drain on economic growth in rural areas and has an affect on national economic growth patterns. Investment in remedial action is hard to quantify, but appears an order of magnitude smaller than the scope of the problem. Actual in country joint assessment with national stakeholders will be necessary to provide specific analysis of the countries concerned.

CHINA


Heilongjiang
Jilin
Liaoning
BEIJING
Tianjin
Hebei
Inner Mongolia
Xinjiang
Gansu
Ningxia
Qinghai
Shanxi
Shandong
Henan
Jiangsu
Shaanxi
Shanghai
Tibet
Sichuan
Anhui
Hubei
Zhejiang
Chongqing
Jiangxi
Hunan
Guizhou
Fujian
Yunnan
Guangxi
Taiwan
Guangdong
Hong Kong
Hainan
Islands of South China Sea
Islands of South China Sea

LAND DEGRADATION IN CHINA: IT'S EXTENT AND IMPACT

Executive Summary

China, with 22% of the world's population has only 6.4% of the global land area, and 7.2% of the world's farmland; hence sustainable productive land management is critical for the country's long-term agricultural economy. However, while some parts of the country have enjoyed continued high levels of productivity, others are experiencing moderate to severe degradation. Over 40% of the country is adversely affected.

China has made a number of regional and national assessments of the cost and other impacts of land degradation. In 1999 total direct costs were estimated at $7.7 billion about 4% of the GDP while indirect costs were $31 billion. Regional impacts are greatest in the Loess Plateau area and in the extensive Western Region. Poverty and land degradation are closely correlated.

The direct causes include ongoing deforestation of steep slopes, over intensive use of grasslands, neglect of community conservation practices under the new rural system, and use of biomass for energy in rural areas.

The root causes relate to decreasing land per capita, poverty in fragile environments, top down application of policies without local participation and sector driven management initiatives.

As the problem has become severe responses have also grown, but while the minimum cost to the country is over 4.0% of GDP, investment is around 0.08%. Regional assessments show that while the return to farmer investment in soil conservation in the Yangtse valley is high; in the Yellow River and the Loess Region this was not so and external investment was needed. Over $13 billion of investment is projected over ten years in the Western Provinces.

In these and other investments; policy and process issues, as well as pricing, marketing and economic infrastructure will need to be addressed.

LAND DEGRADATION IN CHINA: ITS EXTENT AND IMPACT

INTRODUCTION

Scope of Land Degradation in China

China is among the most affected countries in the world in terms of the extent, intensity and economic impact of land degradation. Current estimates suggest that over 40% of the land area (3-4 million km^2) is adversely affected by wind and water erosion, loss of grazing, deforestation and salinization.

As the Peoples Republic of China (PRC) economy has expanded rapidly over the past decade land degradation has intensified with direct and indirect impacts. With arable land per capita at 0.11 ha, the impact of land degradation especially in poor rural areas is considerable. Annual soil loss is around 5 billion tons and 90% of grassland suffers degradation in the face of rising demand for meat and livestock products.

The basic problem is that PRC has to feed 22 per cent of world's population on 6.4% of global land area, 7.2% of the world's farmland and 5.8% of the world's annual water resources.

Basic Land Use and Ecological Setting

China is a large country but with the world's largest population of about 1.3 billion. Only 1.3 million Km^2 is suitable for cultivation, i.e. about 14 per cent of the total land area. Of the remainder 28% is grassland, 24% woodland and forest and the rest unproductive or urban area. About 500 million Chinese live and work in rural areas, 300 million as rural laborers. Population growth is now a low 1.1% year but urban growth continues to be rapid. Land resources available per capita is about 1.3 ha per rural worker but a high percentage of this is grassland. Because China is so diverse the PRC government has divided the country into seven broad regions for the purpose of land and water conservation programs (Table 1).

Table 1. Main Soil Conservation Planning Areas

- The Loess Plateau Region – North/Central China
- The Black Soil Region of Northeast China
- The Red Soils Region of Southern China
    - The Red Soils Hill and Mountain sub-region of Southern China
    - The Red Soils Coastal Plain sub-region of Southern China
- The Northern Mountain Region
- The South West Mountain Region
- The North West Region
    - The Mountain sub-region of North West China
    - The Grassland Plains sub-region of North West China
- The Tibetan High Plateau and Mountain Region

Source: People's Republic of China National Strategies for Soil and Water Conservation. 2002. Final Report (Draft).

The Loess Plateau is a unique region of up to 200 m deep fine sediment, which is dissected by deep gullies and yields high sediment loads to the rivers. The Black Soil region has high potential for grain production, but susceptible to accelerated erosion if not well managed. The Red Soil region of the South is relatively infertile and susceptible to water erosion. The mountain regions, which make up 66 per cent of China are not agriculturally productive except in the valleys and in the northwest grassland areas, while the Tibetan Plateau is high and cold and has a low potential for crop production. These constraining environmental factors have concentrated highly productive agriculture in the river valleys and alluvial plains, but have also led to intensive unwise use of hill slopes and marginal land, together with the intensive livestock occupation of the grasslands.

Water is also a constraint to sustainable land use, and high sediment loads in rivers provides additional problems. Potential for flooding and drought, both natural phenomena, have been increased by inappropriate land use practices.

EXTENT OF LAND DEGRADATION IN CHINA

Changes in Land Cover

Changes in vegetation status in China are well documented. Forest removal has been an historic process in China and the 20th C. saw a partial reversal of that process so that from 1934-1993 forest cover almost doubled, but most of this was in the form of plantations. Natural forest continues to be depleted and biodiversity has significantly decreased. Grasslands in contrast have suffered significant degradation (Table 2) and 34% of grasslands are moderately to severely degraded, while 90% is degraded to some degree. This has resulted in a reduction in production potential. Regional data for Inner Mongolia show that in the 1950's there was 3.3 ha per sheep while in 2000 this had reduced to 0.42 ha per unit.

One consequence of this degradation appears to be in the increase in frequency of severe dust storms in Beijing from 0.5 a year in the 1950's to 2.3 per year in the 1990's. In two storms in March 2002, 56,000 tons of sand and dust were deposited in the capital. (China Daily. 23 March. 2002).

Table 2 – Extent of Grassland Degradation in China 1998

Province	**Grassland Area** (Million ha)	**Grassland Area Moderately to Severely Degraded** (Million ha)	%
Tibet	82.4	21.4	26
Inner Mongolia	79.1	45.9	58
Xinjiang	56.4	26.0	46
Qinghai	36.0	10.8	30
Sichuan	21.1	6.1	29
Gansu	17.6	8.4	48
Yunnan	15.2	0.5	3
Other Provinces	117.8	17.7	15
Total	393.6	136.7	34

Source: Ministry of Agriculture. 1999. cited in World Bank. 2001.

Impacts on Cultivated Land

Some indication of the impacts on cultivated land is that while chemical fertilizers have doubled in use, the application of organic matter has decreased by 70% (Wang, Z. et al 1999). This is because crops residues are increasingly being used for fuel because of the lack of other local energy resources. Surveys yield inconclusive data on the status of soils but organic matter is below 0.6% on 20% of cultivated land, while the northeast shows a decline for all indicators. There is data on salinity constraints on cultivated land indicating 7-8 million ha (8%) are moderately-severely affected. The available data for salinization in general shows no strong trend but monitoring is not precise (Huang J. 2001).

Trends

An important negative trend for cultivated land is the increasing conversion of land to urban uses. This was a major problem in the 1960's-1980's when 538,000 ha/year was converted. More recent regulation has reduced this rate but between 1986-95 an additional 680,000 ha was converted equivalent to 3 million tons of grain production. This significant allocation puts additional stress of the remaining cultivated land (World Bank 2001).

The available data suggests that the most important negative trends in land degradation are in the north and west, i.e. the arid and semi-arid parts of the nation. This pattern of change is dramatized by the increase in number of intensity of dust storms in Beijing quoted above, though cause and effect are not scientifically documented.

Table 3 illustrates some of the identified trends for the arid and semi-arid areas where data is more clearly available.

Table 3. a. Annual expansion of degraded land in arid and semiarid regions

1980's	Mid 1990's	Late 1990's
1800 Km^2	2460 Km^2	3436 Km^2

b. Land degradation due to wind erosion and salinization

1970's	1990's
1500 Km^2 year	3500 Km^2 year

Source: State Forestry Administration 2002 and ADB/GEF Project document (2002)

NATIONAL AND REGIONAL ECONOMIC IMPACTS OF LAND DEGRADATION

The impact of land degradation has national and regional dimensions, which relate not only to the magnitude of the physical losses but also to the nature of the regional economy and livelihood. Annex 1 outlines some of the basic data for China at the conservation region level. (Modified from ADB final draft report National Strategies for Soil and Water Conservation 2002).

National Impacts

A number of assessments of the cost of land degradation at the national level have been made. Total direct costs are estimated at $7.7 billion per year in 1999, 4% of GPD, while indirect costs are thought to be around $31 billion a year (Tables 4 and 5).

Table 4. Economic Costs of Land Degradation

Direct	$ 7.738 billion
Indirect	$ 30.952 billion
Breakdown	
Water Erosion	$ 4.8 billion
Wind	$ 0.43 billion
Salinization	$ 2.24 billion
Sand Storms	$0.16 billion

Source: Chinese Journal of Population and Resources (2002)

Reduced grain yield alone due to nutrient loss was estimated at 5% per annum for the period 1976-89. This is equivalent to 6 million tons of grain with a value of $700 million and representing an equivalent of 30% of the imports of grain for those years (Huang & Roselle 1995).

Table 5 illustrates an alternative set of estimates prepared for the National Strategies report (Ning, 2002). These figures suggest an annual cost of $11 billion with an additional cost of replacing lost nutrients of $6.4 billion. Offsite costs total approximately $12 billion for a total cost of $28.4 billion. The bottom line on both calculations is similar and huge.

Table 5. Estimates from Ning et al

On Site	
	Billion
Desertification	$ 3.4
Soil Erosion	6.4
Salinization	0.05
Soil Pollution	0.18
TOTAL	**$11.03**
Replacement of lost nutrients	6.4 a year
Off Site	
Loss of Reservoir Function	$11.57
Loss of Navigation due to Silting	0.42
TOTAL	**$11.99**

Regional Impacts

There is data from a wide range of provinces to give an indication of regional impact. Some examples are:

- Inner Mongolia: wheat yields decreased from 1875-2250 kg/ha to 525-750 kg/ha over 30 years (Zhang, J. 1998)
- SW China paddy yields decreased by 50 per cent in degraded areas (Zhang, J. 1998)

- Returns to farmers in Guizhon province declined by 50% between 1983 and 1999 mainly because of land degradation. resulting in an increase in relative poverty in this area.

However, the greatest impact of land degradation is felt in the poorest areas and there is data to show a strong positive correlation between poverty and ecologically sensitive environments. In these areas, poverty and land degradation feed off each other in a downward spiral.

Additionally poor degraded areas are also characterized by severe health impacts in terms of malnutrition, disease resulting from poor water quality and respiratory diseases from dust and other contaminants.

Regional Impact in Western Region

The vast western region of China is the area most intensely affected by land degradation.[*] The combination of the arid/semi-arid environment relative isolation and generally low productivity has resulted in a combination of land degradation and poverty. Data for the region suggests that moderate-severe land degradation affects almost half the area, a region of 350 to 400 million people with 27% of the area experiencing wind erosion, 16% water erosion and 10% with advanced desertification (SEPA 2001).

Absolute poverty in this western region affects over 30 million people. This is by the PRC definition of $0.75 million a day in 2001 values. If the world bank $1 a day was used, the total would rise to 100 million. This is a predominantly rural area with low population densities, a general subsistence base of grazing and small farms. There are long distances between population centers, poorly organized local markets and a generally poor economic, institutional and social structures (Cua et al 2002). Poverty and land degradation are closely linked.

APPARENT ROOT AND PROXIMATE CAUSES

Land degradation is a result of environmental conditions and inappropriate human management. In China particular circumstances include:

- High rain intensities in south china often associated with typhoons, especially impacting steeply sloping areas.
- Strong spring winds in North China affecting dry loose loess soils and degraded grasslands.
- Generally mountainous relief adjoining alluvial plains, with flood prone, sediment-laden rivers.

Direct (proximate) human activities include:

- Deforestation of hill slopes and inappropriate cultivation of steep slopes.
- Over intense use of grasslands for livestock production.
- Grain production in dryland areas without soil conservation
- Poor management of ground water resources.
- Improper management of soil and water on irrigated lands.
- Neglect of communal conservation practices under new rural system.

[*] The western region includes six provinces: Sichuan, Guizhou, Yunnan, Sha'anxi, Gansu and Qinghai and five autonomous regions, Tibet, Ningxia Hui, Xinjiang Nygur, Inner Mongolia and Guangxi Zhuang.

- Loss of agricultural land through urban and industrial expansion.
- Use of biomass for rural energy needs. Over 70% of rural energy is natural or cultivated biomass (ADB.TA 2002; ADB/GEF, 2002;.UNDP 1998; World Bank 2001).

Root causes include:

- Low loads of land resources per rural worker (under 0.5 ha cultivated).
- Poverty in the most vulnerable ecological zones (90% of poor live in areas of moderate – severe land degradation).
- Increasing urban demand. As living standards, especially in urban areas, rise rapidly there is increasing demand for meat and livestock products encouraging overuse of grasslands.
- Change in farming and land use systems from traditional to intensive modern with the growing use of chemical fertilization.
- Top down application of policies without respect to provincial conditions.
- Sector driven management and lack of coordination between ministries and between national, regional and local administrations. Even within one sector such as water or soil different agencies are responsible for different uses so there is a compelling need for within sector and cross sector cooperation.
- Inadequate regulatory environment for dealing with land degradation.
- Poor financial incentives for conservation.
- Under pricing or regressive pricing for natural products especially for irrigation water and land rents (Li Zhou, 2002; Wang, Z, 199; ADB.TA 2002).

PAST INVESTMENT IN SUSTAINABLE LAND MANAGEMENT AND IMPACTS OF THIS INVESTMENT

China has a long history of investment in soil and water management, with terracing for rice documented for over 3,000 years and water management on a large scale for an even longer period. This section deals with the PRC government response in the past few decades. A major effort over the past several decades has been efforts to overcome desertification in the arid and semi-arid areas and most national plans included specific environmental goals and objectives. The typical approach is engineering based combined with revegetation and farm based conservation. One government project in the Upper Yangtze basin represented an investment of over $120 million, which produced 4,330 Km^2 of terraces, 15,000 Km^2 of forest production, 5,760 Km^2 of orchards and provided protection to 56,000 Km^2 or 16% of the eroded area (ADB.TA 2002 Ch 4).

As the perception of land degradation has grown and as public concern has become more articulate, investment in sustainable land management has grown. In the 1990's total investment grew from $2.2 billion to $6.5 billion. The largest increase has been in forestry, a sector that has traditionally not contributed significantly to the Chinese economy. Investment in soil conservation has also grown at 10% a year (Table 6), but even so investment is equivalent to 0.08% of the GDP while the minimum cost to the country is over 4.0% of GDP.

Table 6. Five-Year Average Public Investment in Key Land Degradation Control Programmes(U.S. $ million)

Sector		Forestry	Water and Soil Conservation	Total
1991-1995	Total	122	358	480
	Central government	38	31	69
1996-2000	Total	710	705	1415
	Central government	553	102	655

(ADB.TA 2002)

Assessments have been made on a regional basis to value the on-site benefits of soil conservation. Evaluation was attempted for China as a whole, the Yangtse Valley, the Yellow River Valley, and the Loess Plateau (ADB.TA 2002 Annex IV).

Nationally soil erosion was valued at a loss of 4-6% of the value of annual agricultural products. As only on-site losses and benefits were taken into account, this suggests a significant additional investment could be economically profitable. In the regional analysis it was found that in the Yangtse Valley the returns to farmers from conservation measures were so great that there was an internal on farm incentive to invest in conservation. Markets are available for produce and benefits to increased yield are clear.

In the Yellow River and Loess area there are different situations. In these areas the fertile soil is so deep that off-site costs are greater than the perceived loss to the farmer. Therefore, the study suggested more government investment may be a priority. However, in cooperation with Donors, the PRC has a strong commitment to address root and proximate causes in the Western Region over the next decade, though this is being funded through the "line" ministries.

In the western provinces government investment in 2002 was planned at $1 billion and a total of $13 billion is projected over the next ten years with a possible increase to $32 billion . (ADB/GEF2002).

Table 7 illustrates current or recent World Bank and Asian Development Bank projects related to sustainable land management. The Loess plateau project, the Heilongjang agricultural Development project and the West Henon agricultural Development project are noteworthy in that they appear to incorporate a range of policy, conservation and economic issues in a pro-active way.

Annex 2 summarizes some of the most recent specific studies in the literature. The papers on local policy and local government role seen particularly important in future policy and project design.

A current article (Hai & Shaolin 2003) describes the history and practice of ecological restoration in China and suggests that over 200,000 ha have been restored in China with a value of more than $1 billion U.S., but also notes the many millions of hectares that need restoration.

Table 7. Current/recent World Bank and Asian Development Bank projects related to sustainable land management

Agency	Project Title	Duration of Project	Total Cost
World Bank	Loess Plateau Watershed Rehabilitation Project (02)	1999 - 2004	$150 m
World Bank	Heilongjiang Agricultural Development Project	1997 - 2003	$240 m
World Bank	Heilongjiang Land Reclamation Project	1983 - 1989	$80 m
World Bank	Jiangxi Agricultural Development Project	1990 - 1995	$60 m
World Bank	Sustainable Forestry Development Project	2002 - 2009	$215 m
Asian Development Bank	Yellow River Flood Management Sector Project	1999 - 2002	$412 m
Asian Development Bank	Songhua River Flood Management Sector Project	1999 - 2002	$358 m
Asian Development Bank	West Henan Agricultural Development Project	1993 - 2000	$151 m
Asian Development Bank	Sanjiang Plains Wetland Protection (earlier listed as Integrated Natural Resources Management for Sanjiang Plains)	2002	$600,000*
Asian Development Bank	Dryland Farming Project in the Northern Region	2001 - 2002	$450,000*
Asian Development Bank	Fujian Soil Conservation and Rural Development II	1999 - 2001	$650,000*
Asian Development Bank	Yunnan Comprehensive Agricultural DevelopmentI	1998 - 2000	$1,332,000*
Asian Development Bank	Songhua River Flood Wetland and Biodiversity Management Project (formerly “Songhua river Flood and Wetland Management Project”)	1999 - 2000	$1,545,000*

*Prepartory Costs only

INDICATORS TO MONITOR TO IDENTIFY TRENDS

Very significant investment is being planned in the most affected provinces both by PRC and the donor community. It is recognized by both groups that the problem of land degradation can only be efficiently addressed by a combined approach addressing root and proximate causes. Indicators to identify progress in this arena must therefore combine these.

Suggested indicators to identify economic returns from this investment include;

- Land use change – particularly on degraded hill slopes.

- As alternative land use patterns develop the economic benefit of improved productivity in terms of biomass and carbon sequestration can be identified.
- The off-site reduced sediment yield.
- Community participation in land degradation responses (Index of social capital).
- Realization of policy reforms and coordination between institutions(Index of institutional capital).
- Value of production from degraded region (Index of economic capital).
- Reduction in dust storms and improvement in patterns of water flow (Index of natural capital).

CONCLUSIONS

In a potential great step forward the PRC has recognized in principle that rapid economic growth has to become sustainable economic growth in terms of agriculture and natural resources.

However, the "root cause" driving forces still exist and may in some cases be increasing in intensity. While allocation of more financial resources is important, the list of critical root causes includes several which identify policy, style and process issues. These need to be addressed and it appears this is recognized in current national plans.

Any evaluation of progress towards combating land degradation will need to involve:

- Much better integration of administrative mechanisms.
- Devolution of responsibility and implementation to provincial and local levels.
- Participatory involvement in on-site conservation measures.
- Attention to pricing, marketing and economic infrastructure issues.

These are all addressed in plans and proposals. Monitoring and evaluation of these factors will be important in assessing progress towards sustainable land and water management.

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ANNEX 1. Basic Data by Conservation Regions

1. The Loess Plateau Region

Land area	640,000 Km^2 - 6.73% of total area of PRC		
Rural population	Total rural population:	48,000,000	
	Rural population density:	50-100 per square kilometer	
Land use characteristics	Arable land:	150,000 Km^2 or	23.4%
	Pasture land:	256,000 Km^2 or	40%
	Forest & woodland:	38,400 Km^2 or	6%
Land degradation types	Dominant degradation type(s):	Water erosion, wind erosion	
	Other key degradation type(s):	Soil fertility decline associated with soil chemical, physical and biological (organic matter) degradation.	
Land degradation severity and extent	a) Water Erosion		
	None:	288,764 Km^2	45%
	Slight:	114,197 Km^2	18%
	Moderate:	115,826 Km^2	18%
	Severe:	63,478 Km^2	10%
	Very severe:	57,735 Km^2	9%
	b) Wind Erosion		
	Slight:	11,989 Km^2	2%
	Moderate:	35,952 Km^2	6%
	Severe:	39,140 Km^2	6%
	Very severe:	81,539 Km^2	13%
	c) Soil Fertility Decline Anecdotal evidence suggests a severe loss of soil fertility but no quantitative studies were cited.		
	c) Other land degradation types Some areas of landslides, water logging and salinity		
Other comments	Region with the most serious erosion in the PRC. Rates of soil loss may be as high as 50-100 tonnes/ha/yr. Over large parts of the Loess Plateau the surface soil has been completely eroded, leaving only skeletal and immature soils. Much soil is lost through mass wasting in the form of landslides and mud flows.		

2. The Black Soil Region of Northeast China

Land area	1,096,609 Km^2 - 11.54% of total area of PRC		
Rural population	Total rural population: 45,000,000 Rural population density: 10-50 per square kilometer		
Land use characteristics	Arable land:	550,000 Km^2	50.2%
	Pasture land:	200,000 Km^2	18.2%
	Forest & woodland:	228,983 Km^2	25.1%
Land degradation types	Dominant degradation type(s): Wind erosion , water erosion Other key degradation type(s): Soil fertility decline, salinity, waterlogging.		
Land degradation severity and extent	a) Water Erosion		
	None:	942,553 Km^2	85.95%
	Slight:	102,601 Km^2	9.36%
	Moderate:	43,108 Km^2	3.93%
	Severe:	8,085 Km^2	0.74%
	Very severe:	262 Km^2	0.024%
	b) Wind Erosion		
	Slight:	13,279 Km^2	1.21%
	Moderate:	8,777 Km^2	0.80%
	Severe:	3,462 Km^2	0.32%
	c) Soil Fertility Decline Organic matter, K, N, Ph, pH all declining. Because of surface soil erosion, in the Keshan area soil organic matter content decreased from 8-10% in 1950s to 0.15-5.0% at present, correspondingly, contents of N and P lowered from 0.35-0.40% to 0.18-0.20%, and from 0.15-0.20% to 0.1-0.12%, respectively. Crop yield reduced 1-1.25 billion tons each year.		
	c) Other land degradation types Areas of alkaline soils, waterlogging and salinity.		
Other comments	Region is the largest corn supply base of China, so the safety of soil productivity is very important. Major soil type is “Black soil” (phaeozem) whose top layer is fertile but can be easily eroded.		

3. The Red Soils Region of Southern China

Land area	1,163,549 Km^2 - 12.24% of total area of PRC		
Rural population	Total rural population: Rural population density:	203,500,000 100-200 per square kilometer	
Land use characteristics	Arable land: Pasture land: Forest & woodland:	350,250 Km^2 100,000 Km^2 360,700 Km^2	30.1% 8.6% 31.0%
Land degradation types	Dominant degradation type(s): Other key degradation type(s):	Water erosion Soil fertility decline associated with soil chemical, physical and biological (organic matter) degradation.	
Land degradation severity and extent	a) Water Erosion None: Slight: Moderate: Severe: Very severe:	 910,000 Km^2 96,446 Km^2 71,775 Km^2 25,065 Km^2 5,605 Km^2	 78.2% 8.29% 6.17% 2.15% 0.5%
	b) Wind Erosion Slight: Moderate:	 379 Km^2 50 Km^2	 0.03% 0.004%
	c) Soil Fertility Decline Assumed to be declining. Soils have poor physical structure.		
	c) Other land degradation types Waterlogging, naturally acidic soils.		
Other comments	Although the vegetative cover here is the best in China, the high precipitation is able to cause serious erosion. But the ecological restoration is easier than that in the other regions.		

4. The Northern Mountain Region

Land area	717,771 Km^2 - 7.6% of total area of PRC		
Rural population	Total rural population:	179,442,750	
	Rural population density:	200-300 per square kilometre	
Land use characteristics	Arable land:	448,607 Km^2	62.5%
	Pasture land:	150,000 Km^2	20.9%
	Forest & woodland:	71,777 Km^2	10.0%
Land degradation types	Dominant degradation type(s):	Water erosion and wind erosion	
	Other key degradation type(s):	Salinity, soil pollution, fertility decline.	
Land degradation severity and extent	a) Water Erosion		
	None:	494,768 Km^2	68.93%
	Slight:	156,220 Km^2	21.76%
	Moderate:	52,152 Km^2	7.27%
	Severe:	11,979 Km^2	1.67%
	Very severe:	2,652 Km^2	0.37%
	b) Wind Erosion		
	Slight:	6,837 Km^2	0.95%
	Moderate:	3,885 Km^2	0.54%
	Severe:	1,128 Km^2	0.16%
	c) Soil Fertility Decline Conflicting evidence! K and pH declining. Some evidence to suggest N, Ph and organic matter are improving. Soil is poor and rocky in mountainous areas.		
	c) Other land degradation types Chemical pollution from overuse of fertilizers and pesticides, areas of secondary salinity, some desertification on Alluvial fans		
Other comments	Land use characteristics in this region corresponds to its landscape structure stony mountain slopes, earth covered mountain slopes, alluvial fan, or plain. In much of North China, annual double cropping or biannual triple cropping is common.		

5. The South West Mountain Region

Land area	1,196,613 Km^2 - 12.6% of total area of PRC		
Rural population	Total rural population:	89,745,975	
	Rural population density:	50-100 per square kilometre	
Land use characteristics	Arable land:	264,619 Km^2	2.11%
	Pasture land:	550,000 Km^2	45.96%
	Forest & woodland:	216,586 Km^2	18.10%
Land degradation types	Dominant degradation type(s):	Water erosion	
	Other key degradation type(s):	Soil fertility decline associated with soil chemical, physical and biological (organic matter) degradation.	
Land degradation severity and extent	a) Water Erosion		
	None:	778,432 Km^2	65.05%
	Slight:	182,839 Km^2	15.28%
	Moderate:	171,429 Km^2	14.33%
	Severe:	52,192 Km^2	4.36%
	Very severe:	11,721 Km^2	0.98%
	b) Wind Erosion		
	Slight:	2,556 Km^2	0.21%
	Moderate:	3,565 Km^2	0.30%
	c) Soil Fertility Decline No empirical data, but appears to be declining rapidly, especially organic matter.		
	c) Other land degradation types Some waterlogging, rockification.		
Other comments	Thin soils on steep slopes mean that even small amounts of soil erosion is a major problem. Three types of karst landform are recognized in these regions. The latest survey shows that there are about 50,000 km^2 of rockification in Guizhou province at this moment. In recent 20 years, area of rockification in Guizhou province has been expended by 1800 km^2 each year. In Guizhou province about 91333 ha land is changing to bare mountain/hills each year.		

6. The North West Region

Land area	2,072,992Km^2 - 21.81% of total area of PRC		
Rural population	Total rural population:	29,000,000	
	Rural population density:	10-15 per square kilometer	
Land use characteristics	Arable land:	290,000 Km^2	13.99%
	Pasture land:	1,000,000 Km^2	48.24%
	Forest & woodland:	124,379 Km^2	6.00%
Land degradation types	Dominant degradation type(s):	Wind erosion and water erosion	
	Other key degradation type(s):	Soil fertility decline associated with soil chemical, physical and biological (organic matter) degradation.	
Land degradation severity and extent	a) Water Erosion		
	None:	1,807 648 Km^2	87.20%
	Slight:	169,225 Km^2	8.18%
	Moderate:	81,664 Km^2	3.94%
	Severe:	10,400 Km^2	0.50%
	Very severe:	4,055 Km^2	0.20%
	b) Wind Erosion		
	Slight:	701,603 Km^2	33.84%
	Moderate:	166,065 Km^2	8.01%
	Severe:	154,298 Km^2	7.44%
	Very severe:	493,367 Km^2	23.80%
	c) Soil Fertility Decline Assumed extensive, but no firm figures.		
	c) Other land degradation types Overgrazing		
Other comments	A very dry, windy, remote region with a fragile environment. Chinese Government has extensive and aggressive plans to develop this region. Extreme care must be used to ensure development is environmentally sustainable.		

7. Tibetan High Plateau and Mountain Region

Land area	2,615,179Km^2 - 27.52% of total area of PRC		
Rural population	Total rural population:	5,000,000	
	Rural population density:	1-2 per square kilometre	
Land use characteristics	Arable land:	250,000 Km^2	9.56%
	Pasture land:	1,000,000 Km^2	38.24%
	Forest & woodland:	130,758 Km^2	5.00%
Land degradation types	Dominant degradation type(s):	Water erosion , Wind erosion, freeze-thaw erosion.	
	Other key degradation type(s):	Thin soils, suffering decline in fertility.	
Land degradation severity and extent	a) Water Erosion		
	Slight:	86,834 Km^2	3.3%
	Moderate:	18,958 Km^2	0.7%
	Severe:	7,075 Km^2	0.3%
	Very severe:	3,014 Km^2	0.1%
	b) Wind Erosion		
	Slight:	51,610 Km^2	2.0%
	Moderate:	32,904 Km^2	1.3%
	Severe:	49,962 Km^2	1.9%
	Very severe:	44, 389 Km^2	1.7 %
	c) Soil Fertility Decline Assumed to be decreasing, but no quantitative research.		
	c) Other land degradation types Freeze-thaw erosion – difficult to control. Patches of saline and alkaline soils.		
Other comments	Low population density, with large areas of land unsuitable for agriculture. Considerable government investment in this region and tourism is viable option to agriculture.		

ANNEX 2. Recent Research Assessments of Land Degradation and Responses to Investment

STRATEGIES

During the past half century, China has experienced increasingly severe land degradation, soil erosion, and desert expansion. Desertification is affecting one third of China's total territory and the annual accelerating rate of desertification spread is as high as 2460 km(2) in China. In 1996, China developed a National Action Programme to Combat Desertification (NAP), which is aimed to apply new legal measures and technical approaches to slow down desertification processes and achieve a long-term goal control desertification and alleviation of poverty through continuous efforts to fight against desertification, stabilize mobile dunes, revegetate degraded rangeland and control soil erosion in arid, semi-arid, and dry sub-humid areas. The long-term and integrated strategies of China's NAP result in encouragement of social participation, legal institutional guarantees, policy making, and establishment of demonstrations/pilot projects to combat desertification at both national and provincial level.

Source: Zhao JZ; Wu G; Zhao YM; Shao GF; Kong HM; Lu Q. INTERNATIONAL JOURNAL OF SUSTAINABLE DEVELOPMENT AND WORLD ECOLOGY 2002, Vol 9, Iss 3, pp 292-297.

LINKS BETWEEN LAND DEGRADATION AND POVERTY

This paper studies the relationship among population, poverty, and environmental factors, and the impact they have had on China's land, water, forests and pastures, It does so by examining the extent of environmental degradation and China's success in controlling its environmental problems is reviewed; by investigating how the leadership has tried to develop a legal framework and series of institutions to carry out environmental policy; and by providing empirical evidence demonstrating the determinants of the successes that China has achieved in surmounting (or slowing) some of its environmental problems, Five of China's rural resource concerns are surveyed in this paper: water pollution, deforestation, destruction of the grasslands, soil erosion, and salinization, The paper finds that government policy has not been effective in controlling rural resource degradation primarily because it has limited fiscal resources and poorly trained personnel, and under these constraints the government has delegated responsibility for environmental and resource protection to the ministries of agriculture and forestry, two institutions that have an incentive to favor pro-production policies, Instead, China's efforts to alleviate policy, integrate markets, and control population appear to have helped mitigate a number of adverse environmental consequences of China's development effort of the last 40 years.

Source: Rozelle S; Huang JK; Zhang LX . Poverty, Population and Environmental Degradation in China. FOOD POLICY 1997, Vol 22, Iss 3, pp 229-251.

EFFECTS ON POVERTY

The Loess plateau is one of the regions of greatest soil erosion in China, with 80% of its total area (69,000 Km^2) affected. It is also one of the poorest regions of the country. Methods to attempt to control land degradation include biological (afforestation and planting of grasslands), engineering (level ditches, level terraces and reverse slope terraces), and farming methods (contour cropping, deep ploughing, raised edges, etc.).
The study examines the effects of various forms of soil conservation on social and economic life of the people. Villages with and without conservation were compared; and whole watersheds were also analyzed. In each case the presence of soil conservation increased production in both wet and dry years. This increased production translated into increased income and to a more sustained income across wet and dry years in areas with effective soil conservation measures. The three main crises that soil conservation addresses are food, fuel and fodder. The social and economic benefits, present one of the most compelling arguments for investment in soil conservation.

Source: L. McLaughlin. A Case Study in Dingii County, Gansu Province, China. World Soil Erosion and Conservation 1993. D. Pementel (ed). C.U.P. p87-107

SALINIZATION AND LAND DEGRADATION

Increases in water resources development and utilization over the last 30 years have led to significant environmental and hydrological degradation of the Tarim River basin. Water discharge in the lower reaches has been seriously compromised. A total of 300 km of the lower reach has been drained between the 1950s and 1970s. The water table fell from 2-3 to 4-10 m between the years 1960 and 1980, and the annual rate of fall of the water table was 20 cm from 1980 to the present. The area populated by *Populus euphtatica* has declined by two thirds and the biomass has decreased by half between the years 1958 and 1978 in the Tarim River basin. From the 1950s to the 1990s, the area of *P. euphratical/E. angustifolia* forest, the main tree species of the region, declined by 3,820 km^2 in the lower reaches of the Tarim River basin, while the shrub and meadow area declined by 200 km^2. Such hydrological changes have resulted in a marked degradation of aquatic habitats and have caused substantial land desertification. A total of 12,300 km^2 of desertified lands formed between the 1960s and 1990s. During the past 30 years, the salt content of the Tarim River has increased gradually. The maximum salt content in 1981-1984 reached 4.0 $gL^{-1,}$ and in 1998 was 7.8^{-1}. Among factors contributing to these problems, human activities are foremost. Solving these problems will require raising the level of scientific and technological expertise in the monitoring, conservation, protection, and rehabilitation of water resources and associated habitats. Presently the greatest priority is to expand and improve water conservation studies.

Source: Feng, Q. Endo, K.D., Cheng, G.D. Towards Sustainable Development of the Environmentally degraded arid rivers of China – A Case Study fromTarim River. Environmental Geology. 2001. 41:229-238.

LOCAL POLICY FACTORS

This paper analyzes environmental degradation in rural China as structurally embedded in China's rapid economic growth in the post-Mao era. The theoretical discussion focuses on changes in the organization of production, resource use, and regional development. A critical assessment of the Chinese hybrid economy challenges standard views of the reforms. The overall environmental problems of state socialist agriculture in China have been aggravated following the agrarian reforms of the current regime, Rather than mitigating negative trends, marketization and privatization have brought new, qualitatively different, environmental problems. Resource decline and its attendant social problems are not limited to aspects of transitional economy but are a fundamental part of the new hybrid system. It offers an alternative explanation for interpreting increases in rural productivity as an appropriation and use of collective assets, suggesting that the mining of communal capital is hidden behind the economic growth of the rural economy. Case studies in Heilongjiang Province based on long-term field data provide a profile of three aspects: intensification of land use, agroindustrial pollution, and declining social/communal capital. Further, the political legitimacy of the state is gradually eroded by mutually exclusive fiscal constraints on expenditure and political commitments to peasant producers. Recent repression of political dissent by peasants in hinterland regions forces indirect forms of resistance to state policy. Opportunities for sustainable development are nonetheless present within China, providing that policy makers attempt to address the structural conditions of the rural sector.

Source Muldavin JSS. Environmental degradation in heilongjiang: Policy reform and agrarian dynamics in China's new hybrid economy. ANNALS OF THE ASSOCIATION OF AMERICAN GEOGRAPHERS 1997, Vol 87, Iss 4, pp 579-613

LOCAL GOVERNMENT ROLE

China's rapid economic development following the 1978 reforms has resulted in significant economic, social and environmental change. One consequence of this change has been the accentuation of an existing trend of agricultural land loss and degradation. Although the 1978 reforms and their impacts have been subjected to considerable scrutiny, relatively little research has been directed towards the relationship between the evolution of local government structures and practices and the implementation of agricultural land protection policies. This paper presents an analysis of this relationship in Huzhou Municipality, Zhejiang Province. Zhejiang Province is situated on the eastern seaboard and exhibited the highest average annual per capita growth in China between 1978 and 1995. Huzhou Municipality is a growth centre in the northern part of the province. A synthesis of the factual knowledge and perceptions of 40 key-informants suggests that despite the development of a comprehensive legal framework for agricultural land protection, the interpretation of policy at local levels continues to permit the loss of agricultural land (and attendant environmental costs) to be traded-off against increased economic growth. This suggests a need to re-evaluate the role of local levels of government in China with respect to agricultural land protection issues; to look as much at the ways policies are implemented as at policies themselves. The devolution of administrative responsibility in China and the increasing influence of powerful local economic interests will provide an impetus for such a re-focusing of research at local levels.

Source Skinner MW; Kuhn RG; Joseph AE. Agricultural land protection in China: a case study of local governance in Zhejiang Province. LAND USE POLICY 2001, Vol 18, Iss 4, pp 329-340