PROFILE

Land Use and Management in the People's Republic of China

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ABSTRACT / Widespread disregard for essential principles of sound environmental management and protection during the three decades of Communist rule prior to 1980 have exacerbated traditional shortages of good arable land and productive forest cover in the People's Republic of China. The government's policies have also drastically reduced valuable freshwater surfaces, caused extensive grassland deterioration and soil erosion, and brought about many local and regional climatic changes. However, new policies put into effect recently are attempting to reverse these trends with a sound ecosystemic approach to land management.

The People's Republic of China has been through many changes, both gradual and convulsive, since the establishment of the Communist regime in 1949. The 1950s were the decade of Soviet-style planning and considerable economic accomplishments that ended in the collapse of the ambitious Great Leap Forward. Economic restoration during the early 1960s was mostly undone by the policies of the so called Cultural Revolution. Those policies were fully reversed only after Mao's death in 1976 and Deng Xiaoping's subsequent resumption of de facto control.

One of the many benefits of the new pragmatic approach prevailing in China for the past several years has been a veritable flood of critical information on most aspects of the country's life, a situation in sharp contrast with the previously prevailing hagiographies of Maoist accomplishments. This information portrays mismanaged and inefficient economy, struggling agriculture, continuing food shortages, and growing environmental pollution; it also enables researchers, for the first time in two decades, to assemble a fairly detailed image of China's land use.

Management of land and water resources is, naturally, of critical importance for the world's most populous nation (with one billion persons in 1980, it accounts for nearly one-quarter of all mankind), which is still overwhelmingly (about four-fifths) rural, still suffers serious food shortages, and yet aspires for fast modernization of the economy. The following review and analysis of China's land use and management reflects a rather discouraging reality. It was pieced together from scores of news items in national and provincial newspapers and journals, radio broadcasts (regularly monitored abroad), and Xinhua (New China News Agency) releases. Listing all of these references would be impractical, and only the principal items are accompanying this paper; any further information is available directly from the author.

KEY WORDS: Land use; Land management; People's Republic of China

Arable Land

In 1957 China's cultivated area was 1.677 billion *mu* or 111.8 million hectares (ha). According to a document on agricultural development issued by the Central Committee of the Chinese Communist Party (1979), between 1957 and 1977 more than 100 million *mu*, or close to 7 million ha, of cultivated land were requisitioned for various capital construction projects. This loss alone would imply that China's arable land in the late 1970s was no more than about 105 million ha, a decline of at least 6% in comparison with the late 1950s. However, on most occasions in 1979, a variety of Chinese sources, including the Soil and Fertilizer Institute of the Chinese Academy of Sciences (1979), and the official Xinhua releases, was referring to just 1.5 billion *mu* of arable land, that is, only 100 million ha. This would mean a loss of nearly 12% of farmland in just over two decades, a rate to which standard labels such as alarming and very serious would hardly do justice.

Whatever is the actual simple difference between the figures of the 1950s and those of the late 1970s, the real loss of prime farmland had to be much greater. This period was one of extensive mass land improvement (irrigation, terracing, leveling) and reclamation campaigns. Although I do not know of any published reclaimed land totals for the period, the annual official claims were running close to half a million ha for most of the 1970s. In two decades, just one-third to one-half of such a rate would add between 3 and 4.5 million ha, or about 2.5–4% of the 1957 arable land total (Fig. 1). Regardless of the precise total, it is clear that Chinese farmers lost at least 15 million ha of established farmland

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Figure 1. Peasants in Hequ county in northern Shanxi province building new terraced fields in loess deposits with traditional Chinese tools—pickaxes, shovels, shoulder poles, and baskets.

to urban sprawl, mines, large and small factories, roads, railways, housing, water reservoirs, and irrigation canals—and that a part (most likely about one-third) of this loss was replaced by largely inferior reclaimed land.

Significantly enough, the absolute losses may have been higher than the national average in some important populous provinces: Shandong had about 9.2 million ha of farmland in 1949, but by 1978 some 1.35 million ha, or approximately 15%, had been requisitioned just for building projects. This, combined with intervening population increases, halved the provincial per capita availability of cultivated land from 0.2 ha in 1949 to 0.1 ha in 1978 (Shandong Provincial Service 1978).

Moreover, the quantitative decrease of arable land has been accompanied by widespread qualitative decline of soils throughout China. To begin with, more than one-third of the current 100 million ha of farm soils already belongs to a low-yield category: there are semiarid, arid, saline, alkaline, and aeolian sandy soils in the north and northeast; many paddy soils in China's subtropics; and bog, clay, and heavily eroded soils all around the country. These soils yield typically no more than 0.75–1.50 tonnes of grain per ha (100–200 *jin/mu*), and often the harvests are below half a tonne per ha (Soil and Fertilizer Institute of the Chinese Academy of Sciences 1979).

Unfortunately, many recent cropping practices are seriously degrading the previously good or excellent soils. Careless irrigation is spreading the area of saline and alkaline soils throughout the Huabei Plain, and it has created bog or grey soils in the Jiangnan (China south of the Yangzi). In Hunan no less than 40% of cultivated area (1.2 million ha) has been turned into bog soils whose lowered air content and lowered temperature slows down the increase of nutrients and impedes the plant growth. Taihu lakeland in Jiangsu is also seriously affected, as are large areas in Guangdong. Continuous double- and even triple-cropping of rice, improper application of synthetic fertilizers and lower quantities of organic fertilizers, and failure to rotate wet and dry crops (especially decreased green manure and legume plant-

ing) are greatly speeding up the soil degradation. Rice multicropping has been pushed as a part of a simplistic Maoist policy of indiscriminate grain-growing expansion with rising yields as the only goal; more irrigation and more chemical fertilizers were thought sufficient to bring repeatedly higher harvests. Proper crop rotation had been neglected. For example, Jiangnan's area planted to green manures decreased from 8.4 million ha in 1972 to 7.7 million ha by 1977 and Shandong's soybean fields shrank from 2 million ha in 1949 to 0.73 million ha by the mid 1970s, (Soil and Fertilizer Institute of the Chinese Academy of Sciences 1979).

Fewer green manures and lower application of organic fertilizers recently caused a rapid decline of organic content in Guangdong's soils, especially as far as potassium and phosphorus are concerned. Water accumulation in continually cropped paddy fields throughout Jiangnan leads to the formation of "blue asbestos mud," a 10-cm thick clay some 20 cm below the soil surface, which retains water and fertilizer, prevents root growth, and causes frequent rotting (Xi 1979). Crops grown in these degraded shallow soils low in organic matter do not, of course, respond to higher (and costly) water and chemical fertilizer inputs, and many of Guangdong's paddies now yield just 2.25–3 tonnes/ha. Peasants talk about hybrid strains bringing misfortune as their fields cannot surpass the record yields set in the 1960s (Qiu 1979).

Principal changes in the use of China's farmlands during the past three decades have been an initial expansion and subsequent decline of cultivated land, steady and sizable increase of irrigation, growth of multicropping, and an ever-greater stress on grain crops (Table 1).

Massive land reclamation efforts (Fig. 2) including, for many years, participation of 60–80% of the rural labor force during winter (Smil 1978) have been negated by widespread land losses; as China's population nearly doubled between 1949 and 1980, the average per capita availability of farmland is now just 0.1 ha. For comparison, among other large populous developing nations, India has 0.25, Indonesia 0.1, Brazil 0.25, Bangladesh 0.1, and Pakistan 0.26 ha of arable land per capita (FAO 1979). The latest Chinese plans are to reclaim at least 8 million ha of land by 1985.

Irrigated area was expanded more than three times since 1949. It now accounts for nearly half of the cultivated land (with about two-thirds irrigated by liquid-fueled or electric pumps), but the qualitative deficiencies are widespread. For example, total irrigation capacity of more than 6,500 large projects should be some 29 million ha, but only less than 21 million ha are efficiently watered. Leaks and seepages cause average losses of 40–50% of the channeled water, and in many localities the losses are up to 70–80% (Xinhua 1978a).

Table 1. Changes in China's use of cultivated land, 1949–1979[a]

	1949	1957	1978–1979
Cultivated land	97.9	111.8	100.0
Chang Jiang basin	—	—	26.0
Huang He basin	—	—	21.0
Huai He basin	—	—	13.3
Irrigated land	16.0	35.0	46.7
Chang Jiang basin	4.0	—	14.6
Huang He basin	1.8	—	6.8
Huai He basin	—	—	6.7
Mechanically irrigated land	0.3	1.0	29.7
Land irrigated by well water	1.0	5.8	10.0
Stable high-yield land	—	—	34.0
Sown area	117.0	157.2	168.0
Grain crops	101.6	120.9	140.0
Rice	25.7	32.2	36.0
Wheat	21.5	27.5	28.0
Corn	12.0	14.9	16.0
Millet	10.0	10.3	9.0
Tubers	7.0	10.5	14.0
Soybeans	18.3	12.8	9.2
Oil crops	3.6	5.9	6.0
Sugar crops	0.1	0.4	0.9
Cotton	2.8	5.8	4.7
Green manures	1.3	—	7.0

[a] All values are in million hectares. Data for 1949 and 1957 are from various official statistics published in China during the 1950s; data for 1978–1979 are assembled from Chinese news releases, broadcasts, and from the U.S. Department of Agriculture estimates.

Multicropping has been largely aimed at increasing grain output. There are clear indications that its most intensive form—triple-croping in the Chang Jiang lowland and in Guangdong province—is hardly the best long-term strategy to achieve sustainable increases of food output (Leeming 1979,Qiu 1979).

Tree Crops

A mere handful of figures is available on China's tree crops on the national level. The country's fruit trees cover a rather large area—the official figure is 16.56 million ha in 1979 (Xinhua 1979e)—equal to about one-

Figure 2. Terraced fields in Wubu county, Shanxi province, give a good impression of the difficulties and the scale of the reclamation effort throughout China.

sixth of arable land. Most of the orchards are in apples, pears, and peaches. Shandong and Liaodong peninsulas are the two main fruit-growing areas; subtropical and tropical fruits are grown above all in Zhejiang and Guangdong. Poor orchard management and little pomological research have resulted in very low yields. China's total 1978 fruit harvest was just 6 million tonnes, or only 362 kg/ha (Xinhua 1979g).

Traditionally insufficient supplies of edible oil from field crops led to a rather widespread cultivation of oil trees. Industrial or edible oil is pressed from tissues of more than 400 varieties of woody plants grown on about 6.7 million ha in 1978. Teaseed tree, olive, coconut, palm, tung tree, and camphor tree are the principal species. Teaseed tree is grown on about 3.3 million ha in Jiangnan, and there are plans to double the area before the end of the 1980s.

No recent nationwide figure is available for mulberry trees, which are mainly concentrated in Zhejiang, Jiangsu, Sichuan, and Guangdong. However, several provincial and county reports detail irrational destruction of mulberry forests. In the mountainous part of Henan province, more than 5 million mulberry trees were cut down and the forest area reduced by more than a half to eradicate "capitalist tendencies" inherent in private ownership of precious trees. Reports from other provinces indicate that mulberries were uprooted, grain crops planted in their place, and the grain harvest from these new, officially nonexistent fields was added to the output from long-established fields to artificially boost their yield and to overfulfill the planned targets! Finally, rubber plantations in Guandong province cover only about 320,000 ha, and their yield after years of neglect is very low in international comparison, just 300 kg/ha.

Grasslands

Total area of China's grasslands is now usually given as 40% of the country's territory, or about 380 million ha. This umbrella figure covers a wide variety of grassy

ecosystems from cold alpine meadows to large tracts of poor shortgrass steppe to some highly productive tall grasslands. Grassy hills and slopes are occupying some 66 million ha, or nearly one-fifth of the biome's total (Xinhua 1979i).

True grasslands in the semiarid north China cover 4.3 billion *mu* (nearly 287 million ha); 85% of all areas are short grasses and only 15% are abundant long-gress meadow formations. Approximately 3.3 billion *mu* (220 million ha) could be used for pasture, mostly in Nei Mongol, Gansu, Qinghai, and Xinjiang (Xinhua 1979f). However, during the past two decades, the widespread and indiscriminate reclamation for grain fields and frequent overgrazing have led to an alarming devastation of this potentially rich natural resource. According to one source, some 46 million ha of pastures (about 20%) have gradually degenerated; the statistics revealed at a 1979 national conference on grassland development show that more than one-quarter of China's grasslands have deteriorated into sand or have been alkalized (Xinhua 1979f).

Nei Mongol offers the most drastic examples. In Ih Ju league, 1.2 million ha of grasslands turned sandy between 1957 and 1972; in recent years, more than 200,000 ha of pastures became sandy each year. In Ju Ud league, 40% of its 4.7 million ha of grassland have become sandy. Similar grassland losses occurred in Ulanqab and Xilin Gol leagues. The effects are all too predictable. First, advancing desertification cuts down both the quantity and the quality of the grass available for grazing and drastically lowers the amount of hay for winter feeding. Consequently, large numbers of cattle die not only of cold, but also of hunger: the national total of animals perishing in this manner is equal to the number of cattle delivered to the state by herdsmen (Xinhua 1979f). The decline of cattle herding in Nei Mongol is best illustrated by the published growth rates: between 1949 and 1958, animal husbandry output rose by an average 9.2% a year, the rate dropped to 2.9% between 1959 and 1969, and average annual decreases of 0.7% prevailed since 1970 (Xinhua 1978b).

Second, when the formerly grass-protected water-retaining surfaces become barren, the frequency of droughts increases and the strong anticyclonic winds cause more frequent sandstorms, further expanding the desert area. Beijing's Meteorological Observatory recorded an average of 17.2 sandstorm days during the 1960s, but during the years 1971–1978, the mean frequency rose to 20.5 days annually (Anonymous 1979c). Third, the reclaimed fields suffer from intensive erosion and evaporation, with grain yields quickly deteriorating. Thus, in spite of Nei Mongol's large-scale reclamation of arable land, per capita availability of grain by the late 1970s has declined considerably in comparison with that of the mid-1950s, and the region's average cereal yield is now merely 900 kg/ha (Xinhua 1978b).

Irrational grassland reclamation was finally proscribed in late 1978, and large areas of former pastureland are now being returned to their original use in Nei Mongol, Gansu, and Qinghai and also in Heilongjiang. In Qinghai, 23,500 ha of farmland were marked for immediate restoration in 1979, and many localities in Gansu and Nei Mongol will be again exempt from any grain tax; their cereal supply will come from outside, and they will refocus on cattle and sheep raising (Anonymous 1979d).

These long-overdue measures would not only protect the vulnerable northern grasslands—that principal barrier between the southward-moving Mongolian deserts and the intensely cultivated northern and northeastern plains—but would also help to raise the output of scarce animal foods. Mutton and beef have recently accounted for just 7–8% of China's meager meat supply, and even the urban residents living in the grassland region could get only pork. As for milk, Nei Mongol's largest dairy plant in Hohhot has been working at 7% of capacity for the past few years and another large plant in Xilinhot at 15% capability (Anonymous 1979a).

When properly protected and managed, China's grasslands can become a reliable source of high-quality foodstuffs and valuable raw materials. It is encouraging to see that much of the current discussion on the future course of China's food production points toward a vastly increased role for animal husbandry.

Forests

Official Chinese forest figures, old and new, are dubious, contradictory, and not particularly meaningful. During the 1950s, the published estimates of the area covered by forests ranged between 5 and 10% (Richardson 1966). National Symposium on Forestry Economics, held in March 1979, claimed that in 1978 a total of 12.7% of China's territory (121.4 million ha) had forest cover, up from 8% (76.5 million ha) in 1949 (Anonymous 1979e). Yet, at the same time, an official weekly claimed the 1949 forest area to be just 5% of the country's

territory, and a recent statement puts the total land afforested between 1949 and 1979 at 28 million ha (Anonymous 1979b). Simple additions then result in a national 1979 forest total of only between 76 and 105 million ha, assuming, moreover, that no deforestation took place.

In a way, these differences, though large, are irrelevant. China may now have a kind of nominal tree cover over nearly 13% of its territory, but much of it cannot qualify as true forest, and a clear minority can be classified as productive stands in standard forestry terms. In 1963, officials of the Ministry of Forestry admitted to Richardson (1966) that nearly 50% of the then-estimated 96 million ha was secondary forest following partial or complete exploitation and hence of low productivity. The latest afforestation claim itself is very dubious: previously, the total of 27 million ha of afforested land was claimed just for the years 1949–1959. There is no shortage of Chinese admissions and outside observations to conclude that the claimed afforestation totals are abstract targets, some of them seemingly fulfilled in a cursory manner (trees are actually planted) with little or no long-term effect (survival rates are pitifully small just after the first year).

More importantly, the remaining natural stands of good boreal forests in the north and extreme northwest and productive subtropical forests in the southwest and the south continued to shrink during the three decades of Communist rule, and newly established plantings have suffered as well. Recent Chinese writings provide numerous alarming examples. In spite of continuous afforestation campaigns, commercial logging has been surpassing new plantings even in the key timber areas. Illegal firewood cutting by peasants is still widespread, and, until most recently, many forests were cleared to establish new grain fields. In Heilongjiang, China's leading supplier of forest products, over 1.1 billion m^3 of timber were removed between 1949 and 1978, while new growth amounted to only 600 million[3]; in Dahinggan during the 14 years preceding 1978, nearly 200,000 ha were logged without any reforestation (Heilongjiang Provincial Service 1978). In the Yichun area the number of trees felled annually is 2.5 times that of the newly planted ones, and the forest has shrunk by 100,000 ha in the past two decades. Adding the land reclamation for grainfields, the results have been predictable: annual rainfall decreasing by one-third in just 25 years, regular drought in places where it used to be a rare occurrence, and warnings that Heilongjiang is on the way to becoming as barren as the northwest (Xinhua 1979h).

Destruction of few surviving forests continues in the arid North where a mass planting project (the "Green Great Wall") is just beginning. Devastated forests in some provinces and autonomous regions in that area are twice the size of afforested land (Xinhua 1979d), in some counties nine times; where millions of trees are to be planted before 1985 as a "strategic measure" to control erosion and desertification, animal- or tractor-drawn carts can be seen on the roads today, loaded with indiscriminately and illegally cut trunks, branches, and roots. On the already heavily eroded Loess Plateau and in the Wei He valley, unscrupulous lumbering has not ceased, and it is actually worsening in some places (Fig. 3).

Logging, clearing of forests for cultivation, expansion of pastures, and forest fires have so seriously upset the ecosystem balance in the Min Jiang basin in Sichuan that some ecologists are claiming the Chengdu plain, the home of at least 80 million people, faces danger of desertification within a few decades and that the Yangzi could become a second Huang He (Xinhua 1979a). In northern Guangdong, most of the standing trees are less than ten years old, more is logged than planted, and stealing even from the national forests is flagrant (Lin 1979). New plantings along the roads fare no better; a peasant complains in a letter to a Guangdong newspaper that one-third of his county's roadside trees were destroyed by peasants breaking off branches, peeling off bark, and digging up roots (Guangdon Provincial Service 1978).

In Hainan, natural stands of rich subtropical forest covered 863,000 ha in 1949; today only 242,600 ha are left, with floods, droughts, wind, and sand problems worsening steadily (Soil and Fertilizer Institute of the Chinese Academy of Sciences 1979). Serious deforestation is reported from all over the country—from Hunan, Yunan (where China's richest subtropical forest in Damenglong area of Xishuangbanna was destroyed), Shaanxi, and Fujian. Nationwide, 800,000 ha in major forestry regions were cut without reforestation (Xinhua 1979c). As for the timber production outlook, "according to the estimate based upon the actual annual rate of reduction by the end of this century there will be no trees to harvest" (Anonymous 1979e).

Subtracting the poorly stocked secondary growth (at least 46 million ha), the newly planted areas (28 million ha), and the climax forests destroyed during the past two decades (conservatively estimated at about 5 million ha) from the official 1979 national forest figure leaves about 42 million ha of good, productive natural stands, or about 35% of the claimed total. Significantly enough, it

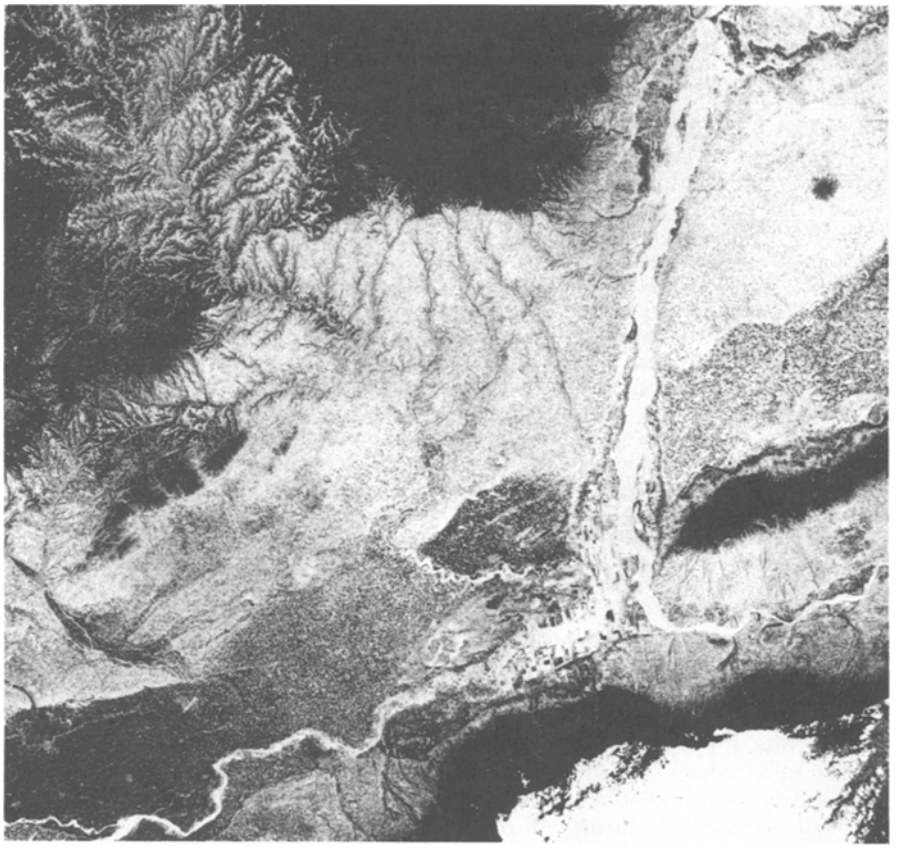

Figure 3. Southeastern edge of the heavily eroded Loess Plateau, valley of the Wei He and Sanmenxia reservoir on the Huang He are seen in this LANDSAT satellite image acquired on 25 August 1975 (spectral band 5). Silt from the plateau (ridge and gully topography in the upper left corner of the image) is washed away into the streams: both the Huang He reservoir (north–south band in the right third of the image) and the Wei river (cutting across the lower third of the image) appear white. Valley of the Wei He, the core of the ancient Chinese civilization, is intensively irrigated (dark field pattern), and new huge fields have been created near the confluence with the Huang He. Clouds cover the easternmost spurs of Qinling mountains (lower right).

was stated at the already-mentioned 1979 National Symposium on Forestry Economics that "only one-third" of China's forests is suitable for commercial logging.

The seriousness of the current situation hardly needs stressing. Newspapers, journals, and broadcasts keep focusing on the deforestation–afforestation problems, but they also keep bringing the discouraging news of continued plundering and appalling resource waste. Direct utilization of the country's scarce timber is only 50%. Only 9% of timber remnants are utilized, and the bulk of the residues are thrown away or burnt. The particle board industry is mismanaged and outdated, without new investment and requisite research. Throughout the country, more than 12 million m^3 of timber and processed remnants either rot in the forests or are used as firewood (Xinhua 1979j). At the same time, people in Zhejiang have to queue overnight to buy a piece of plywood, over a million sewing machines in Shanghai

remain unfinished waiting for wooden boards, and the urban newlyweds throughout the country have to wait yet another year for their simple furniture (Xinhua 1979j).

As usual, there is no shortage of bold plans. There are plans for large-scale reforestation in Heilongjiang; a short-term plan to plant some 700,000 ha of quick-growing, high-yielding trees in the Jiangnan to obtain useful timber in just 10–15 years; and massive afforestation in the three northern arid areas, the planting of a huge system of shelter belts and forests from Xinjiang to Heilongjiang, just the first stage (to be finished by 1985) of which calls for establishment of about 5.3 million ha of new trees, an exceedingly difficult task in the dry, cold northern environment. The nationwide goal is to plant nearly 67 million ha of new forests by the year 2000 (Anonymous 1980), that is, extending the current total by half. While China's environment would certainly need this new huge forest cover, I have deep doubts about the effective fulfillment of such a task; half of the goal well done would have to be considered a huge success.

Inland Waters

Areal decrease and qualitative decline of China's agricultural soils has, unfortunately, a close parallel in the deterioration of the country's aquacultural resources. Freshwater fishing and breeding of fish (especially carp family, shad, perch, silver fish, and bream), crustaceans, and water plants—lotus (*Nelumbium speciosum*), water chestnuts (*Trapa natans*), and prickly water lily (*Euryale ferox*)—are ancient Chinese traditions. In the late 1950s, no less than two-fifths of the nation's aquatic harvest came from inland waters, with 70% supplied by natural catch and 30% by aquaculture (Cong 1979).

Since then, the Maoist policy of "planting crops in the center of lakes and on the top of mountains" has drastically reduced those natural water bodies that were best suited for intensive aquaculture. In Boyanghu, China's largest freshwater lake in northern Jiangxi (originally 565,000 ha), 331 embankments were built during the 1970s to reclaim close to 90,000 ha of fields, and the area devoted to aquaculture shrank by half to just 26,000 ha. Dungtinghu in northern Hunan was, with 435,000 ha, China's second largest freshwater lake, but land reclamation reduced its surface to only 282,000 ha. Half-moon-shaped Taihu in Jiangsu was diminished by more than 10% to 213,000 ha.

Shanghai municipality lost 30% of its fish-breeding area; in Zhejiang province, nearly 3,000 ha of fish ponds were turned into fields; and even in arid Nei Mongol, Ulansuhai Nur was reduced to 20,000 ha, or only one-third of its original area. Hubei, the proverbial "province of a thousand lakes," has been affected most of all: of its 1,065 lakes larger than 1,000 *mu* (66.6 ha), more than half were "reclaimed" between 1949 and 1978 with the provincial water surface total dropping by 75% (Xinhua 1979b). Major lakes that completely or largely disappeared in eastern Hubei include Chen Hu, Diaocha Hu, Xi Hu, and Bei Hu; famous Hong Hu was reduced to 40,000 ha or half its original size (Anonymous 1978a), and much of the remainder is so shallow that people could wade through (Fig. 4). For China as a whole, incomplete statistics for 1949–1978 show a loss of over 20 million *mu*, or at least 1.33 million ha, of waters suitable for inland fishery, an area equal to about 8% of the country's total inland water surface (Cong 1979).

The effects have been predictable. Natural inland catch in 1978 was half that in 1954, and it constituted only 30% of the total freshwater harvest. In spite of the extension of reservoir and pond breeding, the total inland harvest was down from 40% of the total aquatic output in 1959 to just 23% in 1978. Guangdong province's annual catch dropped from 20,000 tonnes in 1966 to about 10,000 tonnes in 1978; Hunan's average 1970s landings were 37% below that of the 1950s; output of Hubei's Hong Hu county fell 60% between 1975 and 1978 compared with that of the 1950s. Harvests of reeds for manufacture, water plants for food, and waterweeds for fertilizer or feed have declined substantially, as did floodwater retention. While the fish and crustacean breeding, spawning, and feeding grounds were destroyed truly en masse, a large part of "reclaimed" land surrounding lakes now lies wasted and empty. The water surfaces are gone and with them their moderating influence on local climate—above all, on the extension of frostfree periods, a critical consideration in all colder double-cropping regions of populous eastern China.

The irrationality is striking and costly. Much heavy labor and investment and many scarce materials (iron, cement) were wasted for massive reclamation of land from waters that could yield valuable protein, regulate water supplies, and moderate local climate. Cultivation of rice or wheat in the newly reclaimed lake land has often resulted in only very low yields. On one hand, there was widespread destruction of freshwater fish through land reclamation, the blocking of migration routes by dams and locks built without special passages (in the Changjiang basin over 50 large lakes have had their outlets to the river cut), and growing urban, in-

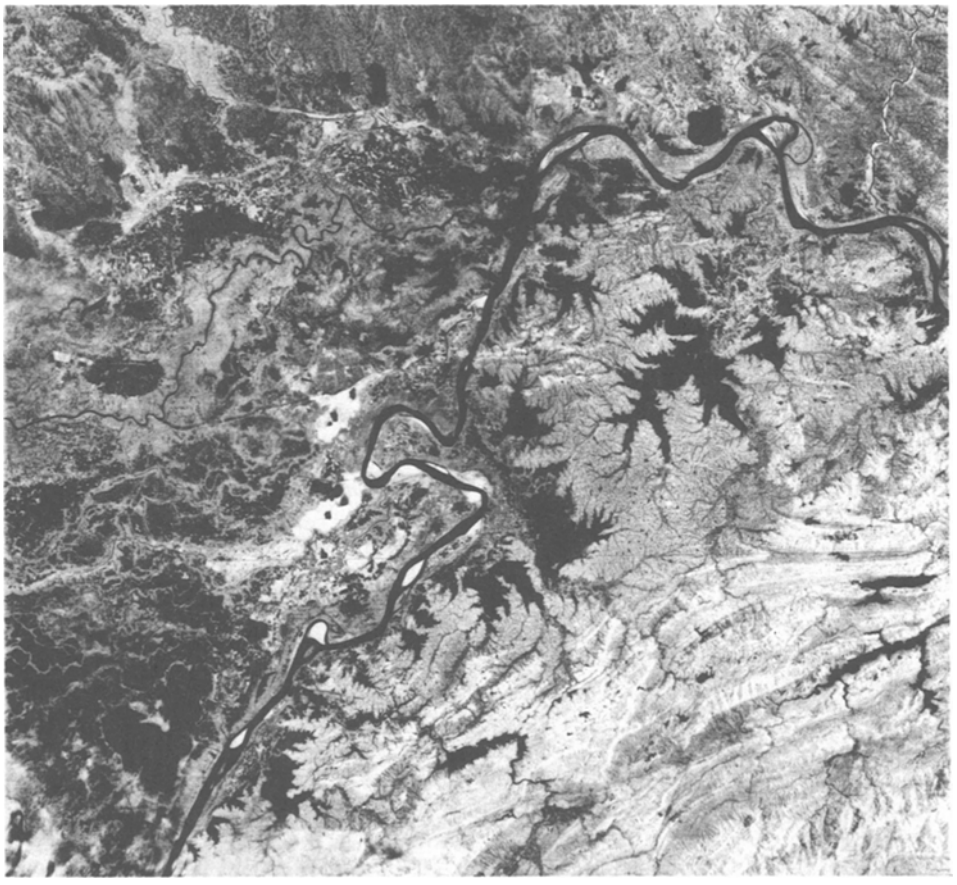

Figure 4. Chang Jiang (Yangzi) valley in Hubei province. This LANDSAT image (band 7, 7 May 1978) shows the two contradictory treatments of China's vital water resources: new reservoirs being created (many large and small irregular black shapes south of the river's bend), while the existing lakes are being reclaimed for grain fields. Water remains only in the center of Diaocha Hu (upper left corner, with drainage canals coming out of drying out sand flats), while the dark oval north of the Han river bend (near the center of the left edge of the image) marks the position of former Chen Hu. Shrinking Hong Hu is in the lower left corner, immediately west of the Yangzi river.

dustrial, and farm pollution (in three northeastern provinces almost all rivers are now seriously polluted), as well as by appalling overfishing including dynamiting and poisoning (Yu 1979). On the other hand, continuing mass campaigns were launched to dig up new suburban fish ponds and to set up new aquatic breeding centers.

The new "Regulations Governing the Breeding and Protection of Aquatic Resources," issued by the State Council on 10 February 1979, finally ban further land reclamation, pollution, and overfishing. The new rural development policies put a desirable stress on aquaculture; the errors have been clearly recognized and the first practical steps are now being taken. Reclamation of lakeland has been stopped in several eastern provinces,

in Wuxi area (Jiangsu) 60% of the reclaimed lakeland have been reflooded, the formerly seriously polluted Yaerh Hu (7,000 ha) in Hubei has been cleaned up, and nearly 200 industrial enterprises were given binding deadlines to cut down or eliminate their effluents (Anonymous 1978b).

Given the proper incentives and conditions, the potential for China's aquaculture is undoubtedly impressive. No less than 40% of China's 16.7 million ha of inland waters are suitable for aquatic breeding. Opportunities are especially good in the country's nearly 90,000 water reservoirs; only less than two-thirds of their 2 million ha are now used for aquaculture, and the average yield has been merely 80 kg/ha (Anonymous 1978b). In contrast, the average 1979 yield of 7,400 ha of China's intensive fish ponds was about 1,000 kg/ha, yields at Hubei's Hong Hu can be around 4,000 kg/ha, *Tillapia* bred in the southern lakes brings up to 18,000 kg/ha, and a new method of raising freshwater fish in nets cast into reservoirs and lakes gives harvests as high as 70,000 kg/ha (Xinhua 1979k). Scientific management of inland fisheries could thus bring enormous nutritional benefits to the Chinese, whose current annual freshwater fish consumption averages a mere one kg per capita (even in Hubei, it is just 2.5 kg per capita).

There are two other traditional uses of China's inland waters that deserve further expansion. The first one is a cultivation of duckweed for pig feed and green fertilizer. Duckweed thrives in paddy fields, ponds, and slow-moving streams of eastern and southern China, but in late spring and summer it does well even in Heilongjiang: it can be collected from the shores or from boats every four or five days. The other practice takes advantage of the temporary submersion of paddy fields to breed carps; it has been especially popular in Sichuan but can be used anywhere, preferably with single-cropped rice whose longer growing period results in higher fish yields (up to 500 kg/ha) and higher paddy yields (up to 10%) owing to the natural fertilization and elimination of many weeds. Sichuan's area devoted to rice–carp growing is now around 50,000 ha, and the nationwide potential for expansion is undoubtedly large.

Discussion of offshore water resources does not fit into a review of China's land use, but it is interesting to note that, according to recent figures, the country has 147 million ha of continental shelf fishing waters (up to 200 m depth) with more than 700 fish species, and one-seventh of this vast area can be used for artificial breeding. Besides marine fish breeding, rich aquaculture growing crustaceans, oysters, laver (*Porphyra laciniata*), kelp, and various seaweeds should be also promoted; all of these activities suffered during the past two decades owing to the reclamation of over 60,000 ha of beaches for grain fields (Yang 1978).

Other Land

Of China's large area of barren land—nearly a third of the nation's territory—at least some 80 million ha are deemed suitable for afforestation, and 33 million ha are classed as reclaimable wasteland (Table 2). Swamps occupy in excess of 10 million ha (with largest areas in northwestern Sichuan, Heilongjiang, Nachu area of Xizang, and Changbai mountains of Jilin) and deserts (about 59% are the dune ones) cover almost 110 million ha, predominantly in Xinjiang, Gansu, Ningxia, and Nei Mongol.

The Chinese achieved many local successes in controlling the advancement of deserts on oases, farm land, grazing grounds, and communication links by planting wind- and drought-resistant tamarisks, oleasters, and sand willows and by creating new vegetation centers with pumped underground water or stored seasonal flood flows in Xinjiang, Gansu, Ningxia, and Nei Mongol. A score of demonstration desert control stations were set up in these provinces and regions to study the ways of coping with shifting sands and managing farming production on the desert outskirts. However, owing to the imprudent large-scale conversions of grasslands to grain fields and to animal overgrazing, overall area of Chinese deserts has been steadily expanding, with the greatest encroachments registered in the Nei Mongol region.

Conclusions

Widespread and flagrant disregard of essential principles of sound environmental management and protection during the three decades of the Communist regime exacerbated China's traditional shortages of good arable land and productive forest cover, drastically reduced the nation's valuable freshwater surfaces, and caused much grassland deterioration and soil erosion, as well as many local and regional climatic changes.

New policies now coming into effect as a part of broad-based de-Maoization of the Chinese society not only recognize most of these errors and problems but are spelling out the detailed modes of action to reverse the dangerous trends (Smil 1980a, b). Some of the new plans

Table 2. Land use–land cover in China in 1978–1980[a]

Land use–land cover	Area (10^6 ha)	Share of China's surface (percent)
Arable land	100.0	10.5
Irrigated land	46.7	4.9
Tree crops		
Fruit trees	16.6	1.7
Oil-bearing trees	6.7	0.7
Rubber trees	0.3	0.0
Grasslands	382.4	40.0
Pastures	220.0	23.0
Degenerated pastures	46.0	4.8
Grassy hills and slopes	66.0	6.9
Forests	121.4	12.7
Afforested 1949–1979	28.0	2.9
Aerially afforested 1959–1979	10.7	1.1
Productive forests	42.0	4.4
Inland waters	16.7	1.7
Lakes	6.3	0.7
Reservoirs	2.0	0.2
Waters suitable for fish breeding	5.0	0.5
Other land		
Deserts	109.0	11.4
Dune deserts	64.3	6.7
Gravel and other deserts	44.7	4.7
Reclaimable wasteland	33.0	3.4
Land suitable for afforestation	80.0	8.4
Swamps	10.0	1.0

[a] Assembled by the author from a variety of Chinese publications, news releases, and broadcasts (all sources available on request).

and goals may be overly ambitious, but the new, and apparently seriously meant, embrace of an ecosystemic approach to the country's land use management is a promising beginning after long years of environmental neglect.

Literature Cited

Anonymous. 1978a. Order for Control of Environmental Pollution. *Beijing Review* 21(46):31.

Anonymous. 1978b. Ensure the supply of fish by all means. *Renmin Ribao*, 18 October 1978, p. 1.

Anonymous. 1979a. The planned targets for livestock industry must be changed. *Jingji Guanli* 1:52–53.

Anonymous. 1979b. Protecting the forests. *Beijing Review* 22(9):4.

Anonymous. 1979a. Sandstorms threaten Beijing. *Guangming Ribao*, 2 March 1979, p. 1.

Anonymous. 1979d. Back to pastureland. *Beijing Review* 22(11):5–6.

Anonymous. 1979c. Strengthening research on forestry economics. *Guangming Ribao*, 17 March 1979, p. 4.

Anonymous. 1980. An all-out effort to plant trees. *Beijing Review* 23(13):5.

Central Committee of the Chinese Communist Party. 1979. Chung-fa No. 4. *Issues and Studies* 15:105–106.

Cong Ziming. 1979. Interview with Deputy Director of the State Agricultural Products Bureau. *Guangming Ribao*, 11 January 1979, p. 1.

FAO. 1979. *Production Yearbook*. FAO, Rome.

Guangdong Provincial Service. 1978. Broadcast in Chinese, 28 January 1978.

Heilongjiang Provincial Service. 1978. Broadcast in Chinese, 22 March 1978.

Leeming, F. 1979. Progress towards triple-cropping in China. *Asian Survey* 19:450–467.

Lin Xi. 1979. Protection of national forests cannot permit a minute's delay. *Nanfang Ribao*, 28 May 1979, p. 1.

Qiu Hongquan. 1979. The ox's nose and soil power. *Nanfang Ribao*, 23 January 1979, p. 2.

Richardson, S. D. 1966. *Forestry in Communist China*. The Johns Hopkins Press, Baltimore.

Shandong Provincial Service. 1978. Broadcast in Chinese, 6 December 1978.

Smil, V. 1978. China's energetics: A system analysis. In *Chinese Economy Post-Mao*. U.S. Government Printing Office, Washington, DC.

Smil, V. 1980a. China's environment. *Current History* 79:14–18, 42.

Smil, V. 1980b. Environmental degradation in China. *Asian Survey* 20:777–788.

Soil and Fertilizer Institute of the Chinese Academy of Sciences. 1979. Rational use of land resources. *Guangming Ribao*, 17 August 1979, p. 2.

Xi Changfan. 1979. Environmental scholar studies soil. *Jiefang Ribao*, 18 January 1979, p. 2.

Xinhua. 1978a. News release in Chinese, 27 July 1978.

Xinhua. 1978b. News release in Chinese, 3 December 1978.

Xinhua. 1979a. News release in Chinese, 13 January 1979.

Xinhua. 1979b. News release in Chinese, 17 March 1979.

Xinhua. 1979c. News release in Chinese, 28 March 1979.

Xinhua. 1979d. News release in Chinese, 10 June 1979.

Xinhua. 1979e. News release in English, 25 July 1979.

Xinhua. 1979f. News release in Chinese, 29 July 1979.

Xinhua. 1979g. News release in Chinese, 30 July 1979.

Xinhua. 1979h. News release in English, 19 September 1979.

Xinhua. 1979i. News release in English, 26 September 1979.

Xinhua. 1979j. News release in Chinese, 24 October 1979.

Xinhua. 1979k. News release in English, 24 December 1979.

Yu Tali. 1979. Adopt effective measures to protect fishery resources. *Guangming Ribao*, 20 March, 1979, p. 2.