WORLD RESOURCES INSTITUTE

THE RESTORATION DIAGNOSTIC

Case Example: China Loess Plateau

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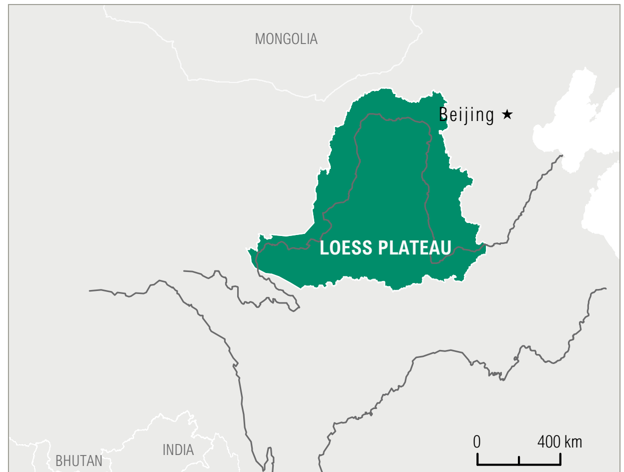
SUMMARY

China's Loess Plateau is a 64 million hectare semi-arid region located in north-central China (Lu et al. 2012). Home to more than 50 million people (World Bank 2007a), the plateau has been farmed for thousands of years. During the 1980s and 1990s, however, the degradation of the region's soils and vegetation was having increasingly noticeable negative effects on food production, downstream waterways, and air quality in faraway cities. This situation was exacerbated by population pressure (Lu et al. 2012).

In order to alleviate this and related challenges elsewhere in China, the Chinese government launched significant financial investments to restore degraded areas. Nationally, China invested about US$100 billion in six forestry programs. These programs covered more than 97 percent of China's counties and targeted 76 million hectares of land for afforestation (Cao et al. 2010c). In 1999, the Chinese government launched "Grain for Green" (Tang et al. 2013). One of the world's largest conservation programs, Grain for Green consisted of projects and practices designed to curb soil erosion, increase the amount and variety of natural vegetation in the landscape, and introduce more sustainable land management practices. The program included a payment for ecosystem services program that directly engaged millions of rural households in project implementation (Lu et al. 2012).



TIME PERIOD: 1994 to 2005

AREA RESTORED: More than 1,000,000 hectares of land[1]

TYPE OF RESTORATION: Active restoration

Working with the Chinese government, the World Bank targeted for restoration approximately 1,100 small watersheds in the Loess Plateau region. The first phase operated from 1994–99. The second phase operated from 1999–2005, aligning with the Grain for Green program (Hiller, B.T. 2014. pers. comm., 5 September). Chinese planners from the Ministry of Water Resources and international planners from the World Bank collaborated with experts in hydrology, soil dynamics, forestry, agriculture, and economics to design the Loess Plateau restoration project (EEMP 2013). A typical watershed contained several villages and ranged in size from 1,000 to 3,000 hectares. Interventions included terracing and planting of trees, shrubs, and grasses over an area of 700,000 hectares (World Bank 2007b). These actions helped gradually change farmers' income source from grain production and open livestock grazing to alternative income-generating activities (Lu et al. 2012), including trees with economic value such as apricots and walnuts (Hiller and Guthrie 2011b).

CHINA LOESS PLATEAU BEFORE

CHINA LOESS PLATEAU AFTER

The project has yielded a number of positive benefits, including:

- Food supplies were secured. Before the project, frequent droughts caused crops cultivated on slopes to fail, sometimes requiring the government to provide emergency food aid. Terracing not only increased average yields, but also significantly lowered yield variability. During the second project period (1999–2005), per capita grain output increased from 365 kg to 591 kg per year (World Bank 2007a).
- Farmers converted 95 percent of sloped farmland in the Yangshuo watershed to new land management practices (i.e., building terraces, returning sloped farmlands to forestland and grassland, expanding orchards) between 1997 and 2006,[2] and communities in the watershed experienced a 159 percent increase in income from 1997 to 2003 (Tang et al. 2013).
- Since terracing required the development of roads to facilitate access by vehicles, farm equipment, and labor, Grain for Green provided new infrastructure and development opportunities to the area (World Bank 2007a).
- Terracing created about 89,600 hectares of new farmland.
- The area of farming on unstable sloped lands fell from 451,000 hectares to 278,000 hectares (World Bank 2007b).
- Sediment in water declined by 99 percent between 1998 and 2007 (Tang et al. 2013), a reduction of approximately 300 million tons per year into the Yellow River (Li et al. 2002). This helped reduce the need for measures to prevent downstream flooding (Hiller et al. 2011a).[3]
- Approximately 290,000 hectares of shrub and economically valuable trees became established in the project area (World Bank 2003).

WHICH FEATURES AND KEY SUCCESS FACTORS WERE EXHIBITED?

Although some observers may not consider the restoration of these 1,100 watersheds within the Loess Plateau as strictly "forest landscape restoration," the restoration did involve the reintroduction of trees into the landscape. And the restoration effort did exhibit a number of the features and key success factors of forest landscape restoration. As such, it may generate insights for other forest landscape restoration initiatives.

Motivate

The government became motivated to pursue restoration due to several factors:

- **CRISIS EVENTS.** The most acute crises triggering resolve to restore the Loess Plateau were sand storms hitting downwind urban areas. In particular, soil erosion in the Loess Plateau contributed to massive sand storms that periodically choked the air of Beijing during the 1980s and 1990s, including the infamous "Black Wind" of 1993 (Qian and Quan 2002). It is no surprise that the first World Bank Loess Plateau project started a year later. Soil erosion was so severe that the plateau contributed more than 90 percent of the total sediment entering the Yellow River (Chen et al. 2007). Furthermore, a large amount of cultivated land had to be abandoned in the Loess Plateau due to soil degradation, resulting in economic losses of approximately US$ 1.28 billion over the past several decades, which presented an unprecedented threat to food security (Chen et al. 2007).
- **BENEFITS.** Decision makers recognized that landscape restoration would provide a number of economic, social, and environmental benefits. Economically, it would improve food security and diversify income generation opportunities, particularly for poor rural communities (Tsunekawa et al. 2014). Socially, it would strengthen household stability and reduce migration to cities. Environmentally, restoration would improve soil health, reduce erosion, ensure cleaner water, and sequester carbon (Lu et al. 2012).

Enable

Several enabling conditions were in place to facilitate restoration in the Loess Plateau, namely:

- **ECOLOGICAL CONDITIONS.** Via the Grain for Green program, factors prohibiting the recovery of natural vegetation were removed. In particular, prohibiting grazing in areas designated for restoration resulted in a 99 percent increase in vegetation cover in those areas (Cao et al. 2011).
- **POLICY CONDITIONS.** Clearing restrictions and land rights played important roles. After 1999, for instance, the government banned cutting trees, growing crops on slopes, and allowing unrestricted grazing in the region. The grazing ban became a cornerstone in the Chinese strategy to reverse soil degradation in the Loess Plateau area and to reestablish natural vegetation (Hiller and Guthrie 2011b). Just as important, the bans were enforced. Combined with replanting of vegetation, these bans

allowed the perennial vegetation cover to increase from 17 percent of the region to 34 percent by the mid-2000s (World Bank 2007a). In addition, the government granted local people the opportunity to purchase low-cost land leases to restore fields followed by the opportunity to acquire land rights such that commodities or payments for ecosystem services derived from a tract of land belonged to them (World Bank 2007b).

In addition, the Rural Land Contracting Law of 2003 provides security for land users. While farmland use contracts are valid for 30 years, those for grassland extend to 30–50 years and for forest land from 30–70 years (Zhao et al. 2014).

- **MARKET CONDITIONS.** Value chains for products from restored areas exist. Originally, the effort to motivate cooperation from local farmers focused on fruit trees and vegetables, with a small amount of payments for ecosystem services. However, what farmers most asked for during the first phase of the World Bank effort was help with new livestock enterprises. Much of the second phase of the World Bank project became a livestock project, with successful introduction of Kashmiri sheep (confined) for wool, and dairy cattle (confined), and lots of planting in difficult areas for biomass harvest. Both of these livestock activities were new activities in the area, made possible by the new biomass being generated through restoration. It is the success of the new labor-intensive, high-value livestock enterprises based on better biomass management that will likely determine the future of the Loess Plateau going forward. Loess provides an important example of why forest and agricultural restoration are highly synergistic (Delgado, C. 2015. pers. comm., 3 September).

Implement

During the project's time period, capacity and resources for implementation came into place that facilitated restoration, including:

- **LEADERSHIP.** The Chinese government and the World Bank demonstrated sustained commitment to Loess Plateau restoration, particularly through the Grain for Green policy since the late 1990s (Hiller and Guthrie 2011b).

- **KNOWLEDGE AND TECHNICAL DESIGN.** In partnership with the World Bank, the Chinese government created a restoration plan that included both technical design and capacity development. The technical design component included activities focusing on terracing, afforestation, orchards, grasslands, sediment control dams, irrigation, grazing, and gully control. The capacity development component included activities focusing on training, research, and technology transfer (World Bank 2003). Integrated watershed management practices created water-harvesting structures and ensured continuous vegetative cover through large-scale reforestation, grasslands regeneration, and agroforestry methods (EEMP 2013).

- **FUNDS AND INCENTIVES.** The Loess Plateau restoration project had significant project financing with a budget of approximately US$500 million between 1994 and 2005. Finance included direct Chinese government expenditures and World Bank loans. This finance fueled subsidies that made converting degraded farmland into trees and other vegetation economically viable for farmers. Subsidies included US$122/hectare for seeds and seedlings and a payment for ecosystem services of US$49/hectare/year lasting for a period of two to eight years (World Bank 2005).

LOOKING FORWARD

The impact of the Loess Plateau restoration project has received a lot of attention. Many ecological and social benefits have been recognized (World Bank 2005, Ferwerda 2012, Tsunekawa et al. 2014). However, its performance against several key success factors highlights what may become challenges to the long-term sustainability of the region's restoration, including:

- **AWARENESS.** The benefits of restoration and soil conservation currently may not be sufficiently understood by all relevant local populations and local officials (Chen et al. 2007; Lu et al. 2012). This lack of awareness may be due—at least in part—to the top-down nature of the project's design and decision making. More local participation and engagement could address this information asymmetry. Most farmers—both inside and outside project areas—participated in the project activities, but sometimes they were mandated to do so by the government. Thus, while participation rates were high, the local sense of ownership of project processes and plans could have been higher (Hiller 2012).

- **FINANCE AND INCENTIVES.** A survey of farmers in the region indicated that 56 percent would recultivate sloping land once the subsidies cease in 2018 (Chen et al. 2007; Jiao et al. 2012). Furthermore, some researchers have argued that the eight-year payment for ecosystem services is too short—the subsidies stop before the land generates a high-enough yield and before robust markets for products from the restored landscape have developed. For example, apricot trees take time to bear enough fruit to provide an economic return[4] (Chen et al. 2007). Given that the cities downstream (e.g., Beijing) are large and have an interest in reduced sand storms, increased water quality, and reduced flooding of the Yellow River, perhaps payment from urban dwellers to rural dwellers is warranted (Hiller 2012). Furthermore, Cao et al. (2009a) noted that transferring state property to private ownership alone is not enough of an incentive for residents to protect and restore the land (Cao et al. 2010b).

  Because most of the program's plots are located in impoverished regions of China, the ban on logging and open grazing has led to severe shrinkage in the parts of the economy that were based on forest resources and open livestock grazing. In some regions, inadequate compensation or alternative livelihoods were available or provided (Cao et al. 2010c).

- **ECOLOGICAL CONDITIONS.** In some parts of the plateau, non-native tree species were planted in an area more suited to grasslands. Furthermore, an adequate and timely supply of high-quality tree and shrub seedlings was lacking due to inadequate incentives for timely delivery. For example, performance targets weren't aligned with in-the-field success; nursery objectives were to transplant all seedlings regardless of quality. As a result, many planted trees were unable to survive drought years and about one-third required replanting. The situation marginally improved toward the end of the project period due to the agricultural reforms of 2002, which established some private nurseries. Nonetheless, farmers and government officials maintain that the supply of high-quality seedlings is a challenge (World Bank 2007b).

- **TECHNICAL DESIGN.** Some technical features of the Loess Plateau project have come under scrutiny. One area is afforestation. Afforestation has been accepted as an important strategy for preventing soil erosion on the Chinese Loess Plateau. Increasingly, however, Chinese scientists are debating the long-term sustainability of afforestation in such a semi-arid environment (Jiao et al. 2012). The total survival rate of trees in the Loess Plateau has been low in some areas. For instance, 400,000 Chinese pine trees were planted in northern Shaanxi, but only 25 percent survived (Chen et al. 2007). Short-lived species that offer attractive short-term gains are often preferred by managers,[5] but landscape regeneration involving the species and species mix needed for sustainability is typically a long-term process (Cao et al. 2011; Cao et al. 2010a).

  Another area of scrutiny is climate resilience. Some researchers have raised questions regarding the resilience of the project's technical design in light of the regional climate having a warming and drying trend. Within the context of climate change, large-scale afforestation on loess soils could increase the severity of water shortages (Cao et al. 2007) because of increased evapotranspiration from trees. In addition, if trees do not grow adequately, they will be unable to control runoff and soil erosion (Chen et al. 2007). Because of poor species/site pairing, excessive tree planting (Cao et al. 2007), and poor management, in some areas tree plantations have grown well initially but die due to water shortages at a later stage (Chen et al. 2007). Vegetation restoration strategies therefore need to be tailored to the water availability and other ecological conditions of the region (Chen et al. 2010; Cao et al. 2011). For instance, restoration designs could rely less on pine plantations, favor tree species with more drought resistance, and utilize shrubs and alternative vegetation more adapted to the ecological conditions (Cao et al. 2007; Chen et al. 2007; Jiao et al. 2012).

  Another area highlighted by some researchers is the use of check dams. While used to reduce soil erosion in the watershed, check dams have had some negative impacts on ecological and hydrological processes (Chen et al. 2007). For example, by 2007, 73 percent of the check dams in northern Shaanxi were found to be unfit for flood control, which could result in greater damages than the impacts from soil erosion.[6] Consequently, some experts are calling for not extending the use of check dams to the entirety of the Loess Plateau (Chen et al. 2007).

- **SOCIAL CONDITIONS.** Another area is local priorities. In Shaanxi Province, researchers found that more than 85 percent of local people had different priorities than the government regarding agriculture and livelihood development. This problem could be partially solved by the adoption of a more comprehensive policy that does not focus exclusively on grain and financial compensation (such as Grain for Green). For example, the project could combine the creation of new agricultural value chains with the implementation of more modern agricultural techniques on the most suitable land (Cao et al. 2009b).

- **FEEDBACK.** The World Bank has highlighted the need for more capacity to monitor and evaluate the project in order to measure outcomes and impacts, particularly socioeconomic ones. Monitoring needs to tackle the risk of unbiased sampling[7] (World Bank 2007b; Hiller 2012). To develop and implement effective restoration strategies, independent monitoring, freedom of scientific research, and a willingness to accept and respond to criticism is needed by governments so that they can detect and correct errors (Guan et al. 2011).

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ENDNOTES

1. The World Bank investments restored an area close to 1,000,000 hectares. The impact of the Loess Plateau projects has extended beyond their borders. Watershed planning and project management methods, as developed under the World Bank Loess Plateau projects, are now used for soil and conservation work in the entire Loess Plateau region. As of 2008, more than 24 million hectares—or 50 percent of the degraded area in the Loess Plateau region—have been restored. Beyond the Yellow River basin, the Ministry of Water Resources has adopted the restoration approaches pioneered for the Loess Plateau for the Yangtze and Pearl River Basins (World Bank 2010).

2. 2006 is beyond the project period, but still relevant in discussion of outcomes.

3. Sedimentation of surface waters can cause stream channels to become clogged with sediment. When stream channels become clogged, the result will be an increase in bank erosion, meandering, and flooding.

4. Fruit trees take two to five years to bear fruit.

5. In the Chinese political system, Chinese officials work in a position for five years and therefore are eager to demonstrate results. Thus planting quick-growing (which can be short-lived) species is often preferred to natural regeneration (Chen et al. 2007).

6. Usually, damage resulting from check-dam breakage is much higher than normal soil erosion. According to the Chinese Ministry of Water Resources, after 1954, more than 3,486 check dams—an average of 68 per year—collapsed. In addition, building check-dam systems is costly. Large amounts of material, finance, and manpower were devoted to the projects. According to an evaluation conducted in the mid-2000s, more than 73 percent of the check dams in northern Shaanxi Province were deemed unfit for the purpose of flood control (Chen et al. 2007).

7. Common errors included: (a) recording data at mid-year and therefore not capturing the entire year's results; (b) surveying high-earning households and omitting poorer ones; (c) omitting large pieces of land; and (d) inaccurately counting household members. Inconsistent treatment of some line items between counties was also quite common (World Bank 2007b).

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