How Many Check Dams Do We Need To Build on the Loess Plateau?

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For more than 400 years, check dams have been constructed on the Loess Plateau of China. Over the past several hundred years, people have increasingly realized the advantages of check dams for capturing sediments, improving gully slope stabilities, and increasing croplands. In Environmental Science and Technology, Wang et al. summarized the advantages of check dams for environmental services and food security. The report demonstrated that about 110,000 check dams have been built on the Loess Plateau over the past 50 years and approximately 21 billion m$^3$ of sediments have been captured by these dams. Moreover, the filled check dams can be reclaimed as croplands, and by 2002, approximately 320,000 hectares of dam croplands had been created. The significant role of check dams in soil conservation and cropland expansion inspires the passions of policy makers. As early as 2003, the Ministry of Water Resources of P.R. China (CMWR) initiated a program for check dams in the Loess Plateau, and 163,000 check dams are planned and an investment of 83.06 billion RMB of funding is required for the period 2003–2020. Policy makers consider that the Loess Plateau has the capacity to allow the construction of as many as 334,000 check dams and will therefore require an even greater amount of investment.

The Loess Plateau is currently undergoing a great leap forward in check dam construction. The CMWR projects that, by 2020, check dam construction will lead to a 4.3–5.5 billion m$^3$ decrease in water yield to the Yellow River. However, the amount of this decrease is highly uncertain. The actual amount may exceed the projected amount due to trends in climate warming and extensive human activities.

The sediment load and streamflow in the Yellow River have dramatically decreased in recent years. Huang et al. reported that the sediment load delivered from the Yellow River to the sea decreased sharply to 0.15 billion tons per year between 2000 and 2005, representing only 14% of the widely cited estimate of 1.08 billion tons per year. The data released by the Yellow River Sediment Bulletin show that the sediment load gauged by the Huayuankou hydrologic station decreased substantially to 0.107 billion tons per year between 2000 and 2010. This value represents only 10% of the sediment load of 1.054 billion tons per year occurring between 1950 and 2000. Moreover, the annual streamflow in the Yellow River averaged 40.05 billion m$^3$ between 1950 and 2000, whereas it decreased to 22.65 billion m$^3$ during the past decade. Many scientists conclude that human intervention is the primary factor that caused the decrease in the sediment load and streamflow in the Yellow River. However, we still have not determined a suitable sediment load and streamflow that would keep the Yellow River healthy, and therefore determine the appropriate number of check dams that should be built on the Loess Plateau.

The Loess Plateau covers an area of 648,700 km$^2$, including 200,000 km$^2$ of highplain plateau, 140,000 km$^2$ of hilly plateau, 107,200 km$^2$ of rocky mountains, 63,600 km$^2$ of Fen River–Wei River fault depression valley, 79,200 km$^2$ of deserts, and 58,700 km$^2$ of Hetao alluvial plains (Figure 1). The different geographical regions play different roles in soil and water conservation and ecosystem services. The hilly plateau regions suffer the most severe soil erosion in the Loess Plateau and should therefore be considered critical areas for check dam engineering. The rocky mountain regions are appropriate for planting and should therefore be considered critical areas for afforestation and water conservation. We suggest that the planning of check dam engineering should comply with the landforms and geographical function zones.

Currently, many significant problems occur in the planning and engineering of check dams. First, there is a lack of critical discussion on the appropriate density and distribution of check dams. The contiguous area of Shanxi-Shaanxi-Inner Mongolia is the central erosion area of the hilly plateau and is therefore the most critical target area for check dam construction. However, a large number of check dams are still planned for construction in the highplain plateau and rocky mountains. Second, effective soil and water conservation measures and climate change significantly decreased soil erosion in the Loess Plateau and...
thus led to less sediment deposition in the check dams. At present, the large scale of check dam construction may lead to considerable quantity of check dams losing their primary functions of sediments interception and croplands creation. Third is the disorganization of local governments, which compete for national investment funds and purposely exaggerate the number of check dams to be built. The Chinese central government should implement multiple types of ecological compensation and avoid heavy investment in check dam construction; otherwise, local governments will be prone to engage in unreasonable competition for national investment funds. We suggest that scientific researchers should be encouraged to cooperate with administrative departments to deal with the above-mentioned problems to develop more effective plans for check dams. The Loess Plateau is currently undergoing a rapid expansion of check dam construction and therefore we need to be more cautious in implementing large-scale engineering efforts.

Figure 1. Geographical function zoning and central erosion areas of the Loess Plateau.

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Notes
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