Effects of an ecological conservation and restoration project in the Three-River Source Region, China

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Abstract: The first-stage of an ecological conservation and restoration project in the Three-River Source Region (TRSR), China, has been in progress for eight years. However, because the ecological effects of this project remain unknown, decision making for future project implementation is hindered. Thus, in this study, we developed an index system to evaluate the effects of the ecological restoration project, by integrating field observations, remote sensing, and process-based models. Effects were assessed using trend analyses of ecosystem structures and services. Results showed positive trends in the TRSR since the beginning of the project, but not yet a return to the optima of the 1970s. Specifically, while continued degradation in grassland has been initially contained, results are still far from the desired objective, ‘grassland coverage increasing by an average of 20%–40%’. In contrast, wetlands and water bodies have generally been restored, while the water conservation and water supply capacity of watersheds have increased. Indeed, the volume of water conservation achieved in the project meets the objective of a 1.32 billion m$^3$ increase. The effects of ecological restoration inside project regions was more significant than outside, and, in addition to climate change projects, we concluded that the implementation of ecological conservation and restoration projects has substantially contributed to vegetation restoration. Nevertheless, the degradation of grasslands has not been fundamentally reversed, and to date the project has not prevented increasing soil erosion. In sum, the effects and challenges of this first-stage project highlight the necessity of continuous and long-term ecosystem conservation efforts in this region.

Keywords: Three-River Source Region; ecological conservation and restoration; ecosystem monitoring and assessment; ecological effects

1 Introduction

The continued degradation of ecosystems in the Three-River Source Region (TRSR) as a
result of the combined effects of climate change and human activities has been of major concern to the community. Indeed, with this in mind, the State Council approved ‘The general planning on ecological conservation and restoration in the TRSR nature reserve in Qinghai Province’ (abbreviated here to ‘The Plan’) in 2005, and decided to invest RMB 7.5 billion yuan in undertaking the first stage of the project (PGQP, 2003), aimed at curbing ecological deterioration in conservation areas, improving and consolidating the results of ecological conservation and restoration, and laying the foundations for later, large-scale implementation of ecological conservation and restoration. Thus, a comprehensive scientific understanding of the ecological effects of the project to date is critical for further effective implementation and scientific management of ‘The Plan’.

A large number of similar domestic and foreign ecological monitoring and assessment projects have been carried out, including the United Nations Millennium Ecosystem Assessment (MA) program which proposed new concepts in ecological assessment, and established a conceptual framework for assessing ecosystem services, based on qualitative judgments of literature (MEA, 2003). In the US, ecosystem condition assessments have been carried out at the national scale using indicators including distributions and patterns of ecosystems, chemical and physical characteristics, products and services, landscape pattern, and the species present in ecosystems (Heinz Center, 2008). Since 2011, on the basis of these data, the US has been developing a ‘National Ecological Observatory Network’ (NEON) to monitor the biosphere (Abbot et al., 2015). Also in North America, Canada has developed an ecological monitoring and assessment network to assess the state of the environment based on long-term observational data (Vaughan et al., 2001). In China, ecological quality has been typically quantified using weight and normalization methods, as well as indicators including biological abundance, vegetation coverage, water network density, land degradation, and pollution load. These approaches are simple, but they lack key indicators of ecosystem services (CNEMC, 2004; EPIS of PRC, 2006; Li et al., 2006). Also, a series of systematic ecological assessments have been carried out at different scales from site to regional, such as the ‘Western Ecosystem Comprehensive Assessment’; however, a systematic and comprehensive evaluation system has not been developed yet (Liu et al., 2006; Guo et al., 2016).

Internationally, key ecological projects stemmed from the ‘Roosevelt Project’ initiated in the US in 1934, including a range of initiatives carried out later around the world, such as the ‘Stalin Plan for Reforming Nature’ in the Former Soviet Union, the ‘Green Dam Project’ in North Africa, the ‘Green Plan’ in Canada, the ‘Watershed Management Plan’ in Japan, the ‘Forestry Ecological Engineering’ project in France, the ‘National Afforestation Program’ in the Philippines, the ‘Social Forestry Program’ in India, the ‘Green Watershed Management Plan’ in South Korea, and the ‘Southern Himalayas Ecological Restoration Project’ in Nepal (Li, 2007). Evaluation of these ecological restoration projects began in the 1950s as the Soviet Union, the United States, France, and Japan carried out evaluations of forest ecological services on the basis of in situ observations and other approaches (Xu, 1992; Wang et al., 2000), to analyze the ecological, economic, and social benefits from a sustainable development perspective (Liu, 2006). Subsequently, evaluation of the effects of ecological projects has evolved from the use of qualitative to more quantitative approaches.

China first carried out a pilot evaluation on the comprehensive effects of forestry ecological engineering in 1989. Since then, a series of systems of evaluation have been devel-