Ecological restoration and conservation tillage programmes reduced soil erosion and sedimentation in China

**THE CHALLENGE**

China experiences the most severe water and wind erosion problems in the world. Almost 40 percent of China’s territory, or 3,569,200 km² of land, suffers from soil erosion, out of this 1.6 million km² is from water erosion and 1.9 million km² by wind erosion. The problem is severe as 5 billion tons of soil is eroded annually, causing billions of dollars in economic losses. To control soil erosion, China has launched two large national ecological restoration programmes over the last five decades. These programmes include the ‘Grain-for-Green’ Program (returning steeply sloping cultivated land to forest area or grassland), which was initiated in 1999, and a much earlier forest restoration project, ongoing since the 1970s. These two large-scale land use changes are playing key roles in minimizing soil erosion and other forms of land degradation, as well as improving the ecological services such as nutrient cycling, organic material provision, and water conservation. The challenge now is to accurately assess the impacts of these land use changes; and provide incentives to land users to continue China’s “best land use and management practices” to minimize soil erosion.

**THE PROJECT**

Through the IAEA Technical Cooperation Project, the technical support from the Joint FAO/IAEA Division of Nuclear Techniques in Food and Agriculture, the Chinese Academy of Agricultural Sciences (CAAS) implemented activities in four locations extending areas from southwestern to north-eastern China including the north-west Loess Plateau (Nianzhuang watershed in Yan’an), south-west China (Xichang site), northern China (Fengning site) and north-eastern China (Baiquan site). Soil erosion in all four sites from different land uses were quantified along with sources of erosion. Fallout radionuclides (FRNs) techniques such as caesium-137 ($^{137}Cs$), lead-210 ($^{210}Pb$) were used to assess China’s ecological restoration programmes in reducing soil erosion and sediment yields while compound specific stable isotopes (CSSI) techniques were used to identify the changes in sediment sources at watershed scales due to land use changes.

At the Xichang site in south-west China, ecological restoration through re-vegetation on degraded hillslopes reduced soil erosion in this order: shrubs > trees with a litter layer > grasses > trees without litter layer. At the Yan’an site on the Loess Plateau, terracing and vegetation of hill slopes also enhanced soil fertility and water infiltration rates, thereby increasing soil resilience against losses from erosion. At the Baiquan site in north-east China, as compared with the sloping farmland (34.5 t/ha/y), terracing and contoured tillage reduced soil erosion losses by 14% (29.67 t/ha/y) and by 34% (22.8 t/ha/y), respectively. At the Fengning site, no tillage for four years and maintaining a stubble height of 50–56 cm from the previous year’s crop residues, led to a significant (44%) reduction in soil erosion (45.5 t/ha/y), when compared with conventional tillage practices (81.2 t/ha/y).
In the Yangjuangou watershed on the Loess Plateau, it was shown that soil erosion rate decreased from 65.1 t/ha/y to 21.9 t/ha/y by cropland conversion to forest for 18 years. The data from CSSI techniques indicate that sediment sources from the watershed has significantly changed, sediment contribution (90%) from previous hillslopes in 1996 decreased to 10% after the ecological restoration in 2000 by re-vegetation on cultivated steep hillslopes.

THE TECHNOLOGY

Fallout radionuclides (FRNs) such as caesium-137 ($^{137}$Cs), lead-210 ($^{210}$Pb), and beryllium-7 ($^{7}$Be) when land on soil surface, are strongly bound to fine soils particles. These radioisotopes are ideal soil tracers which can assist in establishing soil erosion and sedimentation rates and in evaluating the efficiency of soil conservation measures to control soil erosion and associated sedimentation. Compound-Specific Stable Isotope (CSSI) techniques are based on the measurement of carbon-13 ($^{13}$C) natural abundance signatures of specific organic compounds (natural fatty acid biomarkers) in the soil. By linking fingerprints of land use to the sediment in deposition zones or transported sediment, CSSI techniques are being used for determining the source of eroded soil and thereby identifying areas sensitive to land degradation.

THE IMPACT

The above results have been adopted by related Chinese policy makers and organizations such as the Yanhe River Basin Management Office (Loess Plateau) and the Liaohe Water Conservancy Commission in northeast China for developing best landuse and management practices. As series of papers related to above research has been published in the peer-review international journals, more than 20 PhD and MSc students from Mongolia, Myanmar, Bangladesh, Germany and China have been trained and obtained their academic degrees through CAAS and IAEA joint program. In 2014, the combined use of FRN and CSSI tracers have been officially accepted as the key techniques by the CAAS in Agricultural Clean Watershed Research for quantifying land degradation and associated water pollution in China.

Figure 2. Yangjuangou Watershed in Chinese Loess Plateau, where effectiveness of soil conservation measures in reducing soil erosion/sedimentation rates were assessed by using FRN and CSSI techniques.

2 www.reuters.com/article/-/us-china-soil-idUSKBN09Y720141104.
4 RA55055 Improving soil fertility, land productivity and land degradation mitigation.

For further information, please visit:
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