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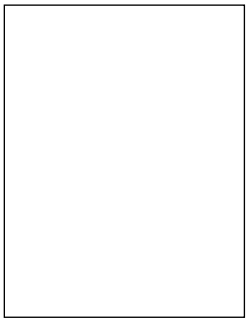

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# The Catastrophe Model to Assess Soil Quality Restoration under Ecological Restoration in the Red Soil Hilly Region of China

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## ABSTRACT

Soil quality restoration under ecological restoration measures was evaluated in the Zhuxi watershed of Changting County, Fujian Province in the red soil hilly region of China by applying the catastrophe model. The results showed that: 1) Among 89 soil sites, unstable soil sites and stable soil sites accounted for 26 (29.21%) and 63 (70.79%), respectively. Twenty--six (29.21%) were in the middle lobe, 10 (11.24%) were in the upper lobe, and 53 (70.79%) were in the lower lobe of the process surface in the cusp catastrophe model. The catastrophic direction of 26 unstable soil sites was to the upper lobe of the process surface according to vegetation cover change as well as fieldwork. There was a significant negative correlation of Δ value of the bifurcation set with vegetation cover increase, and the higher vegetation cover increase related to higher unstable probability. 2) The four ecological restoration measures were listed in the order low--quality forest improvement (LQFI) > arbor–bush–herb mixed plantation (ABHMP) > orchard improvement (OI) > closing measures (CM) according to the proportions of unstable soil sites, and they were all higher than that of no restoration measure. The four ecological restoration measures were listed in the order LQFI < ABHMP < OI < CM according to the average Δ, and they were all lower than that of no restoration measure. 3) Among the four ecological restoration measures, farmers' assessment to soil quality restoration was in accordance with the proportions of unstable soil sites, and inversely proportional to the average Δ. Farmers' assessment can prove the evaluation of soil quality restoration under ecological restoration measures based on catastrophe model.

***Key Words***: soil quality, catastrophe theory, soil and water loss, 3S, farmer' assessment

## INTRODUCTION

Soil quality is the sum of physical, chemical, and biological factors that affect soil structure and porosity, the availability of macro-- and micronutrients, and the activities of biological organisms (Karlen *et al*., 1997; Rowell, 1994). Many researches have demonstrated that soil quality was one of the key conditions of ecological restoration and essential to self--development of ecosystem (Pang *et al*., 2004; Lv and Zheng, 2009; Li *et al*., 2013). There are several most common methods for evaluation of soil quality restoration under ecological restoration. First, soil quality can be compared to the status before the ecological restoration took place (Cai *et al*., 2001). Second, soil quality can be compared to a naturalistic 'reference state' such as "pristine nature", "wilderness" or any other state of nature seemingly unaltered by human activities (Yang *et al*., 1999). Third, soil quality can be compared to a target state, which is ecologically possible, legally admissible, socially acceptable, and economically feasible (Xiong and Wang, 2014). A fourth approach is the 'the with--and--without--treatment' case comparison (Lv and Zheng, 2009; Li *et al*., 2013). However, soil quality restoration under ecological restoration is quite complex and is manifested as a discontinuity generally caused by socio--economic and natural factors at multiple levels and by long-- and short--term variables in multiple--scale processes. The soil quality may not always undergo ordered and gradual development but

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