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The role of community-based ecosystem restoration in forest structure dynamics and livelihood improvement in Indonesia: An integrated geospatial and structural equation modelling approach

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Abstract

The Conservation Partnership in Ecosystem Restoration (CPER) is an Indonesian government programme that aims to restore damaged ecosystems in conservation areas by integrating a community-based social and ecological approach. Although interest in restoration is growing, few studies link livelihood outcomes to ecosystem performance. This study looks at how effective CPER has been after almost ten years by examining its impact on the livelihoods of participating communities and its role in helping forests recover. Using the Sustainable Livelihood Approach, the research focuses on five types of livelihood capital: human, social, physical, natural, and financial, and explores how these affect community socioeconomic outcomes. To study the ecological side, the research uses Geographic Information Systems, object-based image analysis, Random Forest classification, high-resolution satellite images, and drone surveys to track changes in land cover and improvements in forest structure.

Partial Least Squares Structural Equation Modelling was used to study the links between livelihood capitals and socioeconomic conditions. The results show that most participants had high levels of human capital (81.5 %), social capital (73.1 %), physical capital (75.0 %), and natural capital (73.1 %), but financial capital was only moderate, with few people reporting strong financial resources. The model shows that physical capital has the biggest positive effect on socioeconomic outcomes ($\beta = 0.362, p < 0.001$), followed by natural capital ($\beta = 0.259, p = 0.001$) and financial capital ($\beta = 0.212, p = 0.016$). Human and social capital did not have significant direct effects. Spatial analysis found that forest cover increased steadily at the study sites, especially in Lempang Balong and Muntjul Masigit. This suggests that restoration efforts were effective, with overall accuracy between 95 % and 98 % and kappa values from 0.89 to 0.97, supporting the reliability of the geospatial methods. The decrease in secondary forest points to structural succession, while the growth of critical land seems linked to local farming rather than widespread degradation.

These results suggest that CPER has positively contributed to forest recovery and local socioeconomic conditions, through practical livelihood assets. The study presents a combined social and ecological evaluation framework and gives evidence-based recommendations to improve community-led ecosystem restoration policies in Indonesia.

Keywords: Community-based restoration, conservation Partnership in Ecosystem Restoration, forest cover change, geospatial analysis, Indonesia, PLS-SEM, social–ecological systems, sustainable livelihood approach, tropical forest restoration, UAV