



Application of game model for stakeholder management in construction of ecological corridors: A case study on Yangtze River Basin in China



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ABSTRACT

Disasters experienced by most countries are often caused by ecological crises. A worldwide consensus has been reached that building ecological corridors is the breakthrough solution for the phenomena. Developed countries rely on advanced science and technology and highly active social organizations to achieve remarkable results in ecological management. However, ecological management may not be as successful in developing countries because of the lack of development, imperfect social organizations, inadequate public awareness, and insufficient participation in environment-related issues. Ecological management is influenced by the synergy among governments, business enterprises, and the public. The cooperation issues faced by stakeholders in the construction of ecological corridors on Yangtze river basin in China have been rarely explored, and these issues present barriers to the promotion of ecological corridors. Therefore, this study investigates the significance of building ecological corridors along the Yangtze River Basin in China and analyzes the role of the stakeholders, specifically the local governments and construction companies. The Pareto optimality of the project is determined using a game model to ensure controlled and clean operations. This study proposes from the findings that developing countries should strengthen the cooperation among stakeholders, improve and stabilize the construction mechanisms for building ecological corridors, and increase public participation in the project.

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1. Introduction

In most developing countries, people benefit from ecosystem services (e.g., food, fiber, potable water, and flood regulation), which are major contributors to the development of local and national economies (Nkhata, Mosimane, Downsborough, & Breen, 2012; Peng, Shen, Tan, Tan, & Wang, 2013). Approximately 65% of the world population are expected to live in urban areas in 2025. Owing to rapid urbanization, land consumption for urban use has remained high since the 1960s in countries with rapid economic growth; consequently, large areas of natural ecological land are being converted into construction lands (Bao, Zhu, Cen, Peng, & Xue, 2017; Li et al., 2009; Marlow, Ralph, & Kenneth, 1994, p. 673; Shan, Yu, & Wu, 2017; Shen, Peng, Zhang, & Wu, 2012). Land

use change will undoubtedly result in local environmental change by affecting ecosystem services (Bao & Peng, 2016; Long, Liu, Hou, Li, & Li, 2014; Peng, 2015; Peng, Lai, Li, & Zhang, 2015; Wu, Peng, Zhang, Skitmore, & Song, 2012). In *Environmental Culture: The Ecological Crisis of Reason*, Plumwood (year) examined contemporary Western culture and ecological destruction, and proposed a revisionist mode of ecological thought and practice (Jeremy & Bendik, 2004). Ecological crisis has become a global issue. For example, in Chiapas, Mexico, cutting of trees in rainforests and inappropriate subsequent land use with resultant erosion have intensified catastrophic events; these ecological crises have become a new “Central American dilemma” after years of political turmoil (Richter, 2014). In Vietnam, researchers have investigated the connection between rapid growth of precarious settlements, deterioration of technical infrastructure, and water pollution in Ho Chi Minh City. Urgent measures have been proposed to balance development, upgrade urban environments, and protect natural resources (Bolay, Wust, & Du, 2002).

Thus, countries around the world must establish aggressive

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policies to protect communities from the effects of pollution. The accelerated rate of urbanization in many developing countries is not only faster than that in developed countries but also causes serious ecological crises. The concept of “stakeholders” in relation to the operation and management of enterprises was proposed in the 1960s and has been used to manage the construction of ecological corridors. Stakeholders are interest groups or individuals that are closely related to the business and mainly include shareholders, creditors, business managers, employees, suppliers, customers, the government, and the public (Yang, 2002).

The concept of stakeholder emphasizes that practical management activities are conducted in a system or network background because a single action from a single subject does not easily achieve optimal performance. The major stakeholders in the ecological environment include city governments, city residents (the public), enterprises (including environmental protection enterprises), autonomous communities, other government organizations (e.g., adjacent areas or governments) and non-government organizations (NGOs) (e.g., environmental protection NGOs). These stakeholders are sometimes independent but always differ in preferences; for example, governments prefer the overall interests of social development (i.e., performance), the public prefers individual benefits (i.e., health), enterprises prefer profits, and environmental protection NGOs prefer social environment rights; this difference can cause conflicts (Huang & Kuang, 2006). On the basis of cooperation analysis, Li and Li (2013) analyzed the implementation of watershed common governance using the following four mechanisms: participation, utility transfer mechanism, negotiation mechanism, and supervision mechanism.

Scholars focus on the relationship and cooperation between stakeholders in addressing ecological problems. Integrating stakeholder knowledge into nature resource governance is considered to add flexibility to social-ecological systems (Gray, Chan, Dan, & Jordan, 2012). Wang, Wang, Xu, and Zhang (2011) conducted an evolutionary game theory (EGT) modeling of the basin-wide ecological restoration compensation implementation to analyze the relationships among the relevant stakeholders. Scholars also call for significant stakeholder participation in the process of restoration in the ecological restoration field (Couix & Gonzalo-Turpin, 2015). The economic gap in China's Yangtze River economic basin is obvious, with the economic development level gradually decreasing from the East to the West, and the economic gap showing an expanding trend (Liu, 2006). In 2016, Political Bureau of the CPC Central Committee held a meeting and passed the *Outline of Yangtze River Economic Basin Development Plan*. The plan proposes that the ecological environment protection in the Yangtze River is a systematic project that involves the main tasks of breaking the boundaries of administrative divisions and barriers; effectively using market mechanisms; encouraging the government to play its role; strengthening joint prevention and control of environmental pollution; promoting the establishment of ecological compensation mechanism among the upstream and downstream regions; and accelerating the formation of ecological environment prevention, watershed management, and coordinated development of new mechanisms for regional coordination. However, stakeholder analysis in the country is complicated and lacks systematic study because the stakeholders (e.g., the local government, enterprises, and the public) in the upstream and downstream regions face various economic and environmental problems and benefits, as well as the economic gap in the Yangtze River economic belt is significant.

The concept of ecological corridors as a solution to ecological crises has become a popular topic for ecologists, governments, and conservationists. The ecological corridor framework has been criticized by stakeholders for its ambiguity and flexibility (Windt and

Swart, 2008). Thus, this study aims to build a game model that assesses the interests of ecological governance stakeholders on the basis of the concepts of ecological corridors and stakeholders.

2. Literature review

2.1. Ecological corridors

Some scholars state that the ecological network with green corridors can help maintain biological diversity by improving water quality and promoting a good habitat for plants and animals (Fumagalli & Toccolini, 2012). Other researchers link ecological corridors to urban landscapes. Green spaces are enhanced by integrating ecological corridors into the urban landscape, thereby helping in protecting the biodiversity of species (Peng, Shen, Shen, Lu, & Yuan, 2014; Vergnes, Viol, & Clergeau, 2012). The conflict between the demand for economic development and the need for additional green spaces in the society can be determined by combining the analytic hierarchy process for finding a consensus on the weights assigned to different criteria, and the agglomeration hierarchical clustering method for identifying clusters representing common decisions on the criterion of weights (Shapira, Shoshany, & Nir-Goldenberg, 2013). Urbanization is the major cause of biodiversity loss, and ecological corridors can minimize the negative effects of habitat fragmentation in ecosystems by providing living spaces for organisms with low dispersal capabilities in urban cities (Vergnes, Kerbirou, & Clergeau, 2013). Scholars use remote sensing to study the construction and effects of ecological corridors. Ma et al. (2013) investigated the ecological corridors in Chaoyang District in Beijing using the “reduce, reuse, and recycle” technology, ecosystem service value theory, and cost distance model. They revealed that the ecological environment in the area has been destroyed because of severe fragmented landscapes and poor corridor connectivity. They further suggested that the ecological corridor width threshold should be expanded. The combination of hyper-spectra and light detection and ranging remote sensing data is widely applied in monitoring nature, environment, forest, and agricultural protection; the biomonitoring used in the development of ecological corridors uses an integrated technology (Tamás et al., 2015). Tan et al. (2011) used remote sensing technology to monitor the vegetation and farmland in the Tarim River Basin from 2002 to 2004. They found improvements in the vegetation cover and area of cultivated land during the studied period and that the growth rate increases significantly from 1999 to 2002.

Similar to other developing countries, China has a growing economy that has inflicted negative effects on the environment and biodiversity. Finding an effective solution to a problem with two contradictory practices is important for many developing countries. Therefore, this case study aims to investigate the construction of China's ecological corridors as a practical solution to reverse the negative impacts of urbanization. Methods used in previous studies are employed in reviewing the construction of ecological corridors in the Yangtze River Basin. The urban ecological landscape and its surrounding human settlements are analyzed first, and then the river basin ecosystem construction management is explored. Ecological corridor benefits encompass environmental, economic, and social benefits. For example, the Taiyuan Fenhe River Park has become a space for leisure, living, and commercial use. The success of this project has proved the necessity of constructing large number of ecological corridors in urban areas (Fang, 2013). Urban and suburban areas, such as Shenyang City, are planning to establish a scientific system of urban green pathways located around the edge of the city and along the water system to build large number of green cities (Wang, 2009). Wong (2014) proposed 10 steps for

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