Research article

Understanding Socio-Ecological Production Landscapes in the Context of Cambodia

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Abstract In Cambodia, a large portion of the population engages in primary sector production such as agriculture, forestry and fishery, and the people's livelihoods are directly dependent upon the availability of natural resources. The natural environment, however, has been undergoing severe deterioration for several decades. Similar challenges are being faced in many different countries and it is therefore of global importance to explore ways to conserve the environment while allowing people's livelihoods to develop. In this context, the term socio-ecological production landscapes and seascapes (SEPLS) was coined to refer to areas shaped by production activities characterised by harmonious human-nature interactions. The aim of this study is to deepen the understanding of Cambodian production landscapes using three different perspectives drawing on the SEPLS concept: structure, benefits and changes. Based on a literature review, key characteristics of SEPLS were identified including their mosaic structure and the diverse benefits they provide. Further study is needed to understand the significance of SEPLS in Cambodia in terms of the biodiversity and environmental benefits they provide.

Keywords socio-ecological production landscapes and seascapes, mosaic structure, ecosystem services, land use

INTRODUCTION

In Cambodia, people's livelihoods are highly dependent upon access to natural resources from agricultural lands, forests, rivers and lakes. One of the most important industries is agriculture, in which 66% of the total population was engaged in 2010 (FAO, 2010a). The natural environment, however, was severely damaged during the country's civil war and the following years of political instability, while today the environment is strained by the impacts of modernization and globalization. In many parts of the world, recognition of the extent of damage humans have caused to the environment, and the fact that this degradation is now threatening people's lives, has created an understanding that it is essential to explore ways to conserve the environment while allowing people's livelihoods to develop. The underlying conceptualization of this is to consider humans as a part of nature, and that they have adapted to local ecosystems by carefully modifying their features, and derive their livelihoods from these close interactions with their surroundings. Such interactions have often maintained biodiversity while providing humans with a continuous supply of goods and services. Such conceptualizations have begun to be applied in the research, policies and practices dealing with environmental conservation and livelihood development, while leading to the launching of new efforts such as the Satoyama Initiative, a global initiative aiming to conserve and revitalize landscapes and seascapes created through long-term human-nature interactions around production activities such as agriculture, forestry and fishery (UNU-IAS, n.d.).

This paper aims to understand Cambodian production landscapes by using the concept of socio-ecological production landscapes and seascapes (SEPLS), a term coined to refer to the target areas of the Satoyama Initiative. After introducing the Japanese *satoyama* landscape, from which the Initiative and the term SEPLS originated, the characteristics of the Cambodian landscapes are identified based on several points included in the description of SEPLS.

SEPLS IN JAPAN: SATOYAMA LANDSCAPES

Historically, a large portion of Japanese landscapes has been under the influence of human activities, such as agriculture, forestry, and fishery. Adaptation to the surrounding environment through such activities has created unique areas called *satoyama* landscapes, which are characterized by mosaics of paddy fields, upland fields, woodlands, grasslands, ponds and canals, and settlements. Careful management of land uses based on knowledge accumulated across generations, has made it possible for *satoyama* landscapes to continuously provide humans with food, fuel and building materials, while nurturing unique cultures. Management of woodland areas includes collecting fallen leaves and grasses, which are used to maintain soil fertility in combination with manure. A continuous supply of firewood was secured by coppicing of trees where farmers left stumps to sprout again after cutting. After several years of management, including removal of unnecessary branches and weeds, farmers could cut trees again for use as firewood (Takeuchi et al., 2003).

Regular management practices in *satoyama* landscapes, including cutting of trees and mowing, maintain favourable habitats for some plant and animal species, which have adapted to the natural conditions created by such practices. Furthermore, the mosaic landscape has contributed to high levels of biodiversity by including different land uses, each with its own associated vegetation, constituting habitats for a wide variety of animals. This structure is also important for species such as dragonflies and frogs, which need different habitat types during their life stages and for obtaining different resources (Katoh et al., 2009).

Recognition of the importance of *satoyama* landscapes and recent negative trends such as degradation due to urbanization, agricultural modernization and an aging population led to the Japan Satoyama Satoumi Assessment (JSSA), which is a thorough study of ecosystem services and their contribution to human well-being in Japan that included the involvement of more than 200 stakeholders. The assessment recognized the benefits of the landscapes' multifaceted nature, which produces a bundle of ecosystem services for human well-being (JSSA, 2010). It also recognized the global importance of the concept underlying *satoyama* landscapes, which assumes a mutually beneficial relationship between humans and nature, if properly maintained. Based on the JSSA results, the term "socio-ecological production landscapes and seascapes (SEPLS)" has been applied by the Satoyama Initiative to refer to its target areas around the world. Drawing on the similar JSSA definition of *satoyama* landscapes, the Initiative describes SEPLS as "dynamic mosaics of habitats and land uses that have been shaped by the interactions between people and nature in ways that maintain biodiversity and provide humans with goods and services needed for their well-being in a sustainable way". Attempts have been made to understand various production landscapes and seascapes using the SEPLS concept (Gu and Subramanian, 2012; Ichikawa, 2012). Further study, however, is needed to understand the characteristics and significance of SEPLS across various parts of the world. Drawing on the above description of SEPLS, the following sections describe Cambodian production landscapes along three points: structure, benefits and changes.

SEPLS IN THE CONTEXT OF CAMBODIA

Structure: "dynamic mosaics of habitats and land uses"

Situated in the tropics, Cambodia experiences a monsoonal climate with distinct wet and dry seasons. A dry period starts in late November and lasts until April. Cambodia's topography is characterized by extensive areas of extremely flat floodplains containing the Tonle Sap Lake and river complex at the country's centre, and hills in the south-western and north-eastern regions. The Mekong River flows from Laos in the north and at Phnom Penh it converges with the Tonle Sap River, which flows from the Tonle Sap Lake. The Mekong River's water level fluctuates by approximately 9 metres each year. During the wet season, some water flows back up the Tonle Sap River into the Tonle Sap Lake, which can experience a tenfold increase in area to approximately 25,000 km^2 between May and November (Nesbitt, 1997).

A large portion of Cambodians live in lowland areas where their livelihoods have depended on paddy rice cultivation for at least the last 2,000 years (McKenney and Tola, 2002). Other elements of Cambodia's lowland landscape include forests, settlements, rivers, ponds and lakes. One distinct land use is called *chamkar*, a term which encompasses all agricultural land uses except paddy rice cultivation, basically areas where farmers grow cereals, vegetables, etc. (Chann et al., 2011). The distribution of different land uses is directly affected by topography and associated water regimes. For example, in one village in Kampong Cham Province, large areas are dominated by rice fields, which are located in the lower part of the land, while vegetable fields are located in elevated land surrounded by the paddy field (Siriwattananon et al., 2010).

There are several different types of paddy rice field, which vary according to different growing conditions determined by micro-topography and water regime. Accordingly, each type of field utilizes the appropriate variety of rice, which differs in terms of physiological properties such as photo-sensitivity and elongation ability (Javier, 1997). Deep water (floating) rice is primarily grown in areas that are submerged at a depth of 50-300cm for at least one month during the rice growing period. In areas where the water is less than 50cm deep, field levels are further subdivided into three different water levels, in which farmers grow rice varieties that mature at different times. This allows farmers to reduce the risk of a total crop failure due to droughts and floods, optimize labour resources, and increase food security (McKenney and Tola, 2002).

Forest vegetation also occurs in a mosaic pattern consisting of plants of different height and species, affected by seasonal water-level changes and different recovery stages from human disturbance. For example, in the area near the Tonle Sap Lake in Siem Reap Province, forests which are along the shoreline during the dry season and flooded during the wet season, experience fewer disturbances by humans and have a relatively closed canopy of tall trees. Vegetation in inland areas, however, is constantly disturbed due to the collection of firewood, and is characterized by low, sparse cover (Araki, 2007).

Studies on land use and livelihoods in hilly areas in Cambodia shows that landscapes consist of evergreen forests, semi-evergreen forests, deciduous forests, shrubs and grasslands, *chamkar* areas, homegarden, cash crop fields, and settlements (e.g., Fox and Vogler, 2005). Wetland rice is less common in hilly areas (Evans et al., 2003), where *chamkar* has been practiced for centuries in a form of shifting cultivation by ethnic minorities such as the Phnong in Ratanakiri and Mondulkiri Provinces. Shifting cultivation refers to the intermixing of upland rice and other crops (e.g., soybean, sesame, banana, maize, sugarcane, and potato), and plots are usually cultivated for about three years, after which they are left fallow. Old fallow is cleared by burning the trees and grasses (McKenney et al., 2004). Soil can rest and regenerate during the fallow period, and the ashes from the burning provide nutrients to the soil (Andersen et al., 2007). Through this sort of mechanism, shifting cultivation creates unique landscapes composed of a dynamic patchwork of crop fields, fallows of various ages, secondary forest and remnants of the original vegetation.

Benefits: "maintain biodiversity and provide humans with goods and services for well-being"

A set of different land uses provides a diverse range of goods, which are important for subsistence and generating cash income. Historically, rice has been a staple food for Cambodians, and the country depends on rice as a strategic commodity for income growth, poverty reduction, and national and household food security (Yu and Diao, 2011). Paddy fields can also provide a variety of aquatic animals such as fish, crabs, shrimps, edible insects, and frogs, which are sources of animal protein for people, although their importance has not fully recognized in policies and research in Cambodia (Gregory and Guttman, 1997). More than one million Cambodians depend on inland fisheries to support their livelihoods. The Great Lake and Tonle Sap River area produces roughly 50-60% of Cambodia's inland commercial fish catch (McKenney and Tola, 2002).

Forests provide villagers with a variety of goods known as non-timber forest products (NTFPs), such as firewood, food, and medicinal plants. An assessment conducted in four provinces found that medium-income households obtain 30% (345 USD/year) of their total livelihood value from NTFPs, while low-income households obtain 42% (280 USD/Year) (Hansen and Top, 2006). Resin is recognized as one of the most important NTFPs in Cambodia, and is used domestically for

sealing/waterproofing boats and is exported for these uses as well as for manufacturing paint and varnish. It is tapped mainly from evergreen tree species such as *Dipterocarpus alatus* without substantially damaging the trees, which allows for continuous yields across decades (Tola and McKenney, 2003). Income generated from resin collection is estimated at 338 USD/year per family in Ratanakiri Province, helping to cover the cost of buying rice, which runs short several months after harvest (Evans et al., 2003). Firewood continues to be an important cooking fuel and is used by 94% of the population in rural areas (NIS, 2009). Medicinal plants are also important, especially in remote and poor areas, because they help to significantly reduce healthcare costs (Laval et al., 2011). Kimhy et al. (1998) insist on the significance of different "forests", including trees around the households and paddy fields. The woodlands that are left around the dwellings can provide villagers with a variety of food and materials, and contain various species such as neem, coconut, palm, mango and bamboo (Siriwattananon et al., 2010). Trees that are scattered along dikes of rice fields and uncultivated land are not only used for grazing, but also for improving soil fertility and providing shade to people and animals (Kimhy et al., 1998).

Although the environmental benefits of the ecosystems in production landscapes have been discussed in general, aside from the case of carbon sequestration, these issues have not been extensively studied within the Cambodian context. For example, the function of forests in maintaining water quality and flood mitigation is generally known, but the clear and quantifiable link has not been made between deforestation and the change in water quality or flow (Hansen and Top, 2006). Regarding carbon sequestration, the Cambodian Government has made a strong commitment to managing the forests under the anticipated new international climate change agreement on the REDD+ mechanism. Estimation of potential carbon credits generated from improved forest management is underway for existing forest (e.g., Ty et al., 2011).

Changes: "shaped by the interactions between people and nature"

It is believed that population densities were generally low in pre-colonial Cambodia and there was abundant food coming from rice fields, forests and lakes. The farmers, however, also demonstrated innovation by adopting rice production technologies to the poor soils, erratic rainfall, and complex hydrology of Cambodia (Helmers, 2007). This included, for example, subdividing the fields into levels for growing different crops and varieties as mentioned above. The history of water management in Cambodia goes back to before the Angkor period. Modern irrigation systems that were first developed from 1950-1953 by the French include the Colmatage canal system, which uses dykes and sluices to provide controlled annual inundation, allowing a fertile layer of silt to settle on the fields (FAO, 2010b).

The land and people of Cambodia were seriously impacted by the agricultural policy of the Khmer Rouge regime (1975-1979), which aimed to increase rice production by expanding the area under rice cultivation into cleared forest lands and developing irrigation systems, many of which have been assessed today as useless or unusable. The rural labour force was reorganized to conduct collective agriculture, supplemented by people from urban areas, who were forcibly relocated (Helmers, 2007). During the 1980s, in accordance with socialist development policy, agricultural land was collectivized and became state property. Solidarity groups known as *krom samakki*, consisting of 20-25 families, were organized and constituted the basic unit of production, although in practice collectivization was not vigorously pursued. In 1989, the State of Cambodia instituted a new policy favouring a transition to a market economy. Private land tenure was established and most communal lands were broken up and allocated to families (Helmers, 2007).

Fox and Vogler (2005) report that shifting cultivation has maintained a relatively stable percentage of forest cover in Southeast Asia's montane mainland during the latter half of the 20th century. However, there have recently been major shifts in land use in hilly areas. In the 1990s, governmental forest management in Cambodia only focused on timber production from high value forests managed by private companies under large-scale forest concessions (Hansen and Top, 2006). Concession forestry has, however, experienced implementation challenges, resulting in high levels of illegal logging and corresponding degradation of forest resources. It has also caused conflicts over rights with local communities who traditionally used to collect natural resources

from the concession forests (McKenney et al., 2004). In 1969, forests represented more than 74% of the land area, which had changed marginally to 73% by 1990, but decreased drastically to 65% in 2000 and is currently at 57% (Broadhead and Izquierdo, 2010). The advent of cash crop farming by indigenous communities, which has largely emerged since 1993 when the government opened up for international investment, has increased the rate of conversion from shifting agriculture to cash crops. Other factors impacting land use change include the development of road networks, population increase, inadequate enforcement of land laws, together with the dissolution of the communal system, which has led farmers to sell land to outsiders. In Ratanakiri Province, planting of cashew by indigenous communities has increased in part to claim the land, and in part to increase cash income (Ironside, 2010).

In lowland areas, forests in floodplains are decreasing due to exploitation for firewood and conversion to agricultural land (McKenney and Tola, 2002). In areas under rice cultivation, farmers have begun to plant faster-maturing varieties in many areas previously cultivated for late-maturing varieties, because the shorter the time that crops spend in the field, the lower the risk of crop failure (McKenney and Tola, 2002).

CONCLUSION

It was found that the SEPLS concept was applicable in the Cambodian context. Mosaic landscapes were clearly identified in both the lowland and hilly regions. Although lowland areas are characterized by extensive flat areas dominated by paddy field, micro-topography and different water regimes have created heterogeneity, which determines land use distribution, and has created diverse rice growing conditions where appropriate rice varieties are grown. In hilly areas, temporality has also created mosaic patterns of land uses due to shifting cultivation. Recent land use changes seem to be creating more uniform landscapes, a common trend across many other countries. A range of different land uses provides a variety of goods that are crucially important to local people as they directly contribute to their subsistence and cash income. Forests, in particular, produce a variety of resources that supplement diets, provide traditional medicines and can be used to construct shelter. Rice paddies not only produce rice, but also fish and other protein-rich aquatic animals. Regarding the environmental benefits, the author could not find enough evidence that these issues have been studied in-depth within the Cambodian context. While local farmers have historically adapted and developed practices that are applicable to their unique local conditions, the past several decades have seen frequent and dramatic changes in political and economic regimes, which have affected production activities and land uses.

Although Cambodia has recently been experiencing a decline in natural resources, a relatively large area of forests remains compared with the other Southeast Asian countries, and many people depend directly on natural resources for their livelihood. Many studies exist on the various material benefits that SEPLS provide, but in order to explore the paths towards sustainability, it is also important to understand the landscapes holistically, including environmental functions as well as the social and cultural benefits they provide.

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