



Farmer's Perception of Ecosystem Services for Lowland Rice Cropping Systems in Battambang Province, Northwest of Cambodia

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Abstract Rice is significant in Cambodian food security. The main cultivated area is in central plain and floodplain of Tonle Sap Lake (TSL). TSL provides importantly both provisioning and regulating services to rice cultivations in its floodplain such natural flood for irrigation, soil fertility from sediment and aquatics animals specifically fish and snakes which regulated and improve the rice cropping system naturally. However, changes of the Mekong River (flood pulse) and climate change impact on changes of rice cropping systems (RCS) observed recently. The objective of the study aims at carrying out farmer's perception on ecosystem services (ES) in comparison with two sites of Low-water-land (LWL) and middle-water-land (MWL) in Sangkae district, Battambang province. An agrarian system analysis and diagnosis method applied for whole implementation with 120 rice farmers for this survey. Flood-pulse of TSL have change to lower and lower which led some part of floodplain became infertility, so farmers have changed their traditional rice cropping systems (floating rice and long-term rice) to high-yield rice; shifted from traditional techniques to modern systems by adopting new innovations, inputs and technology, chemical fertiliser and modern machineries. Nevertheless, from our study, the new rice cropping systems seem to be less sustainable, inadequate use of new technologies or inputs in the study areas. Rice cropping systems in MWL is more profitable than LML site. Farmers in both sites are aware of the ecosystem services provided by TSL, but not all of them perceived the same importance among the RCS because of agroecosystem differentiation. The poor farmers, who lived in and closer to the TSL basin relied the most on traditional rice; floating and long-term rice, were vulnerable to food insecurity and insufficient household's income, changes of the ecosystem services in their regions. They reported the ES are more importance to their RCS than other medium and large farmers. Adaptive RCS and irrigation system should promote corresponding to the dynamic changes, ecosystems of Tonle Sap Lake.

Keywords rice cropping system, agrarian system and diagnosis, ecosystem services, perception, economic analysis, Tonle Sap Lake

INTRODUCTION

Tonle Sap lake (TSL) is known as a complex ecosystem, which provides a substantial hydrological, biological, nutritional, cultural value and the productive operations as natural floodwater reservoir in the lower Mekong region offering flood protection and assuring dry season flow to the Mekong Delta (Arias et al., 2014; Kummu et al., 2014). The TSL floodplain system plays a critical role not only in

providing necessary water resources and other environmental services for the entire country, but it also represents a global biodiversity hotspot supporting the remarkable productions of fishery and agriculture, mainly rice (Keskinen et al., 2013).

The lowland areas are largely cultivated in TSL floodplain, which accounts for almost 90% of the total rice cultivation fields as well as for 77% of total rice production (Chea, 2015; MAFF, 2016). Particularly RCS are enormously dependent on the natural resources provisioning. Battambang province is the major producer of rice called “rice bowl” located in northwest of Cambodia, where more than 70% of the population depend on agriculture as their main job and almost half of them cultivate rice (provincial department of planning, 2016). However, the extreme flooding occurred which damaged more than one tenth of rice cultivated area in 2011 in the country, but the total areas of rice affected by these floods reached more than 30% in this province, while damages in Sangkae district itself represented 70% of the total cultivated area (Kamoshita and Ouk, 2015). With these changes especially flood pulse of TSL, farmers have changed their RCS by adapting new innovations and technologies in the purpose of increasing their rice production. In floodplain areas of TSL, floating rice (FR) or long-term rice (LTR) areas dramatically shifted to high-yield rice, particularly EWSR and/or RR practices (Keskinen et al., 2013).

OBJECTIVES

The overall objective of this study aims at understanding farmer’s perception on ecosystem services (ES) in comparison with two sites of LWL and MWL in Sangkae district, Battambang province with respect to recent dynamics in TSL floodplain ecosystems.

Based on the interactions of these changes of TSL ecosystem and RCS, the study discusses on the advantages and disadvantages of the changes in RCS as well as to document the perception of ES of TSL affecting the livelihood of households in different agroecosystems. Moreover, there are still lack of scientific studies on such topic from Cambodia which would deeply analyse the changes of agricultural land-use systems of RCS in the floodplains in/around TSL whereas the ES of TSL altered by the changes of its flood pulse. The study proposes to conduct a research on these interactions between ES of TSL and RCS in lowland area in Battambang province.

The limitation of the study did not access to measure economic comparison neither between *RCS in both MWL and MWL, nor the household’s livelihood diversity provided by provisioning and regulating services of ES from TSL*

METHODOLOGY

Agrarian System Overview

The study was adopted agrarian system concept in order to achieve the objective of the study. This is an all-encompassing concept, capable of making sense of agricultural and livelihood activities at a regional scale in a way that accounts for both ecological and socio-economic dimensions (Cochet, 2012). The historical changes study helps to identify and understand the main dynamics of differentiation among farming families and thus help define current farming systems (Barral et al., 2012).

Sample Selection and Data Collection

120 rice producing farmers (60 farmers from each site) were randomly selected in both different agro-ecological systems in Sangkae district. Baset, Oumuni and Rorkar in Middle-water-land (MWL) site, Samdach, Svay Sar, and Boeng Tuem from low-water-land (LWL) site.

Data Analyses

SPSS version 20 (Social Package for Social Sciences) was performed by specific tools basically descriptive statistic, such as frequencies, means and standard deviations. Likert scale, a psychometric response scale primarily used in questionnaires to obtain participant’s preferences or degree of agreement with a statement or set of statements, was also used. The order scaling was set as 4 levels scoring from 1 to 4 which represents from —Strongly agree to —Disagree (1=strongly agree, 2=agree, 3= somewhat disagree, 4= disagree) while the scoring from 1 to 6 representing from —Strongly decrease to —Don’t know (1=strongly decrease, 2=somewhat decrease, 3=the same, 4=strongly increase, 5=somewhat increase and 6=don’t know), and other scoring for awareness was from 1 to 4 (1=strongly aware, 2=aware, 3=somewhat aware, 4=not aware).

Study Area

The study was conducted at floodplain areas in Sangkae districts of Battambang province. The Fig. 1 visualised the layout and location in red of TSL in Cambodia. The hydrological regime of this province supports an unnoticeable support to national economic development contribution of Cambodia by providing a wide range of ecosystems such as high biodiversity and productivity, mainly fish, plant communities, and wildlife. Almost half of the Cambodian population uses resources of TSL (Arias et al., 2014).

Two Ago-ecological zones of the Sangkae distinct were selected for this study (Fig. 2), the This area from 0 -1 m unless there is flooding. Agricultural land is cultivated RCS such as long-term rice (LTR), early season rice (ESR), and dry season rice (DSR). There are not many fruit trees or vegetable grown in this area. There are available supplementary irrigation systems in this zone, which suitable for cultivating short-term RCS.

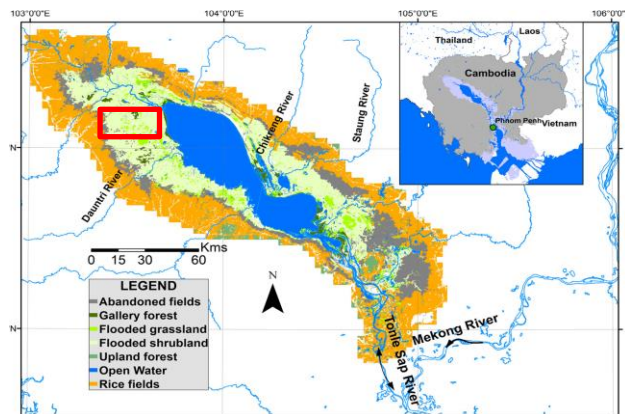
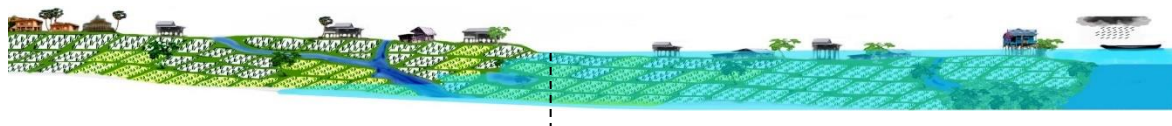


Fig. 1 Map of Cambodia and study area (Arias et al. 2014)



Zone 2: Middle-water- land or middle field

Zone 1: Low-water-land or low field

Note:



Fig. 2 Landscape during wet season (November - April)

RESULTS AND DISCUSSION

Rice Cropping Practices in Two-zones

Fig. 3 shows rice cropping systems cultivated in low-water land and middle-water land. Only floating rice (FL) is existing in LWL while there is no any farmers in MWL cultivated this rice cropping system.

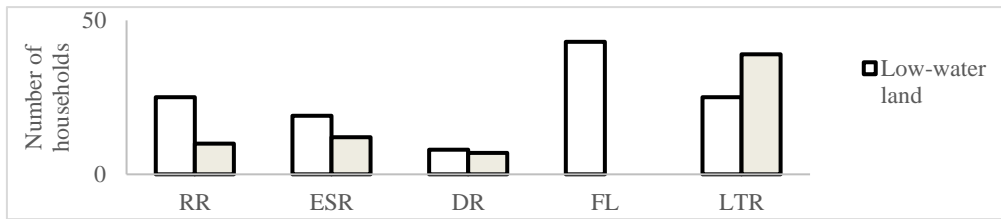


Fig. 3 Rice cropping systems in different agroecology

As a result, majority of farmers (>60%) in both sides have adopted this innovation by changing their old RCS, which practised with traditional techniques and mainly relied on natural resources provisioning, to the new RCS which confirmed by keskinen (2013). Farmers have low adaptive capacity while the climate and ES (flood pulse) variability have occurred in their areas which similar to the studies rainfed upland in Cambodia (Yusf and Francisco, 2009). Insufficient supplementary irrigation systems and depending on unreliable rainfalls and floodwater from TSL led to low productivity improvement while they have shifted to cultivate high-yield RCS in their areas which consistent with Sophea’s study (2012).

Farmer’s Perceptions of Ecosystem Services

Most of the farmers in both areas have similar perceptions of ES such as floodwater, wildlife, fish and forest. They perceived that those ES dramatically declined and changed. The amount of fish was indicated by more than 50% of farmers in the MWL as strongly decrease while 60% in the LWL. On the contrary, among the interviewed farmers had a different opinion of floodwater. They have mentioned that floodwater was strongly increased which more than 5% of them in both areas perceived while more than 2% of farmers in the MWL was found somewhat increase as shown in Fig. 4.

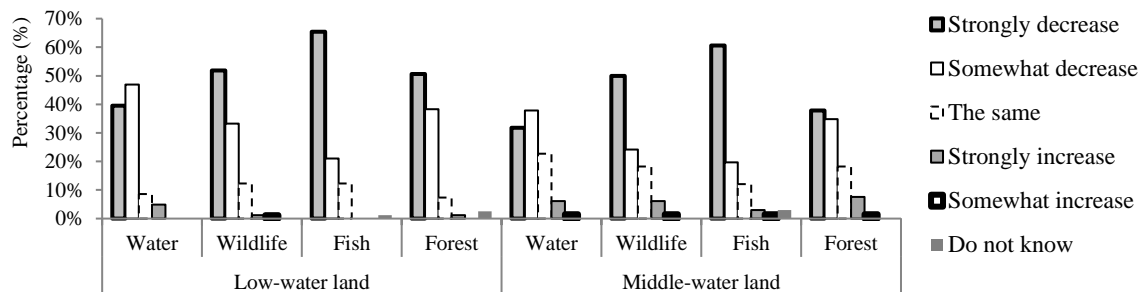


Fig. 4 Farmer's perceptions of ES changed in TSL

FR cropping system was, traditional system, required low cost of production compared to high-yield RCS. Additionally, farmers exercised this RCS with lower labour and cost of inputs, farmers did not apply chemical fertilisers and obtained approximately 900kg/ha. Farmers practice FR for mainly household’s consumption which similar to Sarkkula et al. (2003), who stated that FR is significant for the poorest households on floodplain area due to its cost-efficiency. Therefore, the study found that farmers perceive that ES from TSL not only the water for their RCS, but also provided other fishy research for their livelihood system. The result of analysis indicated that the farmers in LWL valued the ES more importantly to the resources from TLS rather than the farmers in MWL site. From this over-view, the study assumes that farmers who lived in and closer to the TSL basin are aware of and depended directly on the ES of TSL.

Farmer’s Awareness of Ecosystem Services

Farmers provided different information of awareness evaluation as shown in Fig. 5. The respondents in the LWL is higher than who in the MWL, 80% of farmers in the LWL aware the ES in their RCS annually while 60% in the MWL. In contrast, 40% of farmers in the MWL are not aware ES while 20% in the LWL. Additionally, farmers provided their level of awareness on four specific ES such as water, wildlife, fish, and forest contributed in their RCS.

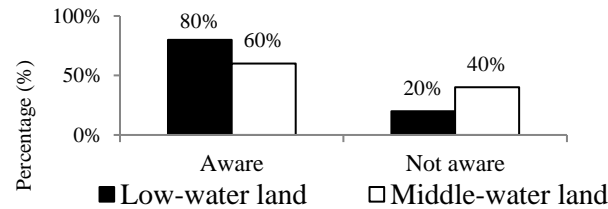


Fig. 5 Farmer's awareness of ES for rice cropping systems in both sites

The Importance of Ecosystem Services

Figure 6 shows the farmer's perceptions of the importance of ES in TSL for their RCS. As the results, more than 80% of local farmers show that the ES are necessary for their RCS particularly floodwater. Meanwhile, 7% of farmers in LWL mentioned not all of the ES are important while 2% of farmers in the MWL also mentioned. Additionally, among those farmers, 10% of farmers in LWL and 17% in the MWL, also did not know whether these ES are important or not.

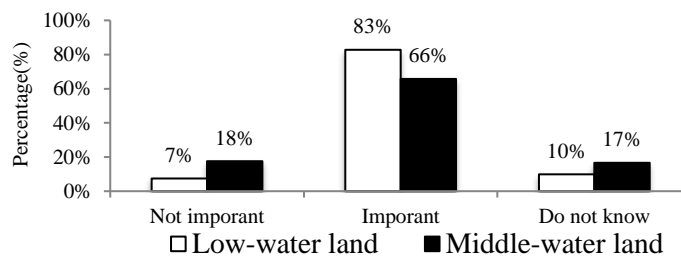


Fig. 6 Farmers' perceptions of the importance of ES for rice cropping systems

Most of the households in the both agro-ecosystems were aware of a wide range of ES provisioning from TSL for their RCS such as freshwater, wildlife, flooded forest, and fish. This awareness was higher among the farmers from LWL with 80%, compared to 60% in MWL, respectively. However, both values were lower compare to 90% observed in Nigeria (Zhang et al., 2016). It explicitly explained that farmers in the LWL might be closely interacted and depended on the ES from TSL for their RCS while farmers in the MWL did not which relatively similar to a study conducted in Philippines (Lasco et al. 2016) and main areas of European grasslands (Lamargue et al. 2011).

Correspondents in the LWL were more likely to be aware the causes of changing while farmers in the MWL were not widely aware. The linkages between their livelihood and ES in TSL also might highlight their different perceptions of ES. Due to the LWL located very closed to TSL, most of them actively and directly relied on those ES which led them to well recognising the causes of changes.

CONCLUSION

Land-use systems in floodplain of Tonle Sap Lake (TSL) were changed resulting particularly in vast deforestation and replacing traditional rice varieties practices in past decades, then to modern rice cropping systems mainly for the household's improvement and Cambodian country's economy. Such changes also affected the TSL'ES and profitability of particular systems. ES variation affected the households' livelihood particularly the poorest households in the floodplains. Changing of the RCS

provided highly negative impacts on ecosystems in TSL, using high chemical fertilisers, pesticides and herbicides among inputs. Farmers were more vulnerable and prone to high risk for their RCS due to low adaptive capacity, lack of supplementary irrigation systems and explicit reliable sources of metrological information to confront with ES and recent climate change. Majority of farmers in both study sites perceived ES of TSL as important directly to their RCS and other fishery resources provisioning to their livelihood. The more closer people to TSL basin, the more they relied on the ES. However, not all of them perceived that ES provided by TSL are important to them while those ES changed particularly flood pulse which in particularly year their RCS were seriously damaged by flooding. Moreover, they were aware about the changes in freshwater, fish, wildlife, and flooded forest, but farmers in LWL were aware the causes of change of ES higher than farmers in MWL due to their closely interaction between ecosystems in TSL.

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