Chapter 4 | Multiscale Gaming Methodology

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Abstract

In Southeast Asia, the rapid expansion of boom crops like hybrid maize, rubber, oil palm, or banana, has brought about daunting environmental and socioeconomic impacts such as deforestation, land degradation, and indebtedness. Why do farmers engage in and keep on pursuing this farming strategy despite the adverse effects on local landscapes and livelihoods? In the context of the northern uplands of Lao People’s Democratic Republic (Lao PDR), we developed an innovative approach to understanding the decisions that lead to the emergence of the maize boom. We successively studied the adoption, expansion, intensification, diversification, and abandonment of intensive maize practices in locations in which these phases were ongoing at the time of study. To better contextualize decision making, we designed and applied local, serious games with farmers in seven different villages that were going through a maize boom. Then we designed a metagame that summarized our findings across all decision phases and local games in a generalized form. National agricultural experts validated the structure of the metagame by taking on the role of farmers and they witnessed that their cumulative decision making within the metagame lead to a maize boom too. Core findings include: (1) the maize boom and bust can be reproduced in a game environment that simulates the change of six factor combinations; and (2) Farmers in northern Laos reinvest maize profits into their long-term, socioeconomic goals. The approach presented combines micro- and macrolevel analysis of land-use change. On the one hand, it allows the exploration of the local, social-ecological contexts of land-use decisions. On the other hand, it provides a systematic procedure to scale up, generalize, and test the contextual knowledge and systemic understanding of a complex, large-scale land-use change process.
4.1 Introduction

4.1.1 Boom Crops as Drivers of the Agrarian Transition
The agrarian transition in Southeast Asia is a long-term and large-scale process of social-ecological transformation. It is often referred to as a shift from a subsistence-based to a market-oriented economy and society (De Koninck 2004, Messerli et al. 2015). Although this may sound like a single trajectory on the macrolevel, it is rather a cumulative effect of multiple, locally specific trajectories (Castella 2012). The variety of trajectories of land systems emerges from overlapping processes of urbanization, market integration, and commodification of labor and land, which occur in different historical and geographic contexts (Lund 2011). Land use conversions of slow and fast nature take place; these include gradual, incremental changes that slowly advance market integration as well as abrupt, profound changes that accelerate the transition process (Müller et al. 2014).

Crop booms are abrupt land use changes that accelerate the agrarian transition. They have appeared repeatedly in different countries of Southeast Asia and are driven by the international market demand of land-based commodities such as palm oil, rubber, banana, coffee, or hybrid maize (van den Top 1995, Fox and Castella 2013, Cramb et al. 2017). Within a decade or less, a particular crop expands rapidly and can quickly disappear again. Hall (2011) defined crop booms as fast increases in the amount of land that is devoted to the production of high value crops through monocropping. Building on this definition, the change of cropping area in a commodity boom can be linked to and conceptualized as a series of decisions by farmers to adopt, expand, intensify, diversify, and abandon a cash crop. Each decision bears consequences for the whole land use at the household, village, or regional level. Although crop booms bring economic growth on an aggregate level, they can also foster land degradation and inequality, e.g., between early adopters and others (Rigg and Vandergeest 2011, Byerlee 2014, Cramb et al. 2017).
Both large agribusinesses and smallholder farmers have engaged in crop booms (Hall 2011, Cramb et al. 2017). The surge of largescale land acquisitions for cash crop production, particularly in the last decade, has been in the spotlight of media and research communities as drivers of land use change and the commodification of farming (Rulli et al. 2012, Heinimann and Messerli 2013, Kugelman 2013, Hirsch and Scurrah 2015). However, in many situations smallholders can also be collectively responsible for large-scale and rapid deforestation. They expand cash cropping onto land that was previously used for shifting cultivation, agro-forestry, or other types of forest cover (Vongvisouk et al. 2016). Despite the risks to their livelihoods and environment, smallholders are attracted by the lucrative opportunities of boom crops.

A recent case of a crop boom occurred in the northern uplands of Lao People’s Democratic Republic (Laos). Lestrelin and Castella (2011) reported that maize production has skyrocketed from the early 2000s and stemmed mainly from the work of smallholder farmers (hereafter referred to as either farmers or smallholders). The boom was triggered by the introduction of new hybrid maize cultivars and the opening of cross-border trade in response to high market demand in the neighboring countries, Thailand, Vietnam, and China in which the maize was used as feed for the expanding livestock industry (Thanichanon 2015). Although the new cash crop created opportunities for farmers to generate higher income, it involved risks of becoming indebted to input suppliers and/or dependent on maize market fluctuations and export prices. The expansion of maize monocropping resulted in land degradation including deforestation, loss of biodiversity, nutrient depletion, soil erosion, and chemical pollution due to herbicides and fertilizers (Lestrelin 2010). On top of that, staple crop production was affected because the soil eroding from the sloping maize fields accumulated in paddy rice fields after heavy precipitation and thus clogged the irrigation channels (Castella 2012).
4.1.2 Studying Land Use Decisions in Crop Boom Trajectories at Local and Regional Levels

Approaches to better understand the phenomenon of crop booms need to address different spatial scales, because of the complex interplay of underlying processes, the high diversity of local trajectories, and the fast pace of change. We identified three levels to study land use change in connection with the agrarian transition and crop booms: (1) the transformation of socialecological systems at the regional level, consisting of (2) land use trajectories at the community level, which emerge from (3) decisions at the individual land user or household level. At the regional level, the role of human agency in land use change patterns and processes was traditionally approached from an outside, regional scale perspective of aggregated human influence, such as changes in population density (Hersperger et al. 2010, Verburg 2014). When behavioral economics and psychological disciplines were integrated into the field of land use science, microscaled approaches were incorporated to get an insider view of the systems, with questions such as “Why and how did the land user decide on this option?” (Moran 2010a). A methodology to combine views on crop booms from both inside and outside, from the micro- and macroscales would shed light on how smallholders created the macrolevel phenomenon of crop booms with their land use decisions.

Among disciplines studying decision making, there is largely consensus about the key role of the immediate context within which choices are made. According to Moran (2010a) and Stern (2000), several psychological theories postulate that “environmentally relevant behavior lies at the end of a long causal chain of factors and the most notable key to behavioral change is the immediate context of behavior, and not deeply held values” (Moran 2010a:40). Rather than looking in depth for cultural differences, we directed our attention toward immediate contexts and path dependency. For example, the immediate context could be the options available at the time and place of a decision and path dependency could come from earlier decisions and contexts that serve as the basis for today’s decisions.
Capturing the diversity of contexts and histories of land use decisions while scaling up and generalizing findings is challenging and resource intensive. Approaches that satisfy both needs are scarce. Synthesis methods, such as meta-analysis of case studies, are cost-effective and can contribute to the upscaling of findings on land use decisions (Castella et al. 2012, Magliocca et al. 2015, van Vliet et al. 2015). However, time lags between the publication of a sufficient number of case studies and completion of the metaanalysis amounts to several years after which the crop boom may already be over. Furthermore, high heterogeneity in the quality and accuracy of context description in the literature underlying meta-analysis tends to diminish the explanatory value of local land use decisions.

(Serious) games allow for much contextualization and are open to perspectives by participants that researchers might oversee as a result of predetermined research designs (D’Aquino et al. 2003, Castella et al. 2005). These games have become popular as a main ingredient for participatory research approaches (Barreteau et al. 2003). Like other participatory approaches, serious games can be used to engage and empower local communities (D’Aquino et al. 2003, Castella et al. 2014, Perrotton et al. 2017) or to elicit local knowledge and decision-making processes (Castella et al. 2005). However, because of this focus on context, games are rarely considered for synthesis purposes.

Our objective was to develop and apply a novel empirical approach for (1) gaining insight into the history and immediate contexts for the decisions of smallholders at the household and village level and (2) to synthesize these insights to the main factors at the regional, emergent level of the maize boom in northern Laos. Thereby, the method had to bridge multiple spatial scales and allow for the observation of a variety of contexts that influence farmers’ decision making, i.e., socioeconomic, environmental, technical, economic, and, to some degree, cultural factors. We present a newly developed
methodology that employs games to both understand the immediate context at
the local level and to synthesize these contextual findings at the regional level.

4.2 Methodology

We developed a new approach called multiscale gaming that allows, on the
one hand, the study of local, social-ecological contexts of land use decisions,
and, on the other hand, it provides a systematic procedure to scale up and
generalize contextual findings toward the regional, emergent level of a large-
scale land use change process.

Serious games play a central role in this approach because of their flexibility
and the fact that they can be designed for different purposes. They combine
entertainment or playfulness with a more serious, problem-driven, and
oftentimes educational purpose (Sawyer 2002, Voinov et al. 2016). Mediums
and designs vary greatly because they range from fully computerized video
games to analogue, or hybrid versions with, for example, a board game being
coupled to an agent-based simulation model (Le Page et al. 2016). Klabbers
(2009) discussed principles underlying games in depth and suggested that
independent of the instrumentality of games, they, at the very minimum,
“include actors, rules and resources” (Klabbers 2009: xv). However, there is
no consensus on a single definition of serious games (Crookall 2010). Our
entry point to games as a methodology stems from the companion modeling
approach, which was developed to understand the complexity of social-
ecological systems and to advance natural resource management (Barreteau et
al. 2003, Bousquet et al. 2005, Campo et al. 2010). However, we harnessed
serious games not only to explore dynamics within social-ecological systems
(Speelman et al. 2014), but also to generate and test hypotheses on land use
decision making (Anderies et al. 2011, Garcia-Barrios et al. 2015). The serious
games in this study were analogue, simplified versions of a land use situation
represented by tactile objects, rules, and roles. They were spatial (board
games) or nonspatial (card games, role playing) and varied in the number of variables (complicatedness) they represented. In essence, the serious games functioned as boundary objects between respondents and researchers and stimulated focused discussion of concrete land use situations (Bourgoin et al. 2012).

4.2.1.1 Overview of the multiscale gaming approach

The approach is called multiscale gaming for brevity, but beyond games, it entails a sequence of methods that complement each other (Figure 4.1). Starting with a view on the entire crop boom at the regional level, we selected a number of field sites that provided insights into each of the successive phases in the boom trajectory. Each phase corresponded to a specific land use decision. Because crop booms are not happening simultaneously in all

![Figure 4.1 Multiscale gaming methodology.](image)

Systematic case study selection at the regional level is followed by field studies at the local level, which each represent different decision stages. Metagame represents the findings from the local level in a generalized form and can be validated in a serious game workshop with stakeholders.
locations of a region, it is possible to study villages that are at the beginning, in the middle, or at the end of the maize boom.

At the local level, we carried out a series of methods that we refer to as field studies. In each site, we started with a focus group discussion with members of the village committee to reconstruct the village history related to hybrid maize. This initial, collective step was followed by interviews with several individual villagers about their household’s history and current situation. Based on the information from the focus group and interviews, we defined one or two research questions to be explored for the respective village in a serious game or workshop element. Subsequently, the research team designed the games in situ within a few hours and held a serious gaming workshop to which we invited a socioeconomically diverse panel of farm households.

After completion of all the field studies, we designed a metagame that summarized our findings across all decision phases and local games. The building process of the metagame forced the research team to distill and formalize the common factors from the single villages' and households’ narratives. The metagame session with experts as players served as an experimental space to test whether the observed and generalized narrative would let them create a maize boom with their decisions as well.

4.2.1.2 Selection of case study villages

The conditions and timing of the maize boom vary widely in northern Laos. In some places, diversification and abandonment had already been observed, whereas others had just passed the adoption phase during our field studies between November 2015 and January 2016. To study each of the five land use phases, we tried to identify places in which those decisions were being made at the time of surveying.

To help us find and select appropriate villages, we organized a participatory workshop with eight researchers from the Department of Agricultural Land
Management (DALaM - Ministry of Agriculture and Forestry of Lao PDR) who worked with the EFICAS Project (Eco-Friendly Intensification and Climate resilient Agricultural Systems). They had a long work experience in 44 villages in the northern uplands of Laos. On a two-dimensional graph, the experts located the relative position of these villages along gradients of market accessibility and land degradation (see result in Figure C 1).

Based on this initial assessment and by cross checking with the Lao agricultural census data 2011 (available at www.decide.la), the whole group of experts, including the authors, selected seven villages that were expected to represent the different conditions and phases in the maize boom trajectory: Houaykai in Luang Prabang Province, Homephan and Phoun-neua in Houaphan Province, Laeng and Namen in Xiengkhouang Province, and Mayphonexai and Namgnang in Sayaboury Province. In Figure 4.2, we locate these villages and we present further details and characteristics of the selected study sites in Table 4.1.

<table>
<thead>
<tr>
<th>Nr.*</th>
<th>Village</th>
<th>Province</th>
<th>District</th>
<th>Agricultural population**</th>
<th>Physical characteristics</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Houaykai</td>
<td>Louang Prabang</td>
<td>Vienkham</td>
<td>387</td>
<td>upland, water scarcity</td>
</tr>
<tr>
<td>2</td>
<td>Homephan</td>
<td>Houaphan</td>
<td>Houameuang</td>
<td>495</td>
<td>upland</td>
</tr>
<tr>
<td>3</td>
<td>Phoun-neua</td>
<td>Houaphan</td>
<td>Viengxai</td>
<td>288</td>
<td>upland, plateau, moderate slopes</td>
</tr>
<tr>
<td>4</td>
<td>Laeng</td>
<td>Xiengkhouang</td>
<td>Kham</td>
<td>578</td>
<td>upland, water scarcity</td>
</tr>
<tr>
<td>5</td>
<td>Namen</td>
<td>Xiengkhouang</td>
<td>Nonghaet</td>
<td>602</td>
<td>plateau, moderate slopes</td>
</tr>
<tr>
<td>6</td>
<td>Mayphonexai</td>
<td>Sayaboury</td>
<td>Boten</td>
<td>988</td>
<td>slopes, erosive soils</td>
</tr>
<tr>
<td>7</td>
<td>Namgnang</td>
<td>Sayaboury</td>
<td>Paklai</td>
<td>1281</td>
<td>plateau, gentle slopes</td>
</tr>
</tbody>
</table>

* indicates chronology of survey missions.
** source: Lao national agricultural census 2010/11.
4.2.1.3 Field studies

In each of the seven villages, we used a sequence of three consecutive steps (Figure 4.1). First, we conducted a focus group discussion with the village committee (7 to 10 persons depending on the village size) on the historical and current land use of the village. Second, we interviewed individual farmers on their household composition, production patterns, land use history, their objectives and constraints, and how these parameters influence decision making. Third, we designed a serious game that specifically targeted the issues the research team prioritized based on results of the focus group and interviews. On the same evening or the day after, we applied the game as part of a participatory workshop with a group of household heads.

To select a varied set of participants, we performed a principal component analysis (Pearson 1901, Wold et al. 1987) to capture each village’s distinct

Figure 4.2 Location of selected case study sites for field survey (incl. local games) in northern Laos.
diversity of wealth, forms of land use (not all had access to paddy or had
dedicated livestock grazing areas), and age groups (< 30 years, 30 until the
mean age, mean age until oldest). Data from household surveys of the
EFICAS project between 2011-2014 formed the basis for this analysis of
three-four distinct farm types. From these farm types, we then randomly
selected 12 farm household heads in total and invited them for the game
workshop. In Laos, the heads of households are currently mostly male. An
important part of the game were the debriefings, both collectively with all
participants and individually through in-depth interviews of selected players.
The field studies were carried out by a team of two researchers (first two
authors of the paper), a native translator, a Lao agricultural technician, and a
different district extension agent in each target district.

4.2.1.4 Focus Group Discussions

Focus group discussions served to reconstruct the village land use history
starting from the time when the farmers first grew hybrid maize. We invited
the village committee and influential farmers, for example, those who
pioneered with the crop. While facilitating the discussions, we documented
and visualized the obtained information on posters to gradually enrich the
overall picture and stimulate reactions from the participants.

The focus group discussions were used to verify/falsify the village’s phase
within the boom in relation to the hypothesis prevailing during the site
selection. We also asked for information on the main crops (upland rice, paddy
rice, maize, and other cash crops) such as area, production, yield, labor, input
costs, and use of herbicides, fertilizers, and machinery. Land use change,
livestock dynamics, and other income generating activities (e.g., non-timber
forest product collection, off-farm activities) were also investigated during the
years 2000 to 2015.

This information was cross-checked with other sources of data such as
qualitative individual interviews done later on, quantitative household surveys
from the EFICAS Project, and secondary data from the district offices and Lao national agricultural census of 2011. We also asked about changes in prices and trading relations, access to credit, road construction, local policies, extreme weather events, and future aspirations of the community. During the discussions, participants brought up additional issues such as clogging of irrigation channels in paddy fields from soil erosion of maize fields, livestock diseases, damages to crops from freely roaming livestock, or the violation of contracts by traders. Overall, the focus group discussions helped the research team to prioritize the problems at hand and also to collect parameters for the local game.

4.2.1.5 Local Serious Games

Based on the previous two steps, the team of researchers and local technicians specified questions regarding the situation of the village that could be explored in a serious game. Within a few hours up to one day, we developed a game that was specific to the village case. The materials for the games were designed and crafted by the team using simple artifacts such as posters with a grid to represent the space of the village, color cards to represent different land uses, tokens to represent people, labor force, or livestock, etc. The gaming sessions took two to four hours and included: (1) an introduction, (2) a few rounds of the game corresponding to cropping years or successive decisions, and (3) collective and individual debriefings to relate the game to the village’s and individual participant’s realities.

During the development of the methodology, we learned that the initial rounds are the most important to observe. When the same participants play the game several rounds, they develop more informed decision strategies. Because our main objective is to elucidate decision mechanisms as close as possible to reality in a crop boom (i.e., a situation of high uncertainty, high time pressure to seize opportunities, and poor understanding of the consequences of the decisions), we were only interested in the first few rounds of the games and,
most importantly, in the player’s comments and debates arising during these first rounds.

During the collective debriefing, we used elements of the game and posters on which we noted the individual and collective game results to ignite discussions on the choices made by participants during the gaming session. We brought in observations that we made before and during the game and asked for the participants’ views and reasons for their decisions during the gaming sessions. The individual debriefings were carried out through semi-structured interviews with three to four players, who came up with assertive ideas and behavior or interesting comments during the game. Immediately following the gaming session or the next day, we interviewed them at their houses, separate from the group to avoid a self-censorship effect. The interviews lasted one to two hours during which we assessed how the players understood the serious game and how their actions in the game related to their reality.

4.2.1.6 The Metagame

After the field studies were complete, we aimed to bring all decisions along the maize boom trajectory into one metagame that contained and represented the essential findings from the field studies and the local games. The process of conceptualization, parameterization, and physical construction of the metagame was essential for us to formalize the knowledge we gained from the field studies into a consistent, testable framework. We then held sessions of the metagame with experts to share our understanding of the generalized system in a way that let the experts experience what it’s like to be a farmer in the maize boom. These metagame sessions were also intended as an experimental validation of the concept behind the game, i.e., to see whether the experts’ land use decisions would cause a boom-bust land use trajectory.

After a calibration test with university students from the Faculty of Environment of the National University of Laos, we played the metagame with six Lao agricultural experts of DALaM who each represented one farm
household. To enrich the learning process, we invited four researchers from different disciplinary backgrounds as observers. The debriefing consisted of a collective round of discussions, interviews with the two experts who played most differently, and a short questionnaire that was filled in by the observers during and after the metagame.

4.3 Results

4.3.1 Field Studies

4.3.1.1 Land Use Trajectory, Decisions, and their Context

Phoun-neua village has gone through the whole maize boom and bust (Figure 4.3). The farmers adopted hybrid maize in 2008 when the first Vietnamese maize trader offered hybrid maize as an opportunity to generate income. This trader also provided credit to villagers for building a four kilometer-long

![Figure 4.3 History of hybrid maize cropping in Phoun-neua village.](image)

For comparability of different units, the changes of agro-economic parameters are shown as a change index relative to the start of hybrid maize cropping in 2008.
“feeder” road with an excavator. Such roads are narrow, unpaved tracks dug on the hillsides and are just sufficient to reach remote areas of the village territory, with a tractor to till the land, trucks to bring the seeds and pick up the harvest, or motorcycles to bring people to work on the land.

These roads feed maize expansion by improving the accessibility to land that was formerly used for shifting cultivation to grow upland rice. In 2009, the roads were built and the maize area and production had doubled. Production peaked in 2012, when a second feeder road was opened.

Even though the villagers still expanded the maize area in 2013, the total production plummeted in that year because maize yields decreased in connection with soil erosion, weed infestation, and nutrient depletion after successive years of monocropping. In the following years, the maize area declined despite a steady upward trend of maize prices. Because farming practices are essentially manual (low degree of mechanization), household strategic choices are strongly related to labor requirements hence family composition. In a young family with newborn children, less area was cropped with maize, especially due to the efforts that manual weeding takes without the use of herbicides. The district authorities exerted strict regulations on maize cropping by prohibiting the use of herbicides and chemical fertilizers and allowing only one authorized trader. The trader they were assigned to was unreliable and uncooperative. These conditions further diminished the attractiveness of maize cropping and villagers had almost fully abandoned maize in 2015.

The bust phase of maize in Phoun-neua was accelerated by traders from Vietnam, who offered a new market opportunity for bamboo stems and shoots that had to be harvested from the community forests. Bamboo harvest fitted well with the agricultural calendar because it complemented labor requirement peaks for annual crops. The construction of additional feeder roads to bamboo forests was facilitated by credits provided by bamboo traders, and good prices
were promised thanks to the support of an international NGO. As a result, bamboo collection quickly skyrocketed until it was abruptly stopped by Prime Minister decree No. 15/PM dated 13 May 2016, which strictly banned the export of unprocessed forest products. From 2013, a few villagers expanded their paddy area when the opportunity to terrace individual paddy fields on credit was offered by a local entrepreneur, and village regulations were amended to make individual paddy area allocation possible. Other investments were reported to be directed at children’s education, vehicle purchase, and most notably, at livestock systems.

4.3.1.2 Local Serious Games

Based on the village trajectory, we designed a serious game for Phoun-neua to explore what the farmers invest in after making profits from maize cropping. A description of the resulting game named MIALU, maize investments and alternative land uses, is given in the Appendix, Table C 2. In the MIALU board game, a virtual village landscape is represented on a grid of 10 x 10 cells with a village center, protected forest area, forest fallow, and current upland and lowland land uses of Phoun-neua including upland rice, maize, and paddy rice. Twelve participants were invited to be players of six game households, i.e., two participants, belonging to different households in reality but with similar socioeconomic conditions, were assigned to a game household. The intention underlying this set-up was to make the decision-making process more easily observable for the research team, as each pair of players would be stimulated to discuss their thoughts aloud.

There were three different types of virtual farms to which we assigned the participants according to their real socioeconomic backgrounds as identified in the principal component analysis (family composition, wealth, farm activities). An initial land use setting was provided with equal conditions for each farm type. The initial number of plots per household was determined by the area a household could manage with its available labor force. In each round, the participants decided how to manage their land and what to buy with the money
they made. Before the start of the first round, we asked the participants to verify and complement the parameters about land uses and items available on the virtual market. New land uses or products in the income-investment cycle were integrated into the MIALU game when brought up by the players, e.g., bamboo, feed for livestock, fishponds, teak, and fruit trees. Communication among participants was encouraged throughout the game. The facilitators and coplayers provided help in case of difficulties in understanding the game. We played two rounds of field allocation and three rounds of investment decisions.

In the first round of the MIALU game in Phoun-neua, the players searched for alternative land uses and income sources to maize cropping and had almost abandoned it fully by the second round. In the first round, four households invested in the education of their children, three chose to open new paddy fields or to expand existing ones and/or invested in livestock, while one bought fruit trees, and one purchased a motorbike. In the second round, several households chose to mechanize and increase mobility (e.g., hand tractors, threshing machine, motorbikes), two thirds invested in livestock, and one third invested in setting up off-farm activities, i.e., a small shop and weaving. In the third round, one household brought up the idea of digging a fishpond, another opened a savings account at the bank, and another household built a road to a newly opened paddy area.

After the game, participants discussed their specific decisions in relation to reality. Almost every player expanded paddy areas during the game, reflecting the recent trend of paddy terracing in Phoun-neua, with a 62% increase of 5.3 ha between 2012 and 2014 from the initial 8.5 ha. Furthermore, the money from cash crops was used for daily family expenses and children’s education. As smallholders abandoned maize, they would also be willing to expand livestock farming in the uplands or adopt a new cash crop following the demand of the market. Individual players mentioned that they decided to invest in livestock, teak, and fruit trees given the decrease of available labor force as they advanced in the family cycle, i.e., ageing of household heads,
children being away at school, or children creating their own households when adult.

Individual debriefings revealed that the farm households abandoned maize (in their real lives) due to both gradual yield decreases and the instability of the market outlet (i.e., delayed collection of harvest by traders and lower prices than promised in the contract). Also, the hybrid maize seeds, which had to be bought every year, created a dependency on a particular trader, unlike with other crops. Moreover, Phoun-neua’s farmers did not experience the labor-saving effect of tillage (slopes are too steep for a tractor to till) or herbicide (a ban is enforced by district authorities). Instead, villagers seized the rising bamboo growing opportunity as a replacement to hybrid maize, accelerating
the abandonment phase of the village maize trajectory. The respondents claimed that their investment decisions in the game largely reflected their reality. They paid for their children’s education, expanded paddy, and wished to take on new cash crops and expand livestock activities. Reinvestments of profits from maize to paddy terracing were explained by respondents as a way to secure land rights and rice self-sufficiency. Furthermore, they obtained better returns on labor and land with rain-fed lowland rice than with upland rice from shifting cultivation.

Addressing similar research questions to Phoun-neua, we also used the principle design of MIALU in Homephan and Laeng villages. In addition, five local games of different natures, addressing different land use decisions along the maize boom and bust trajectory were designed and applied in the remaining four villages (Table 4.2). Detailed descriptions of the local games are available in the Appendix, Table C1 – C6.

4.3.2 The Metagame

The concept underlying the metagame is a result of the synthesis process of the field studies. To build the metagame, we distilled the essence of what we observed in all field studies and arrived at a set of six overarching factors that influenced the land use decisions from a farmer’s perspective. The variation of these factors over time forms the conceptual basis for the design of the metagame (Figure 4.4). The metagame, named mahasaly, Lao translation for higher level (maha) maize (saly), represents the research team’s understanding of how the maize boom emerged from smallholders’ individual decision making.

4.3.2.1 Factors Influencing Land Use Decisions

Based on findings from the field studies, we formed the following generalizations about farmers’ motivations, attitudes, behaviors, and perceptions.
First, the underlying motivation in all stages of the boom is to maintain and improve family well-being in the short and long term. Second, most farmers react to opportunities they perceive and compare them to the available alternatives. Third, risk regarding crop yields, livestock diseases, market prices, and trader’s reliability is omnipresent in farming. Risk avoidance or inversely, the search for stability and security is a key attitude. Fourth, farmers’ perception of the availability of suitable land for maize cropping may stimulate or withhold strategic land use decisions. Fifth, interactions between farmers take place in the form of imitation and less like an active coordination, negotiation, or collaboration. Farmers reported to hardly gathering to exchange information or to set up collective, concerted action, e.g., to address that soil erosion from upland maize fields causes siltation of irrigation

Figure 4.4 Factor combinations that build the context for farmer’s decisions in the maize boom and bust.
This is the narrative/conceptual model underlying the metagame mahasaly. Solid line = factor present; dashed line = factor may or may not be present yet/anymore.
channels in rice paddies (Namen village). We did observe some elements of consultation both in the local games and real life. Where Lao Lum ethnicities prevailed, farmers coordinated to improve livestock management and prevent free roaming animals from eating cultivated crops. However, imitation behavior has been both reported by participants themselves and observed in local games, focus groups, and interviews multiple times, and we suspect that this may be the most common way of interacting. The economic factors (including perceived opportunities and risks) largely prevail over the cultural ones in influencing the successive decisions along the maize trajectories.

In line with these generalizations, six factors crystallized based on the findings from the field studies. The sequence of factor combinations over time constitutes the narrative we distilled and illustrates the changing contexts regarding maize cropping from the perspective of farmers (Fig. 4). First and foremost, the existence of a market outlet was put forward by many respondents as the key factor to their decision to adopt the new cash crop. Many respondents expressed this as: “we can produce anything provided there is a market for it!” Farmers from Phoumnoua and Houaykai regions, for example, explained that they do not grow certain crops (e.g., soybean) “because no trader asked for it.” Second, trust in the trader’s reliability and the market stability of a commodity is of high interest to the farmers, i.e., low price fluctuations when supply increases (a key finding from TAKIT game). In Namgnang, for example, farmers had recently adopted Job’s tears’ crop (Coix lacryma-jobi), another cereal boom crop used generally for food, drinks, and medicinal or ornamental purposes. The area cropped with Job’s tears was not expanded because the prices fluctuated too much, according to the farmers. Third, feasibility is a cumulative term for the farmer’s ability to grow a crop with respect to labor and mechanization requirements, knowledge on the crop’s needs and growth process, financial input, and accessibility of fields. For example, several players mentioned their old age and too little labor capacity as reasons against certain land uses. Fourth, land quantity and quality involve access to sufficient suitable land. It is separated from the other farm
household’s feasibility variables because land scarcity can trigger intensification (because there is too little land to expand into, the available land is used more intensively to meet the demand), even if there is still enough labor capacity to expand maize cropping. The lack of sufficient suitable land is also a consequence of intensive maize cropping, which quickly degrades soil. Land degradation becomes an essential factor that contributes to diversification and abandonment decisions. Fifth, the expected profitability (net revenue) of the boom crop depends on maize price, on crop yield, and on input costs (seeds, herbicide) or reimbursement of credits. Sixth, the availability of a competitive alternative can change the view on a boom crop entirely. It can prevent a boom and cause early diversification or facilitate the bust and make a shift away from maize possible (e.g., TAKIT game in Namgnang and bamboo as an alternative to maize in Phoun-noua). In turn, the lack of a competitive alternative can cause a prolongation of the boom despite the farmer’s willingness to abandon maize or diversify. Individual debriefings in Homephan, Laeng, and Namgnang revealed that farmers wished to stop with maize because they perceived the adverse effects on their land. However, they saw no real alternative income that could support their families.

4.3.2.2 The Metagame Session

The metagame mahasaly incorporates elements of structure, parameters, and lessons from the six local games presented in Table 4.2 and Appendix C. We provide a detailed description of the rationales for the development of the metagame and a brief description of its rules in the Appendix C2 and Table C 7.
When the experts took on the role of farmers in the mahasaly game workshop, their decisions in the game resulted in land use changes that cumulated in a typical boom and bust shape (Figure 4.5). In the metagame, the factors that are relevant for the player’s decisions (e.g., the set of available land use options) varied over time according to the generalized narrative (Figure 4.4). Hence, our understanding of the key decisions in the boom trajectory was confirmed.

Figure 4.5 Results of the mahasaly metagame session with experts. The top graph shows the cumulative land use changes of all players, whereas the bottom graph displays the spatial changes on the game board. How game facilitators changed the conditions for all players (e.g. arrival of different traders) is indicated with each round (compare with Figure 4.4).
Maize was adopted as soon as the opportunity arose on the market: five out of six players immediately engaged in maize cultivation with at least one plot of maize in the following year without knowing about the stability of the market.

The expansion phase followed, albeit at a moderate pace and magnitude. Revenues from the first round were invested into paddy terracing. Many players kept on investing in livestock/pasture despite two disease outbreaks. A poor game household without paddy continued with upland rice because, for the player, maize was too input intensive (factor feasibility) and connected with adverse effects. The expert playing this household recalled memories from the experiences in his own province (Sayaboury).

Intensification did not occur during the metagame because there was still much fallow land available. Participants could have selected intensive cropping systems, but, as they were not constrained by land scarcity, they felt intensification was riskier than diversifying. This reflects the reality of Lao uplands, in which lower population density and less agricultural pressure than in neighboring countries prevails.

The participant’s priority of diversification over intensification between rounds four and five was also a response to (1) contract breaking by the maize trader, (2) appearance of cassava and Job’s tears as two new competitive alternatives, and (3) interest in livestock-pasture as another strong alternative. Throughout the whole metagame, the players diversified their land use portfolio, leading to a gradual decrease in maize areas.

4.4 Discussion

4.4.1 Advantages and Constraints of Multiscale Gaming
The approach we developed and applied in this study meets two challenges that are very common in social-ecological systems research. The first
challenge is to capture contexts of farmer household decision making in real-time and place. The second challenge is to generalize across these contexts and identify the most relevant factors influencing the decision makers over time at the emergent level of the system (Janssen and Ostrom 2006). The multiscale gaming methodology provides the research design needed to explore contexts (field studies, local games) as well as generalize and test the knowledge gained (metagame).

The novelty of the methodology is based on three components. First, there must be a careful selection of case study sites, which are expected to represent the successive stages of the maize boom trajectory. This is a prerequisite to later be able to generalize local contexts. The second component is the use of serious games for each decision phase within the maize boom. They are adapted to the local context on the basis of focus group discussions and individual interviews, which provide insight into the village history and diverse household trajectories, respectively. The third component is a metagame that summarizes, generalizes, and tests the knowledge on contextualized decision behaviors over all decision phases from adoption until abandonment.

Conventional methods to empirically study land use decisions at the household level include questionnaire surveys, laboratory and field experiments, or case studies that test a certain theory (Janssen and Ostrom 2006). Furthermore, meta-analyses are synthesis methods for uncovering insights over larger regions and/or specific land-change processes (van Vliet et al. 2015, Hettig et al. 2016).

The multiscale methodology offers several advantages over these methods.

First, it covers a sequence of decisions that influence each other and are path dependent. In a recent meta-study, Hettig et al. (2016) found that most studies investigating household decision making in the tropics only covered one
decision situation in isolation. Multiscale gaming offers new opportunities to take path dependency and a whole narrative of decision making into account.

Second, the methodology is flexible to the context of each site. Hence, all questions, topics, and factors that are relevant at the moment and location of the study can be considered if they are raised by the respondents or observed by the research team. In more rigid methods, such as questionnaires and experiments, the questions have to be formulated beforehand to guarantee comparability for statistical testing.

Third, the approach asks for participation and validation by the respondents in the games of the field study and the metagame.

Fourth, the multiscale gaming approach does not control for or reduce context like in experiments; rather, it tries to be open to capture diversity and combination of contextual factors.

Fifth, the multiscale gaming approach is fast. We arrived at synthesized knowledge within half a year, whereas the research process from case studies to synthesis in meta studies takes up several years or decades before sufficient material is available from the literature to conduct a systematic review. Sixth, it provides researchers with the opportunity to share their system understanding with stakeholders in an experiential way. Concrete experiences are made by the players, observations are reflected upon, and active experimentation on abstract concepts, such as the maize boom, becomes possible (Dieleman and Huisingh 2006).

Finally, games make it possible to formalize mental models (Anderies et al. 2011). The multiscale gaming method operationalizes the mental model of the researchers by forcing them, during the design of the metagame, to make their understanding of the links, causes, and effects within the system explicit. They need to represent their system knowledge by defining concrete roles, relations
of different prices or resources, and a clear narrative. Thereby, the metagame encapsulates both qualitative and quantitative research findings and serves interdisciplinary research efforts.

The game sessions, and especially the debriefings, allowed the players to validate or correct the researcher’s system understanding. Consequently, the games are built-in instruments of validation.

As with other methods, the multiscale gaming approach is also subject to a number of constraints. The number of people who can attend a game session is limited. Therefore, statistical tests on the results of single sessions are hardly meaningful because the sample size of players per session is too small. More in-depth discussion of the strengths and weaknesses of serious games as a methodology is provided by other authors (Barreteau et al. 2003, D’aquino et al. 2003, Étienne 2011, Speelman et al. 2014, Le Page et al. 2016, Perrotton et al. 2017).

Our selection of household interviewees was intended to be representative of the diversity of livelihoods. For practical reasons and availability of interviewees, this could not always be fulfilled. We recommend that researchers pay attention to this point in further applications of this method.

Furthermore, our approach is not suited for an in-depth analysis of cultural dimensions such as deeply held values or gender differences. Although the villages selected for this study represent a diversity of ethnic groups (cf. table 1), we did not find strong evidence that the ethnic background limited or enabled a decision to the same extent as the availability of a market opportunity (contract farming offered by a trader) did. Even if we would have found evidence for cultural differences, the research design for this study’s objective (different decision phases) does not provide firm grounds for conclusions about cultural aspects because this would have required a research design in which different ethnicities could be compared within the same
decision phase. Nevertheless, during the course of the field studies, we did ask a few probing questions on women’s roles in household decision making. Respondents reported that strategic decisions like those in the maize boom are usually discussed between the couple.

The multiscale gaming approach contains several participatory elements that are inspired by and belong to the methodological family of rapid rural appraisals (RRA) and participatory rural appraisals (PRA). Following the classification by Chambers (1994), the multiscale gaming approach is a form of rapid rural appraisal; our goal was to elicit knowledge rather than facilitate change. In the context of this study, we (the researchers) aimed to learn about the system dynamics rather than to empower the local people. A sharp distinction is difficult to make because spillover effects and empowerment may have occurred. However, it is important to note that we did not intend to facilitate change, but to acquire knowledge about the system dynamics that can further be used to co-design interventions toward sustainable land use.

4.4.2 Main lessons

4.4.2.1 Environmental Trade-offs for Long-term Goals

Cropping maize on steep slopes and erosive soils over the course of 10 to 15 years had a substantial impact on forest cover and land degradation of a large part of northern Laos (Lestrelin 2010, Lestrelin and Castella 2011). In this context, scientists consider intensive maize monocropping to be an ecologically exploitive land use that only yields short-term benefits. Our results suggest that farmers invest these short-term benefits on the cost of ecologic sustainability into long-term goals regarding their livelihoods, including education, housing, mobility, farm mechanization, and livestock purchases. Further, they secure access and rights to land through road building and paddy terracing. They also invest capital gained from maize cropping into off-farm activities like buying trucks to gain income from transportation and trading services. Land degradation is recognized by farmers in their real-life
situations, but often not acted upon because other necessities for livelihoods outweigh ecological concerns. These kinds of trade-offs have also been reported for mountainous farming environments in Europe, where farmers intended to support ecosystem functioning, but other, more influential factors (feasibility, profitability) overruled their concerns for environmental degradation (Lamarque et al. 2014).

Findings of local games and interviews in our study suggest that the continued exploitation of land is seen as a bridging strategy until other competitive alternatives become available or feasible. This is especially the case during times when the household is in need of stability, for example when the farmer’s children are still at a crucial education phase.

4.4.2.2 Risk Buffering and Household Life Cycle

More generally, our findings about risk aversion in land use decisions depending on household composition conform to Chayanov’s model of the household life cycle (HHLC). The HHLC model was developed and applied to areas with similar conditions to northern Laos in terms of (initially) relatively abundant land resources, few market opportunities, and a basic, but evolving road network (Walker et al. 2002 after Goody 1958 and Chayanov 1925, 1966).

According to the HHLC model, demographic composition of a farm household plays a central role in land use decisions at different stages of the household cycle, as it progresses from a nuclear to multigenerational structure. In the nuclear stage, the model assumes high-risk aversion to capital intense investments because of a high dependency ratio (several consuming family members supported by few labor units). Hence, annual cropping is favored. In later household stages, lower-risk aversion is assumed because of an increase in the number of labor units and available capital. This favors reinvestment of profits in perennial cropping and livestock ranching. In line with this, elderly participants in several of our local games opted for tree crops, pasture, and/or
invested in livestock. They argued that their reasons were to prepare for their own evanescent labor force while securing their livelihood. Often, they did not expect their children to contribute to the household’s farming activities in the longer term because they supposed the next generation would migrate to urban centers thanks to higher education.

4.4.2.3 Emergence of a Maize Boom in the Metagame and in Reality

In the metagame with experts as well as in the local games with farmers, we found a variety of land use trajectories that were largely shaped by differences in risk taking and, to a certain degree, by differences in household wealth. At the same time, the shape of the boom could be identified at the village level in local games and surveys. This highlights the cumulative effect of individual behaviors. Observers of the metagame noted the lack of interaction between the players during the mahasaly game. We postulate that interactions did take place, but not in the form of active collaboration, coordination, or negotiation. Instead, based on our observations in the field studies and metagame, we posit that imitation of influential farmers or coplayers, respectively, is a passive form of interaction that contributes to the speed of the boom and bust phases. The degree to which social factors like imitation or coordination influences the speed and outcome of the land use change process remains to be investigated.

4.5 Conclusions

The multiscale gaming approach developed in this study is a tool to elicit, generalize, and share insights from local, microlevel, land use trajectories (i.e., household, village) and their impacts on regional, macrolevel, social-ecological system dynamics. Beyond this, repeated metagame sessions could be used as a learning tool for stakeholders to go through the experiential cycle of the maize boom and bust. The participants of a metagame session would learn by doing without the large environmental and socioeconomic losses that a maize boom can cost in reality. Extension agents who advise and inform
farmers in their decision making would benefit from such gaming sessions. Moreover, the metagame is a tool for researchers to organize, share, and validate their knowledge through interactions with other stakeholder groups such as policymakers.

Our study suggests that the timing of competitive alternative land uses can bifurcate unsustainable trajectories and lead to land use diversification. To inform strategic land use decisions in boom prone areas, we suggest assessing (1) the full set of available land use options perceived by affected farmers, (2) the perceived feasibility, and (3) the perceived profitability of each option. Finally, imitation behaviors as the prevalent (but not only) form of interaction in the decision-making processes should receive more attention in land use planning, development programs, and research agendas. To learn how a crop boom could be avoided, the metagame could help to explore the effects of alternative individual behaviors at the microlevel or alternative policies and intervention mechanisms at the macrolevel.