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Chapter 12

# Modelling the impact of modes of governance on territorial dynamics: the case of the oil palm in Indonesia

*Pierre-Marie Bosc, Julie Wohlfahrt and Cécile Bessou*

The implementation[1] of the agro-industrial palm oil production model in Indonesia is closely associated with the process of internal demographic rebalancing – between overpopulated Java and the other islands of the archipelago, notably Sumatra and Kalimantan – in the form of massive transmigration programmes between 1970 and 1990. During this period, issues of territorial governance were addressed within a strictly hierarchical framework by the State, which, at the same time, controlled and regulated land allocation, migration, and investments in plantations and palm oil factories. This asymmetry in power between the State and local communities had a profound and lasting effect on the distribution of land resources between various categories of actors. The gradual increase in private investments and the privatization of several public agro-industrial complexes did little to change the unequal distribution of land, dominated by industrial plantations (mostly private) and their satellites of family smallholders operating under contract. Furthermore, until the start of liberal reforms which were initiated with the decentralization process in the early 2000s, the State retained ownership of forest areas and allocated concessions, as well as the power to allocate new concessions. However, the process of decentralization seemed to offer opportunities for the first time to local actors to take part in decision making regarding territorial development.

From a conceptual point of view and with regard to the specificity of the oil palm, a territorial approach makes it possible to take into account several different dimensions:
– the establishment of a plantation constitutes an investment and it rapidly becomes a productive capital, whose strong territorial anchorage is very closely linked to agro-climatic conditions (the optimal zones for oil palm cultivation correspond to

1. This chapter is the result of work carried out under the 'Sustainable Palm Oil Production' research project funded by the French National Research Agency, known as the SPOP project (ANR-11-AGRO-0007 project), under the Agrobiosphère 2011 programme.

the equatorial regions) and whose 25-year life cycle, linked with that of farms, shapes the landscape in the long term;
– the extension of palm plantations also influences the distribution of populations (time to travel to plots) and processing activities (delays in processing palm bunches after harvesting);
– the issues of the management of natural resources and the environment justify territorial approaches since agricultural plots and farms generate externalities or amenities whose effects are not contained within their boundaries (most notably effects of pollution from fertilizers and phytosanitary products, effects on the maintenance of biodiversity and on carbon storage). The watershed concept in relation to the pollution of water courses is an apt illustration.

Until recently, decisions pertaining to these different dimensions were beyond the ambit of local authorities. And even now, in spite of the current emphasis on decentralization, the habits inherited from a period of rigid hierarchical management leave little room for new practices because of the asymmetries between agro-industries, local governments, village communities and independent producers.

## The diversity of family farmers

An initial survey conducted in 2013 in Kampar and Siak districts (Riau province) revealed a wide range of oil palm production systems – with farms and plantations ranging in size from 2 ha to 110 ha – which were part of very diverse systems of revenue-generating activities (Baudoin *et al.*, 2015; Moulin *et al.*, 2016). The annual income generated by individual farms varies greatly (5,300 USD on an average, with a maximum of 69,500 USD), but is generally higher than the average Indonesian income. Nevertheless, there is room for improvement. This heterogeneity of household incomes highlights the rapid social differentiation resulting from the growth of oil palm cultivation. It can be attributed to different strategic approaches adopted by the farms, which depend on various possibilities of investment, from one or more plots managed wholly or partly by the agro-industry, optionally in association with plots established independently by the farmer. The technical performance of plots managed by the palm oil agro-industry is higher than that of independently managed plots, where the technical model has to be adapted by the farmer to his financial constraints.

## An example of multi-agent modelling

Modelling was envisaged as a tool for helping varied actors work in concertation in territories where palm plantations represent significant and relatively irreversible investments. As part of the SPOP project, a multi-agent modelling tool – the Palm-Lab Model – was developed using the Cormas multi-agent modelling platform. It uses empirical data to explore different plantation scenarios. This kind of modelling incorporates the diversity of actors and their behaviour, as well as their interactions and resulting effects on the environment in a given context (Grimm *et al.*, 1999). The effects of such processes are not direct or immediate, and recourse to multi-agent modelling – even if it is based on certain unavoidable simplifications – makes it possible to visualize impacts that are difficult to identify through research methods based on observation over conventional time frames.

The Palm-Lab Model takes into account three types of oil producers: industries, villagers, and investors. They are defined by their initial capital (for example, villagers own land at the start of the simulation, whereas investors do not) and by their short-term strategies (limited to fertilization) and those over the long term (decision to set up a plantation and land transfers). Although this model does not consider the State as an explicit agent, the impact of different policies can be assessed through overall scenarios defined by a particular setting of simulation parameters (for example, the imposition of conservation areas that reflect the prohibition on cultivating oil palm in sensitive areas). The physical environment conditions (soil types, especially peat soils, important for carbon storage) have been incorporated to assess the environmental impact of scenarios simulated by the model. The space has been divided into functional units such as the village, farms belonging to villagers, industrial plantations, plantations of investors and the forest. The basic unit of area for the model is the 2-ha plot characterized by attributes such as distance to the road, soil type and vegetation cover, which can vary during the simulation (oil palm, forest, rice, rubber plantation, roads). The age of the plantations increase over the course of the simulation. Each plot is owned by an actor whose resources vary over the duration of the simulation (income, knowledge, etc.) and whose decisions may also change during the same period.

The model's parameters are set based on empirical data since little data is typically available on the different types of actors and their strategies at the territorial scale. As far as the dynamics of sustainability certification proposed by agro-industries are concerned, it was possible to compare the effects of different certification schemes by taking into account indicators that provide information on social equity (according to the types of producers involved) and environmental impacts (forest cover and plantation dynamics).

The model was used for three scenarios that are very different, especially in terms of the distribution and regulation of land use (land sparing):
- without rules or constraints;
- under regulations formulated by palm oil industries;
- with environmental awareness and protected areas guaranteed by the State.

## First results

### Role of the mode of governance

According to the model's simulations, there are several possible perspectives. In the absence of regulation, the entire territory will be covered with oil palm after 50 years, i.e., after two productive 25-year cycles. During the first 25 years, forest cover is greater in the 'awareness' scenario, but it decreases thereafter, and finally becomes smaller than in the 'regulation by industries' scenario. The 'awareness' scenario, which envisages protection of certain areas by the State, leads to 'illegal' practices (unauthorized plantations) which ultimately make this scenario less effective in terms of protection than the 'regulation by industries' scenario. In its present form, the model is thus able to distinguish different situations in terms of land-use distribution. These results call into question the existing modes of governance in the territory. They also

indicate that the parameterization of the model – which makes it possible to take into account the role of the State and, in particular, the distribution of responsibilities between private actors, local authorities and State authorities in terms of decisions regarding land use – may need to be improved in order to correspond better to reality.

## Dynamics of land use

Land use also varies between scenarios: the spread of plantations is significantly faster in a 'no regulations' scenario; it takes just 27 years for the oil palm to cover the total soil surface. On the other hand, in an 'environmental awareness' scenario,

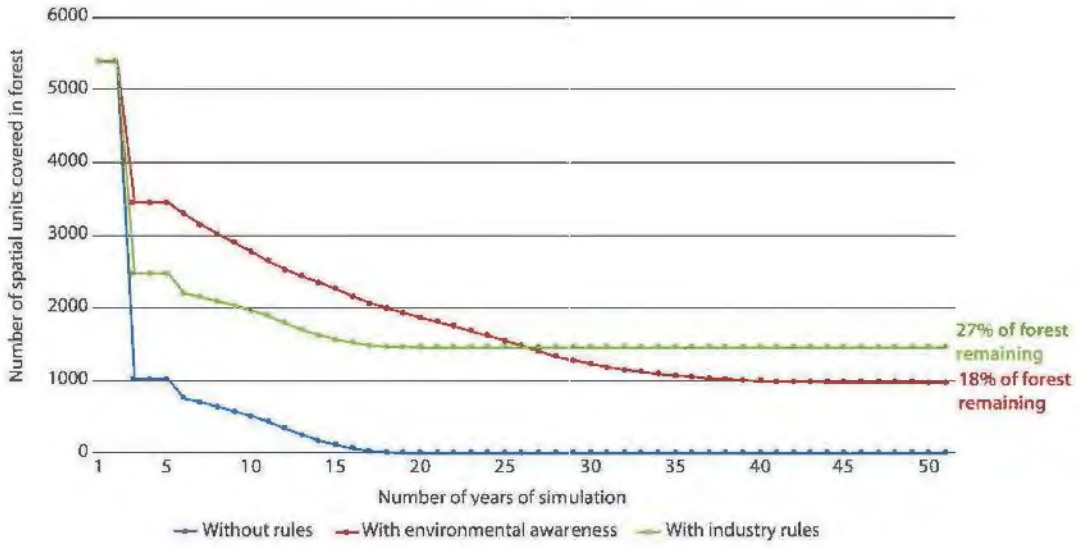


**Figure 12.1.** Dynamics of forest cover over a 50-year simulation cycle.

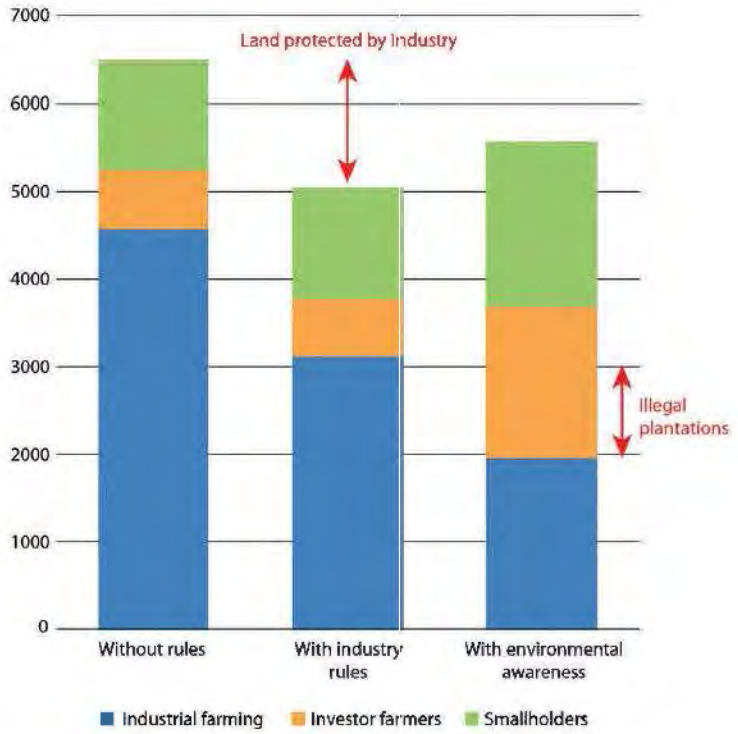


**Figure 12.2** Distribution of spatial oil palm units (2 ha) amongst the different agents after a 50-year simulation cycle and for the three context scenarios.

an equilibrium is eventually reached. When considering sensitive areas, such as peat soils, the 'awareness' scenario, understandably provides more protection, with only 33% of conversion into palm plantations (as against 100%) after three years.

At the end of 50 years (with a year as time step), the distribution of planted plots varies depending on the actors but the simulation shows that it is possible to influence the distribution of cultivated plots of different categories of actors, with the 'awareness' scenario resulting in a more balanced distribution among industrialists, villagers and investors (Figure 12.1). As far as villagers are concerned, increased environmental awareness results in a significant jump in their share, from 19% to 28% of the total surface area under the oil palm (Figure 12.2).

## Conclusions and perspectives

Even though the results presented here are preliminary, they show the value of an approach underpinned by an iterative process whose relevance and accuracy can be improved. This process, launched within the framework of the French National Research Agency's project, should be refined further by incorporating other empirical data and feedback from the actors themselves.

This work highlights the limitations of relying on the category of 'smallholder' commonly used in the literature but which encompasses widely heterogeneous realities. The debate which is polarized between agro-industries, on the one hand, and smallholders, on the other, would gain in clarity if the latter category were better characterized: not all 'smallholders' are 'small' holders.

The model already demonstrates that territorial regulations and controls matter, which is a significant step forward. Indeed, it seems possible for territorial governance to be freed, at least partially, from central control. Decentralization laws are opening up possibilities that territorial actors are seizing, even if this movement remains fragile. The capacity of local actors to manage territorial development is dependent on building up their skills. The model also highlights the possible role that industrial actors can play in defining these regulations. Further improvements can also be envisaged in the model to take into account the role of territorial authorities in formulating these regulations, in connection with national public policies.

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