



Tropentag 2007
University of Kassel-Witzenhausen and
University of Göttingen, October 9-11, 2007
Conference on International Agricultural Research for Development

Planning of Guadua Forest Based on Land Assessment and Site Quality

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Introduction

In the Colombian coffee region the woody bamboo species *Guadua (Guadua angustifolia* Kunth) represents an important natural resource traditionally used by farmers for many purposes such as construction, furniture and handicrafts (Londoño 1998). Due to the variety of uses the commercial value of *Guadua* culms has recently increased (Held 2005). Therefore, this resource has potential productive and protective functions essential for the sustainable development of this important region of Colombia (Camargo 2006).

Guadua stands are relatively small and have irregular shape. Most of them have areas under 5 ha, form a highly fragmented pattern and are mainly located along valleys near to rivers (Camargo & Cardona 2005). Bamboo species have special characteristics. In this sense, growth patterns of the *Guadua* (bamboo) and trees are completely different; therefore bamboo inventory and mensuration should be conducted by using different criterions (Camargo 2006).

According to the last inventory in the coffee region of Colombia there is an estimates of 28,000 ha (Kleinn & Morales 2006). Nowadays, there *Guadua* is the more harvested species to obtain wood for different applications. Some reports show that between 2000 and 2004 roughly 2,420,000 culms of *Guadua* was logged from 2,557 ha (Moreno 2006). However, it represents that 91 % of *Guadua* stands were not harvested in this period of time.

Factors influencing growth, productivity and quality of *Guadua* have been evidenced in some studies (Londoño & Prieto 1983, Hincapié & Penagos 1994, Agudelo & Toro 1994, García 2004, Camargo 2006). However, in contrast to trees, bamboo species and specifically *Guadua* has a different behavior. Whereas dendrometric variables such as height are used as response variables in trees, stand variables are better for *Guadua*. Also predictors or independent variables used to define site quality for *Guadua* are generally a group of variables (factors) and not individual variables.

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Planning of Guadua bamboo forest is a priority for government institutions responsible of giving principles for forest management. However, information collected in inventories and forest plans usually are unarticulated. In addition, because of harvesting is done in small areas the productivity estimate per unit of production is low.

In this context, to achieve a true improvement of forest sector based on Guadua is complicated. Besides, government institutions in charge of promoting the development of forest sector can not provide a guide for an adequate management of Guadua bamboo forest in the Colombian coffee region.

Developing simple models to integrate spatial information and attributes of land and Guadua stands contributes with planning of Guadua forest. Thus the use of tools supported on geographic information systems (GIS) eases the implementation and building of these models.

In this work are presented the main issues of the Guadua forest plan carried out for the coffee region of Colombia. The aptitude of lands for Guadua plantations and the qualification of Guadua stands in terms of productivity were integrated in a simple model by using a GIS. The model allowed to obtain a proposal for consolidating units of forest management (UFM) as a base to lead forest development in the coffee region of Colombia and contribute to an adequate management and promoting of this natural resource in the Colombian coffee region. Also this experience could be replied in tropical areas with fragmented forests.

Materials and Methods

Study area

This study was carried out in the coffee region of Colombia in an approximate area of 5.766.397, whereas guadua stand qualification and consolidation of UFM was done only in 17 municipalities (470.328 ha). These municipalities were previously selected by government institutions due to high commercial activities associated to Guadua.

Development of models for land assessment and units of forest management

To define land capability and potential areas for establishing Guadua plantations in five states of the Colombian coffee region, 24 variables were used in analyses to develop the model. These variables were included within five factors which represent site conditions: topography, climate, soils, landscape ecology and socioeconomics. By using a simple decision model based on the above mentioned five factors, it was feasible to define four classes of land capability: low, marginal, moderate and high.

In order to consolidate the UFM (only for 17 municipalities), additional information on volume of harvesting and characteristic of Guadua stands related to site quality was included in the model. As a complement information on Guadua forest inventories and baseline information on soils, climate conditions, geomorphology, environmental services and socioeconomic aspects, also was included. Thus, three classes of UFM were identified according of productivity level low, moderate and high. The software *Arc View 3.3* and its extensions *spatial analyst* and *3D analyst* were used. Also the extension *Model Builder* included within *spatial analyst 2.0* provided tools to develop the model.

Results and Discussion

Merely 2% of the evaluated total area resulted with high capability for Guadua production. This area is located close to urban centers where are sited most of Guadua stands (**Figure 1**). The main limitation for Guadua production was the lack of roads (to access) and the absence of places for

marketing. Also areas over 2000 m of elevation were immediately excluded, because of Guadua does not grow under these conditions.

Regarding to UFM, those defined at the category of high productivity represent 19 % of the total area of municipalities analysed (**Figure 1**). Due to the characteristics of UFM in this category, it is feasible to develop intensive programs of forest management, since all aspects show a favorable level. Other UFM at the categories of moderate and marginal productivity could potentially become of high productivity. It is workable only if the volume of harvest increase and some conditions as access are improved (**Figure 2**).

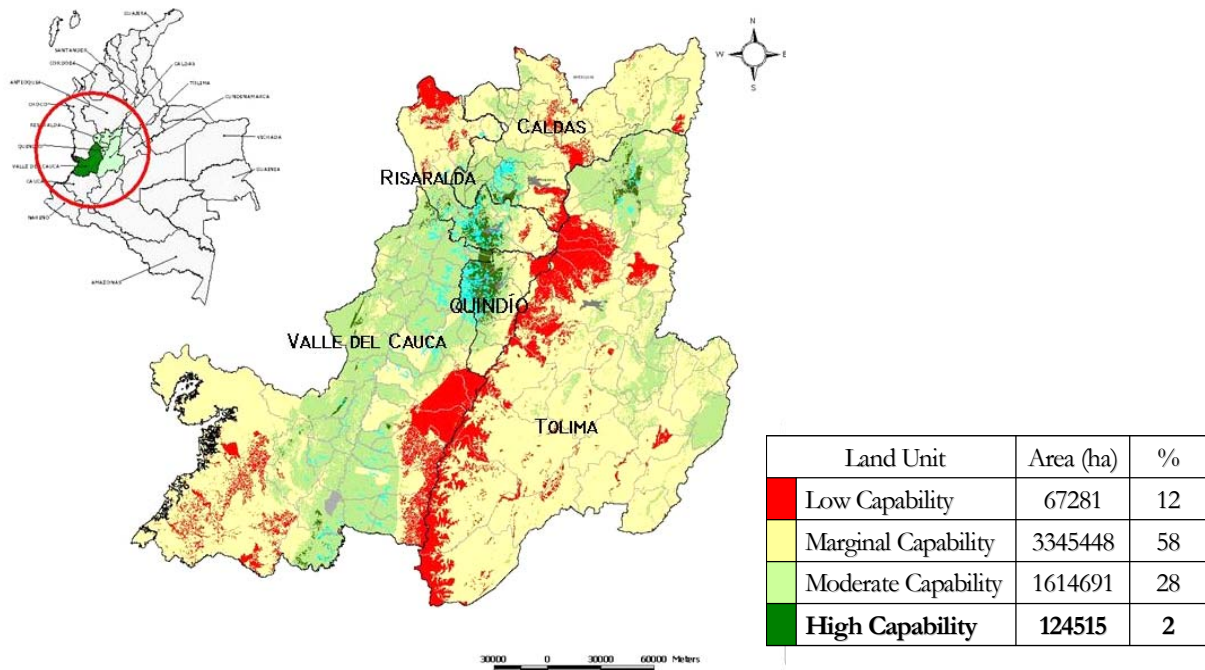


Figure 1. Capability of land for Guadua production. Coffee region of Colombia.

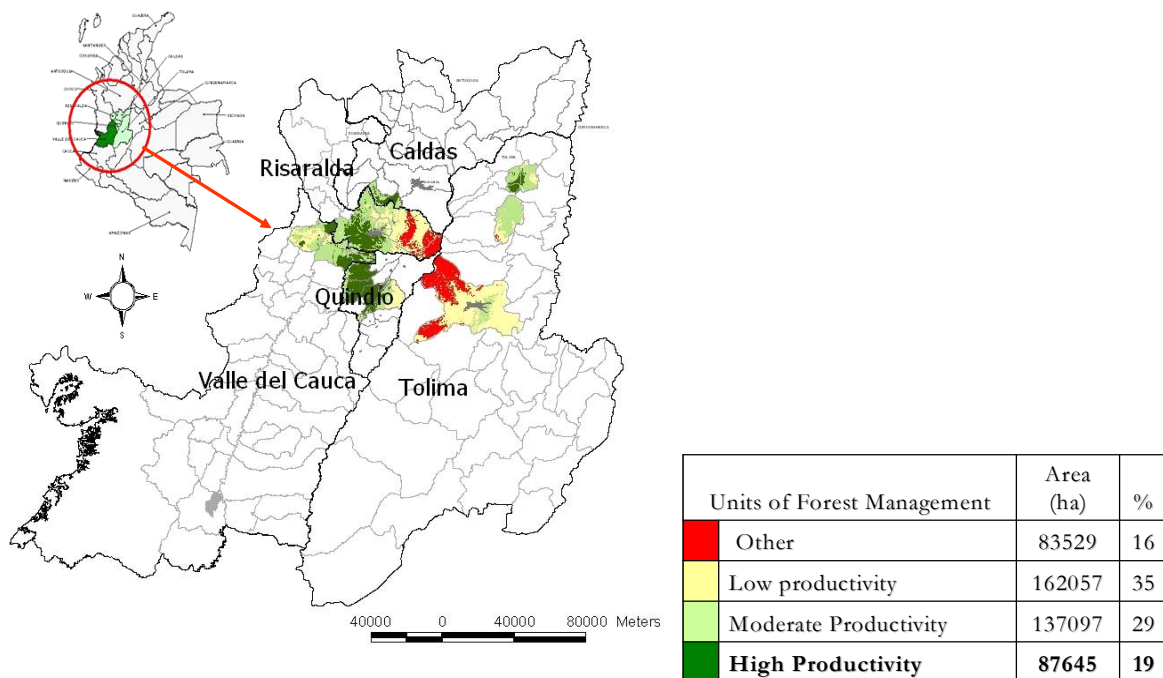


Figure 2. Units of forest management for 17 municipalities in the coffee region of Colombia.

UFM also represent areas with potential for establishing *Guadua* plantations. In addition, *Guadua* stands located within these units were qualified in terms of productivity, quality and as potential protected areas. Hence the conformation of UFM is significant as strategy to promote the management of small *Guadua* stands. The fragmented pattern and small size of *Guadua* stands could be a drawback. However, these forest areas included as a part of UFM can be seen as an opportunity to integrate forest management and a better way for forest planning.

Moreover, management and market of *Guadua* culms is incorporated within a UFM plan and not separately. Plans of management and strategies of marketing can now be done according to the specific characteristics of UFM.

The worth of the issues is because provided a tool for planning *Guadua* forest. Consequently, contribute to an adequate management of this natural resource in the Colombian coffee region. An additional value of this experience is because it could be replied in tropical areas with fragmented forests.

Conclusions

The implemented model for forest planning was useful to define Land capability and also Units of Forest Management. Nowadays, government institutions can lead the planning of *Guadua* stands based on this model. In the other hand, the units of forest management are an alternative against drawbacks relate to size of *guadua* forest and their fragmented pattern because integrated forest management is feasible.

Acknowledges

This work was carried out within the project “Estrategias para la conformación y el fortalecimiento de empresas rurales con base en la *Guadua* (*Guadua angustifolia* Kunth) en la zona cafetera de Colombia”, funded by COLCIENCIAS. Also some information was derived from the Project “Valoración de bienes y servicios de la biodiversidad en paisajes rurales colombianos complejo ecoregional Andes del norte”, conducted by the Genetic Resources and Biodiversity Research and Studies Center, CIEBREG.

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