



The Role of Bamboo in Regenerative Development

The case of Guadua angustifolia in Rural Areas of Caldas, Colombia

A Thesis submitted in the Partial Fulfillment for the Requirement of the Degree of Master of Science in Integrated Urbanism and Sustainable Design

> by Diana Barrera-Salazar

> > Supervised by

Prof. Dr. Mohamed Salheen Professor of Integrated Planning and Design Ain Shams University Prof. Dr. Leonie Fischer Professor of Landscape Planning and Ecology University of Stuttgart

The Role of Bamboo in Regenerative Development

The Case of *Guadua angustifolia* in Rural Areas of Caldas, Colombia

A Thesis submitted in the Partial Fulfillment for the Requirement of the Degree of Master of Science in Integrated Urbanism and Sustainable Design

by Diana Barrera-Salazar

Supervised by

Prof. Dr. Mohamed Salheen Professor of Integrated Planning and Design Ain Shams University Prof. Dr. Leonie Fischer Professor of Landscape Planning and Ecology University of Stuttgart

Examiners Committee Title, Name & Affiliation

Prof. (external examiner) Professor of (...) University of (...)

Prof. (Title/Name) Professor of (...) University of (...)

Prof. (Title/Name) Professor of (...) University of (...)

Prof. (Title/Name) Professor of (...) University of (...)

Signature

Rul hus



University of Stuttgart

08/08/2022

Disclaimer

This dissertation is submitted to Ain Shams University (ASU) and University of Stuttgart - Faculty of Architecture and Urban Planning (USTUTT) for the degree of Integrated Urbanism and Sustainable Design (IUSD), in accordance to IUSD-ASU regulations.

The work included in this thesis was carried out by the author during the period from February - July 2022.

The author confirms that the work submitted is his/her own and that appropriate credit has been given where reference has been made to the work of others. Any disputes regarding the copy right of the content is the sole responsibility of the author.

Ain Shams University holds the right to publicly distribute this thesis in the current university standard format. The author holds the right to publish the content in any other format.

08/08/2022

Diana Barrera-Salazar

Rulpus.

Signature

Acknowledgements

First of all, I would like to express my deep gratitude to my family for their unconditional love and support. To my parents for always encouraging me to be the best version of myself, to my sisters and brothers for being an endless source of motivation, and to my grandmother Zoelia who inspired this research, this is a tribute to her.

To my lifelong friends, who always encouraged me to go a step further and taught me that the best thing about this lifetime journey is growing together.

Special thanks to all my mentors and IUSD staff who contributed to this academic journey. In particular to my supervisors, Prof. Dr. Mohamed Salheen and Prof. Dr. Leonie Fischer, whose expertise, support, and guidance helped me bring this research to life.

A big thank you to the local experts and rural community members in Caldas who generously contributed their time, knowledge, and perspectives to this research.

Finally, to my friends at IUSD, who became my second family during these two challenging years, infinite gratitude for your constant encouragement and insightful advice, it was an extraordinary journey full of personal growth and memorable experiences. May our paths cross again.

Abstract

The current climate crisis, as a consequence of a conventional development paradigm, has increased the vulnerability of rural areas and their communities. Bamboo forests can mitigate these risks in tropical and subtropical countries. In the Americas, Colombia is the country with the second highest diversity of bamboo species; Guadua angustifolia is the most relevant native species and is mainly located in the Coffee Region. The province of Caldas has the second largest amount of hectares of guadua forests in the region; conversely, it has the highest forest fragmentation rate and rural poverty rate. Although guadua has great potential to reduce rural poverty and improve local livelihoods, the deterioration of its forests is increasingly evident. A large body of research has studied the ecological dimension of guadua and its applications for industrial purposes. However, few studies have addressed how guadua can comprehensively mitigate climate change and rural vulnerability in Caldas. The objective of this research is to explain the potential role of guadua in promoting rural development in Caldas through the lens of regenerative development, a theoretical framework for classifying and analysing information in an integrated and correlated manner. For this purpose, documentary research and case study strategies were implemented, using collection methods such as literature review, observations, interviews, and meetings with local actors. From the primary data collected, an analysis was conducted using a content analysis matrix and Atlas Ti software to recognise the dimensions and dynamics of guadua in Caldas. The analysis has shown that the historical and current dynamics of guadua, as well as the ecological, sociocultural, economic, and institutional dimensions immersed in these dynamics have been marked by opposing phenomena that have been drivers of both degeneration and regeneration. Furthermore, future opportunities and challenges for guadua as a renewable natural resource to promote regenerative rural development were identified. These findings will serve as a starting point for regenerative projects aimed at thriving territories involving rural communities and guadua forests.

Keywords: Rural Vulnerability; Renewable Natural Resource; Guadua Forest; Agroforestry; Rural Livelihoods

Table of contents

Acknowledgements

Abstract

List of figures

Chapter 1: Introduction	17
1.1 Research problem	
1.2 Research questions.	19
1.3 Research aim and objectives	20
1.4 Research strategy	20

Chapter 2: Theoretical framework	.25
2.1 Climate Change and bamboo	25
2.2 Rural Vulnerability and bamboo	26
2.3 Regenerative Development	29
2.4 Role as a concept	.30
2.5 Conceptual framework	31

Chapter 3: Case study	
3.1 Context and site selection.	
3.2 Caldas: a socio-ecological system	35
3.3 Rural Caldas and guadua time-line	
3.4 Guadua angustifolia: dimensions	

Chapter 4: Methodological framework	47
4.1 Qualitative methodology	47
1. 2 Primary data collection	48

.2 Primary data conection
.3 Data processing

Chapter 5: Analysis and findings	55
5.1 The four dimensions: trends and saturation	55
5.1.1 Ecological dimension	55

5.1.2 Sociocultural dimension	56
5.1.3 Economic dimension	
5.1.4 Institutional dimension	
5.2 Dynamics of dimensions over time.	
5.2.1 Historical dynamics: Guadua from personal experience	59
5.2.2 Current dynamics: Guadua from current praxis	61
5.2.3 Future dynamics: Guadua for Regenerative Development	64
Chapter 6: Discussion	69
Chapter 6: Discussion	69
Chapter 6: Discussion Chapter 7: Conclusions	69
Chapter 6: Discussion Chapter 7: Conclusions 7.1 Concluding remarks	
Chapter 6: Discussion. Chapter 7: Conclusions. 7.1 Concluding remarks. 7.2 Recommendations.	
Chapter 6: Discussion. Chapter 7: Conclusions. 7.1 Concluding remarks. 7.2 Recommendations. 7.3 Further research.	

References

Appendix

List of figures

Fig. 1—Guadua forest in Caldas, Colombia. Source: Author
Fig. 2—Protective guadua on a riverbank in Caldas. Source: Author24
Fig. 3— Bamboo for climate change mitigation. Source: Adapted from
Terefe et al. (2019)
Fig. 4— Bamboo for rural vulnerability mitigation. Adapted from
Wang et al. (2021)
Fig. 5– Process from conventional to regenerative development. Adapted from
Reed (2007)
Fig. 6— Regenerative development as a framework. Source: Author
Fig. 7— Conceptual framework. Source: Author
Fig. 8– Caldas rural landscape. Source: Author
Fig. 9— Relevant bamboo species in Colombia. Adapted from
Londoño (2011)
Fig. 10— Location of the Coffee Region in Colombia. Source: Author
Fig. 11— Natural guadua forest. Source: Author
Fig. 12— Planted guadua forest. Source: Author
Fig. 13— Caldas: Socio-ecological system. Source: Author
Fig. 14— Timeline: overview. Source: Author
Fig. 15– Map of the native groups that populated the Coffee Region. Adapted
from Nova (2006)
Fig. 16– Illustrations of Quimbayas using guadua. Adapted from Giraldo de
Puech (1986)
Fig. 17– Illustrations of the scenes of Spanish colonisation in Caldas. Adapted
from Barragan (2021)
Fig. 18— The evolution of the use of guadua as a construction material. Adapted
from Castro-Escobar (2016)
Fig. 19— The use of guadua for rural housing and informal settlements in Caldas.
Adapted from Salas Delgado (2006)
Fig. 20— <i>Guadua angustifolia:</i> parts. Adapted from Hidalgo López (1981);
Minke (2016)
Fig. 21— Guadua angustifolia: life cycle. Adapted from Hidalgo López (1981);
Minke (2016)
Fig. 22- Guadua angustifolia: vernacular and contemporary construction
techniques. Adapted from Salas Delgado (2006)42

Fig. 23- Guadua angustifolia: Stakeholders and production chain. Adapted
from Moreno Orjuela and Mejía Gallón (2013)43
Fig. 24— <i>Guadua angustifolia</i> legislative process. Adapted from
Garavito-Rodríguez (2020)
Fig. 25– Guadua according to rural community members. Source: Author46
Fig. 26– Workshop with rural community members. Source: Author51
Fig. 27– Guadua harvesting in Caldas. Source: Author
Fig. 28— Ecological restoration. Source: Author
Fig. 29— Ecological deterioration. Source: Author
Fig. 30— Sociocultural appropriation. Source: Author
Fig. 31– Sociocultural stigmatisation. Source: Author
Fig. 32— Economic leverage. Source: Author
Fig. 33– Economic stagnation. Source: Author
Fig. 34– Institutional improvements. Source: Author59
Fig. 35– Institutional constraints. Source: Author
Fig. 36— Historical dynamics. Source: Author
Fig. 37– Current dynamics. Source: Author
Fig. 38– Future visions. Source: Author
Fig. 39— Focus group with rural community members in Caldas.
Source: Author
Fig. 40– Young farmer harvesting guadua. Source: Author74

Acronyms

Glossary

CAR:	Corporación Autónoma Regional / Regional Autonomous Corporation	Antioqueño:	Native of the Department of Antioquia in Colombia.
	Local environmental authority	Bahareque:	Traditional building technique used in regions such as
ICONTEC:	Instituto Colombiano de Normas Técnicas y Certificación / Colombian		Caldas, which is one of the 32 departments of Colombia.
	Institute of Technical Standards and Certification		Bahareque, which came from the word bajareque, is an old
ICA:	Instituto Colombiano Agropecuario / Colombian Institute of		Spanish term for walls made of guadua and soil
	Agriculture	Esterilla:	Mat made of guadua by splitting the culm
MADR:	Ministerio de Agricultura y Desarrollo Rural / Ministry of Agriculture	Guadual:	Guadua forest
	and Rural Development	Guadua gecha:	Guadua ready to be harvested, usually after the fourth or
MADS:	Ministerio de Ambiente y Desarrollo Sostenible / Ministry of		fifth year after planting
	Environment and Sustainable Development	Guaduero:	Person who cuts and harvests guadua for a living
SENA:	Servicio Nacional de Aprendizaje / National Training Service	Salvoconducto:	Document issued by the CAR to authorise the transport of products, specimens or individuals of wild flora and fauna



Introduction

Conventional development, based on economic growth through activities such as industry, transportation and energy supply, is considered the main cause of increasing levels of greenhouse gases in the atmosphere, and triggering global warming in a phenomenon known as climate change (Global Humanitarian Forum, 2009). In the last decade, climate events have intensified and become more frequent, threatening fragile biodiverse ecosystems and vulnerable rural communities (Masson-Delmotte et al., 2021). Bamboo forests could play a key role in mitigating the climate crisis and supporting safer rural communities (Eliasch, 2008). Bamboos are perennial plants that are part of the grass family Poaceae (Soreng et al., 2015). They are considered a renewable natural resource due to their outstanding regeneration rate evidenced in their capacity for selfreproduction and rapid growth (Muñoz, Camargo and Romero-Ladino, 2017). As climate change mitigator, bamboo sequester twice as much carbon as trees, restore degraded soils, regulate watersheds, and provide habitat for biodiversity (Yiping et al., 2010). As community builder, bamboo can support more resilient and thriving rural communities by creating sustainable local livelihoods through circular economy (Garcia, 2006).

Furthermore, bamboo has been declared by the UN as the material of the 21st century after demonstrating that its production and use is directly related to 7 of the 17 SDGs (INBAR, 2015). Bamboo grows mainly in tropical and subtropical countries in the Americas, Africa, and Asia, where China and Vietnam are the largest producers and exporters with almost 90% of the international market. Colombia, despite being the second country in the Americas with the greatest diversity of bamboos, only contributes 0.1% (Canavan et al., 2017). So far 105

INTRODUCTION

bamboo species have been discovered in the country, 24 are endemic and the most relevant native species is *Guadua Angustifolia* Kunth. This species is mainly concentrated in the Coffee Region, between 900 and 2000 metres altitude (Londoño, 2011).

The Coffee Region is an area located in the central mountain range of the country with a unique landscape identity. It was recognised as a World Heritage Site by UNESCO in 2011 due to the high biodiversity, social capital and capacity built over time. The region is integrated by 3 provinces: Caldas, Risaralda and Quindío, and its rural areas are home to about 50% of the natural guadua forests in Colombia. Although Caldas has the second largest number of hectares, it is the province with the highest fragmentation of guadua forests (Colombia, MADR, 2016a) and the highest rural poverty index defined by the Multidimensional Poverty Index (MPI) (Caldas, Caldata, 2020)

1.1 Research Problem

Guadua as a local natural resource lacks value. Despite the availability of guadua as a local and renewable resource in Colombia, and specifically in Caldas, its participation in the local, national and international economy is very low (INBAR, 2019). Additionally, ecological deterioration is evident in the current fragmentation of guadua forests, affecting ecosystems and livelihoods in rural areas where it is found. This phenomenon, in principle, could be due to two factors. Firstly, the restrictions imposed by current legislation that defines guadua as a protected wild forest resource, limiting its potential and discouraging investment in its production and development (Londoño, 2011). Secondly, social stigmatisation since it is considered the "raw material of the poor" due to its historical use for local and low-cost constructions, limiting its potential for multiple uses and income (Held and Manzano, 2003).

In consequence, these limitations result in the undervaluation and consequent deterioration of this natural resource, constraining its development as an alternative source of livelihood for vulnerable rural communities in Caldas. Therefore, it is necessary to examine the dimensions of guadua, as well as to analyse the dynamics over time, in an articulated manner. The recognition of guadua as an important local and renewable natural resource can be key for the regenerative rural development of Caldas. Thus, this research can become a solid basis for proposing local projects that enable the generation, transfer, and appropriation of knowledge about this natural resource through collaborative strategies that address the risks of climate change and rural vulnerability and, ultimately, promote the regenerative development of rural areas and communities.

Caldas is a complex territory that must be analysed from a holistic perspective. Hence, it is essential to use a theoretical framework that allows for the collection and analysis of information in an integrated and correlated manner. Regenerative Development is a concept transformed into theoretical framework that revolves around the process of building the capacity and capability of socio-ecological systems to renovate, nourish and thrive (Plaut et al., 2016). Its aim is to manifest flourishing living systems through the integration of the internal -value systemsand external dimensions of existence -ecological, sociocultural, economic, institutional- that are necessary for sustainability (Gibbons et al., 2019). To this end, the value system of the inhabitants must shift from a mechanistic and reductionist conception to a holistic and restorative vision that promotes reciprocal relationships resulting in regenerative processes that mitigate and reverse the degenerative effects of modern paradigms (Gibbons, 2020).

1.2 Research Question

The main research question that has driven this research is:

What can be the role of guadua in promoting regenerative development in rural areas of Caldas, Colombia?

This question is complemented by three sub-questions to examine the historical background, the current status and future opportunities and challenges: *-What have been the historical dynamics and dimensions around guadua in rural areas of Caldas?*

-What are the current dynamics and dimensions around guadua in rural areas of Caldas?

-How can the dimensions and dynamics of guadua become opportunities to promote regenerative development in rural areas of Caldas?

INTRODUCTION

1.3 Research aim and objectives

Aim

The aim of this research is to explain the potential role of guadua in promoting rural development in Caldas through the lens of regenerative development.

Objectives

1. To describe the historical dynamics and dimensions around guadua in rural areas of Caldas according to perceptions of members of the rural community, experts, and local authority.

2. To explain the current dynamics and dimensions around guadua in rural areas of Caldas according to perceptions of members of the rural community, experts, and local authority

3. To explore the dimensions of guadua evidencing its capacity to promote regenerative development and explain the opportunities and challenges in rural areas of Caldas through the reflections and perceptions of members of the rural community, experts, and local authority.

1.4 Research Strategy

This qualitative research attempts to explain the potential role of guadua in promoting rural development in Caldas through the lens of regenerative development by exploring and describing the ecological, sociocultural, economic, and institutional dimensions of guadua as part of the socio-ecological system of Caldas at three points in time: past, present, and future. To this end, a mixedmethod approach was used to better understand the complex relationships between the four dimensions and time frames, combining qualitative research methods, while acknowledging their strengths and limitations.

The strategy of this research is divided into two main components. The first strategy is desk research, as it allows for the collection of quantitative and qualitative secondary data related to the research problem in a broader context by relying on secondary sources including books, articles, reports, government records and documentaries (Kumar, 2011). For this purpose, the method used is content analysis, as it allows tracking changes over time and general relationships, contributing to a solid basis for establishing the theoretical framework from which the main concepts will be drawn, as well as the selection of the case study. 85 sources were consulted of which 45 were particularly relevant to the research.

The second strategy is single case study as its basic characteristic is to deal intensively with one unit (Stake, 2003), providing a more in-depth understanding of the research problem in the specific context of Caldas. The type of case study is casual process tracing since it focuses on processes, offering an in-depth story line with a detailed view of events while a particular outcome unfolds over time, uncovering details and complex interactions between multiple factors taking place in a particular context (Denzin and Lincoln, 2005). Henceforth, primary qualitative data in the form of opinions, perceptions and reflections are collected through methods such as observations, semi-structured interviews and focus groups with actors related to guadua as a natural resource in Caldas, including members of the rural community, experts, and local authorities.

Moreover, a qualitative analysis is conducted to identify, examine, and interpret the information through a thematic analysis matrix in which the primary data collected is classified in each dimension (ecological, sociocultural, economic, and institutional) and time frames (past, present, future) to then be translated into a code. This coding is then fed into the ATLAS.ti software, which allows segments to be interrelated and patterns to be discovered in order to recognise commonalities, differences, and undisclosed aspects of the phenomenon under investigation.

Research Structure

The research is divided into 7 sections. The first section introduces the research, presenting an overview of the topic and its relevance in the current context, followed by a description of the research problem, the questions that arise from the phenomenon described, and the focus of the research through the aim and objectives. Finally, the strategies used to structure this research is outlined.

The second section provides an overview of the current state of knowledge on the issues to be addressed in the research including the connections between conventional development, climate change, rural vulnerability, and bamboo, supported by the solid experience in the Chinese context. Furthermore, the definition of regenerative development as a concept and its logic as a framework. The aim of this chapter is to establish the theoretical basis for the research together with the conceptual framework. The third section seeks to contextualise the case study and the site selection criteria, followed by an overview of rural Caldas as a socio-ecological system, and of *Guadua angustifolia* as a local natural resource. Furthermore, the close relationship between Caldas and guadua over time is described through a time-line. The aim is to develop a solid knowledge base of the local dynamics between rural Caldas and guadua that is fundamental for the following section.

The fourth section describes the methods of primary data collection and processing in more depth, followed by the fifth section where the analysis and findings in time frames (past, present, and future) using the four dimensions as categories (ecological, sociocultural, economic, and institutional) are presented. The aim is to depict the results obtained in a comprehensive way.

The sixth section attempts to discuss synergies and mismatches between the pre-investigation assumptions and the findings from the analysis. Finally, the seventh section consists of concluding remarks, complemented by a set of recommendations and suggestions for further research that could address the remaining gaps.

Research limitations

Throughout the research some limitations are acknowledged. On the one hand, desk research poses a significant challenge in the use of secondary data, as it is important to be aware that the data was collected for a different purpose than the current research, as well as the access to information since it may be restricted or limited in certain contexts, and data may quickly become obsolete. On the other hand, case studies have some disadvantages in terms of external validity, as it is not possible to generalise findings since they depend on the specific context. Furthermore, the open-ended design can be a limitation for reliability, hence it is essential to make the research more reliable by being transparent about the research process and documenting each step of the research.



Chapter 2: Theoretical framework

2.1 Climate change and bamboo

Conventional approaches to development are based on a Western modernisation model where developed industrialised countries give a predominant role to economic growth, despite the fact that this growth stimulates increased consumption and even accepts ecological degradation as an inevitable result of progress; the outcome of this reductionist model is known as climate change (Labović, Vujović and Dasic, 2021). According to United Nations climate change is defined as "a change of climate which is attributed directly or indirectly to human activity that alters the composition of the global atmosphere and which is in addition to natural climate variability observed over comparable time periods" (UN, 1992. P.3). Although human influence on climate is not a novelty, in recent decades the impacts of this crisis in the form of heat waves, droughts, floods, hurricanes and forest fires are closely linked to human activities.

In this sense, the current climate crisis is considered mainly anthropogenic. The Intergovernmental Panel on Climate Change (IPCC) has been emphatic in stressing that: *"Historical cumulative CO2 emissions determine to a large degree warming to date, while future emissions cause future additional warming."* (IPCC, 2021. P.36), pointing to greenhouse gases as the main cause of accelerated global warming and underlining the urgency to reduce CO2 emissions significantly to halt the impacts of global warming. Hence, it is necessary to implement concrete strategies to reduce greenhouse gas emissions and curb the accelerated rise in global temperatures, otherwise climate phenomena will become more frequent and devastating, especially for fragile biodiverse ecosystems and vulnerable rural communities (Masson-Delmotte et al., 2021).

Forests are increasingly recognised as a key part of climate action, contributing to mitigation, adaptation, and local development through the multiple services they provide, including carbon sequestration. Bamboo forests have similar characteristics to other forest in terms of their role in the carbon cycle. Bamboos -although not trees but woody grasses- have fast growth rates, high annual regrowth after harvest and high biomass production, which means a carbon sequestration capacity similar or even higher than that of several tree species (Yiping et al., 2010). To prevent the captured carbon from escaping into the atmosphere, bamboo is used to make products where the carbon is stored for the lifespan of the product. (INBAR, 2015). Moreover, bamboo contributes to climate change by reducing carbon release while offering an alternative to fossil fuels, adapting to new growing conditions through management and harvesting practices, restoring ecosystems by regulating soil erosion and watersheds, and finally providing habitat for biodiversity and livelihoods for vulnerable communities in rural areas (Terefe, Jian and Kunyong, 2019).



Fig. 3- Bamboo for climate change mitigation. Source: Adapted from Terefe et al. (2019)

2.2 Rural vulnerability and bamboo

Currently, 3.4 billion of the world's 7.75 billion people live in rural areas, most of them with high rates of vulnerability to climate change and poverty (IPCC, 2021). From 1995 until 2020, the rates of people living in extreme poverty in the global south had been slowly but steadily declining. However, in the last 2 years this trend changed and reversed due to the crisis generated by COVID-19 together with the effects of conflict and climate change (Lazarte, 2017). This issue is particularly pressing in the rural context as the International Fund for Agricultural Development stated in its report: *"Globally, extreme poverty* continues to be overwhelmingly rural: an estimated 79 per cent of those experiencing poverty live in rural areas" (IFAD, 2020. P.1). In this sense, vulnerability in rural areas can be defined as the lack of access to basic assets such as water, land, infrastructure, social services, and livelihoods, combined with environmental, social and economic risks such as climate change, extreme poverty and hunger (Lazarte, 2017).

In the global south, the main causes of rural vulnerability can be grouped into four broad dimensions: environmental, social, economic, and institutional. Environmentally, the loss of biodiversity and the degradation of ecosystems particularly affects the rural population in these latitudes, as they are highly dependent on natural resources for their livelihoods, and this, together with the already severe effects of the climate crisis, is exacerbating the problems that the rural poor have been facing. Socially, patterns of exclusion and inequality in rural communities can make cohesion difficult in some contexts, meaning that certain groups (e.g., women, the elderly, the disabled) may face additional challenges such as land ownership, productivity, and wages to improve their livelihoods. Moreover, economically, the lack of circular economy schemes, the low diversification of rural economies and limited access to markets result in a privation of livelihoods and ultimately in rural poverty (IFAD, 2020). Finally, institutionally, the lack of updated laws with the current reality of rural areas, and the weak relationship of government entities with programmes and processes promoted by civil society that have shown positive results and more appropriate strategies to accompany the rural poor in their development processes (Perry, 2010).

In this sense, mitigating the risks posed by climate change and poverty to aggravate rural vulnerability in the global south becomes urgent. Bamboo as a renewable natural resource is a great option to mitigate climate change and help alleviate poverty due to its native nature, fast growth, low maintenance and cost, and environmental regeneration (Atetwe, 2020). Bamboo or *Bambusoideae* is a subfamily of the *Poaceae* (grasses) with up to 1200 recognised species, it grows naturally in tropical and subtropical countries of Central and South America, Asia and Africa, and accounts for approximately 3.2% (37 million hectares) of the world's forest area (FAO, 2007). Annually, bamboo is worth US\$60 billion worldwide, and an estimated two billion people use bamboo in some form on a daily basis (INBAR, 2019). Historically, bamboo has been an important natural

resource for the livelihoods and development of rural communities in the global south, evidencing the relevance of bamboo-producing countries not only taking an interest in bamboo, but also promoting its production and harvesting to benefit from the environmental, social, and economic advantages of this resource both in its natural form and in value-added uses.

China is a global benchmark for countries considering strengthening production and knowledge around bamboo as it is one of the most expanding and valuable land uses in the country (FAO, 2010). Between 2010 and 2020, bamboo as a sector transformed from an emerging industry to a significant industry valued at US\$14 billion due to a series of transformations in the value chain, where production shifted from a wild bamboo harvesting model to sustainable and privately owned plantation cultivation. As a result, the rural manufacturing industry has grown, generating livelihoods and improving the living conditions of rural people through the development of products such as bioenergy, charcoal, clothing fibres, handicrafts, medicines, edible sprouts, soft drinks and teas (Atetwe, 2020).

Consequently, bamboo can mitigate the risk in rural areas through climate action and poverty alleviation due to its natural attributes and the potential benefits of bamboo products development. A large body of research has studied the ecological dimension of bamboo and its applications for industrial purposes such as food, manufacturing, ecotourism, energy, and construction (Wang et al., 2021). However, there are few studies on how bamboo can address rural vulnerability by addressing the four dimensions holistically. This gap can be addressed by using a comprehensive framework in a systematic way to understand the opportunities and challenges of bamboo in specific contexts by collecting, classifying, and analysing primary and secondary information in an integrated and correlated manner.



Fig. 4- Bamboo for rural vulnerability mitigation. Adapted from Wang et al. (2021)

2.3 Regenerative development

The idea of conventional development was built upon worldwide poverty after WWII. Industrialized countries sought to alleviate poverty through the modernization of the rapidly decolonizing globe, becoming the main global narrative guiding the socalled "progress" of the society, based mainly on economic growth (Sylvester and Gordon, 2004). Under this conventional development paradigm, strategies were focusing primarily on macroeconomic issues such as national income, production, employment, and investment. This model, which sought unlimited economic growth within a system with limited resources, led to rapid changes in the natural environment, inequities among historically vulnerable social groups, and ultimately the degeneration of the system. In response to these problems, a wide range of development alternatives emerged with diverse viewpoints. (Castillo-Ospina and Masullo-Jiménez, 2017).

Development paradigms have been transformed over the decades. The more conventional approach seeks to stabilise global problems based on a mechanistic and reductionist worldview that revolves around human beings and their needs (e.g. the paradox of efficiency). The contemporary approach to sustainable development, while remaining anthropocentric, seeks to maintain balance in ecosystems through ecosystem services, human well-being, and engagement (e.g., SDGs, STAR communities, etc.). The next wave of sustainability is regenerative development, which aims not only to maintain but to regenerate through a holistic worldview by integrating the internal and

external dimensions to achieve developmental change processes (Gibbons et al., 2018; Gibbons, 2020).



Fig. 5— Process from conventional to regenerative development. Adapted from Reed (2007)

THEORETICAL FRAMEWORK

Regenerative Development revolves around the process of building the capacity and capability of social-ecological systems to renovate, nourish and thrive (Plaut et al., 2016). The aim is to manifest thriving and flourishing living systems through the integration of the internal -value systems- and external dimensions of existence -ecological, sociocultural, economic, institutional- that are necessary for sustainability (Gibbons et al., 2019). To this end, the value system of the inhabitants must shift from a mechanistic and reductionist conception to a holistic and restorative vision that promotes reciprocal relationships, reflected in the balance between the external dimensions, and resulting in regenerative processes that mitigate and reverse the degenerative effects of modern paradigms (Gibbons, 2020).



Fig. 6— Regenerative development as a framework. Source: Author

2.4 Role as a concept

In the framework of the research, it is relevant to define the concept of role from different fields of knowledge to finally extract the definition that will be used throughout the research. From a general perspective, roles are defined as the place or function that someone or something has in a situation, organization, or society (Cambridge dictionary). From an ecological perspective, roles are known as the relevance or function that a living being or organism, plays in an ecosystem, the biological features of an individual or species represent their functional role in the ecosystem (Violle et al., 2007). From a social perspective, roles are socially established patterns of conduct that are expected of those who hold particular social positions or belong to certain social groups (Biddle, 1986). Based on the definitions, the role for this research is the purpose that bamboo is estimated to fulfil in fostering regenerative development as a new paradigm for rural areas in a specific territory, in this case Caldas.

2.5 Conceptual framework





Chapter 3: Case study

3.1 Context and site selection

Colombia is located in the northwest corner of South America. It is one of the 17 megadiverse countries and has the second highest biodiversity in the world. The country is bordered by the Atlantic and Pacific oceans and is crossed by the Andes Mountain range, encompassing diverse landscapes such as the Amazon rainforest, highlands, grasslands, savannahs, deserts, coasts, and islands. Furthermore, it is the second country in the Americas with the greatest diversity of bamboos. Currently, 18 genera have been discovered, 105 species of which 69 are woody bamboos and 36 are herbaceous bamboos. There are ten local species that are noteworthy due to their relevance at the local level, and their export potential at the international level, the most outstanding is *Guadua angustifolia* (Londoño, 2011).

Species	Altitude (masl)	Habitat		
Guadua amplexifolia Guadua angustifolia Guadua macrospiculata Rhipidocladum racemiflorum	0-500	Tropical dry forest along rivers and streams; gallery forest; montane and low montane forest; inter-andean valley and Amazon rainforest		
G. angustifolia R. racemiflorum Otatea fimbriata	500-1500	Montane and low montane forest; humid and dry inter-andean valley		
G. angustifolia	1500-2000	Montane forest, along rivers and streams; inter-andean valley		
Chusquea antioquensis C. subulata R. geminatum R. harmonicum	2000-2500	Montane and high montane forest		
Aulonemia queko C. subulata R. geminatum R. lonaisniculatum	2500-3000	High montane forest		

Fig. 9- Relevant bamboo species in Colombia. Adapted from Londoño (2011)

Guadua angustifolia or guadua is the most relevant bamboo species in Colombia. The country has been recognised internationally for the generation of knowledge about this species; local research includes studies on taxonomy, quantification of environmental services, CO₂ capture, forest inventories, management and harvesting regimes, structural behaviour, physical and mechanical properties, among others. Colombia is also a pioneer in the structural use of guadua, the development of construction technologies and the development of quality standards for its cultivation, processing, and uses through ICONTEC (Londoño, 2011). The country has approximately 40,000 ha of guadua forests, of which 85% are natural and 15% cultivated. Guadua is mainly concentrated in the Coffee Region, between 900 and 2000 metres altitude (Castiblanco, 2018).

The Coffee Region is an area located in the central mountain range of Colombia with a unique landscape identity. It was declared a World Heritage Site by UNESCO in 2011 due to the high biodiversity, availability of local resources, social capital and built capacity throughout the time. This region is composed by 3 provinces: Caldas, Risaralda and Quindio, together they have an area of 141,120 ha and a population of approximately 2.2 million inhabitants (Colombia, DANE, 2018). Additionally, about 50% of natural guadua forests are in the rural areas of this region. Although Caldas has the second largest number of hectares (6195ha), it is the province with the highest fragmentation of guadua forests (Colombia, MADR, 2016a). Moreover, Caldas is the province in the region with the highest rural poverty rate (72.6%) defined by the Multidimensional Poverty Index (MPI) (Caldas, Caldata, 2020). These contrasting issues were key for the selection of Caldas as a case study.



Fig. 10- Location of Caldas and the Coffee Region in Colombia. Source: Author

3.2 Caldas: a socio-ecological system

The province of Caldas is located in the northern part of the Coffee Region, bordered by the Magdalena River to the east and the Cauca River to the west. It is divided in 27 municipalities with a total area of 788,800 ha, of which 11.86% is urban area and the remaining 88.14% is rural (Colombia, IGAC 2018), revealing its profoundly rural character. According to the Ministry of Agriculture and Rural Development, natural guadua forests in Caldas cover 5875 ha (95%) while cultivated forests cover approximately 320 ha (5%) (Colombia, MADR 2016).



Fig. 11— Natural guadua forest. Source: Author

Caldas is a complex socio-ecological system that must be examined from different viewpoints. From a social perspective, the demographic count conducted by the National Administrative Department of Statistics (DANE for its acronym in Spanish) in 2018 shows that the province has 923.472 inhabitants, of which 28% are rural population, 32.8% of this population lives in poverty according to the MPI (Caldas, Caldata, 2020). Some of the factors that determine the rural vulnerability to poverty include unemployment or informal jobs, lack of development opportunities for young people, economic dependence on coffee, inequality in land ownership, rural housing deficit, loss of ancestral knowledge, absence of generational shift, lack of connectivity and access to health services (Velasquez, 2011).

Furthermore, 76.3% of the rural economy of the province depends on coffee production (Caldas, Caldata, 2021), there are no alternative crops as relevant as coffee, increasing the risk of rural livelihoods to the impacts of unstable production and international price fluctuations.



Fig. 12— Planted guadua forest. Source: Author

From an ecological perspective, the predominant ecosystem in the rural areas of Caldas is the tropical rainforest, this is evident in the high biodiversity of the area with 8064 different species of flora and fauna (Colombia, SiB, 2021). The province is bordered by two of most important rivers in Colombia, Magdalena and Cauca River (Silva Barrera et al., 2011). In contrast, monoculture such as coffee, extensive use of agrochemicals, livestock farming, and urban growth have generated acute ecological problems such as the contamination of watersheds and deforestation of native forests. Consequently, forest species such as balso, yarumo, nogal, and guadua, which are the natural habitat of birds, mammals, amphibians, and reptiles, have diminished at an accelerated rate, threatening the natural habitat of animal species and thus the balance of the ecosystem (Oviedo-Celis and Castro-Escobar, 2021).



Fig. 13— Caldas: Socio-ecological system. Source: Author

3.3 Rural Caldas and guadua timeline

The territory occupied by Caldas, its rural areas and communities have been deeply linked to guadua since ancient times. Therefore, it is relevant to describe how the dynamics between them have been transformed over the centuries in order to understand the current situation.



Fig. 14- Timeline: overview. Source: Author

Before 16th century

Originally, several indigenous communities inhabited the territory of Caldas. The chiefdoms were distributed throughout the region, particularly in the mountains near the Cauca River due to the fertility of the soil. The most renowned community was the Quimbayas (Robledo, 1996). These settlements were located where the largest areas of natural guadua forests are found today. Guadua was of great cultural and economic importance for the original communities, as they gave it a multitude of uses and meanings. It was a fundamental part of the activities of daily life and rituals as it was the natural resource with the greatest availability; with guadua they provided shade on sunny days, built their shelters and fences, created tools for daily tasks and musical instruments for meeting nights, designed water collection systems, ladders, bridges and canoes (Robledo, 1996).





Fig. 15— Map of the indigenous groups that populated the Coffee Region. Adapted from Nova (2006)

Fig. 16— Illustrations of Quimbayas using guadua. Adapted from Giraldo de Puech (1986)

16th Century

The Spanish colonisation of the territory began in 1539. By 1559, at least 55% of the chiefdoms had disappeared (Cieza de León, 2005). During this period, shelters were built with guadua using the same techniques as the natives, as it was the most abundant resource for timber provision. Guadua lost its relevance as a multipurpose resource and was then used only as a construction material for temporary buildings, while the use of other woods increased due to their greater durability (Valencia Llano, 2010).

19th Century

A few centuries later, the process of resettlement in the Coffee Region started after the independence of Colombia in 1810. The new settlers came to Caldas from the neighbouring region of Antioquia escaping from the political violence they suffered in their territory (Valencia Llano, 2010). Most of the new settlements were established around large natural guadua forests, using colonial legacies combine with remnants of a pre-colonial tradition for the new constructions; temporary structures of guadua, wood and thatch were commonly used as shelters (Robledo, 1996).

Subsequently, when the new settlers found places to stay permanently, they began to build permanent rural dwellings on the mountains with guadua, esterilla and bahareque, a building technique that consists of making the walls with guadua slats and then filling them with earth and lime (Salas Delgado, 2006). Bahareque became the most widely used technique for construction due to the abundance of guadua and its ease of harvesting and collection (Arango, 1990).



Fig. 17— Illustrations of the scenes of Spanish colonisation in Caldas. Adapted from Barragan (2021)



Fig. 18— The evolution of the use of guadua as a construction material. Adapted from Castro-Escobar (2016)

20th Century

From its foundation in 1905, the prosperity of Caldas depended largely on gold mining and coffee cultivation, becoming the economic backbone of the province (Caldas, Gobernacion de Caldas, 2003). Rural communities inherited the ancestral tradition in the management of guadua, according to its life cycle and lunar phases. This knowledge was reflected in its high quality, hence it was used extensively for the construction of both rural and urban housing,

turning it into an important part of the identity of Caldas (Fonseca and Saldarriaga, 1992). However, the internal war and rural poverty provoked large rural-urban exodus, resulting in informal settlements built with low-cost materials as guadua, the most commonly used material for the shelters of the poorest families. Despite its great qualities for construction, the fires in Manizales between 1925-1926 discouraged the use of guadua as a structural material, being replaced by reinforced concrete and

other imported expensive materials (Robledo, 1996).





Fig. 19— The use of guadua for rural housing and informal settlements in Caldas. Adapted from Salas Delgado (2006)

Guadua began to lose its relevance as a rural livelihood, and natural guadua forests were replaced largely by extensive coffee and banana plantations. It was until the earthquake in 1999 that interest in guadua was renewed, as it demonstrated its earthquakeresistant potential due to its high flexibility and resilience. Research led by local experts, academia and international organisations (EU, GTZ, IDB) provided in-depth knowledge of the characteristics of guadua, while local architects and designers explored the multiple possibilities that guadua offers (Caldas, Camara de Comercio, 2002). The recognition of guadua as an extraordinary resource at the end of the 20th century and the beginning of the 21st century allowed the appreciation of its great potential, but

CASE STUDY

at the same time made visible the limitations that have hindered the myriad opportunities to become a natural resource acknowledged, valued, and promoted both locally and globally.

3.3 Guadua Angustifolia: Dimensions

According to its taxonomy, guadua belongs to the subfamily *Bambusoideae* which is part of the family *Poaceae*, featuring long, thorny stems, bands of white hairs in the nodal region and triangular-shaped leaves. It includes approximately 30 species found from 23° north latitude in Mexico, to 35° south latitude in Argentina. In 1822 the German botanist Karl Sigismund Kunth described it using the native word "guadua" from the native communities of Colombia and Ecuador, and the epithet angustifolia meaning narrow-leaved. *Guadua angustifolia* is considered the third largest bamboo in the world, after *Dendrocalamus giganteous* and *Dendrocalamus sinicus* in Asia, and is one of the 20 priority bamboo species in the world due to its physical, mechanical and durability properties, ideal for construction (Filgueiras et al., 1999)

Ecological dimension

Guadua angustifolia is one of the most important native plant species in Caldas due to its remarkable growth rate of 11-21 cm/day, heights of up to 30 metres, diameters of up to 22 cm, and 40% longitudinal fibre tissue. Its forests provide ecosystem services as biomass production, habitat for biodiversity, soil protection, water regulation, wood provision, and carbon sequestration (Londoño, 2011).

		Uses (according to plant section)	Description	Height	Length
1	Leader	Organic material	Apical part	20 m	1.20 - 2 m
Top part	Stick	Structural straps for roofs, and guides for temporal cultivations	Smallest section of the culm	18 m	3 m.
Middle part	Middle	Structures such as roof purlins, scaffolding, structural columns, planks, slender columns and beams	Most usable part of the culm for its diameter	11-15 m	4-8 m
Bottom part	Bottom	Columns in civil works, greenhouses and fences	Most resistant part of the culm since it has the greatest diameter	3 m	3 m
A ALLER AND	Rhizome	Sculpture, furniture, toys	Networks for nutrition and reproduction	2 m	2 m

Fig. 20- Guadua angustifolia: parts. Adapted from Hidalgo López (1981); Minke (2016)

In guadua forests with densities of 4050 individuals (culms) per hectare, carbon sequestration can be up to 126 ± 4 t/ha, where 85% is stored in the stem, branches, and leaves and the remaining 15% in the rhizome. Carbon storage levels peak during the first 2 years, then remain stable for the next 3-5 years and decrease thereafter, hence the culms should be ideally harvested between the fifth and seventh year, in order to fix the Co2 in products resulting from the harvested guadua Acknowledging the life cycle of guadua is key for a correct harvesting process that considers carbon sequestration as well as its regenerative rate to ensure the sustainability of the forest and the ecosystem services it provides (Arango and Camargo, 2010).



Fig. 21– Guadua angustifolia: life cycle. Adapted from Hidalgo López (1981); Minke (2016)

Although, its qualities make it one of the most suitable natural resources for mitigating climate change these forests have been suffering a process of degradation due to poor agricultural practices, pressure from urban growth and the high rate of deforestation and fragmentation evidenced by the fact that 75% of the forests are only 5ha on average (Duque Escobar, Moreno Orjuela and Ortiz Ortiz, 2012). Recent research suggests that this risk can be addressed by advocating for the great potential of guadua forest to benefit from national and international incentives that promote climate change mitigation through the maintenance of forests that store significant amounts of Co2, sustainable wood and energy provision (Arango and Camargo, 2010; Muñoz López, Camargo García and Romero Ladino, 2021)

CASE STUDY

Sociocultural dimension

Guadua angustifolia is an ancestral tradition that has been used since pre-colonial times by the indigenous and rural communities. Some of the uses of guadua over time include housing, handicrafts, paper, panels, boards, veneer, flooring, roofing, textiles and fuel; approximately 90% has been used in constructionrelated activities (Colombia, MADR, 2021a). Its predominant use in construction has resulted in the development of vernacular techniques such as bahareque - commonly used for rural and low-cost housing - and has inspired architects such as Simón Vélez to develop advanced techniques applied to innovative constructions recognised worldwide. Additionally, academia and environmental authorities have been interested in further investigating the properties of this species in the region, establishing research centres and groups articulated with the National Learning Service (SENA) that promotes the training of young bamboo experts (Ospina Villegas et al., 2006).

Nevertheless, some dynamics have restricted its use, such as the negative cultural conception of it as the "raw material of the poor", due to its historical use for low-cost constructions, facing increasing challenges to remain as a local material that provides livelihoods, particularly for rural communities that are the most vulnerable (Duque Escobar, Moreno Orjuela and Ortiz Ortiz, 2012). Moreover, some stakeholders have tried to reverse this tendency through the dissemination of the knowledge generated in the different research and development projects, but as they have been promoted in silos, widespread impact has not been achieved.





Fig. 22— Guadua angustifolia: vernacular and contemporary construction techniques. Adapted from Salas Delgado (2006)

Although there have been efforts to articulate stakeholders in a single production chain, the lack of a shared vision, difficulties of cooperation and trust between the main stakeholders are conflicts that need to be examined in greater depth (Duque Escobar, Moreno Orjuela and Ortiz Ortiz, 2012). The most relevant stakeholders in the sector correspond to each of the links in the production chain; landowners-producers, farm managers, and workers in forestry; guadua harvesters or guadueros, and transporters in harvesting; craftsmen, designers, builders, and industry in processing; traders and timber warehouses in marketing; and finally, the consumers. Additionally, there are cross-cutting actors such as research and funding institutes, academia, producers and traders associations and environmental authorities (Moreno Orjuela and Mejía Gallón, 2013).

Economic dimension

Despite the relevance of guadua as a support material in the development of rural and urban industries such as agriculture and construction, its participation in the local economy is low (Colombia, MADR, 2021a). Guadua industry in Colombia could generate up to 60 million dollars per year, but currently it barely reaches 10 million dollars annually. This low participation is related to the low cost and quality of the harvest, the undervaluation of its potential and the limitations faced by each of the links in the production chain (Londoño, 2011).



Fig. 23- Guadua angustifolia: Stakeholders and production chain. Adapted from Moreno Orjuela and Mejía Gallón (2013)

Despite initiatives developing industrial products with guadua -flooring, laminates, plywood, boards, agglomerates-, and good practices for harvesting, guadua producers and harvesters have not widely adopted them, resulting in low quality (Londoño, 2011). Thus, guadua harvested with low standards is used as raw and disposable material to support construction -formwork, scaffolding, mats-. As it is not yet a value-added resource with a demand increasingly inconsistent, rural livelihoods can hardly depend on it (McCormick and Ledesma, 2007).

CASE STUDY

This situation has prompted the establishment of the Guadua and bamboo production chain and its agroindustry in Colombia. Its mission is to promote and facilitate dialogue between the different links in the chain and the government, to achieve higher levels of competitiveness and contribute to the conservation of the resource as part of the strategies for mitigation and adaptation to climate change and for sustainable development (Colombia, MADR, 2021a).

Institutional dimension

Guadua angustifolia is classified by law as a wild forest species. Although this law was originally created to protect deteriorated guadua forests and regulate their harvesting, it has also limited its use and discourage investment, resulting in its marginal character in the regional and national economy (Londoño, 2011). In some countries such as Mexico, Brazil and even China, guadua and bamboo are classified as agroforestry resources to avoid limiting its production and harvesting, recognising their high growth and regeneration rate and the multiple uses it can supply (Garavito-Rodríguez, 2020).

In Colombia, the legislative process has its origins in the uncontrolled exploitation of guadua. In this process, the expansion of the agricultural frontier, mainly with coffee crops, and guadueros intensifying the exploitation of guadua, led to the reduction of forest areas. In addition, the lack of knowledge of its life cycle and reproduction, supported the belief that when guadua blossoms, dies (Duque Escobar, Moreno Orjuela and Ortiz Ortiz, 2012). Henceforth, law 2811 was created in 1974 to protect and regulate the guadua as a wild forest species (Colombia, National Congress, 1974).

Subsequently, decree 1791 of 1996 establishes that the Regional Autonomous Corporations (CAR) as local environmental authority are in charge of protecting and regulating forest resources such as guadua, through the issuing of harvesting permits that will depend on their prior evaluation of the forest to be intervened. The corporation -Corpocaldas in Caldas- also exercises control over the legality of the timber sold in the warehouses (Colombia, National Congress, 1996). Furthermore, decree 1076 of 2015 dictates that a protective forest area of at least 30 metres must be conserved on both banks of the rivers, where most of the natural guadua forests are located. It also states that the guadua to be transported must have an additional mobility permit (Colombia, National Congress, 2015). Until then, the Ministry of Environment was in charge of protecting and regulating the guadua through the CARs. However, Resolution 1740 established general guidelines for the management of cultivated guadua forests by the Ministry of Agriculture and the Colombian Agricultural Institute (ICA) as the regulatory body, enabling it to be considered an agroforestry resource supported by research that demonstrates its capacity to be a highly renewable natural resource (Colombia, MADR, 2016b). Resolution 000009 of 2021 recognises the organisation of the guadua and bamboo production chain to promote its development as a sustainable livelihood (Colombia, MADR, 2021b). Nevertheless, there is still a conflict between the law that protects and regulates guadua as a forest resource and the latest legislation that promotes it as an agroforestry resource.



Fig. 24— Guadua and bamboo legislative process. Adapted from Garavito-Rodríguez (2020)

In a parallel legislative process, in 1998 the Colombian Standard for Earthquake Resistant Design and Construction (NSR-98) incorporated minimum requirements for the design and construction of one and two-storey houses of bahareque with timber and guadua. In its 2010 updated version (NSR-10), promotes the use of environmentally friendly materials and extends the use of guadua structurally in one and two-storey constructions (Londoño, 2011).



Chapter 4: Methodological framework

4.1 Qualitative methodology

The research interests respond to an interpretative purpose specified in the question and objectives aimed at providing empirical evidence on the dynamics of guadua as a natural resource as well as its dimensions in the rural areas of Caldas. This interest implies the use of a qualitative design. This methodology consists of the construction or generation of a theory based on a series of propositions extracted from a theoretical body that will serve as a starting point for the researcher, for which it is not necessary to extract a representative sample, but rather a theoretical sample consisting of one or more cases (Pérez Serrano, 2014). For this purpose, strategies of desk research and case study are conducted (Yin, 1994).

According to Yin (2003), case studies as a research strategy are used to contribute to the understanding of phenomena related to individual, group, organisational, social and political phenomena; similarly, Rodríguez-Gómez, Gil-Flores and Garcia-Jimenez (1996) argue that case studies are based on inductive reasoning; thus, the generalisations, concepts and hypotheses that can be made about the role of bamboo in regenerative development emerged from a thorough analysis of the conversations and activities with rural community members, experts and environmental authorities participating in this study. The main characteristic of this type of study is that it allows for the discovery of new relationships and concepts, rather than verifying or testing previously formulated hypotheses. This definition of case study has a strong affinity with the interest of this research, which aims to describe and explain the content of the role of bamboo, understanding

METHODOLOGICAL FRAMEWORK

its internal structure of production and enunciation; in other words, from the meaning that the participants gave to their knowledge, experiences, and perceptions from the context in which they are immersed.

For this research, the case study allowed to understand the experiences and perceptions of a group of 21 members of the rural community, 1 representative of the environmental authority, and 7 experts on bamboo in fields such as research, production, sales, architecture, design, crafts, carpentry, and industry. In this sense, past experiences, present perceptions, and future visions are considered for deepening, relating, and differentiating the roles of bamboo in rural development. In terms of Yin (1994), it is an effort that attempts to describe, understand and broaden the conceptual and investigative look that is given to the role of bamboo in regenerative rural development.

Moreover, according to Pérez Serrano (2014) case studies contain rich and in-depth descriptions of phenomena. The information collected is used to develop conceptual categories or to defend or challenge theoretical assumptions defended before the information was collected. Therefore, the aim of the case study is to provide in-depth descriptions that account for the meaning of the experiences, knowledge and dimensions of bamboo and its role in rural regenerative development. In order to achieve an in-depth reconstruction of the aforementioned categories, various techniques and instruments were combined to collect information appropriate to the population, i.e., be attractive and motivating for the different participants. Yin (2003), states that triangulation is not about giving a sequential interpretation of the converging data, but in ensuring that all the different evidence - drawing, explanation, workshop, conversation are directed towards evaluating the same fact or concept.

4.2 Primary data collection

The data collection instruments are indicated to examine in depth the role of guadua in the department of Caldas from the knowledge, experiences, and evaluations of the participants in the specific context addressed in this research. The plan for collecting and generating information in the qualitative approach to social research, is a reflexive process under permanent construction that operates at all stages of the study process. Qualitative research designs combine strategies and research methods according to the object of study and the conditions in

which the research is conducted. To this end, the secondary data obtained in the documentary research is confronted with the results obtained from the primary data (Galeano Marín, 2018).

To answer the question about the potential role of guadua in the promotion of regenerative rural development in Caldas, several types of activities are developed in this research, articulated in two steps:

1. Constitution and delimitation of the participants: consisting of 21 members of the rural community, 1 representative of the environmental authority (Corpocaldas), and 7 guadua experts in fields such as research, production, sales, architecture, design, handicrafts, carpentry, and industry.

2. Information gathering: 1 workshop and 2 focus groups were designed for members of the rural community, and semi-structured interviews were conducted with experts, producers, and environmental authorities. These instruments were validated beforehand through expert judgement by 3 researchers with PhD degrees from public and private universities in Manizales, Caldas. The information derived from the focus groups with the community was also validated by the end of the sessions.

Considering that this research is not intended to generalise results beyond what is offered by the case study and that its main objective was the comprehension of the case itself (Stake, 1995), primary information is provided by the participants through two methods of qualitative data collection:

1. Semi-structured interviews: semi-structured interview allows for an open discussion with greater freedom in the interviewees' narration within a conversation that stems from the general problem of the study in question. Its semi-structured character allows for the clarification of the proposed categories of analysis and the recognition of new categories (Aigneren, 2002).

2. Focus groups: focus groups aim to obtain information on opinions and experiences based on facts, expectations, and knowledge about a topic. The group establishes a space for "group opinion", in which participants make use of the right to share or omit opinions and knowledge that are regulated in the group exchange. This is the essence of its artificial character, as the researcher brings them together and constitutes them as a group (Aigneren, 2002).

Semi-structured interviews dynamics

The interviews were conducted in Caldas between March and May 2022, with a total of 8 participants who are experts on bamboo in fields such as scientific research, production and harvesting, trade, design, carpentry, crafts, architecture, industry, and environmental legislation. Based on the guide I (Appendix A), the modality was offline in 5 cases and online in the remaining 3 due to some restrictions connected to the COVID 19 pandemic.

Focus group dynamics

- 1. *Mapping:* it allowed the location and outlined the work route in the territory in which this research was conducted; the key actors and people who would provide the most relevant features and data on the subject under study were identified. It was a previous moment of documentary review, with preliminary visits to the rural areas, direct observations, and informal conversations.
- 2. *Calling:* the rural community members were encouraged to participate in the sessions, using the database of Junta de Acción Comunal JAC (Community Action Board) in Caldas as a reference point.
- 3. *Team:* a support team was integrated with a research assistant, moderator, and logistical support -adaptation of the space, audio-visual recording, delivery of support material and snacks-.
- 4. *Time slot:* the focus group discussion took place between 2:00 p.m. and 5:30 p.m. The richness of the reflections with the (21) leaders participating in the research left no time for breaks.
- 5. *Instruments:* workshop and discussion were used as instruments at two stages:
 - Stage I -Participatory workshop: Each of the invited participants/leaders of the JAC joined a participatory network workshop with a duration of approximately one hour.
 - Stage II Focus groups: the discussion is opened based on the guide II (Appendix B) which contains open questions designed around the object of the study, such as the role of bamboo in regenerative rural development. The categories proposed in the research were validated and the new emerging categories that arose from the discussion and interaction with the leaders on the topic proposed by the researcher were recognised. The process is recorded through film, audio, and notebook notes -conducted by the principal researcher- and served as a reference to guide the systematisation of the discussions and joint analysis of the results.



Fig. 26- Workshop with rural community members. Source: Author

4.3 Data processing

The data collected is processed through the transformation, systematisation, and analysis of the information to provide a description and interpretation of the roles of the guadua, as well as the detection of possible similarities, differences and undisclosed aspects related to the categories of the study. To this end, three methods are used:

- 1. Transcriptions: organisation and classification of the written sources.
- 2. *Thematic analysis matrix:* construction, naming, and definition of first and second order categories; selection of the units of analysis, assignment of codes
- 3. *ATLAS.ti:* creation of conceptual or semantic networks and analytical interpretation.

The literature review has been permanent in the different phases of the research: formulation of the problem, development, and execution of the research.

1. Transcriptions

The first step is the transformation of the information through natural transcriptions, where the audio and visual information collected in the interviews, the workshop and the focus group were transformed into a written format.

METHODOLOGICAL FRAMEWORK

According to (Davidson, 2009), the main feature of natural transcription is that it presents the information in a clean and fluid way to facilitate further analysis. However, it has the risk of altering the understanding of the context by omitting certain features of the speaker's intonation, which in the researcher's criteria are not relevant to the analysis.

2. Thematic analysis matrix

The second step is the classification of the information contained in the transcripts through a thematic analysis matrix. Thematic analysis is a qualitative research tool for identifying, analysing and reporting patterns, i.e. themes within empirically collected data; it organises and describes the data set in detail, and interprets aspects of each identified theme (Barrera, Tonon and Salgado, 2012). The responses were tabulated in the office program Excel allowing the initial analysis of the perceptions, knowledge, and experiences with guadua in Caldas. The primary information was recorded according to previously identified categories - e.g., Past, present, future - and subcategories - i.e., ecological, sociocultural, economic, and institutional dimensions. This information was summarised in abstracts as a basis for the definition of codes and sub-codes for the next step.

3. Atlas Ti: digital analysis tool

Atlas Ti is a programme that supports the processing of information for qualitative analysis; its theoretical foundation is based on Glaser and Strauss' Grounded Theory (1967). Atlas Ti facilitates the systematic and qualitative description of the manifest or implicit content of data sources such as interviews, focus groups, and other kind of documents. The responsibility for interpretation rests exclusively with the researcher, who must implement these procedures in a flexible manner according to the objectives of the study (Varguillas, 2006).

Atlas Ti works as a container that holds the records of all the data or Hermeneutic Units (HU). The HU holds the source data paths and stores the codes, code families, and network views that are conducted in the research. Coding, as a basic activity for the conduct of the study, refers to the process of assigning categories, concepts, or codes to segments of information that are of interest to the research objectives. Visualisation is another key element in discovering connections between concepts, interpreting findings, and effectively communicating results. These are referred to as Network and Relationship Views which graphically outline the relationship of the data obtained for further analysis (Friese, 2014). In this case, the networks were generated from the categories defined by the dimensions - ecological, sociocultural, economic, and institutional - at three points in time - past, present, and future. The data collected was transformed into codes that grouped similar HU. The networks allowed to recognise the main trends, which were the most saturated related to the number of times they were mentioned by the participants, and the type of relationships between the codes.



Chapter 5: Analysis and findings

5.1 The four dimensions: trends and saturation

The trends recognised in each of the dimensions were based on the recognition of the drivers of regeneration or degeneration around guadua and its dynamic in Caldas. As part of these trends, the events with the highest saturation were determined considering the number of times they were mentioned by the different participants.

5.1.1 Ecological dimension

- *Ecological restoration:* 16% of the codes were connected to ecological restoration as a regenerative drive. The codes with the highest saturation in this trend were:
- Wide range of guadua ecosystem services
- Most ecologically valuable resource in Caldas
- Regular thinning ensuring sustainability, quality and controls spreading
- Guadua extraordinary flexibility rate and load capacity
- Updating guadua classification to local domesticated agroforestry species
- Promoting guadua as building material for its lower environmental impact
- Tackling deforestation as a priority
- Guadua must be reforested and nurtured by rural communities
- *Ecological deterioration:* 5% of the codes were linked to ecological deterioration as a degenerative drive. The codes with the highest saturation in this trend were:
- Misconception of guadua features resulted in its misclassification as a tree
- Deforestation due to decrease in value.
- Livestock farming, agriculture, and urbanisation as the biggest threats to remaining guadua forests
- Inadequate guadua harvesting practices are resulting in low quality





Fig. 29— Ecological deterioration. Source: Author

5.1.2 Sociocultural dimension

- *Sociocultural appropriation:* 26% of the codes were related to sociocultural appropriation as a regenerative drive. The codes with the highest saturation in this trend were:
- Relevance of traditional knowledge to ensure guadua sustainability
- Interest in guadua linked to the contact with it since childhood
- Significant local research and experiments on guadua development
- Guadua and its parts multiple uses
- Rebranding Colombia as guadua producer internationally
- Fostering sense of self-worth of guadua
- Training guadua producers in regenerative production schemes
- Awakening interest in guadua through educational tourism and social events
- *Sociocultural stigmatisation:* 13% of the codes were linked to sociocultural stigmatisation as a degenerative drive. The codes with the highest saturation in this trend were:
- · Greater interest in guadua internationally than locally
- Negative perception affected social housing projects using guadua
- Lack of general knowledge about guadua
- Lack of vision and appreciation for guadua value





Fig. 30— Sociocultural appropriation. Source: Author

Fig. 31— Sociocultural stigmatisation Source: Author

5.1.3 Economic dimension

- *Economic leverage:* 11% of the codes were connected to economic leverage as a regenerative drive. The codes with the highest saturation in this trend were:

- Guadua as the main material of construction boom in the 80's
- The possibility of guadua industry of generate up to 60 billion dollars
- The establishment of guadua production chain seeking to boost its use
- Value-added guadua products that are still profitable.
- Industry dealing directly with guadua producers ensures quality and steady flow
- Government support is needed to boost guadua industry
- Increasing share of guadua in global bamboo market
- Establishing a steady flow demand for guadua
- *Economic stagnation:* 10% of the codes were related to economic stagnation as a degenerative drive. The codes with the highest saturation in this trend were:
- Colombia has failed to develop profitable guadua industry
- From 8 guadua industry attempts only 1 remains
- Inadequate taxes, permits, regulations and corruption
- Corruption keeping local and foreign industry from establishing in the region are economic stagnation.





5.1.4 Institutional dimension

- *Institutional improvements:* 8% of the codes were connected to institutional improvement as a regenerative drive. The codes with the highest saturation in this trend were:

Source: Author

- Local development of standards for using guadua through ICONTEC
- Guadua included in national building code thanks to Simon Velez innovative uses of guadua
- Attempts for Ministry of Agriculture to regulate guadua instead Ministry of Environment
- · Corpocaldas' mission to conserve forests and sanctioning malpractices
- Urging Ministry of Agriculture to take charge of guadua regulation, coordinating institutions to strengthen guadua local development
- Creation of a ministry policy encouraging social housing projects using certain percentage of guadua
- Dismantling bureaucratic processes hindering guadua development
- *Institutional constraints:* 10% of the codes were related to institutional constraints as a degenerative drive. The codes with the highest saturation in this trend were:
- Corpocaldas bureaucracy fuelled corruption around permits to harvest
- Multiple failed attempts to correct the law that misclassified guadua
- Corruption within institutions regulating guadua limit its development
- Environmental authority allowing guadua deforestation in exchange for bribes
- There is nothing to be done since corruption is part of the system





Fig. 34— Institutional improvements Source: Author

Fig. 35— Institutional constraints. Source: Author

5.2 Dynamics and dimensions: three moments

5.2.1 Historical dynamics: Guadua from personal experience

Ecological dimension

In terms of ecological restoration, local researchers demonstrated that guadua was and remains the most ecologically valuable native species in Caldas and a driver of regeneration due to its wide range of ecosystem services, including CO2 sequestration, water regulation, habitat for biodiversity and timber provision. Moreover, guadua proved to be the most relevant native bamboo species and the one with the best construction capabilities, especially for its earthquake resistant quality. However, the ecological deterioration suffered by guadua was connected to the lack of massive awareness of its features and life cycle, causing the deforestation of this resource and its replacement by other more profitable agricultural products such as coffee.

Sociocultural dimension

Regarding sociocultural appropriation, it was highlighted how guadua enabled regional development as an available building material and its contribution to post-earthquake reconstruction, which encouraged interest in guadua and local technical developments at the international level, especially in China and Germany. Due to its great potential as a sustainable local building material, both luxury and low-cost housing projects were designed to promote its use more widely. Nevertheless, sociocultural stigmatisation was evident mainly due to the perception of guadua as a material of the poor and not durable when used in lowcost constructions, resulting in the lack of interest in using it locally. An example of this was the project of social housing built in a large percentage with guadua, which despite being affordable for low-income families, many people refused to invest in them due to this negative perception.

Economic dimension

Concerning economic leverage, guadua was the main construction material for several decades in Caldas before the arrival of steel, iron, and cement. Had this trend continued, guadua could have become a significant part of the local economy. On the contrary, economic stagnation was and still is related to the low market value of guadua, affecting the livelihoods of producers, and the inability to develop a profitable guadua industry as other timber industries have been, despite being foreign species. This is evidenced by the fact that out of eight guadua industry initiatives only one remains.

Institutional dimension

From the perspective of institutional improvements, the use of guadua in construction prompted the creation of the Colombian Bamboo Society to promote scientific knowledge about guadua and the development of local technical standards for its optimal use through ICONTEC (Colombian Institute of Technical Standards). Although there were attempts to ban guadua as a building material by not including it in the national building code, thanks to the efforts of local architect Simón Vélez, internationally recognised for his innovative use of guadua, it was eventually included in the national building code. Conversely, institutional constraints imposed by Law 2811 of 1974, which erroneously classified guadua as a wild tree and subsequently delegated its protection and regulation to local environmental authorities such as Corpocaldas, made it easier for public officials to profit illegally from the issuing of permits to harvest it through bribes. Although there have been attempts to correct this law, none have succeeded.



Fig. 36- Historical dynamics. Source: Author



Ecological dimension

Currently, ecological restoration is based on the recognition of the optimal characteristics of the Caldas ecosystem to produce high quality guadua, demonstrated in the high growth and productivity rates in terms of volume of production per hectare. In order to preserve the high quality, sustainability and control its spread, regular maintenance by means of thinning and better harvesting practices, that also contemplate ancestral knowledge based on the lunar phases, are necessary. Additionally, it should be considered that 95% of the existing guadua is natural and is generally located on riverbanks as protective barriers, requiring effective and sustainable management.

ANALYSIS AND FINDINGS

In comparison, it is considered that the remaining guadua forests in Caldas are mostly fragmented, a trend that is increasing due to activities such as livestock farming, extensive agriculture, and urbanisation, thus resulting in ecological deterioration. Moreover, the steep topography makes it difficult to extract, only 3% of the total available guadua is being harvested and most of it with inadequate practices, diminishing its quality and its capacity to regenerate.

Sociocultural dimension

In terms of sociocultural appropriation, guadua is recognised as an indispensable part of the identity of rural Caldas; through ancestral knowledge, myths, and legends its cultural relevance is perpetuated, and it is seen as a valuable tradition. Some educational programmes have attempted to disseminate the importance of guadua to youth and children to ensure that this knowledge is passed on from generation to generation. Furthermore, local research and experimentation by experts on the parts of the guadua and their multiple uses demonstrates its extraordinary properties and the value they could represent if further developed. One of the most relevant construction techniques developed so far is the technique of injecting cement to make the joints of the guadua more resistant, transforming it into the "plant-based steel".

In contrast, sociocultural stigmatisation remains linked to the widespread lack of knowledge about guadua and the perception that it is either for lower or upper classes, resulting in the waste of its potential as an undervalued and underutilised natural resource. Additionally, the lack of articulation between the different stakeholders is evident in the disconnection of academia with industry both in the research of innovative uses of guadua and in the provision of formal jobs for young people trained in its management, resulting in labour shortages and scepticism in the entrepreneurship of industrialised guadua products.

Economic dimension

Regarding economic leverage, the establishment of the guadua production chain is perceived as a major step towards the articulation of the links and their stakeholders, contributing to the sustainability of the livelihoods of producers and all related actors over time. Furthermore, the remaining industry demonstrates that the potential of guadua, beyond being a secondary building material, lies in value-added products, such as Strand Woven Bamboo and Plywood, which can generate a steady demand and thus meet the abundant supply of guadua. Conversely, economic stagnation is evidenced by the current low value of guadua in the local market, since it is sold mostly as raw material, its value is not sufficient to be a means of livelihood. Experts and investors prefer to migrate to other countries in search of better opportunities, and products made from bamboo, instead of being produced locally, are imported from countries such as China. Despite initiatives to create a guadua industry by both local and international companies, most have failed due to two main factors: inadequate permits, taxes and regulations coupled with corrupt bribe demands, and the lack of steady demand that can absorb the available supply of guadua.

Institutional dimension

As part of institutional improvements, currently, natural guadua forests are regulated by Corpocaldas as part of the Ministry of Environment, while planted forests are regulated by the ICA (Colombian Agricultural Institute) as part of the Ministry of Agriculture. Since it has been proven that guadua is an agroforestry resource rather than forestry, attempts have been made to regulate it exclusively by the Ministry of Agriculture. Opinions are divided on this issue, with some stakeholders recognising the efforts of Corpocaldas in protecting the remaining guadua forests, while others see it as an excuse to continue profiting illegally from the permits, which is directly connected to institutional constraints marred by corruption.

Corpocaldas is the authority in charge of protecting and regulating guadua. Despite being the most harvested native species, it is only allowed to harvest up to 35% of the *gecha* or ready-to-harvest, which is not enough to make it profitable. In addition, Corpocaldas is an institution perceived as inefficient due to delays in issuing harvesting permits, with high levels of corruption reflected in the exchange of permits for bribes and the close relationship with politicians in the House of Representatives who have not allowed the law created in 1974 to be updated. As an outcome of this, deforestation has increased and interest in guadua has diminished. These limitations are also connected to the time-consuming and costly permits required to harvest and transport guadua.

ANALYSIS AND FINDINGS



Fig. 37- Current dynamics. Source: Author

5.2.3 Future dynamics: Guadua for Regenerative Development

Ecological dimension

According to the participants, ecological restoration in a regenerative way has to start by developing an updated inventory of the guadua forests specifying their location, condition, and who owns them. It should also consider the inclusion of landowners and rural communities in the reforestation, nurturing, maintenance and thinning of the guadua forests and the surrounding ecosystem. These wellmanaged forests, in addition to the many ecosystem services they provide, can absorb up to 400 tons of CO₂ per hectare, an opportunity for participate in carbon markets, and capture the CO₂ for a longer period of time if guadua is converted into products. Moreover, characteristics such as high reproductive and growth rates make it a low environmental impact building material, making it a sustainable timber option, and avoiding the deforestation of native trees for these purposes.

Sociocultural dimension

Sociocultural appropriation through the lens of regenerative development has to be built from within, instilling a passion for guadua in new generations by awakening a sense of self-worth about this extraordinary local resource, and providing the tools to make guadua an alternative livelihood for rural youth through training in regenerative management, and educational tourism. Furthermore, the knowledge produced by academia, industry, institutions, producers, and the rural community should be articulated in awareness campaigns where the potential of guadua is disseminated locally, and the design of rebranding campaigns promoting Caldas and Colombia as a bamboo producing country internationally.

Economic dimension

Economic leverage in the framework of regenerative development should consider that the sustained activation of the local market depends on the success of the guadua industry and the production of value-added products. To this end, processing plants should be established close to the guadua forests in order to determine direct relationships and constant flows between industry and production that benefit both supply and demand. It would also be beneficial to establish links with the local construction industry who can drive this constant demand by using a certain percentage of guadua products in their projects. Moreover, participation in the global bamboo market can be increased if the government encourages the local industry by generating international promotional campaigns that raise awareness of the Colombian guadua industry.

Institutional dimension

Institutional improvements shall aim to promote regenerative development through guadua. In the short term, bureaucratic processes within Corpocaldas that foster corruption of some officials, should be dismantled, and permits should be granted more efficiently, e.g., by using technological tools. In the medium term, the legislative classification of guadua should be updated from wild forest species to agroforestry species, differentiating between natural and cultivated forest, so that it is no longer regulated by the Ministry of Environment but by the Ministry of Agriculture. In the long term, the ministries of agriculture and housing should

ANALYSIS AND FINDINGS

be articulated so the use of guadua is promoted in the construction of social housing by establishing a policy of minimum percentage , benefiting landowner/ producers and rural communities in general.



Fig. 38- Future visions. Source: Author



Chapter 6: Discussion

Guadua has been closely linked to the development of Caldas, from the multiplicity of uses and meanings given to it by the Quimbayas, its use in the construction of temporary structures during the Spanish colonisation, and the development of construction techniques during the settlement of the Antioqueños, to its massive use in the construction of the cities that currently constitute the province. Previous assumptions linked the current ecological deterioration and lack of value of guadua to factors such as (1) restrictions imposed by national legislation that defines guadua as a protected wild forest resource, limiting its potential and discouraging investment in its production and development (Londoño, 2011), and (2) social stigmatisation as it is considered the "raw material of the poor" due to its historical use in local and low-cost constructions, limiting its potential for mass use in social housing projects (Held and Manzano, 2003). Despite its potential as a local and renewable natural resource, the undervaluation of guadua is also reflected in its low participation in the local and global economy (0.1%) (INBAR, 2019). The findings of this research have shown that these assumptions are part of the current situation of guadua, however, the dynamics around guadua have been marked by multiple opposing phenomena that have depended mostly on the level of local interest in this renewable natural resource.

In recent history, local knowledge about its characteristics and life cycle was not sufficient to recognise its value, limiting its potential as a means of rural livelihood and earning it the reputation of being "wood for the poor", this situation caused some guadua forests to be eliminated and replaced by more profitable crops such as coffee. This is consistent with previous suggestions by Duque Escobar, Moreno Orjuela and Ortiz Ortiz (2012) when stating that the decrease in the original

DISCUSSION

population of Guadua angustifolia was due to the advance of hillside agriculture in the last two centuries, especially in the consolidation of coffee production. The 20th century meant the transformation of guadua forest into firewood for sugar cane ovens, and its subsequent stigmatisation as a timber element for the poor class, which made it vulnerable once there was demographic expansion in the Coffee Region. The levels of deforestation noted by some experts resulted in the creation of law 2811 which classified guadua as a wild tree in order to protect and regulate it, without considering that this misclassification and restrictions would lead to forms of corruption in the granting of permits at a later stage.

In contrast, guadua was still considered an important part of the landscape identity due to its regulating, provisioning, and cultural ecosystem services. It has particularly excelled in the construction sector for its extraordinary qualities of strength and flexibility, turning it into the main material for post-earthquake reconstruction, arousing the interest of countries such as China and Germany in funding research and experiments around its structural possibilities. Furthermore, local architects and designers developed both low-cost and luxurious constructions to demonstrate the versatility of guadua locally and globally, granting its inclusion in the national building code and local standards of use to be developed with the support of ICONTEC. This agrees with Londoño (2011) who suggested that over the years, different bodies have been created to coordinate activities related to guadua, some of them without legal support and others with legal support. These associations have arisen from the need to unveil together guadua as a unique material.

At present, guadua is still considered a valuable tradition that represents identity in Caldas. Research and experiments conducted by local experts have proven the extraordinary quality of Caldas guadua due to the characteristics of its soils and harvesting techniques based on thinning and regular maintenance, both for natural and cultivated forests. The development of innovative construction techniques and value-added products has allowed the possibility of unlocking the potential of guadua, leveraged by the recent articulation of the production chain and the Ministry of Agriculture's interest in supporting producers and rural communities to make guadua an alternative and sustainable livelihood. This confirms what was indicated by Colombia, MADR (2021) by ensuring that the Guadua production chain has made significant progress in research and technological development in construction systems, and in the generation valueadded products e.g., cosmetic and pharmaceutical. Hence, these innovations are the basis for the strategic direction of this production chain towards the development of new products under quality protocols, to participate in the construction market, mainly at the national level and in export markets for natural ingredients with a green seal.

Nevertheless, the potential of guadua remains largely undeveloped. Despite guadua programmes promoted by local and national experts, the lack of articulation between actors has diminished the local impact; more profitable activities such as livestock farming, extensive agriculture and urban growth have caused the fragmentation of the guadua forests in Caldas. Additionally, the demand for its use in construction has been reduced to a low-cost secondary material, while locally consumed bamboo products are imported from China, affecting the livelihoods of producers and rural communities. Furthermore, outdated laws, taxation, corruption, and inefficiency of Corpocaldas as an environmental authority have led experts and industry to establish themselves in other countries where the development of a steady and profitable demand for guadua is possible. All of the above complements what has been established by García Díaz et al. (2021) by highlighting the great challenges Colombia faces in terms of trade and legislation, although there have been advances in terms of technology and research, this has not translated into income for the stakeholders in the production chain such as producers, transporters, and entrepreneurs, nor has there been market penetration of the products that have been developed in the country.

For the future, guadua is considered a determining factor for the regenerative development of the rural areas of Caldas and climate change mitigation. To this end, actions must be implemented to pave the way ensuring ecological restoration, sociocultural appropriation, economic leverage, and institutional improvements. To begin with, the knowledge generated by the different stakeholders (producers, rural communities, guadua growers, academia, industry, institutions) should be articulated to establish plans for reforestation, stewardship, maintenance, thinning and harvesting of guadua forests, including those located in watersheds, and thus restore their ecological value. Restored guadua forests can also become sites for educational tourism where a sense of self-worth is promoted through local awareness campaigns that increase interest in guadua in new generations.

It is also necessary to have an updated inventory of guadua forests including location, condition, and ownership since with this data it will be possible to determine the exact CO₂ absorption capacity, opening the possibility to participate in national and international carbon markets. As argued by Aguirre and Criollo (2020) guadua forests could be included in such initiatives, at the national level, the Forestry Incentive Certificate (CFI), BanCO₂, and at the regional level the greenhouse gas offset programme "Incorporating Biodiversity in the Coffee Sector in Colombia (IBSCC). Moreover, it could also be included in international initiatives such as the Verification Carbon Standard (VCS), the Reducing Emissions from Deforestation and Forest Degradation (REDD+) framework, and the Forest Stewardship Council (FSC).

Finally, determining the amount that can be harvested for sustainable timber and the production of value-added products is key to ensuring guadua production as a sustainable rural livelihood. The sustainability of these livelihoods depends largely on the constant flow between supply and demand of guadua, which can be ensured through the articulation between producers and industry. Therefore, guadua should be promoted by the local and national government through actions such as updating the law that protects guadua as a forestry species, and change the classification to agroforestry resource, establishing the Ministry of Agriculture as the controlling entity while involving the Ministry of housing in new policies. Thus, foster the creation of policies that establish a percentage of guadua in the construction of social housing locally, while designing rebranding campaigns that promote guadua internationally as a high-quality Colombian bamboo.



Chapter 7: Conclusions

7.1 Concluding remarks

Conventional development paradigm is considered the main cause of the current climate crisis, which in turn has exacerbated the vulnerability of rural areas and their communities. Bamboo forests have proven to be a renewable natural resource capable of mitigating risk through climate action and the provision of rural livelihoods, particularly in tropical and subtropical countries. Colombia, as the second country with the largest variety of bamboo species in the Americas, is also home to the most relevant native species: Guadua angustifolia, located mainly in the Coffee Region. The province of Caldas, despite having the second largest number of hectares of guadua forest in the region, has the highest rate of forest fragmentation and the highest rate of rural poverty. This research was designed to examine the role of guadua in rural Caldas through the lens of regenerative development. To this end, the historical, current, and future dynamics, and visions of guadua were described and explored through ecological, sociocultural, economic, and institutional dimensions, based on previous literature and the experience of local experts, environmental authorities, and rural community members.

This research has shown that the dynamics around guadua in Caldas have been marked by opposing phenomena that have been drivers of regeneration or degeneration. Historically, guadua has been a natural resource that provides multiple services to the local ecosystem. It has also been a factor of sociocultural identity, not only as part of the Coffee Cultural Landscape, but also as a driver of the development of the civilisations that have populated the territory of Caldas.

75

CONCLUSIONS

However, these ecological and sociocultural values have not been reflected in its economic value, as it has been considered an abundant, disposable, low-cost resource and material with little durability. This has led to guadua forests being replaced by more profitable crops, which in turn has resulted in legislation that seeks to protect the resource, limiting its use as a means of rural livelihood.

Currently, greater recognition has been given to the ecological and sociocultural value of guadua in Caldas through the development of local research with international support in fields such as sustainable harvesting practices, Co2 markets, construction, and industrial products. Also, the recognition of the guadua production chain has facilitated the articulation of the stakeholders in the links and improved the flow between the supply of guadua and its demand in the market. Unfortunately, these advances have not been reflected in the income of many of the rural actors, nor in local and international market participation. Moreover, outdated legislation and bureaucratic processes for providing harvesting authorisations have encouraged corruption, as evidenced by the payment of bribes to obtain permits, while deforestation and fragmentation of guadua forests continues to increase.

Looking to the future, guadua has a key role to promote regenerative development by implementing actions in each dimension, which in turn will feed back into the other dimensions. As an approach to ecological restoration, it is necessary to develop an updated inventory of the location of the guadua forests and their conservation status using technological tools. This information will facilitate reforestation, maintenance, thinning and harvesting by producers and rural community members based on best practice standards developed in local research. Reforested forests could become places of sociocultural appropriation through educational tourism, fostering a sense of self-worth of local natural resources and awareness of new generations.

Furthermore, direct articulation between producers and industry would ensure that harvesting practices are sustainable, as evidenced by the high-quality standards of the guadua for the production of value-added products that leverage the local economy. Within the framework of these opportunities and challenges, it is key to update the legislation of guadua to an agroforestry resource regulated by the Ministry of Agriculture, as this will facilitate the production of guadua as a means of rural livelihood. The government should also focus its efforts on promoting guadua locally and internationally through campaigns rebranding guadua as the high-quality Colombian bamboo.

Consequently, the role of guadua in the regenerative development of rural areas in Caldas is linked to its potential for ecological restoration, sociocultural appropriation and economic leverage supported by improvements in current legislation. In order to fulfil its role as a renewable natural resource, it is necessary to articulate its dimensions in a holistic manner.

Firstly, by contributing to the ecological restoration of the deteriorated rural areas of Caldas with their high regeneration and growth rates, and the provision of a multitude of ecosystem services vital for the sustainability and regeneration of the territory. Secondly, by promoting the sociocultural appropriation of the landscape and local natural resources, as it is a representative species of Caldas and the Coffee Region, generating ancestral knowledge and identities inherited by generations, which are currently reflected in its multiple uses and industrial developments. Thirdly, by leveraging the local economy as an agroforestry species that is produced, processed, and transformed locally, contributing to rural livelihoods and local industry. The recent articulation of the guadua production chain is a great opportunity to boost the local economy and the participation in the international bamboo market. Finally, for guadua to fulfil its role in all dimensions, and consequently in regenerative development, it is crucial to improve the current legislation, allowing its sustainable management according to its regenerative capacities, while local governments disseminate and promote its multidimensional value nationally and globally.

7.2 Recommendations

The following set of recommendations responds to the actions that must be considered for guadua to fulfil its role in the regenerative development in the rural areas of Caldas in each of its dimensions.

Ecological dimension

•Develop and update the inventory of guadua forests in Caldas specifying their location, status, and ownership. For this, GIS technology can be used to facilitate the dissemination of data through an open web page or a mobile application.

•Reforest fragmented guadua forests with the participation of landowners and

rural communities, responsible for regular maintenance, thinning and harvesting in an "adopt-a-guadua forest" programme.

•Produce high quality guadua as a sustainable substitute for other types of wood from trees with lower regeneration rates.

Sociocultural dimension

•Awaken the sense of self-worth and passion for guadua in the new generations through educational and experiential tourism programmes.

•Train rural youth in the regenerative management of guadua as a sustainable livelihood and motivation to remain and develop in the countryside.

•Articulate the knowledge produced by ancestral and rural communities, academia, industry, traders, and institutions in an open and accessible online database.

Economic dimension

•Establish guadua processing plants close to the forest where it is harvested to ensure direct contact between producers and industrialists, high quality guadua, and a constant flow between supply and demand.

•Encourage the construction industry to establish a percentage use of guadua and guadua products in local construction, e.g., as a sustainable substitution for other wood products.

Institutional dimension

•Dismantle bureaucratic processes within Corpocaldas that encourage corruption of some officials.

•Grant guadua harvesting and mobilisation permits in a more efficient way, for instance through a mobile application.

•Update the classification of guadua by law as an agroforestry species, enabling its regulation by the ministry of agriculture.

•Articulate both the ministry of agriculture and the ministry of housing to establish a percentage of use of guadua and guadua products in local social housing.

•Promote guadua and guadua products from the government in the local and global bamboo market.

7.3 Further research

During the research, several topics were identified in which further research is needed to ensure that guadua fulfils its role in the regenerative development of rural areas in Caldas, and for which there is not yet a critical mass of research. One of the phenomena identified in the research is the fragmentation of the guadua forests in Caldas, it would be ideal to assess the possibility of creating early warnings of deforestation using GIS systems. It would also be ideal to recognise the feasibility to conform guadua caretaker squads on the ground that in turn benefit from the use of it as a livelihood. In addition, it would be valuable to conduct a study to make an inventory of the guadua ancestral knowledge that has been passed down through the generations, and of the academy-industry initiatives, in order to know the successes and lessons learned as a basis for new ventures.

Furthermore, it would be relevant to examine the limitations of guadua extraction in the hilly territory of Caldas and how technological advances could contribute to this obstacle. Also, based on the establishment of the guadua production chain, investigate how circular economy schemes could be fostered to enhance rural livelihoods, promoting local production of bamboo products, and reducing imports. Finally, it would be worthwhile to document how corruption networks operate in detail around permits for harvesting and transporting guadua to facilitate its dismantling.

REFERENCES

References

Aguirre, D.A.A. and Criollo, M.C. (2020) 'POTENCIAL DE LOS BOSQUES DE GUADUA (Guadua angustifolia Kunth) EN LA REGULACIÓN CLIMÁTICA. CASO EJE CAFETERO COLOMBIANO', p. 67.

Aigneren, M. (2002) 'La técnica de recolección de información mediante grupos focales', La Sociología en sus Escenarios [Preprint], (6). Available at: https://revistas.udea.edu.co/ index.php/ceo/article/view/1611 (Accessed: 20 June 2022).

Arango, Á.M.A. and Camargo, J.C. (2010) 'Bosques de guadua del Eje Cafetero de Colombia: oportunidades para su inclusión en el mercado voluntario de carbono y en el Programa REDD+', (61), p. 9.

Arango, S. (1990) Historia de la arquitectura en Colombia. Bogotá, Colombia: Universidad Nacional de Colombia. Available at: https://www.libreriaunal.com/libro/ historia-de-la-arquitectura-en-colombia_14514 (Accessed: 17 June 2022).

Atetwe, E. (2020) 'Contributions of Bamboo to Poverty Alleviation in Rural China', Atetwe Ezekiel [Preprint]. Available at: https://www.academia.edu/58369385/ Contributions_of_Bamboo_to_Poverty_Alleviation_in_Rural_China (Accessed: 11 June 2022).

Barragan, Y. (ed.) (2021) 'The Social Universe of the Colombian Black Pacific', in Freedom's Captives: Slavery and Gradual Emancipation on the Colombian Black Pacific. Cambridge: Cambridge University Press (Afro-Latin America), pp. 37–104. Available at: https://doi.org/10.1017/9781108935890.002.

Barrera, M.D.M., Tonon, G. and Salgado, S.V.A. (2012) 'Investigación cualitativa: el análisis temático para el tratamiento de la información desde el enfoque de la fenomenología social', p. 32.

Biddle, B.J. (1986) 'Recent Developments in Role Theory', p. 26.

Caldas, Caldata (2020) Índice de pobreza Multidimensional.pdf. Boletín estadístico 15. Caldas, Colombia, p. 13. Available at: https://caldata.caldas.gov.co/wp-content/ uploads/2021/11/BOLETIN-15-Completo-IPM-2020.pdf (Accessed: 16 June 2022).

Caldas, Caldata (2021) Desempeño del sector agropecuario en Caldas.pdf. Boletín estadístico 13. Caldas, Colombia. Available at: https://caldata.caldas.gov.co/wp-content/ uploads/2021/09/boletin-13_1.pdf (Accessed: 6 February 2022).

Caldas, Camara de Comercio (2002) 'Microcluster de la guadua', Revista guadua.

Caldas, Gobernacion de Caldas (2003) La creación del departamento, Gobierno de Caldas. Available at: https://site.caldas.gov.co/historia-caldas (Accessed: 17 June 2022).

Castiblanco, L.M. (2018) 'Acuerdo de competitividad de la cadena de guadua y su industria. 2018 – 2030'. Ministerio de Agricultura y Desarrollo Rural - MADR.

Castillo-Ospina, O.L.C. and Masullo-Jiménez, J. (2017) 'Alternative Development is no longer an alternative – Post-development could be .', Filosofía de la Economía, 6(2), pp. 20–20.

Castro-Escobar, E. (2016) 'Configuración de la migración interna en la región del Paisaje Cultural Cafetero de Colombia', in. Available at: https://doi.org/10.11600/169271 5X.14246080815.

Cieza de León, P. de (2005) Crónica del Perú. Venezuela: Biblioteca Ayacucho. Available at: https://www.digitaliapublishing.com/a/16455/cronica-del-peru (Accessed: 28 January 2022).

Colombia, DANE (2018) Censo Nacional de Población y Vivienda 2018. Available at: https://www.dane.gov.co/index.php/estadisticas-por-tema/demografia-y-poblacion/ censo-nacional-de-poblacion-y-vivenda-2018 (Accessed: 27 November 2021).

Colombia, MADR (2016a) 'INFORME DIAGNÓSTICO CADENA DE LA GUADUA Y SU INDUSTRIA', p. 41.

Colombia, MADR (2016b) Resolución 1740 de 2016. Available at: https://www. minambiente.gov.co/documento-normativa/resolucion-1740-de-2016/ (Accessed: 25 December 2021).

Colombia, MADR (2021a) Cadena Guadua: Acuerdo de Competitividad 2021.pdf. Bogotá, Colombia: MADR. Available at: https://sioc.minagricultura.gov.co/Guadua/ Documentos/2021-03-31%20Cifras%20Sectoriales.pdf (Accessed: 7 May 2022).

Colombia, MADR (2021b) Resolución 000009 DE 2021.pdf. Available at: https:// www.minagricultura.gov.co/Normatividad/Resoluciones/RESOLUCI%C3%93N%20 000009%20DE%202021.pdf (Accessed: 25 December 2021).

Colombia, National Congress (1974) Decreto 2811 de 1974. Available at: https://www.funcionpublica.gov.co/eva/gestornormativo/norma.php?i=1551 (Accessed: 25 November 2021).

Colombia, National Congress (1996) Decreto 1791 de 1996. Available at: https://www.funcionpublica.gov.co/eva/gestornormativo/norma.php?i=1296 (Accessed: 25 November 2021).

Colombia, National Congress (2015) Decreto 1076 de 2015 Sector Ambiente y Desarrollo Sostenible. Available at: https://www.funcionpublica.gov.co/eva/gestornormativo/ norma.php?i=78153 (Accessed: 25 July 2022).

Colombia, SiB (2021) Especies y registros por departamento, Sistema de Información sobre Biodiversidad. Available at: https://cifras.biodiversidad.co.

Davidson, C. (2009) 'Transcription: Imperatives for Qualitative Research', International Journal of Qualitative Methods, 8(2), pp. 35–52. Available at: https://doi. org/10.1177/160940690900800206.

Denzin, N.K. and Lincoln, Y.S. (2005) The SAGE Handbook of Qualitative Research. SAGE.

Duque Escobar, G., Moreno Orjuela, R.D. and Ortiz Ortiz, D. (2012) Legalidad y sostenibilidad de la guadua en la ecoregión cafetera: posicionamiento de la gobernanza forestal en Colombia ; lecciones aprendidas. S.l., Colombia: Gobernanza Forestal.

Eliasch, J. (2008) Climate change: financing global forests: the Eliasch review. London: TSO.

FAO (2007) World bamboo resources: a thematic study prepared in the framework of the Global Forest Resources Assessment 2005. 18. Rome, Italy, p. 80.

FAO (2010) Global Forest Resources Assessment 2010 Country Report: China.pdf. Rome, Italy. Available at: https://www.fao.org/3/al478E/al478E.pdf (Accessed: 13 June 2022).

Filgueiras, T., Judziewicz, E., Clark, L., Londoño, X., Stern, M. and Londono, X. (1999) 'American Bamboos', Taxon, 48, p. 614. Available at: https://doi.org/10.2307/1224589.

Fonseca, L. and Saldarriaga, A. (1992) Arquitectura popular en Colombia: herencias y tradiciones. Altamir.

Friese, S. (2014) Implementing different analysis approaches with ATLAS.ti. Available at: https://doi.org/10.13140/RG.2.1.4790.6164.

Galeano Marín, M.E. (2018) Estrategias de investigación social cualitativa: El giro en la mirada. 2nd edn. Universidad de Antioquia. Available at: https://doi.org/10.2307/j. ctvdfo6h7.

Garavito-Rodríguez, L.L. (2020) Análisis Normativo Del Manejo Sostenible y El Aprovechamiento Productivo Del Bambú-Guadua En Los Departamentos Del Quindío y Cundinamarca en Colombia. Universidad Jorge Tadeo Lozano. García Díaz, R.F., González-Martínez, C., Pérez, C.C., Forero Castiblanco, D., Mahecha Vásquez, G.A., Herrera Silva, L.A., Nieto Castillo, C.A. and Acosta-Leal, D. (2021) La guadua (Guadua angustifolia) Kunth: El oro verde por descubrir. Corporación Universitaria Minuto de Dios - UNIMINUTO. Available at: https://repository.uniminuto. edu/handle/10656/13238 (Accessed: 7 June 2022).

Garcia, J.C.C. (2006) 'Growth and productivity of the bamboo species Guadua angustifolia Kunth in the coffee region on Colombia', p. 9.

Gibbons, L., Berejnoi, E., Rodriguez, N., Sykes, C., Morrison, B.A., Tekola, S., Gabriele, A., Fastiggi, M. and Cloutier, S. (2019) 'Integrating Inner and External Dimensions for Holistic Sustainability', in, p. Ch. 10. Available at: https://doi.org/10.4018/978-1-5225-7302-9.cho10.

Gibbons, L.V. (2020) 'Regenerative—The New Sustainable?', Sustainability, 12(13), p. 5483. Available at: https://doi.org/10.3390/su12135483.

Gibbons, L.V., Cloutier, S.A., Coseo, P.J. and Barakat, A. (2018) 'Regenerative Development as an Integrative Paradigm and Methodology for Landscape Sustainability', Sustainability, 10(6), p. 1910. Available at: https://doi.org/10.3390/su10061910.

Giraldo de Puech, M. de la L. (1986) Asi eramos los muiscas. Fundación de Investigaciones Arqueológics Nacionales, Banco de la República.

Global Humanitarian Forum (2009) Human Impact Report: Climate Change: The Anatomy of a Silent Crisis. Geneva: Global Humanitarian Forum. Available at: https://www.ghf-ge.org/human-impact-report.pdf (Accessed: 14 July 2022).

Held, C. and Manzano, I.D. (2003) El sector productivo y el mercado regional de la guadua en el eje cafetero colombiano.pdf. INBAR. Available at: https://www.inbar.int/wp-content/uploads/2020/05/1489544432.pdf (Accessed: 7 June 2022).

Hidalgo López, O. (1981) Manual de construccion con bambú.pdf. Bogotá, Colombia: Estudios Técnicos Colombianos Ltda. Available at: https://guaduabambucolombia.files. wordpress.com/2016/02/manual-de-construccion-con-bambu.pdf (Accessed: 5 August 2022).

IFAD (2020) 'OVERVIEW: RURAL POVERTY IN DEVELOPING COUNTRIES: ISSUES, POLICIES AND CHALLENGES', p. 7.

INBAR (2015) 'Bamboo, Rattan and the SDGs', in. New York: INBAR. Available at: https://www.un.org/esa/forests/wp-content/uploads/2015/11/INBAR_input_AHEG2016.pdf (Accessed: 29 December 2021).

INBAR (2019) Trade Overview 2017:Bamboo and Rattan Commodities in the International Market.pdf. Beijing, China: INBAR. Available at: https://www.inbar.int/ wp-content/uploads/2020/05/1578283314.pdf (Accessed: 7 June 2022).

IPCC (2021) 'Summary for policymakers', in V. Masson-Delmotte, P. Zhai, A. Pirani, S.L. Connors, C. Péan, S. Berger, N. Caud, Y. Chen, L. Goldfarb, M.I. Gomis, M. Huang, K. Leitzell, E. Lonnoy, J.B.R. Matthews, T.K. Maycock, T. Waterfield, Ö. Yelekçi, R. Yu, and B. Zhou (eds) Climate Change 2021: The Physical Science Basis. Contribution of Working Group I to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change. Cambridge University Press.

Kumar, R. (2011) RESEARCH METHODOLOGY a step-by-step guide for beginners.pdf. 3rd Edition. New Delhi: SAGE.

Labović, B., Vujović, D. and Dasic, B. (2021) 'The comparison of the conventional development and sustainable development model', Ekonomija: teorija i praksa, 14, pp. 85–105. Available at: https://doi.org/10.5937/etp2103085L.

Lazarte, A. (2017) Understanding the drivers of rural vulnerability.pdf. 214. Geneva. Available at: https://www.ilo.org/wcmsp5/groups/public/---ed_emp/documents/ publication/wcms_568736.pdf (Accessed: 12 June 2022).

Londoño, X. (2011) 'El bambú en Colombia', Biotecnología Vegetal, 11(3). Available at: https://revista.ibp.co.cu/index.php/BV/article/view/485 (Accessed: 28 November 2021).

Masson-Delmotte, V., Zhai, P., Pirani, A., Connors, S.L., Péan, C., Berger, S., Caud, N., Chen, Y., Goldfarb, L., Gomis, M.I., Huang, M., Leitzell, K., Lonnoy, E., Matthews, J.B.R.,

REFERENCES

Maycock, T.K., Waterfield, T., Yelekçi, Ö., Yu, R. and Zhou, B. (eds) (2021) Climate Change 2021: The Physical Science Basis. Contribution of Working Group I to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change. Cambridge University Press.

McCormick, D. and Ledesma, P.M. (2007) 'La Construcción de una Visión de Futuro para la guadua: desde la cadena productiva hacia el cluster de la guadua en el eje cafetero', Revista Gestión y Región, (3), pp. 33–52.

Minke, G. (2016) Building with Bamboo: Design and Technology of a Sustainable Architecture Second and revised edition, Building with Bamboo. Birkhäuser. Available at: https://doi.org/10.1515/9783035608656.

Moreno Orjuela, R.D. and Mejía Gallón, M.N. (2013) Estado del arte de la cadena de la guadua en Colombia 2003-2012. Corporación Autónoma Regional de Risaralda. Available at: https://repository.agrosavia.co/handle/20.500.12324/13268 (Accessed: 26 July 2022).

Muñoz, J., Camargo, J. and Romero-Ladino, C. (2017) 'Beneficios de los bosques de guadua como una aproximación a la valoración de servicios ecosistémicos desde la "Jerarquización y Calificación", Gestión y Ambiente, 20, pp. 222–231. Available at: https://doi.org/10.15446/ga.v20n2.66603.

Muñoz López, J., Camargo García, J.C. and Romero Ladino, C. (2021) 'Valuation of ecosystem services of guadua bamboo (Guadua angustifolia) forest in the southwestern of Pereira, Colombia - Valoración de servicios ecosistémicos de bosques de guadua (Guadua angustifolia) al suroriente de Pereira, Colombia', Caldasia, 43(1), pp. 186–196.

Nova, J.M.S. (2006) Caldas cien años: historia y cultura, 1905-2005. Gobernación de Caldas.

Ospina Villegas, J., Arango de Valencia, Á.M., Vélez Vélez, G., Rodríguez Nieto, H., Quintero Ocampo, O.L., Medina Guzmán, N., Alarcón, L.M., Valencia, J.L., López, L.G., Valencia, N.E., Cardona, J.J., Rozo, L.M. and Mario, R.C. (2006) La guadua : caracterización ocupacional. Servicio Nacional de Aprendizaje (SENA). Available at: https://repositorio.sena.edu.co/handle/11404/2098 (Accessed: 7 June 2022).

Oviedo-Celis, R.A. and Castro-Escobar, E.S. (2021) 'Un análisis comparativo de la sostenibilidad de sistemas para la producción de café en fincas de Santander y Caldas, Colombia', Ciencia & Tecnología Agropecuaria, 22(3), pp. e2230–e2230. Available at: https://doi.org/10.21930/rcta.vol22_num3_art:2230.

Pérez Serrano, G. (2014) Investigación cualitativa: retos e interrogantes. 6a. ed. Madrid: La Muralla (Colección aula abierta).

Perry, S. (2010) 'LA POBREZA RURAL EN COLOMBIA', p. 16.

Plaut, J., Dunbar, B., Gotthelf, H. and Hes, D. (2016) 'Regenerative Development through LENSES with a case study of Seacombe West', Environment Design Guide, pp. 1–19.

Robledo, J.E. (1996) La Ciudad en la colonizacion Antioqueña: Manizales. Bogotá, Colombia: Editorial Universidad Nacional. Available at: https://es.scribd.com/ document/88913310/25-La-ciudad-en-La-colonizacion-antioquena-manizales-Jorgeenrique-robledo (Accessed: 27 January 2022).

Rodríguez-Gómez, G., Gil-Flores, J. and Garcia-Jimenez, E. (1996) Metodología de la investigación cualitativa / Gregorio Rodríguez Goméz, Javier Gil Flores, Eduardo García Jiménez, SERBIULA (sistema Librum 2.0).

Salas Delgado, E. (2006) Actualidad y futuro de la arquitectura de bambú en Colombia : Simón Velez : símbolo y búsqueda de lo primitivo, TDX (Tesis Doctorals en Xarxa). Ph.D. Thesis. Universitat Politècnica de Catalunya. Available at: http://www.tdx.cat/ handle/10803/6130 (Accessed: 27 December 2021).

Silva Barrera, M., Robayo Vásquez, B.I., Castro Ñungo, L.Á., Triana Zárate, G.E., Botiva Contreras, Á., Pérez Valencia, V.L. and Caballero Rodríguez, L.L. (2011) Geografía de Colombia. 1a ed. Instituto Geográfico Agustín Codazzi. Available at: https://login.ezproxy. javeriana.edu.co/login?url=https://search.ebscohost.com/login.aspx?direct=true&AuthT ype=ip&db=cato1040a&AN=pujbc.848889&lang=es&site=eds-live. Soreng, R.J., Peterson, P.M., Romaschenko, K., Davidse, G., Zuloaga, F.O., Judziewicz, E.J., Filgueiras, T.S., Davis, J.I. and Morrone, O. (2015) 'A worldwide phylogenetic classification of the Poaceae (Gramineae)', Journal of Systematics and Evolution, 53(2), pp. 117–137. Available at: https://doi.org/10.1111/jse.12150.

Stake, R.E. (1995) The Art of Case Study Research. 1st edn. Thousand Oaks: SAGE Publications, Inc.

 $\label{eq:stake} Stake, R.E. (2003) `CaseStudies.pdf', in The Handbook of Qualitative Reserach. SAGE. Available at: https://www.sfu.ca/~palys/Stake2003-CaseStudies.pdf (Accessed: 8 June 2022).$

Sylvester, J. and Gordon, R. (2004) 'Deconstructing Development', Publications [Preprint]. Available at: https://digitalcommons.law.ggu.edu/pubs/191.

Terefe, R., Jian, L. and Kunyong, Y. (2019) 'Role of Bamboo Forest for Mitigation and Adaptation to Climate Change Challenges in China', Journal of Scientific Research and Reports, pp. 1–7. Available at: https://doi.org/10.9734/jsrr/2019/v24i130145.

UN (1992) United Nations Framework Convention on Climate Change.pdf. New York: United Nations, p. 24. Available at: https://unfccc.int/resource/docs/convkp/conveng. pdf (Accessed: 11 June 2022).

Valencia Llano, A. (2010) Raices en el tiempo: La region caldense.pdf. Manizales, Colombia: Concurso de literatura Caldas 2009. Available at: http://albeirovalencia.com/ recursos/La_region_caldense_Raices_en_el_tiempo%20(1).pdf (Accessed: 29 January 2022).

Varguillas, C. (2006) 'EL USO DE ATLAS.TI Y LA CREATIVIDAD DEL INVESTIGADOR EN EL ANÁLISIS CUALITATIVO DE CONTENIDO UPEL. INSTITUTO PEDAGÓGICO RURAL EL MÁCARO', Revista de Educación, p. 16.

Velasquez, L. (2011) 'Dimensiones de la pobreza en Caldas y factores asociados', RegionEs [Preprint].

Violle, C., Navas, M.-L., Vile, D., Kazakou, E., Fortunel, C., Hummel, I. and Garnier, E. (2007) 'Let the concept of trait be functional!', Oikos, 116(5), pp. 882–892. Available at: https://doi.org/10.1111/j.0030-1299.2007.15559.x.

Wang, R., Guo, Z., Cai, C., Zhang, J., Bian, F., Sun, S. and Wang, Q. (2021) 'Practices and roles of bamboo industry development for alleviating poverty in China', Clean Technologies and Environmental Policy, 23(6), pp. 1687–1699. Available at: https://doi. org/10.1007/s10098-021-02074-3.

World Bank (ed.) (2020) Poverty and Shared Prosperity 2020: reversals of fortune. Washington: World Bank (Poverty and shared prosperity).

Yin, R.K. (1994) Case Study Research: Design and Methods. SAGE Publications.

Yin, R.K. (2003) Applications of Case Study Research. SAGE.

Yiping, L., Yanxia, L., Buckingham, K., Henley, G. and Guomo, Z. (2010) 'Bamboo and Climate Change Mitigation', (32), p. 30.

Appendix

Appendix A: Semi-structured interview - Guide I

Original version (Spanish)

Narrativas centradas en tres momentos

El pasado, el presente y la visión futura de la guadua desde la experiencia personal y/o colectiva en el desarrollo de la región, siguiendo la estructura presentada a continuación:

1. Génesis: historia y experiencia con la guadua.

Narrar la trayectoria de la experiencia con la guadua teniendo en cuenta la relevancia histórica, conocimientos ancestrales, usos tradicionales, transformaciones y el valor material e inmaterial que se le ha dado a la guadua, como recurso natural.

2. Presente: La guadua en la experiencia actual.

Hablar desde su percepción acerca de las características de la guadua en términos: ecológico, sociocultural, económico e institucional.

¿Qué fortalezas y limitaciones encuentra en las cadenas de valor de la guadua? Relatar las experiencias y referentes internacionales que ha conocido sobre el bambú que a su juicio sean relevantes. Comentar alguna anécdota que considere relevante por su semejanza y aporte al desarrollo de la región.

3. Visiones futuras: potencialidades, oportunidades, limitaciones y desafíos de la guadua frente al desarrollo rural regenerativo.

Desde su conocimiento y experiencia,

¿Cuál considera es el potencial de la guadua como promotora del desarrollo rural regenerativo? ¿Cuál es su potencial innovador en su uso?

¿Qué obstáculos puede tener el uso de la guadua como promotora del desarrollo rural regenerativo?

¿Qué transformaciones son necesarias en lo ecológico, sociocultural, económico e institucional? ¿Cuáles son los actores y procesos claves del potencial innovador de la guadua como promotora del desarrollo rural regenerativo?

English version

Narratives focused on three moments

Past, present and future vision of guadua in the development of the region, from the personal experience, following the structure presented below:

1. Genesis: history and experience with guadua.

Narrating the trajectory of the experience with guadua considering the historical relevance, ancestral knowledge, traditional uses, transformations and the material and immaterial value that has been given to guadua as a natural resource.

2. Present: Guadua in the present experience.

Speaking from your perception about the characteristics of guadua in terms of: ecological, sociocultural, economic and institutional.

What strengths and limitations do you find in the guadua value chain?

Give a narrative of the experiences and international references you have learned about bamboo that you consider relevant. Comment on any anecdote that you consider relevant because of its similarity and contribution to the development of the region.

3. Future visions: potentialities, opportunities, limitations and challenges of guadua in relation to regenerative rural development.

From your knowledge and experience,

What do you consider to be the potential of guadua as a promoter of regenerative rural development? What is its innovative potential in its use?

What are the obstacles to the use of guadua as a promoter of regenerative rural development?

What ecological, sociocultural, economic and institutional transformations are necessary? What are the key actors and processes of the innovative potential of guadua as a promoter of regenerative rural development?

APPENDIX

Appendix B: Focus group - Guide II

Original version (Spanish)

Narrativas centradas en tres momentos el pasado, el presente y la visión futura de la guadua desde la experiencia personal y/o colectiva en el desarrollo de la región. Se presentará la siguiente estructura:

•Génesis: historia y experiencia con la guadua.

Parte 1. Se solicita contarnos la experiencia con la guadua en la que nos permita conocer la historia, sus conocimientos, los usos tradicionales y los cambios que se han dado en el manejo de la guadua.

Parte 2. Preguntas focalizadas

¿Qué sabe Usted sobre la guadua? ¿Dónde lo aprendió?

¿Cuál ha sido el uso tradicional de la guadua en el campo?

¿Qué valor ha tenido la guadua en su territorio?

¿Considera que la guadua ha sido importante en la región cafetera? ¿De qué manera? ¿Considera que la guadua se ha aprovechado suficientemente? ¿Por qué? ¿De qué manera?

¿Qué cambios ha notado en el territorio debido al uso de la guadua? Relatar una anécdota.

•Actualidad: La guadua en la experiencia presente.

Parte 1. Se solicita relatarnos la percepción acerca del valor que tiene la guadua tanto en lo económico como en los social y ambiental para Usted y para la comunidad. Parte 2. Preguntas focalizadas

¿Qué conoce sobre los beneficios de la guadua para el desarrollo de la comunidad? ¿Cómo ha cambiado el uso de la guadua en el campo?

¿Cuál considera es la importancia de la guadua en lo ambiental, lo sociocultural y lo económico?

¿Qué resultados han logrado con el uso de la guadua?

¿Qué limitaciones tienen la población campesina para el uso de la guadua actualmente? ¿Cómo podrían solucionarse estas limitaciones?

•Visiones futuras: potencialidades, oportunidades, limitaciones y desafíos frente a la guadua.

Preguntas focalizadas.

¿Cómo cree que la guadua podría ayudar al desarrollo del campo?¿Cómo se imagina los usos de la guadua en un futuro?¿Cuál podría ser el rol de la guadua en el desarrollo rural de la región?

¿Cuáles podrían ser las oportunidades y potencialidades alrededor de este recurso natural?

¿Cuáles son las limitaciones y desafíos que tienen quienes trabajan con la guadua para impulsar el desarrollo rural en la región?

¿Qué actores tendrían que involucrarse para lograr que la guadua promueva el desarrollo rural de la región?

¿Cómo podría el gobierno ayudar a que la gente pueda aprovechar más la guadua? ¿Qué transformaciones serían necesarias?

Discusión y cierre

Se pide a los participantes realizar una cartografía social sobre el papel de la guadua en la región, mostrando el pasado, el presente y la visión futura, con base en las respuestas dadas a lo largo de la sesión.

English version

Narratives focused on three moments: past, present and future vision of guadua from the personal and/or collective experience in the development of the region, following the structure presented below:

-Genesis: history and experience with guadua.

Part 1. They are asked to tell us about the experience with guadua in which you learn about its history, knowledge, traditional uses and the changes that have taken place in the management of guadua.

Part 2. Focused questions

What do you know about guadua? Where did you learn it?

What has been the traditional use of guadua in the countryside?

What value has guadua had in your territory?

Do you consider that guadua has been important in the Coffee Region? In what way? Do you consider that guadua has been sufficiently used, why and in what way? What changes have you noticed in the territory due to the use of guadua? Tell an anecdote.

-Present day: Guadua in present day experience. Part 1. They are asked to give a narrative about the economic, social and environmental value of guadua for you and the community. Part 2. Focused questions What do you know about the benefits of guadua for community development? How has the use of guadua changed in the countryside? What do you consider to be the environmental, sociocultural and economic importance of guadua? What results have been achieved with the use of guadua? What limitations do the peasant population currently have for the use of guadua? How could these limitations be solved? -Future visions: opportunities and challenges regarding guadua. Focused questions. How do you think guadua could help rural development? How do you imagine the future uses of guadua? What could be the role of guadua in rural development in the region? What could be the opportunities and potentials around this natural resource? What are the constraints and challenges for those working with guadua to promote rural development in the region? Which actors would need to be involved in order for guadua to promote rural development in the region? How could the government help people to make more use of guadua? What transformations would be necessary?

Discussion and closing

Participants are asked to conduct a social mapping of the role of guadua in the region, showing the past, present and future vision, based on the answers given throughout the session.

نبذة مختصرة

وأدت أزمة المناخ الحالية، نتيجة لنموذج إنمائي تقليدي، إلى زيادة ضعف المناطق الريفية ومجتمعاتها المحلية. يمكن لغابات الخيزران التخفيف من هذه المخاطر في البلدان الاستوائية وشبه الاستوائية. في الأمريكتين، كولومبيا هي ثاني أعلى تنوع لأنواع الخيزر إن ؛ غوادوا أنغوستيفوليا هي الأنواع المحلية الأكثر صلة بالموضوع وتقع بشكل أساسى في منطقة البن. يوجد في مقاطعة كالداس ثاني أكبر كمية من هكتارات غابات غوادوا في المنطقة ؛ وعلى العكس من ذلك، فإن لديها أعلى معدل لتجزئة الغابات ومعدل للفقر في الريف. وعلى الرغم من أن غوادوا لديها إمكانات كبيرة للحد من الفقر في الريف وتحسين سبل العيش المحلية، فإن تدهور غاباتها يتضح بشكل متزايد. درست مجموعة كبيرة من الأبحاث البعد البيئي لغوادوا وتطبيقاته للأغراض الصناعية. ومع ذلك، فقد تناولت دراسات قليلة كيف يمكن لغوادوا التخفيف بشكل شامل من تغير المناخ والضعف الريفي في كالداس. الهدف من هذا البحث هو شرح الدور المحتمل لغوادوا في تعزيز التنمية الريفية في كالداس من خلال منظور التنمية التجديدية، و هو إطار نظري لتصنيف المعلومات وتحليلها بطريقة متكاملة ومتر ابطة. ولهذا الغرض، نُفذت بحوث وثائقية واستر اتيجيات لدر اسات الحالة، باستخدام أساليب جمع مثل استعر اض المؤلفات، والملاحظات، والمقابلات، والاجتماعات مع الجهات الفاعلة المحلية. من البيانات الأولية التي تم جمعها، تم إجراء تحليل باستخدام مصفوفة تحليل المحتوى وبرامج أطلس تي للتعرف على أبعاد وديناميكيات غوادوا في كالداس. أظهر التحليل أن الديناميكيات التاريخية والحالية لغوادوا، وكذلك الأبعاد الإيكولوجية والاجتماعية والثقافية والاقتصادية والمؤسسية المنغمسة في هذه الديناميكيات قد تميزت بظواهر متعارضة كانت محركًا لكل من الانحطاط والتجدد من البيانات الأولية التي تم جمعها، تم إجراء تحليل باستخدام مصفوفة تحليل المحتوى وبرامج أطلس تي للتعرف على أبعاد وديناميكيات غوادوا في كالداس. أظهر التحليل أن الديناميكيات التاريخية والحالية لغوادوا، وكذلك الأبعاد الإيكولوجية والاجتماعية والثقافية والاقتصادية والمؤسسية المنغمسة في هذه الديناميكيات قد تميزت بظواهر متعارضة كانت محركًا لكل من الانحطاط والتجدد. وعلاوة على ذلك، تم تحديد الفرص والتحديات المستقبلية لغوادوا كمورد طبيعي متجدد لتعزيز التنمية الريفية المتجددة. ستكون هذه النتائج بمثابة نقطة انطلاق للمشاريع التجديدية التي تهدف إلى از دهار الأراضي التي تضم المجتمعات الربفية وغايات غوادوا

الكلمات الرئيسية: الضعف الريفي ؛ الموارد الطبيعية المتجددة ؛ غابة غوادوا ؛ الحراجة الزراعية ؛ سبل العيش في المناطق الريفية إقرار

هذه الرسالة مقدمة في جامعة عين شمس وجامعة شوتجارت للحصول على درجة العمر ان المتكامل والتصميم المستدام. إن العمل الذي تحويه هذه الرسالة قد تم إنجازه بمعرفة الباحث سنة 2022

هذا ويقر الباحث أن العمل المقدم هو خلاصة بحثه الشخصي وأنه قد اتبع الإسلوب العلمي السليم في الإشارة إلى المواد المؤخوذه من المراجع العلمية كلَّ في مكانه في مختلف أجزاء الرسالة.

وهذا إقرار مني بذلك،،،

التوقيع:

الباحث: ديانا باريرا سالازار

التاريخ: أغسطس/2022

دور الخيزران في التنمية المتجددة

قضية غوادوا أنغوستيفوليا في المناطق الريفية من كالداس، كولومبيا

مقدمة للحصول على درجة الماجستير في العمران المتكامل والتصميم المستدام

أعداد: ديانا باريرا سالاز ار

لجنة أشراف

الأستاذ الدكتور محمد صالحين أستاذ التخطيط والتصميم المتكاملين جامعة عين شمس

لجنة الحكم أ.د.الممتحن الخارجي أستاذ..... جامعة

رشيف ينويل روتكدلا ذاتسألا ةئيبلاه ةي عيبطلا رظانملا طيطخت ذاتسأ تراغتوتش ةعماج

التوقيع Rul hus.

أ.د. أستاذ..... جامعة

أ.د. أستاذ..... جامعة

الدراسات العليا

ختم الإجازة موافقة مجلس الكلية .../.../...

تاريخ المناقشة:

أجيزت الرسالة بتاريخ:.... موافقة مجلس الجامعة .../.../...





MM/DD/YYYY



ف

دور الخيزران في التنمية الريفية المتجددة حالة غوادوا أنغوستيفوليا في كالداس، كولومبيا

رسالة مقدمة للحصول على درجة الماجستير في العمران المتكامل والتصميم المستدام

إعداد ديانا باريرا سالازار

المشرفون

الأستاذ الدكتور محمد صالحين أستاذ التخطيط والتصميم المتكاملين جامعة عين شمس

الأستاذ الدكتور ليوني فيشر أستاذ تخطيط المناظر الطبيعية والبينة جامعة شتوتغارت

(أغسطس/2022)