

Impacts of Gaps in Participatory Governance on the Illicit Exploitation of Timber Products in the Andringitra-Ivohibe Forest Corridor

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Abstract: Community-based forest management has become one of the principal instruments of Madagascar's forest policy for reconciliation biodiversity conservation with the improvement of rural livelihoods. Within this framework, the Contractual Forest Management system (Gestion Contractualisée des Forêts – GCF) delegates part of the responsibility for forest governance to Local Community Organizations (Vondron'Olonia) Ifotony – VOI). Nevertheless, the continued occurrence of illegal timber exploitation in forests under community management raises important questions regarding the effectiveness of existing institutional arrangements. This study examines how deficiencies in the implementation of community forest governance mechanisms influence the illegal exploitation of timber forest products within the Andringitra – Ivohibe Forest Corridor, southeastern Madagascar. The research combines documentary analysis of official management records, including management plans, local conventions (dina), infraction reports, sanction registers, and activity reports, with field surveys conducted among 178 households and 36 leaders from four Local Community Organizations. Governance performance indicators were calculated and subsequently analyzed using Principal Component Analysis (PCA) to determine the relationships between governance implementation and the intensity of illegal forest exploitation. The findings reveal substantial institutional weaknesses, including incomplete implementation of management plans, limited enforcement of local regulations and sanctions, irregular participation of community members, and the limited success of income-generating activities intended to reduce pressure on forest resources. The multivariate analysis demonstrates that governance deficiencies are strongly associated with increased illegal harvesting of commercial timber, whereas the exploitation of fuelwood remains primarily driven by household subsistence needs and persistent rural poverty. These findings suggest that strengthening institutional enforcement alone is insufficient to ensure sustainable forest management. Rather, effective community forestry requires a balanced strategy that combines robust governance mechanisms with economic viable alternatives capable of reducing local dependence on forest resources, thereby supporting the theoretical perspectives advanced by Ostrom and Berkes.

Keywords: Community Forest Governance; Contractual Forest Management; Illegal Timber Exploitation; Timber Forest Products; Local Community Organizations (VOI); Madagascar.

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I. INTRODUCTION

The degradation of forest resources is one of the major environmental challenges facing tropical countries today. Under the combined effects of population growth, agricultural expansion, commercial logging, and rural poverty, forest ecosystems are under increasing pressure that compromises their capacity to sustainably fulfill their ecological, economic, and social functions¹. This situation is particularly concerning in countries with high biodiversity, where forests simultaneously represent a global ecological heritage, an essential source of income for rural populations, and a major driver of territorial development².

Madagascar is among the world's leading biodiversity hotspots due to its exceptionally high rate of plant and animal endemism³. Madagascar's forest formations provide essential ecological functions, including biodiversity conservation, hydrological regulation, soil protection against erosion, carbon sequestration, and the maintenance of regional climate balance⁴. They also supply rural populations with numerous timber products, such as firewood, charcoal, construction timber, and lumber, which are vital resources for meeting domestic needs and generating supplementary income⁵.

However, for several decades, these forest resources have been undergoing continuous degradation. The work of Harper et al.⁶ shows that Madagascar has lost a significant portion of its forest cover over the past fifty years due to deforestation, habitat fragmentation, and the uncontrolled exploitation of natural resources. This dynamic results from a complex combination of demographic, economic, institutional, and political factors that promote the overexploitation of forest resources.

Faced with this situation, the Malagasy state has gradually reoriented its forestry policy towards an approach based on the participation of local communities in the sustainable management of natural resources. This evolution is part of the international movement for participatory

governance of common goods, largely inspired by the work of Elinor Ostrom⁷, according to which local communities are able to ensure effective management of common resources when clear, legitimate and effectively enforced rules govern their use.

In Madagascar, this approach materialized with the adoption of Secure Local Management (GELOSE), established by Law No. 96-025 of September 30, 1996, which organizes the transfer of management of renewable natural resources to organized local communities. GELOSE constitutes the general legal framework applicable to all renewable natural resources, whether forests, pastures, fisheries, or watersheds. To address the specific challenges of managing forest ecosystems, a complementary mechanism was subsequently established through Contractual Forest Management (GCF), dedicated exclusively to forest resources and based on management contracts between the forestry administration and Local Community Organizations (VOIs)⁸.

Contrary to a sometimes simplistic view of participatory governance, Community Forest Management (CFM) is not limited to the mere administrative transfer of powers to local communities. It constitutes a complex institutional framework based on several complementary components: a precise legal framework, a forest management plan, internal regulations, local social agreements (dina), a monitoring mechanism, a system of sanctions, monitoring and evaluation mechanisms, and a clearly defined distribution of responsibilities among the various stakeholders. Local Community Organizations, in particular, ensure community monitoring of forest resources, participate in the application of management rules, report violations, organize collective activities, and contribute to the implementation of management plans, while the forestry administration remains responsible for technical control, regulatory monitoring, and institutional support⁹.

From this perspective, the effectiveness of forest governance does not depend solely on the existence of a legal framework or a management transfer agreement. It relies primarily on the effective implementation of the provisions set out in management plans, respect for local social conventions, the effectiveness of sanctions, the active participation of Community-Based Organization (CBOO) members, the functioning of monitoring mechanisms, and the availability of economic alternatives capable of reducing

¹ Food and Agriculture Organization of the United Nations (FAO). (2020). *Global Forest Resources Assessment 2020: Main Report*. Rome: FAO.

² Millennium Ecosystem Assessment. (2005). *Ecosystems and Humans Well-being : Synthesis*. Washington, DC: Island Press.

³ Goodman, SM, & Benstead, JP (Eds.). (2005). *The Natural History of Madagascar*. Chicago: University of Chicago Press.

⁴ MEF (Ministry of Environment and Forests of Madagascar). (2015). *National Policy for the Sustainable Management of Forest Resources*. Antananarivo.

⁵ Food and Agriculture Organization of the United Nations (FAO). (2018). *State of the World's Forests 2018: Forest Pathways to Sustainable Development*. Rome: FAO.

⁶ Harper, G. J., Steininger, M. K., Tucker, C. J., Juhn, D., & Hawkins, F. (2007). "Fifty Years of Deforestation and Forest Fragmentation in Madagascar". *Environmental Conservation*, 34(4), 325-333.

⁷ Ostrom, E. (1990). *Governing the Commons: The Evolution of Institutions for Collective Action*. Cambridge: Cambridge University Press.

⁸ Republic of Madagascar. (1996). *Law No. 96-025 of September 30, 1996, relating to the Secure Local Management (GELOSE) of renewable natural resources*. Official Gazette of the Republic of Madagascar.

⁹ Ministry of the Environment, Water and Forests (MEEF). (2015). *Practical Guide to Contractual Forest Management (CFM)*. Antananarivo.

the dependence of local populations on forest resources¹⁰. Several studies also demonstrate that the performance of community-based management systems varies significantly according to the quality of their institutional implementation rather than simply their legal existence¹¹.

Despite progress made since the introduction of the GCF (Global Forestry Contract), illegal harvesting of timber products remains a widespread phenomenon in many forests under management transfer. This illegal harvesting encompasses various practices that violate forestry regulations, including unauthorized logging, harvesting in prohibited areas, felling protected species, exceeding authorized volumes, falsifying permits, and using bribery to circumvent control mechanisms¹². The timber products involved primarily include sawlogs for commercial markets, charcoal, and fuelwood used for domestic consumption or to supply urban markets.

Several studies conducted in Madagascar highlight that this illegal exploitation rarely stems from a single cause. It generally reflects the interaction between institutional failures, weak control mechanisms, inadequate community support systems, the economic constraints faced by rural households, and the existence of more or less structured¹³ commercial networks. In this context, poverty often constitutes an aggravating factor, as rural populations resort to forest resources as a subsistence strategy when alternative economic activities remain insufficiently profitable or unsustainable¹⁴.

Andringitra Ivohibe forest corridor, located within the vast Ambositra Vondrozo Forest Corridor (COFAV), particularly illustrates this issue. This area ensures ecological continuity between Andringitra National Park and the Ivohibe Peak Special Reserve, while also constituting a territory heavily dependent on forest resources for the livelihoods of local populations. Several Local Community Organizations have benefited from Contractual Forest Management agreements there for over two decades. However, official reports of forestry offenses, field

observations, and testimonies from local stakeholders highlight the persistence of illegal logging activities, suggesting shortcomings in the implementation of the community-based forest governance system.

International scientific literature widely recognizes the importance of participatory governance in the sustainable management of common resources. However, few studies precisely analyze which aspects of the institutional framework remain insufficiently implemented and to what extent these shortcomings actually facilitate the illegal exploitation of timber products in forests under management transfer in Madagascar. This scientific gap fully justifies the present research.

The central question of this study is therefore formulated as follows: *to what extent do the shortcomings observed in the application of the community forest governance system promote the illegal exploitation of timber forest products in the Andringitra Ivohibe forest corridor?*

➤ Two Specific Questions Arise from this:

- What are the main shortcomings observed in the application of community forest governance measures within Local Community Organizations?
- How do these shortcomings influence the intensity of illegal exploitation of timber products?

The overall objective of this research is to analyze the effects of shortcomings in the application of the community forest governance system on the illegal exploitation of timber products in the Andringitra Ivohibe forest corridor.

More specifically, this study aims to: (i) identify the main institutional shortcomings affecting the implementation of Contractualized Forest Management contracts; (ii) assess the level of application of the different governance measures provided for in the management mechanisms; and (iii) analyze the relationships between these institutional shortcomings and the different forms of illegal exploitation of timber products.

The main hypothesis posits that shortcomings in the application of community forest governance mechanisms reduce the effectiveness of Contractual Forest Management systems and promote the intensification of illegal exploitation of timber products, particularly those intended for commercial sectors.

From a scientific perspective, this research contributes to enriching the body of work on common resource governance by offering an integrated analysis of the interactions between institutional governance, community participation, and livelihood strategies. From an operational perspective, it provides decision-making tools that can improve public policies for community-based forest management, strengthen the capacities of Local Community Organizations, and enhance the effectiveness of conservation measures in Malagasy forest landscapes.

¹⁰ Agrawal, A., & Gibson, C.C. (1999). "Enchantment and Disenchantment : The Role of Community in Natural Resource Conservation." *World Development* , 27(4), 629-649.

¹¹ Persha, L., Agrawal, A., & Chhatre, A. (2011). "Social and Ecological Synergy : Local Rulemaking , Forest Livelihoods , and Biodiversity Conservation". *Science* , 331(6024), 1606-1608.

¹² Nellemann, C. (Ed.). (2012). *Green Carbon , Black Trade: Illegal Logging , Tax Fraud and Laundering in the World's Tropical Forests* . United Nations Environment Program (UNEP), GRID-Arendal.

¹³ Rasolofson, R.A., Ferraro, P.J., Jenkins, C.N., & Jones, J.P.G. (2015). "Effectiveness of Community Forest Management at reducing deforestation in Madagascar". *Biological Conservation* , 184, 271-277.

¹⁴ World Bank. (2022). *Madagascar Country Environmental Analysis : Environment for Growth* . Washington, DC: World Bank.

II. MATERIALS AND METHODS

➤ Study Area

This research was conducted in the Andringitra Ivohibe forest corridor, located in the Ivohibe district, Ihorombe Region, in southeastern Madagascar. This corridor belongs to the Ambositra Vondrozo Forest Corridor (COFAV), one of the largest humid forest complexes in Madagascar, recognized for its exceptional ecological importance and its strategic role in maintaining connectivity between several protected areas¹⁵.

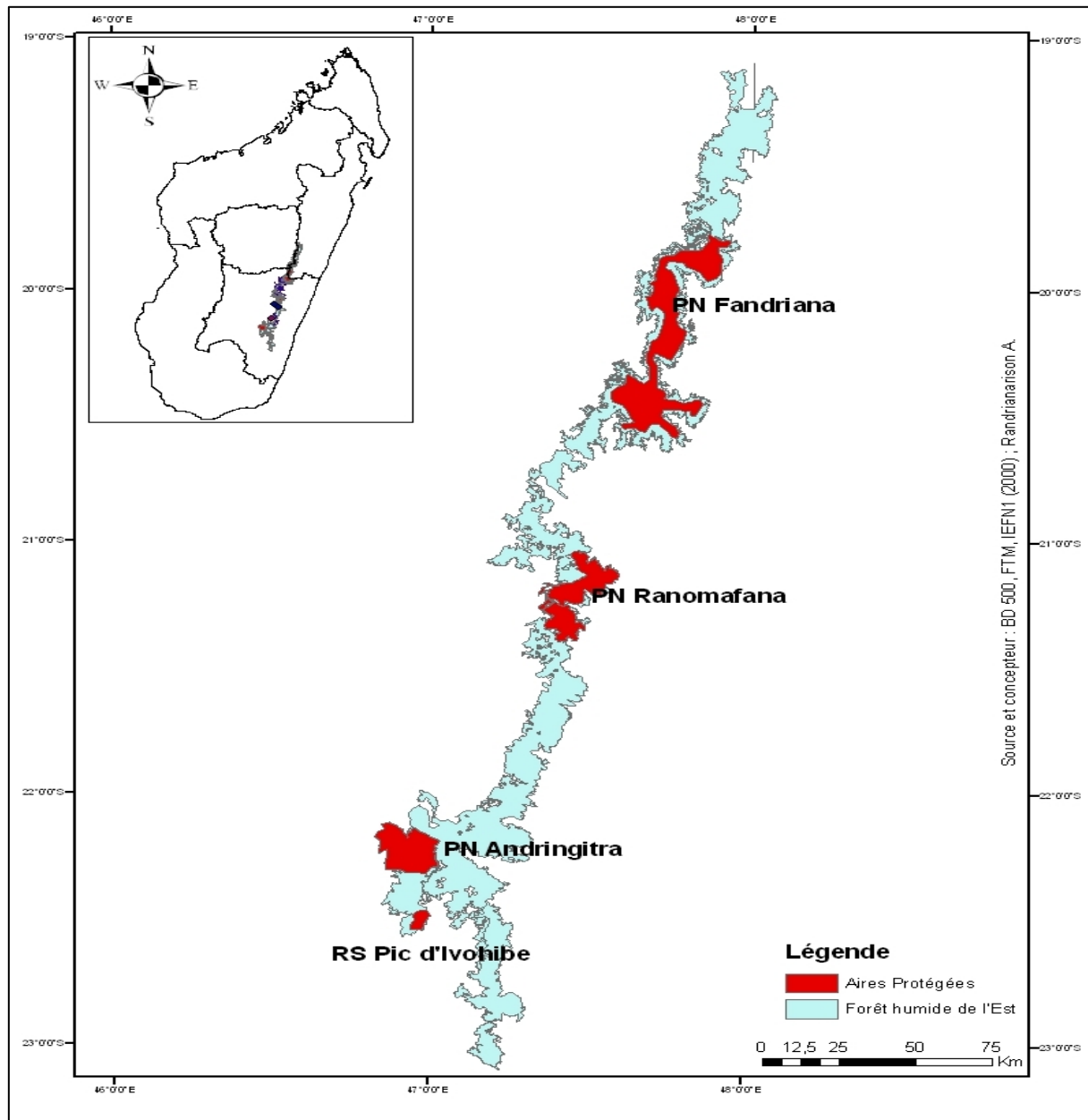


Fig 1 Study Area

Ivohibe Peak Special Reserve and forms an ecological continuum essential for the conservation of numerous endemic species of flora and fauna. In addition to its biological richness, this forest provides a wide range of ecosystem services, including watershed protection, hydrological regulation, carbon sequestration, soil erosion control, and the provision of forest resources vital to the livelihoods of local communities¹⁶.

¹⁵ Ostrom, E. (1990). *Governing the Commons: The Evolution of Institutions for Collective Action*. Cambridge University Press.

¹⁶ Sarrasin, B., Ribot, J., & Gautier, D. (2020). Community forestry and participatory governance: Challenges and opportunities in forest management. *International Forestry Review*, 22(3), 345–360.

Communities living near this corridor rely heavily on timber products to meet their domestic needs and generate supplementary income. Firewood, charcoal, construction timber, and lumber are therefore essential economic resources. However, this heavy dependence increases the pressure on forest ecosystems and poses a major challenge to the sustainable management of natural resources¹⁷.

Contractual Forest Management (CFM) contracts have been progressively implemented in this region since the early 2000s. The Andringitra– Ivohibe corridor thus constitutes a particularly relevant laboratory for analyzing the effects of the application of community forest governance mechanisms on the dynamics of exploitation of timber resources.

➤ Choice of Study Sites

Four Local Community Organizations (Vondron'Olona) Ifotony – VOI) benefiting from an official “Contractualized Forest Management (CFM)” contract¹⁸, the following were selected as observation units: Lovasoa , Avotra , Fiarova and Fitiavana Tontolo Iainana (FTI).

• Ivohibe District

Table 1 Ivohibe District

No.	Yes	Village	Fokontany	Municipality
1	Lovasoa	Marominty and Vohimary	North Ivohibe	Ivohibe
2	Avotra	Ambatovita	North Ivohibe	Ivohibe
3	Fiarova	Angodongodo	North Ivohibe	Ivohibe
4	Fitiavana Tontolo Iainana (FTI)	Bemandresy	Tanandava South	Maropaika

Ivohibe VOI Platform, 2024

The choice of these four VOIs is based on several scientific criteria. First, each has an official management transfer contract signed with the forestry administration for several years, which guarantees sufficient experience in the implementation of community governance mechanisms¹⁹.

Secondly, these organizations exhibit contrasting levels of implementation of the requirements set out in their management plans, allowing for the observation of different situations of forest governance. This comparative approach is consistent with research on the governance of common resources, which emphasizes the importance of studying institutional variations between communities in order to identify the factors influencing the performance of collective management systems²⁰.

Third, the four OIVs face diverse forms of exploitation of timber products, thus providing a favorable comparative framework for analyzing the relationship between governance and illegal logging. Studies on socio-ecological systems show that pressures on natural resources generally result from complex interactions between institutions, human behavior, and local economic conditions²¹.

Finally, the availability of administrative archives (management plans, violation reports, sanctions registers, attendance records, and activity reports) provided reliable information covering several dimensions of community governance. The use of institutional documentary sources is a recognized method for analyzing the actual functioning of forest management systems²².

Using several VOIs with contrasting institutional characteristics thus improves the robustness of statistical analyses and reduces biases related to the study of a single site²³.

➤ Search Type

This study employs a quantitative approach with an explanatory aim. It seeks to identify the relationships between the shortcomings observed in the application of community forest governance mechanisms and the intensity of illegal exploitation of timber products.

¹⁷ Agrawal, A., & Gibson, C.C. (1999). Enchantment and Disenchantment : The Role of Community in Natural Resource Conservation. *World Development* , 27(4), 629–649.

¹⁸ Republic of Madagascar. (1996). Law No. 96-025 relating to Secure Local Management (GELOSE) . Antananarivo.

¹⁹ Bertrand, A., & Weber, J. (2002). *Community management of forests in Madagascar: institutional and social issues* . CIRAD.

²⁰ Ostrom , E. (1990). *Governing the Commons: The Evolution of Institutions for Collective Action* . Cambridge University Press .

²¹ Berkes , F. (2006). From Community-Based Resource Management to Complex Systems . *Ecology and Society* , 11(1), 45.

²² Bowen, G. A. (2009). Document Analysis as a Qualitative Research Method. *Qualitative Research Journal* , 9(2), 27–40.

²³ Yin, RK (2018). *Case Study Research and Applications: Design and Methods* . Sage Publications.

The approach employed relies on the combined analysis of documentary data, field surveys, and multivariate statistical analyses, enabling the explanation of institutional mechanisms that influence forest resource exploitation behaviors. The use of a quantitative explanatory approach allows for the identification of relationships between variables and the measurement of the relative effect of institutional and socio-economic factors ²⁴.

➤ *Study Population and Sampling*

Two categories of actors were considered.

The first group consists of households living near forests under management transfer. They are the main users of forest resources and are the direct or indirect beneficiaries of Contractual Forest Management schemes. Local communities play a central role in conservation dynamics, as their livelihood strategies directly influence the pressures exerted on natural resources ²⁵.

The second group comprises the members of the executive offices of the Local Community Organizations, responsible for the daily implementation of management contracts, monitoring of community activities, application of local rules and control of infractions.

In total, 178 households were surveyed using a structured questionnaire. In addition, 36 VOI officials, including presidents, vice-presidents, secretaries, treasurers, and several technical officers, participated in semi-structured interviews designed to gather more information about the organizations' institutional functioning.

The sample was constructed using purposive sampling based on the actual participation of actors in community governance mechanisms. This method is suitable for research on local institutions when the objective is to interview actors with direct knowledge of the phenomenon under study ²⁶.

➤ *Data Collection*

Data collection is based on a methodological triangulation strategy ²⁷ to improve the scientific validity of the results.

• *Document Analysis*

A systematic analysis of the main management documents was carried out. The documents consulted include:

- ✓ Forest management plans;
- ✓ The specifications;
- ✓ The approved social agreements (*Dina*);
- ✓ The internal regulations of the VOI;
- ✓ The official reports relating to forestry offences;
- ✓ The sanctions registers;
- ✓ Annual activity reports;
- ✓ Attendance records for meetings;
- ✓ Registers of participation in community activities.

These documents allowed for an objective assessment of the degree to which the institutional mechanisms stipulated in the Contractual Forest Management agreements were implemented. Document analysis is an essential method for measuring the gap between the prescribed institutional rules and their actual application on the ground ²⁸.

The information collected relates in particular to:

- ✓ Compliance with the requirements of the development plans;
- ✓ The effective application of the *Dina* ;
- ✓ The application of the prescribed sanctions;
- ✓ The participation of members in statutory meetings;
- ✓ The involvement of communities in collective management activities.

• *Household Survey*

The household surveys were primarily aimed at collecting information relating to income-generating activities (IGAs) developed under Contractualized Forest Management agreements.

These income-generating activities (IGAs) were established with the support of development projects, partner non-governmental organizations and technical services involved in community management of natural resources.

The information collected relates to:

- ✓ The types of agricultural production systems developed;
- ✓ Their level of economic success;
- ✓ Their contribution to household income;
- ✓ Their ability to reduce dependence on the exploitation of forest resources.

The study of household economic strategies is essential to understanding natural resource use behaviors, particularly in rural areas where the forest represents an important source of subsistence ²⁹.

²⁴ Creswell , J. W., & Creswell , J. D. (2018). *Research Design: Qualitative, Quantitative, and Mixed Methods Approaches* . Wise.

²⁵ Angelsen , A., & Wunder , S. (2003). *Exploring the Forest– Poverty Link* . CIFOR.

²⁶ Patton, M. Q. (2015). *Qualitative Research & Evaluation Methods* . Wise.

²⁷ Denzin , N. K. (1978). *The Research Act : A Theoretical Introduction to Sociological Methods* . McGraw -Hill.

²⁸ Scott, J. (1990). *A Matter of Record: Documentary Sources in Social Research* . Polity Press .

²⁹ Ellis, F. (2000). *Rural Livelihoods and Diversity in Developing Countries* . Oxford University Press .

- *Interviews with VOI Managers*

The interviews conducted with community leaders aimed to understand the institutional functioning of Local Community Organizations.

The discussions focused on:

- ✓ The decision-making processes;
- ✓ The organisation of community controls;
- ✓ The difficulties encountered in applying the rules;
- ✓ Conflict resolution mechanisms;
- ✓ Constraints limiting the effectiveness of governance mechanisms.

The qualitative information obtained made it possible to interpret the statistical results in their institutional and social context³⁰.

➤ *Variables Studied and Construction of Indicators*

The main objective of this research is to analyze the influence of the shortcomings observed in the application of the community forest governance system on the illegal exploitation of timber forest products.

To achieve this objective, two categories of variables were selected:

- The explanatory variables , representing the level of application of governance mechanisms (application of *Dina* , functioning of VOI, community participation, control and sanctions);
- The dependent variables , reflecting the intensity of illegal exploitation of forest resources (frequency of offences, estimated volume of products exploited, types of resources concerned).

The construction of composite indicators to measure institutional governance is widely used in research on natural resource management and makes it possible to transform qualitative dimensions into statistically analyzable variables³¹.

- *Explanatory Variables*

The explanatory variables correspond to the main dimensions of community forest governance provided for in the Contractualized Forest Management (CFM) contracts. Their selection is based on the principles of common resource governance developed by Ostrom¹, according to which the effectiveness of a management system depends on the effective application of rules, user participation, collective control and the existence of sanction mechanisms.

Six indicators were selected.

The degree of compliance with the management plan (DRPA) measures the proportion of activities actually carried out compared to those planned in the forest

management plan. This indicator allows for an assessment of the level of operational implementation of the technical management requirements.

The level of *Dina* application (NAD) assesses the frequency with which approved social conventions are effectively applied when a forestry violation is observed. It reflects the communities' capacity to enforce their own management rules.

The level of enforcement of sanctions (NAS) measures the proportion of sanctions actually applied relative to the sanctions stipulated in the management rules. This indicator provides information on the effectiveness of the deterrent mechanisms implemented by Local Community Organizations.

The meeting attendance rate (MAR) represents the actual participation of members in statutory meetings organized by the VOI. It constitutes an indicator of member involvement in local governance.

The participation rate in VOI activities (TPAV) reflects the commitment of communities to collective activities of monitoring, reforestation, maintenance of firebreaks, forest restoration and other actions provided for in management contracts.

Finally, the income-generating activities success rate (IGAR) measures the proportion of economic activities implemented within the framework of the GCF that have actually achieved their economic objectives. This indicator allows us to assess the capacity of economic alternatives to reduce household dependence on forest resources.

- *Dependent Variables*

The dependent variables represent the main forms of exploitation of woody forest products observed in the sites studied.

Three categories of forest products were selected.

The first concerns firewood , mainly intended for domestic consumption by rural households.

The second corresponds to charcoal , a product intended both for self-consumption and for sale to urban centers.

The third concerns timber , consisting in particular of beams, planks and construction timber, the exploitation of which is generally oriented towards commercial markets and has a higher economic value.

The choice of these three categories makes it possible to distinguish forms of exploitation linked to subsistence needs from those more motivated by commercial interests.

³⁰Ellis, F. (2000). *Rural Livelihoods and Diversity in Developing Countries* . Oxford University Press .

³¹ Kvale , S. (2007). *Doing Interviews* . Sage Publications.

➤ *Calculation of Governance Indicators*

Table 2 Parameters to be Collected when Consulting Official Documents

Official documents consulted	Parameters to be collected
Development plan and activity report	Number of planned development measures Number of planning measures respected
minutes and records of offence management	Total number of offences recorded Number of cases where the dina is applied
Sanctions Register	Number of sanctions applied Number of sanctions planned
attendance sheets for VOI member meetings	Number of actual attendances Number of expected attendances
attendance sheets and activity reports	Number of actual participations Number of expected entries

Source: Author, 2025

• *VOI Household and Office Member Survey*

In addition to consulting official documents, surveys were conducted with households and VOI board members. A total of 178 households were surveyed. This allowed for the collection of data on the number of income-generating activities (IGAs) implemented and the number of successful IGAs. It aimed to assess the success rate of income-

generating activities implemented within the framework of participatory management. Furthermore, surveys were conducted with 36 VOI board members, including presidents, secretaries, treasurers, and other officials. These surveys aimed to analyze the internal functioning of the VOIs, the decision-making mechanisms, and the methods of applying management rules.

Table 3 Parameters to be Collected During Household Surveys

Data collection method	Parameters to collect
Household Survey	Number of successful AGRs Number of AGRs implemented

Source: Author, 2025

• *Data Analysis Methods*

In this study, the analysis is based on a set of well-defined variables. The independent (explanatory) variables correspond to the level of application of participatory governance measures, namely: the degree of respect for the development plan, the level of application of the dina, the level of application of sanctions, the rate of attendance at

members' meetings, the level of involvement of members in the activities of the VOI and the success rate of income-generating activities (IGA).

These variables were calculated using well-designed formulas (Table 4). They are expressed as percentages.

Table 4 Methods for Calculating Explanatory Variables

Explanatory variables	Formula (Calculation Method) of the Explanatory Variable
Degree of compliance with the development plan (DRPA)	$(\text{Number of planning measures implemented} / \text{Number of planning measures planned}) \times 100$
Level of application of dina (NAD)	$(\text{Number of cases where the dina is applied} / \text{Total number of violations observed}) \times 100$
Sanctions Application Level (SAL)	$(\text{Number of sanctions applied} / \text{Number of sanctions planned}) \times 100$
meeting attendance rate (TAR)	$(\text{Number of actual attendances} / \text{Number of expected attendances}) \times 100$
Participation rate in VOI activities (TPAV)	$(\text{Number of actual participations} / \text{Number of expected participations}) \times 100$
Success rate of income-generating activities (IGAs).	$(\text{Number of successful AGRs} / \text{Number of AGRs implemented}) \times 100$

Source: Author, 2025

In this study, principal component analysis (PCA) was chosen to examine the relationships between explanatory variables related to community governance of forest-based initiatives (FOIs) and dependent variables representing pressure on forest resources, namely the number of bags of charcoal, bundles of firewood, and batanes (timber). It relies on transforming a set of initially correlated variables into orthogonal principal components, maximizing the explained

variance and thus facilitating the interpretation of underlying structures (Jolliffe, 2002).

The interpretation of the factorial axes derived from PCA, obtained by diagonalizing the correlation matrix, reveals relationships of dependence or opposition between variables. Indeed, variables with strong positive correlations tend to move in similar directions, while those with negative

correlations move in opposite directions along the principal axes (Jolliffe , 2002).

In this context, grouping variables reflecting effective local governance (compliance with the management plan, application of customs and sanctions, strong member participation) and their opposition to forest exploitation variables would confirm an inverse relationship, demonstrating that improving institutional mechanisms contributes to reducing human pressure on resources (Guerrien , 2017).

Method for calculating the overall score:

$$SGG(\%) = \frac{DRPA + NAD + NAS + TAR + TPAC + TRAGR}{6}$$

Where:

SGG (%) = Global Score of Community Forest Governance

DRPA = Score of the DRPA indicator

NAD = Score of the NAD indicator

NAS = Score of the NAS indicator

TAR = Score of the TAR indicator

TPAC = Score of the TPAC indicator

TRAGR = Score of the TRAGR indicator

6 = Total number of indicators included in the calculation.

$$SGG(\%) = \frac{\sum_{i=1}^6 I_i}{6}$$

Where I_i represents each of the six governance indicators.

➤ Statistical Analysis of Data

The collected data were processed using a combination of descriptive and multivariate analyses.

Initially, descriptive statistics were used to characterize the levels of application of the different components of community forest governance as well as the forms of exploitation of timber forest products observed in the four Local Community Organizations.

In a second step, the relationships between governance variables and forest exploitation variables were analyzed using a Principal Component Analysis (PCA) .

The use of this method is justified by the fact that several governance indicators are likely to be correlated with each other. Principal Component Analysis (PCA) reduces this information redundancy while highlighting the main dependency structures existing between the variables studied³².

Unlike a purely descriptive approach, PCA allows us to identify groups of variables that move in the same

direction as well as those that exhibit opposing relationships. Proximities observed between variables reflect positive correlations, while their distance reflects negative correlations.

In this study, particular attention was paid to the relationships between governance indicators (DRPA, NAD, NAS, TAR, TPAV, and TRAGR) and the different forms of exploitation of timber products (firewood, charcoal, and timber). The interpretation is based primarily on correlations between variables rather than on the description of factorial axes, in accordance with methodological recommendations formulated in the specialized literature³³.

The results of this analysis thus make it possible to determine which components of community forest governance contribute most effectively to limiting the different forms of illegal exploitation of timber resources.

III. RESULTS

➤ Shortcomings in the Application of the Community Forest Governance Mechanism

• Incomplete Application of Institutional Governance Mechanisms

Analysis of management documents reveals an incomplete application of the main institutional mechanisms stipulated in the Contractualized Forest Management (CFM) agreements. Compliance rates vary considerably from one Local Community Organization (LCO) to another, reflecting a heterogeneous implementation of forest governance mechanisms.

Development plans are only partially implemented, with completion rates ranging from 40% to 78% depending on the organization studied. Similarly, the procedures stipulated in the social agreements (Dina) are only applied to a portion of the observed violations. The sanctions provided for in the management regulations also remain insufficiently enforced, thus reducing their deterrent effect. Finally, attendance records reveal irregular member participation in the statutory meetings of the VOIs, which limits collective decision-making and the monitoring of community activities.

These observations reflect a significant gap between the institutional requirements stipulated in the management contracts and their actual implementation on the ground. They reveal that governance deficiencies simultaneously affect planning, community oversight, the application of local rules, and member mobilization.

³² Jolliffe , I. T. (2002). *Principal Component Analysis* (2nd ed .). Springer.

³³Abdi, H., & Williams, L.J. (2010). Principal Component Analysis . *Wiley Interdisciplinary Reviews : Computational Statistics* , 2(4), 433-459.

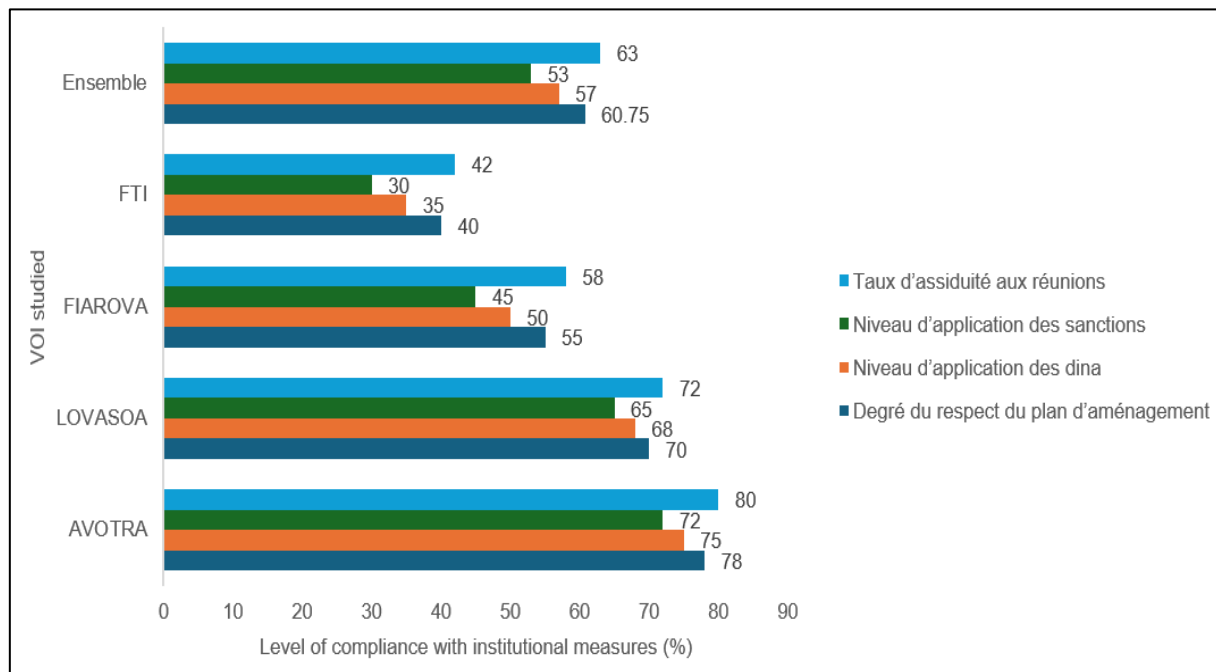


Fig 2 Level of Application of the Main Institutional Mechanisms of Forest Governance within Local Community Organizations. Ivohibe VOI Platform (2025); Ivohibe Forestry District (2025).

Overall, four major shortcomings characterize the systems studied:

- ✓ Partial implementation of forest management plans;
- ✓ Weak implementation of social conventions (Dina);
- ✓ Limited application of the sanctions provided for;
- ✓ Low participation of members in governance bodies.

These results show that the difficulties encountered do not only concern the existence of management rules, but above all their effective application by local actors.

- *Poor Performance of the Economic Alternatives Offered to Communities*

Analysis of data from household surveys reveals that community governance mechanisms remain insufficiently accompanied by economic alternatives capable of sustainably reducing the dependence of populations on forest resources.

Participation rates in collective activities of the VOI remain relatively low, reflecting a still limited community engagement in the implementation of forest management actions.

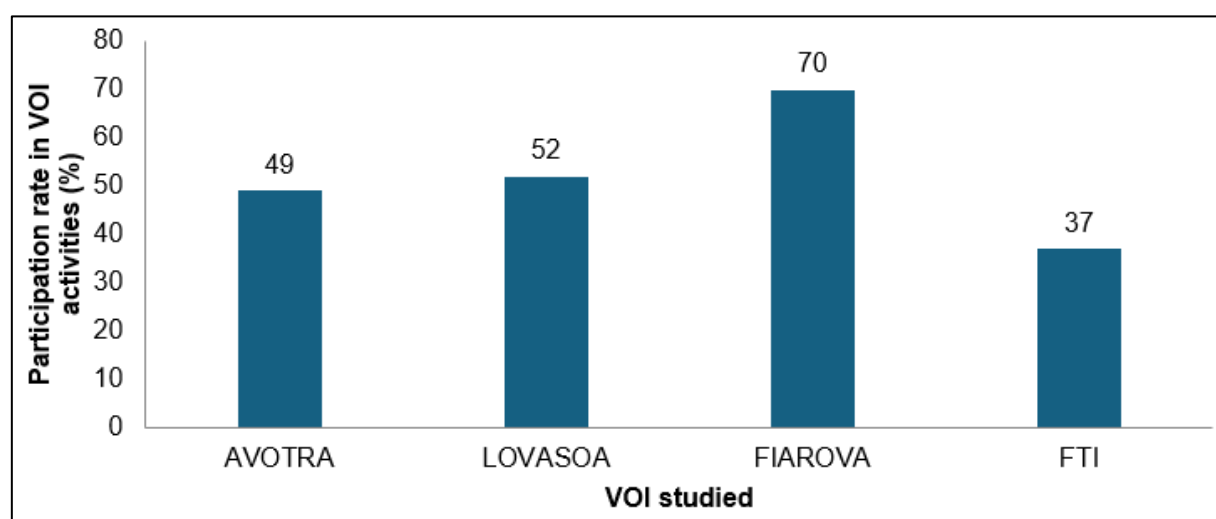


Fig 3 Member Participation Rates in Activities Organized by Local Community Organizations. Ivohibe VOI Platform (2025); Ivohibe Forestry District (2025).

Furthermore, surveys show that income-generating activities (IGAs) developed under Contractual Forest Management agreements have a low success rate. Several

activities have failed to generate sufficient income to constitute a viable economic alternative to forest resource exploitation.

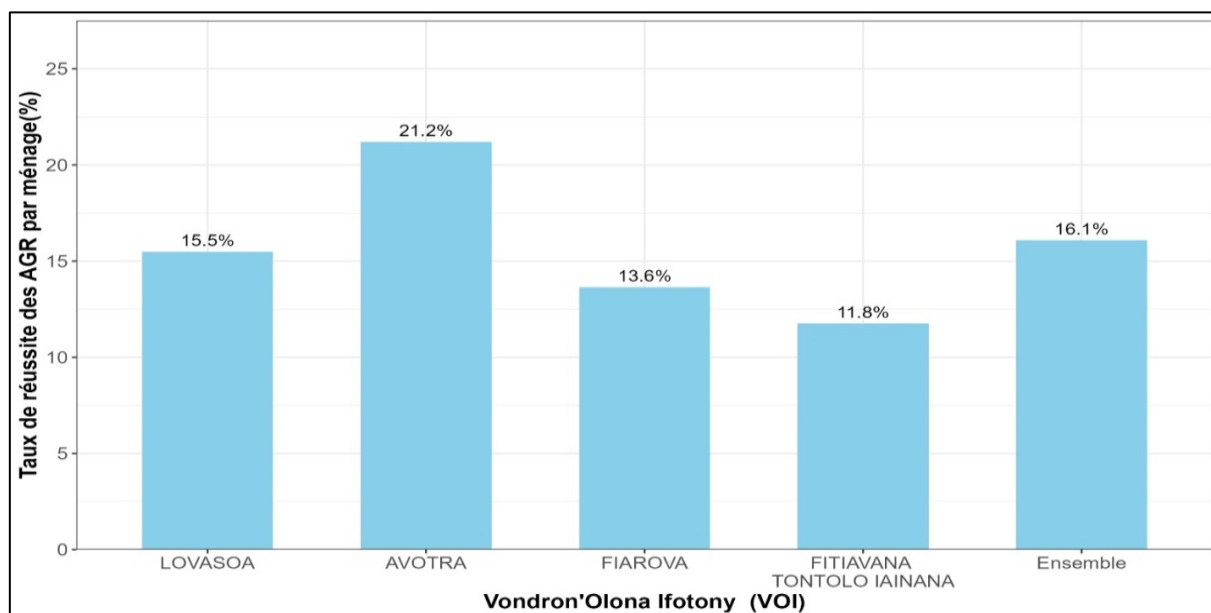


Fig 4 Success Rate of Income-Generating Activities Developed in Local Community Organizations.

Source: Household Survey (2025).

The combination of low community participation and limited effectiveness of income-generating activities significantly reduces the capacity of governance mechanisms to bring about lasting changes in household behavior. Consequently, a large portion of the population continues to depend on the harvesting of timber products for their livelihoods. These findings highlight a disconnect between institutional management mechanisms and the economic support measures intended to assist local communities.

➤ *Influence of Governance Deficiencies on the Illegal Exploitation of Timber Products*

• *Persistence of Illegal Exploitation Practices*

Surveys conducted with leaders of Local Community Organizations show that the illegal exploitation of forest resources remains a widely recognized reality in the Andringitra– Ivohibe forest corridor .

In total, 91.67% of the managers surveyed (33 out of 36 respondents) reported having observed illegal mining activities in their management area. Only 5.56% believed that these practices were non-existent, while 2.78% did not express an opinion.

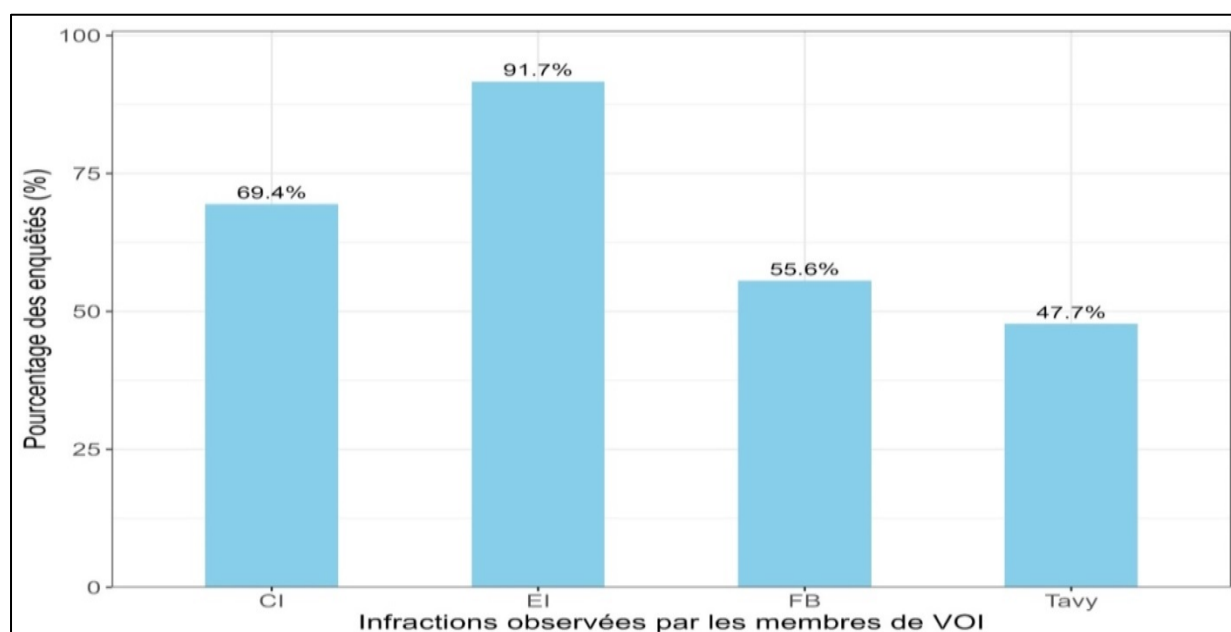


Fig 5 Main Forestry Offences Reported by Leaders of Local Community Organisations.

Source: Survey of VOI Managers (2025).

Beyond the illegal exploitation of timber products, several other forms of environmental offenses were identified. Illegal hunting was mentioned by 69.44% of respondents, bushfires by 55.56% , and slash-and-burn clearing practices (" tavy ") by 47.22%.

These results show that forestry offenses are part of a broader dynamic of human pressure on natural resources. Interviews conducted with households indicate that these activities are primarily motivated by the search for supplementary income to cover families' daily needs.

- *Relationship Between the Level of Application of Governance Mechanisms and the Intensity of Illegal Exploitation*

The relationships between governance indicators and different forms of exploitation of timber forest products were examined using a Principal Component Analysis (PCA).

The results clearly highlight an opposition between indicators reflecting effective community governance (respect for the management plan, application of Dina,

application of sanctions and attendance at meetings) and the intensity of timber exploitation.

Indeed, improved enforcement of institutional mechanisms is associated with a decrease in illegal timber harvesting. Conversely, organizations with the lowest levels of governance also experience the highest levels of commercial timber harvesting.

In contrast, the harvesting of firewood and charcoal exhibits a different pattern. These two forms of exploitation remain relatively significant, even when institutional indicators show relatively satisfactory levels. This situation reflects the weight of the economic constraints faced by rural households, who continue to depend on forest resources to meet their energy needs and ensure their income.

Furthermore, the analysis shows that the two socio-economic indicators the community participation rate and the success rate of income-generating activities are closely associated with reduced pressure on forest resources. Communities benefiting from more effective economic alternatives exhibit lower intensity of timber resource exploitation.

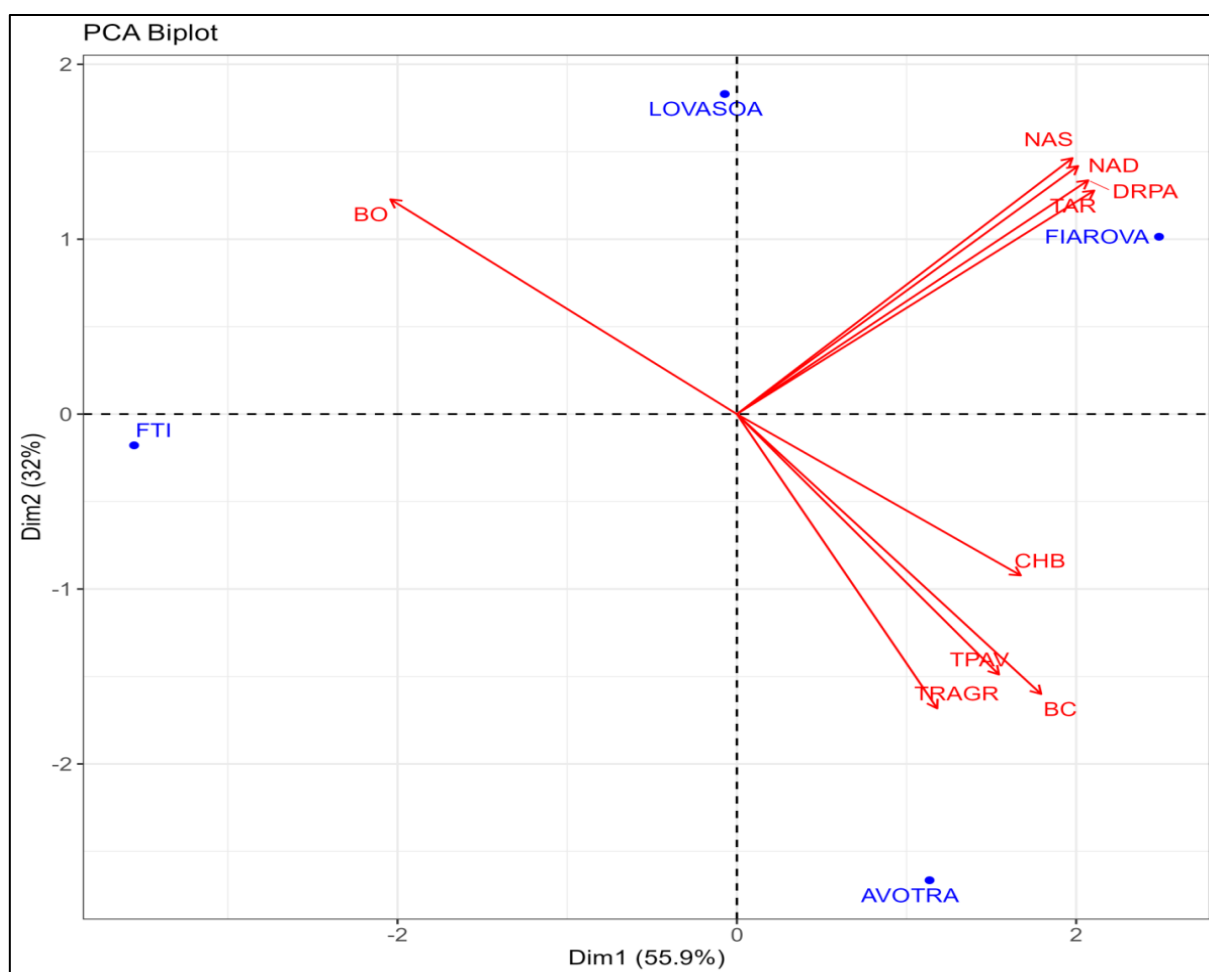


Fig 6 Relationships Between Community Forest Governance Indicators and the Intensity of Timber Product Exploitation (Principal Component Analysis).

Ivohibe Forestry Cantonment (2025); Survey of Local Community Organizations (2025).

The PCA analysis shows that institutional deficiencies primarily influence the harvesting of timber, which is essentially for commercial purposes. In contrast, the harvesting of firewood and charcoal remains largely driven by household subsistence needs. These results thus highlight the multidimensional nature of the illegal exploitation of timber products, which stems from the interaction between institutional failures, local socio-economic conditions, and the survival strategies of rural populations.

IV. DISCUSSIONS

To analyze the impacts of gaps in participatory forest resource governance on the illegal exploitation of timber products in the Andringitra Ivohibe corridor. The hypothesis is that non-compliance with governance measures facilitates the illegal exploitation of timber products.

➤ *Explanation of the Shortcomings in Participatory Governance*

The results highlight three main shortcomings in participatory governance. First, discrepancies were observed between the measures implemented and their application. This confirms that institutional effectiveness depends on their actual implementation by local actors (Ostrom, 1990)³⁴. This finding corroborates Ostrom's (1990) analysis that the sustainability of institutions depends on their capacity to be effectively implemented and appropriated by local actors. Recent work confirms that the effectiveness of community management depends on the quality of participatory governance and the strengthening of institutional capacities (Sarrasin et al., 2020).

Furthermore, the partial application of local customs (dina) and sanctions explains the fragility of local regulatory mechanisms. This situation reduces the deterrent effect of the measures and fosters the persistence of illegal exploitation. This means that participatory governance lacks sufficient control capacity to regulate resource use. This fragility can be explained through normative pluralism, where customary norms and formal rules coexist, leading to conflicts of legitimacy (Agrawal and Gibson, 1999)³⁵. In the Malagasy context, this tension is particularly pronounced when formal mechanisms fail to take local contexts into account. The performance of local authorities can be influenced by external factors that reduce their capacity for control and monitoring. Thus, the failure of institutional control observed in this study illustrates the vulnerability of participatory governance mechanisms.

Finally, the low level of participation among community-based organizations (CBOs) is among the main

shortcomings of participatory governance. This is contingent upon economic and institutional factors. This means that participatory governance is incomplete when stakeholders are not engaged. Effective participation requires appropriate engagement mechanisms and tangible benefits for communities (Carter et al., 2023). Without sufficient incentives, members may gradually disengage, which weakens local governance.

➤ *Structural Limitations of Economic Incentives*

The results reveal structural weaknesses in the economic incentives used to implement forest management. First, the low success rate of income-generating activities (IGAs) constitutes the main shortcoming of participatory governance. These results corroborate criticisms made in the literature. They confirm that the economic alternatives implemented are often ineffective in replacing income from logging (Berkes, 2004; Ferraro, 2001). Lacking economic viability, these alternatives fail to bring about lasting changes in household behavior. The ineffectiveness of IGAs fosters the persistence of illegal logging.

Furthermore, household dependence on forest resources demonstrates a logic of economic rationality in a context of poverty (Angelsen and Wunder, 2003). In this framework, resource exploitation constitutes an essential subsistence strategy.

Recent studies confirm that poverty is the primary driver of illegal logging in Madagascar (Minten et al., 2013). This situation confirms that forest resource degradation and poverty are mutually reinforcing.

Finally, the disconnect between institutional governance and economic incentives is one of the shortcomings of participatory governance. Even when certain rules are applied, their effectiveness remains limited in the absence of viable economic alternatives. Recent literature confirms the need to integrate economic and institutional dimensions into forest resource management policies (Ostrom, 2010). Combining participatory governance with successful economic alternatives allows for the reduction of human pressures on forest resources.

The lack of coordination between participatory governance and economic incentives reduces the effectiveness of participatory governance mechanisms. This finding qualifies the hypothesis by demonstrating that good governance, without viable economic alternatives, does not lead to a reduction in the illegal exploitation of timber products.

➤ *Relationship Between Participatory Governance and Illegal Exploitation*

The results confirm that gaps in participatory governance promote illegal logging, particularly for timber. However, this relationship is not uniform, which confirms the complexity of governance dynamics (Agrawal, 2001)³⁶.

³⁴ Ostrom, E. (1990). *Governing the commons: The evolution of institutions for collective action*. Cambridge University Press.
<https://doi.org/10.1017/CBO9780511807763>.

³⁵ Agrawal, A., & Gibson, C. C. (1999). Enchantment and disenchantment: The role of community in natural resource conservation. *World Development*, 27(4), 629–649.
[https://doi.org/10.1016/S0305-750X\(98\)00161-2](https://doi.org/10.1016/S0305-750X(98)00161-2).

³⁶ Agrawal, A. (2001). Common property institutions and sustainable governance of resources. *World Development*,

The distinction between commercial and subsistence logging is consistent with research on rural livelihoods (Ellis, 2000; Angelsen and Wunder, 2003). The findings show that fuelwood harvesting persists even in the presence of functional governance mechanisms.

The analysis confirms that the relationship between governance and illicit exploitation is multidimensional, involving complex interactions between institutional and socio-economic factors (Berkes, 2006; Froger et al., 2004).

Recent studies on community-based biodiversity monitoring also show that integrating local knowledge can improve governance, but requires appropriate mechanisms to be effective.

Participatory governance influences illegal exploitation in different ways depending on the type of resource and its uses. The hypothesis is confirmed, but not uniformly, being primarily verified for resources with high commercial value. The study does not distinguish in depth between the different exploitation channels.

➤ *Theoretical Contributions and Perspective*

This research confirms that traditional models of common-pool resource governance must be contextualized. In developing countries, the performance of community-based management (CBM) systems is highly dependent on socio-economic and institutional conditions (Ostrom, 2010; Berkes, 2006).³⁷ It is important to consider that socio-ecological systems are complex. The interactions between actors, institutions, and the environment determine the outcomes.

This study contributes to the literature by demonstrating that participatory governance cannot be analyzed independently of local socio-economic dynamics. It highlights that the effectiveness of community-based forest management (CBM) mechanisms is highly dependent on economic conditions and household livelihood strategies. Thus, the results underscore the need for a holistic approach combining institutional and socio-economic dimensions to understand forest resource exploitation.

V. CONCLUSION

This study aimed to analyze the influence of shortcomings in participatory governance on the illegal exploitation of timber products in the Andringitra Ivohibe corridor. It is part of a comprehensive approach to natural resource conservation, considering that environmental dynamics are closely linked to the social, economic, and institutional realities of local communities.

The results obtained generally confirm the hypothesis that weaknesses in participatory governance mechanisms contribute to the persistence of illegal exploitation practices. However, the analysis shows that this phenomenon does not stem solely from an institutional deficit, but from a complex interplay between local management capacity, economic constraints, and the subsistence strategies developed by rural populations.

The study highlights that, despite the existence of devices such as VOIs (Vondron'Olona), forest management plans (dina), and community-based monitoring mechanisms, their effectiveness remains limited by organizational, technical, and financial constraints. The main challenge lies in the gap between established formal rules and their effective application on the ground. Thus, as Ostrom emphasizes, the sustainable management of common resources depends less on the existence of rules than on their appropriation, legitimacy, and actual implementation by the stakeholders involved.

The results also show that community participation sometimes remains insufficient due to a lack of economic incentives, appropriate training, and a low perception of the benefits of conservation. Participatory governance should therefore not be seen as a simple transfer of responsibilities to communities, but as a process requiring sustained institutional support, local capacity building, and consideration of the socio-economic needs of the population.

Furthermore, household dependence on forest resources appears strongly linked to poverty and the limited economic alternatives available. In this context, some forms of logging are more a response to survival needs than a deliberate attempt at environmental degradation. This reality underscores the importance of integrating conservation policies into a sustainable local development approach.

The analysis also reveals that illegal logging is a multidimensional phenomenon. Commercial timber harvesting is primarily influenced by institutional weaknesses, economic opportunities, and marketing networks, while domestic fuelwood harvesting is more responsive to basic household needs. This distinction necessitates differentiated intervention strategies tailored to local realities.

Thus, the research hypothesis is confirmed, but with some nuances. Improving participatory governance is an essential condition for reducing illegal exploitation, but it must be accompanied by complementary actions: institutional strengthening of local authorities, improvement of control mechanisms, development of sustainable income-generating activities, and reduction of the socio-economic vulnerability of communities.

Ultimately, the sustainable conservation of the forests in the Andringitra–Ivohibe corridor cannot be ensured solely through regulatory measures. It requires an integrated approach based on a balance between effective governance,

29(10), 1649–1672. [https://doi.org/10.1016/S0305-750X\(01\)00063-8](https://doi.org/10.1016/S0305-750X(01)00063-8).

³⁷ Ostrom, E. (2010). Beyond markets and states: Polycentric governance of complex economic systems. *American Economic Review*, 100(3), 641–672. <https://doi.org/10.1257/aer.100.3.641>.

social justice, and local economic development. Combating illegal logging thus emerges as a genuine process of institutional and social transformation, in which local communities must be considered not only as beneficiaries but also as essential actors in the protection of natural resources.

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