

Institutional analysis of the conservation management for *Litsea leytensis* Merr. in Laguna and Quezon, Philippines

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Abstract

This paper aims to analyze the institutions involved in the conservation management of *Litsea leytensis* Merr., with the trade name Medang, a wood species preferred by carvers in the Philippines, particularly in Paete, Laguna. The art of wood carving is thriving as a culture and as a wood-based industry for Filipinos, intertwined with natural resource management, where the seeds and wildlings are collected as planting materials for the nationwide greening program, while the wood as raw material is carefully selected from a list of Philippine native species. *Litsea leytensis* Merr. represents the many endemic trees in the country that need serious attention for conservation because of their continuing decline in habitat and population. The study highlights in situ and ex situ conservation of *L. leytensis* by institutions in Laguna and Quezon. The results suggest that the rules-in-form guided the institutions in conservation management, and their interactions in the action arena were in downward, upward, and horizontal patterns. The outcomes of their interventions for *L. leytensis* were relevant, coherent, effective, and efficient, while project impact and sustainability were implied by the participation and community ownership of conservation activities, government policies, and funding.

1 Introduction

The National Greening Program (NGP) of the Philippine government is one of the major approaches to restoring the country's forest ecosystem [1]. It aimed to harmonize all greening efforts where government agencies, including state universities and colleges (SUCs) and civil society organizations, cooperate through Memoranda of Agreements (MOAs) in the nationwide planting of trees in the public domain. Under the NGP, the Department of Environment and Natural Resources (DENR) leads a phased approach to implementation, shifting from exotic species to native trees with preference for indigenous species in seedling production and tree planting [2]. The 28 tapped SUCs as NGP partners for clonal nursery and plantation development selected some priority species for seedling production activities, giving greater importance to threatened native trees with limitations on seed availability. Among the SUCs is Southern Luzon State University (SLSU), which focuses on the clonal propagation of *Litsea leytensis* Merr. commonly known as Batikuling, Balbonera, and Magarilau [3].

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Litsea leytensis Merr., synonymous with *L. baticulin* (Blanco) Kosterm. is an economically valuable tree species of the family Lauraceae with a trade name of Medang in Southeast Asia and other parts of the world for general housing construction, boards, paneling, furniture and cabinets, plywood and veneer, tool handles, agricultural tools, packing, musical instruments, and handicrafts [3]. It is endemic to the Philippines and exists particularly in Laguna and Quezon provinces. The wood of the species is preferred by carvers in Paete as raw material for carving statues and embellishments, and in General Nakar for building boats and house posts. Paete's history and identity as a carving pillar of the economy have established it as the carving capital of the Philippines [4]. Based on the fieldwork report of the Graduate School of International Development in 1999, the industry contributes to a high employment rate because it is dominated by labor-intensive cottage-scale factories in which 80% of their products are exported to other places in the country and abroad, while the remaining 20% are sold locally to tourists. By the end of 1999, Paete had 772 basic handicraft establishments and 590 non-basic establishments (an economic base ratio of 1:3), which can be interpreted as meaning that for every 1 basic handicraft establishment, another 3 non-basic establishments were created, as presented by the Municipal Government of Paete in 2010. The municipal agriculture (MAO) office estimated 3000 to 5000 woodcarvers in the local area from 1970 to 1980 [5], but there were only 146 in 2019, as recorded by the municipal tourism office.

The wood-based industry had its environmental consequences simultaneously with its socioeconomic impact on the livelihood of practitioners of wood carving. The continuing decline in habitat and population of *L. leytensis* listed it as a threatened species [6, 7]. In support of the NGP and in line with resource conservation and protection, the SLSU and other institutions have been involved in conserving it with other threatened native trees to keep the remaining species populations in Laguna and Quezon, translated as local stewardship. [8] defined the actions that persons or groups take with various levels of capacity to protect, care for, or use environmental resources responsibly in a quest for environmental and social outcomes in diverse social-ecological settings. With this, the study conducted an institutional analysis for the conservation management of *L. leytensis* in Laguna and Quezon to (1) determine the exogenous variables that affect the action arena of species conservation, (2) identify the action situations where institutions perform their roles, (3) recognize the patterns of interaction in terms of information flow, and (4) describe the outcomes of interventions with the evaluative criteria of relevance, coherence, effectiveness, efficiency, impact, and sustainability.

2 Methods

2.1 Study area

The study covered Laguna and Quezon provinces in the southern portion of Luzon, Philippines (Fig. 1). Laguna is located at 14.1407°N and 121.4692°E, and Quezon is at 13.9347°N and 121.9473°E, just southeast of Manila and Laguna de Bay. Eight institutions were identified in the conservation management for *L. leytensis* and located in these provinces with the occurrence points of the species: one research agency of the government—the Department of Environment and Natural Resources-Ecosystems Research and Development Bureau (DENR-ERDB); two government agencies that conserve, manage, develop, and properly use the community's environment and natural resources—the DENR-Community Environment and Natural Resources Office (CENRO) of Tayabas City and CENRO Real in Quezon; two local government units (LGUs)—the LGU of Paete, Laguna, and General Nakar, Quezon; one nongovernment organization (NGO)—the Haribon Foundation, Inc.; and two academic institutions—the University of the Philippines Los Baños (UPLB) and Southern Luzon State University (SLSU).

2.2 Data collection

The study was conducted from August 2021 to July 2022. Secondary information about the research, development, and extension initiatives for *L. leytensis* was obtained from electronic and printed journal articles, working papers, other published materials, and accomplishment reports of institutions. Key informant interviews (KIIs) and focus group discussions (FGDs) characterized the species and described the role of institutions in conservation management. In sum, 22 subject matter experts from Laguna and Quezon were interviewed: four from government research agencies, three from the DENR-CENRO, seven staff of the LGUs, including Municipal Environment and Natural Resources Officers (MENROs), two from NGOs, one from a government-owned and controlled corporation, and five from the academe. The FGD was conducted in Paete represented by ten participants: personnel of the LGU, barangay officials, parents, teachers, and youth. The formulated open-ended guide questions, following the Ws and Hs technique, dealt with (1) the status

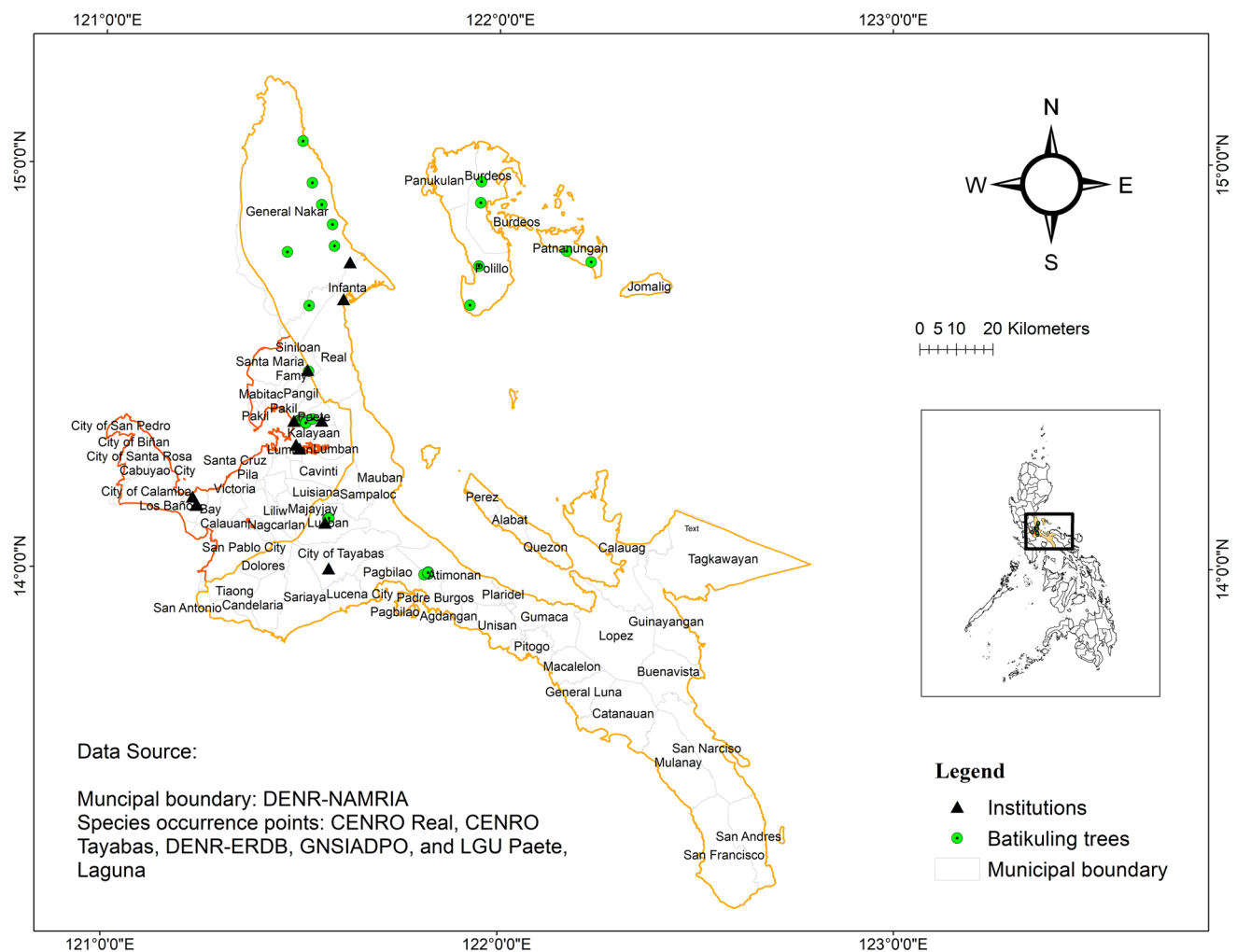


Fig. 1 Location of the institutions with the occurrence points of *L. leytensis* in Laguna and Quezon, Philippines

of *L. leytensis* trees in terms of abundance, location, types of soil and climate, topography, and conservation status; (2) the implemented or ongoing project(s) or activities through the description of objectives, duration, fund source, and implementation method; (3) the nature and involvement of people, groups, or partnerships; and (4) the description of project outcomes. All the gathered information was transcribed and integrated for manuscript writing.

2.3 Data analysis

The role of institutions is relevant in sustaining the survival of an economically important tree species such as *L. leytensis* with human and environmental threats. Identifying the lessons learned and success stories of key institutions in species conservation could contribute to redesigning conservation strategies that are appropriate for the species and the local community. The study applied the institutional analysis and development (IAD) framework as a tool to describe and analyze the conservation management of institutions for *L. leytensis*. The IAD is designed for analyzing and testing hypotheses about actions in various situations examined at multiple levels and concerns analyses of how rules, biophysical conditions, and community characteristics affect the structure of action arenas, the motivations of individuals, and the outcomes [9]. Adopting the framework in the study provides a means to organize the inquiry on the subject and the set of variables to assess, as it assists in clarifying what to think about when analyzing a situation with common pool resources [10].

3 Results and discussion

3.1 *Litsea leytensis* Merr. as a common property resource

The material flow of *L. leytensis* in Fig. 2 shows that it is a common pool resource thriving in the public domain where trees naturally existing in forestlands have social, political, and cultural dimensions. The extraction of the tree species as one of the sources of seeds and wildlings for seedling nursery production to support the planting material requirements of the National Greening Program (NGP). It is one of the threatened forest trees being prioritized for reforestation and the establishment of tree farms and industrial tree plantations in the Philippines (political dimension). The regenerants of *L. leytensis* are free resources collected by people who can access forests, and when timber is harvested for wood, it provides a higher market value for the community, creating carved wood products (the social dimension), thus, contributing to local livelihood sources. Carving the wood of the species is intertwined with the history of wood art, the artists, and the artisans in Laguna, particularly the town of Paete which is passed on from one generation to another (the cultural dimension).

As local communities freely collect and harvest *L. leytensis*, its availability in forests and other landscapes is diminished, affecting the provision of ecosystem services. As an alternative to the limited wood supply, wood carvers in Paete shifted to taka, or papier mâché, making use of carved wooden sculptures as molds, while others carved ice, soap, vegetables, and fruits. Others resort to other tree species as substitutes due to the total log ban and raised wood prices bought from nearby provinces such as Quezon [5]. Hence, *L. leytensis* is under the institutional challenges of conservation management in Laguna and Quezon. Considering that the tree planting efforts of the government are sustained in protected areas, *L. leytensis* could be found naturally existing again in forests and with tree farms and industrial tree plantations established, logging in public domain could be diminished but able to support the raw material requirements of the wood carving industry.

3.2 The institutional analysis of conservation management for *Litsea leytensis* Merr.

An examination of institutional performance through the modified IAD framework described the institutions involved in *L. leytensis* conservation management (Fig. 3).

3.3 Exogenous variables: bio-geophysical setting, community attributes and rules-in-use

The variables that directly influence the actors and action situations of the action arena of conservation management in institutions for *L. leytensis* are presented in Fig. 3. The biophysical conditions describe it as a native tree thriving in low to medium-altitude forests (200 to 700 m above sea level) in Kalayaan, Lumban, Paete, Pakil, Pangil, and Siniloan in Laguna and in Umiray Watershed Forest Reserve (UWFR), Sibulan Watershed Reserve, Mt. Malulod, and Mts. Banahaw-San Cristobal Protected Landscape and Quezon Protected Landscape (QPL) in Quezon (Fig. 3). The probability of species

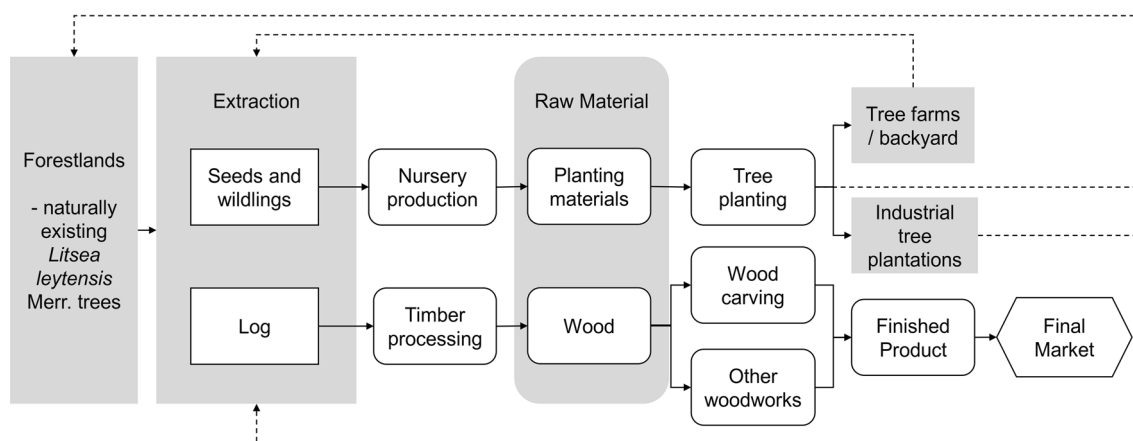


Fig. 2 Material flow of *L. leytensis* as a common property resource

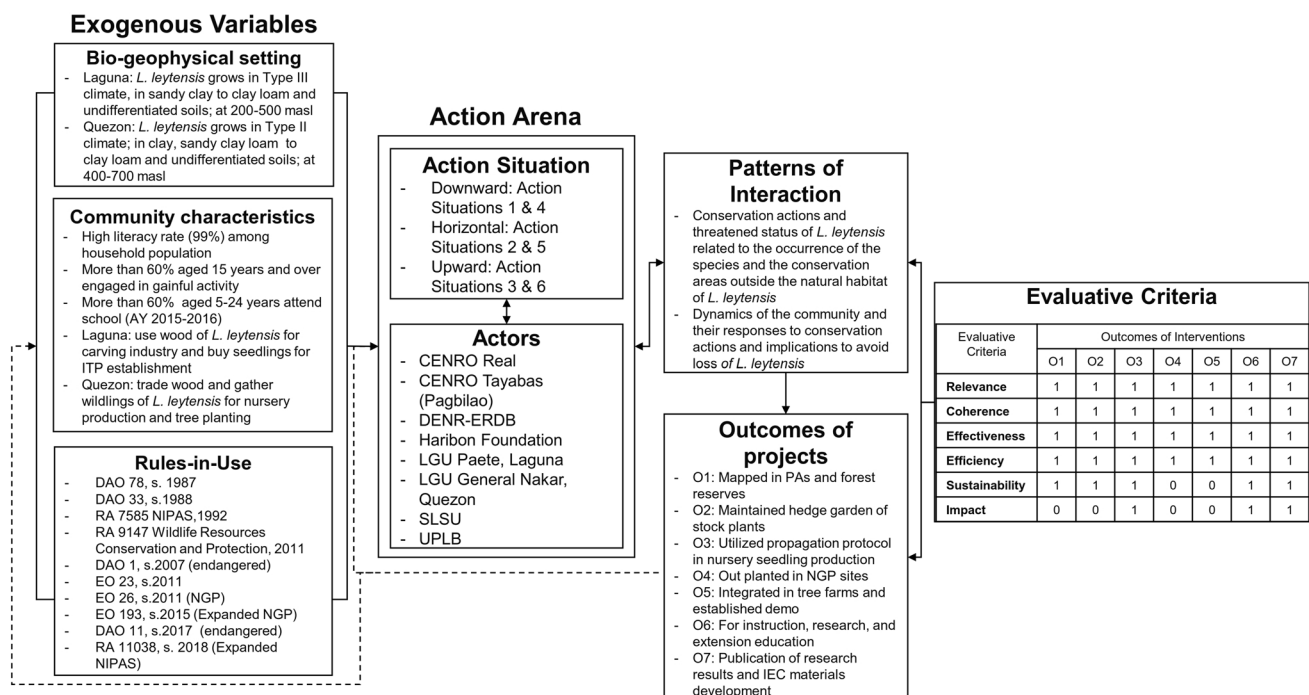


Fig. 3 The framework of the institutional analysis of the conservation management for *L. leytensis* in Laguna and Quezon, Philippines (Note in the evaluative criteria: 0-without or intervention outcome does not exist; 1-with or intervention outcome exists based on documentary records)

occurrence is favorable for it to grow well since Laguna is generally characterized by a Type III climate, while Quezon has a Type II climate [11]. Based on the obtained tree occurrence points, it was found in clay to sandy clay loam and undifferentiated mountain soils of mostly sedimentary and metamorphic rocks.

The native populations are not isolated trees, as they occur in lowland forests of primary and secondary forests nationwide, with stands recorded at the University of the Philippines Los Banos Land Grant Management Office (UPLB LGMO) in Siniloan, Laguna. At present, the entire population is still unknown due to a lack of research activities focused on the inventories and documentation of *L. leytensis* [12]. The extent of the afforestation with this species, where the seedlings were planted in community forests, home gardens, and commercial estates, among others, was documented in Laguna, which covers about 0.6 ha to 7 ha and 0.8 ha to 15 ha in Quezon.

The community attributes based on the 2015 population census report recorded Laguna and Quezon with high literacy rates (99.6% and 99.1%) among household populations, more than three-fifths (61.9% and 60.1%) of those aged 15 years and over engaged in a gainful activity, and more than two in every three persons (67.2%) in Laguna, while less than seven in every 10 persons (68.4%) aged 5 to 24 years were attending school during Academic Year 2015–2016 [13, 14]. The poverty incidence in Laguna is 6.9%, while that in Quezon is 16.3%, and the average family income to meet the minimum basic needs for food and nonfood of a family having five members was calculated at 222.72 USD per month in Laguna and 202.30 USD per month in Quezon [15]. The nature of the communities in Laguna and Quezon derives tangible benefits (use values) from *L. leytensis* trees in forests and other landscapes (Fig. 3). In Paete, the wood is used in the handicrafts industry, which is rooted in the history and identity of the municipality, their religion, knowledge, and skills that preserve the Filipino culture. In General Nakar, the wood of the species is mainly used for the deck of riverboats, housing, and furniture, and the wildlings are collected for nursery seedling production as a livelihood that supports tree planting activities in both provinces and nationwide.

The rules-in-use in the study relate to the conservation management of formal institutions (rules-in-form), as they capture the rules and structures of the government that concern *L. leytensis* (Fig. 3). The informal institutions were excluded due to the limitations of available secondary information on community conservation and the required time to collect primary data given their scope. In 1987, the Department of Environment and Natural Resources (DENR) regulated the cutting, gathering, and utilization of premium hardwood species, including *L. leytensis* [16, 17], followed by regulating the exportation of lumber and plantation logs [18, 19]. The establishment of protected areas [20] assigned the DENR and

Action Arena

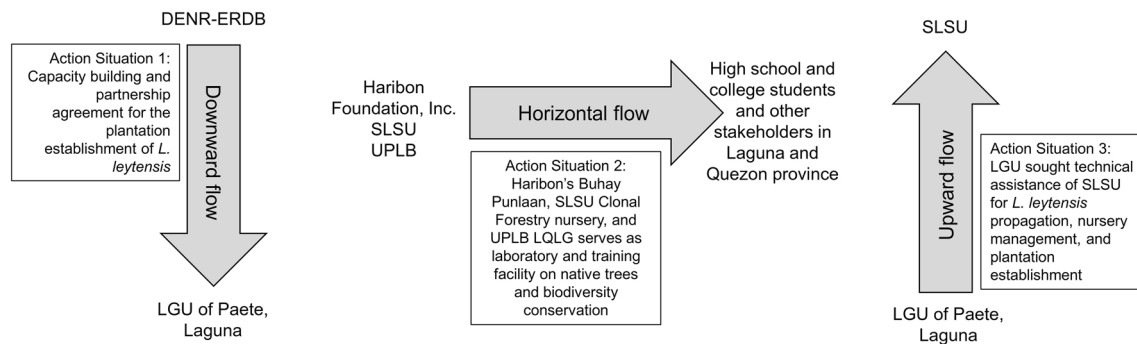


Fig. 4 The action arena with the interactions of actors in action situations 1, 2, and 3

Action Arena

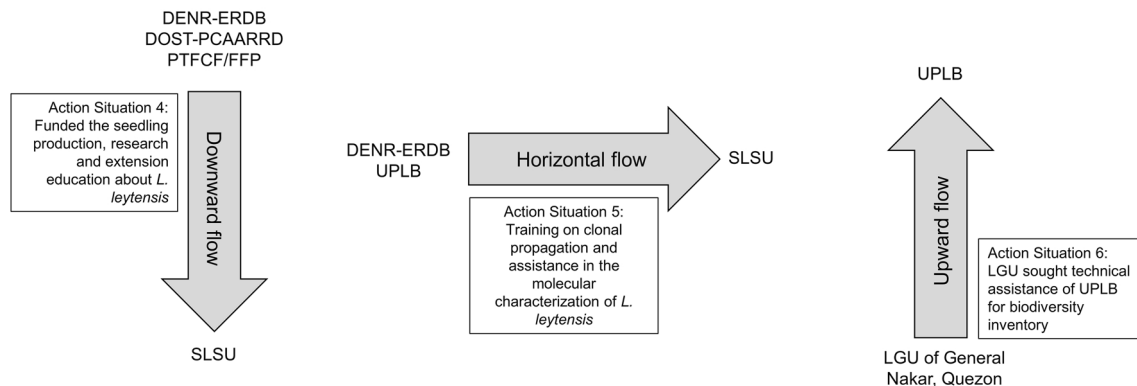


Fig. 5 The action arena with the interactions of actors in action situations 4, 5, and 6

other concerned institutions to establish, administer, and manage the National Integrated Protected Areas System (NIPAS) areas, focusing on biodiversity conservation and sustainable development. In 1998, the IUCN published *L. leytensis* as a vulnerable species due to the continuing decline in area and extent or quality of its habitat; with logging and wood harvesting as an important source of Medang timber [21], the best available evidence indicates that it is facing a high risk of extinction in the wild [7]. The species is covered by the regulation on the collection and trade of terrestrial plant and animal resources [22], and the Ecosystems Research and Development Bureau (ERDB) is the scientific authority to advise the DENR and other agencies on the international trade of this endangered species. Since 2002, the Community Environment and Natural Resources Offices (CENROs) have conducted biodiversity monitoring assessments (BMS) to locate it, monitor its growth and survival in protected areas, and detect illegal collection to recover the declining species populations. Based on [23] following those of the International Union for Conservation of Nature (IUCN), *L. leytensis* was categorized as endangered [24], like the provision of the Convention on International Trade in Endangered Species after [25]. Then, a total log ban [26] was implemented simultaneously with the NGP implementation [1, 27]. According to the DENR updated in [6], *L. leytensis* is still in Category B (endangered). Recently, the government required the full implementation of [28], which links to the conservation of *L. leytensis* in Quezon with the establishment of the Buenavista Protected Landscape, Maulawin Spring Protected Landscape, and QPL within the classification of national parks as provided in the Constitution.

3.4 Action arena: action situations and actors

The institutions in the action arena are presented in Figs. 4, 5. The interaction and relationship between actors and their approach to decision-making that concerns matters through the action arena is the action situation [29], and actors in it

could be utilized to describe, evaluate, forecast, and explain actions within institutional arrangements [9]. The patterns of interaction established by the engagement of actors generate outcomes [30], with information flow in downward, upward, and horizontal dimensions important for organizational learning and good local governance [31].

A downward communication from the DENR on *L. leytensis* flows down to the LGU of Paete (lower level), as shown in Fig. 4. The DENR is the lead agency in forest genetic resources conservation and management [32] and recognized the need to rehabilitate the woodcarving industry in Paete through the establishment of plantations for wood carving species in a memorandum of agreement (MOA) signed between the LGU of Paete, DENR-ERDB, DENR-Forest Management Bureau, Office of the Regional Executive Director of Region 4A, and Ayala West Grove in 2008 [33]. The Haribon Foundation established the Buhay Punlaan Nursery in 2009, a 3-ha restoration site and nursery that ensures the continuous production of native trees, including *L. leytensis*, for forest restoration through collaboration with Coca-Cola, the National Power Corporation, Birdlife International, and Ecosave to protect the Caliraya-Lumot Watershed and Forest Reserve [34]. It is a laboratory and training facility for students and other stakeholders, where it continuously imparts the importance of biodiversity conservation (horizontal flow). As the UPLB studied the seedling growth requirements of *L. leytensis* at the UP Laguna-Quezon Land Grant (LQLG) and in Laguna Land Grant [35], the UPLB LGMO has been conserving it by collecting seeds for nursery propagation and tree planting activities at the LQLG, specifically in Pangil and Siniloan, Laguna, and Real, Quezon. Information drives were conducted for students and teachers during tree planting, specifically in Brgy. Saray, Pakil, Laguna exemplify a horizontal interaction (Fig. 4). In 2018, the LGU of Paete requested a two-year partnership with the Southern Luzon State University (SLSU) for the propagation and establishment of a nursery and demonstration farm for *L. leytensis*. The LGU's local officials realized their problem and the need for planting materials for future wood resources (upward interaction). This partnership encouraged local farmers and other stakeholders to learn more about the tree species by accessing technical assistance from SLSU (horizontal communication).

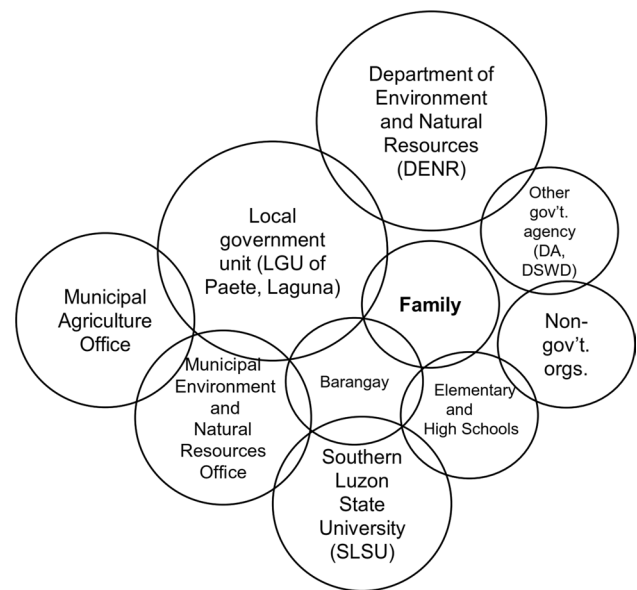
As part of the research, development, and extension strategies to produce high-quality planting materials, the DENR-ERDB developed the vegetative propagation protocol of *L. leytensis* using branchlets in marcots wrapped with sphagnum moss and treated with rooting hormones [36]. From 2013 to 2018, micropropagation protocols were developed for the species, and stock plants were maintained as sources of explants. Different sterilization procedures and culture media for in vitro establishment were identified and tested with a technology forum on nursery and plantation establishment in Paete conducted in 2014 [37], showing a downward flow of information from DENR-ERDB to the community (Fig. 5). To date, the DENR-ERDB, through the Southern Luzon Forest Tree Seed Centre, has conducted seed testing of *L. leytensis* from the collections of CENRO Tayabas City.

In line with the implementation of the NGP, the DENR, through PENRO Quezon and Region IV-A, had an MOA with the SLSU from 2012 to 2014 to produce and deliver quality planting stocks, including *L. leytensis* (adopting the DENR-ERDB clonal propagation technology) in Quezon NGP sites identified by the CENROs Pagbilao and Gumaca. From 2016 to 2018, DENR-ERDB also partnered with SLSU for the delivery of propagated *L. leytensis* in CENROs Pagbilao, Real, and Gumaca, and other NGP sites. SLSU's initiative paved the way for external agencies to support its studies on *L. leytensis*. In 2016, the Forest Foundation Philippines (FFP) funded the in vitro aseptic culture establishment of the species, and from 2018–2019, the Department of Science and Technology-Philippine Council for Agriculture, Aquatic and Natural Resources Research and Development (DOST-PCAARRD) funded the improvement of the quality of planting materials through cloning that produces disease-free and pest-resistant clones for the wood-based industry [38] in cognizance with the DOST Harmonized National Research and Development Agenda (HNRDA) for 2021–2032 that continues in the new HNRDA 2022–2028. The Department of Forest Biological Sciences of UPLB-College of Forestry and Natural Resources (CFNR) assisted SLSU in the molecular characterization of the species through DNA barcoding [39], as it has also been assisting the LGU of General Nakar since 2018 at the latter's request (upward communication) to conduct a biodiversity survey with watershed characterization and plan preparation (Fig. 5). SLSU's engagement with the DENR, DOST-PCAARRD, and FFP exemplifies a downward pattern of interaction, while its alliance with UPLB-CFNR is a horizontal type of interaction since both universities share expertise on *L. leytensis* (Fig. 5).

3.5 Patterns of interaction

The patterns of interaction among institutions were the conservation actions and threatened status of *L. leytensis* related to the occurrence of the species, the conservation areas outside the natural habitat of the species, and the dynamics of the community and their responses to conservation actions and implications to avoid the loss of *L. leytensis*. A Venn diagram was used to determine the constraints for the conservation of the species, with the stakeholders of Paete identifying different institutions and showing how they are working closely with each other through the circles that overlap (Fig. 6).

Fig. 6 Identified institutions of Paete and Laguna stakeholders in the conservation management of *L. leytenensis*



The size of the circles implies that institutions in larger circles have primary roles in the management of *L. leytenensis*, while smaller circles represent a smaller unit of the community actively participating in various conservation activities. The DENR, LGU of Paete, and Municipal Agriculture Office (MAO) led the initiatives for *L. leytenensis* (Fig. 6). The DENR implements tree-cutting regulations, while the Municipal Environment and Natural Resources Office (MENRO) focuses on the regular conduct of tree planting and the maintenance of out-planted seedlings. The LGU delegated seedling distribution to the barangay for tree planting. SLSU provides training and seminars with the available technology to conserve it in partnership with primary and secondary schools. An important inclusion was the family at the center of *L. leytenensis* conservation, which recognizes family roles in instilling values in members about the environment and natural resource management.

3.6 Outcomes and evaluative criteria

The outcomes of interventions implemented by institutions for *L. leytenensis* in Laguna and Quezon were summarized and evaluated based on the (1) relevance of conservation measures for *L. leytenensis*, (2) consistency between project elements that define coherence, (3) ability to produce the desired output(s) for effectiveness, (4) management of conservation activities as affecting efficiency, (5) the long-term result or impact because of the project, and (6) sustainability of accomplishments that balances the environmental, social, and economic aspects. The target-based documentary records provide justification of the study findings with a rating scheme of 0 (without) and 1 (with), where 0 means that the outcome of the intervention does not exist and 1 means that the outcome exists in line with the common definitions of indicators of the [40] in determining the merit of interventions implemented (Fig. 3).

The project outcomes were relevant to the implementation of forest development and management, an international strategy adhering to the Global Plan of the World Summit on Sustainable Development as per [41]. The interventions respond to the needs and priorities of the NGP on biodiversity resource conservation [1, 27] and protection of threatened habitats of endangered species [28]. The partner institutions funded and supervised the intervention of implementing agencies, adapted any changes in the context of intervention that remained relevant [40], and considered the relevance of project outcomes for *L. leytenensis* in relation to the Sustainable Development Goals (SDG), particularly SDG 15 (Life on Land).

The extent of other interventions that are supportive or contrary to the existing projects of institutions and vice versa was examined for coherence. Through the NGP, all greening efforts were harmonized in a National Convergence Initiative that supports the conservation of *L. leytenensis* by promoting it in tree planting activities, shifting from the use of exotics [2]. The project components of interventions were coherent and complementary with each other, particularly with the inventory and identification of mother trees as sources of seeds and wildlings, the production of seedlings in nurseries, the establishment of ramet gardens as stock plants for the collection of stem cuttings, the vegetative propagation in mist and non-mist cloning, and the planting of them in various NGP sites.

The achievement of objectives and the relative importance of what was achieved while understanding the factors that influence the outputs measured effectiveness as indicated by inclusiveness and equity, nondiscrimination, and accountability at all stages. The institutions were able to produce the desired project outputs for *L. leytensis*. Domesticating it at the UP LQLG reached a mean height of 1.2 cm in four months, and the UPLB recorded that it required partial shade under nursery conditions [35]. The DENR-ERDB successfully propagated *L. leytensis* branchlets with 90% survival through marcots wrapped with sphagnum moss treated with rooting hormones [37], while the SLSU developed a propagation protocol for stem cuttings of *L. leytensis* in 100 ppm NAA rooting hormone with river sand and coconut coir dust as rooting media and optimized the polymerase chain reaction cycling condition of the *rbcL* gene for DNA barcoding with the help of UPLB-CFNR [39]. In 2010, the DENR-ERDB published a revised edition of "Development and Management of Forest Plantations: A Guidebook" and featured *L. leytensis* in its 2017 issue of the Research Information Series on Ecosystems. The universities published their work as journal articles and on various information platforms. However, DENR-ERDB and SLSU have not yet achieved the micropropagation protocol using explants, and further research should be conducted. Project effectiveness was further examined in terms of the accountability of the DENR-CENROs, DENR-ERDB, LGUs Paete and General Nakar, SLSU, and UPLB, which rely on the Commission on Audit for the examination, auditing, and settlement of all accounts and expenditures of funds and properties during the entire project duration. For NGOs, annual reports and financial statements with the auditor's report were made available to the public. In terms of equity, training and seminars about nursery production and plantation establishment were conducted for various stakeholders. DENR-ERDB initiated capacity building for barangay officials, farmers, wood carvers, and POs in Paete, Laguna, in 2014 [37], while SLSU involved 159 LGU staff, tree farmers, youth, women, and secondary school teachers between 2018 and 2019. Information drives to primary and secondary schools were also done by the UP LGMO in Paete and Pakil, Laguna.

The efficiency of interventions was assessed in the [40] key areas of cost effectiveness, operations management, and timeliness. The deliverables of SLSU on the clonal propagation and DNA barcoding of the species met the 6 Ps metrics of the DOST-PCAARRD after a one-year project duration with more than P2M in funding. In 2014, CENRO Pagbilao planted 540 *L. leytensis* seedlings in the 80-ha protection zone in Pinagdanlayan, Dolores, Quezon with a 46.30% survival rate in 2016 and replanted Narra (*Pterocarpus indicus* Willd.). In 2017, CENRO Real sourced 850 clones at SLSU and planted them in Brgy. Magsaysay, Infanta, Quezon. Through the implementation of the BMS, CENRO Tayabas City identified 10 *L. leytensis* trees in 2021 at the QPL with diameters at breast height ranging from 20 to 115 cm and merchantable heights of 4.5 m to 11 m, while CENRO Real identified two mature trees during its initial inventory in the Unnamed National Park Wildlife Sanctuary and Game Reserve at Station 8 from Infanta to General Nakar, Quezon. The BMS provides protection and management to standing *L. leytensis* trees, and the laws that restrict their collection and harvesting have penalties and charges.

The generation of significant positive results based on intended or unintended effects, social and economic effects, and transformational change that matters [40] to institutions and stakeholders were the key indicators of project impact.

The social impact of capacity-building activities on propagation technology, nursery production, and plantation establishment and development conducted by the DENR-ERDB is evident by the adoption of SLSU and transfer to the LGU Paete with the establishment of a 2-ha demonstration farm of more than 1700 *L. leytensis* clones and seedlings. The tree inventory and mapping conducted by LGU General Nakar with the assistance of the UPLB-CFNR through the Watershed Characterization and Enhanced Forest Restoration Program found many species of native trees in the UWFR. The General Nakar Sustainable Integrated Area Development Project Office geotagged 10 *L. leytensis* trees as seeds and wildling sources for PO nurseries, producing more than 17,000 seedlings. The economic impact of conserving *L. leytensis* had no reports, but the ecosystem values provided by it could be studied, as it is valued by large- and small-scale industries needing raw materials for manufacturing or processing requirements [17].

Sustainability is the degree to which the net benefits of the intervention continue or are likely to continue considering the interaction between economic, social, and environmental capacities of systems desired to sustain the net benefits over time [40]. Haribon's Buhay Punlaan in Lumban, Laguna, has continuously served as a native tree nursery, laboratory, and training facility that imparts the value of biodiversity conservation since its establishment in 2009 [34]. The SLSU Clonal Forestry Nursery is sustained under the direct management and supervision of the College of Agriculture at SLSU, where the facilities and equipment are continuously maintained, used, and upgraded by the university after project termination by funding agencies. It is used for instruction, student, faculty, and staff research, extension, and production activities that generate income. *Litsea leytensis* Merr. clones are made available for business or for environmental protection initiatives since SLSU maintains the 334 stock plants in its 0.7-hectare clonal nursery complex. SLSU delivered approximately 5,000 quality planting materials to different municipalities of Quezon through the CENROs Real, Pagbilao, Gumaca, and Calauag from 2012 to 2018, demonstrating the university's commitment to support the greening initiatives

of the government and providing a venue for teaching future generations about the importance of native tree species in restoring Philippine forests. The UP-Sierra Madre Land Grants, the QPL, and the Unnamed National Park Wildlife and Game Reserve, as mandated by law, are conservation areas for *L. leytenensis*, providing for the sustainability of the efforts of the UPLB, CENRO Tayabas City, and CENRO Real.

Related to the sustainability of conservation efforts for *L. leytenensis*, there were issues and concerns identified, demonstrating its social, political, and cultural dimensions as a common property resource. The issue of land tenure includes forest occupancy and land grabbing, illegal logging and poaching, and the social acceptability of projects and activities such as the adoption of clonal propagation technology at the local level and forest fires at tree planting sites. Project implementers could consider some decision tools for forest management and marketing the ecosystem values of native trees like *L. leytenensis*, or participatory research that involves tree farmers or people's organizations. The limited number of project staff to engage within the project management team and the availability of funds would not sustain a long-term project duration. Thus, community involvement and local participation are necessary when extending project implementation. The enforcement of laws and the changing priorities of local administrators contribute to project success and failure as they relate to social acceptability. An umbrella committee focused on species conservation could be created to address this, including other technical problems of low germinative capacity seeds, monitoring of out-planted seedlings in NGP sites, replanting of out-planted clones, emerging diseases in mature, aging trees, unsuccessful micropropagation, pests and diseases in hedge gardens, problems with misting systems, and climate change impacts. Although *L. leytenensis* can mass propagate with high potential to establish a plantation; monoculture planting risks the genetic diversity of ecosystems. The perceived risks may include plantation failure, biodiversity loss at the forest and landscape levels, and risks associated with the success rate of vegetative or somatic embryogenesis propagation [42]. A population genetic will provide more beneficial genetic information for the preservation of *L. leytenensis*, and to identify genotypic or allelic variation between individuals or to distinguish between populations [39].

4 Conclusions

The study analyzed the conservation management of institutions for *Litsea leytenensis* Merr. in Laguna and Quezon provinces using the IAD framework. The exogenous variables affecting the action arena include the adaptability or growing environment of *L. leytenensis*, the socioeconomic conditions and relationship of Laguna and Quezon in terms of species demand and supply, and the formal rules that influence the institutions to perform conservation actions. The action arena presented the various action situations that recognized the upward, horizontal, and downward flow of interactions between institutions. The conservation management of institutions for *L. leytenensis* was relevant, coherent, effective, and efficient, while the impact and sustainability of accomplishments were implied by the active participation of the local community and ownership of the conservation activities, enacted government policies, and institutional and external funding. The evaluative criteria can still be improved with respect to giving more weight to the outcomes of interventions with further analysis of the details of the conservation programs or activities.

The in situ and ex situ conservation measures of institutions for *L. leytenensis* preserve biodiversity that protects people and ensures the sustainability of the environment and ecosystem. Their general thrust focuses on how to conserve natural resources sustainably with the policies in place for species conservation, and the IAD framework may be a useful tool in analyzing their efforts to monitor and learn about the effect of past and present policy interventions that foster the sustainability [31] of conservation efforts for *L. leytenensis* and other threatened natural resources of the country. Information gaps in the economic value, genetic fingerprinting, and field trials of *L. leytenensis* clones provide a venue for research, development, and extension education.

Litsea leytenensis Merr. remains endangered, and the major threat to conservation is the continuous loss in the extent and quality of its natural habitat caused by active deforestation and land use and cover changes for agriculture, residential, commercial, and other purposes. The following are proposed to ensure the interventions of institutions for *L. leytenensis* toward species abundance in Laguna and Quezon: (1) the harmonization of conservation initiatives by establishing an umbrella organization or a species conservation committee to complement the individual efforts of institutions in Laguna and Quezon; (2) the institution of *L. leytenensis* trees on farms and other landscapes outside protected areas, including participatory research on the various aspects of domesticating trees; (3) the national and local governments to encourage local communities to establish, develop, and prioritize integrating *L. leytenensis* in the agroforestry system and provide them the necessary assistance and permits to harvest and utilize trees planted to boost the local economy; and (4) with

the DOST's updated HNRDA-AANR, institutions could expand their work in utilizing *L. leytenensis* in urban greening to increase native species populations, consider decision tools for forest management, and market their ecosystem values.

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Code availability Not applicable.

Declarations

Ethics approval and consent to participate The study was performed in line with the approved protocol of the UPLB Graduate School and the Research Advisory Committee with ethical considerations that included securing approval from the concerned agencies for the actual conduct of key informant interviews and focus group discussions.

Consent to participate Informed consent was obtained prior to interviews and discussions from all individual participants included in the study.

Competing interests The authors report no potential competing interests.

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