Trees, culture, and territory: A comparative ethnobotany of the Basque highlands through the lens of TEK. (Ataun, Guesalaz, and the Roncal Valley)

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Research

Abstract

Background: This article presents a comparative ethnobotanical analysis of three territories in the Basque Country—Ataun (Gipuzkoa), the Guesalaz Valley (central Navarre), and the Roncal Valley (Navarrese Pyrenees)—which form an ecological and cultural transect running from northwest to southeast. Drawing on the framework of Traditional Ecological Knowledge (TEK), the study examines how communities with different climates and economic trajectories have constructed and transmitted knowledge concerning local tree flora.

Methods: The documentary corpora—some of which remain unpublished—record approximately 95, 50, and 55 taxa, respectively. Five structuring species common to all three territories have been identified. Jaccard similarity indices reveal an inverse correlation between floristic affinity and ecological distance: Guesalaz-Roncal (≈0.40), Ataun-Guesalaz (≈0.21), and Ataun-Roncal (≈0.15).

Results: The study identifies three models of society-forest relations. In Ataun, timber-related knowledge prevails, organized around a lunar calendar specific to each species. In Guesalaz, agricultural and pastoral knowledge is regulated through communal governance. In Roncal, knowledge centered on resource exploitation and craft production is closely tied to transhumance, traditional trades, and the **almadiero** (log-raft) tradition. Basque vernacular nomenclature functions as a living archive of biological knowledge, exhibiting variable degrees of divergence by district due to intergenerational transmission. Botanical toponymy further enables the reconstruction of the historical distribution of species currently absent from certain elevations or valley floors.

Conclusions: The study concludes that a comparative approach is essential for revealing convergences and divergences among local TEK systems and underscores the urgency of documenting this heritage before the generation that holds it is lost.

Keywords: Traditional knowledge, Biocultural diversity, Cultural landscape, Phytonymy, Ethnoecology

Background

Theoretical framework

Comparative ethnobotany provides a privileged vantage point from which to examine the mechanisms through which different communities elaborate, transmit, and encode knowledge about useful flora. Understood as a discipline that transcends the mere enumeration of uses and instead interrogates the internal logic organizing such knowledge—including its temporal, social, and symbolic dimensions—it is grounded in the concept of Traditional Ecological Knowledge (TEK). This term was coined by Berkes (2012), who defines it as an adaptive system of knowledge, practice, and belief accumulated through iterative observation of the environment, encoded in culturally specific forms, and transmitted across generations. TEK is not a static repository of empirical data but rather a living system that co-evolves with the ecosystem in which it is embedded (Nepal 2024). Its loss, therefore, is not only cultural but also ecological and adaptive (Gadgil *et al.* 1993).

The capacity of cultures to classify flora is not arbitrary. From the perspective of cognitive ethnobotany, Berlin (1992) and Atran (1990) demonstrated that folk classification systems for plants follow universal principles of hierarchical organization—generic, specific, and varietal taxa—modulated locally by economic history, ecological context, and language. This perspective is especially relevant in bilingual settings such as the Basque Country, where language has historically functioned as an indexing system for botanical knowledge. Each Basque vernacular

transferred to the Romance system without significant loss (Maffi 2005). The documented correlation between linguistic breadth and biological knowledge—referred to as biocultural diversity (Maffi & Woodley 2010)—positions the Basque Country as a site of global significance. This region combines a pronounced ecological gradient, a complex linguistic history, and an exceptionally rich ethnobotanical corpus.

It should also be noted that Iberian ethnobotany has established solid methodological foundations. The work of Tardío and Pardo de Santayana (2008) on cultural importance indices and the comparative studies of Rocío Alarcón's team (2015) on Spanish medicinal flora have provided the disciplinary framework for this field. Nevertheless, comparative ethnobotany of the Basque Country remains underexplored. Available studies tend to be site-specific monographs focused on a single locality or valley, and rarely cross administrative boundaries to compare knowledge systems that, historically and culturally, form part of a shared continuum. This article therefore seeks to address this gap through the comparative analysis of three pre-existing documentary corpora drawn from territories across **Hegoalde** or peninsular Vasconia (South Spanish Basque Country) with well-differentiated ecological and linguistic gradients.

Figure 1. Climatic map of the Basque Country showing the location of the three study areas. Source: Authors' own elaboration.

The three territories: A natural and cultural gradient

The three areas under study can be interpreted as the vertices of a dual transect—ecological and cultural—running across the Basque Country from northwest to southeast (Figure 1). Rather than isolated cases, they represent links in a chain in which each territory occupies a differential position along two principal axes: climatic regime and the vitality of active local culture (Aizpuru 2015; Lorda 2013).

Ataun, a municipality in the interior of Gipuzkoa situated in the upper Oria watershed, represents the Atlantic extreme of the gradient (Figure 2). Its oceanic climate (Köppen classification code Cfb), with annual precipitation exceeding 1,500 mm, favors the dominance of *Quercus robur* oak woodlands and *Fagus sylvatica* beech forests, with significant presence of ash (*Fraxinus excelsior*), chestnut (*Castanea sativa*), and hazel (*Corylus avellana*). The ethnobotanical corpus for Ataun is unpublished and was compiled through direct fieldwork. Its most distinctive feature is the existence of an elaborate system of lunar regulation governing pruning and felling, with species-specific prescriptions that organize timber knowledge around the astronomical calendar.

Figure 2. Atlantic Basque climate landscape. Source: Pablo Orduna Portús.

The Guesálaz-**Gesalatz** Valley, in central Navarre, occupies a transitional position between Atlantic and Mediterranean climates. Annual precipitation averages approximately 800 mm, and the landscape is dominated by mixed oak formations (*Quercus ilex* L., *Quercus faginea* Lam., *Quercus pyrenaica* Willd.) and extensive stands of common box (*Buxus sempervirens* L.) on the communal sierras (Figure 3). Guesalaz exemplifies the model of a mixed agropastoral community with deeply rooted communal labor practices (**auzolan/ozolan**). The documentary sources by Irigaray (1976) provide the richest linguistic corpus for botanical nomenclature, while the ethnographic studies by Álvarez *et al.* (2012) address the broader cultural dimension. A dialectal variation of Upper Navarrese Basque is attested in the region, producing up to ten or twelve nomenclatural variants for a single species— a reflection of dialectal fragmentation and passive bilingualism at the time of data collection (Arana 2005 and 2012).

The Roncal Valley-**Erronkaribaxa**, in the eastern Navarrese Pyrenees, constitutes the continental extreme of the transect. Its altitudinal range is pronounced, extending from approximately 400 meters in the Ezka river valley floor to over 2,000 meters at the Pyrenean summits (Figure 4). This variation produces a vertical zonation of vegetation ranging from holm-oak and box stands at the basal level to silver fir (*Abies alba* Mill.) and Scots pine (*Pinus sylvestris* L.) forests in the montane belt (Aizpuru 2015; Lorda 2013). The Roncal corpus documents a historical economy structured around three specialized forest activities:

transhumant pastoralism, complemented by subsistence agriculture and its associated implements, and the timber industry connected to log-raft transport (**almadías**) on the Ezka River (Figure 5). This economic triad shaped a body of knowledge oriented primarily toward industrial timber use and specialized craftsmanship. The decline of the Roncalese dialect in the mid-twentieth century further severed a chain of linguistic transmission that the Navarrese Romance varieties have been unable to replace with equivalent semantic density.

Figure 3. The Guesalaz Valley. Transition to a Mediterranean climate. Source: Pablo Orduna Portús.

Figure 4:.Alpine karst landscape of Roncal. Source: Pablo Orduna Portús.

Figure 5. A log raft descending the Ezka River at Burgui. Source: Jesús M. Lacasia. Archivo Real y General de Navarra. ES/NA/AGN/F481/FOT_LACASIA_227.

The cultural gradient is equally significant. In Ataun, a strong Basque-speaking tradition is maintained, and the Gipuzkoan variety of Basque functions as the language of practical knowledge. Guesalaz is a contact zone in which Upper Navarrese Basque is in recession, and a mixed Romance-Basque botanical vocabulary is attested (Arana 2005 and 2012). In Roncal, a historically mixed-language situation combined Basque with several Romance varieties—Castilian, French, Bearnaise, and Aragonese—leaving numerous traces in phytotoponymy and in the proverbial phraseology linked to flora collected from informants.

Rational and specific objectives

The comparative study proposed here rests on four converging arguments. First, the ecological gradient constitutes a natural experiment that allows for the separation of environmental effects from cultural factors in shaping ethnobotanical knowledge. When two territories share a species but attribute different uses to it, that divergence cannot be explained by floristic availability alone but must reflect differences in cultural or economic logic. Second, the three corpora are sufficiently rich and structurally comparable to support rigorous quantitative and qualitative analysis, though their methodological heterogeneities require interpretive caution. Third, the ethnobotanical knowledge documented in these territories faces an imminent risk of irreversible loss, associated with rural depopulation and the decline of Basque in its Navarrese varieties. Fourth, despite the exceptional density of documented knowledge in this area, it has received scant comparative scholarly attention.

The specific objectives of this study are as follows: (a) to describe and compare the floristic diversity documented in each territory; (b) to identify the dominant use categories and their distribution by territory; (c) to calculate use-value (UV) indices and floristic similarity (Jaccard) indices for the full set of territories, with explicit acknowledgment of the limitations imposed by inter-corpus heterogeneity; (d) to analyze the richness and variation of vernacular nomenclature as an independent comparative axis; (e) to interpret convergences and divergences in light of the climatic gradient, economic history, and linguistic situation of each community; and (f) to propose a comparative reading of the three systems as parallel expressions of a shared logic of society-forest relations, locally adapted.

Materials and Methods

Ethical considerations

This study is based entirely on the secondary analysis of pre-existing documentary corpora and on the synthesis of field observations gathered during multiple research campaigns. The ethnobotanical data for each territory were originally collected in accordance with the protocols in force at each respective time and within the framework of independent research and documentation projects. In keeping with the editorial standards of peer-reviewed journals, it is hereby stated

that the communities and municipalities of the three territories will be the intended recipients of the results of this comparative analysis, in accordance with the principle of Prior Informed Consent and as recognition of the communities that are the custodians of the documented knowledge (Medinaceli 2018).

Description of sources and fieldwork

Each of the three corpora was independently constructed through a methodological combination integrating four avenues of access to local ethnobotanical knowledge. In the cases of Guesalaz and Roncal, semi-structured interviews were conducted with community members within a framework of fieldwork and participant observation. The data for Ataun were obtained through a pre-existing publication on a local specialist in wood-related traditional crafts, produced by a local studies group. Additionally, contact was established with a family member of the original informant, who was likewise affiliated with the cultural life of that community, and the data provided by this individual were corroborated. In all three settings, this initial phase was followed by a systematic review of the prior scientific literature.

Across all three study areas, regardless of territory or research team, the documentation process followed a shared logic: direct engagement with knowledge bearers, individuals over 65 years of age whose working lives had been tied to the forest, livestock herding, or traditional woodland trades. This phase preceded the construction of species-based serial tables, which were in turn cross-checked against available bibliographic sources and against the botanical field data gathered during the preparatory phase.

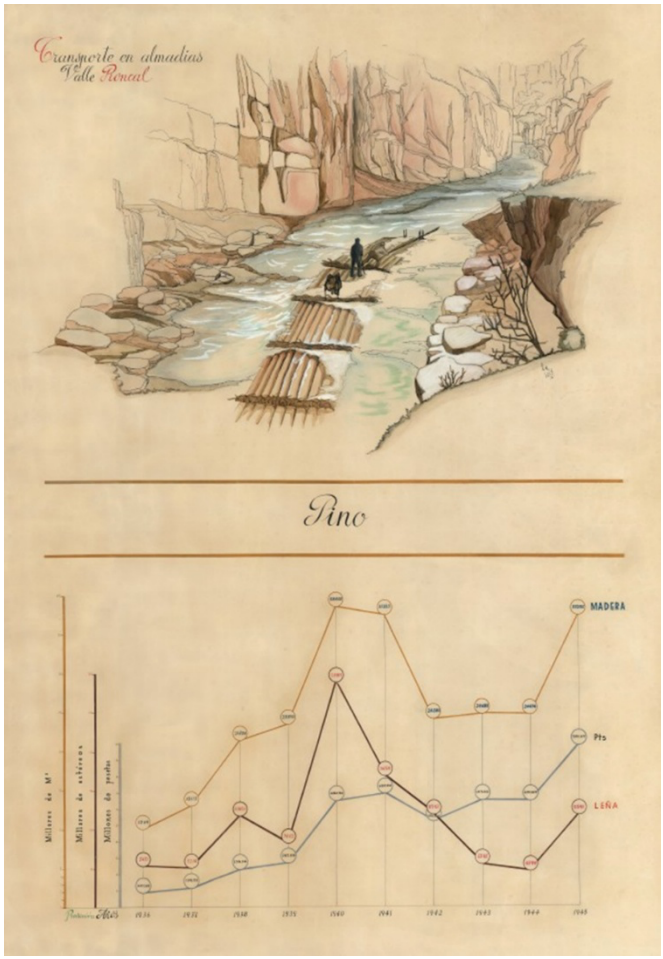

Figure 6. 1946. Pine. Transport by log raft. Roncal Valley. Source: Pedro Lozano de Sotés and Diputación Foral de Navarra. Archivo Real y General de Navarra. ES/NA/AGN/13-2/FIG_CARTOGRAFIA,N.553.

Local informants—loggers, carpenters, farmers, shepherds, and community members who retained memories of traditional forest trades—contributed data on use and vernacular nomenclature, as well as prescriptions relating to pruning and felling practices. Participation in forest activities and the systematic traversal of the study territories made it possible to verify collected names and uses against specimens in their actual ecological context. Botanical toponymy was documented through

direct consultation with informants and cross-referencing with historical cartography. The scientific literature consulted for these areas, spanning botany, ethnography, and history, includes floristic sources on the biota, classical works of Basque ethnography, and publications on the flora of peninsular Basque Country. In the case of Ataun (Gipuzkoa), the fieldwork conducted by the Atauniker research association proved exceptional an exceptional local ethnobotanic corpus. In 2023, data were recorded from the **baserritarra** —farmer— Joxe Bikuña Agirre, born in 1935, resulting in the compilation of an arboreal corpus of 107 taxa (Bikuña 2023).

The Guesalaz corpus draws on published sources corresponding to different independent lines of research, including the foundational work on popular botanical onomastics by Irigaray (1976). This pioneering study focused on the vernacular nomenclature of Navarrese Basque and was compiled through systematic interviews with informants from each locality in the valley. Additionally, the publications of Álvarez (2008, 2012, and 2013) and Ursúa (2001 and 2008) were analyzed; the latter address both agropastoral practices and the social organization of the territory from the perspective of structural anthropology. These studies incorporate data on timber use, farm implements, communal forest management, and the annual agricultural cycle related to plant species and toponymy.

The arboreal corpus for the Roncal Valley was assembled from the ethnobotanical guide by Orduna and Pascual (2017a), a work that provides a comprehensive review of historical and archival sources on the timber trade in the region. The participant observation component for Roncal included systematic traversal of the valley's forested areas, the location of botanical toponymy in historical cartography (with records dating back to 1427), and the in-situ documentation of the ethnobotanically most significant species (Figure 6). Of note in this regard is the body of research produced by the team coordinated by Orduna and Pascual (Orduna and Pascual 2017a, 2017b, 2018, and 2020; Pascual and Orduna, 2019), which constitutes a comprehensive synthesis of this scholarly literature, combined with extensive archival research and fieldwork in the Pyrenean valley.

Construction of serial corpus tables

Each territorial study independently produced a species-based serial table organizing the following variables for each documented taxon: scientific name with authority, Spanish name, Basque name, local vernacular denominations in both Basque and Romance, documented uses and technical data, information on the optimal period or phase of intervention where provided by informants, and associated botanical toponyms recovered from the territory. This shared tabular structure was not the result of prior coordination among the fieldwork teams—as these were independent studies with their own objectives and orientations—but rather reflects a methodological convergence that mirrors the internal logic of ethnobotanical documentation. Nevertheless, the tables for Ataun, Guesalaz, and Roncal differ in the level of detail for certain columns. The Ataun table includes lunar prescription for felling and pruning as a distinct, systematized variable. The Guesalaz table gives particular emphasis to the nomenclatural field, with its multiple dialectal variants. The Roncal Valley table adds columns for oral literature (proverbs, sayings, and songs) and for historical and archival references with explicit dating (Figure 7).

The comparative review of the three corpora was conducted through the construction of a master table that cross-references the three sources around the shared axis of scientific nomenclature, standardized in accordance with *Flora Ibérica* (Castroviejo 1986-2012). For each taxon present in more than one territory, vernacular names, documented uses, and assigned functions were recorded in parallel columns, enabling the visual identification of convergence and divergence patterns prior to the calculation of quantitative indices. Taxonomic discrepancies between corpora—owing in part to differences in the level of determination in the original identifications—were resolved by consulting the authoritative scientific flora through *Flora Ibérica* and its associated database *Anthos* (Castroviejo 1986-2012). Cases of potential synonymy or genus-level grouping—where the original identification did not reach the specific level—were flagged accordingly.

Variables and analytical categories

For each species and territory, the following variables were recorded: (a) presence or absence in the corpus; (b) primary use category, coded into nine mutually exclusive categories—timber and construction, tools and farm implements, food, medicinal and veterinary, fuel and lighting, specialized craftsmanship, symbolic and ritual, and ornamental; (c) number of documented vernacular variants, as an indicator of nomenclatural depth; (d) presence of associated botanical toponyms in the territory; and (e) presence of oral literature linked to the species (proverbs, sayings, songs, and ritual formulae). In cases where a taxon admits more than one use category—as is common for structuring species—the primary use category was assigned on the basis of the highest frequency of citation in the corpus, with secondary uses explicitly recorded (Figure 8).

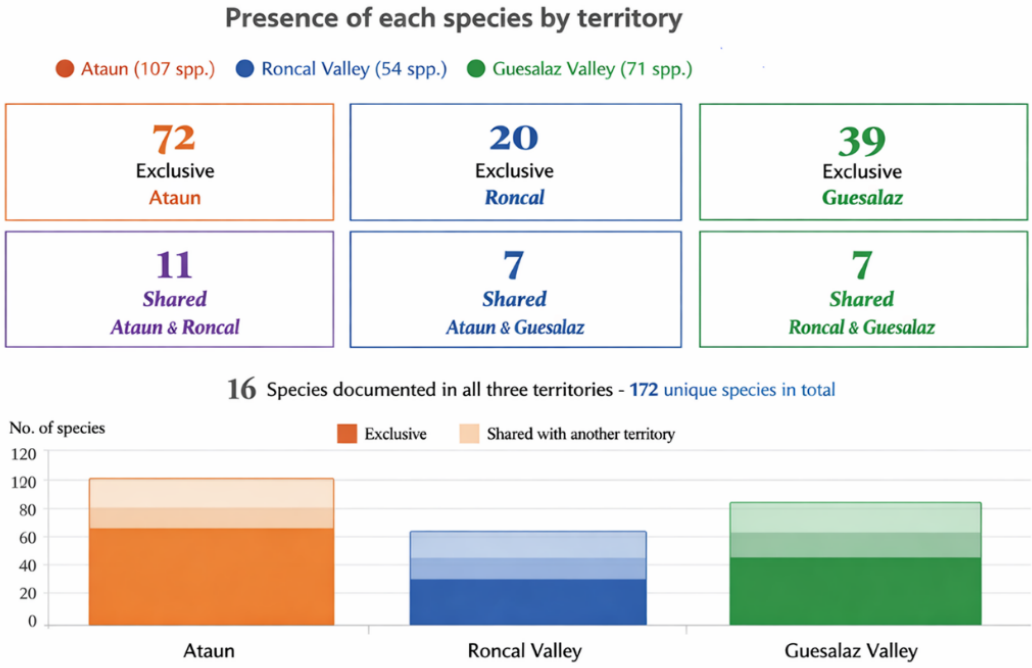

Figure 7. Inter-territorial floral continuity. Source: Authors' own elaboration.

Figure 8. Traditional charcoal kiln in Burgui. Source: Pablo Orduna Portús.

Quantitative analysis

The use-value index (UV = ∑U/n) (Phillips and Gentry 1993) was calculated for species documented in more than one territory, where U is the number of uses mentioned for each species and n is the number of informants or available records in the corpus. Given that the three corpora exhibit heterogeneity in the number of recorded informants—and that, in some instances, this figure is not explicitly stated— the UV is employed here as an indicator of relative salience within each corpus rather than as a normalized value across territories. The informant consensus factor (ICF = $(n_{ur} - n_t) / (n_{ur} - 1)$) (Trotter and Logan 1986) was designed to measure the degree of agreement among individual informants within a single community. Its application at the level of territorial corpora— that is, treating each territory as the unit of analysis rather than each informant—constitutes a methodological adaptation that alters the original meaning of the index. In the present study, the ICF per use category measures the degree of homogeneity of documented uses within each category across the three territories combined, rather than consensus among individuals (Figures 9 and 10). This limitation is explicitly acknowledged, and ICF values should be interpreted with caution. Finally, the Jaccard similarity index (J = c / (a + b − c)) was applied to presence-absence matrices for the three territory pairs to estimate documented arboreal floristic similarity.

Figure 9. Mixed woodland in the Andia Range adjacent to Guesalaz. Source: Pablo Orduna Portús.

Qualitative analysis

Qualitative analysis was applied to the ethnobotanical texts of each corpus through an inductive thematic analysis organized around four axes. The first concerns the identification of knowledge bearers: which social figures—shepherds, spoon-carvers, log-raft workers, carpenters, farmers, and others—hold the knowledge and within what occupational or communal context they exercise it. The second axis examines the context of transmission: whether the knowledge is acquired through labor, oral literature, ritual practice, or some combination thereof. The third addresses the modalities of temporal codification: how each community structures the timing of intervention upon the tree—the lunar system in Ataun, the markers of the festive calendar in Guesalaz and Roncal, and the regulations of the communal forest warden (Figure 11). The fourth axis analyzes the ontological weight of the most extensively documented species— that is, the extent to which a named tree functions solely as a material resource or whether it also accumulates symbolic, ritual, or identity-related meanings that modulate its practical treatment. The systematic comparison of these four axes across the three territories enables the synthesis section in discussion to propose three models of society-forest relations as differentiated expressions of a shared form of arboreal TEK. These are models of environmental interaction and traditional ecological knowledge development sustained not out of deference to the natural environment, but because of material necessity and the absence of alternatives for local development (Hartel 2023).

Figure 10. Forest foothills meeting Pyrenean meadow in the Roncal Valley. Source: Pablo Álvarez Vidaurre.

Figure 11. Traditional timber felling in the Atlantic forest. Source: Pablo Orduna Portús.

Results

Documented floristic diversity.

The Ataun corpus comprises approximately 95 arboreal and shrub species, a significant subset of which corresponds to ornamental or cultivated species of recent introduction, including *Eucalyptus globulus* Labill. *Ailanthus altissima* Mill. Swingle, and *Acacia dealbata* Link. These elements are documented precisely as markers of recent landscape change and of shifts in traditional knowledge. Discounting these species, the corpus of taxa with associated traditional ethnobotanical knowledge amounts to 60. The Guesalaz corpus records 50 taxa, and that of Roncal approximately 55, with a floristic profile more narrowly oriented toward species of direct industrial timber value.

The best-represented families across the three territories are Rosaceae (*Prunus* spp., *Crataegus* spp., *Sorbus* spp., *Rosa* spp., *Malus* spp.), Fagaceae (*Quercus* spp., *Fagus sylvatica* L., *Castanea sativa* Mill.), Aceraceae (*Acer campestre* L., *Acer monspessulanum* L., *Acer opalus* Mill.), and Salicaceae (*Salix* spp., *Populus* spp.). In Roncal, the Pinaceae are additionally prominent, with *Abies alba* Mill. and *Pinus sylvestris* L. as structuring species of the local forest economy.

Analysis using the Jaccard similarity index ($J = c / (a + b - c)$) yields the following provisional values, which will require verification against the final complete dataset. For the Guesalaz-Roncal pair, which shares approximately 30 taxa under comparable recording conditions, the index reaches $J \approx 0.40$, the highest of the three pairs. The Ataun-Guesalaz pair, sharing approximately 25 taxa across documentary universes of differing scope, yields $J \approx 0.21$. The Ataun-Roncal pair, with roughly 20 shared taxa, produces $J \approx 0.15$, the lowest value, consistent with the greater geographic and climatic distance between these two territories. This pattern is consistent with the gradient hypothesis, which posits that similarity is inversely proportional to ecological distance.

The five species shared by all three territories, with rich and consistent ethnobotanical documentation, are: *Buxus sempervirens* L., *Fagus sylvatica* L., *Quercus robur* L.—and/or *Quercus petraea* (Matt.) Liebl. in Roncal—, *Fraxinus excelsior* L., and *Corylus avellana* L. To these may be added *Sambucus nigra* L., *Juglans regia* L., *Ilex aquifolium* L., and *Clematis vitalba* L. as taxa present in all three corpora, albeit with uneven documentary richness. At the opposite extreme, *Abies alba* Mill. represents the most notable case of a species exclusive to a single territory—the Roncal Valley—where it is absent from the other two. In Roncal, its significance is not merely botanical; it forms part of an entire system of differential forest economy (Figure 12).

Figure 12. Uztárroz - Uztarroze. Characteristic Pyrenean silviculture landscape. Source: Pablo Orduna Portús.

Nomenclatural richness and dialectal variation

Nomenclatural variation constitutes the most original comparative axis of this study and the one that most effectively discriminates among the three knowledge systems. The Guesalaz corpus consistently exhibits the greatest number of vernacular variants per species. For instance, *Cornus sanguinea* L. records twelve documented denominations in the valley (**zungandur**, **zilindurri**, **zilimindur**, **zimindur**, **zubandur**, **zumenduz**, **zimindur**, **zibilindur**, **zilindur**, **zimindurri**, **zugarrandur**, **durillo**, among others). Another case is that of *Acer campestre* L. and *Acer monspessulanum* L., which together generate seven variants (**azkarro**, **astiger**, **askarro**, **axkarro**, **aixkarro**, **aizkarro**, **ligarro**, **igarro**). This phenomenon constitutes the

linguistic signature of a contact zone in recession: the Navarrese Basque of Guesalaz was dialectally fragmented and progressively integrated into local Castilian at the time of data collection, such that each village—Muniain, Izurzu, Vidaurre, Salinas de Oro, Iturgoyen—contributes its own phonetic variant for the same plant referent.

By contrast, Ataun presents more stable and univocal denominations in Gipuzkoan Basque: *Fagus sylvatica* L. is consistently **pagoa**; *Quercus robur* L. is **haritz kanduduna**; and *Fraxinus excelsior* is **lizarra** or **lizaia**. The relative homogeneity of Gipuzkoan Basque during the period of data collection translates into a more uniform nomenclatural corpus, in which denominative variation reflects genuine semantic distinctions—grounded in varieties, growth stages, and plant parts—rather than phonetic dialecticisms.

The Roncal Valley presents the most distinctive pattern, characterized by a systematic coexistence of Basque-Romance doublets that in some cases reflects genuine semantic differentiation. For *Pinus sylvestris* L., the denominations **pino royo** (Romance), **ler**, **lerrondo**, and **lerratze** (Roncalese Basque) coexist. The taxon even possesses an evaluative adjective applied to specimens of low timber quality—**cerrudos** or **paragüeros**—with no documented equivalent in the other two corpora. For *Fagus sylvatica* L., the distinct names for its organs (**zakardak** or **barzak** for young beeches; **amaxalak** or **bagailak** for beechnuts; **egargei** for roofing shingles) point to a specialized timber vocabulary of considerable richness and specificity.

At a broader level, botanical toponymy functions as a complementary archive of the first order. In Ataun, the predominant toponyms derive from chestnut (**Gaztiñai Txulo**, **Gaztiñai Soro**, **Gabileneko Gazteñadie**), gorse (**Otaso**, **Otazil**), and oak (**Okaizti**, **Eileorko Aiztie**) (Arín 1928). In Guesalaz, box-derived toponyms are particularly dense—Arguiñano preserves the toponym *Ezpelaga* (box grove)—while maple toponyms are prominent in Iturgoyen (**Astigardi**) and Muniain (**Astigarreta**) (Jimeno 1995). In the Roncal Valley, fir-related toponyms are strikingly abundant: **Izeiluzea** (long fir), **Izeiordoki** (the fir flatland), and **Izeibakotxa** (the solitary fir), documented in the localities of Isaba, Uztárroz, Vidángoz, and Roncal. These fir toponyms are of particular geobotanical interest: some are located at elevations where no fir stands exist today, rendering them indirect evidence of vegetational landscape transformation over recent centuries—consistent with shifts in settlement patterns, rural depopulation, and the intensified impact of industrial timber extraction focused on pine and beech.

Dominant use categories and their distribution by territory

The analysis of use categories reveals differentiated patterns of emphasis that directly reflect the historical economic structure of each community. In Ataun, the craft category (construction, cabinetmaking, tools, and containers) is the most prominent, followed by the medicinal-veterinary and alimentary categories. A feature exclusive to the Ataun corpus is the structuring of knowledge about pruning and felling according to the lunar calendar. The use category here is not merely 'timber' but 'timber at waning moon' or 'timber at new moon'—indicating an additional layer of temporal knowledge codification absent from the other two corpora.

In Guesalaz, the dominant category is agropastoral, encompassing, for example, the manufacture of farm implements (**matxarda**, **sarde**, **nardaka**, and **bardia**), yokes, and tool handles, which account for the bulk of the documented knowledge. Secondary prominence is given to energy and domestic uses, with box (*Buxus sempervirens* L.) serving as a source of light (**apaki/apakia**: dried box branch) and as fuel for lime kilns—a use entirely absent from the other two corpora. Medicinal-veterinary knowledge, while present, is less systematic than in Ataun.

In the Roncal Valley, the distribution is more polarized. The categories of industrial timber use (construction, log-raft transport, and naval shipyards), firewood and specialized craftsmanship (spoon-carving, walking-stick production, and pastoral implements) concentrate most of the ethnobotanical and ethnohistorical corpus (Figure 13). Smaller or less abundant species in the landscape, such as elderberry (*Sambucus nigra* L.) and lime tree (*Tilia platyphyllos* Scop.), are associated with detailed medicinal knowledge; however, it is the industrial dimension of the forest that organizes Roncal knowledge as a whole. Elderberry (*Sambucus nigra* L.) is a notable example of a species with exhaustively documented medicinal applications: it has been used in infusions for respiratory ailments, as an eyewash, and as an anti-inflammatory remedy. This range of resources illustrates the capacity of the Roncal corpus to document phytomedical knowledge alongside—and not merely subordinate to—forest exploitation.

Figure 13. Use of beech wood as heat domestic source. Source: Mª Victoria Portús.

Species with the highest ethnographic use-value

Given the available data and the impossibility of normalizing informant numbers across corpora, the calculation of the use-value index (UV = ∑U/n) (Phillips and Gentry 1993) for species present in more than one territory identifies five species with the highest collective cultural presence across the three territories. In approximate order of combined UV, these are: *Buxus sempervirens* L., *Fagus sylvatica* L., *Fraxinus excelsior* L., *Corylus avellana* L., and *Quercus robur* L. To these may be added *Sambucus nigra* L. and *Pinus sylvestris* L. as species with high UV in their respective territories of greatest presence—pine in the Roncal Valley and elderberry across all three territories.

In this regard, *Buxus sempervirens* L. presents the sharpest contrast across territories. In Ataun, its use is primarily artisanal (boxes, pitchforks, fencing), with felling prescribed at the waning moon. In Guesalaz, as noted above, it is the only species documented with systematic use as a lighting source, and its collective management through **auzolan**—communal felling and transport from the sierras in September—exemplifies a model of forest resource appropriation with no equivalent in the other corpora. In the Roncal Valley, it is used for craft production; there is evidence that, in the early twentieth century, combs made from this wood were exported to factories in Valencia. Locally, in this Pyrenean territory, it also served as raw material for itinerant spoon-carvers who sheltered in sites such as the Cueva de los Cuchareros, located in Burgui.

Beech (*Fagus sylvatica* L.) shows a distribution of uses with strong convergence in productive application (construction and farm implements) but with differentiated emphases. In Ataun, it is felled at the October waning moon (**urriko hilgoran**) for the construction of carts and structural elements. In Guesalaz, it is used to make yokes and the **matxarda** (a forked pole used to push box branches into the lime kiln or to harvest fruit from tall trees), among other implements; the communal forest warden regulated its management. In the Roncal Valley, its uses were multiple: it was employed to make axe handles (**astrales**), components of log rafts (**barreles**, beech logs serving as binding-axis elements for timber sections), and shingle roofing (**egargei**). Taken together, convergence in productive functionality is high, but the technical system into which each use is integrated is radically different.

Ash (*Fraxinus excelsior* L.) is very widely used for agropastoral purposes: across all three territories, it serves to manufacture implement handles and animal yokes. The Roncal corpus adds two uses absent from the other two: the manufacture of whistles and flutes, described in technical detail in the sources, and the ritual function of ash sticks placed in the form of a cross in the fields on May 3rd. Ash toponymy is especially dense in Roncal in Basque (**Ixardoki**, **Lexarchipia**, **Lexarra**, etc.) and equally so in Guesalaz in Romance (**Fresnero**, **Fresnerochiquito**, etc.).

Hazel (*Corylus avellana* L.) is the species with the greatest relative convergence across the three territories. Its use for the manufacture of rods, walking sticks, and baskets is documented in all three, and it is consistently associated with a ritual

context that exceeds purely material application. In Ataun, it is used during the new moon phase for artisanal purposes; in Guesalaz, shepherds fashioned from it an iron-tipped pole with a **ramilleta** for cleaning the plow; and in the Roncal Valley, its twisted withies—**jarcias**—bound the sections of log rafts together. Its importance was such that Uztárroz issued a municipal ordinance regulating payment for its harvesting, at a rate of 1.50 pesetas per raft. The presence of ritual references to hazel in all three corpora—for divination in Guesalaz, for protective crosses over newly sown fields in Roncal, and for craft work within lunar cycles in Ataun—suggests a shared symbolic substratum of greater antiquity than its material uses.

Significant divergences between territories

Three paradigmatic cases illustrate with particular clarity the divergences among the three knowledge systems. The first and most notable concerns *Prunus mahaleb* L. In the Roncal Valley, the St. Lucie cherry is a highly prized wood for making cart pegs and craft objects, and its fruit is greatly valued by local inhabitants. In Guesalaz, the same corpus explicitly states that 'in this valley [...] its cherries are not eaten and are disregarded, unlike in other places such as the Roncal Valley.' This is the only documented instance in the three corpora in which a source demonstrates direct comparative awareness of another territory within the study area. Guesalaz informants were evidently aware that Roncal valued cherries that they themselves rejected. This passage constitutes a first-order ethnographic document attesting to the existence of information networks and comparative knowledge exchange among neighboring communities.

The second paradigmatic case is *Abies alba* Mill. Climatically absent from the Ataun corpus and altitudinally absent from Guesalaz, it is absolutely central to Roncal. Its timber was employed in the shipyards of the Hispanic Monarchy during the Golden Age; it was also used to construct water-resistant log-raft dams (**arka**), and its resin (**permentina**) was harvested as a medicinal remedy. The high density of historical fir-related toponyms in Roncal, documented since the seventeenth century in Urzainqui, Isaba, and Vidangoz, makes this species the single most informative indicator of the ecological and economic differences between the Pyrenean valley and the other two territories. Its exclusive presence in the Pyrenean valley reflects a fundamental particularity of that ecosystem.

The third case is the preservation in Ataun—still active today—of a traditional knowledge system concerning the optimal lunar phases for tree pruning and felling. The species-specific systematization of optimal lunar phases has no documented equivalent in either the Guesalaz or the Roncal corpus. Both latter contain seasonal references to felling (waxing crescent moon for pine and beech in Roncal; agricultural calendar in Guesalaz), but neither exhibits a species-level systematization with its own mnemonic rules. In the Gipuzkoan locality, by contrast, an ordered system is fully articulated: the new moon is prescribed for resinless trees (hazel, beech, alder), while the waning moon is prescribed for resinous trees (oak, chestnut). The system even specifies particular exceptions, such as May alder, which must be felled at the waning moon but specifically at dawn (**uzeprioa azalenian*,* izarditau**).

Discussion

The climatic gradient as a partial structuring factor

The Jaccard indices calculated confirm the initial hypothesis: floristic similarity between territories is inversely proportional to ecological distance. The Guesalaz-Roncal pair exhibits the greatest similarity ($J \approx 0.40$), while the Ataun-Roncal pair shows the lowest ($J \approx 0.15$). When interpreting these values, however, caution is warranted. The climatic gradient accounts for floristic distribution—the presence of *Abies alba* Mill. exclusively in Roncal and the structural prominence of *Buxus sempervirens* L. in Guesalaz—but does not by itself determine patterns of use, which respond more directly to economic history than to ecology. The presence of *Abies alba* in the Roncal landscape did not automatically confer high cultural value upon silver fir. It was access to an imperial timber market, the shipyards of the Monarchy and the demand for naval construction wood— that reinforced this technical forest knowledge and codified it with the density evident in the corpus.

This confirms the theoretical premise of Berkes's (2012) TEK framework: TEK is not a passive reflection of local biodiversity, but an active construction mediated by political economy, communal tenure systems, and supralocal exchange networks. The abundance of *Buxus sempervirens* L. in Guesalaz does not in itself explain its use as a light source. On the contrary, this use is equally a product of communal organization —the **auzolan**— which transformed a shared forest resource into a collective land-management strategy. When the Guesalaz corpus records that 'in September, carts loaded with box branches were brought down from the communal sierras for use as fuel,' it is not merely documenting an ethnobotanical use but also a mode of resource production and distribution that required coordinated community labor.

Economic history and social structure as determinants of knowledge

The historical economic models of the territories under study produce three qualitatively distinct emphases in the ethnobotanical knowledge corpus. The transhumant Roncal community generates highly precise knowledge about woods suited for small objects and materials for travel and pastoral labor: decorated shepherd's crooks with geometric motifs (*Corylus avellana* L., *Betula pendula* Roth.), box spoons, maple pegs, holm-oak clappers (**zeinumiak**), and beech cheese molds (**kaxalak**) (Figures 14, 15 and 16). This constitutes a high-specificity technical timber knowledge that travels with artisanal expertise across the territory, in contrast to the more sedentary knowledge of an agrarian community. For its part, the log-raft trade contributes a productive-scale technical vocabulary, including the ability to evaluate standing pines, the children's game of **toko** for estimating distances and appraising timber, the classification of woods by resin content (**caracales**, **cerrudos**, **paragüeros**, **korala**, and **albar**), and mastery of the techniques for constructing log rafts with their multiple specialized plant components.

The mixed agropastoral economy of Guesalaz produces, by contrast, a body of knowledge oriented toward the manufacture and maintenance of farming and livestock implements. Technical specificity is no less than in Roncal, but it points toward a different horizon: knowing which species has *correa* (elasticity) for yokes, which has 'splintery' wood (**madera saltadiza**), which is best suited for cart pegs that must withstand lateral stress, or how to bend wood overheat to shape the **bardia**. The Guesalaz corpus is the only one of the three that records in detail the names of the implements themselves manufactured from wood: **pertika**, **bigo**, **matxarda**, **aga**, **sarde**, **nardaka**, **txarrantxa**, and **bardia**—a list that is itself an archive of the valley's technical agropastoral knowledge. Communal forest management through **auzolan**—in which the forest warden designates trees for felling and the timber is distributed by auction or collective labor—documents a forest resource governance system that modern silviculture has sought to formalize, not always successfully, as 'adaptive management.'

Figure 14: Roncal clappers.- Source: Pablo Orduna Portús and Mª Victoria Portús.

Finally, the forest-artisanal world of Ataun elaborates a technical knowledge focused on the differential quality of wood according to the lunar cycle. The underlying logic is that the position of the satellite modulates the distribution of sap and resin in the xylem, so that felling at the wrong phase produces wood more vulnerable to wood-boring insects and decay. At the global level, this system has been the subject of empirical inquiry in the context of biodynamic silviculture. Authors such as Zürcher (1998) have documented periodic fluctuations in the water content of wood linked to the lunar cycle. The scientific debate, however, remains open regarding the magnitude and universality of the effect. What is relevant from a TEK perspective is that the lunar system in Ataun operates as a highly effective mnemonic rule: the association between tree type (with or without sap, with or without resin) and lunar phase (waning or new moon) constitutes a binary cognitive structure that can be easily transmitted and applied in the field in traditional societies without the need for additional instrumentation.

Figure 15 **kaxalak**. Source: Pablo Orduna Portús and Mª Victoria Portús.

Figure 16. Spoons and forks. Source: Pablo Orduna Portús and Mª Victoria Portús.

The lunar knowledge of Ataun in comparative perspective

The lunar system of Ataun is not an isolated phenomenon within Basque ethnobotanical tradition. Nevertheless, the Ataun corpus develops this systematization to a level of species-specific codification that has no parallel in the consulted sources. A telling example of its precision is the exception for alder (*Alnus glutinosa* (L.) Gaertn.): a sapless tree that, under the general rule, should be felled at the waxing moon, yet the corpus prescribes felling at the waning moon, in May, at dawn. This divergence indicates that the system is not a mechanical rule applied indiscriminately, but an elaborated body of knowledge that accommodates exceptions grounded in observation.

From a European comparative perspective, the lunar felling calendar has antecedents in medieval silvicultural treatises and in documented practices from Alpine forests, where winter cutting at the waning quarter has historically been associated with greater timber durability in construction. Zürcher (1998) provides the first biophysical evidence of periodic fluctuations in xylem water content linked to the lunar cycle in *Picea abies* (L.) H. Karst., though replication of these results has been inconsistent. From a TEK standpoint, the scientifically appropriate position is neither uncritical acceptance of the lunar system as validated ecological knowledge nor its dismissal as superstition, but rather recognition that the model exists, that it is internally coherent, and that it warrants dedicated empirical investigation before being set aside.

Language as archive and as vector of loss

The nomenclatural variation of Guesalaz is the trace of a linguistic contact zone in which knowledge was transmitted in a mixed Basque-Romance code, with phonetic differences among localities. Each phytotoponymic variant is not merely a dialectal accident but an indicator of the social network through which that knowledge circulated. The informant from

Iturgoyen who uses **astiger** and the one from Salinas de Oro who uses **azkarro** belong to communities that share knowledge about maple but index it within slightly different phonological systems. The loss of this terminological diversity entails a reduction in the idiomatic richness through which botanical knowledge was encoded (Maffi and Woodley 2010).

In the Roncal Valley, the disappearance of the Basque dialect in the mid-twentieth century constituted the definitive rupture of a chain of linguistic transmission that Navarrese Romance has been unable to replace with equivalent semantic density. The Roncalese names for silver fir (**pinabete**, **izai**, **izei**, **abete**, or **izaiatze**) or for birch (**betalain**, **bepalain**, **betulain**, or **urki**) are not simply interchangeable labels. Each has a phonological history and a geographic distribution that reflects the valley's network of linguistic contacts with its Souletin, Bearnaise, Aragonese, and Navarrese neighbors. The Roncal corpus documents this diversity at the moment of its extinction and, paradoxically, constitutes the most complete archive of a knowledge system that is no longer transmitted orally.

These observations are consistent with Maffi and Woodley's biocultural diversity thesis (Maffi 2005; Maffi and Woodley 2010): linguistic diversity and biological knowledge diversity co-evolve and erode in parallel. The Basque case analyzed here is especially instructive in that it allows comparison of three territories at distinct stages of the same process of dialectal erosion. Setting aside the ongoing revitalization of Basque as a standard language, three distinct gradients are observable at the level of local Basque speech survival: Ataun represents a position of greater linguistic vitality; the Roncal Valley, a transitional stage; and Guesalaz, the point beyond extinction. The linguistic gradient is directly mirrored in that of documented nomenclatural richness, revealing that greater linguistic vitality implies not a greater number of phonetic variants, but a greater depth of knowledge encoded in the language.

Implications for landscape and knowledge conservation

Three species warrant particular mention as cases of maximum risk of associated knowledge loss: *Taxus baccata* L., *Quercus pyrenaica* Willd., and *Amelanchier ovalis* Medik. Yew is documented in all three territories with high-demand technical timber uses (bows, **makilak**—walking sticks—, and tools for intensive use), yet the corpora explicitly record that specimens are scarce and that associated knowledge is disappearing (Figure 17). Pyrenean oak (*Quercus pyrenaica* Willd.) appears in Ataun with the notation that 'very few specimens remain,' and its use for forge charcoal in the Roncal Valley during the nineteenth century is absent from the recent corpus. Snowy Mespilus (*Amelanchier ovalis* Medik.), used in Guesalaz for ox-cart pegs and saw teeth, has lost its function with the mechanization of the agrarian economy.

Figure 17. Roncal shepherd's crooks. Source: Pablo Orduna Portús.

The ethnobotanical knowledge documented in these three territories is of considerable value for adaptive silviculture and the communal management of forest resources. The lunar knowledge system of Ataun, the **auzolan** practices of Guesalaz, and the timber-selection criteria of Roncal contain information on harvesting cycles, wood durability, and communal

governance that industrial silviculture has systematically overlooked. Its urgent documentation would require a dedicated protocol grounded in semi-structured interviews with informants over the age of 70 who have held specific rural occupational roles—shepherds, carpenters, and craftspeople—conducted by teams with dual competence in ethnobotany and philology.

Society-forest relations: three models, one logic

When the three corpora are approached not as inventories of uses but as knowledge systems, a common architecture emerges that transcends floristic and economic differences. In each case, the community has elaborated a set of norms regulating when to intervene upon the tree (the temporal dimension), how to intervene (the technical dimension), who may or must do so (the social dimension), and what the tree represents within that community's world (the ontological dimension). This fourfold structure is not the product of the researcher's analytical comparison but is inscribed in the corpora themselves, which in every case intermingle technical information (lunar phase, part of the tree, tool used) with social information (who performs the task and in what communal context) and ontological information (what the tree means and how it relates to the sacred and to group identity).

The temporal dimension exhibits the greatest diversity across territories. In Ataun, timing is organized around the lunar cycle, with species-specific prescriptions. In Guesalaz, intervention is structured around landmarks of the agricultural and festive calendar (Michaelmas for coppicing, September for the transport of box branches) and the regulations of the communal forest warden. In the Roncal Valley, the seasonal pastoral calendar is combined with references to the waxing crescent moon, but without the species-level systematization found in Ataun.

The technical dimension is where the greatest differences appear. The strict **auzolan** of Guesalaz has no equivalent in Ataun or the Roncal Valley, where resource exploitation is familial or individual, albeit communally regulated. The construction of Roncal log rafts requires a high degree of specialization and collective technical knowledge: the ability to select timber by density and resin content, to build *Abies alba*-based water-resistant dams (**arkas**), to bind the raft sections with hazel withies (**jarcias**) measured precisely to the width of the river, and so on. None of this collective technical knowledge has a formal parallel in the other two corpora.

The traditional social dimension reveals clearly differentiated knowledge of actors. In Ataun, the central figures are the carpenter and the family of the semi-autarkic farmstead. In Guesalaz, the community acts collectively in resource exploitation, with the forest warden as the regulatory figure. In the Roncal Valley, two specialized and network-connected figures stand out: the transhumant shepherd and the log-raft worker. Each possesses a distinct technical corpus and a knowledge circulation network that spans the entire valley.

The ontological dimension is perhaps the most difficult to capture through quantitative analysis, yet the richest in the qualitative corpora. In Ataun, trees are material resources permeated by cosmic lunar time; knowledge about them is a form of aligning with that time. In Guesalaz, the tree is both a resource and a communal property; its equitable exploitation and regeneration constitute a collective responsibility that immaterially encodes the vegetational geography of the territory. In the Roncal Valley, trees are a resource and an economy, but also an identity —also religious personality (Figure 18). The Roncal pine, which drove the log rafts of the Ezka River for centuries, is a marker of collective historical memory, and the disappearance of this transport system in the twentieth century was experienced as a profound cultural loss (Figure 19).

TEK as an adaptive system

The three documented corpora are fragments of local TEK systems at various stages of vitality and erosion. What makes them comparable is not that they share the same species—although a shared core does exist—nor the same uses, but that they respond to the same question: how is knowledge about the trees that sustain the material and symbolic life of the community organized? The TEK response, in all three cases, involves four cognitive operations: classifying species according to categories of value (timber, alimentary, medicinal, ritual); codifying the rules of access (when, how, and by whom); anchoring all of this in language through vernacular names that index uses and ecological relations; and distributing it socially through specific transmission practices—learning through labor, proverbs, oral literature, toponymy—that ensure its generational reproduction (Gadgil *et al.* 1993; Berkes 2012).

When one of these mechanisms fails—the language loses vitality, the trade disappears, the resource falls out of use—knowledge is not lost all at once but degrades selectively. The most complex rules—such as in Ataun the lunar system or Roncal's log-raft construction techniques —disappear before the simpler ones— the vernacular name, the location of the

finest specimens. The corpora of all three territories were collected precisely during this process of selective degradation, which confers upon them an extraordinary documentary value. They are records of knowledge in transition, with the most recent layers already eroded and the oldest still visible.

Figure 18. **Izpelko** (*Ruscus aculeatus* L.) used as a Palm Sunday branch in Uztárroz. Source: Pablo Orduna Portús.

Figure 19. **Día de la almadía - Almadiaren Eguna** (Festival of National Tourist Interest), Burgui, 2012. Source: Pablo Orduna Portús.

Deep interconnections

Beyond structural convergence, the territories reveal systems of concrete historical linkages that refute any notion of the three corpora as closed systems. The documented TEK flows operate across several dimensions. At the material level, wood stands out as an essential element of traditional technology throughout rural Basque culture. Shared botanical toponymy reinforces this image of cultural continuity: place names derived from **ezpel** (box), **astigar** (maple), and **haritz/arizti/aretx** (oak) appear in all three territories with phonetic variations that reflect the dialectal gradient of Basque, but not cultural boundaries. The sequence **Ezpelaga** (Guesalaz) - **Ezpelondoa** (Roncal Valley) is a toponymic continuum that documents the historical extent of box woodland across the Basque Country with greater fidelity than any modern phytogeographic map. Similarly, the sequence **Astigardi**-**Astigarreta** (Guesalaz) - **Astigar/Aixtegar** (Roncal Valley) - **Astigar arrunta** (Ataun) traces the historical distribution of maple across the territory through the linguistic imprint of the communities that named it. In other words, the ethnobotanical corpus does not constitute an isolated local knowledge system—anthropological isoglosses, so to speak— but rather a situated knowledge embedded in a network of connections and flows linking the Ezka River with the Oria, at the heart of peninsular Basque Country.

Urgency and responsibility

The erosion of the knowledge documented in the three corpora is not a completed process. The accelerated rural depopulation of mountain areas since the 1960s, combined with the abandonment of traditional systems brought about by agricultural mechanization, has eliminated the contexts in which this knowledge was transmitted. Viewed comparatively, the shared traditional knowledge substrate across three differentiated zones of the Basque cultural and ethnobotanical landscape has undergone a similar decline. What the data make unmistakably clear is that what is being lost is not folkloric curiosity. What is in the process of disappearing are the systems of refined environmental observation developed by local communities—systems intrinsically tied to ways of understanding biodiversity that encode uses and relationships with the surrounding environment. This represents the breakdown of traditional forest management models, for which industrial silviculture has found no replacement with equivalent ecological effectiveness at the local scale (Figure 20).

Figure 20. Timber laid out for transport. Mountain pass of Laza, Uztarroz, 2016. Source: Pablo Orduna Portús.

Conclusions

The results of the comparative analysis support the following conclusions. First, the three territories share a core of five ethnobotanically structuring species—*Buxus sempervirens* L., *Fagus sylvatica* L., *Fraxinus excelsior* L., *Corylus avellana* L., and *Quercus robur* L.—with partially convergent and partially differential uses that reflect their distinct ecological, economic, and cultural contexts. Convergence in basic productive functionality (timber and alimentary use) contrasts sharply with divergence in the specific technical systems into which each use is integrated.

Second, the climatic gradient accounts for the documented floristic composition—and for the most marked differences, such as the exclusive presence of *Abies alba* Mill. in the Roncal Valley—but does not determine the systems of use, which respond primarily to the economic history of each community. The correlation between economic structure and the emphasis of ethnobotanical knowledge is stronger than that between taxon availability and traditional knowledge of the flora (Figure 21). At the linguistic level, vernacular nomenclature, and toponymy function as complementary and mutually irreducible ethnobotanical archives. Phytotoponymy enables the reconstruction of historical species distributions—Roncal fir stands at elevations now devoid of fir, Navarrese box groves in localities bearing the toponym **Ezpelaga**—in a way that modern floristic inventories cannot. Nomenclatural variation, for its part, is a sensitive indicator of linguistic vitality and of the degree of dialectal contact at the time of data collection.

Third, the three corpora constitute local expressions of a single type of arboreal TEK, adapted to different ecological and economic environments. Their surface-level divergences reveal a deep common logic in the way rural communities organize, encode, and transmit knowledge about trees. The four dimensions of arboreal TEK—temporal, technical, social, and ontological—are present in all three territories, albeit with different content. In all cases, the comparative method has enabled the identification of patterns that would not have been visible in a single-case study: both the elements of deep convergence and the most significant divergences only become apparent through contrast. The comparative perspective is not a methodological supplement but a necessary condition for analysis, since without comparison the logic of the gradient is lost and the comprehension of each system is impaired.

Figure 21. **Malatxa** or milk whisk made of holly tree (*Ilex aquifolium*) and formerly used in the preparation of cheeses in Atlantic Basque Country. Source: Pablo Orduna Portús.

Limitations and future research directions

The principal limitation of this study is the heterogeneity among the documentary corpora, which were collected during different periods, using different methodologies, and with differing numbers of informants. These factors prevent the normalized application of the ICF (Trotter and Logan 1986) and restrict quantitative comparability to indicators of relative use salience. Future research should undertake primary documentation with a unified protocol across the three territories, before the generation of knowledge bearers is lost. Finally, the analysis of the network of material and knowledge exchanges among the three territories—of which this article offers only preliminary indications—deserves a dedicated study integrating archival sources and oral documentation.

Declarations

List of abbreviations: ICF = Informant Consensus Factor; J = Jaccard similarity index
TEK: Traditional Ecological Knowledge; UV = Use-Value.

Ethics approval and consent to participate: This study does not involve experiments on animal or plant materials. All information was collected with the prior informed consent of participants and is consistent with data from previous fieldwork.

Consent for publication: Written consent for publication was obtained from all knowledge holders.

Availability of data and materials: All figures and tables presented in this work are original and were generated specifically for this study. The data are available in serial table repositories with access provided through the author.

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