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Sustainability Language in Forest Management Plans: A Comparative Analysis for Public Forests of the US and Turkey

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Abstract: Forest management plans often suggest that economic, ecological, and/or social sustainability will be achieved if the proposed management actions are followed. Using forest plans developed by the US Department of Agriculture Forest Service and the Republic of Turkey, the purposes of this study were to (*i*) extract those statements that suggest sustainability will be achieved and (*ii*) assess whether there exist statistical differences between the two countries' plans and the emphases of the findings. A content analysis and non-parametric statistical tests were employed to measure the frequency of a set of terms related to sustainability and to estimate significant differences in the use of sustainability terms in the plans sampled. Results suggest that ecological aspects are dominant in forest plans from both countries. While *silviculture*, *sustained yield*, and *multiple use* were the most frequently used terms in Turkish plans, the occurrences of *conservation* and *recreation* were significantly higher in US plans ($p < 0.001$). These findings suggest that the differences in the plans' emphases could be attributable to the importance of Turkey's forests for the wood production-related needs of Turkish society, whereas US national forests might no longer be seen as an important wood supply base but instead have been given a more "passive" forest use.

Keywords: forest sustainability; sustainable forest management; forest plans; national forest system; content analysis; sustainability aspects

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1. Introduction

It is difficult to arrive at a single definition of sustainability, as its understanding differs across disciplines and cultures [1–3]. However, the sustainability concept is generally characterized based on the *three main pillars* (aka *triple bottom line*); namely, the economic, ecological, and sociocultural aspects of sustainability [4–6]. The economic aspect of sustainability refers to the maintenance of financial capital, while ecological sustainability aims to maintain natural resources and thus improve the quality of human life [7]. Sociocultural sustainability, on the other hand, is understood as those diverse mechanisms that facilitate society's active participation in and engagement with management [8]. Balancing these sustainability aspects in management-related decision making is challenging because they may compete with each other [9,10], and their priorities often change over time [1,2].

As global environmental problems have become more visible following the end of the 20th century, people's demands and concerns about forest resources have evolved significantly. In response, for many public agencies, the forest management and planning paradigm has transformed from perpetuating wood production (i.e., timber management) to sustaining the multiple ecosystem goods and services provided by forests [9,11,12]. This paradigm shift has resulted in more emphasis being placed on forest sustainability or sustainable forest management concepts in forest plans rather than just wood production.

National agencies, forestry professionals, and landowners now consider ecological and sociocultural aspects of sustainability in their forest management processes, along with economic considerations.

In this context, the US and Turkish forest services have updated their mission statements and revised their previous planning rules. The current mission of the US Department of Agriculture's (USDA) Forest Service, for example, is to "*sustain the health, diversity, and productivity of the Nation's forests and grasslands to meet the needs of present and future generations*" [13], and it intends to address purposes and needs that include the following [14]:

- *"Contribute to ecological, social, and economic sustainability by ensuring that all plans will be responsive and can adapt to issues such as the challenges of climate change; the need for forest restoration and conservation, watershed protection, and species conservation; and the sustainable use of public lands to support vibrant communities";*
- *"Provide for a transparent, collaborative process that allows effective public participation";*
- *"Be effective by requiring a consistent approach to ensure that all plans address the issues outlined by the Secretary and yet allow for land management plans to be developed and implemented to address social, economic, and ecological needs across the diverse and highly variable systems of the National Forest System".*

Accordingly, the US Forest Service released its most recent planning rule in 2012 [14], which provides a process for forest planning that is adaptive and science-based, engages the public, and is designed to be efficient, effective, and within the Agency's ability to implement. It also meets the requirements under the National Forest Management Act (NFMA), the Multiple-Use Sustained-Yield Act (MUSYA), and the Endangered Species Act, as well as all other legal requirements [14]. Moreover, it is recognized that the land planning under the previous 1982 rule procedures guided the agency to mitigate negative impacts in such a way that today would not be sufficient due to the diverse and changing challenges (e.g., adaptive management, social values, science and technology advances), demanding a new approach for the protection of ecological, social, and environmental resources today and in the future. US national forest (NF) plans are currently developed using an interdisciplinary process that provides opportunities for public participation, and these plans define the framework for forest management [15]. From the mid-1950s to about 1990, the volume of timber harvests from the US NFs was two to four times greater than the more recent rate (which is similar to the harvest rate in the 1940s). The recent decline is based on a number of interrelated statutory, administrative, biological, and market factors that have occurred at varying points in time and have increased the complexity, priorities, and transparency of management of US NFs [15].

Similarly to the US, forest planning has undergone significant changes in Turkey over the last few decades [16–19]. The conventional planning system has been replaced by an ecosystem-based functional planning approach with the recent rule issued by the Turkish General Directorate of Forestry (GDF) in 2008. The conventional system could be characterized as timber-oriented area regulation [16], relying on harvesting equal forest areas during each period. After a rotation, one would expect a "regular forest" composed of equal areas in each age class [20]. This even-aged management method was first developed by German silviculturist Heinrich von Cotta in the early 19th century based only on the relationship between stand age and compartment area [21,22]. That is why traditional Turkish forestry has been occasionally called a German-led neoclassic system [16,17]. Today, the public forests of Turkey (>99% of the national forestlands) are planned and managed to sustain ecosystem processes and their functions (forest values) demanded by society owing to the new planning rule [23] and its detailed guideline [24]. To this end, the main forest functions (economic, ecological, and social) are spatially determined using a set of criteria and indicators with a participatory approach. Accordingly, primary and secondary functions are assigned to each forest stand and shown in forest function maps [25]. Afterward, management units are established by collecting appropriate stands with the same or similar function(s), regardless of their adjacency. Each management unit has a well-defined

management objective, which guarantees forest sustainability within these management units [24]. In essence, the main principle in the ecosystem-based functional planning system is to implement multiple-use forestry by considering non-economic forest functions and to schedule tailored management activities for these multi-functional management units. For example, forestlands with ground slope rates between 60 and 80% are allocated for soil protection (i.e., an ecological aspect of sustainability), and harvesting activities (i.e., economic aspects) are considerably limited for those lands. The rationale here is to ensure the provision of the erosion control services of forests (as a primary function) while generating some income for forest enterprises (as a secondary function) through extensive thinning activities [26].

Some of the earliest concerns regarding forest sustainability were related to a dependable flow of wood supplies to urban areas, the effects of economic conditions on wood supplies, and yields from forests, all of which focus on productive aspects of the forest resource [20]. Concerns for the sustainability of production (both wood and water) were primarily emphasized in the management of US NFs through to about the 1960s and continue to be emphasized today in conjunction with other types of landowners. During the mid-20th century, a number of factors (e.g., increased leisure time, improved transportation systems, heightened interest in other resources) influenced a shift in emphasis toward the sustainability of multiple uses (recreation, rangeland, timber production, water, wildlife, etc.) in the management of US NFs [20]. In the last 20 years or so, the sustainability of ecosystem services and ecosystem functions has been emphasized in the management of US NFs. Evidence of this includes statements that refer to the ability to sustain or maintain a resource over a long period of time. Some of these statements can be quantitative, as is typical for projected wood flows, carbon pools, recreation user days, and water yields, for example. While also important, other statements are qualitative (produce a healthy and resilient forest), perhaps reflecting uncertain or undeveloped measurement methods. We anticipated that language related to sustainability in US NF and Turkish forest plans would contain the types of terms and statements suggested in previous research efforts on this topic [27]. These include verbs such as “produce”, “sustain”, “maintain”, and others, along with nouns that could include, among others, “health”, “employment”, “yield”, and “biodiversity”.

Although a shift in emphasis (i.e., away from primarily timber management to multiple-use forestry and then ecosystem function) may be evident in the institutional paradigms and published planning rules of the two countries, there are still concerns about organizations’ ability to develop and implement forest plans that truly demonstrate forest sustainability when only focusing on one aspect of it. Baldwin et al. [11], for example, attribute the timber-oriented planning practices to the US Forest Service’s tradition around silviculture and operational forest management, as well as local people’s dependence on forest resources. Similar concerns also arise outside the US, where forest planners and land managers are generally reluctant to deal with non-economic aspects of sustainability because there are complex interactions between ecological and sociocultural processes due to their distinct characteristics operating at various spatial and temporal levels [10]. In a recent review, Başkent [9] pointed out that timber harvests still stand as the main target of the multiple-use forest planning models, although this approach was originally developed to balance economic, ecological, and sociocultural aspects of forest sustainability. While the tendency towards timber-oriented practices could be explained by the fact that timber is usually the only means of revenue allowing treatments, characterization of forest sustainability is necessary to clarify the abovementioned concerns.

Essentially, characterization or evaluation of the sustainability of a forest system is possible via forest plans or planning models. However, it is a challenging task due to the abstract nature of the sustainability concept and different understandings of sustainability aspects across communities [1–3]. One method for characterizing sustainability would be the use of quantifiable sustainability indicators related to economic, ecological, and social aspects. Following this approach, Diaz-Balteiro and Romero [12] developed

14 planning formulations (i.e., alternative plans) for a public forest in northeastern Spain using 11 indicators. The researchers evaluated these formulations with the goal programming method and ranked 14 forest plans in terms of their overall sustainability scores. The plan with the highest score was "the most sustainable" in this case. However, the indicators used were mostly associated with the economic aspect of forest sustainability (e.g., net present value, veneer volume, rotation age). Therefore, "the most sustainable" plan in their study might be referred to as "the most economically sustainable". To accomplish a full characterization of forest sustainability, it would be necessary to consider ecological and sociocultural indicators—along with economic ones—during the modeling process. In this sense, recent works state that holistic planning still requires more empirical data, indicators, and models for the evaluation of non-provisional ecosystem services provided by forests [9,25,28].

Another method of characterizing forest sustainability is conducting a content analysis of forest plans, which is uncommon in the forestry field. Indeed, the language of the plans could reflect the perceptions, commitments, and foci of countries, agencies, planners, and/or landowners regarding sustainable forestry. Among the few studies in the field, Gutierrez Garzon et al. [27] surveyed forest planners across the US to identify widely used terms associated with sustainability in forest plans. Their findings showed that *conservation*, *long-term*, and *stewardship* were the top three terms most frequently associated with sustainability. The topics of *resilience*, *carbon sequestration*, and *restoration* were rarely associated with sustainable forest management in the US. Based on this work, Gutierrez Garzon et al. [8] then analyzed the textual context of a sample of 30 state forest management plans from ten US states. It appeared that social aspects of sustainability were generally lacking in the state forest management plans, although the term *recreation opportunities* appeared frequently. These works suggested that a balance between economic, ecological, and social dimensions in forest plans would only be possible by building a sound environmental policy and improving the institutional capacities of forestry agencies.

To the best of our knowledge, there are no studies characterizing the sustainability of public (federal) forests based on forest plan contents in the world. However, public forests are of great importance globally in terms of their area coverage and provision of multiple ecosystem services. Within the National Forest System, for example, the US Forest Service manages 154 national forests, 20 grasslands, and 1 prairie covering an area of nearly 78 million hectares (~8.5% of total US land) [29], while private ownership manages about 60% of the forest land in the US, with family forest acreage accounting for 39% of the forest land in the country [30]. In comparison, Turkey has almost no private forestland in its territory. In Turkey, the government owns more than 99% of the country's forest area. Covering almost 23.1 million hectares (~30% of the total land), these areas are managed by one agency, the GDF [31]. In this study, we considered it crucial to gain an understanding of *how* and to *what extent* forest sustainability is demonstrated in forest plans currently being implemented for public forests both in the US and Turkey. The analyses presented here address the following research questions:

- What key terms associated with forest sustainability appear more often in public forest plans?
- Once identified, are there positive or negative relationships between the presence or usage of pairs of key terms?
- Are there any significant differences in the sustainability language between the plans of the US and Turkey?
- Can differences in the sustainability language be categorized according to the economic, ecological, and social aspects of sustainability? From a comparison of these categories, what differences in forest management between the US and Turkey can be inferred?

By conducting this type of analysis, we provide a blueprint for forest managers, planners, and the public in both the US and internationally to identify and verify a focus on sustainability—or lack thereof—within current and future forest management plans.

2. Materials and Methods

2.1. Forest Management Plans

We collected 42 forest plans from 13 states in the US and 12 provinces in Turkey (Table 1). The plans were in effect as of the early 2022 and they were all developed for public forest planning units (FPUs) owned and managed by government (i.e., national forests (NFs) in the US and forest management chiefdoms (FMCs) in Turkey). For the US NFs, the sample collected consisted of all the plans available at the time of the study, developed from 2014 to the present (released after the 2012 planning rule). A similar number of Turkish forest plans were selected based on their recency (released after the 2008 planning rule) and distribution across the country. Due to these procedures, some regions with non-forested land areas, such as the Plains states in the US and southeastern Turkey, were not sampled. Further, some important forested areas were also not sampled because the forest plans were developed prior to 2009. The purposes of the two sets of plans are not necessarily consistent, as the US plans are strategic in nature, suggesting that tactical decisions should be assessed by field personnel as projects are developed but must remain consistent with the strategic forest plan. These plans generally concern larger areas than the Turkish plans. The Turkish plans are both strategic and tactical in nature. These differences are inherent to the planning environment for the forested lands managed at the national level in each country, yet these are the overarching management plans that are used by the managers of these lands.

Table 1. Specification of the forest planning units (FPUs), including the name, location, area coverage, plan period, and plan length (national forest: NF, forest management chiefdom: FMC).

Country	Name of the FPU	State/Province	Plan Period	Number of Pages [1]	Area Coverage (ha)
United States of America	Apache Sitgreaves NF	AZ	2015–2029	304	849,840
	Carson NF	NM	2021–2035	297	601,513
	Chugach NF	AK	2020–2034	177	2,185,302
	Cibola NF	NM	2021–2035	250	647,497
	Coconino NF	AZ	2018–2032	303	728,434
	Colville NF	WA	2019–2033	236	445,154
	Coronado NF	AZ and NM	2018–2032	270	720,340
	Custer Gallatin NF	MT	2022–2036	242	1,214,056
	El Yunque NF	PR	2018–2032	132	11,736
	Flathead NF	MT	2018–2032	412	971,245
	Francis Marion NF	SC	2017–2031	256	105,066
	George Washington NF	VA	2014–2028	374	728,434
	Helena NF	MT	2021–2035	644	1,173,588
	Inyo NF	CA and NV	2019–2033	188	809,371
	Malheur NF	OR	2018–2032	467	687,965
	Nantahala Pisgah NF	NC	2022–2036	352	420,873
	Prescott NF	AZ	2016–2030	181	485,622
	Rio Grande NF	CO	2020–2034	252	740,575
	Santa Fe NF	NM	2021–2035	348	679,871
	Umatilla NF	WA and OR	2018–2032	439	566,559
	Wallowa Whitman NF	ID and OR	2018–2032	463	971,245

Table 1. *Cont.*

Country	Name of the FPU	State/Province	Plan Period	Number of Pages [1]	Area Coverage (ha)
Republic of Turkey	Altıparmak FMC	Artvin	2010–2029	456	45,493
	Ayvacık FMC	Çanakkale	2018–2037	281	64,163
	Bademli FMC	Konya	2016–2035	537	66,041
	Baharlar FMC	Çanakkale	2018–2037	267	13,859
	Başkonuş FMC	K.maraş	2012–2031	573	20,308
	Bayam FMC	Kastamonu	2009–2028	355	16,006
	Boyalı FMC	Erzurum	2022–2041	202	9819
	Büyükdüz FMC	Karabük	2011–2030	354	3024
	Çamkoru FM	Ankara	2015–2034	269	13,693
	Dalaman FMC	Muğla	2013–2032	296	24,628
	Fındıklı FMC	Rize	2011–2030	257	39,936
	Gürgendağ FMC	Balıkesir	2010–2029	499	13,178
	Hadim FMC	Konya	2016–2035	518	90,285
	Hocalar FMC	Afyon	2015–2034	303	59,310
	Hopa FMC	Artvin	2022–2041	293	6063
	İğdir FMC	Kastamonu	2014–2033	415	15,683
	Kartalsuyu FMC	Kastamonu	2014–2033	373	16,085
	Kemalpaşa FMC	Artvin	2022–2041	231	4969
	Kızıldağ FMC	Konya	2016–2035	605	53,292
	Sahara FMC	Artvin	2022–2041	266	10,057
	Sinanpaşa FMC	Afyon	2015–2034	268	86,339

[1] Includes appendices when present.

2.2. Content Analysis

Each forest plan was individually analyzed using NVivo 12 Pro, a specialized software package for content analysis. Accordingly, the plans were coded with a list of search terms related to forest sustainability. Then, the terms were associated with certain aspects of sustainability, such as economic, ecological, and social aspects. If a term did not fall into any of these aspects, it was classified under the "general aspect" category. For example, *multiple use* was categorized as general due to it encompassing all aspects of forest sustainability.

Table 2 shows a revised list (from [27]) of sustainability-related terms and a categorical coding system for evaluating the language in state-level forest management plans used to code our sampled plans in NVivo. The original list was slightly extended by adding three new terms commonly observed in both the US and Turkey's plans concerning the sociocultural aspect of forest sustainability. In addition, the English terms were translated into Turkish by a native speaker (the first author) to analyze Turkey's plans and are also noted in Table 2.

The query of terms in NVivo also included the option "with stemmed words". For example, a search for the term *sustainability* included the terms *sustain*, *sustainable*, and *sustained*, resulting in all references with these keywords. On the other hand, we queried the Turkish terms with the "exact matches" option because NVivo Transcription did not have a Turkish language preference for users. In this case, a Turkish term, such as *rekreasyon*, was queried using a Boolean operator with associated keywords (i.e., *rekrea** or *ekoturi**). Thus, any references with the stemmed words, such as *rekreatif* (recreational) and *ekoturistik* (ecotouristic), were included in the analysis.

Table 2. The key terms and their synonyms used to characterize economic, ecological, and sociocultural aspects of forest sustainability in both languages (revised from [27]).

Sustainability Aspects	Key Terms	Synonyms/Similar Search Terms Used	Key Terms (In Turkish)	Synonyms/Similar Search Terms Used (In Turkish)
General	Sustainability	-	*Sürdürülebilirlik*	*Devamlılık, süreklilik*
	Long term	-	*Uzun dönemli*	*Uzun süreli, uzun vadede*
	Multiple use	Multipurpose, multifunctional	*Fonksiyonel*	*Çok amaçlı, çoklu kullanım*
	Resilience	-	*Esneklik*	*Yılmazlık, dayanıklılık*
Economic	Productivity	-	*Verimlilik*	*Üretkenlik, prodüktivite*
	Silviculture	-	*Silvikültür*	-
	Sustained yield	Sustain timber production	*Sürekli hasıla*	*Devamlı ürün, odun üretimi, sürdürülebilir artım*
Ecological (environmental)	(Bio)diversity	Biological diversity	*Biyoçeşitlilik*	*Biyolojik çeşitlilik*
	Conservation	Protection	*Koruma*	*Muhafaza*
	Forest health	Ecosystem health, stand health, tree health, healthy forests, the health of the landscape	*Orman sağlığı*	*Ekosistem sağlığı, meşcere sağlığı, ağaç sağlığı, sağlıklı ormanlar, sağlık kesimleri, sağlık etası*
	Ecological integrity		*Ekolojik bütünlük*	*Ekolojik bütünsellik, entegrasyon*
Sociocultural	Participatory (approach)	Stakeholder (involvement)	*Katılımcı (yaklaşım)*	*Paydaş (toplantıları)*
	Employment	Job opportunities, local (people), (native) tribes	*İstihdam*	*İşlendirme, yöre halkı, orman köylüsü*
	Recreation	Ecotourism	*Rekreasyon*	*Ekoturizm*

Once the queries were completed, we analyzed all references by reading all the statements (i.e., sentences or paragraphs) shown by the NVivo Interface with shaded PDFs of forest plans. Thus, some of the terms captured by NVivo (e.g., institution names, general descriptions, proper nouns) were excluded from the analysis because they were out of context. In addition, the number of pages for each plan was different (Table 1); therefore, term frequencies were normalized to 100 pages to compare the plans consistent with each other.

Finally, the textual contexts of the US and Turkish plans were carefully read by the native English and Turkish speakers who are the authors of the present paper. By doing so, any relevant words that might have been missed during the computer-aided analysis (e.g., *healthier forests* or *sağlıksız meşcere yapısı*) were manually entered into the list for further analysis.

2.3. Statistical Analyses

The Mann–Whitney U test was employed to assess potential differences in the frequencies of use of sustainability terms between the US and Turkey's forest plans. The Mann–Whitney U test is a non-parametric and unpaired rank sum test widely used in comparisons of the results of independent pairs of groups [32–34]. Our test hypothesis was that there would be no difference between the frequencies of the sustainability-related terms used in the forest plans of the two countries. The difference between the groups was considered statistically significant at a significance level of $p < 0.05$. Additionally, we performed Spearman's correlation analysis (non-parametric) to examine the possible statistical relationships between the key terms and the sets of sustainability aspects, as well as the correlations among the individual key terms themselves. For this, each key term (14 in total; see Table 2) and sustainability aspect (five in total: economic, ecological, sociocultural, general, overall) were considered as independent variables and their frequencies (i.e., word counts) in each forest plan were entered into the statistical software as the data value. We had a total of 42 samples (i.e., forest plans, 42 rows) in the analysis. All statistical tests and analyses were performed using IBM SPSS 20 software.

2.4. Spatial Assessment

We used ArcGIS 10.2 software [35] to illustrate the areas covered by the forest plans and show their multiple features on a map. To this end, the coordinates of each FPU were first located based on their approximate centroids. Second, the names, the total and categorized numbers of terms, and the plans' dominant sustainability aspects were separately entered into the attribute tables of the US and Turkey layers. Third, maps were created for both Turkey and the US illustrating the proportional relationships between the dominant aspect of sustainability (i.e., ecological, economic, etc.) present in each plan and the total number of sustainability terms identified. We used the Jenks natural breaks classification method to group data into three classes according to the total number of sustainability terms used in forest plans.

3. Results

In general, the textual context of forest plans was found to be well-structured in both countries. The visions, desired conditions, objectives, standards, and management units (with their maps) were sufficiently specified in all the plans analyzed. Some forest plans included comprehensive appendices, glossaries, or tabular data at the end of their main texts to elaborate on management guidance and the terms employed. These documents could sometimes be longer than the plan itself, as in the cases of Helena NF, Malheur NF, and Kızıldağ FMC. The average length of the plans was 338 pages. However, on average, the Turkish plans (362 pages) were slightly longer than those of the US (313 pages), although their area coverage was smaller than the US plans.

Turkish forest plans used the definition of sustainable forest management developed by the Second Ministerial Conference on the Protection of Forests in Europe: "*the stewardship and use of forests and forest lands in a way, and at a rate, that maintains their biodiversity, productivity, regeneration capacity, vitality and their potential to fulfil, now and in the future, relevant ecological, economic and social functions, at local, national, and global levels, and that does not cause damage to other ecosystems (p. 1)*" [36]. The US plans, on the other hand, generally emphasized ecosystem sustainability and defined it as: "*the capacity of an ecosystem for long-term maintenance of ecological processes and functions, biological diversity, and productivity. It is also called ecological sustainability, which generally refers to land management practices that provide goods and services from an ecosystem without degradation of the site quality and without a decline in the yield of goods and services over time (p. 236)*" (i.e., [37]). Although the latter seemed a bit more focused on ecological aspects, the general notions in both definitions were similar between the countries.

The forest plans of Turkey differed from the US plans in their level of detail. While the US plans focused more on long-term strategic goals, the Turkish plans might be seen as both strategic and tactical, aimed at planning for the next 10–20 years. In the following sections, more detail from the outputs of the content analysis, findings from the statistical tests, and thematic maps for comparing the two countries' plans regarding forest sustainability are presented.

3.1. Frequency of Terms Associated with Forest Sustainability

Considering the US and Turkish plans together, the terms *conservation* (35.2%), *recreation* (19.6%), and *productivity* (11.0%) were more frequent than the term *sustainability* (10.0%) itself. In contrast, *participatory* (0.5%), *ecological integrity* (0.5%), and *employment* (0.9%) were less frequent terms in forest plans (Figure 1a). Terms such as *sustained yield* (8.2%), *long term* (3.0%), *silviculture* (2.9%), and *biodiversity* (1.7%) sporadically occurred in the main texts, regardless of the countries analyzed.

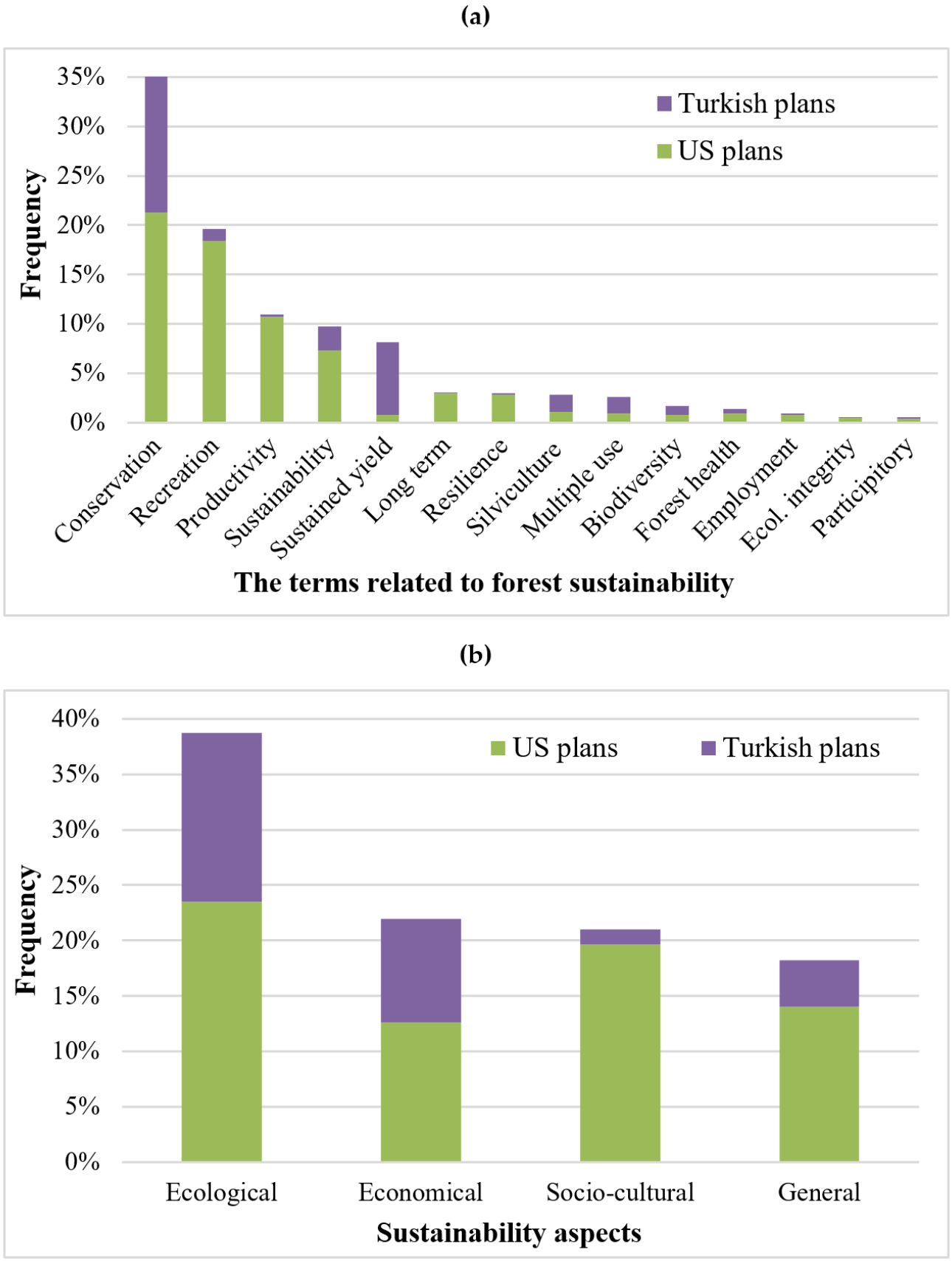

Figure 1. Frequency distributions of terms (**a**) and sustainability aspects (**b**) in forest plans from the two countries (n = 42).

As shown in Figure 1b, the ecological aspect of sustainability (38.3%) was dominant in the forest plans sampled. The economic (22%) and sociocultural (21%) aspects followed it with similar occurrences. The general category (18.4%), consisting of neutral terms, such as *multiple use*, *long term*, and *resilience*, appeared less frequently than all other categories. The relative dominance of sociocultural language in the US plans was one of the most noted takeaway messages (Figure 1b).

3.2. Significant Differences between US and Turkish Plans

Statistical tests showed differences in the US and Turkish plans in terms of the occurrences of the terms related to certain aspects of forest sustainability. Accordingly, both sustainability aspects (economic, ecologic, sociocultural, and general) and overall sustainability itself were more dominant in the US plans than Turkish plans (Table 3). All differences were at the $p < 0.001$ level, suggesting that they were statistically significant.

Table 3. Mann–Whitney U test results for uncategorized data and sustainability aspects.

Terms	Group	Mean Rank	*p*-Value *
All terms related to sustainability	US	32.00	<0.001
	Turkey	11.00	
Economy-related terms	US	28.10	<0.001
	Turkey	14.90	
Ecology-related terms	US	28.62	<0.001
	Turkey	14.38	
Sociocultural-related terms	US	32.00	<0.001
	Turkey	11.00	
General terms	US	32.00	<0.001
	Turkey	11.00	

* Differences between groups were considered statistically significant at the 0.001 significance level.

We also observed significant differences in the occurrences of individual terms used by the two countries (Table 4). Only the terms *sustained yield*, *silviculture*, and *multiple use* appeared more frequently in the forest plans of Turkey than in the US plans ($p < 0.001$), reflecting the importance of Turkey's forests for the provisioning needs of Turkish society [38,39], whereas US NFs, which account for 19% of US forestland yet recently supplied only about 2% of the country's annual harvested wood volume, are seen as a less important wood supply base today [11,15,40,41]. Another reason for the higher frequency of these terms could be the structure and appendices of Turkish forest plans. About one third of a Turkish plan consists of long tables, unlike US NF plans. These tables convey detailed information on (*i*) the area coverage of each (sub-)compartment, (*ii*) aggregated inventory data for each stand, and (*iii*) scheduling for pre-commercial and final harvests. We observed some repeating terms—for example, *silvicultural intervention type* and *allowable silvicultural cut*—as column heads of tables, particularly for table types *ii* and *iii* above. Since a typical FMC in Turkey has hundreds of compartments and thousands of stands, these tables can sometimes be 100 pages long. This difference between the two sets of plans is important because it also reflects the scopes of management planning (i.e., strategic vs. tactical) in the countries.

On the other hand, there was no difference between the plans in terms of the frequency of the term *biodiversity* ($p > 0.05$). This finding showed that, along with many differences, the US and Turkish plans shared some commonalities in their textual context. The frequencies for all other terms in Table 4 were higher in the US plans than Turkish plans ($p < 0.05$). While the significance levels changed depending on the terms, they were generally lower than 0.001.

Table 4. Mann–Whitney U test results for individual terms associated with forest sustainability.

Term	Group	Mean Rank	*p*-Value
Sustainability	US plans Turkish plans	31.43 11.57	<0.001 ***
Multiple use	US plans Turkish plans	15.88 27.12	<0.01 **
Resilience	US plans Turkish plans	32.00 11.00	<0.001 ***
Long term	US plans Turkish plans	32.00 11.00	<0.001 ***
Productivity	US plans Turkish plans	32.00 11.00	<0.001 ***
Silviculture	US plans Turkish plans	14.86 28.14	<0.001 ***
Sustained yield	US plans Turkish plans	11.00 32.00	<0.001 ***
Biodiversity	US plans Turkish plans	24.81 18.19	>0.05
Conservation	US plans Turkish plans	28.43 14.57	<0.001 ***
Forest health	US plans Turkish plans	25.67 17.33	<0.05 *
Ecological integrity	US plans Turkish plans	29.64 13.36	<0.001 ***
Participatory	US plans Turkish plans	28.31 14.69	<0.001 ***
Employment	US plans Turkish plans	31.76 11.24	<0.001 ***
Recreation	US plans Turkish plans	32.00 11.00	<0.001 ***

* Differences between groups were considered statistically significant at the 0.05 significance level; ** differences between groups were considered statistically significant at the 0.01 significance level; *** differences between groups were considered statistically significant at the 0.001 significance level.

3.3. Relationships between Sets of Forest Sustainability Aspects and Individual Key Terms

We found strong correlations between some terms' frequencies and certain sustainability aspects in the group of forest plans sampled (Table 5). In the US plans, for example, the term *productivity* was highly correlated with the total occurrence of economy-related terms ($r = 0.98$, $p < 0.01$). In contrast, the term *resilience* showed a negative correlation with the economic sustainability aspect ($r = -0.46$, $p < 0.05$). Regarding the ecological aspect, the term with the highest correlation coefficient was *conservation* in the US plans ($r = 0.97$, $p < 0.01$). *Biodiversity*, *silviculture*, and *long term* also showed significant correlations but with lower coefficients ($0.51 < r < 0.59$, $p < 0.05$). The terms *recreation*, *employment*, and *productivity* were the terms correlated with the sociocultural aspect, with varying correlation coefficients ($0.43 < r < 0.97$, $p < 0.05$). Interestingly, the term *productivity* showed positive correlations with both economic and sociocultural aspects, but their correlation coefficients were quite different. While its r was 0.98 for the economic aspect ($p < 0.01$), it was only 0.43 ($p < 0.05$) for the sociocultural aspect. This finding suggested that *productivity* was much more strongly associated with economic considerations.

Table 5. The relationships between sustainability aspects and the occurrence of terms.

Sustainability Aspects	Indicators	Significantly Correlated Terms with Their *r* Values	
		US Plans	Turkey's Plans
Economic	Total number of economy-related terms in forest plans	Productivity (0.98 **) Sustained yield (0.72 **) Multiple use (0.47 *) Resilience (−0.46 *)	Sustained yield (0.99 **) Conservation (0.70 **) Multiple use (0.50 *)
Ecological	Total number of ecology-related terms in forest plans	Conservation (0.97 **) Biodiversity (0.59 **) Silviculture (0.56 **) Long term (0.51 *)	Conservation (0.99 **) Sustained yield (0.78 **)
Sociocultural	Total number of sociocultural-related terms in forest plans	Recreation (0.97 **) Employment (0.45 *) Productivity (0.43 *)	Recreation (0.96 **)
General	Total number of general terms in forest plans	Sustainability (0.96 **) Participatory (0.57 **) Multiple use (0.52 *) Ecological integrity (0.49 *) Employment (0.49 *)	Sustainability (0.96 **) Multiple use (0.79 **) Productivity (0.79 **) Silviculture (0.77 **) Forest health (0.75 **)
Overall	Grand total of all sustainability-related terms in forest plans	Productivity (0.86 **) Employment (0.62 **) Recreation (0.55 **) Sustainability (0.53 *) Multiple use (0.44 *)	Conservation (0.93 **) Sustained yield (0.90 **) Multiple use (0.46 *)

* Differences between groups were considered statistically significant at the 0.05 significance level; ** differences between groups were considered statistically significant at the 0.01 significance level.

We also explored the correlations between the total numbers of general terms and individual terms. In this case, the term *sustainability* was in first place, with a correlation coefficient of 0.96 ($p < 0.01$). Its correlation coefficient was the same for both countries, indicating partial similarities in the language of the US and Turkish forest plans. Other similarities in the two countries' plans were observed for the terms *conservation* and *recreation*. They were the most common terms used to highlight the ecological and sociocultural aspects, respectively. Finally, the *productivity* term showed a significant positive correlation with the frequency of all sustainability terms in the US plans ($r = 0.86$, $p < 0.01$).

While the highest positive correlation in the US forest plans was observed between the terms *multiple use* and *ecological integrity* ($r = 0.74$, $p < 0.01$), it was between *sustainability* and *productivity* in the Turkish plans ($r = 0.87$, $p < 0.01$) (Table 6). The negative correlations, on the other hand, were infrequent and quite weak compared to the positive ones. In the US, the term *resilience* was negatively correlated with *productivity* and *sustained yield* ($-0.47 < r < -0.49$, $p < 0.05$). In Turkey, *conservation* and *long term* was the only term pair showing negative correlations with each other ($r = -0.44$, $p < 0.05$). Interestingly, there was no correlation between *recreation* and any other terms. The strong positive correlations among many terms in the US and Turkish samples might be explained by similar or synonymic meanings because, even though the plan writers were not the same people within these two countries, they seemed to use some terms interchangeably across forest management plans.

Table 6. The correlative relationships among the terms related to forest sustainability.

Terms Related to Sustainability	Significantly Correlated Terms with Their *r* Values	
	US Plans	**Turkey's Plans**
Sustainability	Participatory (0.58 **) Multiple use (0.53 *) Employment (0.44 *)	Productivity (0.87 **) Silviculture (0.71 **) Multiple use (0.70 **) Forest health (0.68 **) Long term (0.52 *)
Multiple use	Ecological integrity (0.74 **) Sustained yield (0.54 *) Sustainability (0.53 *) Productivity (0.51 *)	Productivity (0.72 **) Sustainability (0.70 **) Silviculture (0.63 **) Forest health (0.59 **) Employment (0.57 **)
Resilience	Productivity (−0.49 *) Sustained yield (−0.47 *)	Ecological integrity (0.49 *) Participatory (0.47 *)
Long term	Conservation (0.57 **) Ecological integrity (0.44 *)	Sustainability (0.52*) Conservation (−0.44 *)
Productivity	Sustained yield (0.69 **) Multiple use (0.51 *) Resilience (−0.49 *) Social total (0.43 *)	Sustainability (0.87 **) Multiple use (0.72 **) Forest health (0.56 **) Biodiversity (0.53 *) Silviculture (0.46*) Employment (0.45 *)
Silviculture	Conservation (0.45 *)	Sustainability (0.71 **) Multiple use (0.63 **) Productivity (0.46 *)
Sustained yield	Productivity (0.69 **) Multiple use (0.54 *) Resilience (−0.47 *)	Conservation (0.77 **)
Biodiversity	Conservation (0.51 *) Participatory (0.46 *)	Productivity (0.53 *) Sustainability (0.44 *)
Conservation	Long term (0.57 **) Biodiversity (0.51 *) Silviculture (0.45 *)	Sustained yield (0.77 **) Long term (−0.44 *)
Forest health	-	Sustainability (0.68 **) Multiple use (0.59 **) Productivity (0.56 **) Participatory (0.44 *)
Ecological integrity	Multiple use (0.74 **) Long term (0.44 *)	Resilience (0.49 *)
Participatory	Sustainability (0.58 **) Biodiversity (0.46 *) Employment (0.45 *)	Resilience (0.47 *) Forest health (0.44 *)
Employment	Participatory (0.45 *) Sustainability (0.44 *)	Multiple use (0.57 **) Productivity (0.45 *)

* Differences between groups were considered statistically significant at the 0.05 significance level; ** differences between groups were considered statistically significant at the 0.01 significance level.

3.4. Spatial Assessment

Through a spatial assessment, we visualized the distribution of forests in each country, reflecting the density of sustainability language with increasing symbol size (Figure 2). No clear spatial patterns were observed for the US and Turkey, implying there were no significant biases in forest plan attributes towards a specific region of the countries. Nevertheless, the within-country variations were more apparent for Turkey in terms of

the terms' occurrences. For example, the total number of sustainability-related terms was less than 100 per 100 pages in the plans for the Altıparmak, Fındıklı, Gürgendağ, and İğdir FMCs. This could be attributed to the fact that these plans cover a plan period starting during the years 2010–2014 (Table 1). It is possible that these plans do not fully reflect the emphasis on ecosystem sustainability suggested by the current planning rule and its most recent guidelines [23,24]. As for the US, the lowest use of sustainability language was seen in the plans for the Helena and Prescott NFs, but their term frequencies were more than 300 per 100 pages.

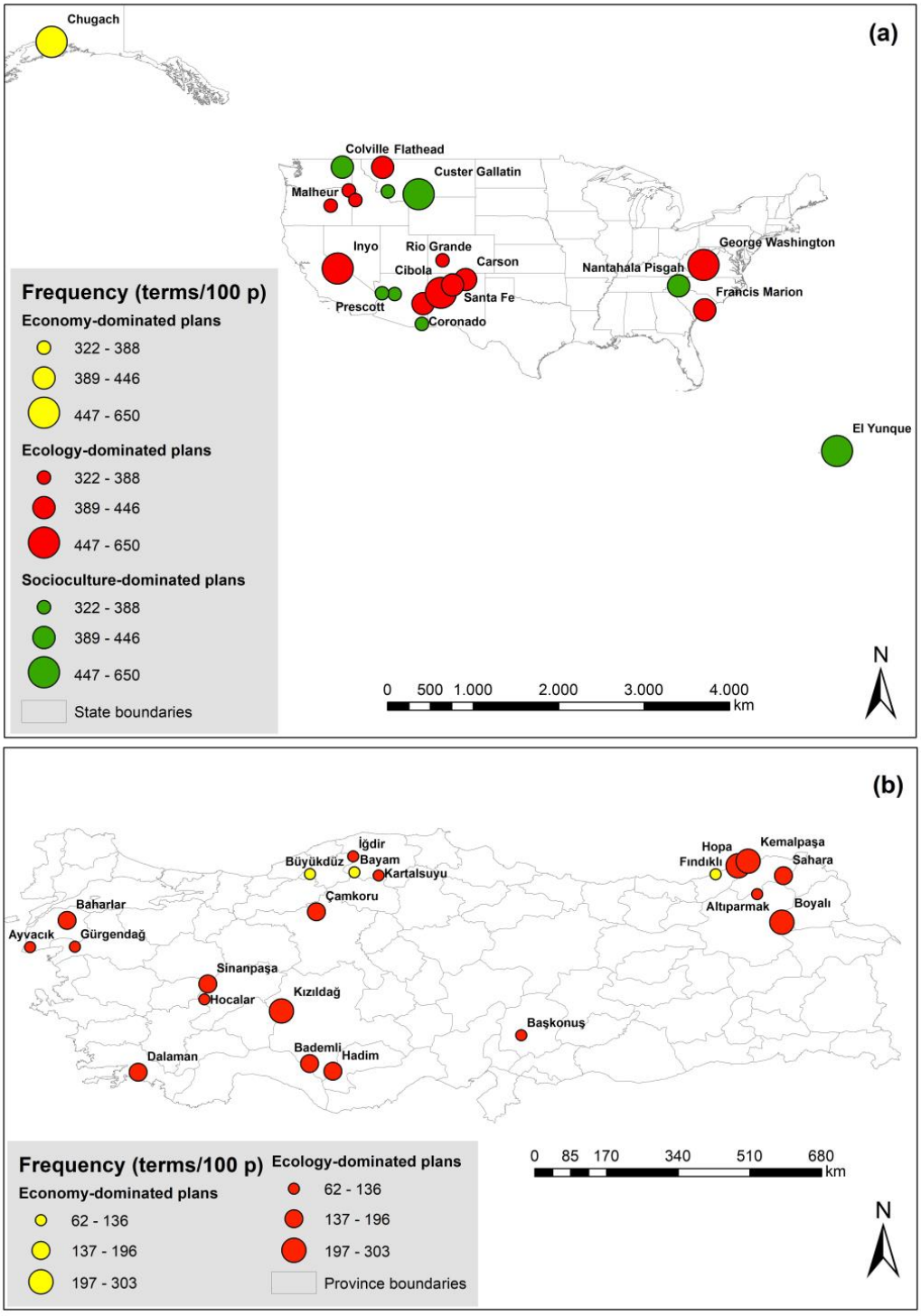

Figure 2. Locations of the US (**a**) and Turkish (**b**) plans with information on term frequency and dominant sustainability aspects.

The maps also show that forest plans dominated by economic sustainability were rarely identified. Three Turkish plans (the Bayam, Büyükdüz, and Fındıklı FMCs, all in the Black Sea Region) appeared to focus mostly on the economic aspect of sustainability, while only one forest plan (Chugach NF, AK) in the US showed this attribute (Figure 2). This finding for Turkey may be attributed to the rich forest resources and high timber production potential in the Black Sea region [31] owing to favorable climate conditions compared to other geographical regions [42]. Unlike the US, there were no forest plans dominated by sociocultural sustainability in Turkey. This finding is interesting because social conflicts between forest villagers, environmentalists, and the Turkish government due to land ownership issues [43], forest crimes [39], and urbanization pressure [38], among other causes, are still common concerns.

The symbol sizes of the Boyalı, Hopa, Kemalpaşa, and Kızıldağ FMCs were the largest in the Turkey map (Figure 2b) because sustainability language was most frequently employed in these FMCs' forest plans. The high frequency of sustainability-related terms here could be partly explained by the recent plan periods (Table 1). Except for that of Kızıldağ, the other three plans were developed in 2022, suggesting that sustainability language has become more prevalent in Turkish plans lately. The Kızıldağ and Boyalı plans, however, were developed by multidisciplinary teams with the support of two international projects: Adapting Mediterranean Forests to Climate Change and Conservation of Forest Biodiversity [44,45]. In the context of these comprehensive projects, biodiversity inventories were carried out and silvicultural prescriptions were developed at the stand level according to, for example, the habitat requirements of an endangered bird species nesting in a given stand. We observed specific sustainability terms, including *conservation*, *biodiversity*, *resilience*, and *forest health*, more frequently in these "exclusive" plans when compared to other Turkish forest plans.

4. Discussion

The approach used in the present work helped us handle our research questions and contributed to revealing the similarities and differences in the context and language in the public forest plans of the US and Turkey. For example, we tried to understand what sustainability terms were dominant in the most current forest plans and found that, in general, terms related to ecological sustainability were used to a greater extent than those related to the economic or sociocultural aspects of sustainability. This characteristic was more explicit in the US forest plans compared to the Turkish plans. Sociocultural sustainability was the weakest aspect of Turkish plans. This aspect was not dominant in any of the Turkish plans sampled, while 8 of 21 US plans were dominated by the sociocultural aspect. The contrast was directly related to the differences in the missions, strategies, and national planning rules guiding land management in each of these countries.

In the US, social expectations and the vision for sound forest management have changed recently towards what seems to be a greater focus on ecosystem management, allowing for the inclusion and discussion of ecological aspects, such as soil protection and productivity, water flow and availability, biodiversity, landscape implications, and global change (e.g., natural and anthropic disturbances) [40]. This shift supports our findings showing a weaker emphasis on economic considerations and high frequency in the use of terms related to ecological and sociocultural considerations in US forest plans. In the current strategic plan of the Turkish GDF [46], two out of four goals were related to economic considerations (goals two and three), including specific targets to increase industrial plantations and decrease the costs of wood-based products for "sustainable competition" in the domestic and foreign markets. In parallel with this new strategy, wood production has significantly increased in Turkey over the last few years. The GDF's annual statistics show an increase of 69.5% in wood production for the five years between 2017 and 2021 [31]. In 2022, Kömürlü et al. [47] reported that the amount of wood produced in 2005 was about 13.9 million m^3, increasing to 31.9 million m^3 as of 2021. This is worrisome because the increases in forest area and growing stock are much lower than the increase in

the wood production level during the same period. On the other hand, the planning rule of Turkey [23] states its compliance with the national forestry principles, which include productivity and (economic) rationality. These kinds of trends and principles must have increased the frequency of the employment of economy-related terms in the Turkish plans. If Turkey is trying to become less dependent on foreign wood markets, then the terms *sustained yield*, *silviculture*, and *productivity* are more likely to appear in the language of the plans aiming to achieve those goals in the future.

Interesting relationships arose from the analysis of the plans sampled. For example, the frequency of use of the term *resilience* was negatively correlated with the use of terms related to economic sustainability (i.e., *productivity* and *sustained yield*) in the US plans, while *long term* and *conservation* had a negative correlation in plans from Turkey and a positive correlation in the US plans. The management foci, forestry histories, and cultures of the two countries are different, likely influencing the understanding and implementation of these terms. In Turkey's plans, the term *resilience* appeared to have a positive correlation with the terms *participatory* and *ecological integrity*, which could be explained by the fact that these terms are fairly new in Turkish forestry terminology. For example, the term *resilience* appeared only in four Turkish plans that were developed in recent years. Another interesting relationship found in the US plans was that the frequency of use of the term *multiple use* was positively correlated with the use of the term *ecological integrity*. This finding was unexpected because management for diverse uses (timber, grazing, wildlife, recreation, etc.) may often degrade ecological integrity [48]; however, there have been successful applications in public lands [49] that defy this understanding and support our findings. Another contradiction found between the US and Turkish plans was that *conservation* showed a positive correlation with *long term* in US plans but a negative correlation in plans from Turkey. One explanation, at least for US NFs, is, again, the changing shift in managing the land, with the two terms now being paired together as *long-term conservation*, indicating an approach based on the maintenance of ecosystems, involving collaboration across multidisciplinary teams, and incorporating adaptive planning. In contrast, for Turkish forestry, the phrase *long term* is generally used in relation to monitoring forest dynamics over time, as seen in studies by Tavşanoğlu and Gürkan [50] and Bozali et al. [51], among others. Such differences are in line with the sustainability literature, suggesting that some sustainability terms could be understood differently across cultures [1,52].

Along with the differences, it was possible to observe numerous similarities in the sustainability language employed in the US and Turkey's forest plans. For example, there was no statistical difference between the plans regarding the frequency of the term *biodiversity*. This finding can be attributed to the high biodiversity values of these two countries, as well as the biodiversity crises they face [53,54]. Owing to its vast lands, the US hosts a broader array of ecosystems than any other country in the world [55]. Turkey, on the other hand, is located at the intersection of three biodiversity hotspots (i.e., the Mediterranean, Irano-Turanian, and Caucasus regions) and, thus, has a species diversity and endemism rate comparable to the entirety of Europe [56–58]. Some Turkish plans have been developed by multidisciplinary teams including biologists and wildlife experts in the context of international projects supported by the World Wide Fund for Nature (WWF), Global Environment Facility (GEF), and Trans-Anatolian Natural Gas Pipeline (TANAP) company. One of the primary objectives of these projects was integrating biodiversity value into forest management plans [44,45]. We observed that non-economic terms, such as *biodiversity* and *participatory*, appeared more in these "exclusive" plans when compared to other Turkish plans. On the other hand, there were no differences between the US and Turkish plan sets regarding the terms indicating the highest correlations with certain sustainability aspects (Table 5). For example, *conservation*, *recreation*, and *sustainability* were the most frequent terms associated with the ecological, sociocultural, and general aspects, respectively. This finding suggests that, despite many controversial uses, forest sustainability language has some steady terms employed and shared by the two countries. It should also be noted that the lack of the sociocultural dimension in Turkish plans is

compatible with the general sustainability literature and the results from other forest research conducted in the US. For example, Gutierrez Garzon et al. [8,27] revealed that the sociocultural aspect of sustainability was rarely emphasized in state forest plans in the US. In another work, Newman [5] stated that social sustainability was the weakest pillar of the sustainable development concept. This can be attributed to the difficulties of developing, measuring, and assessing sociocultural indicators.

From here, there are multiple directions to expand this work. For example, most of the differences found in the analyses presented may be associated with the management foci of each of these two countries, which have undergone recent shifts. It would be worth comparing US NF plans with others from countries with a strategic focus, such as Canada [59], and with plans developed for forests in Asia and Russia, where the US Forest Service has already started to build partnerships and interagency collaboration to address numerous challenges in the sustainable management of forests and, in general, the use of natural resources [60]. For instance, South Korea has started to consider sustainability in accordance with global trends and modified the 4th National Forest Plan (1998–2007) in 2003 to reflect these global trends. In the 4th National Forest Plan, the Korea Forest Service (KFS) focused on implementing legal support and various institutional systems for sustainable forest management [61]. In the 5th National Forest Plan (2008–2017) and 6th National Forest Plan (2018–2037), the concept of sustainability evolved to include more diverse functions of forests, such as recreational and cultural functions [62,63].

Another example of management shifts and emphases on different sustainability aspects is in Ghana, where the language in forest plans refers mainly to the sustainable production of timber and, to some extent, the sustained provision of benefits to forest fringe communities. For instance, the Yakombo Forest Reserve management plan, developed by Ghana's Forestry Commission, divides the forest reserve into protection and production zones. It employs sustainability language strictly for objectives relating to the production zones [64]. This plan was only a 101 page document, but the forest plans belonging to other countries, states, companies, and private forest owners might be even shorter. Gutierrez Garzon et al. [8] stated that the US's state-level plans could be as short as 20 pages. Moreover, some aspects of ecological or sociocultural sustainability might be absent in other types of forest plans. Therefore, future researchers should pay attention to the structures of different plan sets before they start to analyze the textual content of forest plans.

In the present study, we relied on native speakers of both languages to reduce the differences imposed by translating one language to another. However, despite the ability to provide comparative results for the dominant sustainability aspects in two countries using different languages, the evaluation approach in our study had some limitations. First, we assumed that the language used in forest plans could reflect the perceptions, commitments, and foci of countries, agencies, planners, and/or landowners regarding sustainable forestry. However, the frequent use of specific sustainability terms in theoretical plans may mean something other than that the forest is managed sustainably in practice. In order to see whether the plans' sustainability goals are truly being achieved, future research needs to explore the results according to what happened on the ground after the implementation periods of those plans. Alternatively, historical forest plans of the same FPU can be investigated in combination with forest cover maps. Although plenty of spatiotemporal analysis studies exist in the forestry and remote sensing literature [65–68], none have dealt with the textual content of their lands' management plans. Hence, future research should analyze plans' textual content (i.e., proposed sustainability goals, desired forest condition, sustainability aspects) and available spatial data (stand-type maps, satellite images, designated recreation sites, etc.) in an integrative manner. Secondly, our samples were not a random subset of all public forest plans from the two countries. We sampled only the plans available online or those which we had from previous projects. While NF plan texts are freely available on the internet, forest plans in Turkey are purchasable with official permission from the GDF. Although we paid attention to a geographically

balanced distribution of the FPUs across the countries, some large forested regions, such as the Great Lakes and the northeast and Acadian areas in the US, were excluded from the analysis. Similarly, forest plans for heavily managed southern pinelands in the US could not be sampled sufficiently. These limitations in the sampling scheme might have added additional bias to our results. Thus, future researchers should follow a sampling design that is statistically more robust and spatially more explicit.

5. Conclusions

The management plans that we examined for NFs in the US and Turkey contained suitable objectives, standards, and desired conditions for the resources managed by public (federal) agencies. The level of detail was different, however, as the Turkish plans provided both strategic and tactical advice for land managers, while the US plans only provided strategic advice. For example, the Turkish plans contained detailed information on land areas, forest inventories, and management actions, while these were generally lacking in the US plans. The scopes of the two sets of plans were quite different and likely related to the differences in the missions, strategies, and planning rules used in each of these countries. Of the three common forest plan themes (economic, ecological, social), the ecological theme received more treatment than the others in both sets of plans. In general, sustainability language was more prominent in the US forest plans, while the specific terms *sustained yield*, *silviculture*, and *multiple use* were more prominent in the Turkish plans. Furthermore, while the term *productivity* can be associated with the development of many different forest resources, it was frequently associated with economic considerations in the US plans. Some contradictions in the use of terms, such as *conservation*, were observed, perhaps related to the context in which they are commonly used. These findings are reasonable since, in Turkey, forestlands remain an important source of raw materials, while in the US, NFs emphasize ecological integrity and are not seen as an important source of raw materials at this time.

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