environmental sciences proceedings

MDPI

Proceedings

Comparison of approaches for determining grazing capacity in forest rangelands: the case of Pisoderion forest Florina-Greece

Katerina Melfou [1,*], Dimitrios Kalfas [1], Fotios Chatzitheodoridis [2], Stavros Kalogiannidis [3], Efstratios Loizou [2] and Ermelinda Toska[2]

[1] Department of Agriculture, Faculty of Agricultural Sciences, University of Western Macedonia, Terma Kondopoulou, Florina, Greece; kmelfou@uowm.gr (KM); kalfdimi@otenet.gr (KD)
[2] Department of Regional and Cross-Border Development, Faculty of Economic Sciences, University of Western Macedonia, Koila, Kozani, Greece; fxtheodoridis@uowm.gr (FC); eloizou@uowm.gr (EL); drdcbs00002@uowm.gr (ET)
[3] Department of Business Administration, University of Western Macedonia, 50100 Kozani, Greece; aff00056@uowm.gr (SK)
* Correspondence: kmelfou@uowm.gr Tel.:+302385054612

Abstract: False-alpine grasslands also known as summer grasslands or rangelands are mainly associated with transhumance. In the past, transhumance and graze were organized on a mainly family basis and there existed an informal management system for grazing, which was respected by all livestock farmers who used the summer pastures. Nomadic animal husbandry has disappeared, and with it a sense of respect for nature, the rangelands and, more generally, the environment. The aim of this paper is to assess the grazing capacity of rangelands in the Pisoderion Forest which is located at the region of Florina in Greece, under various specifications introduced by Forest Management Plans and relatively recent legislation. The grazing capacity that is theoretically expected following the specifications of previous Forest Management Plans is compared to grazing capacity according to the specifications introduced by relatively recent legislation. The conclusion that can be drawn is that the rangelands are underused and with an appropriate holistic management approach, such as the traditional system of dividing the forest grasslands into yards, the livestock capital can be doubled in these rangelands.

Keywords: grazing capacity; ecosystem services; grazing management plan; forest management plan; Pisoderion forest; Florina-Greece

Citation: Melfou, K.; Kalfas, D.; Chatzitheodoridis, F.; Kalogiannidis, S.; Loizou, E.; Toska, E. Comparison of approaches for determining grazing capacity in forest rangelands: the case of Pisoderion forest Florina-Greece. *Environ. Sci. Proc.* **2022**, *4*, x. https://doi.org/10.3390/xxxxx

Academic Editor: Firstname Lastname

Published: date

1. Introduction

A rising concern in recent years is the ability to manage resources in a sustainable manner and not allow them to be misused and degenerate faster than their capacity for self-restoration. Intensive production systems generate, along with marketable outputs, non-marketed negative externalities, such as pollution and habitat loss for example, that have been often set aside and ignored, having as a result productivity decrease and socioeconomic repercussions. Negative externalities like climate change, pollution and resource over exploitation are the main causes for the loss of biodiversity and the deterioration of natural ecosystems, leading to reduced provision of ecosystem services and diminishing productivities [1,2]. The management of rangelands is a critical factor for biodiversity preservation, ecosystem services and regional socio-economic development [1,3]. Evidence suggests that aiming at ecological rehabilitation can enhance biodiversity and the provision of ecosystem services. Yet the degree of real recovery of either stemming from these efforts remains uncertain and untested [1].

Grasslands are the largest terrestrial ecosystem, accounting for approximately 40% of the world's land area [4,5]. However, due to rapid economic growth and adverse climate change, approximately 16% of global grasslands have been degraded [6,7]. Continued grassland degradation reduces ecosystem services, seriously threatening livestock production and environmental security [6,8]. The way grazing is managed could affect grassland richness, biomass, carbon sequestration capacity and ecological health [5,9].

They provide important ecosystem goods and services, such as livestock supply, soil and water conservation, and carbon storage [10,11]. As one of the most critical ecosystem services provided by grasslands, livestock provisioning will become increasingly important as global demand for animal protein and dairy products increases in the coming decades [12]. However, the actual level of livestock production on grasslands exceeds the grazing capacity and is becoming increasingly serious over the years [5].

Overgrazed rangelands is a case of a complex externality, in which the actions of one livestock farmer affect the production possibility of others, while at the same time the actions of all livestock farmers adversely affect the quality of the resource, imposing damages to society and social welfare [13]. Of course, both the quality and the quantity of the grazing materials in the pastures are affected by biotic and abiotic environmental factors [14,15]. The prohibition of grazing is widely regarded as a practice of restoration and management of rangelands [16,17]. It is an economic approach to rehabilitation which in practice, excludes animal capital and its harmful activities, taking advantage of the natural resilience of ecosystems to achieve the desired recovery [18–20]. Another relatively more modern way of restoration is the holistic management of rangelands or holistic grazing. Savory Allan, linked relatively early on, the state of rangelands to the economic well-being of farmers who manage these areas, and to their social and psychological well-being. He argued that holistic grazing, which is effectively grazing of separate rotated areas, can increase the production of grassland plants, the ability of soil to retain water, and, in general, can bring the degradation to an end and improve the economic indicators of the pasture [21–23]. However, the viability of rangeland ecosystems depends on both anthropogenic and non-anthropogenic interventions, especially in our time, which is characterized by rapid changes at a global scale. Innovative theories and practices are urgently needed to promote sustainable development of these critical and unique ecosystems of world importance [24].

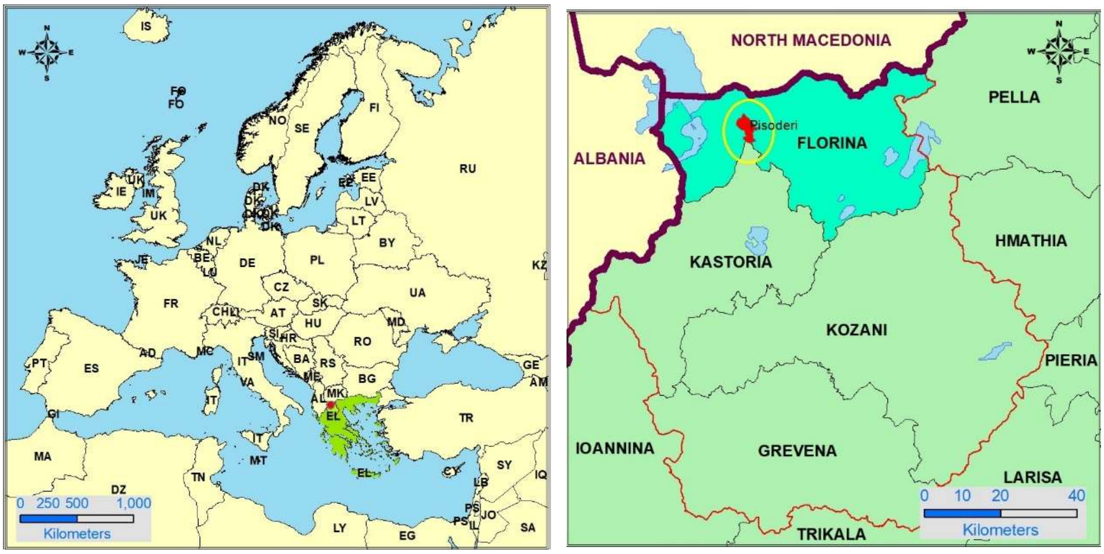
Accurate assessment of forage production methods can be categorized into three types, namely direct measurement by harvesting, statistical determination, and integrated models. The commonly used statistical technique uses remote sensing and ground data to build models and fodder production is estimated with the help of statistical model. The use of modern remote sensing products (satellite images but also drones) in grassland-related studies has increased due to the higher resolution and accuracy they achieve [5,25,26].

This paper aims to compare grazing capacity that is theoretically expected according to the specifications of forest management plans, to the grazing capacity consistent with technical specifications laid down in the new grazing management plans under recent legislation (Law 4264/2014 for temporary management grazing plans, as defined by a Government decision No. 11734 2932/12.12.2014 and published in Greek Government Gazette B 3557/30.12.2014).

2. Materials and Methods

The area under study is the Pisoderion Forest located in Northwest Greece, nearby the city of Florina. The Pisoderion Forest extends on the north-western slopes of Mount Vernon and on the southwestern slopes of Mount Varnounta, the two mountains joining together to form the source of the river Ladopotamos (Pisoderio stream) [16].

A relatively small part (42.6 ha) in the northern side of a NATURA 2000 area belongs to the forest. Another part has been recorded in the Greek habitats of the European CORINE program and has been classified as a Landscape of Special Natural Beauty by the Ministry of Environment and Spatial Planning. One more remarkable habitat is Ladopotamos or Rema Pisoderiou, essential for the mammal Lutra lutra and for the Aquila chrysaetos (Linnaeus, 1758). It is also worth mentioning, that the international trail E6 crosses the Pisoderio forest from North to South and the national road connecting Greece to Albania crosses the forest from West to East direction. A Housing Control Zone is established within the forest and issues regarding a variety of alternative land uses and building construction rules outside the study area are thus resolved [14,27].



Europe - Greece Region of Western Macedonia - Kozani

Figure 1. Orientation map of Pisoderio co-owned forest.

The state of ownership is mixed with about 75 % of the forest being owned by local residents and the remaining 25 % belonging to the Greek State. The forest is managed by a "Rescue Forest Cooperative of Pisoderio" that has been established for this purpose. Hence, the forest map shown in Figure 1, was created as part of the last management plan and depicts the various areas [28]. Moreover, the area measurement of the sections and clusters was carried out in the two most recent management plans using the Geographic Information Systems Software (GIS) and the orthophoto maps of the 'Hellenic Land Registry' that were available at that time. Therefore, the total area of the forest is 2410.88 ha [27,28]. The methodology followed in this paper is to compare the grazing capacity identified by the last two management plans of the forest, that have been compiled according to standard technical specifications of the Ministry of Agriculture to the grazing capacity, which is determined by the temporary management grazing plan under Law 4264/2014 and the more recent specifications.

The depicted areas in each management study differ from the previous one, in terms of the vegetation coverage and soil forms that are recorded, and this is mainly due to the more accurate photo-interpretive classification that has been made possible during its compilation. More specifically, the latest draft shows a 7 % increase in forested area at the expense of grassland (mainly in the higher grounds of the forest), but also the elimination of agricultural land (which is now non-existent throughout the forest) [17]

3. Results and Discussion

With the purpose of determining the grazing conditions in the forest, useful data are gathered from the two recent management plans and more specifically, the areas available for grazing, the grazing capacity and stocking rate. In addition data are compiled on the various types of land available for grazing namely, forest cover, partly forest cover, farms, and barren land.

Regarding the management of small ruminant livestock, according to the Ministry of Rural Development and Food, for the maintenance of a small animal unit (SAU) for example one sheep or goat, the monthly requirements depending on the type of land are, approximately: 5 stremma of forested area, 2 stremma of partly forested area and 0.9 stremma of farm or uncovered areas (1 stremma corresponds to 0.1 ha). The corresponding animal unit equivalent for a Large Animal Unit (LAU) is 5 Small Animal Units (SAU). Due to the mountainous nature of the area, the availability of forage for grazing is limited to 5 months. The grazing capacity fluctuates every year, within the period of the Management Plan, because new grazing prohibition provisions come into force, while, at the same time, past prohibitions expire [27,28].

Grazing exclusion provisions apply for 5 years for sheep, 7 years for large animals and 10 years for goats, unless otherwise stated. Tables are drawn up taking into account all the above restrictions, in order to obtain the annual grazing capacity of the forest for the duration of the study [27,28].In the settlement of Pisoderio, about 500 to 1000 sheep have been declared in the last 20 years. The grazing capacity ranges between 1713 and 1930 small animal units for 5 months [27,28].

Regarding the grazing capacity, as it is determined by the temporary management plan (Law 4264/2014), the available grazing lands in the local community of Pisoderion are shown in Table 1, according to data from the Hellenic Statistical Authority (EL.STAT). The vegetation categories in homogeneous landscape patterns that fall into the class of pastures in the CORINE Land cover system (231, 321, 322, 323, 324, 332 and 333) are transferred (mapped), measured and listed in the same Table 1 [29].

Table 1. Distribution of land uses in the Pisoderio Pasture EL.STAT. and by Corine.

EL.STAT.			**Corine**		
Land use categories	Area, stremma	Percentage, %	Description	Corine Code	Area, stremma
Agricultural land	500	2.7	Land principally occupied by agriculture, with significant areas of natural vegetation	243	1013.9
Pastures	4600	24.9	Broad-leaved forest	311	19,740.5
Forests	13,000	70.3	Natural Pastures	321	1039.5
Other areas	400	2.2	Sclerophyllous vegetation	323	410.9
			Transitional woodland-shrub	324	1903.7
Total	18,500	100	Total		24,108.5

Source: Hellenic Statistical Authority - EL.STAT. and CORINE Land cover system

Another source of information is the Greek Payment Authority of Common Agricultural Policy Aid Schemes (OPEKEPE). The eligible grazing areas from the OPEKEPE cartographic background (in this case ILOTS 2014) are transferred to the map and are measured and listed in Table 2. This procedure is done in such a way that each CORINE vegetation category corresponds to one of the four eligible categories (−37,5−62,5−100) of OPEKEPE. The seven vegetation categories (codes) of CORINE that fall in the class of pastures are classified into four types of rangelands based on the general appearance of the vegetation, as follows: grassland, brushwood, shrubland and forest meadows. In the study area there are mainly two types of rangelands, grassland and forest meadows, which are listed in the same Table 2 [29].

Table 2. Land uses and Eligible Categories in Pisoderio Pasture, according to ILOTS 2014, also types of rangelands

Land uses			**Eligible categories**		**Types of rangelands**	
Land use clusters	COVER ID	Area, stremma	Eligible categories	Area, stremma	Type of rangeland	Area, stremma
Forest	10	8000.7	0	18,739.4	Grassland	5606.9
Forest grazing land 110317	12	15,353.7	37.5	1296.6	Shrublands	592.2

Urban	20	40.4	62.5	494.5	Forest meadows	330.1
Not Pasture at 2003-2007	33	713.7	100	3578	Forest	17,467
					Other	112.3
Total		24,108.5		24,108.5		24,108.5

Grazing capacity is estimated for each type of rangeland, based on an approximation, which relies on the use of bibliography. Attached for this purpose is Table 3 with the grazing capacity of the four types of rangelands found in the mountainous altitude zone to which the area belongs [29].

Table 3. Average production, grazing substance, and grazing capacity of rangelands.

Type of rangeland	**Average production, kg of dry matter/ stremma**	**Grazing substance, kg of dry matter/ stremma**	**Grazing capacity, LAU/acre**		**Average**	
			Range*	**Average**	**stremma/ LAU**	**stremma/ SAU**
Grassland	251–350	125–175	0.42–0.58	0.5	3	0.45
Brushwood	131–180	65–90	0.22–0.30	0.26	5.9	0.88
Shrubland	181–240	117–156	0.39–0.52	0.45	3.1	0.47
Forest meadows	161–220	80–110	0.27–0.37	0.32	4.5	0.67

Note: *The lowest value corresponds to poor site quality (soil depth < 15 cm, transverse slope > 30 %) and the highest value to a site of good quality (soil depth > 30 cm, transverse slope < 15 %).

The estimation of grazing capacity in Table 4 is formed according to the following assumptions: 1) 50 % of total plant growth in the pasture is obtained as forage in the case of grasslands, brushwood and forest meadows, whereas 65% is the corresponding figure in the case of shrublands; 2) The correspondence between one Large Animal Unit (LAU) (mature cow) and a small animal unit (SAU) (sheep or goat) is calculated as follows: 1 LAU = 6.66 SAU or 1 SAU = 0.15 LAU and 3) Daily requirements for forage of a mature cow is estimated at 10 kg of dry matter and the monthly requirements at 300 kg respectively. Daily needs for forage, of a sheep or a goat is estimated at 1.5 kg of dry matter and the corresponding monthly ones at 45 kg. The assessment of grazing capacity in Table 4 is calculated according to the above assumptions and amounts to 3175.59 LAU on average for the whole year.

Table 4. Types of meadows and grazing capacity in the pasture of Pisoderio.

Type of rangeland	**Area, stemma**	**Greece**		**Study area**	
		Grazing capacity, LAU/ stremma	Grazing capacity Total	Grazing capacity, LAU/ stremma	Grazing capacity Total
Forest meadows	330.1	0.32	105.64	0.33	108.94
Brushwood	0	0	0	0	0
Shrublands	592.2	0.45	266.49	0.47	278.33
Grassland	5606.9	0.5	2803.46	0.52	2915.60
TOTAL	6529.2		3175.59		3302.87

The pasture is used within the year depending on the number of months. For example, for 5 months you can graze 661 LAU or 3305 SAU. Overall, as the values in Table 3 reflect average grazing capacity, it would be preferable to use specific local data to calculate the production of forage [29]. From research works and studies that have been done, there are data, but they estimate the grazing capacity by types of habitats. Other studies and works concerning the Regional Unit estimate the grazing capacity by altitude zones or in total [14].

5. Conclusions

The grazing capacity, which is determined by the temporary management grazing plan under Law 4264/2014, is 661 LAU. However, the average grazing capacity determined by the last two management plans is approximately 356 LAU, specifically for grazing 5 months within the year. The conclusion that can be drawn is that the temporary management plan for grazing allows the introduction of about twice the number of animal units compared to the number of animal units allowed by the management study. This difference is certainly not due to a miscalculation. On the contrary, the difference arises from the way in which grazing is determined and, more specifically, the minimum area of rangelands required to cover the diet of one large animal unit.

It is clear that the areas eligible for an aid scheme by OPEKEPE (5369.12 stremma, which is almost all of the area) are much larger compared to Corine's figure and slightly less than the pasture areas, which were identified by photo interpretation in recent aerial photographs and satellite images as well as on-site inspection. The photo-interpretative classification in types of rangelands, performed in the context of Corine and OPEKEPE that relied on recent aerial photographs of the 'Hellenic Land Registry' and satellite images, as well as on-site assessments, indicated the occurrence of significant discrepancies. Regarding the system adopted by OPEKEPE, the occurring divergence in figures is due to the use of a different background year and a different scale of photo interpretation.

Thus effectively, there is no problem of stocking rate in the area under study; on the contrary, the pasture of Pisoderio has been under-utilized in recent years. The vegetation in the rangelands of this area consists mainly of grasses which are better utilized for grazing by both small and large animals. Therefore, the introduction of cattle along with sheep and goats in the area under study, would favor the individual paddocks that are currently being under grazed. In the past, nomadic livestock farming was organized on a mainly family basis and there existed an informal management system for grazing, which was respected by all breeders who used the summer pastures. Nomadic animal husbandry has disappeared, and with it a sense of respect for nature, the meadows and, more generally, the environment. The traditional system of dividing rangelands into paddocks may be thought necessary for a more rational use of pastures and an important element of the holistic management of rangelands.

Livestock farming is an economic and ecological activity, which can be extremely beneficial to the environment and society, as long as economic sustainability is ensured while maintaining and protecting the natural environment. Essential steps for drafting a National Strategy in the field of Livestock Economy are the demarcation of grazing lands, the creation of a spatial inventory of pastures and the estimation of their stocking rate. In addition, it is necessary to carry out a census of the ownership status of grazing lands, to investigate the selectivity of pastures according to the Rural Development Program and to promote appropriate measures for the improvement of pastures. Along these lines, there has been a recent reform in the legislative framework and a final drafting of Management Grazing Plans for the entire country, with the aim of achieving a sustainable economic and ecological management of all pastures.

It is finally concluded that the degradation of grasslands can include their undergrazing which reduces the ecosystem services of grasslands and threatens the production of animal products and environmental security [22,24], with the only benefit being an increase of ecosystem services of forests, due to an increase in their area at the expense of grasslands and biodiversity. Of course, prudent management of grazing could contribute to the richness of meadows and their ecological health, without violating grazing capacity [21,25]. The use of modern technology products, i.e. remote sensing products, satellite images and even aerial photographs could advocate positively for studies related to grasslands and propose solutions for a management that will be sustainable [21,29,30]

Author Contributions: Conceptualization, D.K. and K.M.; methodology, F.C.; validation, S.K., E.F. and E.T.; formal analysis, K.M.; investigation, K.D.; resources, F.C.; data curation, S.K.; writing—original draft preparation, K.K. and E.T.; writing—review and editing, K.K.; visualization, E.L.; supervision, K.M.; project administration, S.K. All authors have read and agreed to the published version of the manuscript.

Funding: This research received no external funding

Institutional Review Board Statement: Not applicable.

Data Availability Statement: Not applicable.

Conflicts of Interest: The authors declare no conflict of interest.

References

1. Ren, Y.; Lü, Y.; Fu, B. Quantifying the impacts of grassland restoration on biodiversity and ecosystem services in China: A meta-analysis. *Ecol. Eng.* **2016**, *95*, 542–550, doi:10.1016/J.ECOLENG.2016.06.082.
2. Melfou, K.; Theocharopoulos, A.; Papanagiotou, E. Total Factor Productivity and Sustainable Agricultural Development. *Econ. Rural Dev.* **2007**, *3*, 32–38.
3. Zhao, H.; Liu, S.; Dong, S.; Su, X.; Wang, X.; Wu, X.; Wu, L.; Zhang, X. Analysis of vegetation change associated with human disturbance using MODIS data on the rangelands of the Qinghai-Tibet Plateau. *Rangel. J.* **2015**, *37*, 77–87, doi:10.1071/RJ14061.
4. Tilman, D.; Reich, P.B.; Knops, J.; Wedin, D.; Mielke, T.; Lehman, C. Diversity and Productivity in a Long-Term Grassland Experiment. *Science (80-.).* **2001**, *294*, 843–845, doi:10.1126/science.1060391.
5. Qu, Y.; Zhao, Y.; Ding, G.; Chi, W.; Gao, G. Spatiotemporal patterns of the forage-livestock balance in the Xilin Gol steppe, China: implications for sustainably utilizing grassland-ecosystem services. *J. Arid Land* **2021**, *13*, 135–151, doi:10.1007/s40333-021-0053-x.
6. Cao, F.; Li, J.; Fu, X.; Wu, G. Impacts of land conversion and management measures on net primary productivity in semi-arid grassland. *Ecosyst. Heal. Sustain.* **2020**, *6*, 1749010, doi:10.1080/20964129.2020.1749010.
7. Gibbs, H.K.; Salmon, J.M. Mapping the world’s degraded lands. *Appl. Geogr.* **2015**, *57*, 12–21, doi:https://doi.org/10.1016/j.apgeog.2014.11.024.
8. Wang, Y.; Wesche, K. Vegetation and soil responses to livestock grazing in Central Asian grasslands: a review of Chinese literature. *Biodivers. Conserv.* **2016**, *25*, 2401–2420, doi:10.1007/s10531-015-1034-1.
9. Atsbha, T.; Belayneh Desta, A.; Zewdu, T. Carbon sequestration potential of natural vegetation under grazing influence in Southern Tigray, Ethiopia: implication for climate change mitigation. *Heliyon* **2019**, *5*, doi:10.1016/j.heliyon.2019.e02329.
10. Zhao, Y.; Wu, J.; He, C.; Ding, G. Linking wind erosion to ecosystem services in drylands: a landscape ecological approach. *Landsc. Ecol.* **2017**, *32*, 2399–2417, doi:10.1007/s10980-017-0585-9.
11. Zhao, M.; Running, S.W. Drought-Induced Reduction in Global Terrestrial Net Primary Production from 2000 Through 2009. *Science (80-.).* **2010**, *329*, 940–943, doi:10.1126/science.1192666.
12. Tabassum-Abbasi; Abbasi, T.; Abbasi, S.A. Reducing the global environmental impact of livestock production: the minilivestock option. *J. Clean. Prod.* **2016**, *112*, 1754–1766, doi:https://doi.org/10.1016/j.jclepro.2015.02.094.
13. Kampas, A.; Melfou, K.; Aftab, A. Designing regulatory policies for complex externalities: the case of agricultural pollution. *Agric. Econ. Rev.* **2013**, *14*, 75–88.
14. Mountousis, I.; Papanikolaou, K.; Stanogias, G.; Chatzitheodoridis, F.; Karalazos, V. Altitudinal chemical composition variations in biomass of rangelands in Northern Greece. *Livest. Res. Rural Dev.* **2006**, *18*.
15. de Aldana, B.R.V.; Ciudad, A.G.; Corona, M.E.P.; Criado, B.G. Nutritional quality of semi-arid grassland in western Spain over a 10- year period: changes in chemical composition of grasses, legumes and forbs. *Grass Forage Sci.* **2000**, *55*, 209–220, doi:10.1046/j.1365-2494.2000.00217.x.

16. Hu, Z.; Li, S.; Guo, Q.; Niu, S.; He, N.; Li, L.; Yu, G. A synthesis of the effect of grazing exclusion on carbon dynamics in grasslands in China. *Glob. Chang. Biol.* **2016**, *22*, 1385–1393, doi:10.1111/gcb.13133.
17. Zhao, J.; Li, X.; Li, R.; Tian, L.; Zhang, T. Effect of grazing exclusion on ecosystem respiration among three different alpine grasslands on the central Tibetan Plateau. *Ecol. Eng.* **2016**, *94*, 599–607, doi:10.1016/J.ECOLENG.2016.06.112.
18. Frank, A.S.K.; Wardle, G.M.; Dickman, C.R.; Greenville, A.C. Habitat- and rainfall-dependent biodiversity responses to cattle removal in an arid woodland–grassland environment. *Ecol. Appl.* **2014**, *24*, 2013–2028, doi:10.1890/13-2244.1.
19. Su, H.; Liu, W.; Xu, H.; Wang, Z.; Zhang, H.; Hu, H.; Li, Y. Long-term livestock exclusion facilitates native woody plant encroachment in a sandy semiarid rangeland. *Ecol. Evol.* **2015**, *5*, 2445–2456, doi:10.1002/ece3.1531.
20. Tang, J.; Davy, A.J.; Jiang, D.; Musa, A.; Wu, D.; Wang, Y.; Miao, C. Effects of excluding grazing on the vegetation and soils of degraded sparse-elm grassland in the Horqin Sandy Land, China. *Agric. Ecosyst. Environ.* **2016**, *235*, 340–348, doi:10.1016/J.AGEE.2016.11.005.
21. Savory, A.; Butterfield, J. *Holistic Management, Third Edition: A Commonsense Revolution to Restore Our Environment*; Third.; Island Press, 2016; ISBN 9781610917438.
22. Savory, A.; Butterfield, J. *Holistic management : a new framework for decision making*; 2nd ed.; Island Press: Washington, DC 20009, 1999; ISBN 155963488X.
23. Gosnell, H.; Grimm, K.; Goldstein, B.E. A half century of Holistic Management: what does the evidence reveal? *Agric. Human Values* **2020**, *37*, 849–867, doi:10.1007/s10460-020-10016-w.
24. Dong, S.; Shang, Z.; Gao, J.; Boone, R.B. Enhancing sustainability of grassland ecosystems through ecological restoration and grazing management in an era of climate change on Qinghai-Tibetan Plateau. *Agric. Ecosyst. Environ.* **2020**, *287*, 106684, doi:10.1016/J.AGEE.2019.106684.
25. Yu, M.; Ellis, J.E.; Epstein, H.E. Regional Analysis of Climate, Primary Production, and Livestock Density in Inner Mongolia. *J. Environ. Qual.* **2004**, *33*, 1675–1681, doi:https://doi.org/10.2134/jeq2004.1675.
26. Oñatibia, G.R.; Aguiar, M.R. Grasses and grazers in arid rangelands: Impact of sheep management on forage and non-forage grass populations. *J. Environ. Manage.* **2019**, *235*, 42–50, doi:https://doi.org/10.1016/j.jenvman.2019.01.037.
27. Kalfas, D.; Karantzidis, N. *Forest Management Study (Report) of Co-owned Pisoderio Forest for the decade 2006 - 2015 (in Greek)*; Florina, 2006;
28. Lagkas, T. *Forest Management Study (Report) of Co-owned Pisoderio Forest for the decade 2016 - 2025 (in Greek)*; Thessaloniki, 2016;
29. Lagkas, T.; Zagkas, D. *Temporary Management Plan for grazing, Co-Owned Forest of Pisoderi (in Greek)*; Thessaloniki, 2015;