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Economic Sustainability vs. Environmental Sustainability: An Animal Crisis in the Middle Ages

Two fundamental assumptions have emerged from the debate on historical forms of sustainability: that environmental sustainability in rural areas and especially in mountainous regions depended on the preservation of traditional practices, and that the ability of medieval societies to establish sustainable relationships with the environment is attributable to medieval ideologies. The late medieval central Alps, particularly the upper Valtellina valley, invite a reconsideration of both claims.

After 1300, the Alpine environment underwent intense transformation, and, far from safeguarding traditional or age-old practices, Alpine communities participated in a process that can aptly be described as commodification, given the extensive evidence for growing connectivity within and beyond the Alps. In other words, natural resources were transformed into consumer goods that could be traded on a large scale in Europe and the Mediterranean. This transformation required the rationalization of resource use in ways comparable to developments in urban areas during the same period. Alpine communities did develop lasting forms of environmental exploitation, but such forms coincided with a turning point and, to a large extent, a deterioration of ecological relations, since they implied a conception of the environment as a set of resources to be selected and deployed for economic purposes. These transformations had dramatic and disruptive consequences for animal species, both domestic and wild.

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The author thanks Daniel L. Smail, Paolo Buffo, Massimo Della Misericordia, Licia Colli, Luca Pedrotti, Emilio Martín Gutierrez, and Enrico Santus for their critical remarks and suggestions.

The disruption of ecological relationships, the systematic hunting of large carnivores, the intensive exploitation of farm animals, and the first recorded appearance of epizootic diseases make it possible to identify a significant decline in animal welfare, and thus to apply the concept of an “animal crisis.”¹

THE PENETRATION OF THE CONCEPT OF SUSTAINABILITY INTO HISTORICAL RESEARCH The concept of sustainability has been deployed in ways that are profoundly inconsistent and that remain linked to the idea of the environment’s functionality with respect to human economies. The concept emerged in the 1970s with the rise of

1 For the perspective of local history as a method for the “historical identification of practices related to the deployment of environmental resources” (with a reflection on the paths followed in Italian and English historiography and geography), see Diego Moreno, “Appunti dal terreno: Storia locale, storia territoriale ed ecologia storica,” in Renato Bordone et al. (eds.), *Lo spazio politico locale in età medievale, moderna e contemporanea* (Alessandria, 2007), 313–328. Regarding the processes of commercialization and commodification in the late Middle Ages, see Katherine Anne Wilson, “Commerce and Consumers: The Ubiquitous Chest in the Late Middle Ages,” *Journal of Interdisciplinary History*, LI (2021), 377–404, esp. 381–383. For an overview of the situation in the late Middle Ages, see Daniel Lord Smail, *Legal Plunder: Households and Debt Collection in Late Medieval Europe* (Cambridge, MA, 2016), 12–19. The issue of ecological risk in the commodification of nature and ecosystem services in the contemporary world has been addressed by Douglas J. McCauley, “Selling Out on Nature,” *Nature*, CDXLIII (2006), 27–28; Erik Gómez-Baggethun and Manuel Ruiz-Pérez, “Economic Valuation and the Commodification of Ecosystem Services,” *Progress in Physical Geography: Earth and Environment*, XXXV (2011), 613–628; for a discussion of the economic concept of commodification, starting with Karl Marx, see *ibid.*, 619–622. Joëlle Burnouf et al., “Sociétés, milieux, ressources: Un nouveau paradigme pour les médiévistes,” in Société des historiens médiévistes de l’Enseignement supérieur public (ed.), *Être historien du Moyen Âge au XXI^e siècle* (Paris, 2008), 95–132. The commodification processes affecting the medieval Alps present similarities with what studies on the history of globalization have shown, namely that globalization processes entail an unequal ecological exchange between central and peripheral areas. See Alf Hornborg, John R. McNeill, and Joan Martinez-Alier (eds.), *Rethinking Environmental History: World-System History and Global Environmental Change* (Lanham, 2007). A comprehensive overview of these phenomena from the point of view of environmental history is arguably lacking. Among the most detailed reflections on urban areas, with an explicit focus on the relationship between connectivity and environmental history, see Emilio Martín Gutiérrez, “Reflexiones en torno a los paisajes bajo-medievales: Algunos ejemplos andaluces,” in *idem* (ed.), *El pasaje rural en Andalucía Occidental durante los siglos bajomedievales* (Cádiz, 2011), 31–51. The topic of the transformation of the environment into a resource and thus of “resource production” lies at the center of contemporary reflections on environmental history, including as a fundamental aspect for the interpretation of the Anthropocene. See Jason W. Moore, “The Capitalocene, Part I: On the Nature and Origins of Our Ecological Crisis,” *Journal of Peasant Studies*, XLIV (2017), 594–630; and *idem*, “The Capitalocene, Part II: Accumulation by Appropriation and the Centrality of Unpaid Work/Energy,” *Journal of Peasant Studies*, XLV (2018), 237–279.

environmental studies. Meadows et al., who introduced the term in 1972, identified exponential population and economic growth as a threat to the planet's environment and biodiversity, a threat that could only be averted by implementing "growth-regulating policies of the previous run to produce an equilibrium state sustainable far into the future." In the same year, the first United Nations Conference on the Environment implicitly promoted an initial definition of the concept of sustainability by asserting future generations' right to environmental resources.²

These texts have played a fundamental role in shaping a new sensitivity toward the environment, but they have also favored an anthropocentric interpretation of sustainability. This concept was understood entirely in economic terms as the durability of a natural resource in the service of economic development. The economic dimension of sustainability is also prevalent in the European Landscape Convention promoted by the Council of Europe. In the text of the Convention itself, the concept of sustainability was used on only three occasions, each time in adjectival form—"sustainable"—twice in tandem with "development" and once with "protection." In short, even the European Convention formulated the idea of sustainability in essentially economic terms.

Through progress made in environmental science, the concept of sustainability has come to mean something entirely different, namely the stability of an ecosystem's balance. As far back as 1980, another policy, promoted by the International Union for Conservation of Nature and Natural Resources with support from leading international organizations (such as UNEP, FAO, WWF, and UNESCO), identified the main objective of "sustainable development" as "the maintenance of essential ecological processes and life-support systems, the preservation of genetic diversity, and

2 "It is possible to alter this growth and to establish a condition of ecological and economic stability that is sustainable far into the future." Donella H. Meadows et al., *The Limits to Growth* (New York, 1972), 24, 165. "The natural resources of the earth, including the air, water, land, flora and fauna and especially representative samples of natural ecosystems, must be safeguarded for the benefit of present and future generations through careful planning or management, as appropriate." *Declaration of the United Nations Conference on the Human Environment* (Stockholm, 1972). In 1987, the United Nations Brundtland Commission defined sustainability as "meeting the needs of the present without compromising the ability of future generations to meet their own needs." This definition is still in use in the organization's documents; see United Nations, *Our Common Future: Report of the World Commission on Environment and Development*, 1987, 3.27.

the sustainable utilization of species and ecosystems.” In this way, sustainability no longer concerns only individual environmental resources for economic use, but also the preservation of ecological processes and biodiversity.³

The authors of these early policy documents generally preferred the term *sustainable* over *sustainability*. They usually associated it with “economic development” or “growth” and primarily employed it in the sense of “durable,” which is closer to the French concept of *durabilité*. The concept of sustainability as the overall balance of the ecosystem in all its biological components (as opposed to the preservation of a set of resources for economic purposes), promoted by the environmental sciences, has not replaced earlier definitions. On the contrary, several notions of sustainability have emerged over the years, covering not only the economic and environmental sphere but also the social one, making it difficult to frame the concept in univocal terms. Indeed, as early as 1987, Barbier noted that “the concept of sustainable economic development is a difficult one to grasp analytically. Given that one is attempting to describe the environmental, economic, and social, features of an ongoing process, the difficulty lies in arriving at a universally acceptable definition that is also analytically precise.”⁴

On the whole, the concept of sustainability has entered historiographical, and particularly medievalist, thinking mainly in an economic sense. Two recent monographs have investigated medieval sustainability by examining forms of production in light of the ideal principles that shaped medieval thought (starting from the monastic ideal). Kehnel has reflected on the adoption of sustainable practices in medieval societies across areas of production based on the development of a circular economy, proposing the medieval economy as a model for contemporary times.⁵ Arnoux has

3 International Union for Conservation of Nature and Natural Resources, *World Conservation Strategy: Living Resource Conservation for Sustainable Development* (Gland, 1980), chap. 20.

4 On *durabilité* and sustainability, see also Mathieu Arnoux, *Un monde sans ressources: Besoins et société en Europe (XI^e–XIV^e siècles)* (Paris, 2023), 320. Edward B. Barbier, “The Concept of Sustainable Economic Development,” *Environmental Conservation*, LXXXVI (1987), 101. On the ambiguity of the concepts of sustainability and sustainable development, see also Dale Jamieson, “Sustainability and Beyond,” *Ecological Economics*, XXIV (1998), 183–192; Paul B. Thompson, “Agricultural Sustainability: What It Is and What It Is Not,” *International Journal of Agricultural Sustainability*, V (2007), 5–16.

5 Annette Kehnel (trans. Gesche Ipsen), *The Green Ages: Medieval Innovations in Sustainability* (London, 2024; orig. pub. 2021).

reconstructed the functioning of the early medieval economic system, which, according to him, was based on the exploitation of renewable resources even before the development of the concept of resources as “ensemble des biens généralement disponibles.” Despite their differing perspectives, these wide-ranging studies of medieval civilization propose an interpretation of medieval sustainability that is primarily based on the ability to meet human needs in a durable manner.⁶

There are deep-rooted reasons why environmental history continues to link sustainability with economic development and resource exploitation. Indeed, historical studies reflected on the consumption of natural resources long before the development of the concept of sustainability, beginning in the history of agriculture. In this field, one of the areas traditionally used by medievalists to measure economic growth, sustainability has been understood first and foremost as the maintenance of a stable agricultural production capacity over time. These aspects have been of interest to historians since the mid-nineteenth century, when the chemist von Liebig linked soil erosion to the end of Classical civilizations, and have become central to medieval studies, especially since Postan’s thesis on the overexploitation of land in the thirteenth and early fourteenth centuries.⁷

Since the 1990s, medieval and early modern scholarship has made explicit reference to the sustainability issues also in the field of the history of the commons and forest resources. Research in these fields has taken up Ostrom’s neo-institutional thesis concerning the role of rules and forms of management with respect to the commons’ sustainability. In recent years, not least because of the relevance of the topic in contemporary society, the study of

6 Arnoux, *Un monde sans ressources*, 16. A fundamental study of the medieval concept of resources—closer to the concept of needs (*besoins*)—Arnoux’s analysis recalls Sombart’s ideas about precapitalist societies devoted to the satisfaction of life’s needs (*Der modern Kapitalismus*), though it relies mainly on literary texts and on texts with a markedly idealistic character and gives less space to local societies’ awareness of resource exhaustibility.

7 On this debate, see Antonio Saltini, “Chimica agraria tra storiografia, geografia economica e ideologia politica,” *Rivista di storia dell’agricoltura*, XLII (2002), 139–189. Von Liebig’s thesis was taken up in George Perkins Marsh, *Man and Nature* (Seattle, 2003; orig. pub. 1864), 7–13. Michael M. Postan, “The Fifteenth Century,” *Economic History Review*, IX (1939), 160–167; *idem*, “Some Economic Consequences of a Declining Population,” *Economic History Review*, II (1950), 221–247. See Richard C. Hoffmann, *An Environmental History of Medieval Europe* (Cambridge, 2014), 158–168. Jules N. Pretty, “Sustainable Agriculture in the Middle Ages: The English Manor,” *Agricultural History Review*, XXXVIII (1990), 1–19.

sustainability through the commons has been made the focus of some research in the field of medieval societies.⁸

With regard to forest resource management, a neo-institutionalist approach also characterizes the research of Appuhn, who in relation to the period between the late Middle Ages and the modern age has highlighted “how institutional growth and the attendant increase in central control affected access to critical natural resources and the ability (or, more often, inability) to create a sustainable system for the allocation and renewal of those resources.” In other words, he has reconstructed the existence of a debate within the modern state (in this case Venice) concerning the sustainability of the use of environmental resources. As summarized in a recent overview, “according to the neo-institutional approach, the research about forest resources rooted in the current environmental problem of de-forestation emphasizes the intrinsic sustainability of the traditional management method, while demonstrating the flaws in an indiscriminate market-driven management that eventually results in resource depletion.”⁹

Some research has moved beyond this economic perspective, touching upon the environmental dimension of sustainability. Starting with the study of traditional agricultural techniques, a stimulating interdisciplinary dialogue has been initiated by

8 Martina De Moor, Leigh Shaw-Taylor, and Paul Warde (eds.), *The Management of Common Land in North West Europe, c. 1500–1850* (Turnhout, 2002). For the development of the economic debate since the 1960s, see Garrett Hardin, “The Tragedy of the Commons,” *Science*, CLXII (1968), 1243–1248; Carol Rose, “The Comedy of the Commons: Custom, Commerce and Inherently Public Property,” *University of Chicago Law Review*, LIII (1986), 711–781; Elinor Ostrom, *Governing the Commons: The Evolution of Institutions for Collective Action* (Cambridge, 1990). On this debate, see Fabien Locher, “Les pâturages de la guerre froide: Garrett Hardin et la ‘tragédie des communs,’” in *Revue d'Histoire Moderne et Contemporaine*, LX (2013), 7–36; Alice Ingold, “Commons and Environmental Regulation in History: The Water Commons Beyond Property and Sovereignty,” *Theoretical Inquiries in Law*, XIX (2018), 425–456; for the use of the concept of sustainability, see Angus J. L. Winchester, “Upland Commons in Northern England,” in De Moor, Warde, and Shaw-Taylor (eds.), *The Management of Common Land*, 33–57, esp. 52–55; Stefan Brakensiek, *The Management of Common Land in North-Western Germany*, 238–240; Esther Pascua Echegaray, “Communities and Sustainability in Medieval and Early Modern Aragon, 1200–1600,” *International Journal of the Commons*, V (2011), 535–556; Maika De Keyzer, *Inclusive Commons and the Sustainability of Peasant Communities in the Medieval Low Countries* (London, 2018).

9 Karl Appuhn, “Inventing Nature: Forests, Forestry, and State Power in Renaissance Venice,” *Journal of Modern History*, LXXII (2000), 864; *idem*, *A Forest on the Sea: Environmental Expertise in Renaissance Venice* (Baltimore, 2009), 9–10, 74–80, 97–124; Giacomo Bonan and Claudio Lorenzini, “Common Forest, Private Timber: Managing the Commons in the Italian Alps,” *Journal of Interdisciplinary History*, LII (2021), 3.

paleoecologists, who, by broadening the focus from cultivated soils to the complex relationship with uncultivated land and forests, have highlighted the overall durability and stability of historical agro-sylvo-pastoral systems. In contrast to historical-economic studies on sustainability, research in historical ecology has enabled a perspective that is not exclusively anthropocentric, despite focusing primarily on the plant world—a perspective that, starting with Rackham's research on English woodlands, has proven capable of grasping the complexity of ecosystem relationships. On the whole, the hallmark of these paleoecological studies has been the adoption of a diachronic approach, which identifies a significant break in nineteenth- and twentieth-century transformations and in the crisis of peasant societies in the face of industrialization.¹⁰

In Italy in particular, Moreno's geohistorical research, firmly framed within a microhistorical and territorialist perspective (referring to two of the most important cultural currents in Italy in the second half of the twentieth century), envisaged biodiversity as the historical product of rural societies in the preindustrial period, highlighting the substantial equilibrium of the ecosystems in which these societies operated. This current of studies sees the "historical production and activation practices adopted in local environmental resource management systems" as a "determining factor for biodiversification"; in other words, the use of resources by rural societies does not destroy biodiversity, but creates it, as part of a process of coevolution between rural societies and the environment.¹¹

Medievalists have also introduced the environmental perspective into the concept of sustainability. Research on environmental disasters and resilience, conducted especially in northern Europe, has prompted reflection on human interactions with the environment. According to these studies, the presence of egalitarian forms of socioeconomic organization enabled a more effective adaptation of ecosystems. Since the early 2000s, the marked development of the debate on wetlands—particularly delicate ecosystems in need

10 See Oliver Rackham, *Trees and Woodland in the British Landscape: The Complete History of Britain's Trees, Woods and Hedgerows* (London, 1976). On the development of the concept of historical ecology within Italian historiography, see Moreno, "Uscire dal paesaggio: Il contributo della ecologia storica e della storia locale," in Marina De Marchi, Mirella Scudellari, and Antonio Zavaglia (eds.), *Lo spessore storico in urbanistica* (Mantua, 2001), 85–87.

11 Massimo Quaini, Moreno, and Roberta Cevasco, "Fra utopie ed eterotopie: quale spazio per una 'storia territorialista' della montagna?" *Scienze del territorio*, IV (2016), 36. All translations from Italian are the author's.

of protection—has further stimulated the debate on sustainability in relation to those environments. In more general terms, Hoffmann recommends interpreting the sustainability of medieval societies as “a dynamic equilibrium between human activities in nature and the ability of the natural system to respond to those activities.” Even in this perspective, however, sustainability is invariably understood in terms of the “human demand” for the “resources” found in the “natural world.”¹²

In short, historiography tends to blend the economic and environmental concepts of sustainability in an ambiguous interplay. The debate on sustainability has failed to move beyond the functional, economic relationship between man and resources. Admittedly, recent studies in environmental history that refer to this concept have been purged of the unconsciously anthropocentric traits that still characterize studies published in the last century; they instead recognize humanity “as an integral part of the ecosystem.” However, this perspective continues to be focused above all on the ability of past societies to construct lasting

12 Bas van Bavel and Erik Thoen (eds.), *Rural Societies and Environments at Risk: Ecology, Property Rights and Social Organization in Fragile Areas (Middle Ages–Twentieth Century)* (Turnmouth, 2013), 15–42; Tim Soens, “Flood Security in the Medieval and Early Modern North Sea Area: A Question of Entitlement?” *Environment and History*, XIX (2013), 209–232; *idem*, “Resilient Societies, Vulnerable People: Coping with North Sea Floods Before 1800,” *Past & Present*, 241 (2018), 143–177; van Bavel et al., *Disasters and History: The Vulnerability and Resilience of Past Societies* (Cambridge, 2020), 3–4; Corinne Beck, Jean-Michel Derex, and Alain Gallicé (eds.), *Les zones humides européennes: Espaces productifs d’hier et d’aujourd’hui* (Cordemais, 2007); Derex, “L’histoire des zones humides: état des lieux,” *Études rurales*, CLXXVII (2006), 167–178; Jean-Loup Abbé and Madeleine Ferrières (eds.), “Étangs et marais : Les sociétés méridionales et les milieux humides, de la protohistoire au XIX^e siècle,” *Annales du Midi*, CCLVII (2007), 5–10; Abbé, *À la conquête des étangs: L’aménagement de l’espace en Languedoc méditerranéen (XII^e–XV^e siècle)* (Paris, 2006), 11–23. For Italy, see Dario Canzian and Remi Simonetti, *Acque e territorio nel Veneto medievale* (Rome, 2012). On Iberia, see Gutiérrez, “Interacción sociedad medio ambiente: El entorno de la laguna de los Tollos (Andalucía Occidental), Siglos XIII al XV,” *Studia Historica: Historia Medieval*, XXXII (2014), 103–130; *idem*, “Los Paisajes costeros interpretados desde la riparia: Reflexiones sobre el Golfo de Cádiz a finales de la Edad Media,” *Riparia*, II (2019), 47–79. See also Julián Clemente Ramos and Gutiérrez, “I paesaggi d’acqua e le loro utilizzazioni nella Spagna sudoccidentale tra il tredicesimo e il sedicesimo secolo,” in Giampiero Nigro (ed.), *Gestione dell’acqua in Europa (XII–XVIII Secc.) / Water Management in Europe (12th–18th Centuries)* (Florence, 2018), 41–61; Antoni Furió, “I paesaggi dell’acqua nella Spagna mediterranea: Le huertas e l’agricoltura irrigua,” in *I paesaggi agrari d’Europa (secoli XIII–XV)* (Rome, 2015), 323–384; for northern Europe, see Stephen Rippon, *The Transformation of Coastal Wetlands: Exploitation and Management of Marshland Landscapes in North West Europe during the Roman and Medieval Periods* (Oxford, 2000); Piet H. Nienhuis, *Environmental History of the Rhine-Meuse Delta: An Ecological Story on Evolving Human-Environmental Relations Coping with Climate Change and Sea-Level Rise* (Berlin, 2008); Hoffmann, *An Environmental History of Medieval Europe*, 156.

forms of access to environmental resources, rather than on the rights of the environment. In particular, the animal world is a neglected subject in studies of the history of sustainability; the intensive exploitation of domestic animals on the one hand and the elimination of wild animals on the other clearly constitute an aspect of past societies that is difficult to reconcile with the concept of sustainability. Studies of sustainability have thus escaped the “animal turn,” which in many disciplines has “suggested new relationships between scholars and their subjects, and new understandings of the role of animals in the past and at present.”¹³

The economic perspective, much like the environmental one, explores the need to establish a balance or equilibrium, arguably the key concept for underlying sustainability. It must be acknowledged that humanity is not external to the environment but fully embedded in it; the issue of use, including the economic use of resources, is fully legitimate and indeed fundamental. It is, however, reasonable to wonder whether the traumatic process of transforming ecosystems into resources suitable for economic exploitation is not being left in the shadows in the study of historical sustainability practices.

Especially in the historical periods of greatest economic growth, the withdrawal of such resources has entailed a decisive reorganization of the environment as a whole. The very use of categories such as tradition or traditional agricultural techniques risks not only idealizing the relationships that past societies created with the environment, but also crystallizing and immobilizing the historical ecosystem by concealing its phases of change. This tendency is particularly true for the Alpine world, where research on historical societies is mostly indebted to the theses of Netting, the American anthropologist, whose idea of the crystallization of Alpine societies in a relationship of durable equilibrium in the exploitation of environmental resources tends to exaggerate the mountain environment’s geographical determinism.¹⁴

13 Ella Hermon, “The Diachronic Evolution of Environmental Concepts on Both Sides of the Atlantic: The Construction of the Riparia Concept as a Cultural Heritage,” *Riparia*, I (2015), 4. This study is an informed reflection on the differing evolution of environmental history between North America and Europe; Harriet Ritvo, “On the Animal Turn,” *Daedalus*, CXXVI (2007), 118–122, 119.

14 See Robert McC. Netting, *Balancing on the Alps: Ecological Change and Continuity in a Swiss Mountain Community* (Cambridge, 1981); for Netting’s criteria for defining sustainable agriculture as stable production, see *idem*, *Smallholders, Householders: Farm Families and the Ecology of Intensive, Sustainable Agriculture* (Stanford, 1993), 136.

Fig. 1 Map of the Valtellina Valley



By focusing on the case of the upper Valtellina, I argue that environmental changes in the late medieval Alps created a system of sustainable—that is, enduring—management of natural resources. This system, however, far from considering the rights of the environment, and particularly of animals, was based on their exploitation in intensive forms or their elimination.¹⁵

CLIMATE VARIABILITY The Valtellina is a wide, populous valley, 120 km long, that stretches from the source of the Adda River to Lake Como (see Fig. 1). Vineyards are cultivated in the lower and middle valleys, and the upper valley takes on the characteristics of high-altitude mountains. In the Middle Ages, the valley was the link between the cities of Lombardy (Milan, Como, Brescia, and Bergamo) and German-speaking areas (the county of Tyrol, the diocese of Chur, and the cities of the Rhine valley). The upper Valtellina (the Bormio area) is particularly well documented thanks to community decisions (such as statutes and resolutions)

15 For a historical perspective on animal rights, see Aliénor Bertrand et al., “Introduction,” in Pierre Serna et al. (eds.), *Dictionnaire historique et critique des animaux* (Paris, 2024), 5–15.

and by notarial registers. The former body of sources documents the transformation of the community's representative institutions as far back as the thirteenth century, illustrating in detail the management measures taken, especially from the early fourteenth century onward. The latter, by contrast, is only available from the fifteenth century onward for this area.

Although it is generally true that average temperatures in Europe were lower between 1250 and 1850—the period commonly known as the Little Ice Age—it is important not to overlook temperature variability within this broader trend. Following a low point around 1350, average summer temperatures remained relatively mild, albeit with high variability, before dropping sharply around 1500. Many of the sustainability strategies described in this article were developed during this phase of variability (1350–1500), which was characterized by a relatively mild climatic phase and the retreat of glaciers in the Alpine region. Written sources also provide evidence of this variability, with climatic indicators pointing to higher temperatures compared to the second half of the sixteenth century. For example, until the early 1500s cattle were taken to pasture in May; after that period, in June. Archaeobotanical samples point to the cultivation in the late Middle Ages of cereals at high altitudes, up to 2,000 m. In the Alps, the expansion of anthropogenic activities probably also targeted areas that would have been less accessible in the colder 1250–1350 phase, with the anthropization of Alpine space extending to the highest altitudes. Significantly, the names of the upper Valtellina's peaks, such as Mounts Platorre, Confinale, Sobretta, and Cevedale, also begin to appear in the written record in this period.¹⁶

16 In general, see Jürg Luterbacher *et al.*, “European Summer Temperatures since Roman Times,” *Environmental Research Letters*, XI (2016). On the early medieval period, see Michael McCormick *et al.*, “Climate Change during and after the Roman Empire: Reconstructing the Past from Scientific and Historical Evidence,” *Journal of Interdisciplinary History*, XLIII (2012), 169–220; for an overview, see Paolo Nanni, “Per un quadro ambientale e biologico: Il periodo caldo medievale e la variabilità climatica,” in *La crescita economica dell'Occidente medievale: Un tema storico non ancora esaurito* (Pistoia, 2017), 69–91, esp. 78–79; for methodological problems related to the analysis of the data, see Fredrik Charpentier Ljungqvist, Andrea Seim, and Heli Huhtamaa, “Climate and Society in European History,” *Wiley Interdisciplinary Reviews: Climate Change*, XII (2021), available at <https://doi.org/10.1002/wcc.691>; Adam Izdebski *et al.*, “Realising Consilience: How Better Communication Between Archaeologists, Historians and Natural Scientists Can Transform the Study of Past Climate Change in the Mediterranean,” *Quaternary Science Reviews*, CXXXVI (2016), 5–22; for a review of many contributions on climate history (and environmental history more generally), see Steven A.

With the documentation from the upper Valtellina, it is difficult to establish a cause-and-effect relationship between the decisions taken by local communities and the specific climatic conditions of the period. The many measures taken, from the spring clearing of high mountain paths to the funding of rescue operations to save people trapped in the snow, seem to indicate first and foremost a growing collective capacity to manage environmental risks in the face of negative and often exceptional weather phenomena. Yet there is evidence that the commune's environmental policies also benefited from a relatively mild climatic phase. The Stelvio road was opened in the second half of the fifteenth century, taking advantage of the highest pass in the area (2,758 m). It was used continuously, even in winter and spring, and was maintained in the last quarter of the century; this route was less traveled in the modern age, at least until the present Stelvio road was built between 1820 and 1825.¹⁷

Similarly, the tendency, even at the end of the fifteenth century, to extend the high-altitude pastures leased via public auction seems to me to be a good indication of the absence of the kind of serious abandonment of such pastures which resulted from the Little Ice Age.¹⁸ The documentary sources provide no clear evidence of the deforestation of wooded slopes in order to create new pastures (due to the impracticability of higher mountain

Epstein, "Environmental History in the JIH, 1970–2020," *Journal of Interdisciplinary History*, L (2019), 213–236; for a historiographical review of climate history, increasingly characterized by a "broader transdisciplinary convergence that brings the power of science to bear on the human past," see McCormick, "Climates of History, Histories of Climate: From History to Archaeoscience," *Journal of Interdisciplinary History*, L (2019), 3–30; Giuseppe Berruti, *Clima e comunità alpine: L'alta valle Canonica e l'alta Valle Trompia tra il XIV e il XIX secolo* (Brescia, 1978), 16–17; Stefania Casini et al., "Piani di Sasso, un insediamento medievale nell'ambiente subalpino orobico: Studio comparativo di archivi naturali, archeologici e storici," in Gian Piero Brogiolo, Giosuè Bonetti, and Matteo Rabaglio (eds.), *Ricerche sulle comunità rurali del Bergamasco tra tardo antico e alto medioevo* (Bergamo, 2022), 152.

17 For example, spring snowfall is documented by the Archivio storico del Comune di Bormio (hereinafter ASCB), *Dati e ricevuti*, I (1492). A rescue mission was financed by the commune on March 26, 1499, to search for people buried by an avalanche in the Umbrail Valley; *ibid.*, 1499, March 26; for documentation concerning the opening of this path, see ASCB, *Dati e ricevuti*, I (1485), February 21; see also Ilario Silvestri, *Le strade dell'Umbrail e dello Stelvio dal Medioevo al 1900* (Bormio, 2001), 30–35. The Stelvio is not a unique case of the opening of Alpine paths at very high altitudes in these years; in 1478 the Marquis of Saluzzo opened the "Viso hole" on Monviso (2,860 m).

18 For example, ASCB, *Statuta seu leges municipales communis Bormii*, chap. 305, *de alpis comunis afflictandis*; the provision refers to particularly high alpine pastures, such as those of Forni (near the glacier of the same name, at 2,600–3,600 m), Forcola, and Vallaccia (2,614 m).

pastures), as found in the upper Valtellina's documentation from later centuries.¹⁹

THE ENVIRONMENT AS A RESOURCE The environment of this valley in the central Alps was profoundly altered during the last centuries of the Middle Ages, a time when the mountain economy experienced a sharp acceleration in production and became firmly integrated into broader trade networks. At the same time, chains of production linked to the exploitation of Alpine environmental resources were established. Ironmaking in particular underwent major development in the late Middle Ages, as Arnoux has shown. The Valtellina iron industry fueled metalworking in Lombardy—particularly the Milan area—the product of which was traded on a large scale in Europe and throughout the Mediterranean. Locally produced wool, timber, and cheese, as well as wine from the lower and middle Valtellina area, were traded and directed toward the markets in Lombardy and transalpine cities through the mediation of merchants from Como. By the late medieval period, the upper Valtellina was fully integrated into regional and nonlocal economic and trade networks, as demonstrated for example by the discovery in Bormio of fifteenth-century Egyptian and Syrian ceramics. This high mountain area thus became an area of intense anthropization and connectivity.²⁰

19 For example, in the upper Malenco Valley over the course of the seventeenth century, see Archivio del comune di Chiesa Valmalenco, I.18., February 4, 1609; *ibid.*, I.30, January 4, 1646.

20 Criticism of isolationist readings of the mountains has been well established since the studies by Jean-François Bergier, "Le cycle médiéval: Des sociétés féodales aux états territoriaux," in Paul Guichonnet (ed.), *Histoire et civilisation des Alpes* (Toulouse, 1980), 163–264. Less attention has been paid to the impact of these transformations on the late-medieval Alpine environment; Arnoux, "Innovation technique, intervention publique et organisation du marché: Aux origines du district sidérurgique de la Valteline (XIII^e–XIV^e siècles)," in Philippe Braunstein (ed.), *La Sidérurgie alpine en Italie (12^e–17^e siècles)* (Rome 2001), 215–251; on the development of steelmaking in this area more generally, see Paolo De Vingo (ed.), *Le Radici della Terra: Le miniere orobiche valtelinesi: da risorsa economica a patrimonio culturale delle Comunità tra medioevo ed età contemporanea* (Milan, 2021); on the Bergamasque Alps as a whole, see François Menant, "Pour une histoire médiévale de l'entreprise minière en Lombardie," *Annales*, XLII (1987), 779–796; on the iron trade in Europe and the Mediterranean, see Luciana Frangioni, *Milano fine Trecento: Il carteggio dell'Archivio Datini di Prato* (Firenze, 1994), I, 244–252; for an overview of economic activities in the Valtellina and Val Camonica, see Massimo Della Misericordia, "Consuetudine, contratto, lucro individuale, uso domestico. Elementi per un'analisi degli ideali economici: La montagna lombarda nel basso medioevo," *Bollettino storico dell'Alta Valtellina*, XIV (2011), 133–188; *idem*, *I nodi della rete: Paesaggio, società e istituzioni a Dalegno e in Valcamonica nel Medioevo* (Morbegno, 2012); *idem*, "I confini

The development of highly specialized chains of production had a profound impact on the Alpine environment, which was beginning to be conceptualized and managed as a set of resources to be deployed depending on production needs. The late medieval sequences of the two paleobotanical analyses published so far for the Valtellina area both show a high concentration of charcoal—the highest prior to the contemporary age—in connection with extensive deforestation and an increase in grazing areas.²¹

Forests and meadows were regarded as areas open to intensive exploitation, as can be inferred from the earliest notarial cartularies preserved in Bormio, starting in the 1420s. In addition to timber for construction, forests were exploited above all for the production of charcoal; during the winter season, the owners of forges and furnaces would usually reach an agreement with coalmen (often immigrants from the Bergamo mountains), who would commit to obtaining the timber required for charcoal from the forests and to delivering it in the summer, when iron- and steel-working activities intensified.²²

dell'economia: Dividere le risorse e delimitare il possesso nella montagna lombarda del tardo medioevo,” in Giorgio Chittolini, Elisabetta Conti, and Maria Nadia Covini (eds.), *Nell'età di Pandolfo Malatesta: Signore a Bergamo, Brescia e Fano agli inizi del Quattrocento* (Brescia, 2012), 241–324; *idem*, *I confini dei mercati: Territori, istituzioni e spazi economici nella montagna lombarda del tardo medioevo* (Morbegno, 2013); for the role played by tradesmen from Como in the Valtellina, see *idem*, *La disciplina contrattata: Vescovi e vassalli tra Como e le Alpi nel tardo Medioevo* (Milan, 2000). The Lambertenghis, a family of Como merchants, are mentioned as trading wool, cheese, butter, and wine in Bormio from as early as the second half of the thirteenth century; see L. Martinelli Perelli, “L'inventario di un archivio comunale del Trecento: Il 'Quaternus eventariorum' di Bormio,” *Studi di storia medioevale e di diplomatica*, II (1977), 256, 276, 318; on the intense trade on both sides of the Central Alps, see Patrizia Mainoni, “Attraverso i valichi svizzeri: Mercè oltremare e mercanti lombardi (secoli XIII–XV),” in Gian Maria Varanini (ed.), *Le Alpi medievali nello sviluppo delle regioni contermini* (Napoli, 2004), 99–121; Donatella Di Ciaccio, “Ceramica postmedievale dal territorio valtellinese,” in Valeria Mariotti (ed.), *La Valtellina nei secoli: Studi e ricerche archeologiche* (Mantua, 2015), II, 807–814. The discovery of oriental ceramics in the late medieval Alps is not exceptional, although it is generally limited to elite contexts. Syrian ceramics from the fourteenth and fifteenth centuries, for example, have been found in the Aosta Valley; see Mauro Cortelazzo, “Il commercio dei prodotti ceramici in un territorio alpino: Il caso del castello di Quart (AO),” in Rao and Federico Zoni (eds.), *Gli oggetti come merci nel tardo medioevo: Fonti scritte e fonti materiali* (Milan, 2024), 145–177.

21 Roberta Pini and Cesare Ravazzi, “Boschi, colture e pascoli nella media Valtellina durante gli ultimi 7000 anni,” *Notiziario archeologico valtellinese*, VII (2009), 73–81, esp. 80–81; Casini et al., “Piani di Sasso,” 153.

22 Archivio di Stato di Sondrio (hereinafter ASSo), *Atti dei notai*, b. 112 (Grassoni, Bernardo Marco di Bormio, 1421–1433), 19r, 85r, 95r, 133v, 140v, 193r, 219v, 263v, 266v; *ibid.*, b. 246 (Marioli, Lazzaro Gervaso di Bormio, 1452–1453), I, 43r; *ibid.*, b. 305/130 (Pegorini, Antonio Eustachio di Bormio, 1461–1462), 27r, 28r, 48r.

The real estate market was particularly dynamic when it came to pastureland, which is the most common type of land asset in sale contracts. Meadows were a rapidly expanding element of the landscape, not least owing to the reclamation or parceling out of vast areas of extensive pastures, as also confirmed by the initial paleobotanical data. This expansion is explained by the late medieval increase in livestock farming activities, which has been highlighted for several areas of the Alps in the same period. As in other areas of the Valtellina and the Alps more generally, there is evidence of the excavation of channels near meadows. Supporting settlement structures, such as barns (*tablati*) and sometimes even huts with living spaces (*domus*), are frequently mentioned in connection with meadows. Sheepfolds (*ovili*), which are practically absent elsewhere in the Valtellina, are almost always mentioned in the documents from the region around Bormio, which points to the particularly important role of sheep raising, stimulated by cloth manufacturing in Bormio. However, what contributed to the development of a meadow economy even more than sheep farming was cattle and horse breeding, which appears repeatedly in the cartularies.²³

The trend toward the commercialization and commodification of environmental resources in the Bormio area had significant repercussions for animals. The written documentation makes it possible to follow these changes especially through domestic animals, which were the object of bargaining. The market for Bormio

23 The first analyses carried out by the CNR at the Cancano Lakes also lead in this direction, insofar as they have identified late medieval traces of wetland reclamation; ASSO, *Atti dei notai*, b. 112, 187v, 364v. See also Cortelazzo, "La metamorfosi di un paesaggio alpino: L'incastellamento valdostano tra X e XIII secolo," *Bulletin d'études préhistoriques et archéologiques alpines*, XXVIII (2017), 181–220, esp. 197; *idem.*, "Un sistema di valori e di gusti: I reperti faunistici del castello di Quart (AO) tra XIII e XVI secolo," in Beatrice Del Bo and Igor Santos Salazar (eds.), *Carne e macellai tra Italia e Spagna alla fine del Medioevo: Economia, politica e società* (Milan, 2020), 51–76, esp. 71–72; Rao, "Le paysage des prés dans les Alpes lombardes du moyen âge tardif: Le cas de la Valmalenco," in Luigi Lorenzetti and Fabrice Mouthon (eds.), *Le paysan et la montagne au Moyen Âge et à l'époque moderne*, forthcoming; Concerning the presence of meadows with sheepfolds, see ASSO, *Atti dei notai*, b. 112, 14v, 18r, 24v, 35r, 48r, 169r, 179r, 181v, 187v, 190r, 206r, 211r, 215v, 233r, 292r, 364v; *ibid.*, b. 305/130, 15r, 29v, 51v, 52v. The presence of barns and other rustic buildings on meadows is highlighted, in relation to the Valfurva area, by Della Misericordia, "Paesaggio, istituzioni, identità locali di una valle alpina nel tardo medioevo: Elementi per una storia sociale della Valfurva," *Bollettino della Società storica valtellinese*, LX (2007), 25–67, esp. 29–30.

cloth (*drapi Bormini*)—a fabric that was much traded by merchants visiting the area from both the north and the south—probably contributed to the greater intensification of sheep farming compared to other areas of Valtellina. The establishment in Bormio of a fair attended by merchants from both sides of the Alps, in which local traders played a crucial role as intermediaries through the buying and selling of goods of various origins, also contributed to increasing biodiversity. The sale of livestock by merchants from the Engadin or German-speaking areas (*de Alemania*) to local merchants and those from other places in Lombardy (Bergamo, Brescia, and Trento) is documented with great frequency, along with a predilection for wethers (castrated rams), probably appreciated on that side of the Alps for their meat.²⁴

Finally, Bormio stands out as a center for horse breeding. Both German-speaking and Italian-speaking buyers traveled to Bormio to purchase local horses. No less than twenty-eight occur in the documents pertaining to the cartularies by Bernardo di Marco Grassoni (1421–1447), and another three occur in the shorter cartulary by the notary Antonio Eustachio Pegorini (1461–1462). The development of horse breeding was likely facilitated by the fundamental role that horses played in the upper Valtellina in connection with the crossing of Alpine passes, which was mostly guaranteed by the presence of local porters. It is also significant that—compared to other horse markets, such as Chiasso—merchants from Lombardy are not among the buyers. Most of the buyers were local or came from other places in the central Alps, suggesting that they chiefly dealt in horses used for transportation. The lack of steeds or other types of horses favored by the aristocracy is also significant. The horses' coats mentioned

24 ASSO, *Atti dei notai*, b. 112, 23r (*castroni*), 45r (*castroni*), 135r (*castroni*), 201r (*castroni*), 254v (*castroni*), 260r (*castroni*), 313v (*bestiamen*), 329v (*bestiamen*), 343v (*castroni*), 375v (*bestiamen*); *ibid.*, b. 113 (Grassoni, Bernardo Marco di Bormio, I (1431–1445), 49r (*castroni*), 50r (*castroni*), 61v (*castroni*); II (1447), 33r (*castroni*); *ibid.*, 246 Marioli, Lazzaro Gervaso Bormio, I (1452–1453), 4v (*castroni*), 34r (*castroni*), 73r (*castroni*), 74r (*bestiamen*); *ibid.*, b. 305/130, 24r (*castroni*), 24v (*castroni*), 54v (*bestiamen*). See Della Misericordia, *I nodi della rete*, 13–14, stressing the liveliness of the interalpine livestock trade in Bormio. Note that the importation of sheep and goats (especially wethers), as well as cattle and horses, from beyond the Alps is explicitly provided for and taxed by the statutes of Bormio. See ASCB, *Statuta seu leges municipales communis Bormii*, chaps. 240–241; Della Misericordia, *I confini dei mercati*, 46–47. A search for the word *castroni* on Loc-Glob (<https://loc-glob.unibg.it/>) reveals that taxes on imported wethers were in place in Como, Milan, and Bergamo.

display a remarkable variety in terms of color, suggesting a rich genetic heritage.²⁵

From these documents, a complex picture emerges in which economic integration breaks down the complex entities that make up an environment into discrete units that are understood as resources to be developed within the context of productive activities. At the same time, the promotion of a greater circulation of biodiversity within the breeding species is dealt with by economic actors.

THE RED COW The case of cattle illustrates especially well how the relationship with animals was transformed into conscious processes of resource selection influenced by economic relations with the surrounding areas and the construction of production chains, especially dairy farming. The transformation of cattle breeding in this era is exceptionally well documented by agrarian and purchase contracts. Cattle breeding was a fast-growing form of animal husbandry, which, as in other areas of the Valtellina, was intended to produce cheese rather than meat; moreover, it almost exclusively involved female animals, sometimes explicitly referring to cheese production among the clauses relating to the rents owed to the owners. Only ten (15 percent) of the animals in the sources were oxen; the remaining fifty-three were heifers and cows (see Table 1). The castrated males were probably used for farming and transport. Although calves do not appear in the sources, it is likely that most of them were not raised but used as food. Overall, beef and veal consumption was lower than that of mutton and lamb. This is

25 ASSo, *Atti dei notai*, b. 112, 8r, 22v, 60r, 68r, 79v, 85r, 107r, 109r, 162v, 166r, 216v, 238r, 261r, 327v, 353v, 372v; *ibid.*, b. 113, 1, 4v, 5v, 52r, 54v, 55r, 58v, 64v, 65r, 75v, 88r, 188r; II, 3r; *ibid.*, b. 305/130, 29v–30r; on the horse market in Chiasso, see Mainoni, “Attraverso i valichi svizzeri,” 117; Della Misericordia, “La natura delle nazioni: Lombardi e tedeschi nelle relazioni politiche di uno stato regionale,” *Reti Medievali Rivista*, XXI (2020), 323–376, esp. 357–359; cattle and horses from Bormio would then regularly be purchased, especially during fairs, by buyers from the Bergamasque and Brescian mountains, thus promoting the spread of upper valley varieties to the Bergamasque Alps. ASSo, *Atti dei notai*, b. 112, 8r, 313v, 353v. The purchase of a cow by a merchant from Bergamo is mentioned by Della Misericordia, *I nodi della rete*, 98). The frequent mentions of horses in Bormio documents are also noted by Della Misericordia, *I confini dei mercati*, 161–168. The equine archaeozoological data for Bormio are limited to a single sample from the fourteenth century, on which no morphological or genetic analyses have been conducted so far. Silvia Di Martino and Paolo Andreatta, “Analisi archeozoologiche sui resti faunistici degli scavi valtellini,” in Mariotti (ed.), *La Valtellina nei secoli*, II, 940.

Table 1 Cattle in the Notarial Cartularies of Bormio

YEAR	COLOR	CLASSIFICATION	S	B	DN	E	SOURCE
1421	red	cow	S+	bl+	Dn+	e	ASSo, 112, 16r
1422	“montana,” star on forehead	cow	S+	Bl	Dn+	E+	ASSo, 112, 34r
1426	red	cow	S+	bl+	Dn+	e	ASSo, 112, 101v
1426	red	cow	S+	bl+	Dn+	e	ASSo, 112, 101v
1426	brown, spotty	cow	s	bl+	Dn+	E+	ASSo, 112, 101v
1427	red “bocardus”	cow	S+	Bl	Dn+	e	ASSo, 112, 119r
1428		ox	?	?	?	?	ASSo, 112, f. 174r
1428		cow	?	?	?	?	ASSo, 112, f. 174r
1428	red and white	cow	s	bl+	Dn+	e	ASSo, 112, f. 183v
1428	red	cow	S+	bl+	Dn+	e	ASSo, 112, f. 184r
1428	white	cow	s	bl+	Dn+	e	ASSo, 112, f. 184r
1429	red “bocardus”	cow	S+	Bl	Dn+	e	ASSo, 112, f. 205v
1429	red	cow	S+	bl+	Dn+	e	ASSo, 112, f. 205v
1429	red and white, spotty	heifer	s	bl+	Dn+	e	ASSo, 112, f. 217r
1429	red and white, spotty	heifer	s	bl+	Dn+	e	ASSo, 112, f. 217r
1429	red	cow	S+	bl+	Dn+	e	ASSo, 112, f. 219r
1430	red, spotty	cow	s	bl+	Dn+	e	ASSo, 112, f. 263v
1431		ox	?	?	?	?	ASSo, 112, f. 306r
1431	red	cow	S+	bl+	Dn+	e	ASSo, 112, f. 325r
1431	red “bocardus,” white marks	cow	s	Bl	Dn+	e	ASSo, 112, f. 325r
1431	red “bocardus”	cow	S+	Bl	Dn+	e	ASSo, 112, f. 328v
1431	red	cow	S+	bl+	Dn+	e	ASSo, 112, f. 328v
1431	red	cow	S+	bl+	Dn+	e	ASSo, 112, f. 328v

I431	red	cow	S+	?	bl+	bl+	Dn+	Dn+	e	e	ASSo, 112, f. 328v
I431	brown	cow	S+	?	bl+	bl+	Dn+	Dn+	E+	?	ASSo, 112, f. 328v
I431	light red	cow	S+	?	bl+	bl+	?	dn	e	e	ASSo, 112, f. 328v
I431	red	cow	S+	?	bl+	bl+	Dn+	Dn+	E+	e	ASSo, 112, f. 328v
I431	light "montana"	heifer	S+	?	bl+	bl+	?	dn	E+	?	ASSo, 112, f. 328v
I431	red	heifer	S+	?	bl+	bl+	Dn+	Dn+	e	e	ASSo, 112, f. 328v
I432	red	ox	S+	?	bl+	bl+	Dn+	Dn+	e	e	ASSo, 112, f. 360r
I432	red "bocardus"	ox	S+	?	Bl	bl+	Dn+	Dn+	e	e	ASSo, 112, f. 360r
I432	black "bocardus"	cow	S+	?	Bl	bl+	Dn+	Dn+	ED	?	ASSo, 112, f. 360r
I432	red	cow	S+	?	bl+	bl+	Dn+	Dn+	e	e	ASSo, 112, f. 360r
I433	red and white, spotty	heifer	s	s	bl+	bl+	Dn+	Dn+	e	e	ASSo, 112, f. 376v
I438	red	ox	S+	?	bl+	bl+	Dn+	Dn+	e	e	ASSo, 113, f. 54r
I438	red and white	ox	s	s	bl+	bl+	Dn+	Dn+	e	e	ASSo, 113, f. 54r
I438	dark red	cow	S+	?	bl+	bl+	Dn+	Dn+	e	e	ASSo, 113, f. 59r
I438	red	cow	S+	?	bl+	bl+	Dn+	Dn+	e	e	ASSo, 113, f. 59r
I438	red, star on forehead	ox	s	s	Bl	bl+	Dn+	Dn+	e	e	ASSo, 113, f. 62v
I438	dark "montana"	cow	S+	?	bl+	bl+	Dn+	Dn+	E+	?	ASSo, 113, f. 64r
I438	light "montana"	cow	S+	?	bl+	bl+	?	dn	E+	?	ASSo, 113, f. 64r
I438	red	cow	S+	?	bl+	bl+	Dn+	Dn+	e	e	ASSo, 113, f. 64r
I439	red "bocardus"	cow	S+	?	Bl	bl+	Dn+	Dn+	e	e	ASSo, 113, f. 83r
I439	brown	cow	S+	?	bl+	bl+	Dn+	Dn+	E+	?	ASSo, 113, f. 85r
I439	red and white	cow	s	s	bl+	bl+	Dn+	Dn+	e	e	ASSo, 113, f. 85r
I445		ox	?	?	?	?	?	?	?	?	ASSo, 113, f. 205r
I453	red	ox	S+	?	bl+	bl+	Dn+	Dn+	e	e	ASSo, 246/1, 46r
I453	red	cow	S+	?	bl+	bl+	Dn+	Dn+	e	e	ASSo, 246/1, 46r
I461	red	cow	S+	?	bl+	bl+	Dn+	Dn+	e	e	Asso, 305, 10r
I461	white	cow	s	s	bl+	bl+	Dn+	Dn+	e	e	Asso, 305, 10r
I461	white	cow	S+	?	bl+	bl+	Dn+	Dn+	E+	?	Asso, 305, 10r
I461	red "bocardus"	cow	S+	?	Bl	bl+	Dn+	Dn+	e	e	Asso, 305, 10r

Table 1 (Continued)

YEAR	COLOR	CLASSIFICATION	S	B	DN	E	SOURCE
1461	red "bocardus"	heifer	S+	Bl	Dn+	e	Asso, 305, 26v
1461	red "bocardus"	heifer calf	S+	Bl	Dn+	e	Asso, 305, 26v
1461	light red	heifer	S+	bl+	?	e	Asso, 305, 26v
1461	light red	heifer calf	S+	bl+	?	e	Asso, 305, 26v
1461	red	cow	S+	bl+	Dn+	e	Asso, 305, 26v
1461	red "bocardus"	cow	S+	Bl	Dn+	e	Asso, 305, 33r
1461	brown	cow	S+	bl+	Dn+	E+	Asso, 305, 33r
1461	red	cow	S+	bl+	Dn+	e	Asso, 305, 41r
1461	white and black	cow	s	bl+	Dn+	ED	Asso, 305, 42v
1461	red	ox	S+	bl+	Dn+	e	Asso, 305, 43r

NOTE An analysis of genes based on coat color. The columns report the data relating to the loci and the hypothetical combination of alleles. Spotting is represented by S (S⁺, s); Blaze, B (Bl, bl⁺); dun, DN (DN⁺, dn); Extension, ED (ED, E⁺, e); a question mark signifies any data that were impossible to determine.

confirmed by the late medieval zooarchaeological remains not only from Bormio, but from the entire Valtellina.²⁶

As with horses, the sources reveal the overall biodiversity of cattle herds. In studies on the Alps from the Neolithic to the early Middle Ages, the increase in genetic diversity tends to coincide with phases of greater connectivity and the presence of larger animals. Bottlenecks in terms of circulation and genetic diversity have instead been identified for the period from the fifth to the seventh century. The zooarchaeological literature on cattle tends to privilege the prehistoric period, whereas studies on the late Middle Ages are more limited.²⁷

Case studies from South Tyrol (Campo Tures) and the Aosta Valley (Quart) provide a framework in which to contextualize the data from Valtellina. Both areas show a significant presence of cattle in the period between the tenth and thirteenth centuries. At Campo Tures in the latter period, the specimens were relatively small, being similar to those of the prehistoric age, with a slight tendency to increase in the late Middle Ages. At Quart, where late medieval developments similar to those in Bormio in terms of the expansion of grazing areas and canalization, late medieval cattle remains not only suggest a growing number of this species to the detriment of sheep, goats, and pigs, but also show fewer signs of osteoarthritic alterations than those from the previous period, indicating that between the fourteenth and fifteenth centuries they were used less for field work and probably more for cheese production, including through dairy barns.²⁸

26 On zooarchaeological remains in Valtellina, see Martino and Andreatta, "Analisi archeozoologiche sui resti faunistici degli scavi valtelinesi."

27 José Granado et al., "The mtDNA D-Loop Legacy of Cattle: Fluctuations in Diversity from the Neolithic to Early Medieval Times in Switzerland," *Diversity*, DCLXXXVII (2023), available at <https://doi.org/10.3390/d15050687>. It should be noted, however, that cattle imports, even with deliberate attempts at genetic improvement, are documented even in the Iron Age and the Roman Age. See Konstantina Saliari et al., "Morphometric and Genetic Evidence for Cattle Imports from the Mediterranean into Present-Day Austria during the Iron Age," *Journal of Archaeological Science: Reports*, XLVIII (2023), available at <https://doi.org/10.1016/j.jasrep.2023.103842>; Elizabeth Wright, "Investigating Cattle Husbandry in the Swiss Late Neolithic Using Different Scales of Temporal Precision: Potential Early Evidence for Deliberate Livestock 'Improvement' in Europe," *Archaeological and Anthropological Sciences*, XIII (2021), available at <https://doi.org/10.1007/s12520-020-01252-6>.

28 Umberto Tecchiati, "Resti faunistici di età medievale provenienti dalla rovina di Toblburg presso Campo Tures/Sand in Taufers in Valle Aurina (BZ)," *Atti dell'Accademia Roveretana degli Agiati*, CCLXII (2012), 128–129; Cortelazzo, "Un sistema di valori e di gusti," 61.

Although there is a scarcity of zooarchaeological research on the upper Valtellina in the Middle Ages, the animals' coat coloring, which is almost always described in the contracts, makes it possible to collect data, if only in an approximate manner, on their genetic makeup. In particular, some specific color features offer clues to derive the genotype from the phenotype. The "Spotting" locus (hereinafter *S*) is responsible for spotting patterns; the "Blaze" locus (*B*) for the white coloration of parts of the muzzle; the "Dun" locus (*DN*) for the absence or dilution of melanin (that is, the coat is either white in color or a light color); the "Extension" locus for the color as well as a black (*ED*), brown (*E*⁺), or red (*e*) tint. The combination of alleles can be traced, if only hypothetically, as some are dominant while others are recessive. For example, in the case of Extension, the dominance sequence between the alleles is *ED* (black) > *E*⁺ (Wild Type, brown, but which later was shown to be a mutation) > *e* (red). Therefore, since *e* is recessive, a red cow will have to have had a mother and father both carrying the *e* variant (either in a homozygous or heterozygous state) and therefore have inherited a combination of *e/e* alleles. Similarly, the spotting allele *s* is recessive with respect to *S*⁺. The presence of spots or stars on the forehead, on the other hand, is usually the result of the combination *Bl/bl*⁺. These color features are never due to epigenetic changes.²⁹

29 Gabriele Senczuk et al., "The Genetic Heritage of Alpine Local Cattle Breeds Using Genomic SNP Data," *Genetics Selection Evolution*, LII (2020), available at <https://doi.org/10.1186/s12711-020-00559-1>; Célia Maudet, Gordon Luikart, and Pierre Taberlet, "Genetic Diversity and Assignment Tests among Seven French Cattle Breeds Based on Microsatellite DNA Analysis," *Journal of Animal Science*, LXXX (2002), 942–950; François Rouzard et al., "A First Genotyping Assay of French Cattle Breeds Based on a New Allele of the Extension Gene Encoding the Melanocortin-1 Receptor (*MC1R*)," *Genetics Selection Evolution*, XXXII (2000), 511–520; for an overview of bovine genetics, see Timothy A. Olson, "Genetics of Colour Variation," in Ruedi Fries and Anatoly Ruvinsky (eds.), *The Genetics of Cattle* (Wallingford, U.K., 1999), 33–53. For a more extensive examination of the genetic heritage of cattle in the central Alps, see work currently being conducted by Enrico Santus, whom I thank for his collaboration on genetics; on epigenetic changes, see Eva Jablonka and Marion J. Lamb, *Evolution in Four Dimensions: Genetic, Epigenetic, Behavioral, and Symbolic Variation in the History of Life* (Cambridge, MA, 2006), 245–254. According to Karolina Kasprzak-Filipek et al., "Polymorphism of the Melanocortin 1 Receptor (*MC1R*) Gene and its Role in Determining the Coat Colour of Central European Cattle Breeds," *Animals*, X (2020), available at <https://doi.org/10.3390/ani10101878>, "While most phenotypic features of animals result from the interaction of genetic and environmental factors, coat colour is considered to be almost exclusively genetically determined." On the other hand, epigenetic changes in cattle not related to color are found in Emanuele Capra et al., "Comparison between Indicine and Taurine Cattle DNA

All in all, out of sixty-two individuals, as many as forty-four are described as red, light red, or red and white mottled (*e/e*); a similar genotype seems equally conceivable—to a certain degree of approximation—for individuals defined as dark red (in only one case, *rubeus brunus*). The three completely white individuals, in which in all probability the dilution gene (*dn/dn*) affected the red phenotype in a conspicuous way, should also be interpreted as *e/e*. In short, more than 75 percent of the individuals had the *e/e* genotype. Only one is black (*ED/?*) and five are brown; for those individuals, as well as for others defined as mountain animals, an *E+/?* genotype can be assumed. At least eight unrelated individuals were also sired by cattle with the recessive mottling gene (*s/s*), indicating a rather large population with such characteristics, thirteen with the white coloration gene (*Bl/bl⁺*) on the muzzle (*bocarda* or *cum stela in fronte*) and eight with the lightening gene (*?/dn*), inferred from their having a coloration described as “light” (*clarus*).³⁰

The presence of four specimens defined as “mountain” animals is noteworthy, perhaps as an indication of the presence of breeds perceived to be native to the area. In particular, in two of the three attestations where mountain cows are mentioned, they are sold together with red cows. It is plausible—if only hypothetically—that these cows were alpine browns, the breed with persistent and ancient alpine roots, as genetic investigations show. Even when considering only Pegorini’s cartulary, drafted between twenty and thirty years after Grassoni’s earliest records—one to two cattle generations later—the situation does not appear to be very different, though with a relative increase in the importance of cattle with genotype *E⁺/?*. Of the fourteen cattle recorded, six are red, four dark red, two brown, one white, and another black (the only spotted one).³¹

Methylation Reveals Epigenetic Variation Associated to Differences in Morphological Adaptive Traits,” *Epigenetics*, XVIII (2023), 2163363, available at <https://doi.org/10.1080/15592294.2022.2163363>.

30 On the meaning of *boccardus* as “with a white muzzle,” see Massimo Prevideprato, “O povera mi! I processi per stregoneria di Grosotto (1595–1597),” *Bollettino storico alta Valtellina*, XIX (2016), 92.

31 ASSO, *Atti dei notai*, b. 112, 16r, 34r, 44r, 101v, 119r, 174r, 183v, 184r, 205v, 217r, 219r, 263v, 306r, 325r, 328v, 360r, 376v; *ibid.*, 54r, 59r, 62v, 64r, 83r, 85r, 205r; *ibid.*, b. 246, l. 46r; *ibid.*, b. 305/130, 10r.

These initial data are surprising; the most widespread native breeds in Italy today—apart from the Alpine Brown breed in the Alps—have white coats, such as the Chianina, Piemontese, and Marchigiana. Red coats are only found in a few Apennine/lowland varieties, such as the Varzese and Reggiana. But the implications are far greater. The red phenotype is possible thanks to the combination of recessive alleles (e/e). The clear dominance of red coats—which, according to an initial survey of agrarian contrast in notarial cartularies, had been common to the entire Italian side of the central Alps since at least the thirteenth century—suggests two hypotheses. First, the small number of brown and black cattle could derive from recent imports, perhaps through purchases of cattle from other areas. The intensification of late medieval trade could therefore have favored the circulation of different genetic traits compared to those most common in the area. Second, the predominance of red, which survived in Valtellina throughout the late Middle Ages, may point to breed selection practices, or the tendency to breed specimens of the same color.

Similar considerations can be made for the recurrence of specimens with mottled coats (s/s), which implies a desire to maintain this genetic combination. Individual animals were therefore consciously selected based on their coat color, perhaps also because production capacities were attributed to certain breeds. For example, studies show that the milk of red cows of northern Italy (the Reggiana) is particularly high in kappa-casein, making it highly suitable for cheese production.³²

Therefore, it is plausible that the descriptive elements appearing in notarial deeds in a relatively standardized manner in local usage regardless of the individual notaries were useful not only to identify the animals, but also to certify their genetic potential. In other words, for buyers it was not a matter of indifference whether a cow was red, black, white, or brown, as it had to be precisely that color if it was to be bred with specimens of the same color. In this respect, it is significant that no mention is made of the coat color of four of the ten oxen listed for sale, as the transaction had no reproductive implications.

32 Università di Parma, “La qualità casearia del latte di differenti razze bovine,” *La razza bruna*, I (2002), 7–13. Future genetic analyses on zooarchaeological remains may help better understand the reasons for the spread of red cows in this area.

Equally revealing is the fact that the remaining six animals were red (one of them with white spots); the prevalence of the red phenotype on the oxen is confirmed by larger-scale surveys on the Valtellina and Bergamasque Alps, where most of them would appear to have been red or white, and more rarely of other colors. The preference for red oxen might also suggest that animals characterized by this phenotype were larger than brown and black ones (and thus better suited to the transport and field work required of oxen). Such variations, however, do not lead to differences in economic value, as cows overall tended to be variously appraised (at around seven lire in the 1430s), regardless of color.³³

Overall, the focus on such selection processes for cattle breeds, combined with patterns seen for wethers and horses above, confirms that domestic animals were also beginning to be treated as environmental resources for specific forms of production and trade.

LISTING AND REGULATING PASTURES AND FORESTS The public authorities in the commune of Bormio dealt with the transformation of the late medieval environment through a complex system of management and documentation. Two new tools were adopted by the local community, surveys (*inquisitiones*, that is, administrative practices that made it possible to verify the existence of public rights over the land) and the writing of registers. These innovations became widespread in many Italian communes between the end of the twelfth and the beginning of the thirteenth century.³⁴

This new system of norms and writings introduced in the late Middle Ages represents a break in environmental management compared to the practices that characterized the valley in the early Middle Ages. The forms of extensive use of pastures and forests were greatly reduced in favor of the intensive exploitation and commodification of such resources. The environment was transformed into a space measured and delimited according to its economic utility. These new forms of management and recording thus fall within

33 Out of 64 oxen whose color is indicated in the Bergamasque Alps and Valtellina, only 7 are brown or black and are concentrated exclusively in the Morbegno area at the beginning of the fourteenth century.

34 On the late medieval investigations, see Massimo Vallerani, "Logica della documentazione e logica dell'istituzione: Per una rilettura dei documenti in forma di lista nei comuni italiani della prima metà del XIII secolo," in Isabella Lazzarini and Giuseppe Gardoni (eds.), *Notariato e medievistica: Per i cento anni di 'Studi e ricerche di diplomatica comunale' di Pietro Torelli* (Roma, 2013), 109–145.

the range of “environing technologies” (“writing, sensing and shaping”) of a conceptual nature, which, as Sörlin and Wormbs have suggested, played a crucial role in the making of the environment. The outcome was paradoxical, since on the one hand forms of management emerged that ensured the economic “sustainability” of the use of environmental resources, while on the other there was an increase in the process of deployment and selection of these resources, with a marked ecosystemic impact.³⁵

The commune of Bormio was a small mountain town in this period. In the late thirteenth and early fourteenth centuries, the local community acquired many of the organizational traits characteristic of urban communes, starting with the presence of a chief magistrate (*podestà*) from outside the local community and the creation of a significant number of documents (especially registers and lists). The commune carefully managed communal property through a system of surveys and concessions recorded in a register and exercised control over the village streets.³⁶

In addition to the streets within the town, the communal authorities surveyed environmental resources. In 1309, the commune of Bormio, governed by *podestà* Corrado dei Capitanei from Sondrio, created a “book of the boundaries between *alpes* and *sentiti*,” with the aim of specifying which areas could be used collectively and privately. The *alpes* were alpine pastures customarily used for the summer grazing of livestock, according to what we might call an outfield system. By contrast, the *sentiti* were lands that could not be used freely but were subject to private use. According to the commune’s statutes, in the period between the feasts of St. George and St. Michael (late April through late September), access to *sentiti* was only permitted to those who had properties there (by virtue of ownership or municipal concessions); trespassers would be fined. Bracchi has shown that the geography of *sentiti* mainly concerned “the safeguarding of productive land

35 Sverker Sörlin and Nina Wormbs, “Environing Technologies: A Theory of Making Environment,” *History and Technology*, XXXIV (2018), 107.

36 Gian Piero Bognetti, “Il ‘Liber stratarum’ di Bormio trecentesca,” *Bollettino della società storica valtellinese*, XI (1957), 8–35. On the documentary system in Bormio see Della Misericordia, “Mappe di carte: Le scritture e gli archivi delle comunità rurali della montagna lombarda nel basso medioevo,” in Attilio Bartoli Langeli, Andrea Giorgi, and Stefano Moscadelli (eds.), *Archivi e comunità tra medioevo ed età moderna* (Rome, 2009), 172–175; Rita Pezzola, “Item canevarius habet: Un ‘quaternus chartarum’ duecentesco del comune di Bormio (1237–1287),” *Scrineum Rivista*, V (2008), 250–295.

against grazing.” This land was mostly located below or along the forest line and had to be distinguished from the alpine pastures, which were instead mostly located above this line and were freely accessible. Nonetheless, quite a few *maggenghi* (medium altitude pastures) and valley floor areas can be found, such as the Alude marshes and the areas near the village of Bormio, which likely had traditionally been open to collective use by the inhabitants of the village and were therefore regarded as alpine pastures.³⁷

Sentiti were particularly productive and sought-after meadows and pastures, which on the one hand had to be protected from overgrazing, but on the other often constituted an unavoidable crossing for livestock headed toward higher mountain pastures. For this reason, the law specified that the ban (*tensum*) over alpine pastures could not be issued by the surrounding rural communities of the district (*vicini* or *contrate*) before the animals had reached the alpine pastures (and had crossed the sentiti). However, the law allowed for exceptions to the prohibition to access sentiti in the case of exceptional weather conditions, such as snowfall preventing the animals from remaining on mountain pastures, or livestock spending only one night on a sentitum on their way back down to the valley.³⁸

The 1309 survey of sentiti was conducted by two commissioners appointed by the commune. The work of the commune’s delegates was accompanied, though, by the swearing of oaths by the *vicini* of the *contrate*. The result was boundaries fixed within the territorial communities that accessed the high pastures. By expressing in linear terms rights that mainly pertained to the use of this land, the commune also clearly circumscribed the *vicini*’s customary rights over local pastures.³⁹

In short, the survey (part of which is lost) records sixteen areas. Some are exclusively set aside as alpine pastures, and others are divided between alpine pastures and sentiti. The survey covers almost the whole Bormio territory (the Braulio alpine pastures and

37 These and similar process involving the written recording and fencing off of environmental resources are highlighted by Della Misericordia, “I confini dell’economia,” 284–305; Remo Bracchi, “Divisione tra alpi e sentiti a Bormio nel 1309,” *Bollettino della Società storica valtellinese*, LI (1998), 31–94; *idem*, “Divisione tra alpi e sentiti,” 35, 44–45; the statutes are published in *ibid.*, 41–43.

38 *Ibid.*, 41, 42.

39 See, for example, *ibid.*, 34.

the Livigno and Fraele valleys are missing, perhaps due to a gap in the text). Within the sentiti, meadows outnumber grazing areas. More generally, where meadows are found, whether managed through communal rentals or privately, there is a higher density of settlements, witnessed by the presence of huts and barns. Compared to the alpine pasture landscape, the landscape of sentiti was heavily affected by human activity and densely parceled out, with large tracts of land fenced off. This intensive use, though, was tempered by communal law, which restricted seasonal access to the owners, ensuring greater sustainability. The environmental laws governing sentiti should be interpreted as a means of preserving the ecosystem in a way that was functional to its protection as an economic resource. This legislation reflects first and foremost a conception of meadows as private areas, either as properties in the hands of private landowners or as communal allotment (*presure*).⁴⁰

A similar census was produced for woods. The statutes compiled after around 1368 include a section devoted to woodland (the so-called *statuta nemorum*), which identifies and regulates in detail the forested areas of the commune. This section collects material compiled at different times between the fourteenth and fifteenth centuries. Unfortunately, the *statuta nemorum* are not always easy to date because they are not preserved in original documents but through a sixteenth-century copy. This collection establishes the officers in charge of the safeguarding and conservation of the communal woods, the *procuratores nemorum* or *advocati nemorum* (forest procurators or advocates). This is followed by a list of fifty-seven woods, probably drawn up by the 1390s, which was integrated with another six woods through other fourteenth-century measures.⁴¹

40 In the case of the Braulio alpine pastures, one explanation might be the fact that they were all leased out.

41 The year 1368 constitutes the *ante quem* for the drafting of a new collection of statutes, when the communes resolved to “exemplare statutum novum comunis.” ASCB, *Dati e ricevuti*, 2/31 (1368); these archives also preserve around 50 individual leaves of the medieval manuscript. A critical edition of the remaining part of the original text is currently being prepared by Lorenza Fumagalli; Vera Credaro, “Lo statuto dei boschi della contea di Bormio,” in *Mons Braulius: Studi storici in memoria di Albino Garzetti* (Sondrio, 2000), 120–137, 138–139. The first list seems to be from earlier than 1389 because it does not include the Freita wood that the commune of Bormio acquired that year; *ibid.*, 121–122.

These woods appear to have been *tensi*, that is, they were marked as unavailable for free use through a rope (*filum*) that was stretched (*tensum*) to circumscribe these protected spaces (equivalent terms found in other parts of Italy are *banditi* and *foresti*). This detailed census suggests a vast appropriation of forest spaces by the commune. Nevertheless, the laws provided for a stratified social use, which varied depending on the residence of the users. Indeed, for each forest, the boundaries of the area that was off limits were specified, but so were exceptions; the *vicinantie* or *contrate* bordering the *tensum* wood benefited from broad exemptions from the prohibition, linked to the collection of dry wood (*ligna sicca*), which did not damage the woodland. The statutes appear to have incorporated older local customs into the restrictive communal legislation. However, there is tension between the commune and the *contrade*, exacerbated by the fact that the legislation made the *contrade* jointly liable for penalties imposed by the forest advocates, although they could exonerate themselves by naming the culprit.⁴²

Moreover, the laws reflect the need to establish different rules of use for each forest. For example, in certain woods, branch picking and clipping were tolerated. In others, craft activities involving the processing of wood were permitted in exceptional cases to manufacture planks for the roofs of buildings (*asserres a tecto*); barrels (*vegetes*), including hoops (*circuli*); and kitchenware (*pro vasis et utensilibus*). In some woods, only the most harmful activities were prohibited, such as the use of charcoal kilns for ironmaking. The latter were permitted in other woods, mostly located close to forges, to which the commune would sometimes grant sole use of the woodland. Still other woods were not *tensi*, and, from April to June, local inhabitants could collect foliage and timber for the construction of canals.⁴³

The sixty-three woods that extended across the Bormio district were in any case only a part of its forested area, as there were

42 *Ibid.*, 124, 138.

43 *Ibid.*, 124, 134. On craft activities in woods and the production of tableware, mostly as a source of additional seasonal revenue for farmers, see Rinaldo Comba, *Contadini, signori e mercanti nel Piemonte medievale* (Roma, 1990), 114. On the trade in *circuli*, which in northern Italy were generally made from flexible woods, see Giuliana Alliaud, "Cantine e vasi vinari nel tardo Medioevo piemontese," in Comba (ed.), *Vigne e vini nel Piemonte medievale* (Cuneo, 1990), 80–83; see Credaro, "Lo statuto dei boschi," 123, 138, 136. For an overview of the restrictions imposed by rural communities on woodland use in the Lombardy Alps, see Della Misericordia, *I confini dei mercati*, 19–20; Credaro, "Lo statuto dei boschi," 137.

also some woods owned by *contrate*. The statutes include a further survey, which marks an additional thirty-five woods as *tensi* and was conducted by Giacomo Alberti and Nicola Bruni in the fifteenth century.⁴⁴

From the fourteenth-century survey onward, the woodland landscape appears strongly anthropized—albeit not to the same degree as the *sentiti* area—and is marked by the extensive use of manmade spatial markers. This landscape was subjected to a process of strong territorialization through the tracing of linear boundaries and the affixing not only of boundary markers (trees marked with crosses and boundary stones), but of actual fences to keep people and animals out.⁴⁵

The forest management regulations laid out by communal statutes also reveal the public authorities' concern with managing environmental risks—not least because the uncontrolled use of forest resources could lead to hydrogeological instability—for example by making it illegal to drag timber over snow or to collect wood from avalanches. These laws should not be interpreted as traditional texts codifying ancient practices, but rather as largely innovative regulatory systems reflecting the needs of the institutions that produced them. This new system of public rules contributed to the further fragmentation of the environment frequented by humans and animals, spatializing it according to the exploitation of forest and pasture resources.⁴⁶

44 Such was the case with the Freita wood, whose ownership the *vicinia* of Livigno transferred to the commune of Bormio in exchange for a forested area of similar size near the *Blesatia* wood. Credaro, "Lo statuto dei boschi," 121–122, 139–148. The dating to the fifteenth century is suggested by the greater presence of vernacular names.

45 On the affixing of boundary markers, see Della Misericordia, "Significare il confine: I simboli della delimitazione nelle testimonianze documentarie fra medioevo ed età moderna in Valtellina e nelle Alpi centrali," *Notiziario dell'Istituto archeologico valtellinese*, IX (2011), 93–106. On territorialization processes and the drawing of linear boundaries in the Late Middle Ages, see *idem*, "I confini dell'economia," 262–277; Joseph Morsel, "Appropriation communautaire du territoire, ou appropriation territoriale de la communauté? Observations en guise de conclusion," *Hypothèses*, IX (2006), 89–104; Luigi Provero, "Una cultura dei confini: Liti, inchieste e testimonianze nel Piemonte del Duecento," *Reti Medievali. Rivista*, VII (2006), available at <https://doi.org/10.6092/1593-2214/165>.

46 ASCB, *Statuta seu leges municipales communitalis Burnii*, chaps. 227–228. On the management of environmental risk and risk societies, see van Bavel and Thoen, *Rural Societies and Environments at Risk*; van Bavel et al., *Disasters and History*, 167–168. Among the studies that, in approaching statutes as an expression and mirror of institutional relations in a local area, have shifted the focus from the content to the moment of production, see Chittolini, "Legislazione statutaria e autonomie nella pianura bergamasca," in Maria Cortesi (ed.), *Statuti rurali*

THE “SUSTAINABLE” MANAGEMENT OF WOODS In the upper valley, the problem of guaranteeing the sustainability of forest resources was solved by developing a highly restrictive system of public rules governing the use of such spaces—that is, by assigning the status of *tensum* wood to many of the territory’s forested areas. Additionally, strict forms of supervision were established by appointing special officers to punish any infringement. Deforestation and the depletion of woodland resources were significantly reduced, since the removal of living trees was conditional upon the granting of special exemptions by the commune. At the end of most of the chapters on the use of an individual forest, the *statuta nemorum* contained clauses either allowing such exceptions or excluding them altogether.

Although the use of wild areas was strictly controlled by the public authorities, through council resolutions the commune granted special exceptions to the rules governing the use of woods and pastures to individual inhabitants and neighborhood communities who had requested them with good reason. The petitions addressed to the commune reveal stratified forms of using the forest; they express the collective needs of the *contrade*, most notably the gathering of wood for heating, but also individual needs, for instance associated with the construction of buildings or even lime kilns. Some requests concern the exercising of craft activities in the woods, as mentioned above, such as the manufacture of wooden tableware or *circuli*, the wooden hoops used to close barrels.⁴⁷

To ensure the sustainability of the woodland, the trees to be felled were mostly distributed across various woods and had to be marked one by one by special officers of the commune in charge of protecting the forest cover, who were known as *advocati nemorum* (forest advocates). The council records for 1485 suggest that this practice was well established. For example, when the *vicini*

e statuti di valle: La provincia di Bergamo nei secoli XIII–XVIII (Bergamo, 1984), 93–114; Chittolini, “A proposito di statuti e copiatucci, ius proprium e autonomia: Qualche nota sulle statuizioni delle comunità non urbane nel tardo medioevo lombardo,” in Pio Caroni (ed.), *Dal dedalo statutario. Atti dell’incontro di studio dedicato agli Statuti. Centro seminariale Monte Verità* (Bellinzona, 1995), 171–192; Varanini, review of *Carte di regola e statuti delle comunità rurali trentine* by Fabio Giacomoni, *Storia e Regione*, I (1992), 154–161; Varanini, *Studi di storia trentina* (Trento, 2020), I, 623–633.

47 ASCB, *Quaderni dei consigli*, 1/1 (1334); *ibid.*, 2/5, (sorte primaveraile, 1481), 6r; authorization granted to Andrea Cristoforo Ioncla of Livigno to use a wood; *ibid.*, 8 (sorte primaveraile, 1485), 12 (concession to fell trees in order to build two *tecta* in Valscura).

of Fumarogo requested permission to collect some timber to build a lime kiln near the Osteglio bridge, the selection of trees to be felled was entrusted to the *advocati nemorum*. Likewise, when a citizen of Livigno was granted permission to cut down 100 trees to build a sheepfold and a mountain hut, the trees were divided between the Palipert and Freita woods, again near Livigno. That same year, another inhabitant of Livigno who wished to build a mountain hut on a meadow in the area was granted permission to chop down a certain amount of wood, equally distributed between those two woods. In the case of a similar concession granted to an inhabitant of Cepina, it was the *advocati nemorum* who were charged with selecting the trees. Through this careful management of forested areas, the population's need for timber supplies did not irreversibly damage the woodland.⁴⁸

One of the most critical issues for the sustainable management of woodland resources concerns its coexistence with ironmaking activities. The surviving documents detail how the construction of smelting furnaces at high altitudes throughout the valley and of forges at the bottom of the valley—in the Bormio area—went hand-in-hand with deforestation and the expansion of grazing areas. Such furnaces are often mentioned as being adjacent to pastures and charcoal kilns. In 1493 the gathering of wood to supply a forge with charcoal was authorized within a *tensum* forest at Pecello, in an area already subjected to controlled fires. That same year, a license was granted to a citizen of Livigno to collect 20 *madere* in the Freita wood, and the *advocati nemorum* were put in charge of selecting the trees. In this case, the concession was justified by the need to repair and expand a forge, hinting at the dynamic interplay between the pressure of ironmaking activities on the forest and the need to regulate strictly the harvesting of wood.⁴⁹

The strong productive pressure on environmental resources in the upper Valtellina entailed not only the transformation of material structures within the landscape, but also the building of a system of rules for its conservation and sustainability, made possible with surveys and registers between the late thirteenth and

48 ASCB, *Quaderni dei consigli*, 2, 9r; ASCB, *Quaderni dei consigli*, 2, 6r, 12r; ASCB, *Dati e ricevuti*, 8 (sorte primaverile, 1485), 12r. *Ibid.*, 8.

49 ASCB, *Quaderni dei consigli*, 2/21 (sorte estiva, 1493), 9r; *ibid.*, 2/20 (sorte primaverile, 1493), 2r.

fourteenth centuries. This system of sustainable rules was based on the creation of strictly regulated spaces through the selection of the times and ways in which pastures and forests could be accessed. Although these areas were marked off in a way that was not always linear—since distinctions based on altitude were taken into account—the rules sometimes drew distinctions of a seasonal nature (by prohibiting the use of certain resources at certain times of the year so as to favor their regeneration), as well as social distinctions, as seen in the distinction between *sentiti* and alpine pastures.⁵⁰

THE ESTABLISHMENT OF A HIERARCHY WITHIN ANIMAL SOCIETY
How did the new productive dimension of late medieval mountain areas change animals' way of life? Broadly speaking, alpine economic and productive specialization defined the use of land in relation to individual species; in other words, it tended to disassociate different species that until then had lived and interacted within ecosystems. There was likely a reduction in the mixed grazing of sheep, goats, and cattle, which is one of the most effective methods of traditional pastoralism, in terms not only of the more efficient use of pastures, but also of the animals' well-being. The late-medieval reduction in mixed grazing may have had a negative impact on animal health; veterinary research has shown that the interaction between sheep and cattle reduces gastrointestinal infections.⁵¹

The system of rules that the commune of Bormio designed to ensure sustainable economic growth spatialized the presence of animal species, favoring forms of intensive farming and ultimately banishing those species most harmful to the economy (namely bears and wolves). This hierarchy is encapsulated by the economic value of the fines recorded in the statutes for animals that do not respect the boundaries of *sentiti*; increasing penalties were set for sheep, goats, pigs, and—at the top of the social ladder—cattle and

50 On the Alps in the late Middle Ages, see Rao, "Le Alpi marittime e l'invenzione bassomedievale della montagna," in Paolo Cesaretti and Renato Ferlinghetti (eds.), *Uomini e ambienti dalla storia al futuro* (Azzano San Paolo, 2014), 30–45.

51 Eric Baratay, *Le Point de vue animal: Une autre version de l'histoire* (Paris, 2012); S. H. M. Esmail, "Multispecies Grazing by Cattle and Sheep," *Rangelands*, XIII (1991), 35–37; Hervé Host, Jean-Paul Guitard, and J. C. Pons, "Pâturage mixte entre ovins et bovins: Intérêt dans la gestion des strongyloses gastrointestinales," *Alteragri*, LXI (2003), 20–23.

horses. (In the same period, the same kind of social differentiation of penalties is found in the laws governing human conduct in the statutes of Italian cities, with lesser penalties being imposed on *populares* and harsher ones on *milites*.) Conversely, the social hierarchy of wild animals was determined by the rewards imposed for their capture, which increased according to the perceived danger of the species; greater rewards for large, adult bears and wolves, and smaller ones for small bears and wolves.⁵²

The mountain landscape was rethought in light of this new social hierarchy of the animal world, which largely corresponded to that of their owners. During the 1400s, cattle were increasingly concentrated in the rich meadow areas of the *sentiti*, which were obtained through productive investments and the reclamation of peat bogs. Such areas were also used as grazing grounds for sheep supplying the Bormio cloth industry. Sheep and goats were prevalent on poorer pastures and meadows. The statutes explicitly state that certain pastures were reserved for cattle so that their numbers could be increased as much as possible, excluding sheep and goats. Such was the case with the Ruinacia, Areita, and Braulio pastures and, following a 1539 resolution, also with the *sentitum* of Uzza. Additionally, especially on the most crowded alpine pastures, the commune's strict regulations could include gender distinctions. For example, these statutes prohibited the introduction of ungelded male horses into the Braulio, Areita, and Ruinacia pastures for fear that they might impregnate the females.⁵³

Unlike livestock that stayed on the alpine pastures, animals that had access to *sentiti* could only move freely within a strictly delimited space, as characterized by the presence of shelters (sheepfolds and barns, which are clearly documented in the sources). Through the strict marking out of alpine areas and their productive development, mostly as grassland, these animals enjoyed the best diet. The expansion of meadows also favored the consumption of feed in barns through haymaking. The livestock's mobility was confined by the extensive presence of fences, but also—where no fences were in place—by an extremely fragmentary distribution of pastures, which forced the animals to remain within their owner's land.

52 Bracchi, "Divisione tra alpi e 'sentiti,'" 42. Bracchi does not mention horses).

53 ASCB, *Statuta seu leges municipales communitalis Burmii*, chap. 239, *De alpe Humbratii*, chap. 277, *de ovibus et alia mobilia que non possint pasculari in Areita*. Bracchi, "Divisione tra alpi e 'sentiti,'" 36; ASCB, *Statuta seu leges municipales communitalis Burmii*, chap. 257.

Not only that, but the tendency to demarcate woodland areas probably decreased livestock access to mixed grazing and woodland areas, thereby limiting undergrowth consumption by domestic animals, primarily goats. In short, the animals enjoyed a richer diet on sentiti but little individual freedom—which again reflects the relationship between economic well-being and the complex social rules affecting their human owners.

Animals enjoyed greater freedom of movement on communal high-altitude pastures, which were accessible to livestock farmers from the most diverse social strata. The animals there had to deal with a more complex range of social relations, since on alpine pastures there were not just animals belonging to different owners, who were not used to living together in the winter months, but also animals belonging to different species. Within the almost undivided space of alpine pastures, competition for food between groups of the same species was also greater, although competition did not increase between cattle, sheep, and goats, as those species have different dietary requirements. Alpine pastures, however, were also under the pressure of flocks belonging to shepherds from outside the community, who would pay rent to the commune in exchange for access to this land. For example, at the end of the fifteenth century, the Gavia pastures were let to shepherds from the upper Val Camonica. This practice, which undoubtedly favored not only trade but also an increase in the varieties of sheep in the upper valley, was intensified by the commune in the second half of the century, even to the detriment of local livestock.⁵⁴

In any case, the new late medieval forms of organizing livestock had a negative effect on animal welfare. A further indicator of this deterioration is suggested by the first mention of an epizootic disease in the records at the end of the period under consideration.⁵⁵

The strict regulation of uncultivated areas also affected the lives of wild animals. Written sources offer data almost exclusively

54 ASCB, *Quaderni dei consigli*, 2/20 (sorte primaveraile, 1493), 7v; the Gavia pastures were let to a person from Vione. The public auctioning of the Braulio pastures, over which the bishop held the *herbaticum* and various other rights, is documented in ASCB, *Quaderni delle esecuzioni*, 4 (sorte primavera, 1491), 4–5; Della Misericordia, *I nodi della rete*, 68–72, 90, 95–98.

55 ASCB, *Dati e ricevuti*, 4 (1560), August 17. On epizootic diseases as a phenomenon to be framed within the context of broader environmental changes, see Appuhn, “Ecologies of Beef: Eighteenth-Century Epizootics and the Environmental History of Early Modern Europe,” *Environmental History*, XV (2010), 268–287.

concerning large predators. The commune promoted the hunting of such animals by offering rewards. In particular, the statutes provided for rewards for the killing of wolves, bears, and lynxes. The development of these written laws went together with the process of the demarcation of *sentiti* and woods. The anthropization of the environment, as an increasingly delimited and territorialized space subject to human domination even as far as pastures and woodlands were concerned, went together with the demonization of large predators, which came to be regarded as “pests” and “beasts,” in keeping with a trend characteristic of Western societies that has already been studied in detail in relation to wolves and bears. The spatial perception of the alpine territory and its forests, physically delimited by recording their boundaries in writing and drawing physical ones (through the use of wires, crosses, etc.), coincided with the communal authorities’ decision to likewise control the animal life within such areas.⁵⁶

The laws concerning bears can be dated precisely on the basis of a council resolution of 1383. The manuscript statutes, which were probably reworked in the late fourteenth and early fifteenth centuries, also include measures against wolves and lynxes. In the case of wolves, the bounty varied depending on whether large or small individuals were captured, thus distinguishing between adults and pups; the information suggests stable packs and not just dispersed individuals. For bears, the late medieval version of the statutes appears even more detailed than that of 1383. It explicitly refers not only to the species in general (*ursus*), but also to female individuals (*urse*). Since female bears are philopatric (they tend not to move from their area of origin), this record indicates the stable presence of bears in this high mountain area, which was optimally suited to the species’ characteristics.⁵⁷

As for the statutes that regulated the hunting of wild animals more generally, with particular reference to birds, especially partridges, hunting with nets was banned (although it appears to have been permitted for quail), as it risked compromising the presence of the species, whereas hunting with snares or birds of prey was

56 On bears, see Michel Pastoureaux, *L'ours: Histoire d'un roi déchu* (Paris, 2007); on wolves, see Gary Marvin, *Wolf* (London, 2011); Rao, *Il tempo dei lupi: Storia e luoghi di un animale favoloso* (Milan, 2018).

57 ASCB, *Quaderni dei consigli*, 2/38 (1383); ASCB, *Statuta seu leges municipales communis Burmii*, chaps. 216–217.

tolerated, thus favoring aristocratic hunting activities. Birds were also converted into an economic resource; the commune sold by public auction a special license to hunt *merli* (literally blackbirds, but the term probably referred to several species of passerines). Among the birds of prey used for hunting, the statutes mention “sparrow hawks, goshawks, or any noble bird,” suggesting that, although the first two species were the most common, others could also be used.⁵⁸

THE PROSOPOGRAPHY OF LARGE CARNIVORES Although sporadic, the council resolutions mentioning individual rewards for the killing of wolves or bears provide some insight into the presence of such species. These data are numerically limited, yet particularly valuable, because they are uncommon for the late medieval Alps (this kind of documentation only becomes more frequent in the Early Modern Age). Baratay has opened an innovative avenue for the study of animal history through the application of the biographical method to animals. Different research strategies borrowed from the analysis of human societies seem more suitable for reconstructing ecosystemic links. In particular, insofar as it studies populations of individual animals, prosopography is better suited to understanding the demographical dynamics of the societies of large medieval carnivores.⁵⁹

In total, apart from sporadic mentions of the catching of wolves and bears in the records of council meetings from 1383 onward, fifty large carnivores appear in the expenditure books between 1485 and 1500—eighteen wolves (three adults and fifteen cubs), twenty-nine bears (eleven large adults, four of which are females; four medium-sized individual animals, including one female; and fourteen cubs), and three lynxes (see Fig. 2).⁶⁰

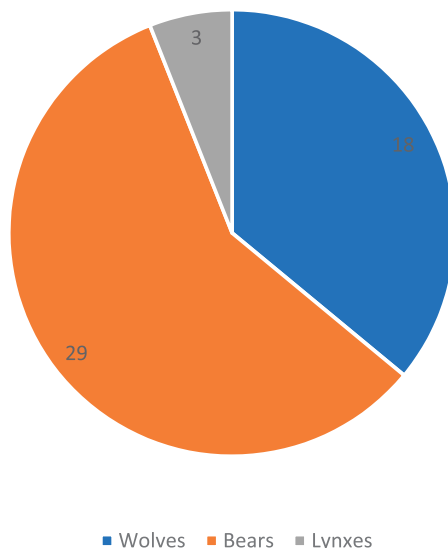
The most noticeable pattern to emerge is the greater number of data on bears. In addition to the ecological conditions in the high mountains, which are particularly favorable to the settlement of this large carnivore, it is likely that bears constituted a more noticeable presence and were therefore pursued with greater intensity. Owing to the nature of the documentation, however, it cannot be ascertained whether wolves had been the focus of

58 ASCB, *Statuta seu leges municipales communitalis Burmii*, chap. 214, 215.

59 Baratay, *Cultures félines (XVIII^e–XX^e siècle): Les chats créent leur histoire* (Paris, 2021).

60 ASCB, *Quaderni dei consiglieri*, 2/38; *ibid.*, 2/35 (1475); ASCB, *Dati e ricevuti*, 1 (expenditure books 1485–1500).

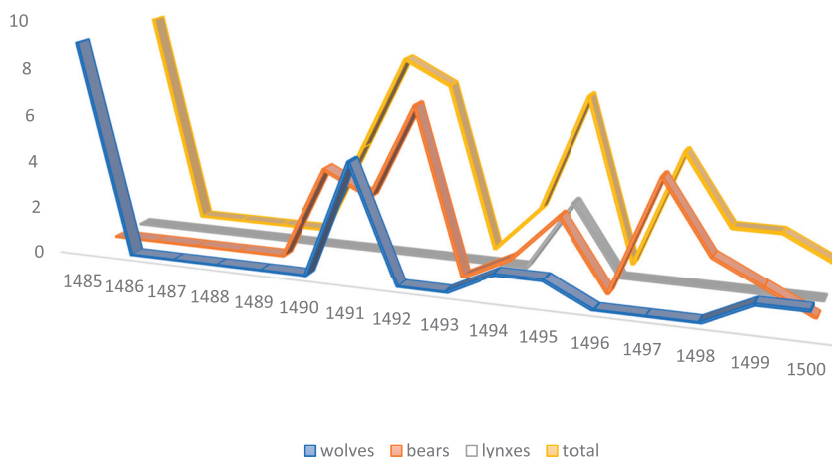
Fig. 2 Large Carnivores Captured in Bormino, 1485–1500



intensive extermination campaigns in the previous period, which would explain their more limited presence. At present, any connection between human-carnivore coexistence and climatic trends remains hypothetical. It cannot be ruled out that the expansion of anthropogenic activities in the Alps due to mild temperatures in the period 1350–1500, thought marked by significant variability, increased episodes of conflict in this period. Even so, what emerges is the presence of sedentary populations of wolves and bears (with pups and cubs), which are eventually diminished by extermination, especially in the last quarter of the fifteenth century (the period from which most of the surviving documentation dates).

Nevertheless, when compared with modern data, when the presence of wolves, bears, and lynxes is documented, the late medieval hunting of such species did not lead to their disappearance from the area, even though it reduced their numbers. Across the vast territory of the upper valley, the documented annual average amounts to about one wolf and two bears killed per year: too little to cause the disappearance of these species from the area, but probably enough to contain the presence of large carnivores and to reduce attacks on livestock. Hunting did not occur on a regular basis, but periodically, roughly every three years. It was probably

Fig. 3 Annual Capture Trend, 1485–1500



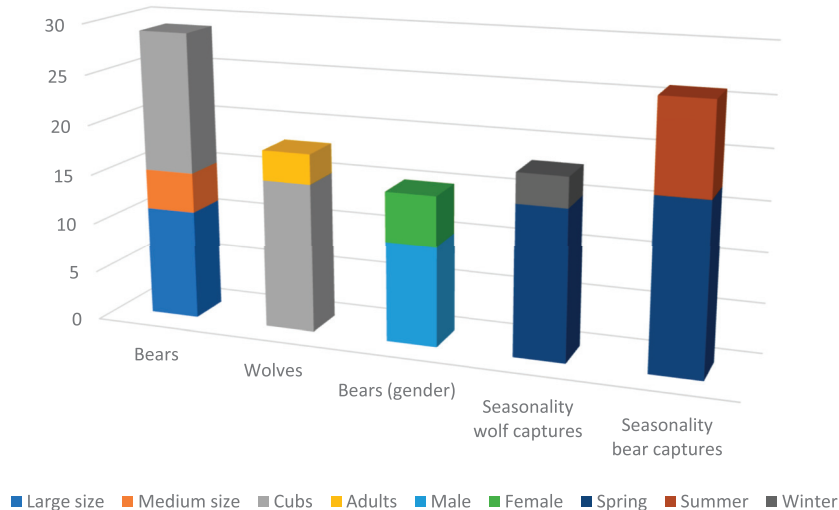
also affected by certain psychological factors. For example, in 1490 the sighting of a large bear in Bormio, where it had caused unspecified damage (*maximum dampnum*), sowed terror among the population. After this episode, several bears (a female and two cubs) and wolves were hunted (see Fig. 3).⁶¹

The capture of animals, both bears and wolves, was concentrated in spring and summer, the period when the area was most accessible to humans, even at high altitudes. It was also the season when the alpine pastures were open, triggering more conflicts with large carnivores. In the case of the bear, this period also falls outside the hibernation season, which normally occurs between mid-November and March. Overall, winter and autumn are seasons of lower availability of food for large carnivores, but also of greater security with respect to hunting activities. Overall, captures only rarely concern larger individual animals, as they tend to involve young adults and cubs (see Fig. 4).

The sources rarely allow for the identification the specific areas frequented by the animals, with the significant exception of a few individual specimens (a female and a cub in 1490 and an adult male in 1492) hunted in the Umbrail valley, one of the

61 See Massimo Favaron et al., “La presenza storica, l’assenza e il ritorno del lupo nel Parco nazionale dello Stelvio,” *Archivio storico ticinese*, LXIX (2021), 72–87; ASCB, *Dati e ricevuti*, 1 (sorte estiva, 1490), August 27.

Fig. 4 Bears and Wolves in Bormio from the Archival Sources (1485–1500)



wildest and least populated areas in the region. It is therefore likely, partly owing to the intensive exploitation of the mountains, that the animals had chosen as their habitat the most out-of-the-way areas, far from settlements. This valley, however, was close to the Braulio pastures, which were rented out by the commune of Bormio for summer grazing (creating a potentially problematic coexistence between farmers and wild animals). The transformations affecting large carnivores would thus also appear to have been strongly conditioned by the late medieval process of selecting environmental resources, which limited not only these animals' populations, but also the periods of the year and areas in which they could roam freely.

The research for this article did not yield the romantic picture of a mountain area inhabited by archaic societies in a balanced relationship with nature, handed down from generation to generation. On the contrary, this article reveals the emergence of several dynamic and innovative elements in that period—a real environmental break due to the creation of a new connectedness and unprecedented anthropogenic pressure on the environment, leading to the “reinvention” of Alpine “nature.” Increasingly

integrated into broad economic circuits, Alpine societies promoted the intensive exploitation of environmental resources and the integration of productive activities and trade on both sides of the Alps. The case of the upper Valtellina clearly illustrates this dynamic thanks to a wealth of public and private documents. Although this specific case study cannot be automatically extended to other areas of medieval Europe, or perhaps even to the entire Alpine arc, the methodological issues that it raises deserve to be explored in depth for other areas.⁶²

A superficial reading of the abundant documentation from this area suggests a high degree of environmental preservation. But the strict system of public surveillance created by the commune of Bormio must be interpreted as a profound rethinking of the modes of access to the environment, destined to alter ecological relations radically. This rethinking took place through a new spatialization of the mountain environment, which became hierarchized through particularly strict rules governing its use, a development that falls within the broader process of boundary creation at all economic and social levels reconstructed in relation to Alpine societies of this era by Della Misericordia. Indeed, it may certainly be argued that this phase was crucial for the emergence of the idea of the environment as a set of resources to be exploited in a sustainable manner. In this regard, within the debate on sustainability the analysis conducted on the documentation from the upper Valtellina comes closer to Kehnel's perspective—in identifying sustainable economic practices in medieval societies—than it does to that of Arnoux, who instead questions the applicability of the concept of resources to the Middle Ages.⁶³

The meticulous system of environmental management developed by the commune of Bormio seems almost like a handbook when compared to the traditional sustainability practices

62 Despite the specific forms of production, which varied from area to area, a similar trend can be detected across large stretches of the Alps. On the economic integration of the Alps and the exploitation of natural resources in general, see Braunstein (ed.), *La Sidérurgie alpine en Italie*; Menant, "Pour une histoire médiévale de l'entreprise minière"; Della Misericordia, *I nodi della rete*; Pierre Dubuis, *Une économie alpine à la fin du Moyen Âge: Orsières, l'Entremont et les régions voisines, 1250–1500* (Sion, 1990).

63 Concerning the tracing of boundaries in the late medieval Alpine world, see Della Misericordia, "I confini dell'economia," 272–277; *idem*, *I confini del mercato*, 179–181; on the idea of the "re-closing" of the Alps at the end of the late medieval cycle in which they "opened up," see Bergier, *Le cycle medieval*, 253–258.

highlighted in recent historiography, often by explicitly referring to the urgency of the issue in contemporary society. What emerges is the creation of systems to control and safeguard environmental resources, rules governing their use, and forms of distribution in the extraction of environmental resources to avoid their depletion. The conscious development of such measures by the local community is certainly impressive. It occurred within a historical ecological framework in which “sustainability” was achieved through the protection of economic resources, generally implemented in the phases of greatest environmental pressure. In other words, economic utilization was ensured, along with management methods that guaranteed the regeneration of woods and pastures.

The economic sustainability created by this commune, however, raises important questions about the environmental sustainability of the area. The forms of management conceptualized meadows, pastures, woods, and wildlife as elements disconnected from their ecosystemic context. The community created a system of rules that isolated these spaces, leading to a crisis in the forms of ecological entanglement that had characterized the alpine environment during the previous centuries. From this point of view, the central Alps appear to have adapted to the transition from “a subsistence regime in flux, typical of natural ecosystems” to a “stock economy.” This transformation was brought about by the presence of spaces that had become profoundly anthropized by the late Middle Ages and was founded on the accumulation of resources. It also crucially affected balances within the animal world, since “the ecological crisis affecting animals also made them future commodities.”⁶⁴

The situation in the upper Valtellina therefore challenges any anachronistic praise of medieval sustainability. Although the Alpine communities’ awareness of the risk of the depletion of environmental resources is evident, their sophisticated capacity to preserve such resources was governed by functional and economic objectives. This selective process eroded some of the pillars of the ecosystem, such as the interpenetration of different soils and the interaction between species, not to mention the elimination of certain environmental components (such as large carnivores) that carried considerable ecosystemic value, yet were

64 Arnoux, *Un monde sans ressources*, 123.

perceived as a hindrance to the economic exploitation of environmental resources.

By constructing representations of reality based on individual features of the environment (for example, the list of alpine pastures and sentiti or the statutes governing woods), the public documentary system (in this case, that of the commune of Bormio) crucially contributed to this way of understanding the environment as a resource. In this regard, even more so than the view of the relationship between man and nature borrowed from Christianity, it was the development of a public system for regulating resources that promoted the selective management of the environment, a process sustainable only insofar as it preserved economic resources.⁶⁵

65 This reference to the role of Christianity in undermining man's relationship with the environment has been suggested by Lynn White, Jr., "The Historical Roots of Our Ecologic Crisis," *Science*, CLV (1967), 1203–1207. By contrast, an emphasis on systems of rules as the foundation for economic sustainability can be found in the neo-institutionalist studies drawing upon Ostrom, *Governing the Commons*.

