Environmental History Advance Access published January 31, 2013

Iñaki Iriarte-Goñi

Forests, Fuelwood, Pulpwood, and Lumber in Spain, 1860–2000: A Non-Declensionist Story

Abstract

This article analyzes wood consumption in Spain between 1860 and 2000, taking into account underlying forces and exploring the effects on Spanish forests. The use of wood as a source of power tended to decline in Spain after the dawn of its industrial development, but this was compensated for by the use of wood as a raw material for industrial and urban purposes. The transition between those two models of wood consumption was very slow. Until the 1960s, the consumption of firewood remained high due to the difficulties in extending modern energy networks, and this coincided with a slow but continuous growth of wood consumption as a raw material. From the 1960s on, firewood consumption collapsed, but the use of wood as a raw material grew rapidly. This article shows the links between those transformations and major changes in the economic, technological, social, and political evolution of the country. It also explores the effects of wood consumption on the Spanish forests, highlighting the complex relationship between those two variables. In the long run, the growth of wood consumption

Iñaki Iriarte-Goñi, "Forests, Fuelwood, Pulpwood, and Lumber in Spain, 1860–2000: A Non-Declensionist Story," *Environmental History* (2013): 1–27.

doi:10.1093/envhis/emt002

did not lead to a national deforestation, but it did significantly affect the nature and the quality of the forests in Spain.

INTRODUCTION

Historians' attention to wood varies considerably, depending on which era they research. Historians of early modern Europe view wood of primary importance, highlighting its role as a source of heat energy for homes and industry, and also as raw material for a varied range of products (from ships to houses, from tools to transportation). As historian Paul Warde has indicated, in early modern Europe, "Wood provided, literally, the framework for everyday life."[1] Historians of nineteenth- and twentieth-century Europe, in contrast, pay less attention to wood, for they typically view the Industrial Revolution as a transition from economies based mainly on firewood to those based on fossil fuels.[2] They argue that once coal deposits became the "subterranean forests" from which an abundant energy source could be extracted, wood use began to lose its importance.[3] However, the emergence of fossil energy and new materials did not necessarily mean that wood ceased to be of prime importance after the Industrial Revolution. As F. T. Evans suggested in the 1980s, historians, influenced by the "journalists, poets and propagandists" of the Industrial Revolution "have been tempted to ignore wood's properties and uses."[4] Fortunately, since Evans's claim, some researchers have focused on recent wood use. For instance, the works of John R. McNeill and of Michael Williams offer an interesting global overview of the growth of wood consumption and its effects on forests, with emphasis on deforestation problems.[5] Similarly, recent works analyzing changes in global socioeconomic metabolism, through the accounting of material flows, also report substantial growth in global wood use throughout the twentieth century, and they highlight the growth of gross domestic product (GDP) and population as the main drivers of that growth.[6]

The analysis of wood use helps us better understand how the relationship between society and nature has changed over time. This work examines the evolution of wood consumption in Spain over 140 years. I explain the economic, political, and ecological forces that drove wood use, and I explore the effect of wood consumption on Spanish forests.

In the middle of the nineteenth century, more than two thirds of Spain could be considered forest surface. However, only a small part of this area was actually covered with trees, the majority of the Mediterranean type: oak (*Quercus pyrenaica*), holm oak (*Quercus ilex*), cork oak (*Quercus suber*), and various species of pine (*Pinus halepensis* near the Mediterranean shore and *Pinus sylvestris* var. *iberica* and *Pinus*

sylvestris var. *pyrenaica* inland and in the mountain areas). A small strip in the north of the country was covered by Atlantic forests of beech (*Fagus sylvatica*), chestnut (*Castanea sativa*), and oak (*Quercus robur*). Given the intense human use of the forests in Spain from ancient times, most of the forest surface was covered not by trees, but by Mediterranean brush and scrub-like heath (*Erica arborea*), gorse (*Ulex europaeus*), thyme (*Thymus vulgaris*), and rosemary (*Rosmarinus officinalis*). Thus much of the forest area had little economic value. Access for exploitation was limited by the available technology and infrastructure. Those areas that were exploited were mainly cleared for pastureland or used for firewood and charcoal to sustain the organic-based economy predominant in most of the country.

From the mid-nineteenth century on, Spain began a process of economic modernization until it became first an industrial economy, and later postindustrial. By the end of the twentieth century, it had an income level similar to other Western European countries. The energy transition proceeded by considerably increasing fossil fuel use and by adopting many of the technological and organizational innovations predominant in other Western economies. Spain experienced a series of forms of government that implemented distinct economic and environmental policies. All those changes were linked, in one way or another, with wood consumption and forest use. Exploring those links will provide a more complete, and more complex, understanding of the relationship between socioeconomic changes and the use and exploitation of natural resources.

The first section of this article examines the cycle of wood consumption between 1860 and 2000, differentiating between the consumption of firewood and wood as raw material. The next two sections investigate the economic, technological, and social forces behind the consumption of forest products. The fourth section evaluates the major consequences for the forests of the exploitation of wood.

A QUANTITATIVE APPROACH

I analyzed the evolution of wood consumption in Spain between 1860 and 2000 by combining the few existing works on the topic with certain reliable estimates and with available official statistics. I differentiated between firewood as an energy source and wood used as raw material. As explained later, the methodology varied according to the data available for different chronological periods.

For the period 1860–1935, no official statistics exist that allow us to calculate consumption, so I have resorted to sources and indirect methods.[7] The estimates of firewood consumption have as a starting point the only two available estimates of firewood consumption for the city of Madrid in the middle of the nineteenth century. Around 1860, the forest engineer González de la Peña reported a wood

consumption of 1.5 kilograms per person per day, although this figure is assumed to be a little low.[8] Recently Bernardos et al. reported a daily consumption of 2.1 kilograms per capita per day for the same period, but they admit that this figure could be high because of the concentration of many large houses for the nobility in Madrid that would require greater energy consumption than the average for the population.[9] Thus, our assumption is that daily national firewood consumption per inhabitant could be as high as 1.8 kilograms in 1860, a figure in line with those provided by other authors who have analyzed the consumption of firewood in other European countries in the same period.[10] I then followed the estimates of Mar Rubio who, in her analysis of energy consumption in Spain over the long term, reports a slow but continuous decline in firewood consumption per capita, due to the partial substitution of coal for firewood.[11] Given the method of calculation, these estimates are likely conservative, and they do not account for firewood coming from outside the forests, that is, in the form of residues of certain woody crops like grapevines, olive trees, and fruit trees.[12]

The consumption of wood as a raw material for this period is estimated based on the method used by industrial engineer Antonio Robert, who calculates wood consumption from estimations of final demand of those sectors of the Spanish economy that continued to use wood in the 1950s.[13] Other Spanish researchers apply different measurements to calculate the quantity of wood each sector used annually from 1860 to 1935. That measurement was tested in an earlier work.[14] With these calculations, it is possible to show a reasonable estimation of firewood and timber used both for domestic and for industrial uses. To estimate firewood and timber extracted from Spanish forests, I subtracted net imports from the estimates on national consumption.[15]

I gathered information about firewood as well as wood as a raw material for the period 1946–2000 from official production statistics. I accept that these data contain certain errors, and I made corrections following the methodology proposed by other authors.[16] Finally, I combined production data with that of foreign commerce.[17] Unfortunately, reliable data do not exist for the period 1936–46 (the Spanish Civil War of 1936–39 and the immediate postwar years). Disregarding that gap, I offer an annual series of 140 years that allows us to characterize wood consumption in Spain along the following basic lines.

The intensity of use (IOU; that is, the consumption of wood related to GDP) suffered a significant decline in the long term (figure 1). The Spanish economy used around 0.9 cubic meters of wood per unit of GDP in 1860 and only 0.04 in 2000. The decline was not completely linear, since there were some periods of stagnation and even temporary reversal of the trend. Nevertheless, that evolution leaves no

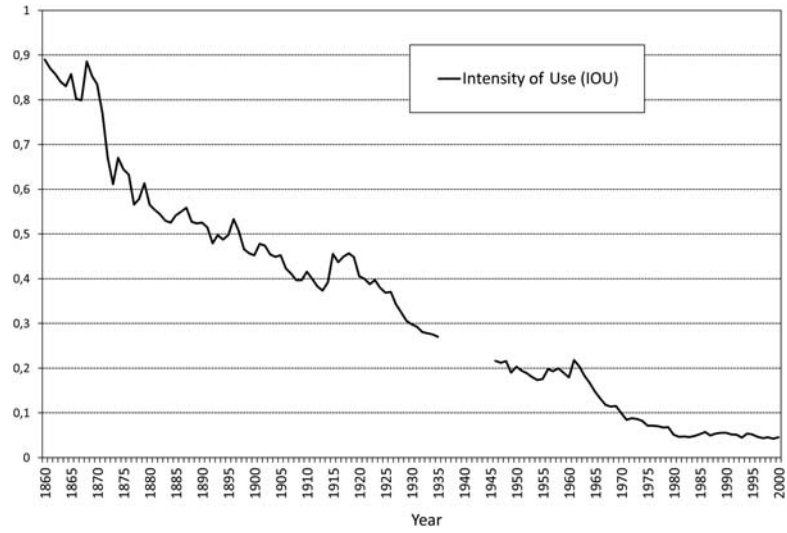

Figure 1: Intensity of use (IOU) of wood in Spain, 1860–2000. Measurements are in cubic meters of wood used per unit of gross domestic product (GDP). Credit: For GDP, see Angus Maddison, *The World Economy: A Millennial Perspective* (Paris: OCDE, 2001). For wood in the period 1860–1935, see Iñaki Iriarte-Goñi and María Isabel Ayuda, "Wood and Industrialization: Evidence and Hypotheses from the Case of Spain, 1860–1935," *Ecological Economics* 65 (2008): 177–86. For wood in the period 1946–2000, see Spanish Forest Statistics. See the text and endnotes 7–17 for more details.

doubt about the decline of the importance of wood in economic activity as a whole.

That loss of relative importance did not mean a total decrease in wood consumption (figure 2). On the contrary, if we compare the initial and final figures, we see that total consumption grew: the 17.2 million cubic meters consumed at the height of 1860 had increased by around 60 percent by the end of the twentieth century, reaching 28.1 million cubic meters in 2000.

The increase in total consumption is explained, in good measure, by a radical change in composition. In 1860, more than 90 percent of the wood consumed was firewood; that is to say, wood was an energy source. By the end of the twentieth century, in contrast, the percentages had been reversed, and it was wood as a raw material that dominated practically all consumption. Within wood as a raw material, wood pulp for paper had attained considerable prominence and made up a third of total consumption.

This basic evolution over the long term was not orderly over time, but was subject to considerable variations. In the case of firewood, there were periods when the downward trend was reversed and consumption grew, resulting in an elevated maintenance of the consumption of firewood until the beginning of the 1960s (a date that could be considered late in relation to other Western European

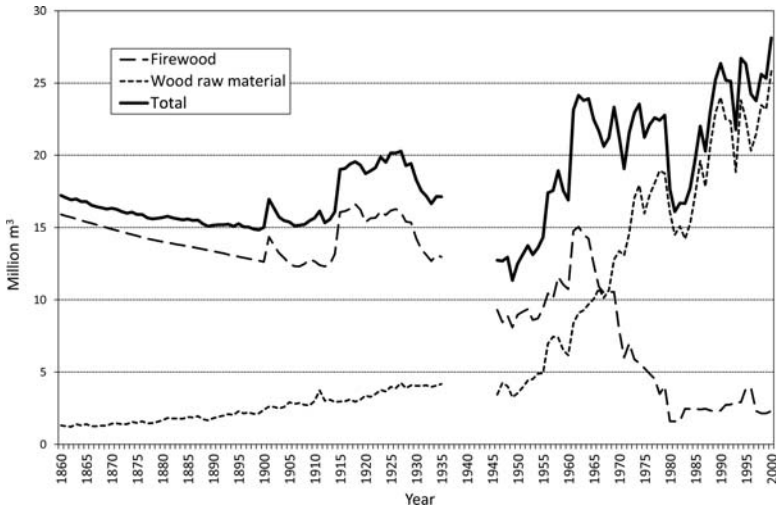

Figure 2: Firewood as energy source, wood used as raw material, and total wood consumption in Spain, 1860–2000. Measurements are in cubic meters. Credit: For wood in the period 1860–1935, see Iñaki Iriarte-Goñi and María Isabel Ayuda, "Wood and Industrialization: Evidence and Hypotheses from the Case of Spain, 1860–1935," *Ecological Economics* 65 (2008): 177–86. For wood in the period 1946–2000, see Spanish Forest Statistics. See the text and endnotes 7–17 for more details.

countries). In the case of the consumption of wood as a raw material, the evolution was much more orderly and the trend of growth was practically constant. Until the 1950s, growth was slow, and it was only from then that it accelerated, more than compensating for the fall in consumption of firewood. This points to the existence of a long transition process between the two distinctly different models of wood consumption, closely related to the economic and social transformation of the country, with significant environmental implications.

During the entire period studied, most consumption was derived from wood and firewood obtained from Spanish forests, bringing a growth and a restructuring of national wood extractions that evolved in close parallel to consumption and exerted considerable pressure on the country's forests. However, this pressure came about under two different scenarios (figure 3). During the long period in which the major consumption was that of firewood, imports and exports of wood were very low. In contrast, as the consumption of wood as a raw material gained prominence, Spain depended much more on international markets, for both imports and exports, suggesting some kind of timber specialization in Spain during the second half of the twentieth century that influenced the evolution of many forests in the country, about which I will comment later.

In short, these data allow us to affirm that, in spite of its decline in relative terms, wood did not disappear from the socioeconomic

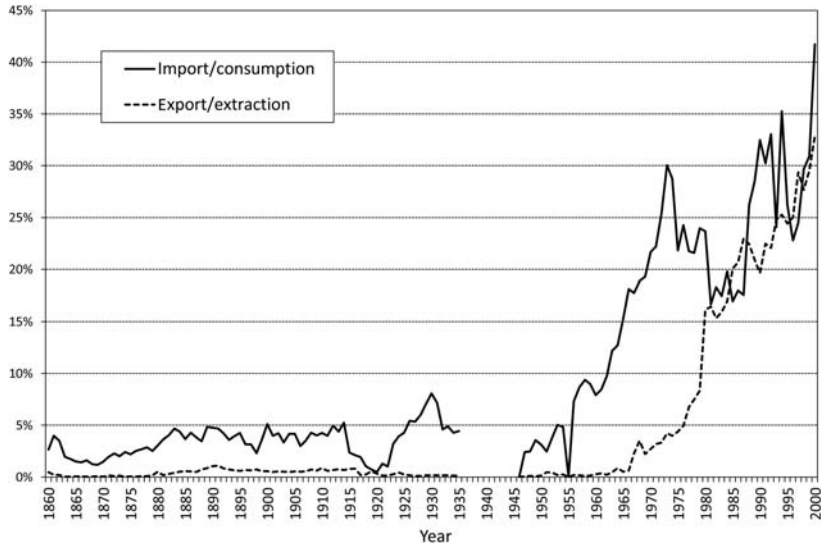

Figure 3: Wood imports and exports in Spain, 1860–2000. Percentage of cubic meters of wood imported over wood consumed and percentage of cubic meters of wood exported over wood extracted from the Spanish forests. Credit: For wood consumed and extracted, see the text and footnotes 15 and 17. For imports and exports of wood, see Spanish Foreign Trade Statistics, 1860–2000.

scene. On the contrary, it continued to be an important material whose uses were adapting to new situations. But what determined that evolution? To deal in an orderly way with the social, economic, and technological forces behind the changes, we can proceed to trace separately the evolution of the two basic kinds of wood (firewood and wood as a raw material) to see what elements influenced each case.

MAIN FORCES DRIVING FIREWOOD CONSUMPTION

In the middle of the nineteenth century, biomass was an essential energy source in Spain. Households and industries could burn almost anything that produced heat, be it straw, reeds, broom, or dried animal manure.[18] Of course, firewood and charcoal were the main energy sources, and the salient fact is that, despite the process of modernization of the Spanish economy, the level of firewood consumption remained high for one more century. Thus two questions need to be addressed: Why was the substitution of firewood slow and irregular until 1960, and why, from that moment, did the process accelerate?

The difficulties Spain had in adopting an energy mix similar to that of more advanced countries helps answer why firewood consumption remained high. This was in part due to Spain's reliance on its coal resources, which were primarily concentrated in a peripheral region of the country (Asturias) and were also of inferior quality, entailing high extraction costs that did not favor widespread use.[19] In fact, the areas that achieved greater industrial development in Spain (Catalonia and the Basque country) had to resort to imports of British coal in order to meet demand.[20] The construction of a basic rail network in the 1860s helped to alleviate this problem but did not extend the use of coal to the whole nation.

The situation began to change in urban areas during the first decades of the twentieth century, mainly due to the increased production of Spanish coal for industrial purposes and to the appearance of new energy sources. In the 1930s, Spain developed a hydroelectric production system as an alternative to its problematic coal resources.[21] Nevertheless, reliance on energy coming from firewood continued in rural areas.

During the nineteenth century, urbanization was fairly limited. Although migration to urban areas accelerated during the first decades of the twentieth century, the absolute number of people living in rural areas increased until the 1950s.[22] Given the absence of transportation and electricity infrastructures that might have permitted the expansion of modern energy use into the countryside, it seems logical to conclude that the greater part of the rural population, especially in the interior of the country, continued to depend on firewood for heating and cooking.

In short, although the consumption of firewood tended to decrease, it did so slowly and in an irregular way, picking up considerably when the country endured energy shortages. The first such shortage occurred during the First World War when the Spanish economy, thanks to its neutrality, increased its exports to the countries at war and so needed greater quantities of fuel. Given the difficulties in importing British coal in time of war, and given also the sharp rise in price of that fuel, firewood use had already increased by 1915. However, consumption did not decrease at the end of the war but instead remained elevated until the end of the 1920s, in a context of economic growth in which energy continued to be scarce and in which certain industries continued to use wood as a calorific source. During that decade, the use of firewood also intensified in the manufacturing of chemical products.[23]

The second period of recovery, much more evident, occurred in the 1940s and 1950s. By 1946, the level of consumption of firewood was very low, probably due to the demographic effects of the Civil War, which led to the death of 1.1–1.5 percent of the population.[24] After the war, the Franco regime instituted an autarchic policy that isolated

the country from the rest of Europe and led the Spanish economy to the worse economic period in the twentieth century. Lack of capital impeded imports of energy. Franco's government controlled the national distribution of coal, funneling it to certain priority national industries, and the production of electricity went through difficult times, with frequent cuts in supply.[25] The result was an energy shortage that increased consumption of firewood once more. In this context, the Franco regime itself had no other choice but to promote a return to firewood. The government declared the Gasifier industries—for the manufacture of charcoal-based fuel—to be of national interest during this period, in an attempt to guarantee "exploitation, without solving the continuity of all the national forest riches."[26] All of that led firewood consumption to increase to the levels of the 1920s, and these levels remained until the beginning of the 1960s.

To sum up, until the 1960s, Spain had serious difficulties in expanding modern energy networks, and this led, in turn, to the maintenance of high firewood consumption. In other words, the use of modern energy, despite its expansion, was not sufficient to produce a decoupling between energy consumption and land surface.[27] And this could have had a twofold effect: on the one hand, it could involve an energy restriction on growth; on the other, it increased pressure on the forests, with significant effects on deforestation, as we will see later.

From the 1960s on, that situation changed, and consumption of firewood plummeted. The date is no accident since, in 1959, the Franco regime had put in place the so-called Plan of Stabilization and Liberalization, an economic program inspired by various international institutions. The plan led to an acknowledgment of the failure of autarchic policies and, without dismantling the political system of the dictatorship, to the adoption of necessary measures favoring Spain's participation in the path of growth enjoyed by other European countries.[28] From an energy point of view, the relative opening up of the economy coincided with a general decline in the price of oil on world markets. This allowed for growing oil imports, which became the predominant energy source. At the same time, industrialization had begun, accompanied by a significant rural exodus.[29] The population that remained in the countryside also relied on other sources of energy. The electrification of rural areas spread, and during the 1960s, electricity came to practically all the municipalities of the country. Perhaps the most important development was the appearance of the butane gas cylinder, a relatively inexpensive form of energy that could be distributed individually, house by house, meeting the needs for heating and cooking in both urban and rural areas.

These transformations were not immediate but rather required a certain period of time for the population to adapt to the changes and to acquire the kitchens or stoves necessary for the new energy

supply. But that same industrial development, and the concomitant increase in per capita income, made it possible for change to occur relatively quickly. Changing gender roles were also important. Using gas rather than firewood saved time for the household, which was particularly important when at an important time of social change Spanish women were beginning to enter the industrial workforce.[30] It is also possible that people began to see firewood as obsolete or old fashioned, given the new energy possibilities.[31]

The combination of all these elements caused the consumption of firewood to fall sharply in less than a decade to very low percentages of total energy consumption. Only from the 1980s did firewood stabilize around 8–10 percent of total wood consumption, centered on uses related to recreational aspects (fireplaces in second rural residences, charcoal for barbecues and grills, etc.), which were marginal in overall energy consumption. In other words, it was only in the last decades of the twentieth century that the decoupling between energy and land surface became a reality in Spain.

FORCES DRIVING WOOD AS A RAW MATERIAL

The consumption of wood as a raw material underwent a very different evolution, with growth that was maintained throughout the 140 years under examination. Nevertheless, two significant periods can be distinguished: between 1860 and 1950: consumption grew at a constant but moderate rate (1.4 percent annually), and from 1950, the rate of growth shot up (3.1 percent annually). The basic idea is that modern economic growth, far from dispensing with wood as a raw material, used it in greater measure. But what led to these differences in the growth of consumption over these two periods?

In the middle of the nineteenth century, Spain was not a significant consumer of wood as a raw material, explained in part by the Mediterranean character of the greater part of its forests that provided a timber of inferior size and quality to that available in northern forests.[32] This, together with the long-term loss of forest surface, resulted in less wood as a raw material use in Spain than in central or northern European countries. Nevertheless, that natural limitation did not prevent the consumption of wood as a raw material from increasing, although modestly, starting in 1860.

In Spain, as in other Western countries, industrialization was associated with the socio-metabolic transition that affected not only the uses of energy but also the materials used.[33] First iron and then steel were replacing wood in some traditional uses such as boatbuilding, construction of large infrastructures, and the manufacturing of machinery and tools. Later, the appearance of reinforced concrete would have the same effect on the construction of large buildings. Nevertheless, wood continued to fulfill essential roles in the

construction of houses and buildings (roof structures, doors, windows, stairs, and floors). At the same time, industrial development promoted the use of wood as a raw material: the development of coal mining required significant quantities of pit props; the expansion of the rail network used large quantities of sleepers; the growth of commerce increased the demand for wood for the construction of barrels, boxes, and crates, and from the end of the nineteenth century, the spread of telephone and electric networks increased the use of poles to support the cables.[34]

These uses were favored by technological changes that affected wood. The arrival of the circular saw accelerated sawing and allowed for more precise cuts, and the technical possibilities of combining wood with metal elements offered greater strength and durability. At the same time, improvements in chemical treatments with creosote extended the life of the product, and steam-bending treatments facilitated the job of curving wood. New techniques emerged that allowed for the manufacture of products like plywood and, especially, wood pulp for paper.[35] All of this suggests that, from the middle of the nineteenth century, the consumption of wood as a raw material was closely related to changes in socio-metabolic processes, and as industrialization continued to progress, consumption of wood as a raw material and other materials increased.[36]

In this context, Spain saw an increase in the consumption of wood as a raw material, although it was modest compared to more industrialized countries like Britain. In 1860, Great Britain used three times more wood as a raw material per person than Spain, and that difference was slightly expanded in 1935 (figure 4). This was due to the fact that the economic achievements of Spain in the second half of the nineteenth century were also modest. The Spanish economy used wood in the same sectors as other countries (building, mining, railroads, and packaging for transportation), but limited population growth, the relatively slow urbanization process, the only moderate growth of coal mining, and the limited reach of the railway network caused the demand of wood as a raw material to grow more slowly than in other countries. In addition, Spain was not a leader in technology, and the necessity of importing the innovations related to wood as a raw material also delayed increased consumption.

Despite these differences, the consumption of wood as a raw material in Spain doubled between 1860 and 1900, due in large part to the increase in agricultural exports (especially of wine) and the need for wooden crates to transport these products. Later, consumption doubled again between 1900 and 1935, driven this time by industrial modernization, the urbanization process, and the increase in agricultural exports that took place in the 1920s.[37]

From the postwar period on, the consumption of wood as a raw material in Spain entered a new phase. One of the drivers of that change

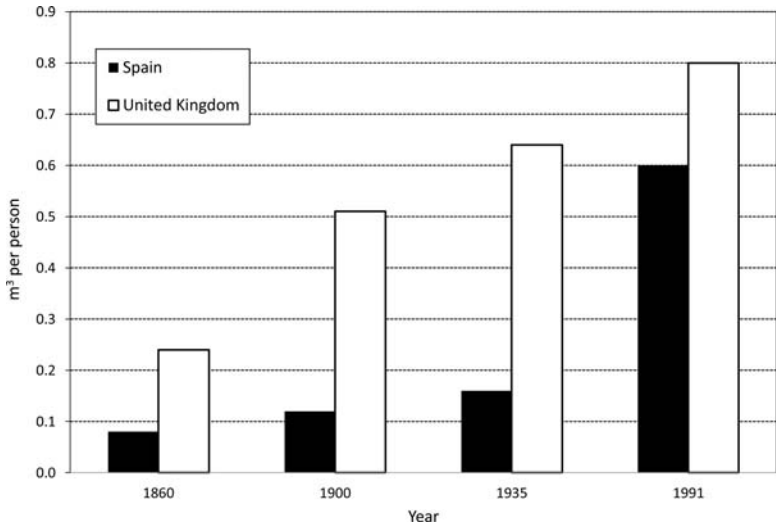

Figure 4: Wood consumed as raw material per capita in Spain and the United Kingdom, 1860–1991. Measurements are in cubic meters. Credit: For population, see A. Maddison, *The World Economy: A Millennial Perspective* (Paris: OCDE, 2001). For wood consumption in the United Kingdom in the years 1860, 1900, and 1935, see I. Iriarte-Goñi and M. I. Ayuda, "Not Only Subterranean Forests: Wood Consumption and Economic Development in Britain (1850–1938)," *Ecological Economics* 77 (2012). For wood consumption in Spain in the years 1860, 1900, and 1935, see Iñaki Iriarte-Goñi and María Isabel Ayuda, "Wood and Industrialization: Evidence and Hypotheses from the Case of Spain, 1860–1935," *Ecological Economics* 65 (2008): 177–86. For wood consumption in 1991 in both in United Kingdom and Spain, see E. Portillo, "Producción y consumo de madera industrial," *Revista de Estudios Agrosociales* 158 (1991).

was the economic policy of the 1940s and 1950s. The difficulties of importing raw materials in a fully autarchic system caused the regime to try to extend the uses of domestic wood, seeking self-sufficiency in a range of diverse products. In that context, the state initiated an ambitious plan of reforestation and, at the same time, attempted to develop specific industries concerned with the transformation of wood. One of the main attempts was to put into effect the so-called Cellulose Plan, which aimed to increase the uses of wood pulp for paper and textile fiber manufacturing.[38] To that must be added the continuing use of wood in construction, mining, rail networks, and the manufacture of shipping containers that continued to represent a considerable percentage of wood consumption until the 1950s.[39]

Again starting in 1959, changes in economic policy, and the accelerated industrialization process that followed, were essential to the increased consumption of wood as a raw material. It is certain that, from then on, wood began to lose some of its utility due to the arrival in Spain of certain innovations. For example, beginning in the early 1960s, rail sleepers were manufactured with reinforced

concrete, a technology that Spain was among the first countries to adopt. Similarly, construction of poles for telephone and electrical lines also began to use concrete and iron, and shipping containers came to be made of plastic.[40]

Nevertheless, those same innovations contributed to the development of new wood products. It was from then on that the use of plywood increased in Spain, and new board technologies began to arrive in the country: laminated veneer lumber, parallel strand lumber, oriented strand board, and new adhesives for reconstituted wood.[41] These new products allowed for standardized production and facilitated the inclusion of wood in the typical mass consumption of the second half of the twentieth century. The establishment in 1962 in Spain of the Wood Industries Technical Research Association (AITIM is the Spanish acronym) was significant in that process, disseminating knowledge of new technologies among the industries of the sector and allowing for better quality standardization. AITIM became a center for research in the properties of wood and promoted the use of wood in a wide range of industries and activities.

In 1977, AITIM highlighted the qualities of new wood products for the construction of housing and buildings for tourism and industry. These were products with high strength-to-weight ratios and were easy to work with, allowing greater freedom in construction and offering considerable levels of insulation and soundproofing. In addition, the possibility of combining wood with other materials in the so-called wood-cement complex and wood-plastic complex increased their range of use.[42] At the same time, new chemical treatments made wood much more resistant to fire and deterioration. The available statistics do not allow us to know the exact quantity of wood destined for construction in Spain, but the forecasts of the Spanish Ministry of Housing for the 1970s estimated a growth in demand for wood products (doors, windows, blinds, built-in wardrobes) of approximately 20 percent annually.[43] Given population growth and the intense process of urbanization that took place in Spain from the 1960s, and given also the successive booms in real estate that occurred in the following decades, a large percentage of wood consumption must have been taken up by the building sector.[44]

Another significant industry was the production of household and office furniture. In the 1950s, most products of the Spanish furniture industry were primarily handcrafted but a trend began toward standardized production following the acquisition of technology and foreign production methods. The modernization began with the simplification of generic furniture models and the production of standard interchangeable pieces. The Spanish furniture industry never attained the size and scope of its peers in other timber-rich countries, but beginning in the 1960s it grew considerably. Increased per capita income, the development of more comfort in housing, and the increase in

the number of public as well as private offices reinforced the growth in demand. The versatility of wood allowed for products available to people across different income levels and to accommodate a variety of professional needs. By the 1980s, Spanish furniture design began to play a significant role in the sector, setting new trends that created new lines of production and consumption.[45]

Finally, the third significant activity was the production of wood pulp for paper. Although the necessary technology for this had arrived in Spain at the beginning of the twentieth century, it was not until the 1950s that pulp industries began to grow, thanks to the government boost generated by the Cellulose Plan mentioned earlier. From then on, the increase in demand for paper and cardboard that accompanied economic modernization did the rest. In fact, paper registered among the most rapid growth of any Spanish industrial sector in the second half of the twentieth century.[46] This growth was related to the development of a large office/administrative sector and the development of the education sector in the 1960s. The growth of print journalism and of market-oriented publishing in Spanish (for both national and Latin American sectors), and the increase in the use of packaging for transportation and other commercial activities characteristic of mass consumption, also underpinned this expansion.

The strong growth in consumption of wood as a raw material that resulted from all those changes accounts for the fact that the gap between Spain and other European countries was considerably reduced by 1991 (figure 4). It also explains the changes in Spain's participation in the international wood market (figure 3).[47] The course that was followed via new technologies for wood processing allowed the use of this raw material, broken up into small particles and converted into pulp, in a way that was relatively independent of the size, shape, and quality of the original trees. This benefited a Mediterranean country like Spain that was not known for the quality of the wood from its forests. The Franco regime, which was already promoting the exploitation of domestic wood by the 1940s, took maximum advantage of this and continued to provide incentives for the planting and exploitation of rapid-growth wood principally destined for the industrial manufacturing of boards and pulp. That, together with the low salaries characteristic of the Spanish economy, allowed the country to begin to export those products to foreign markets. In contrast, Spain was deficient in quality wood and resorted more and more to imports.[48] This specialization of wood was maintained after the dictatorship and even intensified in recent decades after Spain joined the European Union with the investments that certain Nordic countries made in the Spanish wood pulp industry.[49]

THE EFFECTS ON SPANISH FORESTS

Ecological changes in forests historically have depended on a combination of factors.[50] Wood consumption was not the only element that influenced the evolution of Spanish forests. Nevertheless, changes in consumption, and their effect on the extraction of firewood and wood as a raw material, can highlight key factors in forest change.

Figure 5 shows available data regarding the expansion of Spanish forests.[51] For the years between 1860 and 1930, inclusive, we only know the total forest surface. This measure includes scrublands, brush areas, and natural grasslands, in addition to areas covered with trees. From 1946, the official data allow us to differentiate between total forest surface and the surface actually covered by trees (high forest surface). Between 1860 and 1946, there was a considerable loss of forested land. From then on, a recovery of total forest surface as well as of high forest surface began, which, with some variations, has continued to the present day. The end result is that at the beginning of the twenty-first century, Spain has 17 percent less total forest surface than in 1860, but an increasing proportion of that area is composed of high forests.

These data clearly show that it is not possible to establish a simple and mechanical causality between the quantity of firewood and wood as a raw material extracted from Spanish forests and

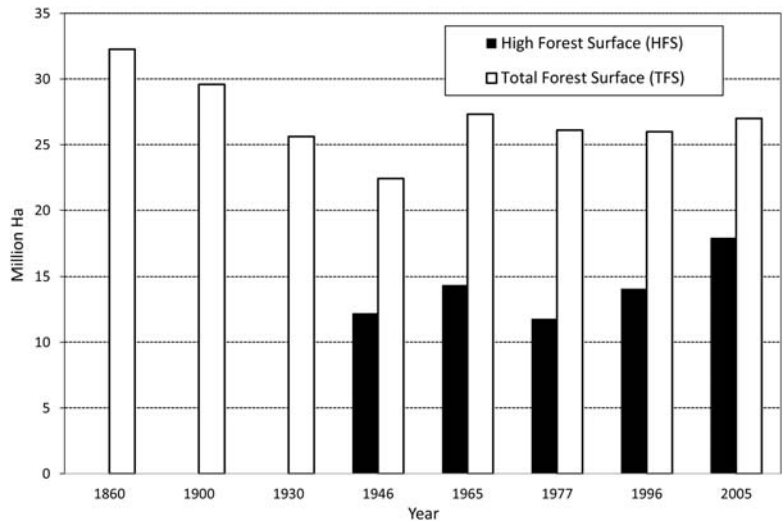

Figure 5: Total forest surface and high forest surface in Spain, 1860–2005. Measurements are in million hectares. Credit: For the years 1860, 1900, and 1930, see GEHR, "Más allá de la propiedad perfecta," *Noticiario de Historia Agraria* 8 (1994). For the years 1946 and 1965, see Congreso Forestal Español, "Situación de los bosques y del sector forestal en España" (Madrid: SECF, 2009). For the years 1977, 1996, and 2005, see Inventarios forestales españoles.

deforestation. In fact, in the last two decades of the twentieth century, extractions were greater than at any previous time, but total forest surface, and especially high forest surface, expanded. Obviously, that does not mean that close relationships cannot be found between wood consumption and the evolution of forest over time.

Between 1860 and the decade of the 1930s, the Spanish economy continued to support itself on a mainly organic basis.[52] In that context, as the population and GDP were growing, pressure on the forests also grew, mainly due to agricultural expansion. Environmental limitations in most of the country (especially the scarcity of water) made the intensification of farming very difficult. Therefore, the spread of cultivated land at the expense of forests, scrublands, and grasslands was the main route to increased food production.[53] It must be stressed that the pressure exercised by agriculture on forests was not limited to newly tilled areas. In addition, feeding livestock (the primary motive force) and the use of organic fertilizers also depended in great measure on products obtained from forested areas. Thus, the maintenance of an elevated consumption of firewood and the growth of commercial production of wood as a raw material were additional causes of deforestation, since they contributed to a vicious circle: the reduction of forest lands increased pressure on the remaining forests, and that increased pressure created, in turn, greater destruction of the forested surface. This dynamic caused some areas of southeastern Spain, which were especially sensitive to erosion, to become genuine deserts during the nineteenth century.[54]

The situation tended to worsen during the first third of the twentieth century when a new wave of plowing coincided with an upturn in wood consumption during the First World War and in the 1920s. At that time, Octavio Elorrieta, one of the principal Spanish experts on forests, reported deforestation since 1862 of 1.2 million hectares of oak and holm oak, and 0.9 million hectares of various kinds of pine, laying the blame on the excessive expansion of farming and consumption of charcoal.[55] Deforestation occurred mainly in relatively well-connected areas close to cities and villages. In this context, it is probable that firewood coming from vineyards, olive trees, and fruit trees replaced, to a significant extent, firewood coming from the vanished forest.[56] However, as some forest engineers complained, many rich forests of the country's mountainous areas remained largely unexploited through lack of public or private investment in creating access and building transportation infrastructures.[57] Thus, there was likely not a problem of general overexploitation but a problem of deficient use of resources. In 1918, and again in 1924, the government passed laws forbidding the indiscriminate cutting of wood and firewood, but they were largely ineffective. In the 1930s, a plan was designed for reforestation in an attempt to halt the destruction of the forests,

although the outbreak of the Spanish Civil War in 1936 prevented its immediate implementation.[58]

We do not know what specific effects the Spanish Civil War had on the consumption of wood, but as in the case with other wars, the use of wood and the deterioration of the forests could have been intense.[59] The fact that the lowest amount of total forest surface recorded in the whole period (figure 5) occurred in 1946 supports this idea. From then on, forested lands reversed the trend and the expansion did not stop until 1965. This is explained by the attitude toward forests that the Franco regime adopted after the war.

From its establishment, the Franco dictatorship saw a means of alleviating the economic difficulties of its autarchic policy through the development of forest riches. For this reason, it claimed as its own, and even broadened, the plans for reforestation that had been designed before the war. Later, once the worst postwar years were over, the regime saw a dual opportunity in the large-scale planting of trees to develop the industrial sectors related to wood, and to protect the other grand project of Francoism, building large water reservoirs.[60] The reforestation was an operation on an enormous scale, developed over many years and executed via the dictatorial methods that characterized the regime. In many cases, local living conditions were ignored, and, on occasion, entire villages were expropriated, their inhabitants expelled and replaced with trees.[61] By 1965, 1.9 million hectares had been reforested, the vast majority with monocultural plantations of coniferous trees (mainly *Pinus pinaster* and *Pinus radiata)*, in some cases, of the nonnative eucalyptus (*Eucalyptus globulus*).[62]

The process of reforestation coincided with other changes of a broader nature. From the end of the 1950s, technologies of the Green Revolution began to arrive in Spain (mechanization, chemical fertilization, and irrigation) that radically changed the relationship between farming and forests. Food production intensified and became much less dependent on the amount of cultivated land, and migration to the city generated by mechanization decreased the direct pressure of the population on the land.[63] The motivating force, as well as fertilizers, depended now on the respective industrial sectors and not on the area of the surrounding forest.[64] The combination of all these elements explains why, between 1946 and 1965, the forested surface grew, despite increasing extractions of firewood and of wood as a raw material. The reforested surface was, of course, different; it had lost its multifunctional character with links to traditional rural society, and it was primarily dedicated to supporting the growth of the new industrial society.

The available data on the reduction of high forest surface between 1965 and 1975 raise a number of concerns. The decline could simply be due to technical changes in methods of measuring the surface,

but that there existed a certain degree of deforestation cannot be discounted. Those were the years in which the consumption of firewood fell sharply, but they were also the years in which the extraction of wood as a raw material continued to grow. This was also the time when Spanish exports of wood pulp began to gain importance (figure 3). Despite the fact that during that period reforestation continued, the pace was much slower than that of the extraction of wood as a raw material, and that resulted in a net loss of forested surface, which specifically affected high forest surface (figure 5).[65] It is possible, therefore, that the overexploitation of some forests for purely industrial purposes, to cover both domestic and foreign demand, caused problems.

In any case, there is little doubt that in the last twenty-five years of the twentieth century, forest surface recovered its growth through various complementary causes. First, the crisis in the Spanish economy (a reflection of the international oil crisis) slowed consumption of wood between 1975 and 1985 (figure 1). This reduced logging, thus increasing recovery of some forests. Second, once the Franco dictatorship ended, management of public forests ceased to be centralized and came to depend on the various regional governments that, in many cases, carried out policies more focused on the conservation of forests rather than production.[66] Third, the decrease in farm incomes and the loss of competitiveness of agriculture, especially in mountainous areas, culminated in a general decline in farming activity.[67] Fourth, the accession of Spain to the European Union in 1986 encouraged reforestation. In fact, the European Union's Common Agricultural Policy provided incentives for farmers to abandon less profitable crops while subsidizing the planting of trees.[68] Private initiatives were involved in reforestation with rapid growth species from the 1960s, thanks to the incentives established by the Franco government. But it was through the help of the Common Agricultural Policy that the private planting of certain species, such as eucalyptus, gained greater prominence.[69]

By the end of the twentieth century, these elements had led to a highly specialized forest model. Logging focused almost exclusively on certain rapid-growth species capable of producing high yields per hectare per year. Between 1996 and 2000, 40 percent of timber removals were obtained from eucalyptus groves. If we add to that the removal of Pinaster pine (*Pinus pinaster*), Insigne pine (*Pinus radiata*), and poplar (*Populus tremula*), the figure reaches 90 percent of wood extractions. At the same time, a geographic concentration of commercial exploitation was produced, centering on those regions that could offer the greatest yields due to their environmental characteristics. By the close of the twentieth century, the Atlantic regions of the north (from Galicia to the Basque country) and of the southwest (Huelva, in

Andalusia), were producing 70 percent of the wood in Spain, even though they had only 20 percent of the nation's total forest surface.[70]

This new scenario of high forest productivity explains why the increase in logging was compatible with the growth of the surface covered by high forest. Despite this, the forest model established in Spain was not exempt from problems. The landscapes dedicated to wood production of wood were crops oriented toward industry, not forests. Many forests of species typical of the Mediterranean climate—oak, Holm oak, and cork oak—as well as many of the coniferous trees planted through reforestation efforts, remained at the margin of the prevailing wood model and are currently in a state of abandonment. The near-total lack of economic use of these particular areas puts them at high risk for forest fires and generates conservation problems.[71] Although many foresters consider the growth of forested area in recent decades to be good news, doubts exist whether that growth in quantity has meant an improvement in environmental quality.

CONCLUSION

The nineteenth and twentieth centuries were, in Spain as in the rest of the industrialized world, eras of new sources of energy, new technologies, and new materials. However, this did not initially lead to a decline in wood consumption. In spite of the fact that wood's significance declined in macroeconomic terms, its absolute consumption grew. Modern economic growth, rather than displacing traditional materials, superimposed an even more intense growth of the new materials.

The evolution of wood consumption in Spain was closely related to the great socioeconomic transformations undergone by the country. The relatively slow industrialization of the Spanish economy and its difficulties in expanding the use of fossil fuels before the middle of the twentieth century maintained a high level of consumption of firewood. This coexisted with the slow but constant growth of the consumption of wood as raw material. From the 1960s, economic modernization and the process of convergence with other Western countries in per capita income led to a sharp fall in the use of firewood. But these economic changes favored growth in the use of wood as raw material. During both periods, technological changes, the great majority coming from outside the country, played a dual role. On the one hand, they made possible the use of energy sources and substitute materials in certain wood applications. On the other hand, technology made possible the appearance of new wood-based products that eventually made up the bulk of Spanish wood consumption.

One of the peculiarities of the Spanish case is that the Franco regime presided over the connection between the periods of traditional and modern uses of wood. During its almost forty-year reign, the Franco

regime imposed a new forest model based primarily on monocropping coniferous trees, either to protect the large hydropower projects or to supply the national wood industry. That brought with it a specialization in the production of wood chips and wood pulp that satisfied the domestic market and began to be exported from the 1960s on. Despite that, the model was not self-sufficient because a significant portion of good quality wood came from imports in that same decade. In any case, this model created a type of path dependency that survived Franco's regime and intensified in the last decades of the twentieth century within the framework of the European Union.

The effects of wood consumption on forests in Spain were complex, and we cannot establish a mechanical relationship between the increase in consumption and the reduction of the forest surface. The major problems of deforestation were produced in the long period during which Spain began to develop a process of industrialization and growth that continued to be sustained, in great measure, by organic bases. During this period, there was no complete decoupling of energy and land surface. Food for people and fodder for animals continued to compete for land with energy in the form of firewood and with the production of wood as raw material for industrial purposes.

Later, the spread of modern energy sources and the intensification of agricultural production eased the pressure on the land, favored the decoupling, and facilitated expansion of the forests. It was this second scenario that made possible the consolidation of the forest model designed by the Franco regime. That, together with a growing concentration of extractions of wood from a very few species and in a very few regions, meant that, at the end of the twentieth century, the growth in forest surface and the increase in the production of wood were compatible. The growth in surface area of the forests has not necessarily improved the quality of those forests, either in social terms or environmental terms. The historic process by which the expansion of forest surface has been shaped seems, rather, to indicate the contrary.

Iñaki Iriarte-Goñi *is senior lecturer in economic history at the University of Zaragoza.*

Notes

I want to thank the Spanish Department of Education-MICIN projects ECO2009-07796 and HAR2009-09700 and the Department of Science, Technology and Universities of the Aragonese Government, consolidated research group "Agro-Food System History" (DGA 169-61) for financial support. I also wish to express gratitude for the useful comments of the two reviewers of *Environmental History*.

1 Paul Warde, *Ecology, Economy and State Formation in Early Modern Germany* (Cambridge: Cambridge University Press, 2006), 5–6. On the uses of wood in

preindustrial societies, see also Joachim Radkau, *Nature and Power: A Global History of the Environment* (Cambridge: Cambridge University Press, 2008), 131–36; and Kenneth Pomeranz, *The Great Divergence: China, Europe and the Making of the Modern World Economy* (Princeton: Princeton University Press, 2000), 221–26. See also Jason W. Moore, "Amsterdam Is Standing on Norway. The Alchemy of Capital, Empire and Nature in the Diaspora of Silver, 1545–1648," *Journal of Agrarian Change* 10 (2010): 33–68; and Jason W. Moore, "Amsterdam Is Standing on Norway. Part II: The Global North Atlantic in the Ecological Revolution of the Long Seventeenth Century," *Journal of Agrarian Change* 10 (2010): 188–227.

2 Tony Wrigley, *Continuity, Chance and Change: The Character of the Industrial Revolution in England* (Cambridge: Cambridge University Press, 1988); Tony Wrigley, *Energy and the English Industrial Revolution* (Cambridge: Cambridge University Press, 2010). An historiographic summary of the relations between the Industrial Revolution and energy can be found in Susana Barca, "Energy, Property, and the Industrial Revolution Narrative," *Ecological Economics* 70 (2011): 1309–15.

3 The expression "subterranean forests" comes from Ralph P. Sieferle, *The Subterranean Forest: Energy Systems and the Industrial Revolution* (Cambridge: White Horse Press, 2001).

4 F. T. Evans, "Wood Since the Industrial Revolution: A Strategic Retreat?" *History of Technology* 7 (1982): 37.

5 Michael Williams, *Deforesting the Earth: From Prehistory to Global Crisis. An Abridgment* (Chicago: Chicago University Press, 2006), 263–356, 466–69. John R. McNeill, *Algo Nuevo bajo el sol. Historia medioambiental del mundo en el siglo XX* (Madrid: Alianza Editorial, 2003), 279–89, 369–70.

6 Fridolin Krausmann, Simone Gingrich, Nina Eisenmenger, Karl-Heinz Erb, Helmut Haberl and Marina Fischer-Kowalski, "Growth in Global Materials Use, GDP and Population during the Twentieth Century," *Ecological Economics* 68 (2009): 2696–2705. On the concept of social metabolism in historical perspective, see Manuel González de Molina and Victor Toledo, *Metabolismos, naturaleza e historia. Hacia una teoría de las transformaciones socioecológicas* (Barcelona: Icaria, 2011).

7 This part of the work follows mainly the contribution of Iñaki Iriarte-Goñi and María Isabel Ayuda, "Wood and Industrialization: Evidence and Hypotheses from the Case of Spain, 1860–1935," *Ecological Economics* 65 (2008): 177–86.

8 González de la Peña's data comes from tax sources, and some degree of tax evasion cannot be discounted. González de la Peña, "Consumo de combustible vegetal y madera en Madrid," *Revista de Montes* (1873): 79–86.

9 José Bernardos, Javier Hernado, Gonzalo Madrazo, and José Nieto, "Energy Consumption in Madrid 1561 to c.1860," in *Common Ground: Integrating the Social and Environmental in History,* ed. Geneviève Massard-Guibaud and Stephen Mosley (Cambridge: Cambridge Scholars Publishing, 2011), 316–39.

10 Paulo Malanima, "Energy Crisis and Growth 1650–1850: The European Deviation in a Comparative Perspective," *Journal of Global History* 1 (2006): 101–21; Sieferle, *The Subterranean Forest*. According to those authors, daily firewood consumption per capital could range from 1 kilogram in the south of Italy to 7–10 kilograms in the Scandinavian countries.

11 Mar Rubio, "Energía, economía y CO_2: España 1850–2000," *Cuadernos Económicos del I.C.E.* 70 (2005): 52–75. The author's estimates are based on the evolution of firewood extractions from Spanish public forests.

12 Some recent works highlight the importance of this kind of firewood as an energy source in rural environments. In the actual state of the art, it is not possible to make reliable national estimates for that kind of firewood. Xavier Cussó, Ramón Garrabou, and Enric Tello, "Social Metabolism in an Agrarian Region of Catalonia (Spain) in 1860–1870: Flows, Energy Balance and Land Use," *Ecological Economics* 58 (2006): 49–65. Juan Infante highlights in his work the important use of olives trees residues (including firewood) for energy purposes. See Juan Infante, "El carácter de la especialización olivarera en el sur de España (1750–1930)," Ecología, campesinado e historia, *WP Sociedad Española de Historia Agraria,* 1201. http://ideas.repec.org/p/seh/wpaper/1201.html.

13 Antonio Robert, "La Producción Forestal y el Crecimiento Económico," in *Estudios hispánicos de desarrollo económico*, ed. A. Robert (Madrid: Instituto de Cultura Hispánica, 1957). The author considers a variety of timber uses: house building, sleepers for railroads, pit props for mining, poles for electric networks, and cases and crates for transportation.

14 For a detailed explanation of assumptions and coefficients, see Iñaki Iriarte-Goñi and María Isabel Ayuda, "Una estimación del consumo de madera en España entre 1860 y 1935," Documento de trabajo de la Asociación Española de Historia Económica, DT-AEHE 0603 (2006).

15 Since total wood consumption has been estimated, the formula used to calculate wood extractions from Spanish forests is extractions = consumption − imports + exports.

16 Regarding the statistical errors and the methods of correction, see Grupo de Estudios de Historia Rural, "Bosques y crisis de la agricultura tradicional. Producción y gestión de los montes españoles durante el franquismo (1946–1979)," in *Historia y economía del bosque en la Europa del sur (siglos XVIII–XX)*, ed. José Antonio Sebastián Amarilla and Rafael Uriarte Ayo (Zaragoza: SEHA, 2003), 293–370. Between 1956 and 1970, statistics provide data of extremely high levels of consumption of firewood in a specific region in the north of the country (Galicia). Given the doubtful credibility of this statistical jump, a correction has been made with the assumption that the percentage of production of firewood from Galicia with regard to all of Spain was the same between 1956 and 1970 as it was between 1946 and 1956.

17 In this case, consumption was calculated from national production, according to this formula: consumption = production + imports − exports. Production information was obtained from the *Estadísticas Forestales* (Forests Statistics) (1946–70) and from the chapter "Wood" from the *Anuario de estadística Agraria* (yearbooks of agrarian statistics) (1970–2000). Information on imports and exports was obtained from Spanish statistics on foreign trade.

18 Bernardos et al., "Energy Consumption in Madrid," 333.

19 On the problems of Spanish coal, see Sebastian Coll and Carles Sudria, *El carbón en España, 1770–1961: una historia económica* (Madrid: Turner, 1986); and Carles Sudría, "La restricción energética al desarrollo económico de España," *Papeles de economía española* 73 (1997): 165–88.

20 See the classic work of Jordi Nadal, *El fracaso de la revolución industrial en España, 1814–1913* (Barcelona: Ariel, 1975).

21 Carles Sudría, "La restricción energética al desarrollo económico de España," *Papeles de economía española* 73 (1997): 165–88.

22 Fernando Collantes and Vicente Pinilla, *Peaceful Surrender: The Depopulation of Rural Spain in the Twentieth Century* (Cambridge: Cambridge Scholars Publishing, 2011), 37.

23 The commercial firm El Irati in the north of Spain is a good example of the development of firewood distillation for commercial purposes. See Josean Garrués, "El Irati, compañía general de maderas, fuerzas hidráulicas y tranvía eléctrico de Navarra: una empresa autoproductora comercial de electricidad, 1904–1961," *Documentos de trabajo Fundación SEPI* 1 (2008).

24 Figures were taken from Jordi Catalán, *La economía española y la segunda guerra mundial* (Barcelona: Ariel, 1995). During the Spanish Civil War, there was a sharp increase in mortality and a decrease in births, halting population growth for several years. To that was added the exile of several hundred thousand people for political reasons. See Roser Nicolau, "Población, salud y actividad," in *Estadísticas históricas de España, siglos XIX y XX*, ed. A. Carreras and Xavier Tafunell (Madrid: BBVA, 2005), 455– 502.

25 Regarding energy problems in Spain in the 1940s, see Jordi Catalán, *La economía española y la segunda guerra mundial* (Barcelona: Ariel, 1995).

26 Comisaría General de Abastecimientos y Transportes (Dirección Técnica), "Circular número 757 on price fixing in the consumption of firewood and charcoal," *Boletín Oficial del Estado*, 250, September 9, 1950, 3914–15. Despite this law, the data suggest that prices of firewood rocketed due to the high demand. See Juan Infante, "El carácter de la especialización olivarera," 39.

27 Sieferle, *The Subterranean Forest,* 100–5, detected a clear saving of land in England due to the use of coal coming from subterranean forests. This idea must be handled with caution in the case of Spain, where pressure on land remained high.

28 Regarding the Plan of Stabilization and Liberalization of the Spanish economy, see Enrique Fuentes Quintana, "El Plan de Estabilización Económica de 1959: veinticinco años después," *ICE: Revista de economía* 612–13 (1984): 25–40.

29 Fernando Collantes and Vicente Pinilla, *Peaceful Surrender: The Depopulation of Rural Spain in the Twentieth Century* (Cambridge: Cambridge Scholars Publishing, 2011), 37.

30 In many Spanish rural areas, the gathering of firewood was a task for women, as was cooking, in both rural and urban areas.

31 New energies associated with new home machines could reduce the use of firewood for other domestic works like laundry. See, for instance, Constance L. Shehan and Amanda B. Moras, "Deconstructing Laundry: Gendered Technologies and the Reluctant Redesign of Household Labor," *Michigan Family Review* 11 (2006): 39–54.

32 The relative scarcity of rain and excessive heat had a negative influence on the growth of trees, often giving rise to specimens of reduced and irregular dimensions compared to those from more northern forests. In addition, short mild winters caused the growth rings to be less compact, so that the product obtained, with some exceptions, offered less strength. See Omar M'hirit, "El bosque mediterráneo: espacio ecológico, riqueza económica y bien social," *Unasylva* 197 (1999): 3–15.

33 On the idea of socio-metabolism, see Marina Fischer-Kowalski and Helmut Haberl "Metabolism and Colonization Modes of Production and the Physical Exchange between Societies and Nature," *Innovation in Social Sciences Research* 6 (1993): 415–42. Long-term views of the material flows related to the socio-metabolic transition appear in Fridolin Krausmann, ed., "The socio-metabolic transition: Long term historical trends and patterns in global material and energy use." Social Ecology working paper 131 (2011).

34 A general view of the main uses of wood at the beginning of the twentieth century appears in Nelson C. Brown, *Forest Products, Their Manufacture and Use: Embracing the Principal Commercial Features* (Boston: John Wiley, 1919).

35 On the technical changes that affected wood throughout the nineteenth century, see Charles M. Haines, "The Industrialization of Wood: The Transformation of a Material" (PhD diss., University of Delaware, 1990).

36 See, for instance, the comparison between the United Kingdom and Austria-Hungary in Simone Gingrich, "Foreign Trade and Early Industrialisation in the Habsburg Monarchy and the United Kingdom—Two Extremes in Comparison," *Ecological Economics* 70 (2011): 1280–88.

37 For the variations in Spain's foreign trade of agricultural products, see Vicente Pinilla, "Cambio agrario y comercio exterior en la España contemporánea," *Agricultura y Sociedad* 75 (1995): 153–80.

38 As was happening in other economic sectors, the "Cellulose Plan" was in good measure a copy of the actions that had been set in motion during the 1930s in other totalitarian countries that followed autarchic policies (Germany, Italy, and Japan). The aim of Franco's regime was to use technologies from those countries to exploit the maximum economic possibilities of national organic raw materials such as wood. Although the plan did not achieve the desired objectives, it had significant effects on the increase in demand for wood for industrial purposes. See Eduardo Rico, "La política autárquica y la industria de la celulosa en España," Comunicación al VII congreso de la Asociación Española de Historia Económica, Zaragoza (2001).

39 Antonio Robert, "La Producción Forestal y el Crecimiento Económico," in *Estudios hispánicos de desarrollo económico* (Madrid: Instituto de Cultura Hispánica, 1957).

40 On the substitution of rail sleepers, see Fernando Najera, "Traviesas de madera y traviesas de hormigón," *Revista AITIM* 14 (1965). On the substitution of poles, see Renee Peyresaubes, "El poste de madera, soporte de las líneas telefónicas y eléctricas aéreas," *Revista AITIM* 37 (1969).

41 On the development of the use of plywood, see Cesar Peraza, "El tablero contrachapado. Su fabricación y aplicaciones," *Revista AITIM* 8 (1964). On the evolution of boards, see Redacción AITIM, "Encuesta 1968 de la FAO sobre capacidad de producción de Tableros Contrachapados, de Partículas y de Fibra," *Revista AITIM* 36 (1969); Santiago Vignote, "Los tableros de fibras de densidad media," *Revista AITIM* 98 (1979); Redacción AITIM "Nuevos adhesivos para OSB," *Revista AITIM* 183 (1996).

42 Cesar Peraza, "La madera y sus productos derivados. Posibilidades en la construcción en función de sus características tecnológicas," *Revista AITIM* 86 (1977).

43 Redacción AITIM, "Consulta mundial sobre el empleo de la madera en viviendas: Informe AITIM sobre la situación española," *Revista AITIM* 41 (1970).

44 On the evolution of the construction sector in Spain, see Xavier Tafunell "Urbanización y vivienda," in *Estadísticas históricas de España, siglos XIX y XX*, ed. A. Carreras and X. Tafunell (Madrid: BBVA, 2005), 455– 502. On the booms in real estate, see José Manuel Naredo, *La burbuja inmobiliario-financiera en la coyuntura económica reciente, 1985–1995* (Madrid: Siglo XXI, 1996).

45 On the evolution of the furniture industry in the decade of the 1960s, see José I. de Cisneros, "Historia de la productividad en las fábricas de muebles en España," *Revista AITIM* 19 (1966); On the evolution of furniture design, see Redacción AITIM "B. D. 30 años de diseño de muebles," *Revista AITIM* 220 (2002).

46 Gabriel Tortella, *El desarrollo de la España contemporánea* (Madrid: Alianza Editorial, 1994), 370.

47 Spain, with consumption of wood as a raw material at 0.60 m^3 per person in 1991, fell slightly below the European mean, which stood at 0.67 m^3 in that same year. These figures were obtained from Emilio Portillo, "Producción y consumo de madera industrial," *Revista de Estudios Agro-sociales* 158 (1991): 149–64.

48 Various authors coincide in the maintenance of that model of wood during the last decades of the twentieth century. See Alberto Prada Blanco, "Política forestal y circuitos de la madera: Galicia y España en los contextos europeos," *Revista de Estudios Agro-Sociales* 158 (1991): 165–87; Luis Díaz, Casimiro Herruzo, and Victor Pérez, "Evolución y características del comercio exterior de la industria forestal, l995–2003," *Boletín Económico del ICE* 2861 (2005): 27–39; and Juan Antonio Pernas, "Evolución del comercio exterior de la cadena de la madera en la última década," *Boletín Económico del ICE* 2862 (2005): 157–74.

49 María Luisa Chas Amil, "Comercio exterior español de productos forestales," *Agricultura y Sociedad* 85 (1998): 167–78.

50 Nancy Langston, "On Teaching World Forest History," *Environmental History* 10 (2005): 20–29; Michael Williams, *Deforesting the Earth. From Prehistory to Global Crisis. An Abridgment* (Chicago: University of Chicago Press, 2006); John R. McNeill, *Algo nuevo bajo el sol. Historia medioambiental del mundo en el siglo XX* (Madrid: Alianza, 2003), 279–89.

51 Data prior to 1977 are estimates of the surface that are subject to possible revisions. They deal with approximate data but are all that is currently available. After 1977 the data come from the Inventarios Forestales Nacionales (Spanish Forests National Inventories) and have a greater degree of reliability.

52 In 1935, 51 percent of the energy consumed in Spain came from traditional sources; in the case of the Netherlands, that number was 17 percent. Ben Gales, Astrid Kander, Paolo Malanima, and Mar Rubio, "North versus South: Energy Transition and Energy Intensity in Europe over 200 years," *European Review of Economic History* 11 (2007): 219–53.

53 On the limitations of traditional agriculture in Spain, see M. González de Molina "Condicionamientos ambientales del crecimiento agrario español (siglos XIX y XX)," in *El pozo de todos los males*, ed. Jordi Pujol et al. (Barcelona: Crítica, 2002), 43–94.

54 Juan García Latorre, Andrés Sanchez Picon, and Jesús Garcia Latorre, "The Man-Made Desert: Effects of Economic and Demographic Growth on the Ecosystems of Arid Southeastern Spain," *Environmental History* 6 (2001): 75–94.

55 Octavio Elorrieta was the first Forest General Manager of Spain from 1925 to 1931. See Iñaki Iriarte-Goñi, "La obra de Octavio Elorrieta (1881–1962). El monte al servicio de la economía," *Historia Agraria* 48 (2010): 133–49.

56 See Infante, "El carácter de la especialización olivarera," and Cusso et al., "Social Metabolism in an Agrarian Region of Catalonia (Spain) in 1860–1870," 63.

57 See, for instance, Fernando Baró, "Los transportes forestales en España: su importancia económica y social," *Primer Congreso Nacional de Ingeniería, Sección 8ª, Industria Forestal y sus derivadas* (Madrid: Sucesores de Rivadeneyra, 1920).

58 Ley de defensa de los bosques, Gaceta de Madrid, Nº 209, 28 de julio de 1918, 273 y ss. And Gaceta de Madrid, Nº 339, 4 diciembre de 1924, 1067 y ss. On the reforestation project in the 1930s, see José Ignacio Jiménez Blanco, "El monte: una atalaya de la historia," *Historia Agraria* 26 (2002): 141–92.

59 On the importance of wood in wars throughout history, John R. McNeill, "Woods and Warfare in World History," *Environmental History* 9 (2004): 388–411. For the case of France during the Second World War, see Charles Pearson, "The Age of Wood: Fuel and Fighting in French Forests 1940–1944," *Environmental History* 11 (2006): 775–804.

60 The reforestation of the hillsides was fundamental to avoid problems of muddy runoff into the reservoirs. See Grupo Estudios Historia Rural, "Bosques y crisis de la agricultura tradicional," 342.

61 On the effects of the monocultural plantations in some areas of the Pyrenees, see Francis Chauvalier, *La repoblación forestal en la provincia de Huesca y sus impactos geográficos* (Huesca: Instituto de estudios Altoaragoneses, 1990).

62 Reforestation with eucalyptus and coniferous trees, both of which grow rapidly, was done mainly in the Atlantic regions of the country, initiating a specialization of industrial wood production in these areas that grew over time. Josefina Gómez Mendoza y Rafael Mata Olmo, "Actuaciones forestales públicas desde 1940. Objetivos, criterios y resultados," *Agricultura y Sociedad* 65 (1992): 15–64.

63 The extent of cultivated surface that existed in the 1930s was never again attained during the second half of the twentieth century. See A. Carreras and X. Tafunell, eds., *Estadísticas históricas de España, siglos XIX y XX* (Madrid: BBVA, 2005), 304.

64 J. M. Naredo and C. Abad, "Sobre la modernización de la agricultura española," in *Agricultura y sociedad en la España contemporánea*, ed. J. J. González and C. Gómez (Madrid: McGraw-Hill Interamericana de España, 2002), 81–142.

65 Reforestation between 1965 and 1975 had a mean annual growth rate of 0.4 percent. The extraction of wood as a raw material in that period grew at an annual rate of 6.7 percent.

66 From the 1980s on, the views of the environmental movements were extremely critical of the existing forest policy and claimed a new policy more oriented to native species reforestation and biodiversity conservation. See, for instance, Carmen Ortega Hernández-Agero, ed., *El libro rojo de los bosques españoles* (Madrid: Adena W.W.F, 1989).

67 José Manuel Naredo, *La evolución de la agricultura en España, 1940–1990* (Granada: Servicio de Publicaciones Universidad de Granada, 1996); Fernando Collantes, *El declive demográfico de la montaña española (1850–2000) ¿Un drama rural?* (Madrid: Ministerio de Agricultura, 2004).

68 On the effects of the CAP in the Spanish forests, see Jaime Lamo de Espinosa, "Las áreas de montaña y la política forestal en la nueva política agraria comunitaria," *Revista de Estudios Agro-Sociales* 158 (1991): 29–55.

69 The production of eucalyptus wood in Spain grew mainly in the last twenty-five years of the twentieth century. Between 1975 and 1999, its growth was greater than 200 percent. *Anuario de Estadística Agraria* (Agrarian Statistics Yearbooks), 1975 and 1999.

70 *Anuarios de Estadística Agraria* from 1996 to 2000. Juan Carlos Fernández-Espinar, "La legislación forestal en el Estado de las autonomías," *Revista de Estudios Agro-Sociales* 158 (1991): 107–31, shows that in the Atlantic regions of Spain, regional government forest policies were much more oriented to high yields of wood production.

71 On the relationship between the disappearance of economic uses in the forests and fires, see Ricardo Vélez, "Los incendios forestales y la política forestal," *Revista de Estudios Agro-sociales* 158 (1991): 83–105. On the possible effects of the abandonment of the forests and their environmental deterioration, see Enrique Arrechea, "La gestión forestal en los espacios naturales protegidos: el ejemplo del Parque Natural del Moncayo," *Ecosistemas* 2 (2002).