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ENERGY PRODUCTION, ECOLOGICAL FOOTPRINT AND SOCIO-ECONOMIC TRANSFORMATION OF THE TERRITORY IN AN ORGANIC ECONOMY. THE CASE STUDY OF EARLY MODERN MADRID.

Javier Hernando Ortego (UAM)
Santos Madrazo Madrazo (UAM)
Gonzalo Madrazo García de Lomaza (UCM)

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Energy Production, Ecological Footprint and Socio-Economic Transformation of the Territory in an Organic Economy. The Case Study of Early Modern Madrid

SANTOS MADRAZO MADRAZO
Universidad Autónoma de Madrid

JAVIER HERNANDO ORTEGO
Universidad Autónoma de Madrid

GONZALO MADRAZO GARCÍA DE LOMAZA
Universidad Complutense de Madrid

Introduction[1]

The purpose of this article is to study the impact that fuel consumption in Madrid had on the territory of Castile in the early modern age. This paper will analyze the impact of the two million *arrobas*/year of fuel consumed by Madrid during this period, both from an economic and an ecological viewpoint.[2] The first reflects how the energy demands of Madrid conditioned the exploitation systems of the forests and its economic, taxation and institutional structure, as well as the occupations of the rural populations that worked on meeting the demands of charcoal. Madrid, through its domestic and industrial needs for fuel, forced the economic structures of the villages of Castile to adapt to the rising needs. The second trend that will be analyzed involves the ecological footprint that the charcoal industry that supplied Madrid had on its surrounding areas. This paper also aims to define the area affected by the city's charcoal consumption, to explore the nature of the changes that occurred in this territory because of the expansion of the city's population and economy, and lastly, to discover whether this impact limited or stimulated the economic development of the affected area.

The Changeable Organization of the Supply of Charcoal of a Privileged City

Until 1753, Madrid's charcoal supply was organized through the charcoal merchants (known as *obligados*) that would coordinate with the city the distribution of this product at selling posts at a fixed price and specific deadline. These charcoal merchants had taken over the market, but charcoal was also brought in by merchants, drovers and other minor intermediaries. In the 1740s, the charcoal merchants had great difficulty facing the growing rate of demand, already over half a million *arrobas*, and also charcoal

[1] This paper is part of the research projects "Energía y Economía en Madrid, siglos XVI-XIX", HUM2007-66598/HIST and "La Energía en el Madrid del Antiguo Régimen: Consecuencias Económicas y Ecológicas en el Territorio", CCG07-UAM/HUM-1719. A previous version has been presented in the Congress "Common Ground, Converging Gazes. Integrating the Social and Environmental in History", EHESS, Paris, 11-13 sept. 2008. Translated by Fabio Bartolomei.

[2] The *arroba* is equal to 11.5 kg.

production was moving further away from the city and there was an overall increase in the cost of production. The Spanish Forests Ordinance of 1748 echoed the problems of the charcoal supply in relation with the state of the forests due to the: "...negligence by the Justices to enforce the ordinances, specially with respect to my court and a boundary of 30 leagues, mostly uninhabited, burnt down or cut down without enough charcoal or firewood production to meet the demands, undergoing price increases 20 or more leagues away and without having introduced enough types of ordinances and writs, which have been issued at other times..."[3].

The ordinance of 1748 foresaw the deep crisis that took place two years later. By the late 1750s, urgent measures were taken to resolve the shortage in charcoal. The reoccurrence of large problems in 1752 ended with the final withdrawal of the charcoal merchants and the introduction of the Board of Supply (*Junta de Abastos*), an organization depending directly on the Council of Castile in 1753, who became the main group of supply. It goes without saying that the arguments of the new organization providing the supply reiterated those exposed in the ordinance of 1748, accusing the charcoal merchants of being tyrants of deforestation, benefiting at the expense of the principles of conservation, but it was yet another indicator of the interventionist change of direction in the supply. Let us not forget that the Council took control of the supply of basic products such as meat, bacon, oil, cod and candles in 1743, as well as the *Pósito*, an institution that controlled the wheat supply, which was integrated in 1744[4]. By mid XVIII century, the bureaucratic intervention in the supply was consolidated, but during the second half of the century, paradoxically, foundations were laid to the end of the protection model and the crisis of the system. The period between 1753 and 1806 can be divided in various phases. The first, from 1753 to 1766, counted on management by the Board of Supply and saw how consumption rose to almost two million *arrobas*. The Council authorised a system of commissions that distributed the zones spatially into administrative areas surrounding Madrid (an area between 80 to 140 kms away from the capital). The commissioners were in charge of finding and contracting forests with charcoal producers and controlled the transport of charcoal to the court. The conditions imposed on the commissioners when contracting forests are set out in a 1760 instruction, which attempts to establish measures to make exploitation compatible with conservation along with the control and safety of the carters[5]. For one decade, the supply operated without significant problems, but the difficult situation of 1763-65 and the attempts to liberalize the production and supply ended in the rebellion of 1766 against Esquilache and the end of the Board of Supply[6].

[3] *Archivo de la Villa de Madrid* (from here on AVM), Secretaría, 2-395-12.

[4] A more detailed analysis on management development found in J.U. Bernardos (2004), pp. 694-700.

[5] AVM, *Contaduría,* 2-83-2 *Libro de Acuerdos,* fs. 49-59.

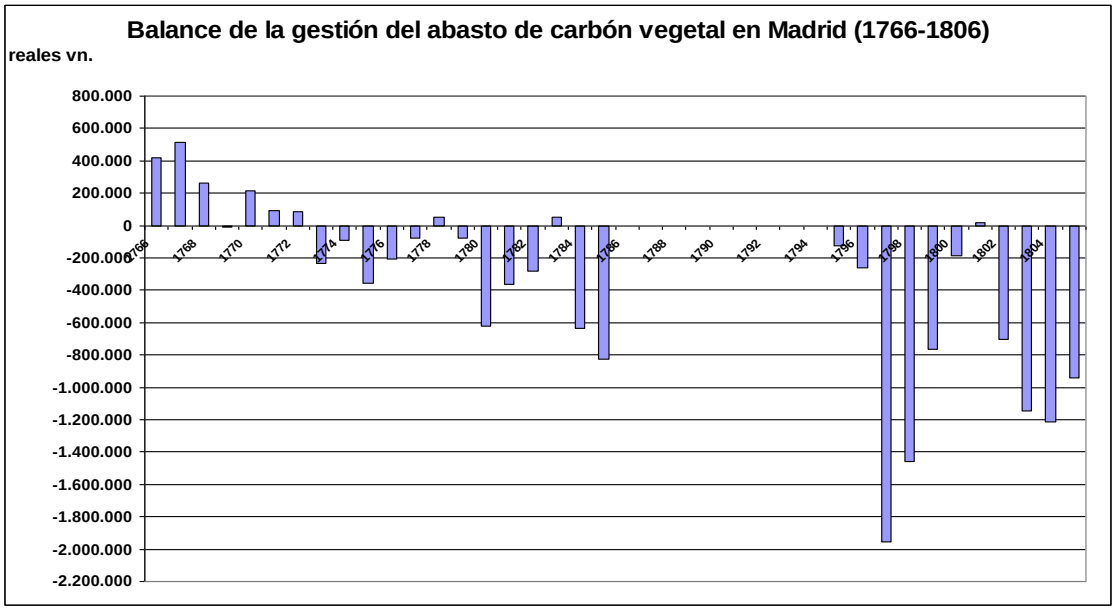
[6] J. M. López García (2006), pp. 92-95.

The supply of charcoal ended up in the hands of the city, conserving in essence an organizational structure very similar to that of the defenestrated Board. This phase was prolonged until mid 1780s and coincided with the application of the liberal legislation in grain trade and the attempt to extend it to different articles with the resulting conflicts. The financial equilibrium achieved in the beginning of the administration truncated in 1780. Therefore, the end of the municipal administration in 1784-85 can be attributed to the loss of more than one million *reales* that were dragged by the management in 1784. The supply of charcoal was then entrusted to the Five Main Guilds, a private institution in which important merchants of Madrid were grouped; all with strong economic capabilities and the economic experience of having lent money to the city and to its suppliers.

However, the appearance of the Five Main Guilds did no solve the problems. Their management started poorly, given that during the first year the warehouses in Madrid contained very little reserves of charcoal. The Five Main Guilds demanded privilege of moving forward the lumbering season to August. However, this was outlawed by the regulation for the conservation of forests, since this premature lumbering would damage the trees and could result in a fire hazard. The inability of the guilds to understand the municipal policies on production ended up in new financial failure and the return of administrative power to the city in 1794.

This new municipal administration was extended for almost four years with non-stop loses as can be seen in Figure 1. Taking production further away left the system exposed to the safety of the behaviour of the product itself. The difficulties of maintaining an appropriate system of transportation, mainly due the dependence of there being pastures during periods of activity for the livestock used for transporting the charcoal, affected the prices notably. Facing the increasing prices in transportation, those in charge of delivery refused to sign agreements with the Royal Association of Carters (*La Cabaña Real)*, and they were forced to transport charcoal in terrible conditions. The last year of municipal control finished in July (1797), and it ended in disaster (see balance sheet). A new attempt at management control came from another governmental organization, the Royal Direction of Supply *(La Real Dirección de Abastos)*, responsible for supplying Madrid with charcoal from July 1798. From this date until 1805, the same structural problems regarding production, transportation, supply, etc. continued, and all balances were negative except for one, as can be seen on the balance sheet. The reasons were once again centred on the serious problems of transporting the charcoal, which were caused by the controversial problems of not having enough pastures to feed the livestock and the poor state of the road network due to excessive seasonal rains. There is no doubt that these problems got worse and worse with production taking place so far away and the inability to meet the demands and the increasing rates of consumption.

Figure 1.



Source: AHN, *Consejos*, leg. 6.785, exp. 6; ibid., leg 6.789, exp. 12; AVM, *Contaduría*, 2-176-1 y 2-255-1.

With the turn of the century, attempts to liberalize the public supplies grew stronger. The administration started initiative of that nature; and in 1805, only bread, meat and charcoal were regulated. In this last chapter, posts would continue to receive only the supply at retail; and in 1806, the supply was liberalized with the entry into the market of private traders. Also, the public administration ceded its reserves of charcoal from the forests and from the distribution centers. With the improvement of the situation, prices decreased, though they were still above 200 *maravedis* per *arroba*. This is when the supply began to run parallel to the structural reforms being introduced by the forest property regime. In the following years, seizure and occupation of the forest lands for ploughing forced the framework of the supply to change, through the exploitation of numerous forests, which was sometimes done indiscriminately, as can be seen in the conservation policy of the areas providing charcoal.

The Cost of Supply

Having seen the main phases of the business, let us now analyze the structure of the costs and how they developed, in order to draw conclusions that reflect the reality of the supply. In 1767, a fiscal solution showed the main costs incurred in the supply, which included the cost of wood (or lumbering), production, transportation, salaries of the dependents, warehouse rents, and other administrative expenses. During this period, the costs of lumbering and production were 45 *maravedis* per *arroba*, and the stipulated conditions of 3 *maravedis* per *arroba* were above 58 *maravedis* (an average of 19 leagues). General costs added another 11 *maravedis*, which sums up to a total of 11

reales[7]. Between 1804 and 1805, the 1.5 million *arrobas* brought from production sites decreased to an average supply of 174 maravedis per *arroba*, while the manufacturing and lumbering costs ended up around 79 maravedis per *arroba*. That is, a total of 251 *maravedis* without including the administration costs. In sum: in 1767 with surplus management, an *arroba* of charcoal was sold at 128 maravedis, whereas in 1804, with a negative balance of more than one million *reales*, the same unit was sold at twice the price, 256 *maravedis*. During the last forty years of the XVIII century, prices of lumbering and production doubled and transport tripled.

Clearly, the growing demands in charcoal production caused growth in the production area, which pressured the transportation system, which in the long run turned into a bottle neck with a very difficult solution[8].In 1780 a shortage in charcoal was forewarned for the circumference of 18 leagues; therefore, the administration was forced to resort to: "… greater distances, from 19 to 30; so in turn, transport costs increased more than the goods coming from the 18 leagues". This period also marks a drop in the number of transport carts, due to the large losses of livestock suffered in 1780, as well as the shortage of meadows and the high cost of renting pastures for wintering. The traditional amount of transport of the Royal Association of Carters was considerably reduced due to the reduction in carts, which meant looking for more expensive transportation alternatives.

However, the problems in transportation did not refer to the effects of a linear increase as a function of increased distance from the production area. In 1767, the average distance considered for charcoal from the forest was slightly over 19.3 to 106.5 leagues, whereas in 1794 distance had increased to 115 km. Some forests had been contracted very far, but had not increased at all with relation to the rise of the costs which had spiralled as a consequence of the strict offer and the failure of the livestock to meet the demand (very sensitive to climate conditions). In addition, prices rose seasonally. During the rain season, over-prices were paid due to water being soaked up by the charcoal during transport. The supply administration tried to adjust the provisions with the Royal Association of Carters on an annual basis. Negotiations with carters came with problems and in effect no government agreements were reached with the authorities for some years. All these problems came together presenting a crisis with the supply in general, since not only charcoal but also wheat had to be transported from distant areas. More kilometres meant longer work days, and consequently, a delay in transportation, higher prices and incertitude. This situation was exemplified in 1803, which is when once again the animals used for transporting wheat and charcoal regained the privilege of using private preserves and pastures, amen to the Royal Preserves neighbouring Madrid. In 1804, finally, the adjustment in supply was made at 5 *maravedis* per league and *arroba*; and in 1805, it increased to 6 *maravedís* for the first

[7] *Memorial ajustado de orden del Consejo …*.One Castilian *real* is equivalent to 34 *maravedis*. One Castilian league is equivalent to 5,5 kms.

[8] S. Madrazo (1984, II) p. 440.

transport, and if a third transport was taken, 8 *maravedí* would be paid, which is twice as mush as in the beginning of 1790, an extraordinary cost[9]. By the beginning of the XIX century many European cities were able to introduce mineral coal massively as the main fuel at very affordable prices[10]. However, in 1860 a structure of cost in charcoal –the most widely consumed- could still be contemplated by observers such as Gonzalez de la Peña similar to that of the century before. This was partly due to forest contracts and factory costs and partly due to the costs of transportation freight, rights, damages and utilities[11]. In sum, charcoal price strictness was adjusted to some charcoal exploitation and supply models without hardly any changes.

The Extent of the Impact: Supply Areas

During the early modern age, Madrid received two important types of charcoal from its surrounding areas. These were pipe or bituminous charcoal, made of scrubland holm oak (*Quercus ilex*) that came from the eastern forests of La Alcarria; and charcoal of thick holm oaks of hollow woodlands of Talavera and Old Castile. The production areas of La Mancha were divided up equally between scrubland and hollow woodlands, while heath or forge charcoal came exclusively from the *Montes* of Toledo. The presence of oak tree was much more scarce, although it would normally appear in the north and north-eastern supply areas (Real Manzanares and La Alcarria)[12].

Madrid's consumption of charcoal and wood was felt in Castile, specifically in the areas supplying these fuels. The arrival of the Court in Madrid in 1561 marked the continuous growth in this area providing the supply. The reserves for supplying an area of 10 leagues had doubled since 1620. By the middle of the XVIII century, the areas supplying Madrid with charcoal were divided into six administrative areas that were covered by the commissioners of supply. Five percent was supplied by the traditional space of the Real de Manzanares, even though there were also private traders who were contracted to supply the capital with charcoal, taking advantage of their proximity. La Alcarria and countryside in the north-eastern area of Madrid, covered a large part of the west of the province of Guadalajara which supplied 30% of the total. The area of Talavera included the land of Plasencia in the north of Cáceres, the south of Ávila, the northwest of Toledo and the southwest vertex of Madrid. The area of Toledo and Mancha Baja was centred around the *Montes* of Toledo, about 340,000 hectares, which is located between the current provinces of Toledo and Ciudad Real where several villages located. The administrative areas of Old Castile –an area whose boundary

[9] AVM, *Contaduría*, 3-612-2.

[10] G. Turnbull (1987). For France E. Gallo (2006), p. 39.

[11] P. Gonzalez de la Peña (1873-74), p. 84.

[12] A geographical analysis of a part of these areas of supply found in N. Lopez and E. Saez (2002).

reached Salamanca, and even passed it –and Mancha Alta–the south of Alcarria- completed the radius of supply.

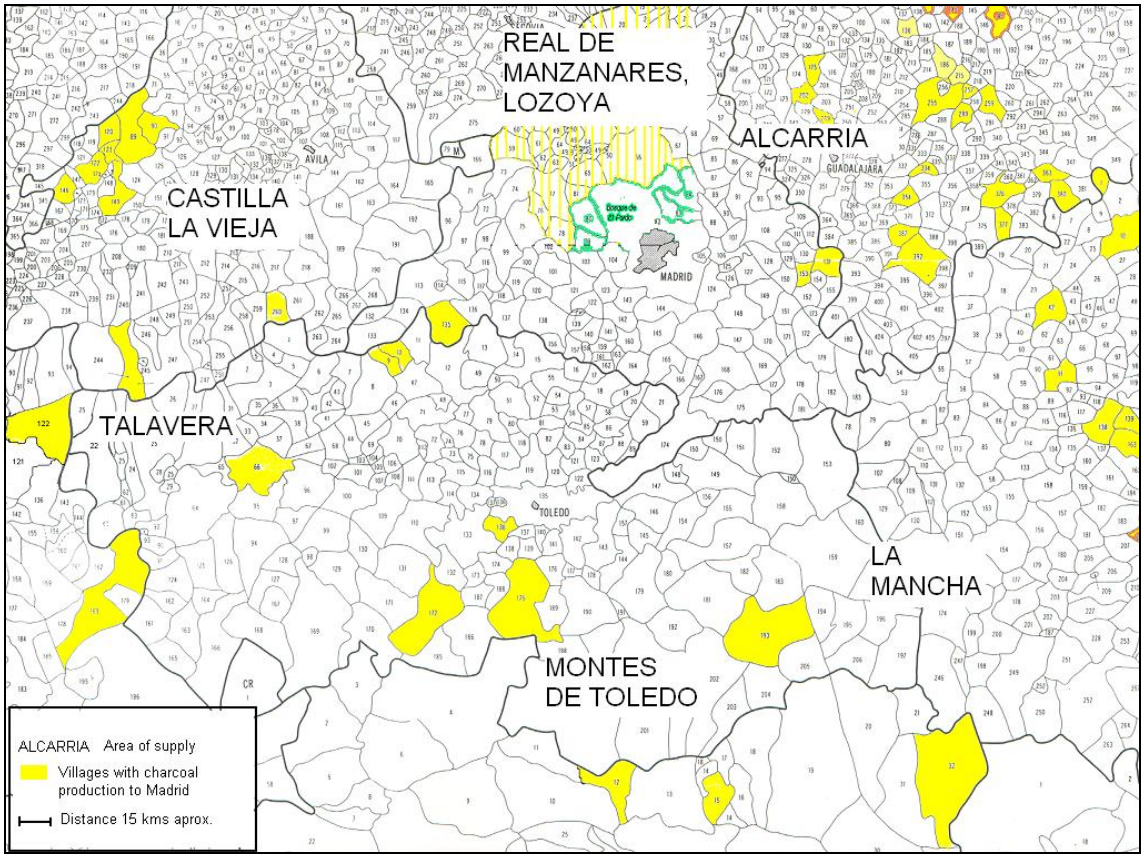
Table 1. Areas Supplying Madrid with Charcoal. Forest ownership

Administrative Areas	**1736-1752**			**1767**		
	Own	**Individuals**		**Own**	**Individuals**	
		Neighbours	**Privileged**		**Neighbours**	**Privileged**
Mancha Alta	8		1	9	1	3
Castilla la Vieja	1	3	1	5		3
Talavera	5	2		4		5
Toledo y Mancha Baja	1		2	3		3
La Alcarria and environs	25			14		5
Real de Manzanares	3	4	1	--		--
Unknown			3			
Total	43	9	8	35	1	19

Archivo Histórico de Protocolos de Madrid (AHPM), Protocolos 16361-16362 y *Memorial…*

In the equator of the XVIII century, the purchase of charcoal and firewood by the charcoal merchants (o*bligados*) profiles some initial characteristics of supply villages (Table 1 and map 1). First of all, La Alcarria was the most important supplying area. Secondly, it was mostly villages that sold their resources and the ownership of forests was public. Thirdly, the villages sold their forests –their only resource- driven by tax burden enforced by the Crown. And lastly, among the individuals, a greater number of the populaton is made up by the underprivileged than members of nobility or the clergy. Some features change in 1767, under the regime of the administration of supply. For example, an area outside of the district of the Real de Manzanares was contracted. This area was made up of 55 forests, of which 35 belong to towns and places, one to a monastery, another to an individual and the rest to nobles. If not, the villages would have felt the effects of tax burden, and their fall would have only been replaced with a greater presence of privileged members of the community.

MAP 1. **Areas Supplying Madrid with Charcoal in 1767 (source table 1)**



During all those years, the supplying forests belonged mostly to the villages; that is, they were public. But the advance of the privileged is envisaged in the significant patches of noble property, such as in Old Castile with the forests near the town of Navas del Marques, belonging to the Duque of Medinaceli, or Castronuevo belonging to the Duque of Alba. In Mancha Baja, there was the Mata that belonged to Prince Philip in his capacity as prior of San Juan. In La Alcarria, there was Anguix, located 16 leagues from the capital, which belonged to the Marquis of Mondejar; and also in Baides, in the administrative area of Sigüenza, the property of Count Salvatierra, at a similar distance. Miñano dates these, even in the XIII century, as important places of charcoal production. Toledo owned its own surrounding forests, as it purchased the area from the king in mid XIII century; therefore, it acted as lord and produced coal from its own forests to obtain resources for its own; nevertheless, the inhabitants of that area enjoyed the pastures, wood and beehives. Others belonged to the commons of a town as in the case of Segovia.

More information on the decade of the 1760s helps us to further see how land ownership and geography intervened in the provisions available in Madrid. Luckily, we are now able to know how much different land owners supplied the city: a total of 1,698,000 *arrobas*, divided between the 892,000 townships and the 806,000 private property owners. In addition, we know where charcoal came from between 1762 and

1765, since La Alcarria was the biggest supplier, followed, at a great distance, by Talvera and Old Castile (Table 2).

Table 2. Origin of the Charcoal Supplied to Madrid in 1762-1765

Administrative Area	Carts	*Arrobas*	%
Mancha Alta	11,566	694,000	13.4
Castilla la Vieja	12,883	833,000	16.1
Talavera	17,867	1,072,000	20.7
Toledo and Mancha Baja	13,279	797,000	15.3
La Alcarria and environs	25,199	1,512,500	29.2
Real de Manzanares	4,500	270,000	5.2
Total	85,294	5,178,500	100
Annual average	28,431,3	1,726,166,7	

Memorial…, pp. 64-66.

Social-occupational Changes

From an occupational point of view, the impact of the Madrid fuel demand on Castile can be analysed in three main lines: charcoal production, transportation to the city and the auxiliary industries that made it possible.

Charcoal production. The production or transformation of charcoal in the forests was stimulated from Madrid and had serious effects on the work-force structures of the production villages. In the heat of the demand in Madrid, the villages could produce the charcoal themselves, or leave this task to the charcoal merchants or to the administration responsible for the Madrid supply. With one system or the other, there were few villages in Castile that did not earn additional income from producing charcoal in addition to their other agricultural and industrial activities, showing a clear example of the "peasant economics of improvisation". Further, the seasonality of both –production took place during low agricultural season, starting with San Andres or at the end of November- allowed staggering the work and reducing down time[13].

Given that coal production works implied organisational skills, this task was carried out by "producers" or specialised workers that normally were neighbours to the villages or Castilian, Galician or Portuguese immigrants. These workers were highly valued for their skills and mobility; having no established address they could easily move and setup in any place no matter how uncomfortable that new place was. Most non-skilled workers, mainly charcoal porters, came from groups formed between the inhabitants of these villages as well as Galician, Portuguese and Maragato immigrants[14].

[13] On this economy and the industrial dedication of the Castilian Manchego villages, J. Nieto (2000).

[14] Portuguese and Galician immigration and the charcoal industry, J. Bravo (1993), p. 263 XVII century.

This was the general view given through the contracts signed between the villages and the charcoal merchants. Official figures and testimonies by contemporaries affirm this perspective and introduce new nuances. Suddenly, communities and villages spring up that would in turn provide production workers in mid XVIII: the Montes of Toledo and, most importantly, Mazarambroz. In 1767, 17 of the 38 producers –almost 45%- came from this town in the region of Toledo. Twenty years later, the informer of Cardinal Lorenzana was very clear in calling this town: "…the area from which the group or team of charcoal producers, where production took place with guidance and under order of the Board of Supply, came to supply most of New Castile and its forests". Many neighbours specialised in dealing with the Board itself, who in turn relied on the producers of Mazarambroz to organise production. Therefore, it is not rare to find these Toledan producers negotiating with the faraway towns of Alcarria. The charcoal production businesses of Navahermosa or Navalucillos stayed closer to home, where charcoal production was made of smoke charcoal and heath for the forges"[15].

Many producers from the Montes of Toledo specialised in heath charcoal or industrial charcoal. In the small town of Retuerta – with 68 inhabitants in 1787- the residents produced this charcoal, but there was such a high demand for production that it went in parallel with the high demand of foreign producers and mule drivers. The origin of these foreign workers is unknown, but thanks to their work in aiding the residents producing the charcoal, the production of 8,000 *fenegas* and its delivery to Toledo, Madrid and other places was possible. Incentives in production and transportation of charcoal reached as far as Fuente del Fresno, in Campo de Calatrava, where residents lived off agriculture and off "the production and transportation of charcoal to the Court of Madrid and its vicinity"[16].

The involvement in charcoal production of the inhabitants of the Montes of Toledo continued in the XIX century. The *Paper on the Montes of Toledo*, written by Julian Antonio and agricultural scholar Francisco Martinez Robles in 1820, insisted on the charcoal production and transportation in Ventas con Peña Aguilera, San Pablo, Retuerta, Horcajo and Navehermosa[17]. The same occurred in 1850, when P. Madoz affirmed that the "the main industry of this area was charcoal production and its transportation to Madrid and Toledo". These activities, "…occupied many hands". In Navahermosa charcoal production gave work to "…about half of the residents..." (it had 710), and these production activities also touched Ventas con Peña Aguilera (300 residents) and Menasalbas. In this last town, "a large number of residents work on the production of charcoal from heath, which is mostly then taken to the court". The

[15] Diocesan Archive of Toledo (from here on ADT), *Descriptions of Cardinal Lorenzana.*

[16] ADT, *Lorenzana.*

[17] *Paper on the Montes of Toledo* (1820).

residents of Urda (517) worked the fields, and in the summer transported carts of charcoal that they had produced in winter to Madrid[18].

Charcoal production was equally important in other areas. The inhabitant of La Alcarria were used to producing charcoal for themselves, since they had been doing it for years, and in the XVIII century, the reoccurrence of the agricultural crisis, forced them to produce for the market of Madrid. Madoz claimed in the XIX century that many inhabitants of La Alcarria were still working on "…cutting down wood for fuel and charcoal to supply Guadalajara and the Court".

Transportation of Charcoal to the City. The aforementioned references already reveal that charcoal transportation to Madrid had a similar impact to that of the factories. Let us underline here that Madrid is a special case in relation to other European capitals, since it relies on a system of transportation that is exclusively land bound[19]. Given this, land transportation is indispensable, thereby giving importance to the entire network of towns that signed contracts, binding them to transport the charcoal to the city themselves. Clearly, these towns relied on their own livestock and on the drover experience of their inhabitants to reach the objective of transporting duly and on schedule that which was agreed by the contracts. But for every town that bore this obligation, there were many more that allowed the charcoal merchants to contract with the professional carters. Traditionally, this task was carried out by the Royal Association of Carters from the forests of the regions of Soria and Burgos. But since this happened during the charcoal merchant period, other porters also came up from areas sometimes very faraway. This can mostly be seen through the transport contracts signed with carters from Murcia before 1753. There were 29 of a total of 48 carters from San Juan del Palmar, Alhama, Jumilla and Murcia itself, which is 400 km from Madrid[20].

The appearance of carters from Murcia and Alicante seem to have been occasional during the second half of the XVIII century, and the most important contracts endorsed by the Royal Association of Carters came from regions in Soria and Burgos, which took care of most of the transportation of heavy products, such as salt, cereal and wood with about five thousand carts in the middle of the XVIII century. (Other carters also participated from places such as Almodovar del Pinar in the mountains of Cuenca, Navarredonda in Avila, or other villages in the mountains of Guadarrama).

Transportation problems became severe by the end of the XVIII century. The agreements between the administration and the carters, that many years were established

[18] P. Madoz (1845-50).

[19] This distinguishes Madrid from other capital cities with river routes they can use for transport. J. Boissière (1996).

[20] AHPM, Prots. 16361-16362.

to resolve the totality of the contracts, could not be carried out due either to the general increase in price of transportation which the authorities were not willing to pay, or to the climate conditions and pastures that caused the carters to withdraw. During these cases, the administration paid the heavy cost that came with the increase in price of transporting charcoal on back, sometimes embargoing mules and carriages, and the social cost of the affected towns.

The auxiliary industries. Charcoal transportation would not have been possible without having esparto creels as a receptacle to transport charcoal with the ropes, string and cords that were used to prevent the cargo from moving during transport. A network of towns specialized in making and delivering carts equipped with these products sprouted in Mancha Baja. The close relationship between the suppliers of towns like El Romeral or Almonacid de Toledo and those in charge of the supply since the XVII century was strengthened further in the second half of the XVIII century. Therefore, this industry continued in this last area in 1780. As recalled by Lorenzana: " the poor continue to manufacture esparto, panniers, rope, string , baskets, reels, cords, all raw…some poor drovers and farm workers also engaged in these manufacturing activities." Since the demand of products made of esparto was increasing, manufacturers from this town as well as those of Almonacid de Toledo and others, stocked up on esparto from Albacete and Murcia so that they could then make baskets and ropes. Even at the end of the XVIII century, Minaya in Albacete, part of the old kingdom of Murcia, continued to be an important provider of large esparto baskets. According to Madoz, even in 1850 many inhabitants of the villages of Mancha Baja continued to make large quantities of products made of esparto. The main town providing esparto rope and twine were Valdelaguna, Barajas, Villarejo de Salvanés and most importantly, Belmonte de Tajo, that produced the best quality. According to the registry, different residents worked on the manufacturing with their wives and children as an additional activity to farming and working in the fields[21].

The Ecological Footprint in Madrid through Time

Until the appearance of the railway and mineral coal, the supply of charcoal had a fixed calendar. Trees were cut at the end of Autumn and production took place in Winter. Carters began transporting in May, and most of the transports took place in Summer, taking advantage of the pastures on their routes and the dry roads. Starting in October, the rain and the poor state of the roads along with the arrival of the cold, the carters would retire their oxen for wintering. The system was very fragile. All rested on the

[21] The involvement of these towns in the production of esparto can be found in J. Nieto (2006), pp. 389-391.

land and an area with productivity limits in the framework of social relations that impeded the mobilization of flexible resources.

The Ecological Footprint in the Landscape of the Charcoal Providing Forests: An approximation.

Which was the ecological footprint generated by Madrid's demand of fuel? Each forest had specific characteristics and charcoal production turns appropriate for its regeneration conditions. Apart from the physical characteristics, it also relied on human activities and their quality. This diversity of conditions complicated the calculation of the annual area affected by charcoal production. It is not strange to see that this diversity turned into great divergence when observing the recorded estimates on this subject. In the beginning of the XIX century, J.A. Rodriguez estimated about 450,000 *arrobas* per square league, or 149 *arrobas* per hectare with a recovery time of 12-14 years. However, in 1874, Gonzalez de la Peña calculated 545 *arrobas* of charcoal per hectare, or 3.5 more, counting on rotation of 15 years. According to Rodriguez's figures, the 2.5 million *arrobas* that Madrid could need during the best moment of the XVIII century would require an annual productive forest area of 163.353 km^2, but it needed a regeneration time of 15 years. Therefore, the real impact would imply 2,465.625 km^2, or 249,562.5 hectares so as to guarantee sustainability in the supply and on the land. However, according to P. Gonzalez de la Peña, the 3,167,943 *arrobas* of charcoal consumed 60 years later would only require 87,180 hectares. The lack of reports on specific areas makes difficult for us to learn how forest exploitation affected charcoal producing places.

In absence of more precise documentation, we will use different resources available: the Land Registry of Ensenada of 1751-52, the Dictionary of Sebastian Miñano (1826-28) and the Dictionary of Pascual Madoz of 1848, although general affirmations should not always be taken for granted. For example, the case of the forests of Anguix in the region of La Alcarria with an area of 4,000 *fanegas* or 2,575.82 hectares with Portuguese oak and some holm-oak, which gives us the idea that it came from these forests[22]. In effect, in 1767, charcoal made of holm-oak coppice is contracted along with scrubland oak, where 24,000 *arrobas* are produced. Sebastián Miñano writes about Anguix in 1826, saying: "...they make charcoal out of oak with an annual production of 25,000 *arrobas*". According to the estimate of whether 450,000 *arrobas* of charcoal can be produced in one square league, the area of the forests of Anguix would result in a total of 383,200 *arrobas*. Since 25,000 *arrobas* of charcoal were produced annually, the forest area would be rotated every 15 years, thereby regenerating the vegetation for its conservation and sustainable use. This figure, would therefore, be closer to that given by Rodriguez than that given by Gonzalez de la Peña[23].

[22] One square fanega is equal to 6,439.561 square meters; and therefore, 1 hectare is equal to 1.55 fanegas.

[23] This estimate agrees with the rotation process presented by P. Gonzales de la Peña (1873-74), p.84.

The example of Anguix leads us to believe that sustainability existed in the exploitation of some forests. However, when speaking of the forests of the region of Jadraque, even Miñano affirmed that although "most forests had been shamelessly destroyed, there was still some woodland with holm-oak and oak to supply Madrid with charcoal". Far from improving, it appears that this situation get even worse. During the first decade of the XIX century, ploughing affected most forests, which was carried out to stimulate agricultural development. Pascual Madoz describes the decade of the 1830s as a period of abusive and indiscriminate exploitation. He observes individual cases, such as the neighbouring area of Fuentelaencina where residents paid a toll "...for ploughing a forest known as Fresneda that was uprooted in 1838-39". These ploughing activities that were legalized in the end were accompanied by disentitlement dispositions of the mid century, the Madoz law of 1855 and later decrees, which in turn caused the period ending in the 1870s to be remembered as "the triumph of the predators" and the darkest time for the forests[24]. The demand of fuel in the capital during the time in which mineral coal was still not being used, served to seal an ill-fated trace on the woodlands neighbouring Madrid.

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[24] On the growth of crops by J.A. Sebastián (2004). The effects of disentailment laws of 1855 and the dispositions in the following years by J. Sanz Fernández (1995), p. 207: "...invoking the magic formula: private property equals richness and progress. This became the main argument from the mouths of the progressives in power, who started a huge movement of expropriation, that turned out to be, among other things, the biggest ecological disaster in our history of forestry".

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