

Looking backwards into a Mediterranean edge environment:  
Landscape changes in El Congost Valley (Catalonia), 1850-2005

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ABSTRACT

We examine the evolution from the mid-nineteenth century to the present of the cultural landscape in two Catalan townships, that jointly constitute an edge environment between Mediterranean plain and mountain. This environmental edge has changed over time, from a border between an agricultural plain confronting an area of forestry and livestock-raising in the mid-nineteenth century, to a limit of the Barcelona Metropolitan Region confronting two 'natural' protected sites in the present. Over a century and a half land use changes in this area have brought about the two main, but superficially 'opposed' dynamics that characterize landscape evolution throughout Catalonia and great parts of Europe today: intensification and abandonment. The most salient ecological impact of both processes has been the loss of landscape mosaics. In the plain those mosaics interwove cereal cropping with vineyards and olive orchards together with patches of woodland, scrubland and pastureland into an agricultural land matrix. In the mountains, a woodland matrix of holm oaks and pines became cleared through timber and firewood extraction, and the pruning of branches for charcoal making, creating a mixture of open forest articulated by grazing areas, cropland and scrub. Both sides of the edge interlinked, and jointly played a key role as ecological connectors to maintain biodiversity. From the 1960s onwards the ecological dynamics attendant upon the abandonment of the prevailing integrated management of forests, livestock breeding and cropland has led to a significant loss of these landscape mosaics. In spite of the transformation of much of this area into natural protected sites, the growth of a uniform and continuous afforested woodland canopy, directly confronted with urban sprawl, is endangering its species richness—such as Mediterranean orchids whose habitats are disappearing.

## KEYWORDS

Land-use change, landscape mosaics, biodiversity, edge environment, Catalonia

Over the last sixty years the prevailing landscape trends in the Mediterranean bioregion, as in many parts of Europe, have been the growth of urban sprawl and industrial sites related to transport, energy or communication networks, sometimes surrounded by rings of intensive and mechanized agriculture, while the rest of the land tended to be increasingly abandoned and afforested.<sup>1</sup> Together urban sprawl, agricultural intensification and rural abandonment jointly entail a severe loss of the agro-forest mosaics created in many traditional cultural landscapes,

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<sup>1</sup> Recent European land-use statistic and trends can be found in European Environment Agency, *Land accounts for Europe 1990-2000. Towards integrated land and ecosystem accounting* (Luxembourg: Office for Official Publications of the European Communities, 2006), [http://www.eea.europa.eu/publications/eea\\_report\\_2006\\_11](http://www.eea.europa.eu/publications/eea_report_2006_11); J.L. Weber, 'Implementation of land and ecosystem accounts at the European Environment Agency', *Ecological Economics* 61 (2007): 695—7; J. Feranec, G. Jaffrain, T. Soukup and G. Hazeu, 'Determining changes and flows in European landscapes 1990-2000 using CORINE land cover data', *Applied Geography* 30 (2010): 19—5; and F. Gerard, S. Petit, G. Smith, A. Thomson, N. Brown, S. Manchester, R. Wadsworth, G. Bugar, L. Halada, P. Bezak, M. Boltziar and E. De badts, 'Land cover change in Europe between 1950 and 2000 determined employing aerial photography', *Progress in Physical Geography* 34 (2010): 183—5. Drivers and effects of this ongoing global change are discussed in W. Vos and H. Meeks, 'Trends in European cultural landscape development: perspectives for a sustainable future', *Landscape and Urban Planning* 46 (1999): 3—4; M. Antrop, 'Changing patterns in the urbanized countryside of Western Europe', *Landscape Ecology* 15 (2000): 257—0, and 'Landscape change and the urbanization process in Europe', *Landscape and Urban Planning* 67 (2004): 9—6; E.F. Lambin and H. Geist (eds), *Land-use and land-cover change: local processes and global impacts* (Berlin: Springer, 2006). Urban imprints are assessed and discussed from a historical perspective in G. Billen, J. Garnier and S. Barles, 'History of the urban environmental imprint: introduction to a multidisciplinary approach to the long-term relationships between Western cities and their hinterland', *Regional Environmental Change* 12 (2012): 249—3.

which have been increasingly praised by ecologists for their role in maintaining biodiversity.<sup>2</sup> Since these landscape mosaics come from human intervention in ecosystems, while at the same time retaining functioning natural processes within them, they become a kind of nature transformed. In order to effectively manage them we need a historical perspective to understand the magnitude, causes and consequences of these interlinked cultural and natural processes. Even more, recovering the historical dynamics behind our current land-use patterns becomes a necessity for more encompassing, complex and multidimensional approaches to sustainable cultural landscapes. This landscape history research has to be addressed on different geographical scales and time spans by interdisciplinary teams as the one assembled here—which includes two historians, a biologist, an architect, a geographer and two environmental scientists.<sup>3</sup>

## MAIN FEATURES OF OUR CATALAN STUDY AREA

Edge environments show ongoing environmental processes in a particularly dramatic light, partly because they help highlight the existence of earlier, more diverse and integrated landscapes as being characterised by the very prevalence of smaller ‘edges’ within them.<sup>4</sup> The two Catalan townships studied are currently located at the very edge of the Barcelona Metropolitan Region (BMR), situated in one of the few North-South axes that for many centuries have connected the coastal area of Barcelona to the Pyrenees. Following this axis

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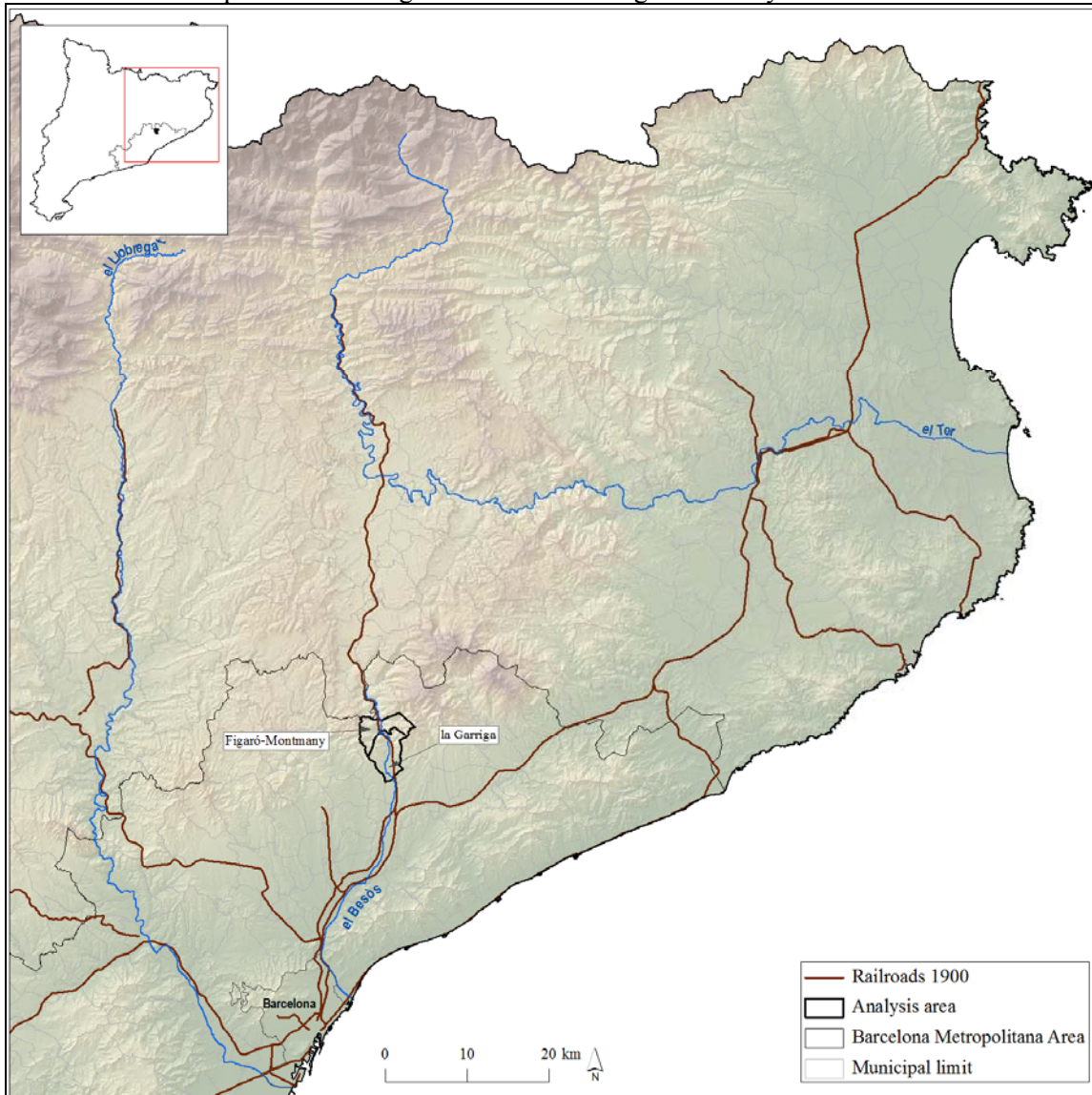
<sup>2</sup> The environmental role of agro-forest mosaics was pointed out, among others, in R. Margalef, ‘Ecological Theory and Prediction in the Study of the Interaction between Man and the Rest of Biosphere’, in H. Siolo (ed), *Ökologie und Lebensschutz in Internationaler Sicht* (Freiburg: Rombach, 1973; reprinted in *Medi Ambient. Tecnologia i Cultura* 38 (2006):114—5; [http://mediambient.gencat.net/cat/el\\_departament/revista/38/sumario\\_ingles.jsp](http://mediambient.gencat.net/cat/el_departament/revista/38/sumario_ingles.jsp); M. Giampietro, ‘Socioeconomic constraints to farming with biodiversity’, *Agriculture, Ecosystems & Environment* 62 (1997): 145—7; and T.G. Benton, J.A. Vickery and J.D. Wilson, ‘Farmland biodiversity: is habitat heterogeneity the key?’, *Trends in Ecology and Evolution* 18 (2003): 182—8; for the same approach applied to Catalan case studies see J. Marull, J. Pino and E. Tello, ‘The Loss of Landscape Efficiency: An Ecological Analysis of Land-Use Changes in Western Mediterranean Agriculture (Vallès County, Catalonia, 1853-2004)’, *Global Environment. Journal of History and Natural and Social Sciences* 2 (2008): 112—0; and J. Marull, J. Pino, E. Tello and M.J. Cordobilla, ‘Social metabolism, landscape change and land-use planning in the Barcelona Metropolitan Region’, *Land Use Policy* 27(2010): 497—0. For the new approaches to cultural landscapes see A. Farina, ‘Recent changes of the mosaic patterns in a montane landscape (north Italy) and consequences on vertebrate fauna’, *Options Méditerranéennes* 15 (1991): 121—4; A. Farina, A.R. Johnson, S.J. Turner and A. Belgrano, ‘Full’ world versus ‘empty’ world paradigm at the time of globalisation’, *Ecological Economics* 45 (2003): 11—8; M. Agnoletti, M. (ed), *The Conservation of Cultural Landscapes* (Wallingford: CABI Pub., 2006) and *Paesaggi Rurali Historici. Per un Catalogo Nazionale/Historical Rural Landscapes. For a National Register* (Roma-Bari: Laterza, 2010). For the environmental threads on them, see D. Schröter, W. Cramer, R. Leemans, et al., ‘Ecosystem service supply and vulnerability to global change in Europe’, *Science* 310 (2005): 1333—7.

<sup>3</sup> For the new approaches to sustainable landscapes see A. Farina, ‘The Cultural Landscape as a Model for the Integration of Ecology and Economics’, *BioScience* 50 (2000): 313—0; M. Antrop, ‘Sustainable landscapes: contradiction, fiction or utopia?’, *Landscape and Urban Planning* 75 (2006): 187—7; R. Matthews and P. Selman, ‘Landscape as a focus for integrating human and environmental processes’, *Journal of Agricultural Economics* 57 (2006): 199—1; and M. Rössler, ‘World heritage cultural landscapes: a UNESCO flagship programme 1992-2006’, *Landscape Research* 31 (2006):333—3.

<sup>4</sup> We are using in the title and in this introductory section a geographical-wide meaning of ‘edge environment’, a notion that needs to be distinguished from the ecological ‘edge effect’ in ecotones seen on a smaller land-cover scale—as discussed below. In the same vein, William Cronon spoke in *Changes in the Land: Indians, Colonists and the ecology of New England* about the patchwork pattern of the New England pre-colonial landscape as mainly determined by topography (slopes, sunny and shaded sides, etc.) seen in a geographical scale, and then also about the ecological ‘edge effect’ looked on a smaller scale as in the clearing of forest patches made by the Indians through controlled fires (New York: Hill and Wang, 2003, 25-33 and 51).

along the township of Figaró-Montmany, the river Congost runs North-South through a small gorge between the massif of El Montseny and the cliffs and crags of the Cingles de Bertí. The southern limit of the gorge ends where the Congost River reaches the neighbouring township of La Garriga, opening to the Vallès plain located between the pre-littoral and littoral mountain ranges of Catalonia. There, it drains its tributary flow to the Besòs River. (Map 1).

MAP 1. Location of the study area in Catalonia, the Barcelona Metropolitan Region and the main transport routes along the rivers—showing the railways built in 1900



Sources:

Drawn at the IERMB, with its own dataset on railroads and other transport facilities.

The Congost valley was traversed by Roman path and medieval royal routes linking the Catalan littoral with the South of France, as a small portion of the old-age interconnectivity among diverse Mediterranean micro-regional environments—diverse natural endowments created within the same bioregion by different gradients of altitude, proximity to the sea, slopes and sunny or shady sides of the land, and the relative abundance or shortage of water. In interaction with settlement patterns, population densities and institutional settings these provided complementary economies. Starting in the harbour of Barcelona, and following the same route, the railway reached the inland town of Vic in 1875 and the Pyrenees in 1880. Then, during the

1970s the old cart-road was turned into a highway up to Vic. These transport facilities linked the rural economy of our study area with coastal urban markets from an early date. Commercial linkages intensified during the processes of industrialization, urbanization and globalization from the second half of the nineteenth century.<sup>5</sup>

Both municipalities reacted to these market stimuli in very different ways. La Garriga evolved in a similar way to the adjacent Vallès plain. Vineyards spread and mixed with cereal cropland and small woodlands in an agro-forest mosaic that extended from the irrigated orchards surrounding the Congost River up to the forests and pastures in the nearby mountains. In 1858 vineyards occupied a great proportion of cultivated land in Figaró-Montmany too, in fact the northern limit at that time within the province of Barcelona. Nevertheless most of the municipality's steep and elevated land was devoted to woodland, scrubs and pasture.<sup>6</sup>

While the rural economy of La Garriga became mainly horticultural and agricultural, that of Figaró-Montmany remained mainly oriented to lumbering, firewood extraction, charcoal making and livestock breeding. The neighbouring northern townships also provided snow collected in the Montseny Mountains and stored in ice wells dug in the land. According to the *Land-Use Statistics of the Province of Barcelona* compiled in 1858 the taxable value-added of one acre of cropland in La Garriga was double that in Figaró-Montmany—the former was 42 per cent above the average in the East Vallès County, the latter was 31 per cent below.<sup>7</sup>

The nucleated habitat of the village in La Garriga also contrasted with the scattered farms of Figaró-Montmany, where most inhabitants lived in lateral valleys near the most important resources: woods, pastures, watercourses and snow. Only a few houses and three inns on the old royal road clustered by the Congost River. The traditional name of the township was then Montmany de Puiggraciós and Vallcàrquera, after the two main side valleys inhabited by cattle breeders, lumberjacks and charcoal makers. The official name changed in the last quarter of the nineteenth century with the arrival of the railway, taking Figaró from the name of the main inn. Thereafter most new houses clustered around the railway stop, while many isolated farm dwellings became abandoned.

Manufacturing also evolved in opposite ways in the two villages. Traditional as well as modern textile industries, and furniture making were developed in La Garriga. In Figaró-Montmany manufacture remained small, hand-powered and tightly linked to the raw materials locally available such as sawmills, cutting clogs and wooden planks, stone slabs for floors and fireplaces, or charcoal making. In 1852 La Garriga had one taxpayer in industrial or commercial activities for every five agricultural ratepayers, compared to one for every nine in Figaró-Montmany. La Garriga's payment of commercial and industrial taxes was ten times higher than

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<sup>5</sup> The idea of interconnected micro-regional environments is taken from P. Horden and N. Pourcell, *The corrupting sea. A study of the Mediterranean History* (London: Blackwell, 2008). They express the same idea with the term 'microecologies', which is a rather confusing term from a natural science standpoint (as microecology is the study of the interactions between microorganisms and their environment).

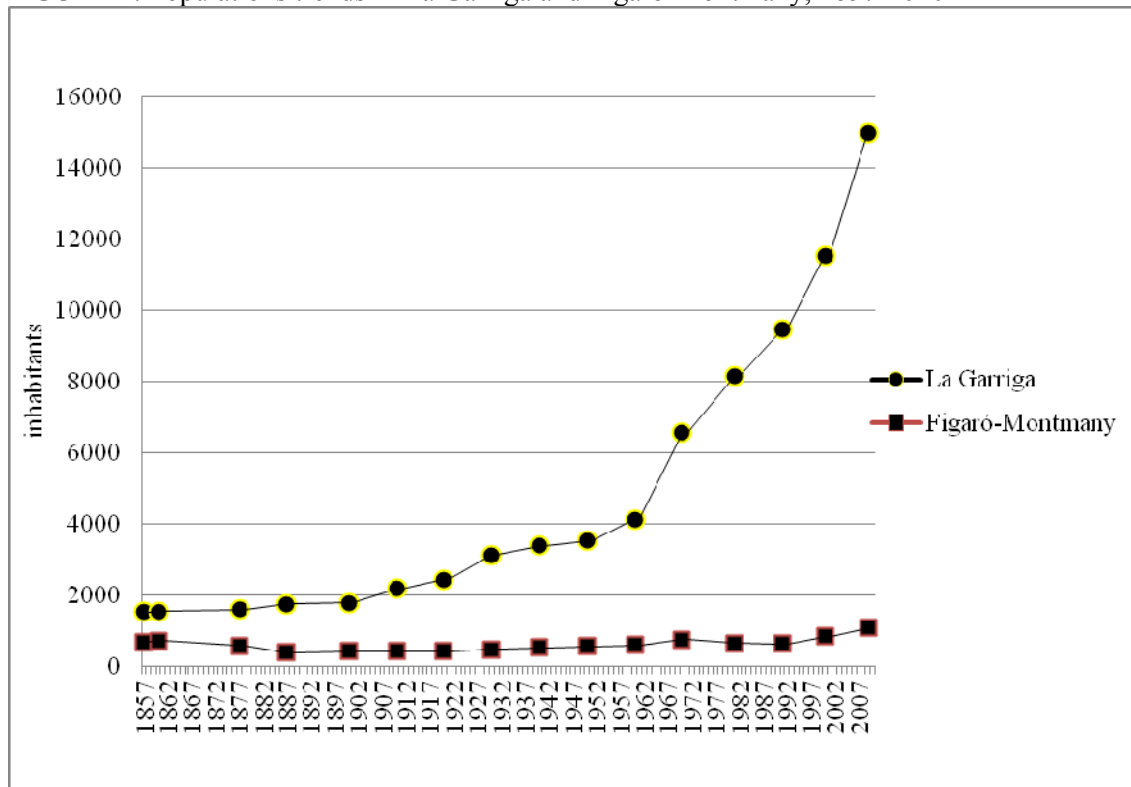
<sup>6</sup> We have studied the vineyard specialization in this Catalan region in X. Cussó, R. Garrabou and E. Tello, 'Social metabolism in an agrarian region of Catalonia (Spain) in 1860-70: flows, energy balance and land use', *Ecological Economics* 58 (2006): 49—5; X. Cussó, R. Garrabou, J.R. Olarieta and E. Tello, 'Balances energéticos y usos del suelo en la agricultura catalana: una comparación entre mediados del siglo XIX y finales del siglo XX', *Historia Agraria* 40 (2006): 471—0; E. Tello, R. Garrabou and X. Cussó, 'Energy Balance and Land Use: The Making of an Agrarian Landscape from the Vantage Point of Social Metabolism (the Catalan Vallès County in 1860/70)', in M. Agnoletti (ed), *The Conservation of Cultural Landscapes*, 42-56; R. Garrabou, E. Tello, X. Cussó and M. Badia-Miró, 'Explaining agrarian specialization in an advanced organic economy: The province of Barcelona in mid-nineteenth century', in V. Pinilla (ed), *Markets and Agricultural Change in Europe from the Thirteenth to the Twentieth Century* (Turnhout: Brepol Pub., 2009), 137—1; and R. Garrabou, E. Tello and X. Cussó, 'Ecological and Socio-economic functioning of the Mediterranean agrarian systems in the middle of the nineteenth century. A Catalan case study (the Vallès county, 1850-70)', in E. Landsteiner and E. Langthaler (eds), *Agrosystems and Labour Relations in European Rural Societies (Middle Ages-20th Century)*, (Turnhout: Brepols Pub., 2010), 119—2.

<sup>7</sup> Published by J.I. Muro, F. Nadal and L. Urteaga (eds), *Estadística Territorial de la Provincia de Barcelona 1858* (Barcelona: Societat Catalana de Geografia/Institut d'Estudis Catalans, 2011).



its mountain neighbour's, five times on a per capita basis.<sup>8</sup> Consequently, population and income growth followed diverging paths. In 2010 the number of inhabitants of Figaró-Montmany was only 52 per cent higher than in 1860, whereas in La Garriga increased tenfold (Figure 1).

FIGURE 1. Populations trends in La Garriga and Figaró-Montmany, 1857-2010



Sources:

Taken from Centre d'Estudis Demogràfics (<http://www.ced.uab.es/index.php>).

While La Garriga became a wealthier town that attracted affluent newcomers as residents and investors, Figaró-Montmany remained a poorer rural provider of mainly organic energy carriers: wood, charcoal and meat. As seen in Table 1, in 1857 population density was nearly two times greater in La Garriga (80.7 inhabitants/km<sup>2</sup>) than in Figaró-Montmany (42.7). Cultivated land occupied 56 per cent of the useful surface of La Garriga, and woodlands, scrublands or pasturelands only 44 per cent. The opposite was true in Figaró-Montmany: in 1858 only 28 per cent was devoted to crops and 72 per cent was woods, scrubs and pastures. In 1852 the total net taxable income coming from agricultural, forestry and livestock breeding was more than four times higher in La Garriga than in Figaró-Montmany, and nearly two times higher in per capita terms. Inequality in the wealth distribution of land, houses and livestock was also higher in La Garriga (with a Gini Index of 0.743) than in Figaró-Montmany (0.601).<sup>9</sup> In both places the land

<sup>8</sup> According to the *Parte Industrial y de Comercio* of the taxpayer's lists published as a supplement of the Official Gazette of the Province of Barcelona the 20<sup>th</sup> of April of 1852, kept in the library of the University of Barcelona, reference 146-1-II/13 box III.

<sup>9</sup> The 1852 tax lists referred in the previous footnote evaluated the land, houses and livestock assets of every taxpayer through its net taxable income in an average year, excluding other family incomes coming from wages or domestic manufacturing activities. Therefore, these Gini indices reflect agricultural wealth distribution, as explained in E. Tello and M. Badia-Miró, *Land-use profiles of agrarian income and land ownership inequality in the province of Barcelona in mid-nineteenth century*, Working Paper DT-SEHA n. 11-01. It is worth noting that the lower rural wealth inequality found in Figaró-Montmany compared

was mainly owned by a group of small or medium-size family farms (called *masies* in Catalan) that leased small plots and hired labour from landless peasants.<sup>10</sup>

TABLE 1. Socioeconomic features of our study area in mid-nineteenth century

	La Garriga	Figaró-Montmany	province of Barcelona
km <sup>2</sup>	18.8	15.8	7,610.4
Inhabitants (1857)	1,518	676	706,877
Inhabitants/km <sup>2</sup> (1857)	80.7	42.7	92.9
Cropland acreage (has 1858)	898.3	438.5	224,256.5
Cropland has/inhabitant (1857-1858)	0.59	0.65	0.32
Land sown with cereals (has 1858)	278.4	137.3	96,612.2
Land sown with cereals/inhabitant (has 1857-1858)	0.18	0.20	0.14
Vineyards acreage (has 1858)	504.8	245.4	114,162.8
Vineyards/inhabitant (1857-1858)	0.33	0.36	0.16
Woodland & pasture acreage (has 1858)	708.5	1,145.3	444,040.2
Woods & pasture/inhabitant (1857-1858)	0.47	1.69	0.63
Coverage rate of cereal consumption by local production (% 1858-1867)	32.3	54.7	38.6
Agricultural wealth estimated by the cadastre (Spanish <i>reales</i> of 1852)	389,667	91,239	106,164,548
Taxable agricultural wealth/inhabitant (Spanish <i>reales</i> in 1852-1857)	256.7	135.0	150.2
Gini index of inequality in agricultural wealth distribution (1852)	0.743	0.601	0.682

Sources:

Population figures are taken from the Centre d'Estudis Demogràfics; land uses from the *Land-Use Statistics in the Province of Barcelona*; taxable agricultural incomes from the *Distribution of Personal Income from Real Estate Ownership in 1852* and E. Tello and M. Badia-Miró, *Land-use profiles of agrarian income and land ownership inequality in the province of Barcelona in mid-nineteenth century*, Working Paper DT-SEHA n. 11-01, <http://ideas.repec.org/p/seh/wpaper/1101.html>; and coverage rate of cereal consumption for local production from R. Garrabou, X. Cussó and E. Tello, 'La persistència del conreu de cereals a la província de Barcelona a mitjan segle XIX', *Estudis d'Història Agrària* 20 (2007): 185, 196.

Thus in mid-nineteenth century the township border between La Garriga and Figaró-Montmany was already an edge environment between two agro-ecological worlds: the intensive and poly-cultural agriculture of the plain of Vallès County; and on the other hand the multiple and integrated use of woodlands, scrub and pastures of the slopes, hills and small valleys along the Catalan pre-littoral mountains. Another salient feature of these two contrasting worlds was the livestock densities on each side of the border. With only 6 livestock units of 500 kg of standardized live weight per square kilometre of cropland (LU500/km<sup>2</sup>), the intensive agricultural system of La Garriga lacked sufficient beasts to obtain through manure all the nutrients needed for the replenishment of cultivated land, as was then often the case on the Vallès Plain. In contrast, thanks to the small proportion of cropped land and the larger herds grazing in pasturelands and forests, in 1858 Figaró-Montmany had a livestock density per unit

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with La Garriga contradicted the opposite pattern prevailing in the whole province of Barcelona, as shown in the referred working paper.

<sup>10</sup> As many places in the North-East of Catalonia, the distribution of land ownership that arose from liberal reforms during the nineteenth century consolidated a previously existing structure of medium-size poly-cultural family farms ranging from some five to fifty hectares each—mainly depending on the more intensive or extensive uses of the land inside them. As population grew and commercial ties with the Atlantic economy developed, these medium-sized landowners started to lease small plots of poor sloping soils to a growing stratum of winegrower tenants. This process of market specialization and land-use intensification polarized rural society, which saw lasting social conflict up to the Spanish Civil War. After the repression and impoverishment suffered during the first decades of Franco's dictatorship, rapid economic upswing started in the sixties putting an end to the old dispute about land entitlements and agricultural income distribution. Again a pattern of small and medium-size family farms prevailed, increasingly managed part-time as agriculture became more marginal economic activity.

of cropland as high as 21 LU500/km<sup>2</sup> (Table 2)—although some of these were horses used for hauling carts along the road.<sup>11</sup>

TABLE 2. Livestock heads and densities in La Garriga and Figaró-Montmany in 1858

	heads		average live weights per head in kg*	live weights	
	La Garriga	Figaró-Montmany		La Garriga	Figaró-Montmany
Horses	3	59	326	978	19,234
Mules	34	4	326	11,084	1,304
Donkeys	4	15	172	688	2,580
Cows and oxen	10	25	371	3,710	9,275
Sheep	212	312	30	6,360	9,360
Goats	11	82	34	374	2,788
Pigs	50	14	77	3,850	1,078
TOTAL**	324	511		27,044	45,619
LU500				54.1	91.2
Useful Agricultural Area (km <sup>2</sup> )				16.1	15.8
LU500/km <sup>2</sup> of useful agricultural area				3.4	5.8
Cropland area(km <sup>2</sup> )				9.0	4.4
LU500/km <sup>2</sup> of cropland area				6.0	20.8

Notes:

\* Live weights per head are taken from E. Tello, R. Garrabou, X. Cussó, J.R. Olarieta and E. Galán, 'Fertilizing methods and nutrient balance at the end of traditional organic agriculture in the Mediterranean bioregion: Catalonia (Spain) in the 1860s', *Human Ecology* 40 (2012): 369—3.

\*\* Chickens, rabbits and transhumant sheep are not included.

Sources:

Taken from the *Land-Use Statistics in the Province of Barcelona*.

It is likely that some manure collected in Figaró-Montmany was sold to fertilize the more intensive crops grown in irrigated lands in La Garriga, such as hemp and vegetables. At the same time pasturelands existing in la Garriga were probably leased in exchange for manure, either to livestock coming from neighbouring townships or transhumant sheep. These are good examples of the socio-metabolic flows linking both sides of this edge environment, while both townships participated at the same time in other biophysical fluxes moving along broader commercial routes. According to the statistics from 1858-1867, the average share of cereal consumption covered by the local production was only 32.3 per cent in La Garriga and 54.7 per cent in Figaró-Montmany—while in the whole province of Barcelona the average was 38.6 per cent. The rest was supplied by wheat imports from the Barcelona's seaport, in return for exports

<sup>11</sup> Most of the horses recorded in Figaró-Montmany were probably employed in the post service and in hauling carts along the route between Barcelona, Granollers and Vic towards the Pyrenees. During the preindustrial 'solar' or 'organic' economy the three inns located in the gorge of this township were strategically placed at one-day journey from Barcelona, and half a day to Vic (see Map 1 and the reference given in footnote 8). V. Frigola, *Relación de los pueblos de que consta el Principado de Cataluña*, and Anonymous, *Itinerario de la mayor parte de caminos y veredas de las cuatro provincias de Barcelona, Tarragona, Lérida y Gerona, con los pueblos y posadas situadas en sus carreras, y las horas que á paso de tropa distan unos de otros* (Barcelona: Imprenta de Manuel Texero, 1838). When in 1854 the train reached the city of Granollers, the railways soon started carrying the loaded carts themselves from Barcelona to Granollers in a nearly one hour thus allowing them to attain the city of Vic in one day. The resulting relocation of the need for fresh horses may explain the sharp reduction in the subsequent livestock censuses of Figaró-Montmany. The construction of Catalan railways and their impact is explained in P. Pascual, *Los caminos de la era industrial: la construcción y financiación de la Red Ferroviaria Catalana (1843-1989)*. (Barcelona: Edicions Universitat de Barcelona, 1999). For the relevance of this things in an 'organic' or 'solar' economy, see R.P. Sieferle, *The Subterranean forest: energy systems and the Industrial Revolution* (Cambridge: The White Horse Press, 2001), and E.A. Wrigley, *Energy and the English industrial revolution* (Cambridge: Cambridge University Press, 2010).



of wine, hemp, vegetables, cattle, wood, charcoal or snow. Therefore, these two small rural communities were far from an isolated and autarkic world.<sup>12</sup>

Their different but complementary land-use patterns began to change at the end of the nineteenth century when well-to-do urban elites started to look for cooler places to spend their leisure time during summer vacations, such as the foothills of the Montseny Mountains. La Garriga was favoured as a location for second homes by some of these wealthy families because it had thermal waters and several old spa-hotels that also allowed a longer stay in winter. Others preferred the cooler gorge of the Congost River in Figaró-Montmany.<sup>13</sup>

These summer vacations also led to a Romantic and Nationalistic rediscovery of ‘wild nature’ in the landscapes that already existed behind the urban backs of Catalan elites and intellectuals. Hiking, climbing and the study of rural life became fashionable activities at this time, not only among some affluent professionals but also proletarian families educated by the working-class athenaeums in the libertarian ideals of emancipation as well—which in Catalonia were increasingly mixed with vegetarian and naturalist undercurrents. Lying only one hour by train from Barcelona, Figaró-Montmany became popular for hiking, climbing and cycling and as a gateway to the Montseny and Cingles de Bertí mountains.<sup>14</sup>

During the first third of the twentieth century investments in second homes opened up new tertiary employment opportunities for local people: as maids, laundresses, seamstresses, nannies, gardeners, plumbers and so on. At the same time the cultural mixing with different back-to-nature intellectual and social movements also led to an increasing adoption of the ideas of nature conservation, tightly linked in Catalonia to new proposals for city-gardens, green belts and regional planning. In 1932 the Catalan autonomous government published a Regional Planning of Catalonia which qualified the Montseny massif as an ‘area of reserved parks and forests’ surrounded on its North-East border by a ‘grazing area’.<sup>15</sup> However this pioneering attempt at land-use planning during the Second Republic was abruptly stopped by the Francoist dictatorship after the Spanish Civil War (1936-1939). The effective protection of the Montseny (1977) and the Cingles de Bertí (2002) areas only arrived after the death of the dictator (1975) and the restoration of democracy in Spain.

Conversion into natural protected sites happened when these landscapes were already experiencing one of the most fundamental shifts in their long environmental history. The new era of cheap oil in the 1960s saw the diffusion of gas butane cylinders, putting a sudden end to local charcoal making. Lorry transportation allowed the delinking of the small cluster of furniture makers located in La Garriga and L’Ametlla de Vallès from their former supply of planks in Figaró-Montmany. Industrialization of agriculture during the so-called Green Revolution led to the abandonment of steep slopes where mechanization was most difficult. As happened in many other European regions, new intensive monocultures and the breeding of livestock in industrial feed-lots were adopted in the plains, leading to the abandonment of the

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<sup>12</sup> The cultivation of hemp and vegetables was pointed out in the descriptions of la Garriga township given in V. de Frigola, *Relación de los pueblos de que consta el Principado de Cataluña* (Barcelona: Imprenta de la viuda de Antonio Brusi, 1824), and P. Madoz, *Diccionario geográfico-estadístico-histórico de España y sus posesiones de ultramar*, (Madrid: Est. Tipográfico-Literario Universal, Tomo VIII, 1847), 322. In Figaró-Montmany the same *Diccionario geográfico-estadístico* stressed the forestry and livestock breeding activities in the mountains and the inns in the gorge (Tomo XI, 1848), 506.

<sup>13</sup> Leisure as such was not a novelty of that time, as pointed out by J.-Ll. Marfany, ‘The Invention of Leisure in Early Modern Europe’, *Past & Present* 156 (1997):174—1. But the family summer vacations in the countryside do became a new urban habit for a wider range of high and middle classes of the time. J.-Ll. Marfany, *La cultura del catalanisme: el nacionalisme català en els seus inicis* (Vic: Empúries, 1995), and Marfany, ‘El paisatge, el nacionalisme i la Renaixença’, *Estudi General* 13 (1995): 81—6; and J. Nogué and J. Vicente, ‘Landscape and national identity in Catalonia’, *Political Geography* 23 (2004): 113—2.

<sup>14</sup> For the connections of the Catalan anarchism with naturism, vegetarianism, nudism and the city-garden movement, see J. Martínez Alier, ‘Urban sprawl and ecology in Barcelona’, *Temes de disseny* 11 (1995): 67—1 (available at <http://www.raco.cat/index.php/Temes/article/view/29437/50910>), and E. Masjuan, *La ecología humana en el anarquismo ibérico* (Barcelona: Icaria 2000).

<sup>15</sup> The map of the first Catalan Regional Planning passed in 1932 can be seen in <http://cartotecadigital.icc.cat/cdm/singleitem/collection/catalunya/id/1112/rec/5>.

former integrated management of cropland with extensive cattle-raising in upland pastures and woods. The agro-ecological complementarities among different land usages, that had created the traditional agro-forest mosaics, were suddenly ended. The mosaics themselves started to disappear with the rural society that had kept them alive.<sup>16</sup>

Taking advantage of the easy connections by railway and highway to Barcelona, in the last quarter of the twentieth century many former second residences were turned into permanent homes occupied by commuters. First La Garriga and then Figaró-Montmany became new edge residential areas of the metropolitan region. At the same time the socio-ecological pathologies of rural abandonment started to show their face: wildfires –there was a dangerous one between La Garriga and Figaró-Montmany in 1994—, the loss of many old springs and paths used by former woodcutters, shepherds and charcoal-makers, and the proliferation of wild boars crossed with fast-reproducing pigs which increasingly became pests.<sup>17</sup> Given the dual nature of cultural landscapes, both human-made and natural patterns, this loss of agro-forest mosaics also implied a decline of knowledge about managing the natural resources in an integrated manner. The increasing apparent homogeneity of these abandoned landscapes is making the relicts of previous ecologies harder to discern (and more easily to degrade) in a society where the local inhabitants have less and less information or interaction with them.

We have seen in this outline of the landscape evolution the same basic trends and the three major driving forces summarized by Marc Antrop for the whole of Europe: accessibility, urbanization and globalization. Accessibility has to be understood not only as physical transport or cultural connection but as the increasing purchasing power of goods and services as well. At the beginning of the twenty-first century easy market access to natural resources at any place in a globalized world has led to some levelling of the standard of living across the metropolitan hinterlands of developed countries, far from the former sharp divides between cities, towns and rural villages. The average taxable household income is now only slightly higher in La Garriga than in Figaró-Montmany, and both lie near to the average GDP per capita in the fifteen countries into the Eurozone: some 28,400 € at 2008 prices (Table 3).<sup>18</sup>

TABLE 3. Socioeconomic profiles of the study area in the beginning of the twenty-first century

	La Garriga	Figaró-Montmany	Catalonia
Inhabitants (2011)	15,236	1,112	7,539,618
Inhabitants/km <sup>2</sup> (2011)	810.4	74.1	990.7
Average taxable income per household (in € of 2007)	22,997	19,840	20,843
GDP/inhabitant (in € of 2008)	24,700	n.a.	29,160

Sources:

Taken from IDESCAT (<http://www.idescat.cat/en/>) and EUROSTAT (<http://epp.eurostat.ec.europa.eu/portal/page/portal/eurostat/home/>).

<sup>16</sup> The importance of integration in farmland management is very well explained in C.A. Edwards, R.R. Grove, C.J. Harwood and P. Colfer, 'The role of agroecology and integrated farming systems in agricultural sustainability', *Agriculture, Ecosystems & Environment* 46 (1993): 99—1.

<sup>17</sup> The socio-ecological consequences of rural abandonment have been examined, among others, by J. McNeill, *The Mountains of the Mediterranean World: An environmental history* (Cambridge: Cambridge University Press, 1992); S.J. Pyne, *Vestal fire: An environmental history, told through the fire, of Europe and Europe's encounter with the world* (Seattle: University of Washington Press, 1997); D. MacDonald, J.R. Crabtree, G. Wiesinger, T. Dax, N. Stamou, P. Fleury, J. Gutierrez-Lazpita and A. Gibon, A., 'Agricultural abandonment in mountain areas of Europe: environmental consequences and policy response', *Journal of Environmental Management* 59 (2000): 47—9; and A.T. Grove, and O. Rackham, *The Nature of Mediterranean Europe: An ecological history* (New Haven: Yale University Press, 2001). The recent unsustainable trends in the BMR are examined in E. Tello, 'Changing course? Principles and tools for local sustainability', in T. Marshall (ed), *Transforming Barcelona* (London: Routledge, 2004), 110—5.

<sup>18</sup> M. Antrop, 'Why landscapes of the past are important for the future', *Landscape and Urban Planning* 70 (2005): 21—4.

In the following sections we will describe how accessibility, the rural-urban divide, metropolitan networks and globalization combined in different proportions as historical driving forces for land-use changes in the study area from mid-nineteenth century to the beginning of the twenty-first century. Throughout this environmental history those local landscapes experienced some long-term continuities, but also several deep discontinuities and big accelerations at specific turning points. The most important of these was, no doubt, the land-use changes fostered by urbanization and globalization experienced during second half of the twentieth century. Nevertheless, a longer term perspective helps to identify the agro-ecological roots of the traditional cultural landscape and its environmental services that have been undermined by the fast-growing industrial economy during the era of cheap oil.<sup>19</sup>

This environmental history of land-use changes has been as complex and multidimensional as cultural landscapes are themselves. They range from the substitution of former land cover by newer ones, to the human perceptions of them, or the sense of identity adopted by the communities which have altered their land usages, consumption baskets and ecological imprints overtime. In the rest of this article we will focus on how land cover changes between 1854 and 2005 have affected ecological patterns in these landscapes, and their capacity to host biodiversity.<sup>20</sup>

## LAND-USE CHANGES IN LA GARRIGA: FROM A POLY-CULTURAL MOSAIC TO A METROPOLITAN EDGE

We have three excellent sources to study landscape changes in La Garriga from the mid-nineteenth century to the present: 1) a cadastral land-use map at approximately 1:2,500 scale drawn up from fieldwork in 1853-1854, and kept in the Historical Municipal Archive of the township; 2) digital land-use maps created by GIS photo-interpretation and geo-referencing from overlapping aerial photographs taken in 1956 by the United States Army; and 3) a land cover digital map of 2005 created from satellite images. Beyond the unavoidable margins of error incorporated into any land mapping that explain small differences in acreage obtained with GIS metrics, or taken from the historical land-use statistics assessed without maps, the larger picture of land cover obtained from these digital maps are reliable. They are a fundamental basis for any landscape analysis from a historical perspective, as well as the only sources available to perform a GIS cover intersection analysis in order to obtain matrices of land-use changes experienced between two dates in a given territory.<sup>21</sup>

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<sup>19</sup> Ch. Pfister, 'The '1950s Syndrome' and the Transition from a Slow-Going to a Rapid Loss of Global Sustainability', in F. Uekoetter (ed), *The Turning Points of Environmental History* (Pittsburgh: University of Pittsburgh Press, 2010), 90—8.

<sup>20</sup> On the complexity of landscapes see Z. Naveh, 'Interactions of landscapes and cultures', *Landscape and Urban Planning* 32 (1995): 43—4, and 'Ten major premises for a holistic conception of multifunctional landscapes', *Landscape and Urban Planning* 57 (2001): 269—4, as well as by B. Tress, G. Tress, H. Décamps and A.M. d'Hautesserre, 'Bridging human and natural sciences in landscape research', *Landscape and Urban Planning* 57 (2001): 137—1. For the linkages between changing living standards and their historical ecological imprints, see G. Billen, J. Garnier and S. Barles, 'History of the urban environmental imprint', and K.P. Donaghy, 'Urban environmental imprints after globalization', *Regional Environmental Change* 12 (2012): 395—5.

<sup>21</sup> The making of these historical cadastral maps in Catalonia has been studied and inventoried by F. Nadal, L. Urteaga and J.I. Muro, *El Territori dels geòmetres*. The cadastral map of 1854 has been processed with GIS software by Natàlia Valldeperas and Anna Ollés with the funds provided by the Batista i Roca Grant 2010PBR00002. The digital land cover maps of 1956 and 2007 have been provided by the Centre of Forest Ecology Research and Applications (CREAF) at the Autonomous University of Barcelona (<http://www.creaf.uab.es/eng/index.htm>). To make them comparable, the different categories of land uses adopted in each map have been homogenized in a single common legend following criteria consistent with the subsequent application of landscape ecology metrics (as explained in greater detail in J. Marull, E. Tello, P. Warde, F. Coll, N. Valldeperas, A. Ollés and P. Wilcox, 'Recovering the history behind the ecological connectivity between two natural protected sites and a metropolitan edge: The

Unlike the typical distribution provided by other land-use statistics, these matrices not only allow us to know the land cover profiles of the same place at two different points in time. They also let us discover the historical dynamics behind any given land-use changes, as the former land usages that lie behind every land cover become apparent. Besides showing which land covers have increased or decreased from a specific historical period to the next, a matrix of land-use changes reveals into what the shrinking land covers were transformed, or from which older covers new ones were created. As in any other matrix, these flows of land-use change are shown from the former date along the rows, while they are accounted from the latter date along the columns. The surfaces unchanged appear in the diagonal, as the cells marked in grey in Table 4.

TABLE 4. Matrix of main land-use changes from 1856 to 1956 and 2005 in La Garriga

	1 woods	2 scrubs	3 pasture	4 grains	5 vines	6 olive &	7 irrigated	8 built-up	9 infra.	hectares 1956 ↓
<b>% 1856 →</b>		<b>3.6%</b>	<b>19.5%</b>	<b>4.7%</b>	<b>26.6%</b>	<b>3.0%</b>	<b>11.8%</b>	<b>0.6%</b>	<b>0.3%</b>	<b>100.0%</b>
<b>hectares 1856 →</b>		<b>66.9</b>	<b>367.3</b>	<b>87.7</b>	<b>499.8</b>	<b>55.5</b>	<b>221.5</b>	<b>10.6</b>	<b>6.2</b>	<b>1,879.7</b>
1. woodland	<b>398.6</b>	11.4	203.1	9.2	253.0	8.7	6.7	0.6	0.9	<b>892.1</b>
2. scrubland	12.8	<b>20.1</b>	15.0	1.5	17.9	0.7	8.1	0.3	0.2	<b>76.7</b>
3. pastureland	0.2	0.0	<b>2.1</b>	0.2	3.9	0.9	0.0	0.0	0.0	<b>7.3</b>
4. rain-fed grains	57.6	7.4	81.8	<b>35.9</b>	115.4	10.5	30.0	1.2	2.1	<b>341.8</b>
5. vineyards	11.2	0.3	13.1	2.7	<b>14.1</b>	3.7	1.2	0.0	0.0	<b>46.3</b>
6. olive & other trees	52.1	2.8	28.5	15.3	72.0	<b>24.1</b>	21.0	0.6	0.5	<b>216.9</b>
7. irrigated orchards	27.1	17.9	18.7	17.1	8.0	2.8	<b>93.9</b>	0.7	0.7	<b>186.9</b>
8. built-up area	2.2	5.6	3.1	3.8	11.3	3.1	54.0	<b>6.9</b>	1.6	<b>91.5</b>
9. infrastructure	2.3	1.3	1.9	2.0	4.3	1.1	6.7	0.3	<b>0.3</b>	<b>20.3</b>
<b>Area with no land-use change from 1856 to 1956</b>										<b>596,1</b>
<b>id. land-use changes</b>	<b>165.5</b>	<b>46.8</b>	<b>365.2</b>	<b>51.8</b>	<b>485.7</b>	<b>31.4</b>	<b>127.6</b>	<b>3.6</b>	<b>5.9</b>	<b>1,283,6</b>
	woods	scrubs	pasture	grains	vines	olive &	irrigated	built-up	infra.	2005 ↓
<b>% 1956 →</b>	<b>47.5%</b>	<b>4.1%</b>	<b>0.4%</b>	<b>18.2%</b>	<b>2.5%</b>	<b>11.5%</b>	<b>9.9%</b>	<b>4.9%</b>	<b>1.1%</b>	<b>100.0%</b>
<b>hectares 1956 →</b>	<b>892.1</b>	<b>76.7</b>	<b>7.3</b>	<b>341.8</b>	<b>46.3</b>	<b>216.9</b>	<b>186.9</b>	<b>91.5</b>	<b>20.3</b>	<b>1,879.7</b>
1. woodland	<b>843.2</b>	40.8	1.1	109.2	7.4	42.5	8.7	1.2	0.4	<b>1,054.5</b>
2. scrubland	23.6	<b>13.3</b>	1.1	39.1	5.2	13.5	5.5	1.1	0.2	<b>102.6</b>
3. pastureland	2.7	6.1	<b>0.0</b>	11.1	1.3	4.1	5.7	0.9	0.1	<b>32.0</b>
4. rain-fed grains	3.1	1.5	0.1	<b>70.9</b>	8.6	51.6	40.2	0.3	0.1	<b>176.5</b>
5. vineyards	0.4	0.0	0.6	6.1	<b>3.5</b>	1.0	0.0	0.0	0.0	<b>11.7</b>
6. olive & other trees	1.0	0.4	0.0	27.1	6.6	<b>50.2</b>	2.7	0.1	0.0	<b>88.1</b>
7. irrigated orchards	0.0	0.2	0.0	0.4	0.0	0.1	<b>5.9</b>	1.0	0.3	<b>7.9</b>
8. built-up area	15.2	14.3	4.2	72.3	13.1	52.8	116.7	<b>86.9</b>	2.3	<b>377.6</b>
9. infrastructure	3.0	0.1	0.2	5.6	0.6	1.1	1.5	0.0	<b>16.9</b>	<b>28.8</b>
<b>Area with no land-use change from 1856 to 1956</b>										<b>1,090,9</b>
<b>id. land-use changes</b>	<b>48.9</b>	<b>63.4</b>	<b>7.3</b>	<b>270.9</b>	<b>42.8</b>	<b>166.7</b>	<b>181.0</b>	<b>4.6</b>	<b>3.4</b>	<b>788.8</b>
<b>hectares 2005 →</b>	<b>1,054.5</b>	<b>102.6</b>	<b>32.0</b>	<b>176.5</b>	<b>11.7</b>	<b>88.1</b>	<b>7.9</b>	<b>377.6</b>	<b>28.8</b>	<b>1,879.7</b>
<b>% 2005 →</b>	<b>56.1%</b>	<b>5.5%</b>	<b>1.7%</b>	<b>9.4%</b>	<b>0.6%</b>	<b>4.7%</b>	<b>0.4%</b>	<b>20.1%</b>	<b>1.5%</b>	<b>100.0%</b>

Sources:

Congost Valley in Catalonia (1850-2005)', submitted to *Landscape History*). The matrices of land-use change have been calculated using these homogenized land-use categories.

Calculated by Natàlia Valldeperas and Anna Ollés with GIS software out of the digital maps of land-use and land covers of La Garriga township in 1854, 1956 and 2005.

If we examine the extent of the land cover reallocations experienced in La Garriga, by adding up all the hectares recorded in the diagonal of the two matrices shown in Table 4, we can see that from 1854 to 1956 only 32 per cent of land covers remained unchanged; 58 per cent from 1956 to 2005; and for the whole period from 1854 to 2005 the corresponding figure is 26 per cent. Even if the land-use changes registered are potentially exaggerated a little due to unavoidable mismatches in the land cover intersection with GIS from the cumulative effects of small errors in geo-referring the perimeters of all landscape units from the original cadastral maps, nevertheless they are still so large we can perceive the real existence of a very strong landscape turnaround during a century and a half. Change was registered in 68 per cent of the territory from 1854-1956, or 42 per cent from 1956-2005, and 74 per cent from 1854 to 2005. Another interesting point revealed by these matrices is that land-use changes seem have to be much less unidirectional than expected: reallocations appear in both directions across land uses for almost all possible categories, even where there is a net outcome with a clear direction.<sup>22</sup>

As seen in Map 2, the starting point in 1854 was the cultural landscape created by an intensive organic and polycultural agricultural system, combining a significant amount of irrigated orchards on 12 per cent of the territory along the Congost River, with a mosaic made out of rain-fed cereals (5 per cent), vineyards (27 per cent), other tree crops such as olive orchards, almonds or hazelnuts (3 per cent), and pastures (19 per cent) that spread over the flattest parts of two thirds of the municipal area. An interesting feature of this case study is that pasturelands were tightly interwoven with arable land, instead of being found with woods and scrubs as seems more usual in the Vallès County or other Catalan regions. This suggests that these pasturelands were seasonally leased in exchange for manure, either to cattle coming from Figaró-Montmany or to transhumant sheep coming from the Pyrenees, a common practice that would help to fill the fertilizer gap. This patchwork mosaic was extended up to the woodlands (30 per cent) and scrubs (4 per cent) covering the other third of the land. Again it is worth noting that these forestlands not only overlaid the steepest hillsides in the Northern and Western borders of the township, but the Southern and Eastern plains as well (Map 2).<sup>23</sup>

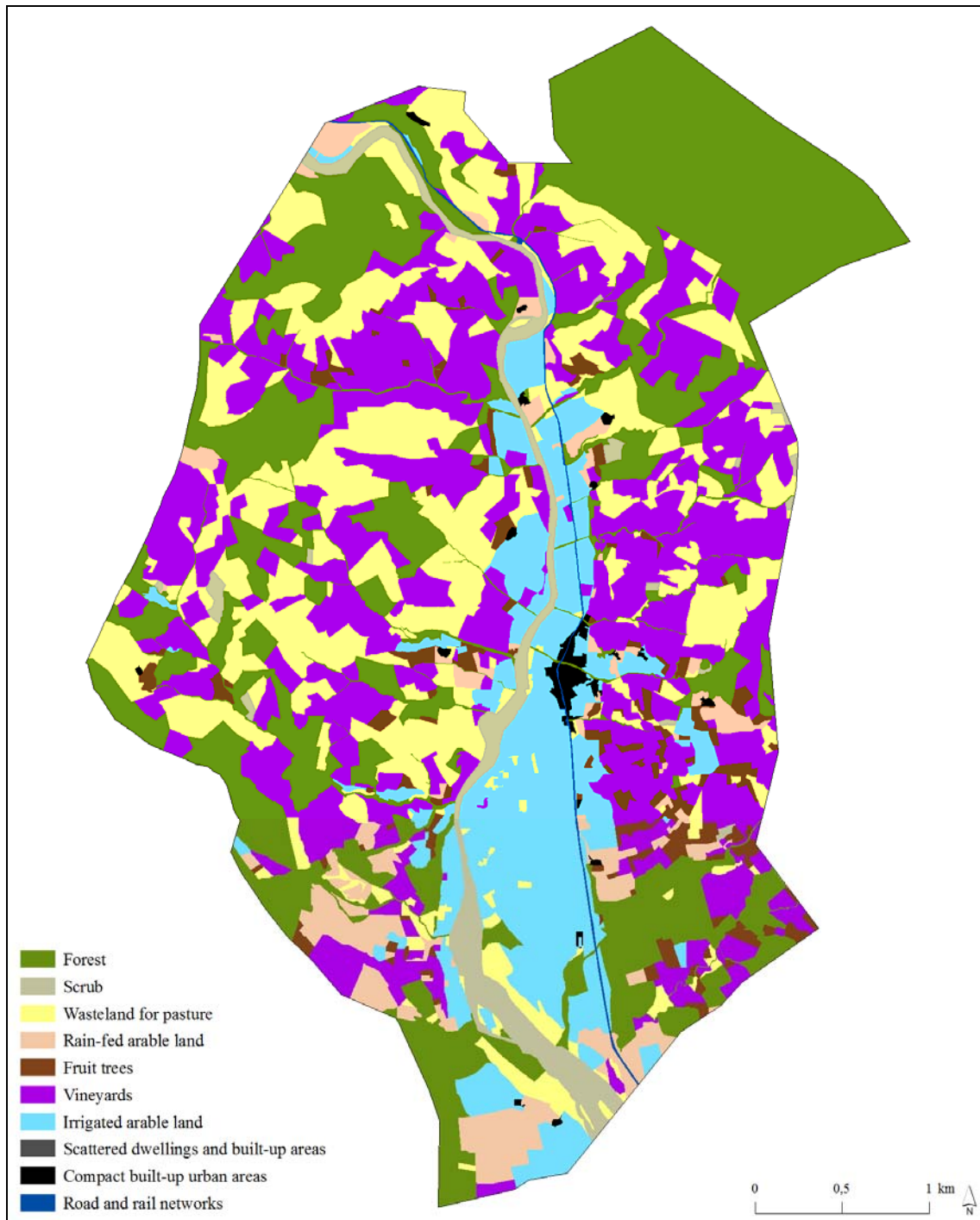
#### MAP 2. Cultural landscape in La Garriga according to the cadastral map of 1854

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<sup>22</sup> Using GIS techniques in historical studies is still a novel area of work, so there are few examples with which to compare these data. In the case of Tuscany, Mauro Agnoletti has found 60% of land cover changes from 1832 to 1954 and 29% from 1954 to 2004 in a sample of thirteen study areas—rather similar values to our figures after considering the marginal errors that all of them may contain (our own calculation, from the land-use matrices published in ‘The Development of Historical and Cultural Evaluation Approach in Landscape Assessment: the Dynamic of Tuscan Landscape between 1832 and 2004’, in *The Conservation of Cultural Landscapes*, 16 and 19). See also, in the same volume, G. Chirici, P. Corona and M. Köhl, ‘Earth Observation Techniques and Geographic Information Systems as Tools for Assessing Land Use/Cover Changes in a Landscape Context’, 57—0.

<sup>23</sup> Land-use patterns and dynamics in other parts of the province of Barcelona can be seen in E. Tello, R. Garrabou and X. Cussó, ‘Energy Balance and Land Use’; R. Garrabou, E. Tello and X. Cussó, ‘El cambio de usos del suelo en la comarca del Vallès (1850-2000): fuerzas motoras y agentes rectores de la transformación del territorio’, in R. Garrabou and Naredo, J.M. (eds), *El paisaje en perspectiva histórica. Formación y transformación del paisaje en el mundo mediterráneo* (Zaragoza: SEHA/Prensas Universitarias de Zaragoza, 2008), 233—8; and Ll. Parcercisas, J. Marull, J. Pino, E. Tello, F. Coll and C. Basnou, ‘Land use changes, landscape ecology and their socioeconomic driving forces in the Spanish Mediterranean coast (El Maresme County, 1850-2005)’, *Environmental Science & Policy* 23 (2012): 123—2.





Sources:

Drawn by Francesc Coll and Joan Marull at the IERMB out of the GIS digital layers obtained by Natalia Valldeperas from the cadastral map of 1854 kept in the Historical Municipal Archive of La Garriga.

From 1854 to 1956 the total amount of cultivated land (46 per cent in the former and 42 per cent in the latter) or land covered by wood, scrub and pasture (53 per cent and 52 per cent respectively) does not registered highly significant changes. There were however other important rearrangements within each of these land-use categories that transformed the overall cultural landscape. First of all, during the 1880s all vines were killed by the *Phylloxera Vastatrix* plague, and only a small fraction of the former vineyards were replanted in La Garriga with resistant strains coming from America. In 1956 the new vines only occupied 2 per cent of the

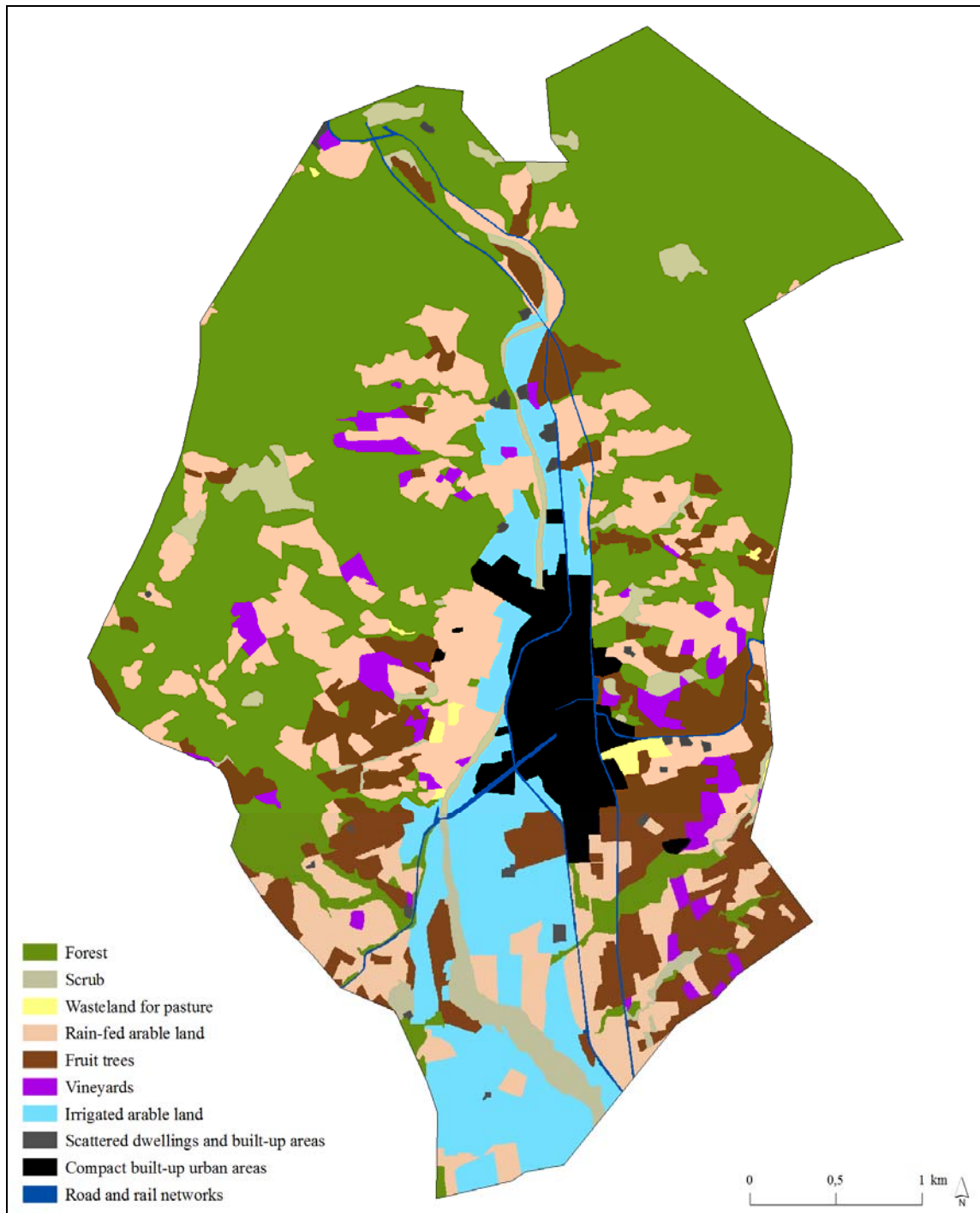
municipal area, and 55 per cent of the vineyards existing in 1854 had been turned into forests, scrub or wasteland (-275 ha), 23 per cent into rain-fed arable land sown with grains (-115 ha), 14 per cent into different tree crops (-72 ha), and the rest (-7 ha) became irrigated gardens or built-up areas. The abandonment of winegrowing was the first important land-use change from mid-nineteenth to mid-twentieth century in this township.<sup>24</sup>

A second deep change happened inside the uncultivated lands, with a significant decrease in pasturelands (-360 ha) that mainly became afforested. Woodlands and scrubs also increased significantly (+338 ha)—although the fluxes of land-use reallocations were more complicated than simply changing pasture areas into forests, as shown in the matrices of Table 4. Behind the practical disappearance of pastureland lay the collapse of the extensive, organic grazing of herds, replaced with new industrial feed-lots where livestock was fed with imported grains. Pasturelands were invaded by new forests and brushwood, mainly in the Northern and Western sides of the municipality. The joint abandonment of extensive grazing and winegrowing entailed a reduction in the complexity of landscape mosaics, where all sorts of cropland had been interwoven. Those two trends were combined with a noticeable increase of built-up land and areas devoted to infrastructure facilities, both in absolute numbers (+95 ha, jumping from only 17 ha in 1854 to 112 ha in 1956) and in relative terms—a nearly seven fold increase. Nevertheless, as seen in Map 3, the agricultural mosaic remained in place over a significant share of the township together with the irrigated gardens near the river, which in 1956 had lost -35 ha out of the 222 ha existing in 1854.

MAP 3. Cultural landscape in La Garriga according to the aerial photographs of 1956

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<sup>24</sup> For the regional impact of this plague see M. Badia-Miró, E. Tello, F. Valls and R. Garrabou, ‘The Grape Phylloxera Plague as a Natural Experiment: The Upkeep of Vineyards in Catalonia (Spain, 1858-1935)’, *Australian Economic History Review* 50 (2010): 39—1.



Sources:

Drawn by Francesc Coll and Joan Marull at the IERMB out of the geo-interpretation of the aerial photographs taken 1956 by the United States Army provided by the CREAM.

The biggest landscape turnaround occurred between 1956 and 2005. What stands out most when comparing Map 4 with 2 and 3 is the explosion of built-up areas, whether urban land or infrastructural facilities. During this period +303 ha was paved, or covered with concrete and asphalt: 16 per cent of the whole municipal area and 38 per cent of all land cover changes undertaken in this territory during this period. It is also striking that most of this probably irreversible soil degradation has been undertaken on the most fertile irrigated lands of the township. This draws attention towards the particular dynamics of another type of edge, the one linking built-up land with the countryside. Following the market-driven logic pointed out by

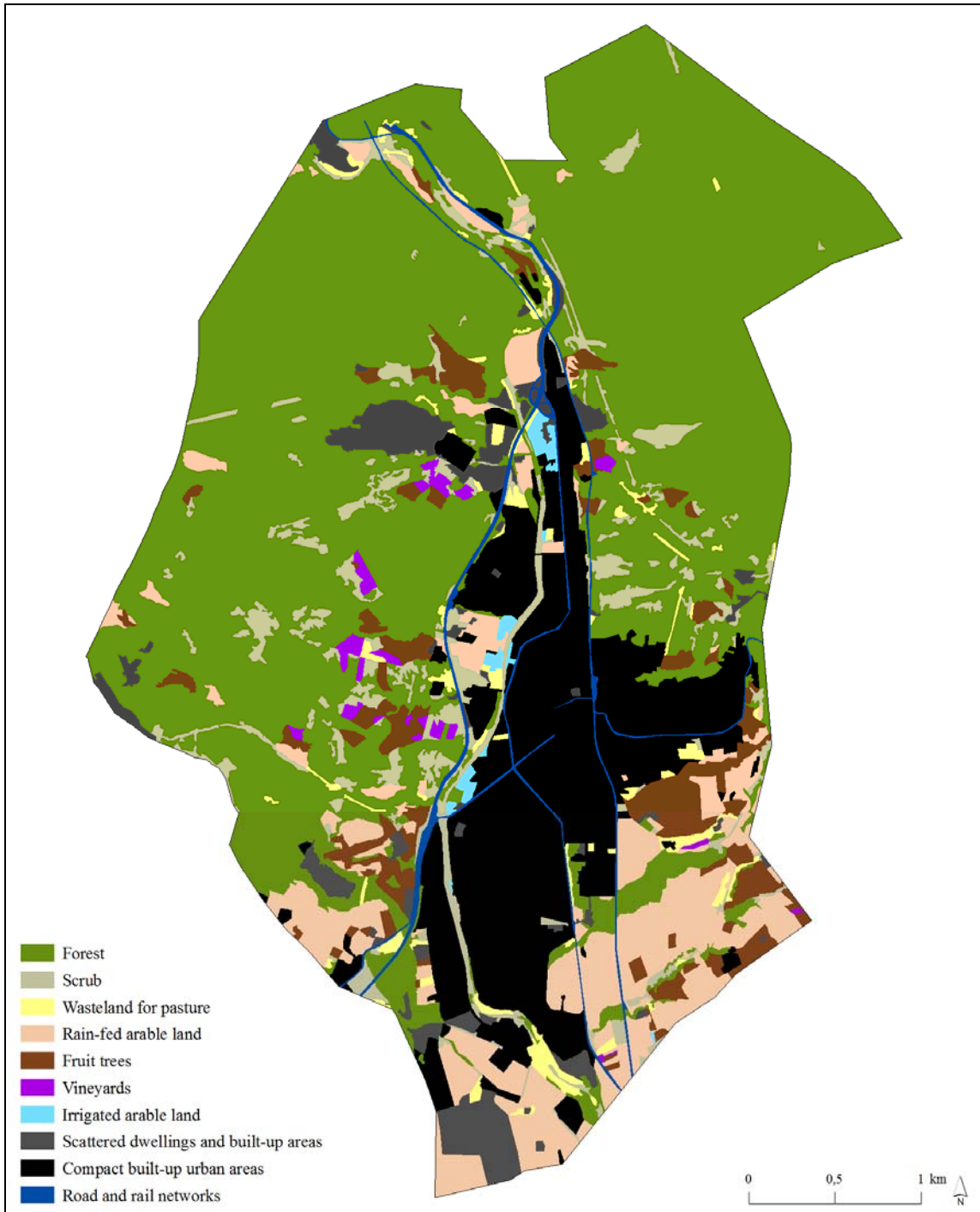
Von Thünen, the village border created around it a ring of irrigated orchards where fresh vegetables were grown. A question was going to be posed when the village border needed to be extended due to population and economic growth: should new land developments be extended over the market gardening zone or should that be preserved by building on a more distant location?

Once the vegetation along both sides of the river, long ago transformed into orchards, was built over it could never be reproduced elsewhere. The choice of building over the gardening zone of a village like La Garriga gave no option of return. This is not an extemporaneous question: it was already raised in Catalonia in the early twentieth century by Cebrià de Montoliu (1873-1923) and other land-use planners who advocated the city-garden movement leading to the Regional Planning of Catalonia passed in 1932. The failure of these alternative approaches epitomises the lack of an adequate land-use zoning and regional planning in Catalonia both during the long dictatorship of the General Franco, and after.<sup>25</sup>

MAP 4. Cultural landscape in La Garriga according to satellite images of 2005

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<sup>25</sup> The Catalan city-garden movement during the 1920s and 1930s, and its connections with the anarchism, are explained in J. Martínez Alier, 'Urban sprawl and ecology in Barcelona', and E. Masjuan, *La ecología humana en el anarquismo ibérico*. We present other apparent examples of the Spanish lack of regional planning in Ll. Parcerisas et al., 'Land use changes, landscape ecology and their socioeconomic driving forces in the Spanish Mediterranean coast'.



Sources:

Drawn by Francesc Coll and Joan Marull at the IERMB out of the GIS digital layers obtained from satellite images.

The second biggest land cover change during the last fifty years is reforestation following rural abandonment. Together with urban expansion this means that the traditional agro-forest mosaics only survive in La Garriga as relicts mainly located in the South-East side of the township—perhaps because a small water reservoir allows the irrigation of the area. People owning these remaining fields face the dilemma of whether to continue as peri-urban farmers or taking offers



from urban land developers to give up their land. As always, decisions will be shaped by public policy and the implementation of regional planning.<sup>26</sup>

The cultural landscapes of La Garriga experienced a deep socio-ecological transition from a poly-cultural mosaic of 1854, created by highly intensive organic agriculture in a mainly rural but already industrializing village, to a residential town located in 2005 inside the farthest edge of the BMR—now placed face to face with the Montseny Natural Park and the protected site of the Cingles de Bertí. In 1956 its landscape was still a combination of agro-forest mosaics with a growing residential town and a blooming resort area joined to a small industrial cluster of textiles and furniture. Now the future of this community placed in such an edge environment will depend again on Catalan and European society decides to value environmental services and care for the ecological functioning of the land matrix on which they live. As in the past, market forces operate within a framework of cultural values, institutional settings and public policies which may or may not respond to environmental externalities, asymmetric information, lack of transparency and market power.

## CHANGE BENEATH APPARENT PERMANENCE: FIGARÓ-MONTMANY

The most prominent feature of the landscape evolution of Figaro-Montmany seems at first to be permanence—exactly the opposite of La Garriga. However, we must take a critical distance from this image of immobility. The overall picture of the land-use pattern in this mountain township is blurred by the ambiguities and shifting criteria of assessment of what was considered pasture, wasteland, scrub or woodland. There were two different sides behind these problems in categorization. When relying in written sources and maps, historians have to deal with the information that rulers obtained about rural society, through which those documents were drawn up. They always found more difficult to get information on large and inaccessible forestlands and pastures, as well as the people living on them in scattered settlements compared with denser agricultural townships located in the plains.<sup>27</sup> The complexity and adaptability of the multipurpose uses of forests integrated with other uncultivated areas was also a great ally in local efforts to escape control and taxation. Thus, it was not only their ability to deceive tax collectors; the land-use categories which the surveyors wanted to assess in a fixed and separate way were always overlapping and shifting their boundaries in an manner incomprehensible to people lacking the local knowledge of the villagers who managed those lands.<sup>28</sup>

Looking at the available cadastral figures, the land devoted to woodland and pasture was always over 70 per cent during the nineteenth century and 90 per cent in the twentieth century. Vineyards were by far the main crop in the cultivated land during the former period,

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<sup>26</sup> These trends are local expressions of the global ones examined, for example, in E. Lambin, M.D.A. Rounsevell and H.J. Geist, 'Are agricultural land-use models able to predict changes in land-use intensity?', *Agriculture, Ecosystems and Environment* 82 (2000): 321—1; C. Stoate, N.D. Boatman, R.J. Borralho, C. Rio Carvalho, G.R de Snoo and P. Eden, 'Ecological impacts of arable intensification in Europe', *Journal of Environmental Management* 63 (2001): 337—5; and T.K. Rudel, O.T. Coomes, E. Moran, F. Achard, A. Angelsen, J. Xu and E. Lambin, 'Forest transitions: towards a global understanding of land use change', *Global Environmental Change* 15 (2005): 23—1. These trends are also studied in the BMR by B. Catalán, D. Saurí and P. Serra, 'Urban Sprawl in the Mediterranean? Patterns of growth and change in the Barcelona Metropolitan Region 1993-2000', *Landscape and Urban Planning* 85 (2008): 174—4; and J. Marull et al., 'Social metabolism, landscape change and land-use planning in the Barcelona Metropolitan Region'.

<sup>27</sup> The inaccuracies and ambiguous meanings of land-use statistics in mainly woodland mountain areas is stressed by A.T. Grove and O. Rackham in *The Nature of Mediterranean Europe*.

<sup>28</sup> For a general perspective, see M.A. Altieri, 'Agroecology: the science of natural resource management for poor farmers in marginal environments', *Agriculture, Ecosystems and Environment* 93 (2002): 1—24. For a Catalan case study of a mountain village made combining written and oral sources, see I. Otero and M. Boada, *El patrimoni socioecològic de la pagesia. L'exemple d'Olzinelles, al massís del Montnegre* (Barcelona: Publicacions de l'Abadia de Montserrat, 2012).

but was reduced to almost nothing after the Phylloxera Plague. Giving up winegrowing further strengthened the forest character of this township (Table 5).

TABLE 5. Main land uses in Figaró-Montmany according to the available statistics (1858-1976)

	1858		1861		1941		1976	
	Ha	%	ha	%	ha	%	ha	%
irrigated vegetables	--	--	--	--	2.3	0.1	--	--
irrigated fruit trees orchards	--	--	--	--	5.2	0.3	--	--
irrigated cereal cropland	28.4	1.8	27.9	2.3	13.0	0.9	--	--
<i>TOTAL IRRIGATED LAND</i>	28.4	1.8	27.9	2.3	20.4	1.3	44.0	3.1
rain-fed cereal cropland	108.9	6.9	88.8	7.3	66.2	4.3	33.0	2.3
<i>TOTAL CEREAL CROPLAND</i>	137.3	8.7	116.8	9.6	79.2	5.2	--	--
vineyards	245.4	15.5	196.9	16.2	0.0	0.0	--	--
olive groves	55.8	3.5	35.6	2.9	13.2	0.9	--	--
<i>TOTAL TREE CROPS</i>	301.2	19.0	232.4	19.2	13.2	0.9	13.0	0.9
TOTAL CROPLAND AREA	438.5	27.7	349.2	28.8	99.8	6.6	90.0	6.4
Timberland/ pine woodland*	182.3	11.5	180.3	14.9	435.3	28.6	1,078.0	76.4
Firewood/ holm oak woodland**	371.1	23.4	357.6	29.5	453.4	29.8	--	--
Scrubland***	--	--	--	--	208.4	13.7	--	--
TOTAL WOODLAND AREA	553.4	34.9	537.9	44.3	1,097.2	72.0	1,078.0	76.4
PASTURELAND****	591.9	37.4	326.4	26.9	326.9	21.5	243.0	17.2
TOTAL WOODS AND PASTURE	1,145.3	72.3	864.3	71.2	1,424.1	93.4	1,321.0	93.6
TOTAL UAA*****	1,583.8	100.0	1,213.5	100.0	1,523.9	100.0	1,411.0	100.0

Notes:

\* 'Timberland' ('*bosque de construcción*' in Spanish) is the name given by the statistics of 1858 and 1861, and again in 1976 ('*monte maderable*'), while the category 'pine woodlands' ('*pinares*') is used in 1941 for these areas.

\*\* 'Firewood woodland' ('*bosc de fagina*' in Catalan) is the name given by the statistics of 1858 and 1861, and again in 1976 ('*monte leñoso*' in Spanish), while the category 'holm oak woodland' ('*encinares*') is used in 1941 for these areas.

\*\*\* The category 'scrubland' ('*monte bajo*' o '*matorral*') only appears differentiated in 1941, in the rest of the years must be mixed with holm oak woodland.

\*\*\*\* We have included here the Spanish categories of '*yermo*' and '*erial*' (or '*erm*' in Catalan, which literary means 'wasteland') that sometimes are also referred to as '*erial a pastos*' ('wasteland devoted to pasture') in the sources.

\*\*\*\*\* 'Useful Agricultural Area'. The official total extent of the township is 1,580 hectares at present, and the differences in the total acreage recorded in the table come from the respective inaccuracies in land accounts. Rocky crags, water streams and built-up areas are not included in these figures (e.g. the *Amillaramiento* of 1861 included 157 ha of 'rocky lands').

Sources:

Taken from the *Land-Use Statistics in the Province of Barcelona* in 1858, the cadastral *Amillaramientos* of 1861 and 1941, and the agricultural census of 1976 kept in the Historical Municipal Archive of Figaró-Montmany.

Unfortunately, the cadastral map of this township made in 1854 has been lost. We have however a very detailed map made in 1949.<sup>29</sup> Although this reduces the possibility to calculate a matrix of land-use changes to the second half of the twentieth century, it is enough to test the lesser land cover reallocation which took place in this municipality. While in La Garriga up to 42 per cent of the area changed land cover from 1956 to 2005, in Figaró-Montmany only 28 per cent did so from 1949 to 2005 (Table 6). In addition to the reduction experienced by all sorts of

<sup>29</sup> See F. Nadal et al., *El Territori dels geòmetres*. The year 1949 is a surprising date for such an expensive task. Possibly the old map of 1854 was simply copied and rectified according to the land uses recorded in the *Amillaramiento* of 1941, which would explain the lack of interest in keeping the former one in the archive. The 1949 map is kept by the City Council of Figaró-Montmany.

cropland, and the increase in built-up areas or devoted to infrastructures, it is worth noting the contraction suffered in the pastureland: from nearly 80 in 1949 to less than 20 hectares in 2005.

TABLE 6. Matrix of main land-use changes from 1949 to 2005 in Figaró-Montmany

	1	2	3	4	5	6	7	8	9	hectares
	woods	scrubs	pasture	grains	vines	olive &	irrigated	built-up	infra.	2005 ↓
<b>% 1949 →</b>	<b>81.20</b>	<b>0.00</b>	<b>5.33</b>	<b>4.92</b>	<b>0.51</b>	<b>2.37</b>	<b>3.03</b>	<b>0.80</b>	<b>1.83</b>	<b>100.00</b>
<b>hectares 1949 →</b>	<b>1,216.4</b>	<b>0.00</b>	<b>79.91</b>	<b>73.68</b>	<b>7.66</b>	<b>35.46</b>	<b>45.44</b>	<b>12.05</b>	<b>27.41</b>	<b>1,498.06</b>
1. woodland	<b>1,041.68</b>	0.00	61.83	29.18	2.93	22.06	17.94	1.82	18.56	<b>1,196.01</b>
2. scrubland*	136.16	<b>0.00</b>	10.63	7.47	2.00	8.84	3.03	0.58	2.87	<b>171.58</b>
3. pastureland	10.93	0.00	<b>5.02</b>	1.99	0.09	0.25	0.94	0.22	0.30	<b>19.74</b>
4. rain-fed grains	9.52	0.00	0.26	<b>25.45</b>	1.94	0.16	1.57	0.32	0.62	<b>39.85</b>
5. vineyards	0.00	0.00	0.00	0.00	<b>0.00</b>	0.00	0.00	0.00	0.00	<b>0.00</b>
6. olive & other trees	0.43	0.00	0.00	0.53	0.10	<b>0.00</b>	0.00	0.00	0.00	<b>1.06</b>
7. irrigated orchards**	0.00	0.00	0.00	0.00	0.00	0.15	<b>0.33</b>	0.00	0.00	<b>0.49</b>
8. built-up area	0.00	0.00	0.00	0.00	0.00	0.00	19.30	<b>8.53</b>	4.11	<b>60.51</b>
9. infrastructure***	13.69	0.00	1.96	8.85	0.47	3.59	2.32	0.60	<b>0.94</b>	<b>8.82</b>
<b>Area with no land-use change from 1949 to 2005****</b>										<b>1,081.94</b>
<i>id. land-use changes</i>	174.76	0.00	74.89	48.23	7.66	35.46	45.11	3.53	26.47	<b>416.12</b>
<b>hectares 2005 →</b>	<b>1,196.01</b>	<b>171.58</b>	<b>19.74</b>	<b>39.85</b>	<b>0.00</b>	<b>1.06</b>	<b>0.49</b>	<b>60.51</b>	<b>8.82</b>	<b>1,498.06</b>
<b>% 2005 →</b>	<b>79.84</b>	<b>11.45</b>	<b>1.32</b>	<b>2.66</b>	<b>0.00</b>	<b>0.07</b>	<b>0.03</b>	<b>4.04</b>	<b>0.59</b>	<b>100.00</b>

Notes:

\* The land cover map of 1949 does not include scrubland. Due to its strong forestry bias, it is likely that areas covered by shrubs and thickets were considered potential woodlands.

\*\* This land-use category includes in the land cover map of 1949 a small proportion of flood plains along the Congost river, and its tributary creeks, which in some places were used to plant and grow alders, poplars and planes.

\*\*\* This land-use category includes in the land cover map of 1949 some amount of 'unproductive areas'.

\*\*\*\* As explained in the text, there are some differences in acreage between this GIS metrics applied to the available land cover maps, and the figures given in Table 6 taken from land-use historical statistics. They come from the unavoidable margins of error of these land accounts and the diverse criteria used in land-use categories by the original maps.

Sources:

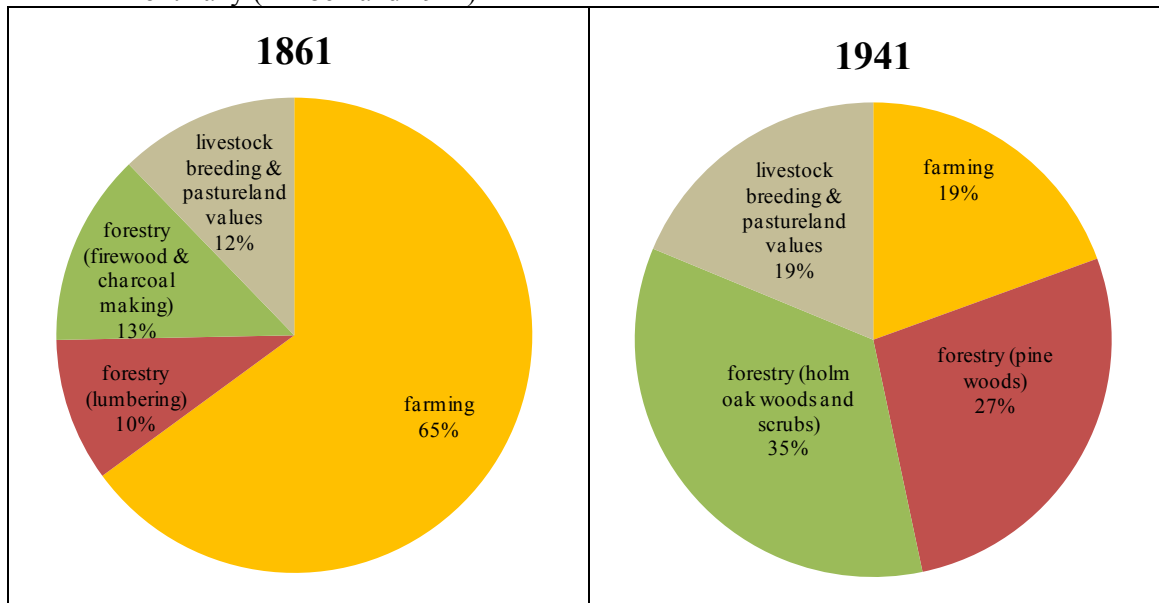
Calculated by Natàlia Valldeperas and Anna Ollés with GIS software out of the digital maps of land-use and land covers of Figaró-Montmany township in 1949 and 2005.

Combining Tables 6 and 7 we can see that from mid-nineteenth to mid-twentieth century arable land shrunk from some 28 per cent to only 7 or 10 per cent of the territory, to less than 3 per cent in 2005. It is also notable that the population almost halved from 695 inhabitants in 1860 to only 379 in 1887—just when the Phylloxera Plague had ravaged all vines. Then, mainly due to the economic impact of incoming vacationers, the local population increased slowly again to 463 in 1930, 519 in 1940, and 571 in 1960. Under the effect of urban sprawl inside the MBR, population increased again to 624 in 1991 and 1,057 in 2009. As throughout this period around 80 per cent of the land was woodland, and between 8 per cent to 13 per cent scrubs or afforesting lands, it becomes important to disentangle the different non-agricultural land usages.

To recover some real changes underlying the seeming immobility, we can examine not only to the surface areas but also the values of taxable net incomes recorded in the cadastres. Figure 2 shows a transition from a mixed agro-forestry-pastoral village economy in 1861, where most taxes were raised from farming activity (65 per cent), towards a forestry specialization that by 1941 provided the majority of income (62 per cent) from lumbering and charcoal making. It is likely that mid-nineteenth century non-agricultural incomes were overestimated due the inability of tax collectors to assess livestock breeding and forestry activities. Nevertheless the shift is too large not to reflect a real transition towards a mainly forestry economy. This also fits

very well with recent historical studies which have stressed that during industrialization and urbanization wood and firewood consumption continued to grow, adding to the increase in fossil fuels consumed instead of being replaced by them.<sup>30</sup>

FIGURE 2. Distribution of cadastral taxable net incomes among rural activities of Figaró-Montmany (in 1861 and 1941)



Sources:

Taken from the cadastral *Amillaramientos* of 1861 and 1941 kept in the Historical Municipal Archive of Figaró-Montmany.

The ongoing urbanization and economic growth in Barcelona and the Vallès plain probably entailed rising domestic fuel consumption, which was mainly provided by charcoal-makers such as those working in the holm and oak woods of Figaró-Montmany. It is even likely that charcoal-making reached its peak during the first half of the twentieth century, just before the arrival of butane gas cylinders during the early 1960s. In 1941 firewood collection and pruning of oak branches to be burnt in charcoal-kilns still provided 35 per cent of net incomes of Figaró-Montmany, while lumbering and sawing pine planks generated another 27 per cent, supplying the furniture industry in the neighbouring townships of La Garriga and L'Ametlla del Vallès.

Looking at Tables 6 and 7 we can assume an overall stability in the land devoted to pasture –some of which was probably included under the category of abandoned or denuded lands in the 1949-2005 matrix of changes— or perhaps a slight decline. However it is very difficult to make any definitive statement on that issue due to elusive criteria about what was considered as woodland, scrubland or pasture in each cadastral source or map. Another clue is the relative increase in net income attributed by tax sources to livestock breeding, as shown in Figure 2. This also fits with the impression given by the livestock numbers appearing in the census: they diminished but a little and changed composition when the local economy underwent a forestry specialization after the abandoning of winegrowing from the mid-nineteenth century to the first half of the twentieth century. Then the extensive livestock grazing suddenly collapsed during the 1960s, more or less at the same time as charcoal-making was

<sup>30</sup> I. Iriarte-Goñi and M.I. Ayuda, 'Not only subterranean forests: Wood consumption and economic development in Britain (1850-1938)', *Ecological Economics* 77 (2012):176—4; and for the case of Spain, I. Iriarte-Goñi, 'Forests, Fuelwood, Pulpwood, and Lumber in Spain, 1860-2000: A Non-declensionist story', *Environmental History* (forthcoming).

abandoned. This sudden withdrawal of traditional multiple-use of woodlands, scrubs and pastures entailed a deep caesura in the landscape leading to reforestation after abandonment.<sup>31</sup>

In order to understand the environmental impact of this event we need to go beyond the general categories of land-use statistics, to recover the how the integrated uses of land had been articulated by the inhabitants. Historical pictures can help us in this task. We can see in Figure 3 a comparison of two photographs taken circa 1908 and 2012 from the same place in Figaró-Montmany, showing a section of the lateral valley of Can Oliveres. We can see an apparent reforestation today contrasting with the lower woodland coverage at the beginning of the twentieth century, particularly along the slopes of the hills on the left side of the pictures. Just above the column of smoke coming from the locomotive, the effects of large forest clear-cuttings can be observed circa 1908. The contrast becomes even more apparent when comparing the hilltops in the background of the images. In 2012 these appear totally wooded and crossed by a high voltage power line up. In 1908 most of these lands located between 500 and 600 meters altitude appeared to be open spaces probably used as pasturelands. After the abandonment of extensive cattle grazing they became afforested.

FIGURE 3. The lateral valley of Can Oliveres, also known as Sots Ferèstcs or ‘untamed crags’, seen from Figaró-Montmany circa 1908 and 2012.



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<sup>31</sup> We omit the data taken from the livestock census kept at the municipal archive from 1861 to 1951—an indicator in itself of the maintenance of this activity— due to its low reliability. They repeated then exact same quantities of each type of cattle over several periods, leading us to suspect tax fraud. This is confirmed for 1951, when the comparison between the individual statements signed by each breeder and the final list sent to the authorities reveals that there were far more beats than officially declared. In these official lists livestock had to be ascribed to the municipality where their owner resided. Leasing of pastures or animals through partnership contracts were common verbal agreements which offered many opportunities for tax evasion.



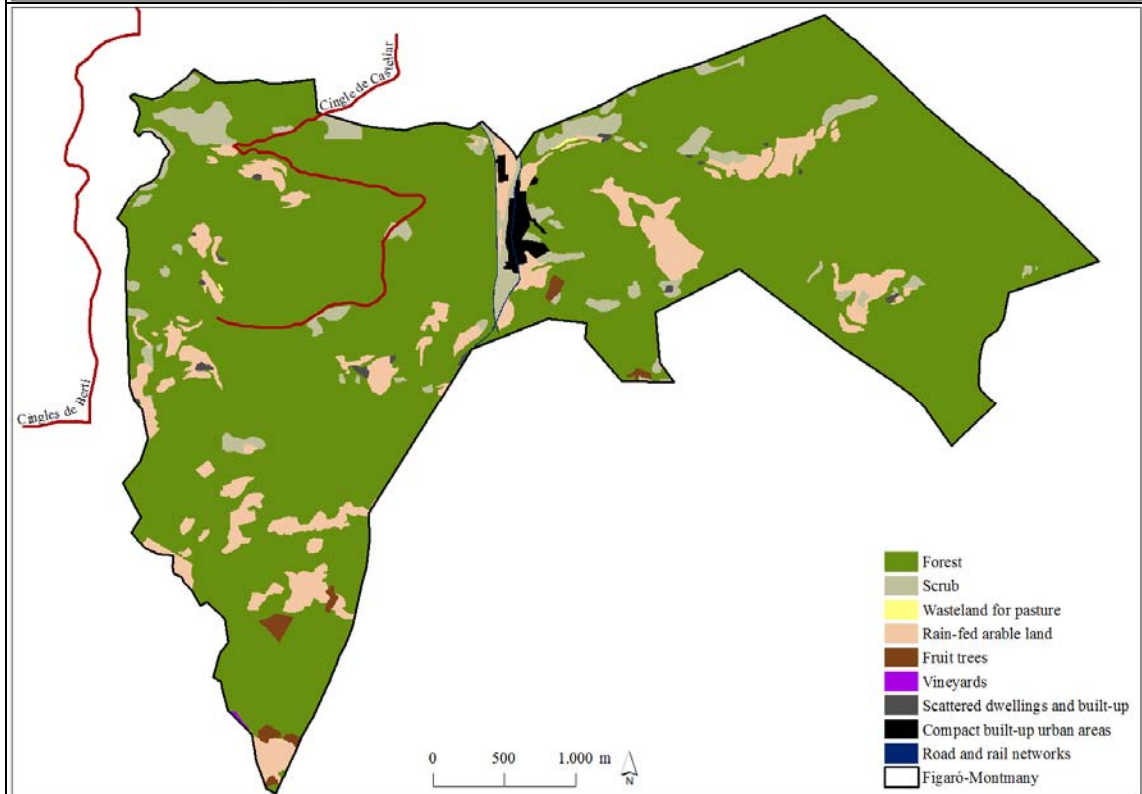
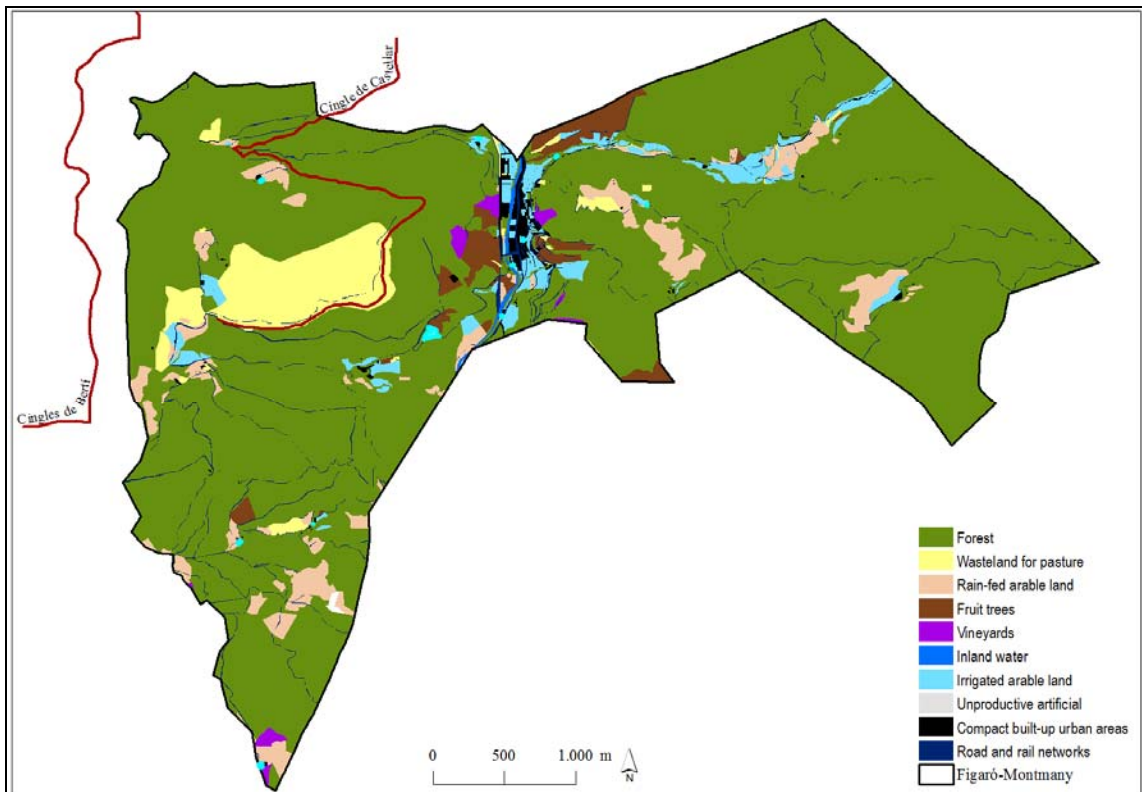


Sources:

Personal archive of Enric Tello.

The cadastral map of Figaró-Montmany drawn in 1949 allows the identification of pasturelands and croplands that extended in a flatter corridor that lay between two rows of cliffs in the Cingles de Bertí and Castellar—in spite of its clear bias towards recording forestry uses and its tendency to mix pasturelands with forests or wastelands. Pastures also appeared scattered in some open and flatter spaces located higher in the Vallcàrquera valley and other parts of the Montseny massif. We can see some of the same land, although in a more blurred way, with the land cover geo-interpretation made from aerial photographs taken by the US army in 1956—in this case mixing former meadows or grazing areas with abandoned crops (Maps 5).

MAPS 5. Cultural landscape in Figaró-Montmany according to the cadastral map of 1949 and the aerial photographs of 1956



Sources:

Drawn by Natàlia Valldeperas and Anna Ollés from the cadastral map of 1949 kept in the Historical Municipal Archive of Figaró-Montmany with the funds provided by the Batista i Roca Grant 2010PBR00002, and out of the GIS digital layers of the geo-interpretation of the aerial photographs taken 1956 by the United States Army provided by the CREAM, adapted by Francesc Coll and Joan Marull at the IERMB.

However, by comparing the two land cover maps of 1949 and 1956 we can note considerable differences, when it is implausible that in only seven years land uses had experienced such large changes. Shifting and overlapping land-use categories may explain, for examples, the ‘disappearance’ in 1956 of the above-mentioned big grazing land unit in the Cingles de Bertí area, shown in yellow as ‘wasteland for pasture’ in the 1949. In the 1901 novel *Els sots feréstcs* Raimon Casellas described the local herdsmen driving their flocks in the shaded sides—called ‘obaga’, ‘baga’ or ‘bac’ in Catalan— at the edge of the woods of oaks and holms precisely in this corridor along the Cingles de Bertí, while according to him the charcoal-makers looked for other open spaces in the sunny sides of the same areas.<sup>32</sup> This spatial distribution makes sense, and fits with what we can see in Figure 3 and Maps 5. Throughout the topography of the massif, from the Congost River upwards, there was a first level of slopes covered with pines mainly exploited for lumber and firewood—like the clear cuts shown above the locomotive in the picture taken in 1908 (Figure 3). Then, above the first row of cliffs, this corridor of flatter lands was covered by a peculiar mosaic of croplands, pasturelands, woodland-meadows and woodlands of oaks and holms. Woodsmen regularly removed firewood in these sparse forests where charcoal-makers also pruned their branches for their kilns, usually located in bare or rocky lands as near as possible to a spring in order to better control the fire.

Thanks to this multiple exploitation, the oaks and holms of these woodlands probably became taller and more distant from one another. Sunlight could penetrate the canopy allowing the grassy layer of the land to grow fescues or thatching grasses to be eaten by flocks of sheep, goats and pigs. These new types of Mediterranean woodland-meadows increased the spatial heterogeneity of forestlands inside a mosaic with cropland and scrubs, as well as the height and age differentials of the remaining trees. Due to the edge effect generated by this combination of open and wooded mosaics, connected with a network of streams, a wide set of microhabitats was offered to many plants (e.g. orchids) and animals—from butterflies to partridges, crested larks, rabbits, hares and their predators.<sup>33</sup>

This also helps to explain why pasturelands tended to fade out in the land-use statistics and maps drawn up by people with a forestry-oriented mind. When the traditional livestock breeding was stopped at the same time as charcoal-burning and firewood collection, the whole system of multiple and integrated use of forestlands and pastures suddenly collapsed. This can be seen by comparing 1949 or 1956 shown in Maps 5 with present land covers in Map 6. The

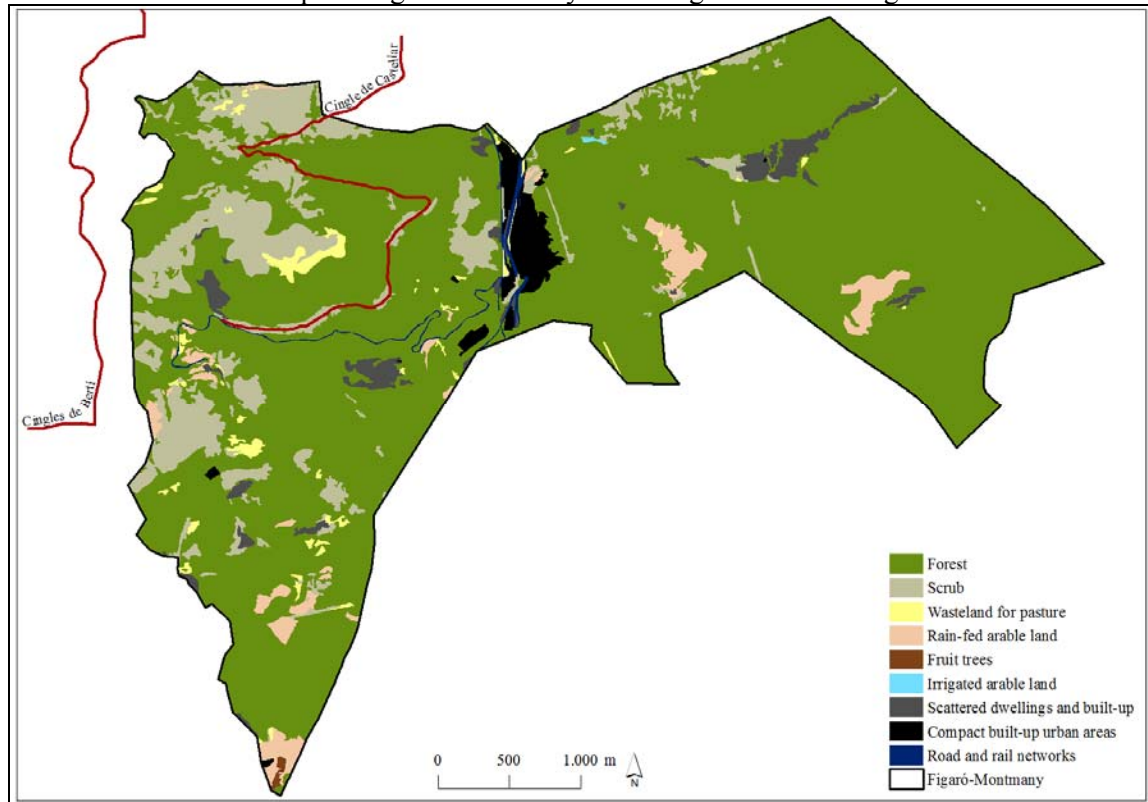
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<sup>32</sup> R. Casellas, *Els sots feréstcs* (Barcelona: Llibreria de Francisco Puig, 1901), 11, 15, 18 and 20. *Els sots feréstcs* («Untamed crags») contrasted the ‘wilderness’ and untamed nature of the inhabitants of those mountains in a lateral valley of Figaró-Montmany, with the Catholic fervour of their parish priest. The author had lived in this small valley when he was a child, and some of the characters or events included in the narrative evoked real people and historical facts. (see J. Castellanos, foreword to *Raimon Casellas, Els sots feréstcs*. Barcelona: Laia, 1980).

<sup>33</sup> The association of these grassy layers at the edges of woodland-meadows with orchids has been pointed out, among others, by W.S. Alverson, D.M. Waller and S.K. Solheim, ‘Forest to Deer: Edge Effects in Northern Wisconsin’, *Conservation Biology* 2 (1988): 348—8; and in Italy by R. Cevasco and D. Moreno, ‘Paesaggi rurale: alle radici della biodiversità/Rural landscapes: the historical roots of biodiversity’, in M. Agnoletti (ed), *Paesaggi Rurali Historici. Per un Catalogo Nazionale/Historical Rural Landscapes. For a National Register* (Roma-Bari: Laterza, 2010), 128. The effects of ongoing land cover changes on the habitat of other plant and animal species, in a context of global warming, are analyzed in Catalonia by J. Peñuelas, I. Filella, and P. Comas, ‘Changed plant and animal life cycles from 1952 to 2000 in the Mediterranean region’, *Global Change Biology* 8 (2002): 531—4; J. Peñuelas and M. Boada, ‘A global-change induced biome shift in Montseny mountains (NE Spain)’, *Global Change Biology* 9 (2003): 131—0; C. Stefanescu, S. Herrando and F. Páramo, ‘Butterfly species richness in the north-west Mediterranean Basin: the role of natural and human-induced factors’, *Journal of Biogeography* 31 (2004): 905—5; C. Stefanescu, J. Peñuelas and I. Filella, ‘Butterflies highlight the conservation value of hay meadows highly threatened by land-use changes in a protected Mediterranean area’, *Biological Conservation* 126 (2005): 234—6; and I. Otero, M. Boada, A. Badia, E. Pla, J. Vayreda, S. Sabaté, C.A. Gracia and J. Peñuelas, ‘Loss of water availability and stream biodiversity under land abandonment and climate change in a Mediterranean catchment (Olzinelles, NE Spain)’, *Land Use Policy* 28 (2011): 207—8.

big grazing area we discussed in the 1949 map has in 2005 turned into scrubland, except in some remnant edges where there are still open meadows (coloured in yellow in the map).

MAP 6. Cultural landscape in Figaró-Montmany according to satellite images of 2005



Sources:

Drawn by Natàlia Valdeperas and Anna Ollés out of the GIS digital layers of the geo-interpretation of the satellite images, and adapted by Francesc Coll and Joan Marull at the IERMB.

#### ORCHIDS AS BIOINDICATORS OF GRAZING AREAS LEFT ABANDONED

Nevertheless, the traditional mosaic once maintained by traditional multiple uses has left a lasting imprint on this cultural landscape, to which we can add another clue from modern fieldwork: the location of orchids. Most Mediterranean orchids cannot grow under a closed canopy, but need sunlight. They cannot live inside a thick forest—except *Limodorum abortivum*, *Cephalanthera rubra* and sometimes, species of *Epipactis*. On the other hand, to germinate their seeds need a mycorrhiza which it is not present in ploughed and fertilized soils, meaning most of these orchids cannot grow in arable farmland. They are thus mainly present in uncultivated open spaces, making them an interesting bio-indicator of former woodland-meadows and other pasturelands interwoven with agro-forest mosaics now abandoned and evolving towards continuous land covers of scrubs and woodlands (Figure 4).

FIGURE 4. An example of Mediterranean orchid in the remaining meadows and other open spaces of Figaró-Montmany: the *Ophrys catalaunica*





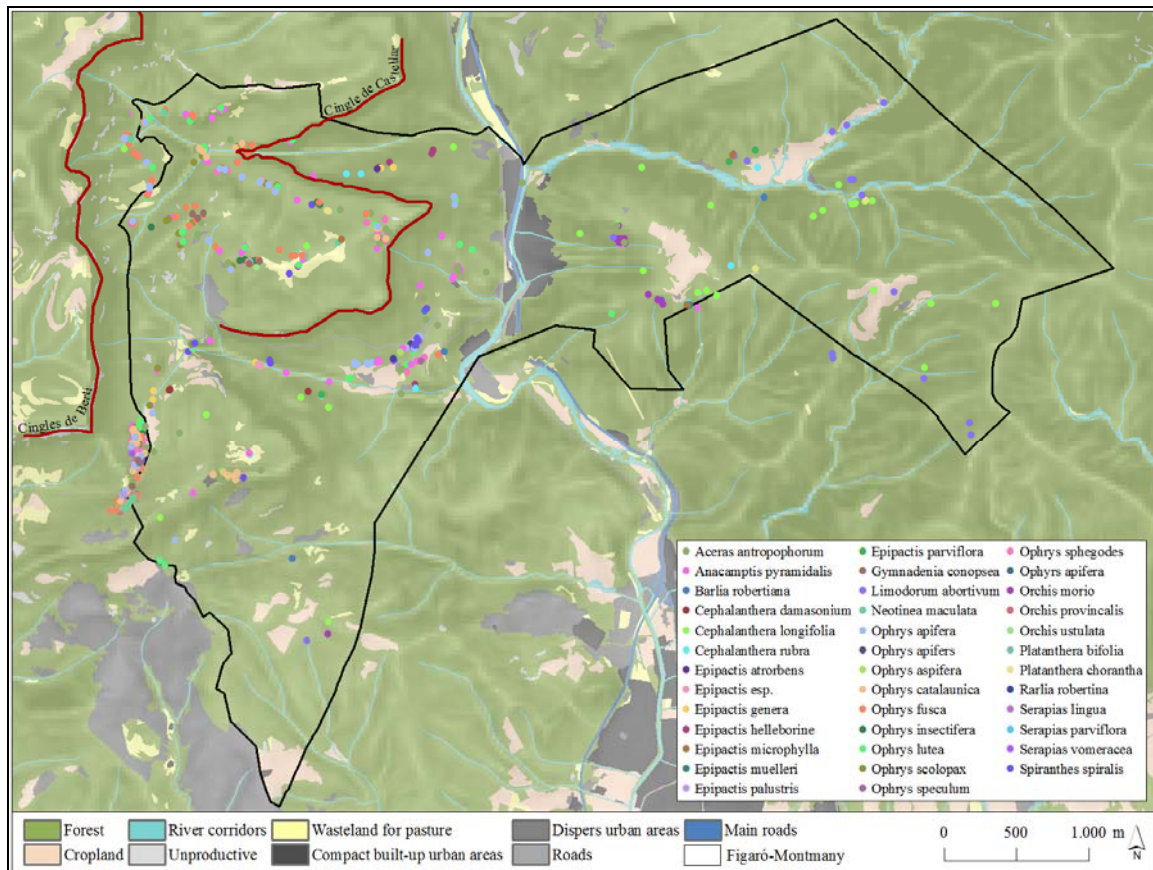
On the left photo, taken the 9/05/2009, we can see an *Ophrys catalaunica* (according to P. Delforge *Guide des orchidées d'Europe, d'Afrique du Nord et du Proche-Orient*, Lausanne: Delachaux et Niestlé, 1994) with its host-specific pollinator, a male bee of genus *Andrena* *esp.* carrying pollinia. The right one, taken the 6/05/2009, shows another specimen standing in a typical local meadow of an open space in Figaró-Montmany as it looks like in Spring.

Sources:

Personal archive of Paul Wilcox.

A systematic sampling conducted between 2007 and 2012 has identified up to 37 different species of orchids in Figaró-Montmany. We can see in Map 7 how their locations clearly fit with those areas that had been considered as former pasturelands or abandoned crops. Most of them appear in the abovementioned flatter corridor between the two rows of cliffs of the Cingles de Bertí and Cingle de Castellar, while the rest tend to be located in margins of roads or trails that go up towards those crags—which become a kind of relict linear meadows. We should not view such a great richness of orchid species in these areas only in narrow terms, but also as an indicator of the likely presence of high biodiversity and an environment that deserves to be studied and valued.

MAP 7. Locations of the Mediterranean orchids found in Figaró-Montmany in 2007-2012



Sources:

Drawn out of the sampling collected and location maps geo-referred by Paul Wilcox and adapted by Francesc Coll and Joan Marull at the IERMB.

## CONCLUDING REMARKS

The border between the townships of La Garriga and Figaró-Montmany has been an edge environment throughout the long history from 1850 to 2005 studied in this article. It was a border of an agricultural plain confronted with a mountainous area of forestry and livestock-raising in the mid-nineteenth century, and it remains a border between a metropolitan edge and two natural protected sites today. In spite of its changing nature, the contrast between widespread land cover changes experienced in La Garriga and the seemingly immobility of mainly woodland land cover in Figaró-Montmany means that the topography and ensuing natural thresholds have created a very long-lasting continuity in the environmental history of this area. These natural endowments established an edge environment at the beginning of our story and still pose a limit to the boundary of the BMR.

This edge environment also brings in contact the two main opposite but related dynamics that characterize landscape change throughout Catalonia and great parts of Mediterranean Europe: intensification and abandonment. We find some very global trends in a very site-specific context. Studying land cover changes in small places like this, and their ecological and landscape impacts, may provide useful knowledge to design and implement wiser private choices and better public policies aimed at a more sustainable future not only there, but everywhere.

The most salient landscape ecological impact of these long-term land use changes has been similar on both sides of the environmental edge: the loss of landscape mosaics. No doubt, these traditional mosaics were different in the plain or in the mountains. In the Vallès plain they interweaved cereal cropping with vineyards, olive orchards and other tree crops together with



patches of woodland, scrubland and pastureland into an agricultural land matrix. In the mountains, a woodland matrix of holm oaks and pines became cleared and opened by timber or firewood extraction, as well as by pruning of branches for charcoal making, creating a mixture of sparse forest articulated with open spaces of grazing meadows, croplands and scrubs. Both types of mosaic interlinked, and jointly played an important role in keeping up biodiversity as ecologically functional cultural landscapes. Unfortunately, after having transformed a great share of it into natural protected sites, the abandonment of an integrated management of forests, livestock breeding and cropland has led to a significant loss of these cultural mosaics. The diversity of traditional agro-forest mosaics offered more habitats to different species and created a greater amount of ecotones which, in turn, also provided more opportunities to diverse edge species. Therefore, species richness used to be higher in these patchy landscapes while the populations of each species were lower. Provided that the mobility of all those species and their capacity to interact throughout the land matrix were not prevented by insurmountable barriers – that might reduce and isolate their populations up to the point of endangering them with extinction—, the land cover diversity of traditional agro-forestry mosaics could host a greater deal of biodiversity than the more uniform land covers found nowadays.<sup>34</sup> The Mediterranean orchids testify to the ecological virtue of a world that no longer exists, whose land-use management relied on an intermediate pattern of ecological disturbance through cultural agro-forest mosaics. No doubt, natural protected sites are important achievements for biological conservation, but as long as they remain isolated and unmanaged will not be enough to prevent biodiversity loss.<sup>35</sup>

The orchids' attempt to survive year after year in Figaró-Montmany, while their microhabitats are fading out becomes like a silent cry that calls upon us to search for a more sustainable land-use management. The open question is whether we will decipher their cries in a fast changing landscape seen from our urban side of the edge.

## ACKNOWLEDGEMENTS

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<sup>34</sup> In a forthcoming article we are going to use landscape ecology metrics to undertake a deeper evaluation of the ecological impact of this loss of landscape mosaics. A state-of-the-art on the ecological 'edge effect' of patchy landscape mosaics can be found in C. Murcia, 'Edge Effects in fragmented forests: implications for conservation', *Trends in Ecology and Evolution* 10 (1995): 58—62; and more recently, in K.A. Harper, S.E. MacDonald, Ph.J. Burton, J. Chen, K.D. Brosnoff, S.C. Saunders, E.S. Euskirchen, D. Robert, M.S. Jaiteh and P.-A. Esseen, 'Edge Influence on Forest Structure and Composition in Fragmented Landscapes', *Conservation Biology* 19 (2005): 768—2. From an agricultural approach, see D. Gabriel, I. Roschewitz, T. Tschardt and C. Thies, 'Beta diversity at different spatial scales: plant communities in organic and conventional agriculture', *Ecological Applications* 16 (2006): 2011—1. In our Catalan context see M. Guirado, J. Pino and F. Rodà, 'Understorey plant species richness and composition in metropolitan forest archipelagos: effects of forest size, adjacent land use and distance to the edge', *Global Ecology and Biogeography* 15 (2006): 50—2. For our forthcoming article applying landscape ecology metrics to the same study area, see J. Marull, E. Tello, P. Warde, F. Coll, N. Valldeperas, A. Ollés and P. Wilcox, 'Recovering the history behind the ecological connectivity between two natural protected sites and a metropolitan edge: The Congost Valley in Catalonia (1850-2005)', submitted to *Landscape History*.

<sup>35</sup> As a general approach to these processes, see T.G. Benton et al., 'Farmland biodiversity: is habitat heterogeneity the key?'. See also U. Reier, E.-L. Tuvi, P. Meelis, R. Kalamees and M. Zobel, 'Threatened herbaceous species dependent on moderate forest disturbances: A neglected target for ecosystem-based silviculture', *Scandinavian Journal of Forest Research* 20 (2005): 145—2; T. Kull and M. Hutchings, 'A comparative analysis of decline in the distribution ranges of orchid species in Estonia and the United Kingdom', *Biological Conservation* 129 (2006): 31—9; S.F. Jackson, K. Walker and K.J. Gaston, 'Relationship between distributions of threatened plants and protected areas in Britain', *Biological Conservation* 142 (2009): 1515—2; and M. B. García, D. Goñi and D. Guzmán, 'Living at the Edge: Local versus Positional Factors in the Long-Term Population Dynamics of an Endangered Orchid', *Conservation Biology* 24 (2010): 1219—9.

This work has been supported by the Batista-i-Roca Grant 2010PBR00002 funded by the Anglo-Catalan Society through the Catalan Research Agency AGAUR, and also with the research project HAR2009-13748-C03-01 on *Environmental History of Mediterranean Agrarian Landscapes* (<http://www.ub.edu/histeco/p2/eng/>) funded by the Spanish Ministry of Economy and Competitiveness. Both projects are included in the Partnership Grant SSHRC-895-2011-1020 on *Sustainable farm systems: long-term socio-ecological metabolism in western agriculture* funded by the Social Sciences and Humanities Research Council of Canada.