

SUPPLEMENTARY MATERIAL

Information about the reclassification process

We wanted to identify and characterized (i) land cover changes linked to agricultural uses (crop production and extensive livestock grazing), (ii) land cover changes due to urban growth (artificial areas) and (iii) land cover changes due to agricultural abandonment and the concomitant forest and shrubland expansion (forest and seminatural areas). For doing so, we used CORINE Land Cover project (CLC). Particularly the first (1990) and last (2018) datasets available. Spanish CORINE changed the methodology in 2006 for mapping the territory [2,3]. As a result, there was an overestimation of some CLC categories before and after 2006, particularly the following categories: transitional woodlands-shrub and sclerophyllous vegetation, at the expense of natural grasslands and forests [2,4,5]. This meant that comparisons between CLC1990 and CLC2018 should not be conducted straightforward, as this could lead to misleading outcomes.

Based on CLC Level 1 and 3 classes (Table 1) [1], we defined four new categories that allow us to distinguish between (i) urban areas, (ii) crops, (iii) pastures, pasture-shrubland areas and agroforestry systems (extensive livestock grazing) and (iv) forest and shrubland areas (without livestock use). The description of this new categories is as follows:

- **Artificial surfaces.** Areas mainly use for dwellings, leisure urban parks, institutional buildings, industrial, commercial and transport networks, but also mines, dump areas or construction sites.
- **Crop production areas.** Areas used for cropping, which in our study areas are mainly rain-fed cereals and small orchards.
- **Livestock grazing areas.** Areas mainly covered by herbaceous vegetation and sparse shrubs in some cases, and agroforestry systems with clear signs of livestock grazing, such as water points, paths, stone walls, etc.
- **Forest and shrubland areas.** Areas covered with (semi-)natural woody vegetation such as forests (pine and different species of oak) and shrublands without signs of livestock presence and/or livestock grazing.

Once we had the CLC datasets (1990-2018) clipped in both sets of plots, the reclassification process entailed the assignment one of the new categories to each of the polygons included in the study plots. To do this, we first reviewed each polygon using high resolution aerial photos (Photogrammetric flight 1991 - Total Community, 1:18,000, Consejería de Política Territorial; 2020 - Total Community PNOA RGB, 25 x 25 cm, Plan Nacional de Ortofotografía Aérea (PNOA) 2020). We then assigned to each polygon one of new categories. This reclassification was verified with field visits to the study areas and checked with expert knowledge in the territory. We then calculated the area (in hectares) of each of the new categories (urban, crop production, livestock grazing and forest-shrubland) in each period (1990 and 2018), area (SR and CV) and buffer type (around village center and away from village center).

Finally, we calculated the percentage of the area of each plot represented by the CORINE level 3 class (Table 1) with the new categories (Tables 2-5). As a result of the reclassification process, we realized that e.g., pasture for livestock grazing and forest-shrubland were originally classified as sclerophyll vegetation (323 in CORINE

nomenclature), especially in areas away from village centers in SR (Tables 2-3). Moreover, forests and shrubland in our study areas mostly come from forest (31 in CORINE nomenclature) and sclerophyll vegetation (323) categories, while pastures for livestock grazing, come mostly from natural grasslands (321).

Table S1. The standard CORINE Land Cover nomenclature (class names only) for the 3 level 1 classes identified in our study.

Level 1	Level 2	Level 3
1. Artificial surfaces	1.1. Urban fabric	1.1.1. Continuous urban fabric
		1.1.2. Discontinuous urban fabric
	1.2. Industrial, commercial and transport units	1.2.1. Industrial or commercial units
		1.2.2. Road and rail networks and associated land
1.2.3. Port areas		
1.2.4. Airports		
1.3. Mine, dump and construction sites	1.3.1. Mineral extraction sites	
	1.3.2. Dump sites	
	1.3.3. Construction sites	
1.4. Artificial, non-agricultural vegetated areas	1.4.1. Green urban areas	
	1.4.2. Sport and leisure facilities	
2. Agricultural areas	2.1. Arable land	2.1.1. Non-irrigated arable land
		2.1.2. Permanently irrigated land
		2.1.3. Rice fields
	2.2. Permanent crops	2.2.1. Vineyards
		2.2.2. Fruit trees and berry plantations
		2.2.3. Olive groves
	2.3. Pastures	2.3.1. Pastures
	2.4. Heterogeneous agricultural areas	2.4.1. Annual crops associated with permanent crops
		2.4.2. Complex cultivation patterns
		2.4.3. Land principally occupied by agriculture, with significant areas of natural vegetation
		2.4.4. Agroforestry areas
	3. Forest and seminatural areas	3.1. Forests
3.1.2. Coniferous forest		
3.1.3. Mixed forest		
3.2. Shrub and/or herbaceous associations		3.2.1. Natural grassland
		3.2.2. Moors and heathland
		3.2.3. Sclerophyllous vegetation
		3.2.4. Transitional woodland-scrub
3.3. Open spaces with little or no vegetation		3.3.1. Beaches, dunes, sands
		3.3.2. Bare rocks
	3.3.3. Sparsely vegetated areas	
	3.3.4. Burnt areas	
	3.3.5. Glaciers and perpetual snow	

Table S2. Description of the original CLC classes that make up the new categories for SR in 1990. We show the area (ha) of each original CLC classes and the % of total area for each of the new categories and type of plot.

SR 1990				
Type of plot	New Categories	Original CLC classes	Area (ha)	% of total area
Around village center	Forest and shrubland	311	33.3	2.4
		312	478.9	34.8
		321	37.7	2.7
		323	589.0	42.7
		324	167.3	12.1
		332	71.8	5.2
	Livestock grazing	311	144.7	10.0
		321	214.8	14.8
		323	924.8	63.6
		324	169.5	11.7
Away from village center	Crop production	242	451.4	100.0
	Forest and shrubland	311	128.9	42.6
		312	32.8	10.8
		321	36.1	11.9
		324	104.6	34.6
	Livestock grazing	231	242.1	12.3
		242	63.9	3.2
		243	95.1	4.8
		311	68.2	3.5
		321	490.5	24.9
323		765.9	38.9	
		324	241.8	12.3

Table S3. Description of the original CLC classes that make up the new categories for SR in 2018. We show the area (ha) of each original CLC classes and the % of total area for each of the new categories and type of plot.

SR 2018					
Type of plot	New Categories	Original CLC classes	Area (ha)	% of total area	
Away from village center	Forest and shrubland	311	387.6	18.3	
		312	214.9	10.1	
		321	154.2	7.3	
		322	326.9	15.4	
		323	649.3	30.6	
		324	165.5	7.8	
		332	28.0	1.3	
	Livestock grazing	333	194.2	9.2	
		311	36.0	5.9	
		321	557.7	91.5	
	Around village center	Crop production	324	16.1	2.6
			231	110.6	29.4
		Forest and shrubland	242	265.1	70.6
311			887.7	73.9	
321			7.6	0.6	
322			273.4	22.7	
323			22.2	1.8	
324			10.9	0.9	
Livestock grazing		333	0.1	0.0	
		211	0.9	0.1	
		231	15.8	1.3	
		243	117.5	10.0	
		313	36.8	3.1	
	321	794.9	67.8		
	323	120.5	10.3		
324	86.2	7.4			

Table S4. Description of the original CLC classes that make up the new categories for CV in 1990. We show the area (ha) of each original CLC classes and the % of total area for each of the new categories and type of plot.

CV 1990					
Type of plot	New Categories	Original CLC classes	Area (ha)	% of total area	
Away from village center	Crop production	211	36.0	100.0	
		311	3.7	0.5	
	Forest and shrubland	323	77.1	10.5	
		324	655.1	89.0	
	Livestock grazing	321	1815.5	88.1	
		323	179.7	8.7	
		324	65.2	3.2	
	Around village center	Crop production	211	2.1	29.2
			244	5.1	70.8
Forest and shrubland		311	793.1	98.6	
		313	3.7	0.5	
		324	7.9	1.0	
Livestock grazing		211	6.7	0.2	
		321	3856.1	99.8	
Artificial surfaces		111	124.7	13.1	
		112	591.8	62.1	
		121	67.9	7.1	
	131	34.6	3.6		
	133	133.4	14.0		

Table S5. Description of the original CLC classes that make up the new categories for CV in 2018. We show the area (ha) of each original CLC classes and the % of total area for each of the new categories and type of plot.

CV 2018					
Type of plot	New Categories	Original CLC classes	Area (ha)	% of total area	
Away from village center	Forest and shrubland	311	297.1	36.6	
		312	1.2	0.1	
		313	446.8	55.1	
		323	18.0	2.2	
		324	47.7	5.9	
	Livestock grazing	211	74.2	3.7	
		231	48.9	2.4	
		244	164.6	8.1	
		311	135.4	6.7	
		313	65.5	3.2	
		321	1452.8	71.9	
		324	80.1	4.0	
	Around village center	Crop production	211	50.4	100.0
		Forest and shrubland	244	46.6	4.7
311			788.8	80.1	
313			56.3	5.7	
323			26.5	2.7	
324			66.5	6.8	
Livestock grazing		231	331.1	13.2	
		233	1.1	0.0	
		321	2040.1	81.1	
		323	93.6	3.7	
		324	50.2	2.0	
Artificial surfaces		111	128.3	6.1	
		112	908.4	43.0	
		121	562.1	26.6	
		122	47.8	2.3	
		131	45.5	2.2	
		133	203.3	9.6	
		141	76.7	3.6	
	142	5.0	0.2		
	231*	60.4	2.9		
	321*	75.7	3.6		

References

1. Büttner, G.; Kosztra, B.; Maucha, G.; Pataki, R.; Kleeschulte, S.; Hazeu, C.; Vittek, M.; Schröder, C.; Littkopf, A. Copernicus Land Monitoring Service - Corine Land Cover User Manual. *Eur. Environ. Agency* 2021, 1.
2. García-Álvarez, D.; Camacho Olmedo, M.T. Changes in the methodology used in the production of the Spanish CORINE: Uncertainty analysis of the new maps. *Int. J. Appl. Earth Obs. Geoinf.* **2017**, *63*, 55–67, doi:10.1016/j.jag.2017.07.001.
3. Hazeu, G.; Büttner, G.; Arozarena, A.; Valcárcel, N.; Feranec, J.; Smith, G. CORINE Land Cover 1990–2000 Changes: Analysis and Assessment. *Eur. Landsc. Dyn.* **2016**, 129–134, doi:10.1201/9781315372860-27.
4. Martínez-Fernández, J.; Ruiz-Benito, P.; Bonet, A.; Gómez, C. Methodological variations in the production of CORINE land cover and consequences for long-term land cover change studies. The case of Spain. *Int. J. Remote Sens.* **2019**, *40*, 8914–8932, doi:10.1080/01431161.2019.1624864.
5. Martínez-Fernández, J.; Ruiz-Benito, P.; Bonet Jornet, A. La última actualización de la cartografía CORINE Land Cover (CLC2012) en España: repercusiones para los estudios de cambios en la cobertura y uso del suelo. *Estud. Geográficos* **2018**, *79*, 267–281, doi:10.1201/9781315372860-27.

Table S6. Land uses and covers at village-level based on Corine Land Cover Project (CLC 1990 and 2018), distinguishing between areas ‘around village center’ and ‘away from village’. CV: Colmenar Viejo and Tres Cantos municipalities; SR: municipalities from Sierra del Rincón. Since municipalities in SR are very small, not all municipalities (9) have data in plots “away from village center”.

Regional	Municipality	Intra-regional	Category	Area	Area
				(ha) 1990	(ha) 2018
CV	Colmenar Viejo	Around village center	Forest-shrubland	11,6	6,2
			Livestock grazing	2292,6	1845,1
			Crop production	0,1	0,0
		Away from village center	Artificial cover (Urban)	538,5	991,6
			Forest-shrubland	660,1	771,8
			Livestock grazing	1689,0	1613,1
	Tres Cantos	Around village center	Crop production	35,8	0,0
			Livestock grazing	1500,6	670,0
			Artificial cover (Urban)	412,3	1108,4
		Away from village center	Forest-shrubland	250,3	344,5
			Crop production	2,0	42,3
			Livestock grazing	291,4	270,0
SR	Horcajo de la Sierra - Aoslos	Around village center	Crop production	0,2	0,0
			Forest-shrubland	0,0	21,6
			Livestock grazing	266,6	205,8
		Away from village center	Crop production	108,4	125,5
			Forest-shrubland	0,9	44,6
			Livestock grazing	312,9	71,9
	Horcajuelo de la Sierra	Around village center	Forest-shrubland	0,0	241,0
			Livestock grazing	261,2	130,8
			Crop production	0,3	0,3
		Away from village center	Forest-shrubland	47,0	177,4
			Forest-shrubland	248,6	472,7
			Livestock grazing	280,0	55,9
La Hiruela	Around village center	Forest-shrubland	139,7	233,1	
		Livestock grazing	139,1	45,7	
	Away from village center	Forest-shrubland	41,3	102,3	
		Livestock grazing	83,6	22,6	
Madarcos	Around village center	Livestock grazing	120,0	131,0	
		Crop production	112,0	74,7	
		Forest-shrubland	0,0	26,2	
Montejo de la Sierra	Around village center	Livestock grazing	185,3	151,1	
		Crop production	118,6	69,7	
		Forest-shrubland	0,0	83,2	
	Away from village center	Livestock grazing	292,7	155,3	
		Forest-shrubland	70,9	208,3	
		Livestock grazing	107,8	64,5	
Prádena del Rincón	Around village center	Crop production	141,2	70,1	

		Forest-shrubland	1,0	115,3
	Away from village center	Livestock grazing	484,5	304,0
		Forest-shrubland	12,1	192,6
Puebla de la Sierra	Around village center	Livestock grazing	268,8	122,1
		Forest-shrubland	45,8	192,6
	Away from village center	Forest-shrubland	628,5	628,5
Robregordo	Around village center	Forest-shrubland	7,0	164,1
		Livestock grazing	303,7	111,3
		Crop production	0,0	35,4
Somosierra	Around village center	Forest-shrubland	43,6	161,0
		Livestock grazing	268,5	151,1
	Away from village center	Forest-shrubland	359,5	359,5