

Supporting Information to:

What changed, and what do people perceive to have changed? Land use transformations in peninsular Spain over the past 50 years

Landscape Ecology

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Table S1 Classification and reclassification of LULUCF categories. The table shows the correspondence between original land classes, their identification codes (ID code) and the reclassified categories (Reclassified ID) used for the integrated land transformation analysis.

Category	Class	Description	ID code	Reclassified ID
Forest land (FL)	Forest land*	Land with woody vegetation meets the following criteria: Forest canopy cover (FCC) $\geq 20\%$, a minimum area of 1 ha, a minimum height of mature trees of 3 meters; and a minimum width for linear elements of 25 meters. It also includes systems with vegetation currently below these thresholds but expected to exceed them.	100	1
	Broadleaved (FL _b)	Land with woody vegetation dominated by broad-leaved species.	110-112	2
	Coniferous (FL _c)	Land with woody vegetation dominated by coniferous species.	120-122	3
	Mixed (FL _m)	Land with mixed woody vegetation (neither broadleaved nor coniferous dominant)	130-132	4
	Undetermined (FL _u)	Woody vegetation land (unspecified species)	140-142	5
Cropland (CL)	Cropland*	Cropland. including rice paddies and agro-forestry systems	700	6
	Perennial Woody Crops (CL _p)	Cropland with perennial woody crops, including agroforestry systems with perennial woody crops.	710-715, 719	7
	Annual Crops (CL _a)	Cropland with annual and multi-annual crops (as opposed to perennial woody crops), including rice paddies and agroforestry systems.	720-722, 729	8
	Temporary fallow land (CL _f)	Land left fallow for one or several years before being cultivated again (When it has not been possible to differentiate them. fallow land is included in the “Annual crops” subcategory)	730	9
Grassland (GL)	Grassland*	Grazing lands and grasslands are dominated by herbaceous or shrubby vegetation. as well as woody vegetation with a tree canopy cover (or tree crown cover) $\geq 10\%$, which are not considered under the CL (Cropland) category and fall below the threshold values of the FL (Forest land) category.	200	10
	...with trees (GL _w)	Grazing lands and grasslands with woody vegetation with a tree FCC $\geq 10\%$	210	11
	...with shrubs (GL _s)	Grazing lands and grasslands dominated by shrubs	220	12
	Perennial Grasses (GL _g)	Grazing lands and grasslands dominated by herbaceous vegetation	230	13
	Burned Grassland (GL _b)	Official class for burnt grazing lands. Functions as a transitional indicator of canopy loss and shrubland degradation following fire.	240	14
Wetlands (WL)	Wetlands*	Surfaces covered or saturated by water during all or part of the year	500	15

	Peatlands (WL _p)	Peatlands, including both managed (exploited) and unmanaged (abandoned or pristine) areas.	510-512	
	Flooded Land (WL _F)	Reservoirs for energy production, irrigation, navigation, and recreation. Regulated lakes and rivers where a substantial increase in water surface area has occurred.	520-527	
	Other Wetland (WL _O)	Regulated lakes and rivers where no substantial increase in water surface area has occurred	530-537	
Settlements (SL)	Settlements*	All developed land. including transportation infrastructure and human settlements of any size	800	16
	Urban Units (SL _u)	Residential areas (urban/rural)	810	
	Industrial or Commercial Units (SL _I)	Industrial or commercial units	820-822	
	Port Areas and Airports (SL _p)	Port areas and airports	830-832	
	Road and Rail Transport Networks (SL _t)	Transport infrastructure: Roads, non-electrified railways and others	840-842, 849	
	Mineral Extraction Sites (SL _m)	Mineral Extraction Sites	850	
	Dump Sites (SL _D)	Dump Sites	860	
	Construction Sites (SL _S)	Construction Sites	870	
	Vegetated Areas (SL _V)	Land with vegetative cover that is not included under the Forest Land, Cropland or Grassland categories	880-883	
	Renewable energies	Wind and solar farms	823, 824	17
Other Land (OL)	Other Land	Bare soil. rock. ice. and all those areas not included in any of the other five categories above	400	18

Note. The dataset incorporates the national disaggregation implemented in the Spanish National Greenhouse Gas Inventory to comply with IPCC Tier 3 (higher-order methods) guidelines (Volume 4. Chapter 3). Under this framework, general land-use classes are officially stratified into specific subcategories according to the structural features of the original data sources. (*) General category applied when the original cartographic sources don't have a breakdown by subcategory but strictly meet the threshold set for the usage class.

Table S2 Matrix of temporal correspondence between the reference decades used in social surveys and the specific data periods for land-use change.

Decade survey	Period LULUCF	Irrigated Arable Land (IRR)	Protected Areas (PA)	Intensive Livestock Farming (FARM)
1960			1962-1971	1962
1970	1970-1990		1972-1981	
1980				
1990	1990-2000	1990-2000	1992-2001	1989
2000	2000-2012	2000-2006	2002-2011	1999
2010	2012-2018	2006-2012	2011-2020	2009
2020	2018-2021			2020

Table S3 Questionnaire section on landscape change perception by decade.

Have you perceived relevant land use changes at your municipality in the last decade?	
Yes	
No	
If you have chosen “Yes”:	
What were the main reasons for the changes in land use in your municipality? Please. indicate the decade or decades in which these changes occurred.	
Land transformation process	Decades available for selection
Agriculture intensification	☐ 1960 ☐ 1970 ☐ 1980 ☐ 1990 ☐ 2000 ☐ 2010 ☐ 2020
Conversion to irrigation crop	☐ 1960 ☐ 1970 ☐ 1980 ☐ 1990 ☐ 2000 ☐ 2010 ☐ 2020
Afforestation	☐ 1960 ☐ 1970 ☐ 1980 ☐ 1990 ☐ 2000 ☐ 2010 ☐ 2020
Urbanization	☐ 1960 ☐ 1970 ☐ 1980 ☐ 1990 ☐ 2000 ☐ 2010 ☐ 2020
Intensive livestock farming	☐ 1960 ☐ 1970 ☐ 1980 ☐ 1990 ☐ 2000 ☐ 2010 ☐ 2020
Protected areas	☐ 1960 ☐ 1970 ☐ 1980 ☐ 1990 ☐ 2000 ☐ 2010 ☐ 2020
Intensification of hunting practices	☐ 1960 ☐ 1970 ☐ 1980 ☐ 1990 ☐ 2000 ☐ 2010 ☐ 2020
Wetlands alteration	☐ 1960 ☐ 1970 ☐ 1980 ☐ 1990 ☐ 2000 ☐ 2010 ☐ 2020

Renewable energies	☐ 1960 ☐ 1970 ☐ 1980 ☐ 1990 ☐ 2000 ☐ 2010 ☐ 2020
Forest fires	☐ 1960 ☐ 1970 ☐ 1980 ☐ 1990 ☐ 2000 ☐ 2010 ☐ 2020

Table S4 Questionnaire items for the socio-demographic characterization of survey respondents.

Gender: Woman/Man/Other	
Age:	
Residence	
Rural (< 2,000 hab.)	
Semi-rural (entre 2,000 y 10,000 hab.)	
Urban (> 10, 000 hab.)	
Location	
Province:	Municipality

Table S5 Spatiotemporal summary of land cover flows across the analyzed decades, including intensity of change and heads per farm (see text for details).

Land Cover Flow (LCFs)	Metric level	1960	1970	1990	2000	2010	2020
Urbanization (URB)	Intensity of change	NA	0.02	0.04	0.07	0.04	0.04
Renewable energy expansión (ENE)	Intensity of change	NA	0	0	0.01	0	0
Agricultural intensification (AGR)	Intensity of change	NA	0.15	0.22	0.20	0.21	0.24
Irrigated arable land (IRR)	Intensity of change	NA	NA	0.05	0.01	0.13	NA
Afforestation (AFF)	Intensity of change	NA	0.15	0.23	0.26	0.22	0.06
Burned grassland (BURN)	Intensity of change	NA	0	0	0.01	0.02	0.05
Protected area (PA)	Intensity of change	0.01	0.04	0.36	0.48	0.30	NA
Intensive livestock farming (FARM)	Heads per farm	8.9	NA	104.50	47.80	114.10	957.50

Note. The intensity of change defines the rate of intensity of change (S_t) for each time interval, as formulated by Aldwaik and Pontius (2012). This metric is calculated based on the area affected by each LCF (except for FARM) in each sampling period. NA: Not Available/Not Applicable. For LCF, NA indicates different starting periods in the historical cartographic sources (1960, 1970, or 1990). For FARM the flow is measured in livestock heads per farm, preventing the calculation of a proper land-area intensity of change.

Table S6. Percentage of survey responses on the perceived causes of land cover flows by decade and by age group. Positive responses are expressed as the percentage relative to the total number of responses per decade (see text for further details).

Land Cover Flow	Age	Metric level	1960	1970	1980	1990	2000	2010	2020
Urbanization (URB)	18-24	Positive responses	6	9	22	26	42	43	27
		Percentage	8.60	8.20	12.40	10.20	11.70	13.10	15.10
	25-34	Positive responses	11	15	25	56	83	76	33
		Percentage	6.90	9	9.80	14	14.70	13	9.80
	35-44	Positive responses	5	20	35	76	121	83	42
		Percentage	3.30	9.90	11.30	13.80	16.40	10.50	9.40
	45-54	Positive responses	8	23	32	56	105	67	28
		Percentage	3.60	9.40	10.10	11.70	14	9.60	8.30
	55-64	Positive responses	22	31	37	53	68	45	21
		Percentage	7.90	11.50	11.60	14.60	14.60	9.70	9.10
	65-99	Positive responses	28	51	74	100	94	68	22
		Percentage	7.40	12.10	15.10	16.20	13.10	9.60	7.20
Renewable energy expansion (ENE)	18-24	Positive responses	4	4	13	20	30	43	26
		Percentage	5.70	3.60	7.30	7.80	8.40	13.10	14.50
	25-34	Positive responses	7	6	6	21	41	72	69
		Percentage	4.40	3.60	2.40	5.20	7.30	12.30	20.50
	35-44	Positive responses	6	7	15	31	55	93	75
		Percentage	4	3.50	4.80	5.60	7.50	11.80	16.80
	45-54	Positive responses	17	13	16	29	54	92	61
		Percentage	7.56	5.30	5.05	6.10	7.20	13.10	18
	55-64	Positive responses	14	11	16	19	40	74	35
		Percentage	5	4.10	5	5.20	8.60	15.90	15.10
	65-99	Positive responses	12	14	19	39	76	106	54
		Percentage	3.20	3.30	3.90	6.30	10.60	15	17.70
Agricultural Intensification (AGR)	18-24	Positive responses	13	14	25	29	29	31	16

		Percentage	18.60	12.70	14.10	11.40	8.10	9.50	8.90
	25-34	Positive responses	23	17	29	41	61	39	22
		Percentage	14.50	10.20	11.40	10.20	10.80	6.70	6.50
	35-44	Positive responses	30	35	43	56	67	78	28
		Percentage	19.90	17.30	13.80	10.20	9.10	9.90	6.30
	45-54	Positive responses	30	31	45	43	69	63	28
		Percentage	13.30	12.70	14.20	9	9.20	9	8.30
	55-64	Positive responses	59	37	32	31	28	29	15
		Percentage	21.10	13.70	10	8.50	6	6.30	6.50
	65-99	Positive responses	70	58	51	40	49	44	18
Percentage		18.60	13.80	10.40	6.50	6.90	6.20	5.90	
Irrigated arable land (IRR)	18-24	Positive responses	12	13	17	23	34	27	17
		Percentage	17.10	11.80	9.60	9	9.50	8.30	9.50
	25-34	Positive responses	21	24	30	46	53	58	26
		Percentage	13.20	14.50	11.80	11.50	9.40	9.90	7.70
	35-44	Positive responses	23	33	35	61	70	75	40
		Percentage	15.20	16.30	11.30	11.10	9.50	9.50	8.90
	45-54	Positive responses	20	29	35	52	67	68	26
		Percentage	8.90	11.80	11	10.90	8.90	9.70	7.70
	55-64	Positive responses	28	44	41	33	43	39	16
		Percentage	10	16.30	12.90	9.10	9.20	8.40	6.90
65-99	Positive responses	47	61	52	47	47	56	21	
	Percentage	12.50	14.50	10.60	7.60	6.60	7.90	6.90	
Afforestation (AFF)	18-24	Positive responses	4	14	10	29	44	23	13
		Percentage	5.70	12.70	5.60	11.40	12.30	7	7.30
	25-34	Positive responses	16	22	30	42	51	52	25
		Percentage	10.10	13.30	11.80	10.50	9.10	8.90	7.40
	35-44	Positive responses	16	17	24	68	66	72	41
		Percentage	10.60	8.40	7.70	12.40	9	9.10	9.20

	45-54	Positive responses	29	27	40	49	74	61	22
		Percentage	12.90	11	12.60	10.20	9.80	8.70	6.50
	55-64	Positive responses	24	26	40	32	48	38	19
		Percentage	8.60	9.60	12.50	8.80	10.30	8.20	8.20
	65-99	Positive responses	39	50	60	67	63	56	22
		Percentage	10.40	11.90	12.20	10.80	8.80	7.90	7.20
Burned grassland (BURN)	18-24	Positive responses	6	5	14	21	40	43	26
		Percentage	8.60	4.50	7.90	8.20	11.10	13.10	14.50
	25-34	Positive responses	11	14	21	41	56	74	45
		Percentage	6.90	8.40	8.30	10.20	9.90	12.70	13.40
	35-44	Positive responses	14	11	27	41	72	90	53
		Percentage	9.30	5.40	8.70	7.50	9.80	11.40	11.90
	45-54	Positive responses	21	16	34	43	77	85	59
		Percentage	9.30	6.50	10.70	9	10.20	12.10	17.50
	55-64	Positive responses	19	21	28	38	48	61	31
		Percentage	6.80	7.80	8.80	10.50	10.30	13.10	13.40
	65-99	Positive responses	19	25	37	67	82	90	50
		Percentage	5.10	6	7.60	10.80	11.50	12.70	16.40
Protected area (PA)	18-24	Positive responses	3	13	17	29	32	33	19
		Percentage	4.30	11.80	9.60	11.40	8.90	10.10	10.60
	25-34	Positive responses	14	12	22	37	57	49	29
		Percentage	8.80	7.20	8.70	9.20	10.10	8.40	8.60
	35-44	Positive responses	11	12	26	48	71	71	43
		Percentage	7.30	5.90	8.40	8.70	9.60	9	9.60
	45-54	Positive responses	21	21	21	61	70	62	28
		Percentage	9.30	8.60	6.60	12.70	9.30	8.80	8.30
	55-64	Positive responses	17	15	24	40	62	48	25
		Percentage	6.10	5.60	7.50	11	13.30	10.30	10.80
	65-99	Positive responses	23	29	38	66	93	73	29
		Percentage							

		Percentage	6.10	6.90	7.80	10.70	13	10.30	9.50
Intensive livestock farming (FARM)	18-24	Positive responses	10	13	21	22	36	27	14
		Percentage	14.30	11.80	11.90	8.60	10	8.30	7.80
	25-34	Positive responses	14	15	31	35	53	57	33
		Percentage	8.80	9	12.20	8.70	9.40	9.80	9.80
	35-44	Positive responses	15	24	41	65	65	76	45
		Percentage	9.90	11.90	13.20	11.80	8.80	9.60	10.10
	45-54	Positive responses	19	26	30	47	75	63	33
		Percentage	8.40	10.60	9.50	9.80	10	9	9.80
	55-64	Positive responses	30	26	32	36	40	42	27
		Percentage	10.70	9.60	10	9.90	8.60	9.10	11.60
	65-99	Positive responses	46	43	50	63	64	60	27
		Percentage	12.20	10.20	10.20	10.20	9	8.50	8.90
Others	18-24	Positive responses	12	25	38	56	72	57	21
		Percentage	17.10	22.70	21.50	22	20.10	17.40	11.70
	25-34	Positive responses	42	41	60	82	108	107	55
		Percentage	26.40	24.70	23.60	20.40	19.20	18.30	16.30
	35-44	Positive responses	31	43	65	103	149	153	80
		Percentage	20.50	21.30	20.90	18.80	20.20	19.30	17.90
	45-54	Positive responses	60	59	64	99	161	140	53
		Percentage	26.70	24.10	20.20	20.70	21.40	20	15.70
	55-64	Positive responses	67	59	69	81	89	88	43
		Percentage	23.90	21.90	21.60	22.30	19.10	19	18.50
	65-99	Positive responses	92	89	109	130	147	154	62
		Percentage	24.50	21.20	22.20	21	20.60	21.80	20.30