

TUTORIALS TO SUPPORT PRACTICAL CLASSES

Tutorial 7. Simulation of landscape dynamics in the future with and without fire

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OBJECTIVES

Simulate the evolution of land cover in the future with and without fire, using Markov chains (or Markov matrices – the relative transition matrices).

In this exercise we will simulate the dynamics of the future landscape with and without fire, using the relative transition matrices that were built in the previous lesson. The elements (cells) of these matrices contain the proportions of change of each LULC class for another class, which were observed in a 24-year period (1995-2018).

In general, the probabilities of transition from one state to another state in a finite Markov chain given by the matrix P in k steps is given by P_k . In our case study, k corresponds to a period of 24 years. We can now simulate transitions for various periods in time, with and without fire. For example, we can multiply the probabilities of the global relative transition matrix by the areas (ha) of each LULC class in 2018 to obtain the areas of these classes in 2041 ($t = 24$), and so on into the future. These calculations can be done directly in MExcel, using the function “Matriz Mult”, which will be shown in the class.

Notice that Markov matrices or chains assume that the transition proportions are maintained over time.

Instructions in MExcel

1. Use the global matrix to start the exercise
2. Transpose the global **relative** matrix

Transposing a matrix is to switch lines with columns, that is: the first line of the matrix becomes the first column of the transposed matrix, the second line becomes the second column, and so on.

A		B										C	D	E	F	G	H	I	J	K	L	M	N	
		MATRIZ DE TRANSIÇÃO RELATIVA GLOBAL (M)										2018												
		AFS with AFS																						

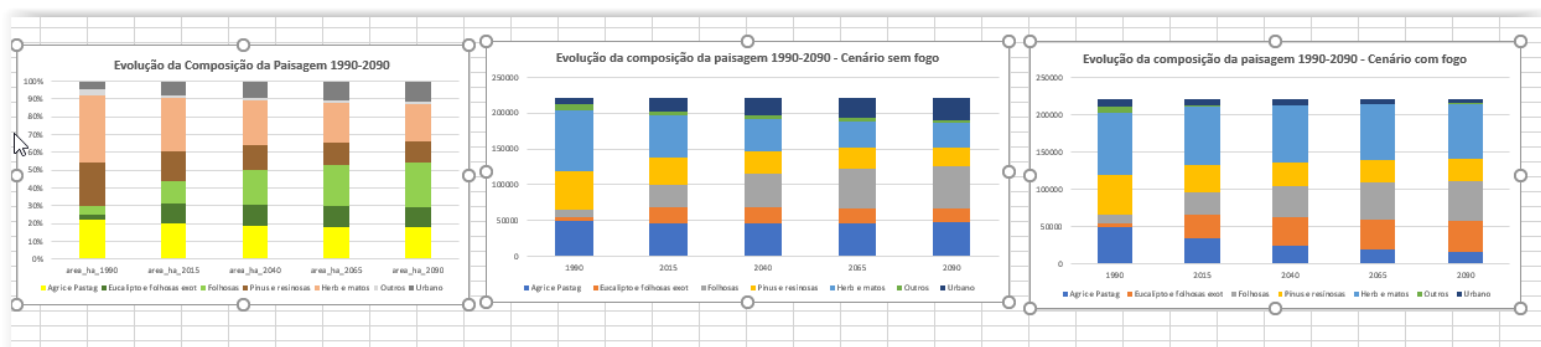
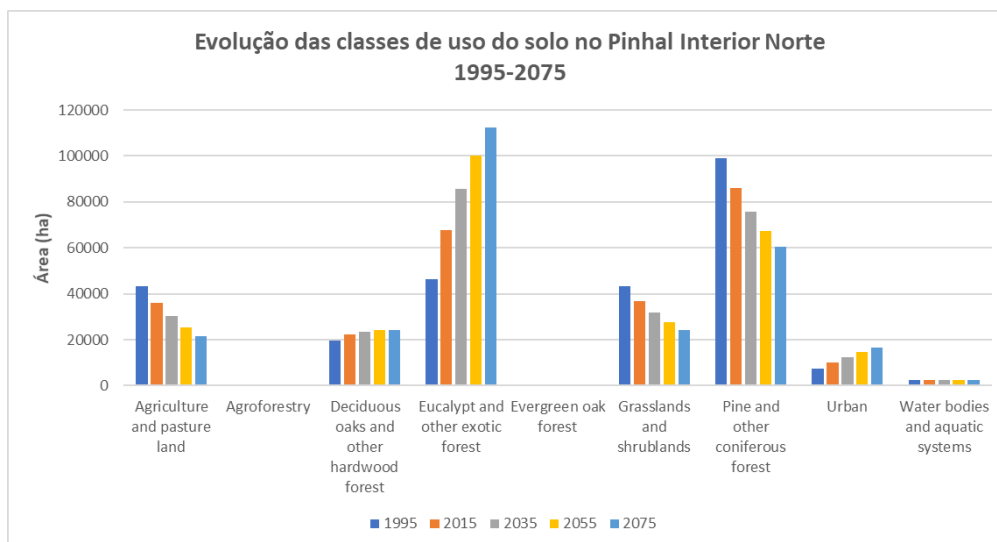
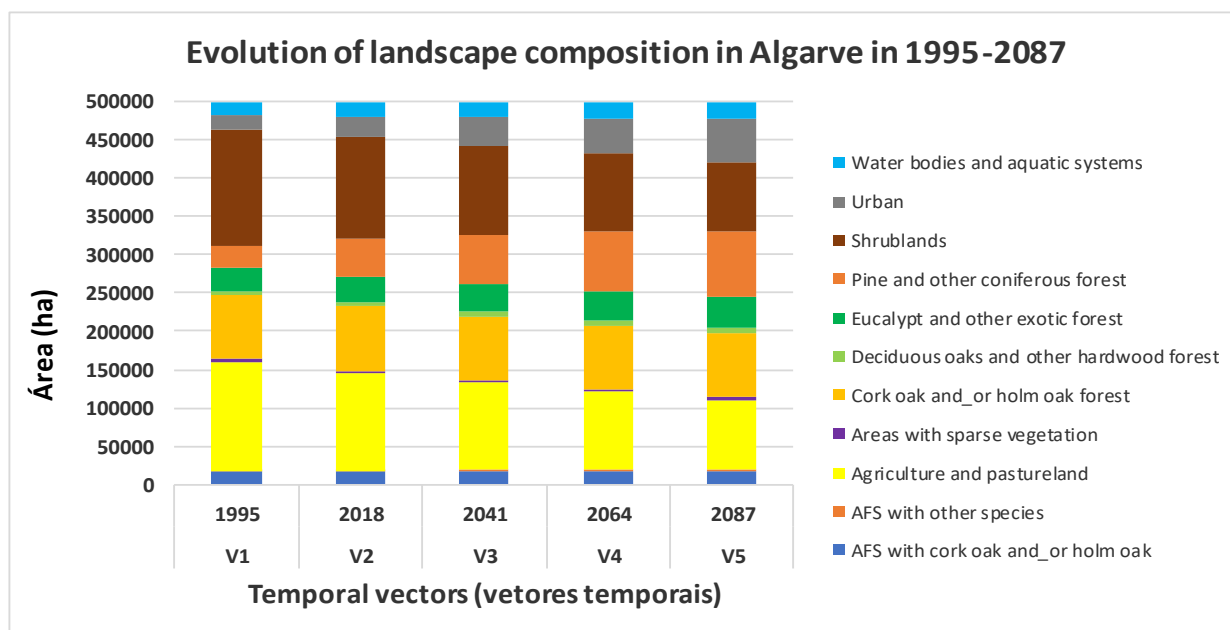
The transposed matrix (M') is again multiplied by Vector V2 (which corresponds to the area occupied by LULC classes in T2 - 2018) to obtain V3 - the vector in T3 (2041), and so on until 2087. There are LULC classes with an increasing trend in area and others with a decreasing trend in area, over the analyzed period. However, the total area of the study region is always the same (sum of all classes).

	V1	V2	V3	V4	V5
	1995	2018	2041	2064	2087
AFS with cork oak and_or holm oak	16189,65	16512,05	16805,58	17068,83	17301,12
AFS with other species	1700,25	1889,58	2107,77	2338,61	2570,12
Agriculture and pastureland	142510,45	127026,55	113382,93	101377,91	90826,76
Areas with sparse vegetation	3103,85	3132,36	3156,10	3176,02	3192,90
Cork oak and_or holm oak forest	83258,79	83758,40	84010,98	84050,18	83904,98
Deciduous oaks and other hardwood forest	4485,51	5237,03	5873,03	6406,84	6850,49
Eucalypt and other exotic forest	31131,19	33418,34	35770,26	38149,65	40526,49
Pine and other coniferous forest	28424,61	48899,37	64791,43	76932,67	86010,89
Shrublands	153170,64	133050,54	116118,13	101824,09	89720,46
Urban	17408,00	27274,12	37029,93	46595,86	55913,17
Water bodies and aquatic systems	18278,81	19463,42	20615,63	21741,09	22844,36
TOTAL	499661,76	499661,76	499661,76	499661,76	499661,76

5. Repeat the previous steps using the relative transition matrices for burned and unburned area. **Note that you need to use always the same initial landscape composition – V1, to allow comparisons among the 3 scenarios.**

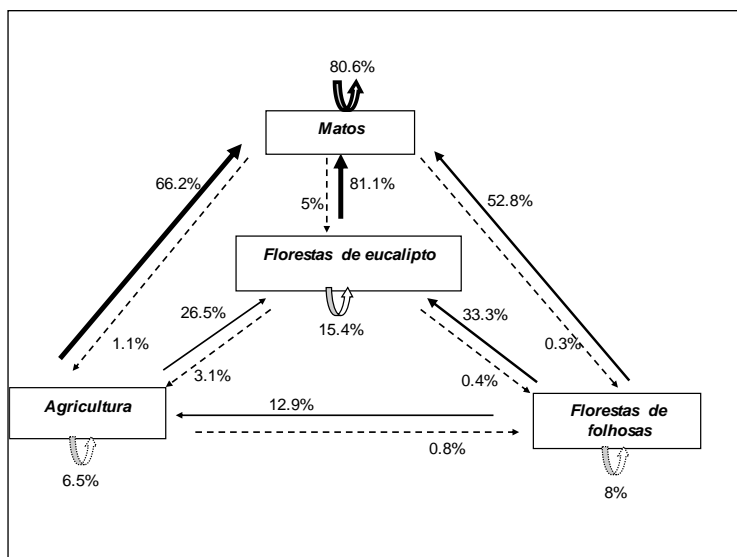
6. Represent the results graphically (3 scenarios: whole area - global matrix, burned area and unburned area)

Graphical representation of results in MExcel: examples



Graphical representation of landscape dynamics: examples

Beyond the charts that were produced in MExcel in the classes, we show below some other examples of graphical representation of changes in land cover and land use (based on relative transition matrices or Markov chains), either to represent the past dynamics or to represent the simulation of the landscape dynamics in the future. Many other examples can be found in the literature.



Landscape dynamics 1990-2007
Mainland Portugal

