Nationwide climate-sensitive models for stand dynamics and forest scenario simulation

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doi: [*pending doi*]

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Table C.1: Coefficients of the tree diameter increment model (DI; in cm) for 27 tree species and species groups. The coefficients are significative at 0.05 level. The explanatory variables are the initial tree diameter (D; cm), the inverse of D (invD), the natural logarithm of D+1 (lnD), the square of D (sqD), the square root of D (sqrtD), the natural logarithm of stand basal area (lnG; whereas stand basal area G is in $m^2 \cdot ha^{-1}$), the basal area of larger trees (BAL; $m^2 \cdot ha^{-1}$), the basal area of larger trees divided by the natural logarithm of D+1 (BAL/lnD), the cumulative basal area of extracted trees of larger size (BAL_{ext}; $m^2 \cdot ha^{-1}$), the mean annual temperature (T; ºC) modified as $(T-15)^2$ (Temp15sq), the moisture index (PPET) estimated by the ratio of the mean annual precipitation (in $mm \cdot yr^{-1}$) to mean annual potential evapotranspiration (in $mm \cdot yr^{-1}$), the soil water holding capacity (SWHC; mm), the potential radiation (Rad; $MJ \cdot m^{-2}$), and the slope (degrees).

Species/group	Intercept	D	invD	lnD	sqD	sqrtD	lnG	BAL	BAL/lnD	BAL_{ext}	$T_{emp}15sq$	PPET	SWHC	Rad	Slope
Pinus pinea	1.262			0.107	-6.826E-05		-0.214		-0.075	0.038		0.519	0.002		-0.006
Pinus sylvestris	5.128		-14.629	-0.993			-0.204		-0.067	0.026		0.398	0.002	0.014	-0.002
Pinus uncinata	4.545		-8.137	-0.873			-0.142		-0.068	0.031				0.011	
Pinus pinaster	4.287		-9.904	-0.711			-0.134		-0.096	0.027		0.500	0.002		-0.004
Pinus halepensis	0.272			0.198	-1.550E-04		-0.135		-0.101	0.049		1.618	0.002	0.010	-0.004
Pinus nigra	0.581			0.132	-2.481E-04		-0.104		-0.093	0.038		1.002	0.003	0.009	-0.008
Pinus canariensis	2.823		-6.734	-0.430			-0.157		-0.083	0.057		0.834	0.004		-0.004
Pinus radiata	0.453			0.410	-1.641E-04		-0.156		-0.112	0.041		0.497	0.004	0.018	
***Abies/Picea/Pseudotsuga* spp.**	5.850		-16.616	-0.888			-0.239		-0.072	0.021	-0.002		0.005	0.010	
Juniperus thurifera	0.810						-0.142		-0.068	0.032					-0.006
***Juniperus* spp.**	0.445								-0.048		-0.013	0.280			
***Cupressus/Taxus* spp.**	-0.876	-0.028		0.565					-0.069	0.064				0.043	
Other conifers	5.621		-15.853	-1.010					-0.091	0.022	-0.002		0.004	0.009	
Quercus ilex	-0.115			0.116	-4.313E-05		-0.048		-0.055	0.040	-0.004	0.484	0.003	0.004	-0.004
Quercus suber	1.117								-0.055	0.028	-0.170	0.374	0.001		-0.006
Quercus faginea	0.094			0.286	-6.984E-05		-0.079		-0.054	0.045	-0.004	0.350	0.001		-0.003
Quercus robur/petraea/rubra	0.064			0.339	-7.482E-05		-0.137	-0.021		0.037	-0.007	0.547	0.003		-0.007
Quercus pyrenaica/pubescens/canariensis	-0.066			0.308	-1.016E-04		-0.104		-0.072	0.034	-0.006	0.393	0.003	0.006	-0.003
***Populus/Platanus* spp.**	1.035	-0.040				0.531	-0.162		-0.066	0.042	-0.005				-0.020
***Fraxinus/Salix* spp.**	-0.596			0.574	-1.186E-04		-0.216					0.438	0.005		-0.009
***Eucalyptus* spp.**	-0.848			0.477	-9.007E-05		-0.165		-0.117	0.056	-0.020	1.449	0.004	0.024	
Erica arborea	-0.336	-0.048				0.472			-0.033		-0.035				-0.001
Laurisilvas	-0.035	-0.049				0.618	-0.204		-0.031		-0.052		0.003	-0.006	
Fagus sylvatica	0.119	-0.031				0.428	-0.190		-0.062	0.034	-0.007		0.003	0.006	
Castanea sativa	0.448	-0.013				0.174	-0.184			0.007		0.454	0.003	0.009	-0.004
***Betula/Acer* spp.**	-0.421	-0.036				0.398	-0.103	-0.015		0.024	-0.005	0.347	0.005		
Other broadleaves	-1.247	-0.033				0.497			-0.027	0.025	-0.005	0.595	0.003		-0.006

Table C.2: Coefficients of the tree Height increment model (HI; in m) for 20 tree species and species groups. The coefficients are significative at 0.05 level. The explanatory variables are inverse of the initial tree Height (invH; whereas Height H is in m), the natural logarithm of H+1 (lnH), the radio of H to initial tree diameter D (H/D; whereas D is in cm), the stand basal area (G; $m^2 \cdot ha^{-1}$), the basal area of larger trees (in $m^2 \cdot ha^{-1}$) divided by the natural logarithm of D+1 (BAL/lnD), the cumulative basal area of extracted trees of larger size (BAL_{ext}; $m^2 \cdot ha^{-1}$), the mean annual temperature (T; ºC) modified as $(T-15)^2$ (Temp15sq), the moisture index (PPET) estimated by the ratio of the mean annual precipitation (in $mm \cdot yr^{-1}$) to mean annual potential evapotranspiration (in $mm \cdot yr^{-1}$), the soil water holding capacity (SWHC; mm), the potential radiation (Rad; $MJ \cdot m^{-2}$), and the slope (degrees).

Species/group	Intercept	invH	lnH	H/D	G	BAL/lnD	BALext	Temp15sq	PPET	SWHC	Rad	Slope
Pinus pinea	3.925	-5.538	-1.408		0.011	-0.027		-0.056		0.004		
Pinus sylvestris	2.905	-2.238	-1.023	0.462	0.020	-0.033			0.585			-0.021
Pinus uncinata	3.606	-5.257	-1.414							0.012	-0.017	
Pinus pinaster	1.858	-4.152	-0.853	-0.17		-0.031		-0.005	0.982	0.004	0.015	-0.005
Pinus halepensis	-0.115			0.265	-0.005				1.151	0.002		
Pinus nigra	4.025	-7.896	-1.659		0.025	-0.032		-0.007	1.297			-0.015
Pinus canariensis	3.255	-3.842	-0.887	0.433	0.029	-0.059					-0.034	
Pinus radiata	0.943	-5.791	-0.865			-0.055			1.390	0.011	0.037	-0.013
Abies/*Picea*/*Pseudotsuga* spp.	5.994	-17.087	-1.898			-0.065				0.022		
Quercus ilex	-1.407			-0.29				-0.019	1.063			
Quercus suber	-1.508								1.674	0.006		
Quercus faginea	-0.56								0.677			
Quercus robur/*petraea*/*rubra*	2.312	-2.363	-0.442			-0.029	0.011	-0.009	0.721			-0.018
Quercus pyrenaica/*pubescens*/*canariensis*	-0.878				0.006	-0.021		-0.005	1.093	0.006		-0.026
Fraxinus/*Salix* spp.	-0.764								0.687		0.031	
Eucalyptus spp.	4.778	-14.002	-1.797	-0.237	0.012	-0.112	0.017		1.839	0.011	0.023	
Fagus sylvatica	3.967	-6.339	-0.819	-0.226		-0.018		-0.011		0.003	-0.011	-0.007
Castanea sativa	3.139	-5.478	-1.001						0.867			-0.014
Betula/*Acer* spp.	2.494	-4.969	-0.85			-0.024		-0.009	0.616	0.005		-0.016
Other broadleaves	-0.605							-0.006	1.183			-0.01

Table C.3.: Coefficients of the Static height model (H; in m) for 27 tree species and species groups. The coefficients are significative at 0.05 level. The explanatory variables are the moisture index (PPET) estimated by the ratio of the mean annual precipitation (in $mm \cdot yr^{-1}$) to mean annual potential evapotranspiration (in $mm \cdot yr^{-1}$), the soil water holding capacity (SWHC; mm), the potential radiation (Rad; $MJ \cdot m^{-2}$), and the elevation (Elev; m), the inverse of initial tree diameter (invD, whereas the initial tree diameter D is in cm), and the inverse of the square of D (invDsq).

Species/group	Intercept	PPET	SWHC	Rad	Elev	invD	invDsq
Pinus pinea	23.736		0.020	-0.191	-0.0043	18.891	-19.829
Pinus sylvestris	19.292		0.036	-0.127		11.842	
Pinus uncinata	29.446		0.034	-0.129	-0.0052	15.425	
Pinus pinaster	16.616	8.041	0.049		-0.0059	15.838	-0.774
Pinus halepensis	12.343	5.329	0.038	-0.059	-0.0022	10.569	
Pinus nigra	19.116	2.691	0.051	-0.110	-0.0022	16.496	
Pinus canariensis	28.065		0.074	-0.162		19.638	146.956
Pinus radiata	28.732	4.704	0.053	0.000	-0.0072	18.326	-10.743
Abies/*Picea*/*Pseudotsuga* spp.	37.185		0.097		-0.0068	25.555	
Juniperus thurifera	5.743	4.998	0.020		-0.0009	6.938	
Juniperus spp.	5.537		0.009		-0.0004		25.094
Cupressus/*Taxus* spp.	12.905		0.050		-0.0041	9.041	
Other conifers	27.823		0.135	-0.336	-0.0042	15.217	
Quercus ilex	11.228	2.010	0.013	-0.095	-0.0014	8.229	
Quercus suber	11.688	3.984	0.022	-0.089	-0.0005	16.043	
Quercus faginea	12.518	2.968	0.021	-0.042	-0.0019	10.057	
Quercus robur/*petraea*/*rubra*	14.679	4.902	0.042	-0.080	-0.0019	11.546	
Quercus pyrenaica/*pubescens*/*canariensis*	13.519	3.723	0.040	-0.033	-0.0020	11.332	
Populus/*Platanus* spp.	22.088		0.053	0.167	-0.0053	9.242	
Fraxinus/*Salix* spp.	15.102	2.604		-0.072	-0.0018		43.122
Eucalyptus spp.	18.889	11.798	0.178	-0.113	-0.0119	16.653	
Erica arborea	3.662	3.348	0.033	0.123		5.881	
Laurisilvas	10.386		0.065			8.935	
Fagus sylvatica	30.078	0.000	0.048	-0.092	-0.0056	14.071	
Castanea sativa	8.050	4.833	0.015				39.737
Betula/*Acer* spp.	13.118	4.892	0.030		-0.0042	6.614	
Other broadleaves	3.835	5.116	0.049	-0.031	-0.0005		56.442

Table C.4: Coefficients of the survival logistic model for 27 tree species and species groups. The coefficients are significative at 0.05 level. The explanatory variables are the initial tree diameter (D; cm), the square of D (sqD), the square root of D (sqrtD), the logarithm of the diameter increment in the SNFI2-3 period divided by the logarithm of diameter at SNFI3 (lnDIprev); the initial tree Height (H; m), the natural logarithm of stand basal area (lnG; whereas stand basal area G is in $m^2 \cdot ha^{-1}$), the basal area of larger trees (BAL; $m^2 \cdot ha^{-1}$), the cumulative basal area of extracted trees of larger size (BAL_{ext}; $m^2 \cdot ha^{-1}$), the mean annual temperature (T; ºC) modified as $(T-15)^2$ (Temp15sq), the moisture index (PPET) estimated by the ratio of the mean annual precipitation (in $mm \cdot yr^{-1}$) to mean annual potential evapotranspiration (in $mm \cdot yr^{-1}$), the soil water holding capacity (SWHC; mm), the potential radiation (Rad; $MJ \cdot m^{-2}$), and the slope (degrees).

Species/group	Intercept	D	sqD	sqrtD	lnDIprev	H	lnG	BAL	BAL_{ext}	Temp15sq	PPET	SWHC	Rad	Slope
Pinus pinea	0.596		-4.443E-04		1.225	0.004		-0.070				0.013		-0.035
Pinus sylvestris	0.901		-3.079E-04		0.912	0.016		-0.051	0.296				0.027	-0.011
Pinus uncinata	4.119		-2.077E-04		-0.309	0.066		-0.040						
Pinus pinaster	-0.676		-7.078E-04		1.750	0.008		-0.058	0.271					-0.023
Pinus halepensis	3.280		-4.550E-04		0.582	0.030	-0.347	-0.081	0.515			0.004		-0.013
Pinus nigra	3.132		-5.556E-04		0.804	0.030		-0.069	0.249					
Pinus canariensis	-2.729		-3.314E-04		2.463			-0.062	0.328				0.034	
Pinus radiata	0.260		-3.833E-04		0.443	0.121	-0.265	-0.072	0.390			0.005	0.039	
Abies/*Picea*/*Pseudotsuga* spp.	4.702	-0.020		-0.167		0.070		-0.039	0.723					-0.015
Juniperus thurifera	4.888		1.438E-03		0.766		-1.056							
Juniperus spp.	1.621		-2.973E-04		0.554	0.020	-0.776			-0.024			0.063	
Cupressus/*Taxus* spp.	2.284					0.122								
Other conifers	2.719					0.155		-0.077	0.395					
Quercus ilex	4.172		-3.720E-05		0.137	0.055	-0.319	-0.051	0.380			0.005	0.018	
Quercus suber	4.514		-1.758E-04		0.359	0.087	-0.601			-0.053				-0.028
Quercus faginea	3.530		-1.176E-04		0.563	0.013	-0.234	-0.053						
Quercus robur/*petraea*/*rubra*	3.468		-7.909E-05		0.391	0.079	-0.377	-0.052	0.440					-0.015
Quercus pyrenaica/*pubescens*/*canariensis*	2.041		-2.116E-04		1.073	0.017	-0.153	-0.057	0.449		0.469		-0.020	-0.011
Populus/*Platanus* spp.	1.799					0.040		-0.056	0.809			0.011		-0.027
Fraxinus/*Salix* spp.	-0.322		5.723E-05		1.000	0.010	-0.679		0.218				0.066	
Eucalyptus spp.	-3.707		-2.603E-04		0.783	0.032		-0.040	0.193		0.695	0.017	0.112	
Erica arborea	2.335		2.508E-04		0.601			-0.051	31.984					
Laurisilvas	1.294		-2.086E-04		0.854			-0.048	1.572	-0.202				
Fagus sylvatica	4.676		-1.328E-04		-0.628	0.151	-0.271	-0.047	0.117		0.199	0.003	0.010	
Castanea sativa	1.785					0.088		-0.015	0.183				0.007	
Betula/*Acer* spp.	2.720					0.110		-0.035	0.225					-0.009
Other broadleaves	3.410					-0.001		-0.022	0.296					-0.021

Table C.5: Coefficients of the logistic model of ingrowth incidence in the second survey for species present in the initial survey. The coefficients are significative at 0.05 level. The explanatory variables are stand density (N; ind·ha^{-1}), the local stand-relative abundance of the species spp (Nspp/N), the stand basal area (G; m^2·ha^{-1}), the natural logarithm of stand basal area (lnG), the standard deviation of tree diameter (sdD; cm), the mean annual temperature (T; ºC) modified as (T-15)^2 (Temp15sq), the moisture index (PPET) estimated by the ratio of the mean annual precipitation (in mm·yr^{-1}) to mean annual potential evapotranspiration (in mm·yr^{-1}), the soil water holding capacity (SWHC; mm), the potential radiation (Rad; MJ·m^{-2}), and the slope (degrees).

Species/group	Intercept	lnN	Nspp/N	G	lnG	sdD	Temp15sq	PPET	SWHC	Rad	Slope
Pinus pinea	-7.912	1.491	2.217	-0.047	-1.516	0.087			0.010	-0.064	-0.025
Pinus sylvestris	-8.996	1.385	2.250	-0.057	-1.088	0.091			0.003	0.013	
Pinus uncinata	-7.707	1.128	2.360	-0.095							
Pinus pinaster	-7.855	0.784	2.260	-0.055	-0.639	0.073		0.804	0.008	0.027	-0.016
Pinus halepensis	-8.488	1.076	1.776	-0.083	-0.678	0.035		0.755	0.012		
Pinus nigra	-8.652	1.443	2.092	-0.043	-1.269	0.053			0.010	-0.021	
Pinus canariensis	-7.198	0.815	2.282	-0.049	-0.812	0.044			0.013		-0.019
Pinus radiata	-7.634	0.999	1.378		-1.577				0.014	0.047	
Abies/*Picea*/*Pseudotsuga* spp.	-7.060	1.070	1.446		-1.635	0.023		2.111		0.028	
Juniperus thurifera	-6.059	1.011	2.148		-0.820	0.039				-0.056	
Juniperus spp.	-8.467	0.636	2.882						0.010		
Cupressus/Taxus spp.	-8.197				-1.409				0.025	0.242	
Other conifers	-11.730		2.941							0.251	
Quercus ilex	-8.848	1.399	1.165	-0.027	-0.803	0.028		0.424	0.005		
Quercus suber	-8.958	1.244	2.262		-1.110		-0.058		0.012		
Quercus faginea	-7.523	1.133	2.014		-1.193	0.050			0.010	-0.017	-0.021
Quercus robur/*petraea*/*rubra*	-5.502	0.620	1.028	-0.035	-0.717	0.030		1.008	0.006	0.027	-0.057
Quercus pyrenaica/*pubescens*/*canariensis*	-6.614	1.082	1.915	-0.042	-0.743	0.040					-0.022
Populus/*Platanus* spp.	-8.014	1.038	2.229		-0.763						
Fraxinus/*Salix* spp.	-7.614	0.716	1.845	-0.091		0.032			0.012		
Eucalyptus spp.	-4.044	0.213	1.616	-0.014		0.008	-0.032	1.009	0.008		
Erica arborea	-7.706	1.287	1.440	-0.115		0.048					
Laurisilvas	-10.459	1.885	2.413		-1.766	0.049					
Fagus sylvatica	-5.650	1.177	1.346	-0.031	-1.178	0.036			0.002	-0.018	
Castanea sativa	-6.324	0.726	1.983		-0.903	0.025		0.552	0.012		
Betula/*Acer* spp.	-7.938	0.700	1.851	-0.064		0.037	-0.008	0.800	0.009		-0.019
Other broadleaves	-8.925	1.057	2.401	-0.047		0.019				0.020	

Table C.6: Coefficients of the ingrowth density model. The coefficients are significative at 0.05 level. The explanatory variables are natural logarithm of the stand density (lnN; whereas N is in ind·ha^{-1}), the local stand-relative abundance of the species spp (Nspp/N), the stand basal area (G; m^2·ha^{-1}), the natural logarithm of stand basal area (lnG), the standard deviation of tree diameter (sdD; cm), the mean annual temperature (T; ºC) modified as (T-15)^2 (Temp15sq), the moisture index (PPET) estimated by the ratio of the mean annual precipitation (in mm·yr^{-1}) to mean annual potential evapotranspiration (in mm·yr^{-1}), the soil water holding capacity (SWHC; mm), the potential radiation (Rad; MJ·m^{-2}), and the slope (degrees).

Species/group	Intercept	lnN	Nspp.N	G	lnG	sdD	Temp15sq	PPET	SWHC	Rad	Slope
Pinus pinea	4.147	0.286	0.313		-0.414		-0.012				
Pinus sylvestris	3.668	0.305	0.488		-0.443	0.024			0.004		
Pinus uncinata	3.982	0.459	0.708		-0.741						
Pinus pinaster	4.125	0.082	0.443		-0.276	0.007		0.382	0.003	0.016	
Pinus halepensis	3.573	0.296	0.330		-0.440	0.010		0.382	0.003		
Pinus nigra	3.563	0.328	0.531	-0.010	-0.391	0.019			0.003		
Pinus canariensis	4.368	0.037				0.005			0.006		
Pinus radiata	5.096	-0.195	0.391	0.011		0.022			0.008		-0.019
Abies/*Picea*/*Pseudotsuga* spp.	2.728	0.393			-0.461			1.206			
Juniperus thurifera	3.761	0.280			-0.362	0.021		0.487			
Juniperus spp.	4.463		0.525					0.664			
Cupressus/*Taxus* spp.	10.886									-0.189	
Other conifers	5.475										
Quercus ilex	4.004	0.296	0.339	-0.007	-0.242				0.002		
Quercus suber	4.676	0.067	0.446				-0.036				
Quercus faginea	3.799	0.223	0.487		-0.222	0.008			0.004		
Quercus robur/*petraea*/*rubra*	5.178	0.106	0.190		-0.328	0.010				0.014	-0.010
Quercus pyrenaica/*pubescens*/*canariensis*	4.499	0.188	0.226	-0.009	-0.348	0.007		0.119	0.003	0.014	-0.003
Populus/*Platanus* spp.	4.319						-0.020		0.013		
Fraxinus/*Salix* spp.	4.936	0.185			-0.291						
Eucalyptus spp.	5.036		0.460	0.005					0.003		
Erica arborea	4.006	0.263	0.641	-0.029							
Laurisilvas	3.319	0.423	1.053		-0.486						
Fagus sylvatica	5.458	0.169	0.327		-0.472	0.007					
Castanea sativa	5.583	0.086	0.705	0.015	-0.433						
Betula/*Acer* spp.	6.677	-0.067	0.557		-0.249						-0.027
Other broadleaves	4.005	0.202	0.685	-0.012			-0.004		0.002		

Table C.7: Coefficients of the ingrowth diameter model. The coefficients are significative at 0.05 level. The explanatory variables are the stand basal area (G; $m^2 \cdot ha^{-1}$), the natural logarithm of stand basal area (lnG), the mean annual temperature (T; ºC) modified as $(T-15)^2$ (Temp15sq), the moisture index (PPET) estimated by the ratio of the mean annual precipitation (in $mm \cdot yr^{-1}$) to mean annual potential evapotranspiration (in $mm \cdot yr^{-1}$), the soil water holding capacity (SWHC; mm), the potential radiation (Rad; $MJ \cdot m^{-2}$), and the slope (degrees).

Species/group	Intercept	G	lnG	Temp15sq	PPET	SWHC	Rad	Slope
Pinus pinea	2.493		-0.048					
Pinus sylvestris	2.452		-0.060					
Pinus uncinata	2.295							
Pinus pinaster	2.574		-0.078		0.073			-0.004
Pinus halepensis	2.247		-0.028		0.142			
Pinus nigra	2.344		-0.055		0.131			-0.003
Pinus canariensis	2.346	0.009	-0.177	-0.006	0.595			
Pinus radiata	2.500	0.022	-0.286			0.004		
Abies/*Picea*/*Pseudotsuga* spp.	1.994						0.014	
Juniperus thurifera	2.211	-0.002						
Juniperus spp.	2.122							
Cupressus/*Taxus* spp.	2.113				0.377			
Other conifers	2.574	-0.012						
Quercus ilex	2.192	-0.001		-0.002	0.053			-0.001
Quercus suber	2.318	-0.005						
Quercus faginea	2.091					0.001		
Quercus robur/*petraea*/*rubra*	2.234	-0.002		-0.002	0.088			
Quercus pyrenaica/*pubescens*/*canariensis*	2.178		-0.009	-0.001	0.089			
Populus/*Platanus* spp.	2.542							
Fraxinus/*Salix* spp.	2.371							
Eucalyptus spp.	2.125		-0.038		0.190		0.006	
Erica arborea	2.162							
Laurisilvas	2.058				0.220			
Fagus sylvatica	2.402		-0.059	-0.001				
Castanea sativa	1.939		-0.036		0.210		0.011	
Betula/*Acer* spp.	2.318		-0.023	-0.002				
Other broadleaves	2.149				0.070			-0.002