

## Drivers of treeline shift in different European mountains

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Table S1. Factors influencing the rate of tree line shift in selected European mountains

Country; part of Mts.	N	E	Timberline elevation	Tree species forming the treeline	Abiotic limits (scale 0-3)	Biotic limits (scale 0-3)	Human activity limits (scale 0-3)	Temperature increase between periods 1961-1990 and 1991-2015 (°C)	Treeline shift per year (m)
Central Pyrenees (CP)	42°40'N	0°22' W	2400	C	2	0	1	0,8	1.92 m yr-1 in 1956-2006
Eastern Pyrenees (EP)	42°28'N	1°30'E	2250	C	2	0	2	0,8	0.71 m yr-1 in 1956-2006
Apeninnes (AP)	42°05'N	14°05'E	1800	B	1	1	0	1,4	1 m yr-1 in 1954-2007
Shara Mts. (SH)	41°47'N	20°33'E	1850	C, B	1	1	0	0,7	1m yr-1 in 1934 - 2010
Pirin (PI)	41°42'N	23°31'E	1900	C	1	0	2	0,5	1 m yr-1 in 1954-2007
Central Balkan Mts. (CB)	42°47'N	24°36'E	1600	C, B	1	1	3	0,7	no data
Northern Dinaric Mts. (DI)	45°36'N	14°28'E	1540	B	1	1	0	1,3	no data
Central Alps (CA)	46°46'N	9°52'E	2000	C	1	1	1	0,7	1.3 m /yr in 1954-2015
Eastern Alps (EA)	46°17'N	11°45'E	1800	C	1	1	0	0,9	1.3 m /yr in 1954-2015
Low Tatras (LT)	48°55'N	19°31'E	1400	C	1	0	0	0,9	0.57 m yr-1 in 1975 - 2016
Giant Mts. (GM)	50°42'N	15°38'E	1250	C	2	1	1	0,7	0.43 m yr-1 in 1936 - 2005
Hardangervidda I (HG)	59°48'N	9°20'E	900	C, B	0	1	2	0,5	0.8 m yr-1 in 1915 - 2007
Dovre (DO)	62°19'N	9°17'E	1000	B	0	2	1	0,7	0.8 m yr-1 in 1915 - 2007
NS	68°19'N	18°42'E	700	B	1	2	1	1,1	0.6 m yr-1 in 1958 - 2008
FL	69°45'N	27°00'E	290	B	2	1		1,0	0.6 m yr-1 in 1958 - 2008

NS - Northern Swedish Lapland; FL - Inner Finnmark/northernmost Finnish Lapland; C – conifers; B - broadleaf trees

Rate of limiting factors: 0 - no process/factors limiting the tree-line shift; 1 - tree line shift can be limited by the mentioned processes/factors; 2 - tree line shift is seriously reduced by the mentioned processes/factors; 3 - tree line shift is completely hampered by the mentioned processes/factor

Table S2. Factors influencing treeline ecotone characteristics in selected European mountains

Mountain area	North latitude	East longitude	Parent rock				Mountain size (km <sup>2</sup> )	Start of HI (yr)	Start of HI decrease (yr)	Timber -line (m asl)	Width of treeline ecotone (m)	Tree species forming the treeline
			granite	gneiss	schist	lime-stone						
Central Pyrenees (CP)	42°40'N	0°22' W	1	0	0	1	55000	1000	1930	2400	300	C
Eastern Pyrenees (EP)	42°28'N	1°30'E	1	0	0	1	55000	1000	1930	2250	300	C
Apeninnes (AP)	42°05'N	14°05'E	1	0	0	1	740	1000 BC	1950	1800	300	B
Shara Mts. (SH)	41°47'N	20°33'E	1	0	0	1	1600	1300	1970	1850	350	C, B
Pirin (PI)	41°42'N	23°31'E	1	1	1	1	2585	680	1962	1900	400	C
Central Balkan Mts. (CB)	42°47'N	24°36'E	1	0	1	1	11600	1700	1980	1600	250	C, B
Northern Dinaric Mts. (DI)	45°36'N	14°28'E	0	0	0	1	1000	1400	1900	1540	160	B
Central Alps (CA)	46°46'N	9°52'E	0	1	0	0	180000	1300	1880	2100	550	C
Eastern Alps (EA)	46°17'N	11°45'E	0	1	0	1	180000	1150	1950	1800	400	C
Low Tatras (LT)	48°55'N	19°31'E	1	1	0	1	1240	1400	1922	1400	330	C
Giant Mts. (GM)	50°42'N	15°38'E	1	1	1	0	630	1000	1963	1250	250	C
Hardangervidda (HG)	59°48'N	9°20'E	0	0	1	0	9000	800	1970	900	150	C, B
Dovre (DO)	62°19'N	9°17'E	0	1	1	0	6000	1000	no decrease	1000	400	B
NS	68°19'N	18°42'E	0	1	1	0	4000	1000	no decrease	700	300	B
FL	69°45'N	27°00'E	0	0	1	0	60000	1600	2000	290	90	B

NS - Northern Swedish Lapland; FL - Inner Finnmark/northernmost Finnish Lapland; Mountain size - the size of the whole mountain massive, functioning as a mezoscale climate unit, not only the studied mountain area; ST of HI - start of significant human influence; Start of HI decrease - start of decrease of human influence; Width of treeline ecotone - subtraction of value of mean timberline elevation from the value of upper tree species limit; C –conifers; B - broadleaf trees

Table S3. Parameters influencing the impact of climate and land use change on biodiversity in selected European mountains

Mountain area	North latitude	East longitude	Timberline (m asl)	Tree species forming the treeline	Start of HI yr	Start of HI decrease yr	Temperature increase between periods 1961-1990 and 1991-2015 (°C)	Impacts of CC and LU change		
								biodiversity loss of meadows	biodiversity loss of forests	impacts on animal diversity
Central Pyrenees (CP)	42°40'N	0°22' W	2400	C	1000	1930	0.8	2	0	1
Eastern Pyrenees (EP)	42°28'N	1°30'E	2250	C	1000	1930	0.8	2	0	2
Appenins (AP)	42°05'N	14°05'E	1800	B	1000 BC	1950		2	1	1
Shara Mts. (SH)	41°47'N	20°33'E	1850	C, B	1300	1970	0.7	2	1	1
Pirin (PI)	41°42'N	23°31'E	1900	C	680	1962	0.5	2	1	0
Central Balkan Mts. (CB)	42°47'N	24°36'E	1600	C, B	1700	1980	0.7	2	2	2
Northern Dinaric Mts. (DI)	45°36'N	14°28'E	1540	B	1400	1900	1.3	2	1	1
Central Alps (CA)	46°46'N	9°52'E	2000	C	1300	1950	0.7	1	1	1
Eastern Alps (EA)	46°17'N	11°45'E	1800	C	1150	1950	0.9	2	1	1
Low Tatras (LT)	48°55'N	19°31'E	1400	C	1400	1922	0.9	2	0	1
Giant Mts. (GM)	50°42'N	15°38'E	1250	C	1000	1963	0.7	1	1	0
Hardangervidda (HG)	59°48'N	9°20'E	900	C, B	800	1970	0.5	0	1	2
Dovre (DO)	62°19'N	9°17'E	1000	B	1000	no decrease	0.7	0	2	1
NS	68°19'N	18°42'E	700	B	1000	no decrease	1.1	1	2	1
FL	69°45'N	27°00'E	290	B	1600	2000	1.0	1	2	1

NS - Northern Swedish Lapland; FL - Inner Finnmark/northernmost Finnish Lapland; C - conifers; B - broadleaf trees; Start of HI - start of significant human influence; Start of HI decrease: start of decrease of human influence

Rate of impact on biodiversity: 0 - no impact on biodiversity; 1 - weak impact on biodiversity; 2 - medium impact on biodiversity; 3 - strong impact on biodiversity