Global distribution modelling, invasion risk assessment and niche dynamics of *Leucanthemum vulgare* (Ox-eye Daisy) under climate change

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Supplementary information

Supplementary Table S1: AUC (ROC), TSS and KAPPA values of ensemble model

	Testing data	Cut off	Sensitivity	Specificity
TSS	0.850	445.0	95.754	89.225
ROC	0.977	438.5	95.799	89.225
KAPPA	0.845	46.0	99.094	81.370

Supplementary Table S2: Regional invasion risk categorization in terms of the area (km^2) invaded by *Leucanthemum vulgare* under current climatic conditions.

Category	Southern America	Oceania	Northern America	Australia	Asia	Africa
No Risk (0 - 0.25)	12,753,989	111,387	26,523,996	5,805,395	48,378,451	23,818,782
Low Risk (0.25 - 0.5)	1,017,237	6,901	2,745,450	323,734	1,940,117	329,071
Moderate Risk (0.5 -0.75)	563,076	51,452	2,834,536	177,547	554,858	84,343
High Risk (0.75 - 1)	234,038	214,258	2,636,435	263,849	280,962	8466
Total Area (Sq. km)	14,568,340	383,998	34,740,417	6,570,525	51,154,388	24,240,662
Invaded Area (%age)	2%	56%	8%	4%	1%	0.03%
Risk Category	**Low Risk**	**High Risk**	**Medium Risk**	**Low Risk**	**Low Risk**	**Low Risk**

Supplementary Table S3: Regional invasion risk categorization in terms of the area (km^2) invaded by *Leucanthemum vulgare* under RCP 2.6 2050.

Category	Southern America	Oceania	Northern America	Australia	Asia	Africa
No Risk (0 - 0.25)	13,594,190	113,808	27,148,802	6,173,220	49,748,837	24,168,654
Low Risk (0.25 - 0.5)	229,345	6,934	1,582,092	81,758	438,646	36,909
Moderate Risk (0.5 - 0.75)	322,203	32,051	1,861,275	81,247	338,607	26,928
High Risk (0.75 - 1)	422,604	231,206	4,148,315	234,286	628,281	8,186
Total Area	14,568,342	383,999	34,740,484	6,570,511	51,154,371	24,240,677

(Sq. km)						
Invaded Area (%age)	3%	60%	12%	4%	1%	0.03%
Risk Category	**Low Risk**	**High Risk**	**Medium Risk**	**Low Risk**	**Low Risk**	**Low Risk**

Supplementary Table S4: Regional invasion risk categorization in terms of the area (km^2) invaded by *Leucanthemum vulgare* under RCP 2.6 2070.

Category	Southern America	Oceania	Northern America	Australia	Asia	Africa
No Risk (0 - 0.25)	13,624,066	113,808	27,529,029	6,196,558	49,700,086	24,170,170
Low Risk (0.25 - 0.5)	213,072	4,645	1,352,072	75,828	469,016	38,787
Moderate Risk (0.5 - 0.75)	310,970	26,303	1,921,209	93,039	395,181	23,684
High Risk (0.75 - 1)	420,232	239,243	3,938,175	205,084	590,087	8,037
Total Area (Sq. km)	14,568,340	383,999	34,740,485	6,570,509	51,154,370	24,240,678
Invaded Area (%age)	3%	62%	11%	3%	1%	0.03%
Risk Category	**Low Risk**	**High Risk**	**Medium Risk**	**Low Risk**	**Low Risk**	**Low Risk**

Supplementary Table S5: Regional invasion risk categorization in terms of the area (km^2) invaded by *Leucanthemum vulgare* under RCP 4.5 2050.

Category	Southern America	Oceania	Northern America	Australia	Asia	Africa
No Risk (0 - 0.25)	13,683,243	121,087	27,067,638	6,257,118	49,634,470	24,200,030
Low Risk (0.25 - 0.5)	181,779	13,654	1,773,819	70,080	516,120	25,594
Moderate Risk (0.5 - 0.75)	237,580	34,966	1,960,111	76,042	351,898	11,397
High Risk (0.75 - 1)	465,739	214,291	3,938,916	167,269	651,883	3,656
Total Area (Sq. km)	14,568,341	383,998	34,740,484	6,570,509	51,154,371	24,240,677
Invaded Area (%age)	3%	56%	11%	3%	1%	0.02%
Risk Category	**Low Risk**	**High Risk**	**Medium Risk**	**Low Risk**	**Low Risk**	**Low Risk**

Supplementary Table S6: Regional invasion risk categorization in terms of the area (km^2) invaded by *Leucanthemum vulgare* under RCP 4.5 2070.

Category	Southern America	Oceania	Northern America	Australia	Asia	Africa
No Risk (0 - 0.25)	13,721,602	125,600	26,378,105	6,270,870	49,195,165	24,206,470
Low Risk (0.25 - 0.5)	158,820	11,562	1,399,604	81,230	756,912	19,830
Moderate Risk (0.5 - 0.75)	246,259	36,662	2,695,595	68,960	369,208	11,068
High Risk (0.75 - 1)	441,660	210,174	4,267,179	149,449	833,086	3,310
Total Area (Sq. km)	14,568,341	383,998	34,740,483	6,570,509	51,154,371	24,240,678
Invaded Area (%age)	3%	55%	12%	2%	2%	0.01%
Risk Category	**Low Risk**	**High Risk**	**Medium Risk**	**Low Risk**	**Low Risk**	**Low Risk**

Supplementary Table S7: Regional invasion risk categorization in terms of the area (km^2) invaded by *Leucanthemum vulgare* under RCP 6.0 2050.

Category	Southern America	Oceania	Northern America	Australia	Asia	Africa
No Risk (0 - 0.25)	13,645,840	116,838	27,201,671	6,223,453	49,608,859	24,167,716
Low Risk (0.25 - 0.5)	213,402	11,282	1,547,505	65,336	488,599	36,135
Moderate Risk (0.5 - 0.75)	304,547	30,190	1,957,328	89,761	375,747	26,006
High Risk (0.75 - 1)	404,553	225,688	4,033,981	191,958	681,166	10,821
Total Area (Sq. km)	14,568,342	383,998	34,740,485	6,570,508	51,154,371	24,240,678
Invaded Area (%age)	3%	59%	12%	3%	1%	0.04%
Risk Category	**Low Risk**	**High Risk**	**Medium Risk**	**Low Risk**	**Low Risk**	**Low Risk**

Supplementary Table S8: Regional invasion risk categorization in terms of the area (km^2) invaded by *Leucanthemum vulgare* under RCP 6.0 2070.

Category	Southern America	Oceania	Northern America	Australia	Asia	Africa
No Risk (0 - 0.25)	13,666,444	118,090	26,691,842	6,261,005	49,572,477	24,201,825
Low Risk (0.25 - 0.5)	215,263	10,162	1,794,802	67,214	554,067	22,959
Moderate Risk (0.5 - 0.75)	280,468	44,947	2,073,606	85,809	342,757	`12,040
High Risk (0.75 - 1)	406,167	210,800	4,180,234	156,481	685,070	3854
Total Area (Sq. km)	14,568,342	383,999	34,740,484	6,570,509	51,154,371	24,240,678
Invaded Area (%age)	3%	55%	12%	2%	1%	0.02%
Risk Category	**Low Risk**	**High Risk**	**Medium Risk**	**Low Risk**	**Low Risk**	**Low Risk**

Supplementary Table S9: Regional invasion risk categorization in terms of the area (km^2) invaded by *Leucanthemum vulgare* under RCP 8.5 2050.

Category	Southern America	Oceania	Northern America	Australia	Asia	Africa
No Risk (0 - 0.25)	13,694,920	118,633	26,800,775	6,241,998	49,687,141	24,196,143
Low Risk (0.25 - 0.5)	186,210	11,710	1,497,222	72,419	460,896	26,105
Moderate Risk (0.5 - 0.75)	274,225	38,227	2,012,519	80,159	282,477	13,588
High Risk (0.75 - 1)	412,985	215,428	4,429,969	175,933	723,856	4,842
Total Area (Sq. km)	14,568,340	383,998	34,740,485	6,570,509	51,154,370	24,240,678
Invaded Area (%age)	3%	56%	13%	3%	1%	0.02%
Risk Category	**Low Risk**	**High Risk**	**Medium Risk**	**Low Risk**	**Low Risk**	**Low Risk**

Supplementary Table S10: Regional invasion risk categorization in terms of the area (km^2) invaded by *Leucanthemum vulgare* under RCP 8.5 2070.

Category	Southern America	Oceania	Northern America	Australia	Asia	Africa
No Risk (0 - 0.25)	13,811,264	133,983	26,070,215	6,327,889	48,880,259	24,222,231
Low Risk (0.25 - 0.5)	166,660	22,416	1,388,668	62,092	693,914	11,249
Moderate Risk (0.5 - 0.75)	195,960	50,925	2,339,201	59,868	558,135	5,880
High Risk (0.75 - 1)	394,456	176,674	4,942,400	120,659	1,022,062	1318
Total Area (Sq. km)	14,568,340	383,998	34,740,484	6,570,508	51,154,370	24,240,678
Invaded Area (%age)	3%	46%	14%	2%	2%	0.01%
Risk Category	**Low Risk**	**High Risk**	**Medium Risk**	**Low Risk**	**Low Risk**	**Low Risk**

Supplementary Table S11: Climatic and topographic variables used to model the distribution of *Leucanthemum vulgare* during the present study. Variables in bold indicate the ones retained after correlation analysis to build the model.

Factors	Variables
Climatic	BIO1 = Annual Mean Temperature
	BIO2 = Mean Diurnal Range (Mean of monthly (max temp - min temp))
	BIO3 = Isothermality (BIO2/BIO7) (* 100)
	BIO4 = Temperature Seasonality (standard deviation *100)
	BIO5 = Max Temperature of Warmest Month
	BIO6 = Min Temperature of Coldest Month
	BIO7 = Temperature Annual Range (BIO5-BIO6)
	BIO8 = Mean Temperature of Wettest Quarter
	BIO9 = Mean Temperature of Driest Quarter
	BIO10 = Mean Temperature of Warmest Quarter
	BIO11 = Mean Temperature of Coldest Quarter
	BIO12 = Annual Precipitation
	BIO13 = Precipitation of Wettest Month

	BIO14 = Precipitation of Driest Month
	BIO15 = Precipitation Seasonality (Coefficient of Variation)
	BIO16 = Precipitation of Wettest Quarter
	BIO17 = Precipitation of Driest Quarter
	BIO18 = Precipitation of Warmest Quarter
	BIO19 = Precipitation of Coldest Quarter
Topographic	**Altitude**

Supplementary Table S12: Pairwise correlation coefficients between variables. Red colour indicates the variables that are correlated and excluded from the present study

	Alt	bio_1	bio_2	bio_3	bio_4	bio_5	bio_6	bio_7	bio_8	bio_9	bio_10	bio_11	bio_12	bio_13	bio_14	bio_15	Bio_16	Bio_17	bio_18	bio_19
Alt	1																			
bio_1	-0.05																			
bio_2	0.43	0.14																		
bio_3	0.36	0.69	0.36																	
bio_4	-0.07	-0.63	0.34	-0.71																
bio_5	0.01	0.60	0.71	0.29	0.18															
bio_6	-0.06	**0.87**	-0.23	0.69	**-0.90**	0.17														
bio_7	0.06	-0.52	0.58	-0.51	**0.95**	0.34	**-0.86**													
bio_8	-0.18	0.11	0.16	-0.21	0.35	0.40	-0.12	0.32												
bio_9	0.09	**0.75**	0.02	0.72	**-0.76**	0.26	**0.81**	-0.64	-0.39											
bio_10	-0.15	**0.76**	0.46	0.29	0.01	**0.93**	0.37	0.11	0.43	0.36										
bio_11	-0.01	**0.93**	-0.07	**0.76**	**-0.87**	0.29	**0.98**	**-0.78**	-0.10	**0.84**	0.48									
bio_12	0.23	0.30	0.04	0.44	-0.40	-0.004	0.34	-0.33	-0.35	0.43	0.04	0.37								
bio_13	0.30	0.23	0.14	0.43	-0.30	0.04	0.24	-0.20	-0.28	0.37	0.04	0.28	**0.90**							
bio_14	0.06	0.24	-0.13	0.25	-0.35	-0.12	0.31	-0.36	-0.27	0.28	-0.01	0.30	0.72	0.41						
bio_15	0.25	-0.11	0.32	0.08	0.17	0.13	-0.21	0.27	0.01	-0.03	0.01	-0.14	0.04	0.41	-0.54					
bio_16	0.28	0.24	0.11	0.43	-0.32	0.02	0.26	-0.23	-0.30	0.38	0.03	0.30	**0.92**	**0.99**	0.44	0.38				
bio_17	0.10	0.29	-0.09	0.31	-0.39	-0.06	0.35	-0.37	-0.30	0.35	0.03	0.35	**0.77**	0.47	**0.98**	-0.51	0.50			
bio_18	0.21	0.01	0.03	0.03	0.03	-0.03	-0.05	0.02	0.19	-0.17	0.01	-0.02	0.58	0.48	0.60	-0.08	0.48	0.59		
bio_19	0.14	0.30	0.01	0.49	-0.49	-0.04	0.41	-0.41	-0.52	0.58	-0.02	0.42	**0.87**	**0.81**	0.53	0.10	**0.84**	0.59	0.15	1

Supplementary Table S13: TSS, AUC (ROC) and KAPPA values for individual models

GLM, RUN1

Testing.data	Cutoff	Sensitivity	Specificity
TSS	0.810	463	94.491	86.577
ROC	0.951	486	94.264	86.913
KAPPA	0.795	74	98.453	77.852

GBM, RUN1

Testing.data	Cutoff	Sensitivity	Specificity
TSS	0.817	370	95.434	86.242
ROC	0.954	355	95.472	86.242
KAPPA	0.796	40	98.868	75.839

GAM, RUN1

Testing.data	Cutoff	Sensitivity	Specificity
TSS	0.814	598	93.208	88.255
ROC	0.954	596	93.208	88.255
KAPPA	0.811	35	98.906	77.517

CTA, RUN1

Testing.data	Cutoff	Sensitivity	Specificity
TSS	0.802	506.5	93.925	86.242
ROC	0.911	507.5	93.925	86.242
KAPPA	0.686	171.5	94.302	85.235

ANN, RUN1

Testing.data	Cutoff	Sensitivity	Specificity
TSS	0.700	541.0	94.302	71.812
ROC	0.900	545.5	85.509	84.564
KAPPA	0.699	102.0	97.358	70.805

SRE, RUN1

Testing.data	Cutoff	Sensitivity	Specificity
TSS	0.688	495	76.83	91.946
ROC	0.844	500	76.83	91.946
KAPPA	0.366	495	76.83	91.946

FDA, RUN1

Testing.data	Cutoff	Sensitivity	Specificity
TSS	0.789	747.0	97.170	81.879
ROC	0.942	757.5	94.113	85.235
KAPPA	0.810	677.0	99.170	75.839

MARS, RUN1

Testing.data	Cutoff	Sensitivity	Specificity
TSS	0.803	334.0	94.755	85.570
ROC	0.952	326.5	94.906	85.570
KAPPA	0.781	70.0	98.453	75.839

RF, RUN1

Testing.data	Cutoff	Sensitivity	Specificity
TSS	0.856	889	94.717	90.940
ROC	0.963	888	94.717	90.940
KAPPA	0.845	313	98.604	84.899

MAXENT Philips, RUN1

Testing.data	Cutoff	Sensitivity	Specificity
TSS	0.720	10.0	84.151	87.248
ROC	0.874	67.5	82.566	89.597
KAPPA	0.486	0.0	100.000	0.000

GLM, RUN2

Testing.data	Cutoff	Sensitivity	Specificity
TSS	0.823	269.5	96.717	85.570
ROC	0.959	258.5	96.868	85.570
KAPPA	0.829	75.0	98.868	80.201

GBM, RUN2

Testing.data	Cutoff	Sensitivity	Specificity
TSS	0.817	541.0	93.774	87.919
ROC	0.961	497.5	94.113	87.584
KAPPA	0.822	39.0	98.943	79.530

GAM, RUN2

Testing.data	Cutoff	Sensitivity	Specificity
TSS	0.818	409.0	95.509	86.242
ROC	0.954	400.5	95.547	86.242
KAPPA	0.822	46.0	98.981	78.859

CTA, RUN2

Testing.data	Cutoff	Sensitivity	Specificity
TSS	0.849	134	95.925	88.926
ROC	0.941	111	95.962	88.926
KAPPA	0.775	59	97.887	78.188

ANN, RUN2

Testing.data	Cutoff	Sensitivity	Specificity
TSS	0.729	633.0	91.396	81.544
ROC	0.924	629.5	91.509	81.544
KAPPA	0.685	57.0	97.925	65.772

SRE, RUN2

Testing.data	Cutoff	Sensitivity	Specificity
TSS	0.682	495	77.547	90.604
ROC	0.841	500	77.547	90.604
KAPPA	0.370	495	77.547	90.604

FDA, RUN2

Testing.data	Cutoff	Sensitivity	Specificity
TSS	0.811	737.0	98.000	82.886
ROC	0.948	749.5	96.604	84.899

KAPPA	0.816	722.0	98.868	78.523

MARS, RUN2

Testing.data	Cutoff	Sensitivity	Specificity
TSS	0.810	301.5	95.094	85.906
ROC	0.959	290.5	95.245	85.906
KAPPA	0.812	89.0	98.491	80.537

RF, RUN2

Testing.data	Cutoff	Sensitivity	Specificity
TSS	0.874	786	96.755	90.604
ROC	0.969	824	96.453	90.940
KAPPA	0.852	383	98.340	87.919

MAXENT Philips, RUN2

Testing.data	Cutoff	Sensitivity	Specificity
TSS	0.748	51.0	84.000	90.604
ROC	0.894	51.5	83.849	90.940
KAPPA	0.537	0.0	100.000	0.000

GLM, RUN3

Testing.data	Cutoff	Sensitivity	Specificity
TSS	0.837	428.0	94.075	89.597
ROC	0.965	426.5	94.113	89.597
KAPPA	0.806	104.0	98.000	82.886

GBM, RUN3

Testing.data	Cutoff	Sensitivity	Specificity
TSS	0.843	476.0	94.113	89.933
ROC	0.968	476.5	94.075	90.268
KAPPA	0.799	67.0	97.774	83.221

GAM, RUN3

Testing.data	Cutoff	Sensitivity	Specificity
TSS	0.841	430	94.528	89.262
ROC	0.964	433	94.528	89.597
KAPPA	0.826	36	99.057	78.859

CTA, RUN3

Testing.data	Cutoff	Sensitivity	Specificity
TSS	0.839	452	94.302	89.597
ROC	0.934	452	94.302	89.597
KAPPA	0.739	70	96.377	82.215

ANN, RUN3

Testing.data	Cutoff	Sensitivity	Specificity
TSS	0.688	570.5	97.019	71.812
ROC	0.848	571.0	97.019	71.812
KAPPA	0.693	570.5	97.019	71.812

SRE, RUN3

Testing.data	Cutoff	Sensitivity	Specificity

TSS	0.711	495	76.491	94.631
ROC	0.856	500	76.491	94.631
KAPPA	0.374	495	76.491	94.631

FDA, RUN3

Testing.data	Cutoff	Sensitivity	Specificity
TSS	0.816	754.0	96.000	85.570
ROC	0.956	756.5	94.755	87.584
KAPPA	0.787	677.0	98.642	75.839

MARS, RUN3

Testing.data	Cutoff	Sensitivity	Specificity
TSS	0.831	496.0	93.132	89.933
ROC	0.966	496.5	93.132	89.933
KAPPA	0.794	69.0	98.075	80.537

RF, RUN3

Testing.data	Cutoff	Sensitivity	Specificity
TSS	0.883	829	95.396	92.953
ROC	0.974	824	95.472	92.953
KAPPA	0.849	39	98.981	82.550

MAXENT Philips, RUN3

Testing.data	Cutoff	Sensitivity	Specificity
TSS	0.773	20	88.792	88.255
ROC	0.907	26	88.491	88.926
KAPPA	0.624	0	100.000	0.000