

Assessing the vulnerability of a forest ecosystem to climate change and variability in the western Mediterranean sub-region of Turkey: future evaluation

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Abstract This study evaluates the multifactorial spatial modelling used to assess vulnerability of the Düzlerçamı (Antalya) forest ecosystem to climate change. This was done to produce data, to develop tools to support decision-making and the management of vulnerable Mediterranean forest ecosystems affected by climate change, and to increase the ability of these forest ecosystems to adapt to global change. Based on regionally averaged future climate assessments and projected climate indicators, both the study site and the western Mediterranean sub-region of Turkey will probably become associated with a drier, hotter, more continental and more water-deficient climate. This analysis holds true for all future scenarios, with the exception of RCP4.5 for the period from 2015 to 2030. However, the present dry-sub humid climate dominating this sub-region and the study area shows a potential for change towards more dry climatology and for it to become semiarid between 2031 and 2050 according to the RCP8.5

high emission scenario. All the observed and estimated results and assessments summarized in this study show clearly that the densest forest ecosystem in the southern part of the study site, characterized by mainly Mediterranean coniferous and some mixed forest and maquis vegetation, will very likely be influenced by medium and high degrees of vulnerability to future environmental degradation, climate change and variability.

Keywords Forest ecosystem · RCP scenarios · Regional climate model · Vulnerability

Introduction

Climate change, whether driven by natural or human events, can lead to changes in the likelihood and strength of extreme weather and climate events (IPCC 2013). Human-induced climate changes are continuing to affect the Earth's energy budget through changes to regulations governing greenhouse gas emissions and aerosol usage. However, atmospheric concentrations of radiatively active gases (greenhouse gases) and aerosols continue to increase and land surface properties change; this is in addition to changes in natural forces and mechanisms that govern the climate system. The evidence for global climate alteration and global warming is now considered irrevocable (IPCC 2014).

In spite of significant empirical, scientific and modeling developments, and even improvements in the understanding of the chaotic aspects of climate change and variability, there are still many important arguments to be resolved. The main concern is quantifying climate change and its impact, and identifying a means to adapt to it. A better solution is to mitigate the human-induced causes of climate

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change by addressing the increased greenhouse gas emissions from fossil fuels, industrial processes, cement production, mining and agricultural activities (Türkeş 2014). Fortunately, policymakers have become increasingly aware that the impacts and risks of global climate change are so great that ignoring them or any delays in addressing them would be far costlier than inaction. With the expansion of global climatic datasets, a worldwide increase in the number of studies on climate variability has taken place. In most of the Mediterranean Basin, global climate models project both a decrease in precipitation and changes in the pattern of distribution (Brunetti et al. 2006; Dünkeloh and Jacobbeit 2003; Gibelin and Dèquè 2003).

Climate projections for the Mediterranean suggests that the region will become warmer and drier with more frequent and extreme weather events (IPCC 2013, 2014). Climate change will very likely affect forest ecosystems and biotopes through higher temperatures, longer and more frequent heat-waves, forest fires and their related hazards, and more variable and substantially reduced precipitation leading to changes in the precipitation/soil water regimes of subtropical Mediterranean climate regions. Giannakopoulos et al. (2009) investigated the impacts of a 2 °C global warming on natural ecosystems and associated sectoral impacts in the Mediterranean through comparison of a control period (1961–1990) and a future period (2031–2060). Some researchers have focused on studies into the sensitivity of forests in the Mediterranean region to climatic change (Bugmann 1997; Stephens et al. 2010; Keenan et al. 2011; Mazza and Manetti 2013). Lloret et al. (2013) explored the response of some Mediterranean plant species to future climatic conditions. They suggested that the extrapolation of species performance to future climatic scenarios based on current patterns of dominance was constrained by factors other than auto-ecology; in particular, human activity was shown to play a great part.

According to Turp et al. (2014), there will be an increase between 0.5 and 4 °C in mean air temperatures over Turkey between 2020 and 2050. This will be more severe in warmer than in colder seasons. According to the regional climate model results, decreased precipitation, varying from approximately 0.4 to 1.2 mm/day, is expected to occur during all seasons, particularly in the southern and western regions of the country dominated by the Mediterranean climate.

The objective of this study was to make a scientific vulnerability assessment to climate change and variability of a Mediterranean forest ecosystem: Pilot Site of Düzlerçamı (Turkey) under a Food and Agriculture Organization of the United Nations (FAO) and Plan Bleu Component 1 of the Project entitled “Maximize the production of goods and services of Mediterranean forest

ecosystems in the context of global changes (GCP/GLO/458/FRA)” (Türkeş and Musaoğlu 2016).

Materials and methods

Climate change scenarios and projected climate data

Projected changes between 2015 and 2050 in terms of common climatic parameters (i.e., precipitation, evapotranspiration, moisture content of soil layers, mean, maximum and minimum air temperatures) with respect to the control period 1971–2000 were investigated for the larger western Mediterranean sub-region including Antalya and the study region. The outputs of the Regional Climate Model (RegCM4.3.5) of the Abdus Salam International Centre for Theoretical Physics (ICTP) were used to analyze future projections under both low- and high-emission scenarios. “RCP4.5” and “RCP8.5” of the IPCC were used to simulate climate conditions (IPCC 2013).

Following this, the HadGEM2 global climate model of the Met Office Hadley Centre was dynamically downscaled to cover Antalya and the study site via RegCM4.3.5 and thereafter used at a 10-km-resolution by applying a double-nested method to the outputs of the 50-km-resolution simulations (Turp et al. 2014; Öztürk et al. 2015). Based on the results of Turp et al. (2014), precipitation decreases varying from approximately 0.4 to 1.2 mm/day are expected in all seasons, particularly over the southern and western regions of the country, both dominated by a Mediterranean climate.

Future evolution of environmental vulnerability

In the following section, basic scenarios (incorporating aging, population, grazing pressure, policy enforcement, and climate) were created independent of the IPCC greenhouse gas emissions scenarios to assess future environmental vulnerability of forest ecosystems in Mediterranean region to climate change and variability.

The same methodology (Kosmas et al. 1999a, b, c; Türkeş and Musaoğlu 2016) used for analyzing vulnerability of the forest ecosystem under projected conditions for 2015–2030 and 2031–2050 was applied as in the previous part of the paper for the current conditions. However, there are differences between the two sections with respect to some basic data items and considerable changes with regard to all climatic indicators due to the future climate projections of the regional climate modeling outputs (Fig. 1).

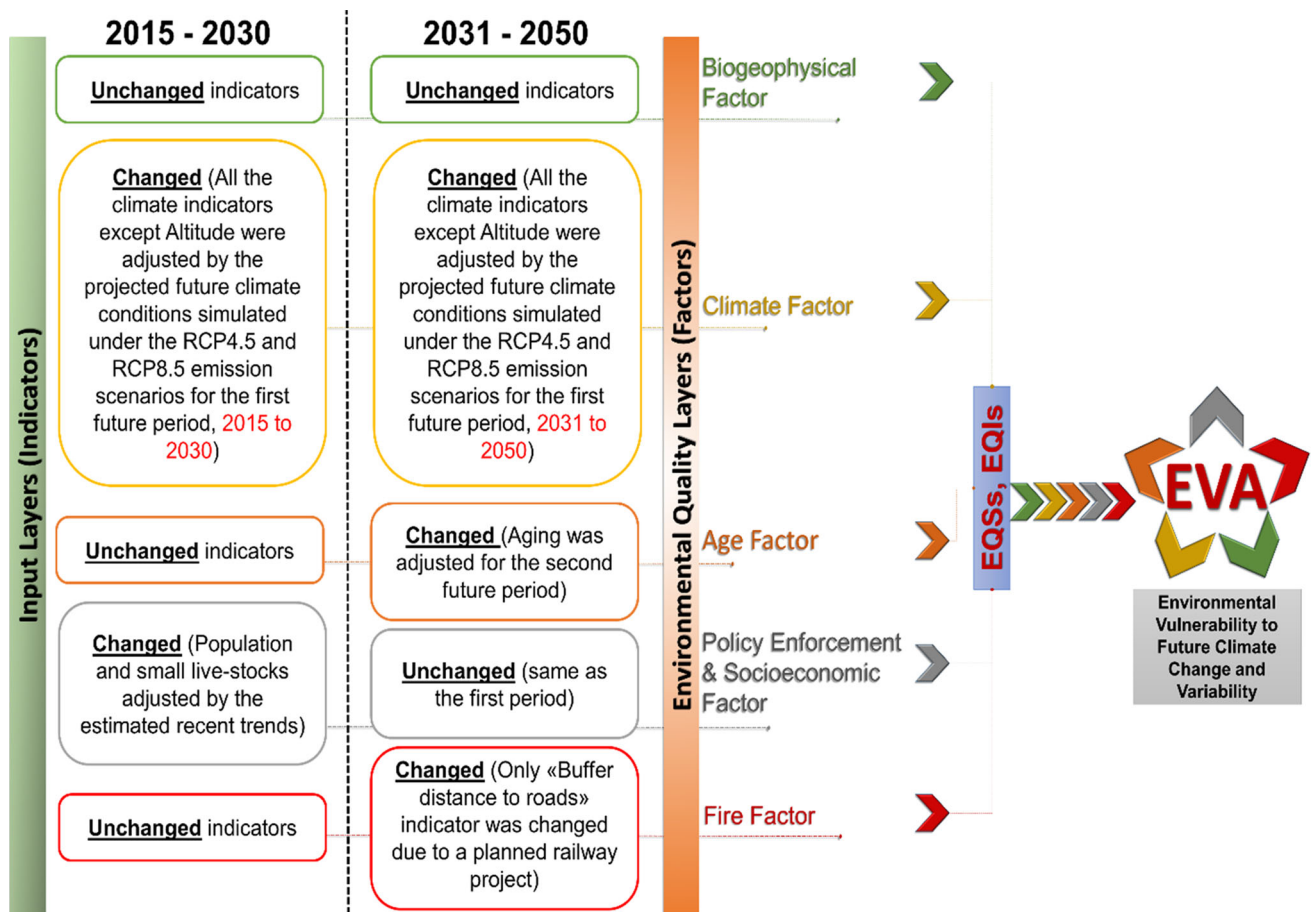


Fig. 1 Simplified schematic representation of the computing algorithm of EVI and EVA based on the combined methodology for vulnerability of the forest ecosystem to climate change and variability under the projected conditions for the periods 2015–2030 and 2031–2050

Results

Modeling and scenarios of the environmental quality layers (EQLs) and indicators

The five individual EQLs and their environmental quality scores (EQSs) from the basic data input-layers (i.e., indicators) were re-determined. Each elementary unit in each Quality Layer (i.e., each EQS of each EQL) for any grid point in the study area is represented according to its geographical coordinates, and was estimated as the geometric mean of the relative scores of its sub-layers (i.e. indicators) using Eq. 1.

$$EQS(x_{ij}) = (Sublayer_{1ij} \times Sublayer_{2ij} \times Sublayer_{3ij} \times \dots \times Sublayer_{nij})^{(1/n)} \tag{1}$$

where *i, j*, denote rows and columns of a single elementary land unit of each sub-layer and *n* the number of sub-layers used.

The final EVSs were evaluated from the EQSs of the EQLs and estimated with Eq. 2 using the *n*-number of qualities (*Quality Scores, QSs*) from Eq. 1.

$$EVS_{ij} = (Quality\ Score_{1ij} \times Quality\ Score_{2ij} \times \dots \times Quality\ Score_{nij})^{(1/n)} \tag{2}$$

where *i, j* denote rows and columns of a single elementary land unit for each quality layer and *n_{ij}* the computed quality scores. Finally, the EVIs were derived by normalizing them with respect to maximum and minimum values of the EVSs (Eq. 3).

Climate Quality Index (CQI)

Projected changes in the climatic parameters including precipitation and evapotranspiration amounts (mm), mean, maximum and minimum air temperatures (°C) for 2015–2030 and 2031–2050 with respect to the control period 1971–2000 were simulated for the western Mediterranean sub-region including the forest districts of

the study region. All climate variables and indicators were calculated on a monthly basis and regionally. In addition, all grid points were analyzed at a 10-km resolution. Thus, the regionally averaged present and projected climate indicators could be calculated for the forest districts in the study region (Table 1).

The climate factor used in this work consists of the following elements and indicators: (1) Emberger’s Pluviothermic Quotient (Q_E) (Emberger 1930); (2) Emberger’s Thermic Variant (E_{TV}) (Emberger 1932); (3) Rivas Martinez Continentality Index (I_c); (4) Annual Precipitation Amount (P_{ann}); (5) Precipitation Seasonality Index (PSI); (6) Percentage Precipitation of Warm/Hot Period of the Year (% P of WP to P_{ann}); (7) Annual Climatological Water Availability (W_a); and (8) Altitude, as shown in Fig. 1. Seven are shown in Table 1.

Based on the regionally-averaged future climate assessments, the study region, characterized today with a dry-sub humid climate according to Emberger’s bioclimatic (E_Q) classification, will probably be associated with a drier and hotter climate. This holds for all future periods and scenarios, with the exception of RCP4.5 for 2015–2030. Apart from the result arising from the most optimistic scenario for 2015–2030, the present dry-sub humid climate that dominates the forest ecosystem and the larger western Mediterranean sub-region will very likely tend to be much hotter and drier in the future, and according to the high emission scenario RCP8.5 it will become a semiarid climate in the period 2031–2050.

The maps of the individual Climatic Quality Indices (CQIs) are presented in Fig. 2. All the individual climate quality indicators (based on both RCP4.5 and RCP8.5 scenarios) were changed and adjusted to new environmental quality layers for the future periods.

Aging Quality Index (AQI)

In the study, an average annual diameter increment (cm/year) of the trees was used in order to calculate the Aging

Quality Index (AQI). The Forest District Management Directory has recently introduced a new management plan for the study region. This provides for a forested area of 29,168 ha consisting of 30% non-forest, 39% logging forest and of 22% degraded forest, which will culminate in 2021. Regarding forest functions, the 10 plans of operation showing the order and extent of forestry work to be carried out during this period are shown in Table 2.

All the information and the future work summarized here indicate that the legal, administrative, and institutional statutes of the forest district will not change. This is a positive development for the future of the district because it will not only stabilize or preserve the current environmental vulnerability, but will also reduce environmental degradation, including land degradation, drought, climate change impacts and desertification.

Turkish red pine, *Pinus brutia* Tenore (red pine), is the main pine species of the Turkish Aegean and Mediterranean coastal belt. The area is characterized by a dry and hot summer subtropical Mediterranean (Csa) climate and the Mediterranean biome, except the high northern exposures of the mountains. Mature Red pine trees in Turkey are 15–25 m in height, rarely reaching 40 m. Diameters of up to 140 cm at breast height have been recorded.

In the study area, the Forest District Directorate reports the average annual diameter increment of *Pinus brutia* as 0.5 cm/year by considering the climate, topography and ecological factors. The rotation ages of *Pinus brutia* forests are 50 years on good sites, and 60 years for medium and poor sites. The selection of optimum rotation age is based on the forest functions of the site, in line with costs and timing of all operations. The rotation ages of forest operations according to their stand type are listed in Table 2 as A-80 years, B-100 years, C-100 years, D-160 years, E-160 years, F-80 years, G-160 years, H-160 years, I-160 years and J-160 years. These rotation ages were determined by the Directorate based on the costs and values of the selected operations in the management plan. Therefore, an average annual diameter increment of

Table 1 Comparisons between all of the regionally averaged present and future climate indicators

Climate indicators	Observed (present)	Simulated future climate changes					
		RCP 4.5 scenario		RCP 8.5 scenario			
		2015–2030	2031–2050	2015–2030	2031–2050		
P_{ann} (mm)	567.78	599.72	▲ 575.2	▲	562.96	▼ 457.47	▼
W_a (mm)	–230.38	110.92	▲ 124.47	▲	108.51	▲ 59.82	▲
PSI (index)	0.77	0.59	▼ 0.64	▼	0.55	▼ 0.58	▼
%P of WP to P_{ann}	23.31	27.23	▲ 22.91	▼	23.98	▲ 24.36	▲
I_c (index)	20.49	23.09	▲ 23.69	▲	23.49	▲ 24.22	▲
Q_E (index)	58.19	61.99	▲ 57.85	▼	57.31	▼ 45.21	▼
E_{TV} (°C)	–0.61	1.7	▲ 1.57	▲	1.34	▲ 1.97	▲

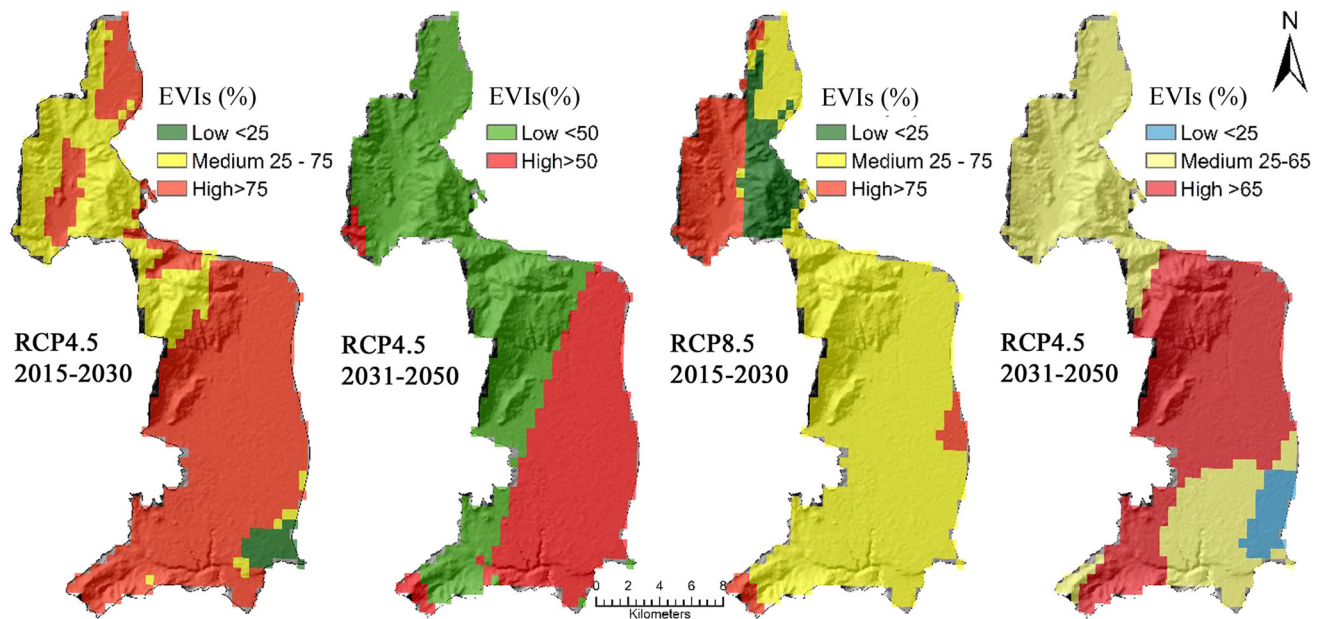


Fig. 2 Geographical distributions of the future Climate Quality Index values with respect to projections of the regional climate modeling outputs

Table 2 Forest operation plans for 2012–2021 (GDF-1 2012)

Operations	Function	Forest (ha)	Non-forest (ha)	Total (ha)	
A	Productive forest-land (<i>Pinus brutia</i> Tenore)	Economic	882.9	10,047.6	10,930.5
B	Plantations without timber production aim (almond)		22.4	–	22.4
C	Non-timber forest products (<i>Pinus pinea</i> and almond)		36.2	–	36.2
D	Wildlife protection and improvement area (WIA)	Ecological	13,100.9	1029.1	14,130
E	Worse forest site		3601.1	12	3613.1
F	Seed orchard		19.5	–	19.5
G	Archaeological protected areas		0.1	23.1	23.2
H	Protection of water resources	Social and cultural	15.8	343.1	358.9
I	Recreation		23.3	2.8	26.1
J	Research forest		8.3	–	8.3

0.5 cm/year was used in determining the future environmental quality of the age factor. By also considering the present age classes of the study ecosystem, it was assumed that there will be no significant change in aging quality between 2015 and 2030 because there will be no major felling operations. On the other hand, based on the rotation age of forest operations in the management plans, some pine stands will be harvested when they reach 40 cm diameter. Consequently, because it is assumed there will be a considerable change in aging quality between 2031 and 2050, the age of the forest ecosystem was considered as one of the changed factors for the assessments of the second period 2031–2050 (Fig. 3).

Policy enforcement and Socioeconomic Quality Index (PQI)

During the past 30 years there has been a population shift from rural areas to Antalya due to economic and cultural changes in the district. However, the gradual growth in the proportion of people living in Antalya has decreased recently. According to current projections of population growth underlined in the master plan, the population is currently growing by 4.7% annually. It was estimated that by 2030, the population of Antalya will likely reach over 2,000,000 inhabitants (twice its current size), and the population in the study area will increase to more than five times its current size to over 167,000 inhabitants (ABBB 2013).

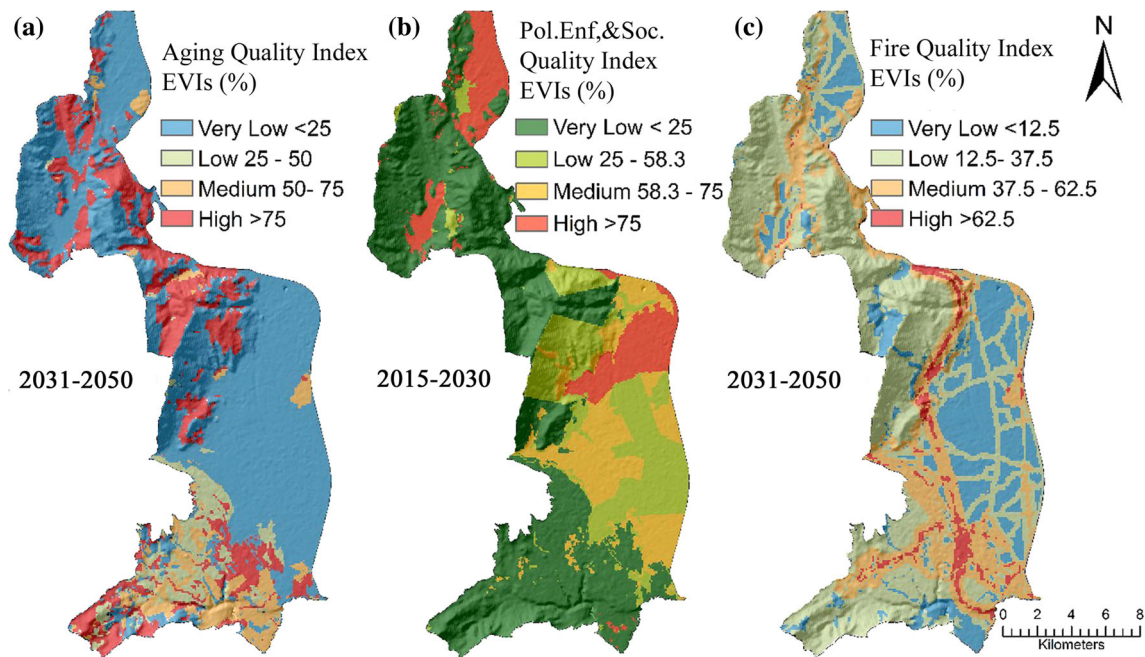


Fig. 3 Geographical distributions of future **a** AQI, **b** PQI and **c** FQI values with respect to the scenarios and evolution of the EQLs in the study region

Consequently, demography was given as a changed factor for the assessment of the first period, 2015–2030, and the impact of this was taken as having a negative effect on the forest district. According to the agricultural master plan, the number of goats rapidly decreased from 581,887 in 2002 to 344,642 in 2008. After establishing state subsidies in 2009, the number increased until 2013 but only from 357,452 to 537,634. Although there is no state subsidy for sheep production, the number of sheep increased from 188,113 in 2009 to 368,498 in 2013, an increase of more than 95%.

According to Musaoglu et al. (2014), the recorded number of goats and sheep in 2014 were 39,593 and 19,802 respectively. This was interpreted positively as an indicator of a reduction of overgrazing in the forest ecosystem for the near future. Overgrazing is not as serious as it was in the past, because the number of animals in the district has decreased. Based on the estimated human population and the numbers of small livestock, human and small livestock populations are expected to change during the first period, 2015–2030 (Fig. 3). However, we assumed that human and livestock populations will very likely remain stable in the second period, 2031–2050.

Fire Quality Index (FQI)

A catastrophic forest fire occurred 21st of July, 1997. It destroyed 745 ha of forested land in the study area and 970 ha outside the district. Since then there have not been

any significant forest fires in the area. In fact, the potential for the occurrence of a major forest fire has decreased thanks to measures undertaken by the Directorate of Forestry. Natural and artificial tree regeneration projects were carried out over a 12-year period after the 1997 fire. However, according to future fire risk scenarios, a railway will probably be built to pass through the site during 2031–2050, and the potential negative influence of this railway has been recognized (Fig. 3).

Vulnerability analysis of the Düzlerçamı forest ecosystem for the periods 2015–2030 and 2031–2050

According to the evolution of the EQLs, the final environmental vulnerability scores (EVSs) and environmental vulnerability indices (EVI) of the study area were re-evaluated from the EQSs of the EQLs based on the methodology for analyzing environmental vulnerability to land degradation, climate change and variability. Finally, in order to derive the EQIs and EVIs for the 2015–2030 and 2031–2050 periods, and two emission scenarios, RCP4.5 and RCP8.5, the EQSs and the EVSs were re-arranged from 0 to 100 by normalizing them with the maximum and minimum values of the EQSs and EVSs using the maximum values given in Table 3, which are based on Eq. 3.

$$\text{Normalized EVS (EVI)} = \frac{(\text{Value} - \text{Min.Value})}{(\text{Max.Value} - \text{Min.Value})} \times 100 \quad (3)$$

Table 3 Calculated values used for the normalization of the EQSs and EVSs used in estimating EQIs and EVIs for 2015–2030 and 2031–2050 according to RCP4.5 and RCP8.5 emission scenarios

Environmental quality layers	RCP4.5 scenario				RCP8.5 scenario			
	2015–2030		2031–2050		2015–2030		2031–2050	
	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.
	EQSs/EQIs (scores/% of critical factors)							
Biogeophysical quality	1.0/27.8	1.9/72.2	1.0/27.8	1.9/72.2	1.0/27.8	1.9/72.2	1.0/27.8	1.9/72.2
Climate quality	1.4/25	1.6/75	1.6/50	1.7/50	1.5/25	1.7/75	1.6/25	1.8/65
Aging quality	1.0/25	2.0/75	1.0/25	2.0/75	1.0/25	2.0/75	1.0/25	2.0/75
Policy Enf. and Soc. quality	1.1/25	1.7/75	1.1/25	1.7/75	1.1/25	1.7/75	1.0/25	1.7/75
Fire quality	1.0/15	2.0/55	1.0/12.5	2.0/62.5	1.0/15	2.0/55	1.1/25	2.0/62.5
	EVSs/EVIs (scores/% of critical factors)							
Environmental vulnerability	1.1/30	1.6/70	1.0/50	1.6/78.6	1.1/30	1.6/70	1.0/30	1.6/70

Spatial magnitude of future EVAs

According to schematic representations of the computing algorithm for EVI and EVA under the projected future conditions for the 2015–2030 and 2031–2050 periods, as illustrated in Fig. 1, the final maps were produced of the future variability of EVAs over the entire study region. Figure 4 depicts the geographic distribution patterns of the final future EVAs. These are based on the estimated final EVS and EVI values of environmental degradation, climate change and variability for 2015–2030 and 2031–2050 according to RCP4.5, RCP8.5, and other scenarios incorporating several indicators.

According to the RCP4.5 scenario, which incorporates changed and adjusted climate, policy enforcement and socioeconomic conditions, most of the area with forest cover will be characterized by a mixed environmental vulnerability varying from “very low” to “high” between 2015 and 2030. However, in the future, the area of the vulnerability is very fragmented with a high spatial variability. On the other hand, the area with “very low” and “low” vulnerability degrees covers mainly the town, its surrounding settlements and the agricultural fields which are mostly found over the low and flat travertine plateau and the alluvial plain to the east and southeast of the district (Fig. 4a). Based on the GIS calculations, the spatial magnitude of the EVAs (Table 4) was calculated as follows: “very low” accounted for 26% of the total area of the forest ecosystem district, “low” for 36%, “medium” for 17%, and “high” for 21%.

For the period 2031–2050, according to the RCP4.5 scenario, which incorporates changed and adjusted climate, aging and fire conditions, most of the area, with or without forest cover, will be characterized a “very low”

environmental vulnerability mainly due to the low scores assigned to aging, fire, policy enforcement, and socioeconomic factors. These vary from “very low” to “high” vulnerability levels. The area with “very low” vulnerability dominates, again mainly covering the town, its surrounding settlements and agricultural fields found over the low and flat travertine plateau, the alluvial plain to the east and southeast of the district and over the northern part of the area (Fig. 4b). The spatial magnitude estimation shows that “very low” EVAs dominate 58% of the total area and “medium” EVAs for about 19%.

Within the RCP8.5 scenario, which incorporates changed and adjusted climates, policy enforcement and socioeconomic conditions, most of the area with forest cover will be characterized by a mixed environmental vulnerability rating varying from “very low” to “high” for 2015–2030. This estimated future vulnerability pattern has great similarity with one estimated by the RCP4.5 scenario. The area of vulnerability is also very fragmented, with a high spatial variability as in the distribution pattern of the RCP4.5 scenario.

The area with “very low” and “low” vulnerability degrees can be found mainly in the town, its surrounding settlements and the agricultural fields over the low and flat travertine plateau and the alluvial plain to the east and southeast of the district (Fig. 4c). Based on GIS calculations, the estimated real magnitude of the EVAs were similar for figures for 2015–2030, but according to RCP4.5 climate scenario, about 24% of the total area consists of “very low” EVAs and 37% of “low” EVAs. “Medium” and “high” environmental vulnerability areas cover approximately 16 and 22%, respectively, which account for approximately 39% of the total area.

For the 2031–2050 period, the RCP8.5 scenario, which incorporates changed and adjusted future climate conditions, aging and fire conditions, predicts that most of the

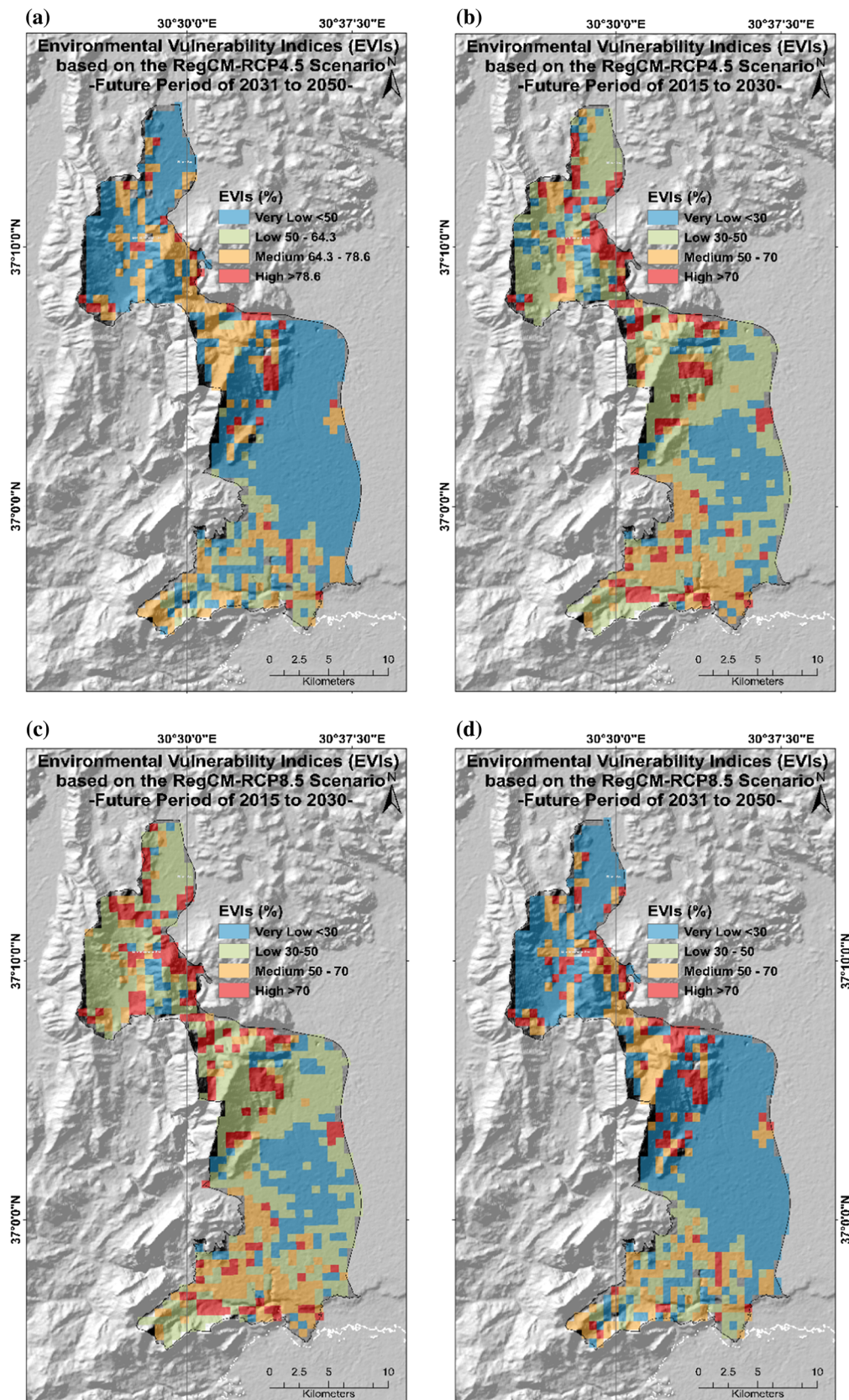


Fig. 4 Geographic distribution of the final future EVAs over the forest ecosystem for the periods **a, c** 2015–2030 and **b, d** 2031–2050 according to both RCP4.5 and RCP8.5 scenarios

area with or without forest cover will be characterized by a “very low” environmental vulnerability mainly due to the “low” scores assigned to aging, fire, policy enforcement, and socioeconomic factors varying from “very low” to “high” vulnerability levels. The area with “very low” vulnerability dominates mainly again over the town, its surrounding settlements, and the agricultural fields (Fig. 4d). Areas characterized with “very low” environmental vulnerability dominate at 58% of the total area, and the second largest area is the “medium” class at 17%. Spatial coverage of the “high” EVA has a rate of 15%, somewhat larger than the 13% estimated by the RCP4.5 scenario for 2031–2050.

Discussions and conclusions

The observed and estimated results and assessments summarized here show clearly that the densest forest ecosystem in the southern part of the study site, characterized by mainly Mediterranean coniferous and mixed forest and maquis vegetation, will very likely have “medium” and “high” degrees of vulnerability with respect to the future environmental degradation, climate change and variability. This vulnerability is partly due to negative human influences related to increasing numbers of recreation areas and other daily recreational activities, in addition to the effects of climate change on the western Mediterranean sub-region of Turkey. To reduce this vulnerability, it is recommended that reasonable reductions be made in the number of the visitors coming to the existing and/or planned future recreation areas. For mitigating and/or adapting to the expected impact of future climate change on the forest ecosystems goods and services, measures such as establishing genetic islands, using trees adapted and improving and strengthening biodiversity to meet more variable and warmer/drier climatic conditions that are projected.

Although every 10-year management plan for state-owned forests in Turkey are being updated, significant efforts should be focused on monitoring the impact of management decisions on the ecosystem, producing concordant management plans and making decisions to increase the sustainability of natural resources. Consequently, the vulnerability of an ecosystem to the impact of current and future climate change and variability closely depends on that system’s adaptation capacity.

According to Turp et al. (2014), there will be an increase between 0.5 and 4 °C in mean temperatures between 2020 and 2050. This increase will be more severe in warmer than in colder seasons. Based on regionally-averaged future climate assessments, this sub-region will likely be associated with a drier and hotter climate with water deficits according to all scenarios, with the exception of RCP4.5 for 2015–2030. However, according to the RCP8.5 high emission scenario, the present dry-sub humid climate dominating this region will be hotter and drier in the future and will become a semiarid climate in 2031–2050.

Under the final EVSs estimated for 2015–2030, the RCP8.5 scenario and other scenarios related to several policy indicators and socioeconomic factors, most of the sub-region will likely be characterized by a mixed environmental vulnerability varying between “very low” and “high”. The estimated future vulnerability pattern has great similarity with the future vulnerability pattern estimated by the RCP4.5 scenario.

Finally, based on estimated final EVSs to the ED, climate change and variability for the adjusted climate conditions was suggested for the 2031–2050 period according to the RCP8.5 scenario. The other scenarios related to the indicators of aging and fire factors, either with or without forest cover, will be characterized by “very low” environmental vulnerability due to the low scores assigned to aging, fire, policy enforcement and socioeconomic factors.

Table 4 Spatial magnitudes (with areas in km² and ratios in %) of the final future EVAs for 2015–2030 and 2031–2050 according to both RCP4.5 and RCP8.5 scenarios

EVI/EVS Classes	RCP4.5 scenario				RCP8.5 scenario			
	2015–2030		2031–2050		2015–2030		2031–2050	
	Area	Ratio	Area	Ratio	Area	Ratio	Area	Ratio
Very low	121.41	26.46	266.56	58.1	111.69	24.34	263.73	57.48
Low	164.66	35.89	47.75	10.41	169.84	37.02	45.55	9.93
Medium	76.57	16.69	86.63	18.88	74.95	16.34	79.42	17.31
High	96.15	20.96	57.85	12.61	102.3	22.3	70.09	15.28

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