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Management challenges and adaptations with climate change in Iran forests

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ABSTRACT

Nowadays, climate change is one of the global issues. Given the occurrence of climate change in different parts of the world in recent years, a major concern of environmental and forestry activists and policy makers has been to explore the direct and indirect deteriorative impacts of this phenomenon on different facets of forest ecosystem and local communities. The present study run an opinion poll among 315 activists, students, teachers, and experts of environment in Iran during 2019 to find out the extent to which they believed that severe climate change was happening in different forests and how they assessed the performance of environmental resources and forest management practices. The analysis of data exhibited that over 90% of the participants acknowledged the occurrence of severe climatic changes in recent years and almost none of them assessed the present forest management style to be appropriate. On the other hand, the participants suggested that the Zagros and northern forests of Iran have most severely been affected due to climate change by about 53% and 31.7%, respectively. Thus, to reduce destructive impacts of climate and global warming on human and local community, it is recommended to prioritize climate change adaptive management strategies in these regions.

Keywords: Adaptive capacity, Climate change, Forest management, Iran.

INTRODUCTION

Forests play a very important role in the economy and environment, due to providing variety of commodities and services (Crowther *et al.* 2015; Sousa-Silva *et al.* 2018), and also constituting an important section of the welfare and health of people (Bussotti *et al.* 2015). Currently, alteration in the climate is considered to be an unavoidable environmental problem. Therefore, communities need to be compatible until minimizing its vulnerability and negative effects (Yousefpour & Hanewinkel 2009; Yousefpour *et al.* 2015). The ecosystem services of forests and the related societies are in danger due to climate change worldwide (Lawrence & Nicoll 2016). Accretion the heat stress and intense of drought caused by changes in the climate could basically change the conformation, structure and biology of forests (Allen *et al*. 2010). In addition, climate change can influence tree growth in vast geographical areas (Ameztegui *et al.* 2017). Forest management and control can play an effective role in reducing the vulnerability of climate change (Klapwijk *et al*. 2018).

Many researchers have already worked on the adaptation of forest management to climatic change. It, however, seems imperative to take up the subject for individual forests because of the importance of climate change, sustainability, and its impacts on qualitative and qualitative facets of plant cover, animal communities, and welfare as well as health of human communities on the one hand and the differences in climates and plant species in different regions on the other hand. The forests of Iran are strategic from the economic, environmental and social

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point of view, so it is vital to find approaches to adapt them to climate change. The present study aims to scrutinize the extent to which environment activists, students and teachers of environmental science and related fields, as well as environment experts in Iran are informed about the phenomenon of climate change, the effect of forest management on easing the susceptibility to climate change, and the need for accommodating forest management with climate change.

A major challenge for developing countries is to adopt approaches to achieve sustainable development. This requires identifying facilities and resources available in these countries. Given the potential of forests for production and employment generation and the dependence of livelihood of some families to forest ecosystems, it is crucial to protect them.

Nowadays, climate change has become a global concern. Greenhouse gas issuance have considerably changed global climate (Allen *et al.* 2010). Forests and their management are affected by climate change (Nelson *et al.* 2016) due to its substantial effects on the procurement of forest ecosystem services and commodities (Bele *et al.* 2015). This will have adverse impacts on human welfare in the long run. In addition, it will change their consumption and production patterns (Martens *et al*. 2003; Ding & Nunes 2014). Hence, forest management and climate change need to be adapted to provide sustainable ecosystem services (Steenberg *et al.* 2011).

Various management approaches have been introduced to make adaptation and protect forest ecosystems exposed to future climate change (Millar *et al.* 2007; Puettmann *et al.* 2009; D'Amato *et al*. 2011). However, the rate of adaptation of the already taken actions has been inadequate in alleviating the detrimental effects of climate change and forest management (Lawrence & Nicoll 2016; Andersson *et al*. 2017). A key requirement for viable planning and management of forests at the national and regional levels is to build up knowledge, information, and capability of managers about climate change, forest conditions and so on. Accordingly, conducting comprehensive studies on climate change and forests is of crucial importance for recognizing people's capabilities and developing practices and purposeful strategies. Various studies have focused on climate change and the adaptation of forests: Booth (2018) reported the effect of species distribution modeling (SDM) technique on trees and forest management in the context of climate change, finding that this modeling technique, as well as other options, are good approachs for assessing the effects of climate change on forests and other related species. Shannon et al. (2019) in a study on adaptation strategies and approaches for forest watersheds, reported two practical projects for adapting these watersheds to climate change.

Muller *et al.* (2019) studied forest adaptation strategies, concluding that planning and selection of suitable plant species in forests can improve forest health and sustainability in the face of climate change. Halofsky et al. (2018) worked on the adaptation of forest management to climate change in Canada and the US and by assessing the vulnerability of forests to climate change, suggested some strategies to speed up adaptation. Klapwijk *et al*. (2018) studied forests of Sweden and climate change mitigation actions as well as examining barriers against sound decision-making about adapting forests management practices to climate change. Laakhonen *et al*. (2018) addressed the attitude of forest owners to climate change in Finland, reporting that they did not mostly perceive climate change to be influential on their forests. So, they had not accommodated their management practice with climate change. Since forest owners have diverse attitudes, according to the afforementinoed study, it is impossible to discuss the social effects of this phenomenon. Hence, accurate statistical works are needed for better policymaking.

In a study on forests and climate change, Marchi *et al*. (2018) addressed the effect of appropriate forest management on responding to climate change. They found that enhancement of environmental resources by employing technology, improvement of the safety of labors and other workers in forest industries, as well as enhancement of the motivation of forest experts to improve management practices and skills, are among the approaches to sustainable forest management that can mitigate the adverse impacts of climate change. Rezende *et al.* (2018) explored land use policy as a way to accommodate Brazilian Atlantic forests in Rio de Janeiro with climate change. They used satellite imagery to examine plant cover of the protected lands. The results revealed that forest adaptation to climate change calls for revising the perspective on the improvement of ecosystem service supply to create new job opportunities and enhance social conditions.

Sousa-Silva *et al*. (2018) investigated climate change and its adaptation to forest management in seven European countries by an opinion poll from forest owners and private and public management using Kruskal-Wallis and Spearman tests. The first survey was conducted in Romania in 2013-2014 and the second in six other countries in 2015 and 2016. The results exhibited that 91% of (participant) forest managers were informed to the impact of

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climate change on forests, but forest management had not well adapted to climatic conditions yet. The degree to which countries adapted their forest management to climate change varied with their climatic context. Sow *et al.* (2018) studied the epigenetics in forest trees and their breeding in the context of climate change. They addressed the requirements for the growth and longevity of trees regarding specific environmental characteristics and introduced epigenetics as a requirement for the adjustment of forest tree breeding and management process. Vilà-Cabrera *et al.* (2018) assessed the action efficiencies of adapting forest management to climate change in the Mediterranean basin. According to the results, strategies to reduce susceptibility to climate change have mostly a short-term perspective in these regions. Furthermore, to strengthen approaches to climate change adaptation of forest management, further short and long-term empirical and experimental studies are believd to be required. Mostegal *et al.* (2017) assessed climate change adaptation approaches adopted by the owners of 919 forests at a scale of < 20 ha in Austria. They found that small-scale and private forest owners should be provided with information on the impacts of climate change so as to adopt sound management practices to adapt to these changes. In a simulation study, Thiele *et al.* (2017) worked on climate change and its influence on Norway spruces in a forest district in Europe. They reported that dynamic modeling technique would enable forest managers to make plans for adapting to climate change and alleviating its adverse implications.

Using a hybrid assessment model, Ding *et al*. (2016) dealt with biodiversity and ecosystems of European forests and the effect of climate change on them. They indicated that the European countries around the Mediterranean Sea were most benefited from these changes so that they enjoyed 86% higher value in the cultural sector, 24% in wood products, and 45% in carbon sequestration. The results can help identifying ways to improve welfare and health in different regions and taking a fundamental step to expand planning and improve performance of policies on climate change adaptation to forest ecosystems.

Nelson *et al.* (2016) studied the extent to which forest management practitioner participated in climate change adaptation and concluded that forest experts and practitioners had different attitudes towards climate change. Some were concerned about the adverse impacts of climate change and were looking for appropriate management approaches to adapt to this phenomenon, but others would not tend to revise their management practices. Some factors hindering practitioners' participation in their management practice reform included lack of knowledge, resource limitations, and organizational barriers against climate change adaptation.

In a study on adapting the Congo Basin forests management to climate change, Bele *et al.* (2015) focused on the relationship between forests, human welfare, and biodiversity. The study revealed that the forests of the Congo Basin should be managed sustainably in order to be adapted to climate change. Forests resources and biodiversity would thereby be protected better and the adverse impacts of climate change would be alleviated. Also, this would contribute to job creation, income generation, and sustainable rural development, which would in turn reduce people's susceptibility to climate change.

Yousefipour *et al.* (2015) used the Bayesian theory to model how the management practitioners of the Veluwe forest in the Netherlands dealt with climate change adaptation. It was found that changing people's attitudes and improving adaptation practices would alleviate adverse impacts of climate change and increase its favorable effects on forest ecosystems over time.

In a study on climate change adaptation strategies of forests management, Ordóñez Barona (2015) concludes that if forest management is perceived as a factor underpinning the reduction of climate change susceptibility, then the participation of citizens in adaptation management and more tree planting can be fostered by concentrating on climate change adaptation management. Van Gameren & Zaccai (2015) explored climate change adaptation practices in the Wallonia forests of Belgium. They found that actions adopted for climate change adaptation were pre-planned in some cases but haphazard in other cases.

Wellstead *et al.* (2014) explored the adaptation of North American forests and their climate change vulnerability. They found that Canada had been planning strategies for climate change adaptation of ecosystems for several years. In the US, e.g. in California and Alaska, actions had recently been taken for climate change of forests, such as in case of fires. The report lists the shortages in national strategies of climate change adaptation of forests and points that the management practices need to be put in a broader perspective to allow adopting modern policies for climate change adaptation.

Mori *et al.* (2013) focused on ecosystem management in the context of climate change. They found that ecosystem management could play a more effective role in alleviating the adverse effects of climate change by adopting such

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approaches as reducing greenhouse gas emissions by correct land use, creating capacity for adaptation, and restoring and protecting natural ecosystems.

Seidl & Lexer (2013) addressed climate change and the management of federal forests of Austria under these conditions. They found that actions to adapt forest management to climate change had reduced the negative effects of climate change and increased their adaptation potential. Besides, the study exhibited the significance of management planning to create a capacity for climate change adaptation to alleviate its adverse influences. If expected climate change and adaptation capacities are the same, climate change adaptation can be improved.

In a study about the effectiveness of updating information and beliefs of managers on management style and climate change adaptation of forests, Yousefpour *et al.* (2013) focused on the case of Norway spruce in the Black Forest, Germany. They simulated climate change and forest management methods. The results displayed that managers responded better to climate change, e.g. temperature and precipitation, and had more updated information. Also, it could be claimed that the viability of climate change adaptation strategies strongly depended on managers' awareness of this phenomenon.

In summary, numerous studies have focused on climate change adaptation of forest ecosystems and management and this has widely been scrutinized in different regions, especially in the European countries. However, given the persistent effects of climate change on forest ecosystems and the specificity of the issues of forests and environment protection for increasing society welfare and economic development of the countries, it is imperative to explore this challenge thoroughly until reaching an optimal performance in the adoption of useful practical policies. So, the present paper aims to assess climate change awareness of forest owners, management practitioners, and the officials of forest-related departments in Iran, as well as the strategies adopted by them in the context of an opinion poll from forest owners and management practitioners. The results of the study can contribute to improve the adaptive strategies and partially providing information for adopting preventive policies and controlling climate change.

MATERIALS AND METHODS

To explore the climate change adaptation of forest management, an opinion poll was run among environmental experts (Environmentalists), students (environmental and natural resources students), teachers (environmental and natural resources professors), and activists (members of environmental NGOs) in Iran. The study encompasses the climatic conditions of different forest regions, different forests, and climate change adaptation strategies across Iran. According to Sousa-Silva *et al.* (2018), the following procedure was applied. First, a questionnaire was developed containing sections on awareness of climate change, approaches to make adaptations, and demographic information. The questionnaire was administered in an online form to forest management practitioners and officials in Iran. A total of 315 respondents participated in the survey. Thereafter, the questionnaires were collected and their data were extracted, then subjected to analysis by the Kruskal-Wallis test. In addition, the effect of managers' personal experiences and beliefs on adaptation was assessed by the Spearman test.

The Kruskal-Wallis test, or the so-called H test, examines the equality of the average of different statistical populations based on the sum of the ranks of observations in each studied group. This is equivalent to the analysis of variance. However, it does not need the assumption of data distribution normality and the equality of the variance of groups. The Kruskal-Wallis test is calculated by:

$$\mathrm{H} = \frac{12}{\mathrm{n}(\mathrm{n}+1)} \sum_{i=1}^{k} \frac{R_i^2}{n_i} - 3(n+1) \qquad \textbf{(1)}$$

where *k* denotes the number of groups and *n* denotes the number of members in all groups. Then, H statistic is compared with the values of χ^2 with k-1 degrees of freedom. If the value of H statistic exceeds the value of χ^2, the null hypothesis is not refuted, but if H-statistic is within the domain of χ^2 distribution, the null hypothesis is rejected (Azar & Mansouri 2003).

When nominal data are available, Spearman's rank coefficient of correlation can be used to measure the linear relationship between two variables (X, Y). To calculate this coefficient, at first, the values of X_i and Y_i are derived by calculating the ranking of X and Y. Then, $d_i = X_i - Y_i$ is employed to find out the difference in ranks between each pair (corresponding members of two groups). Finally, Spearman's rank coefficient of correlation is derived from:

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$$r_s = 1 - \frac{6\sum d_i^2}{n\left(n^2 - 1\right)} \qquad (2)$$

in which *n* represents the number of ranks or the size of each group (Vazifedust *et al.* 2010).

RESULTS AND DISCUSSION

Climate change in Iran: The perspective of three studied groups

The participants belonged to three groups: environmental activists (N = 70), students and teachers of environment or related disciplines (N = 210), and environmental experts (N = 35; total number of participants = 315). Fig. 1 displays a summary of all responses.

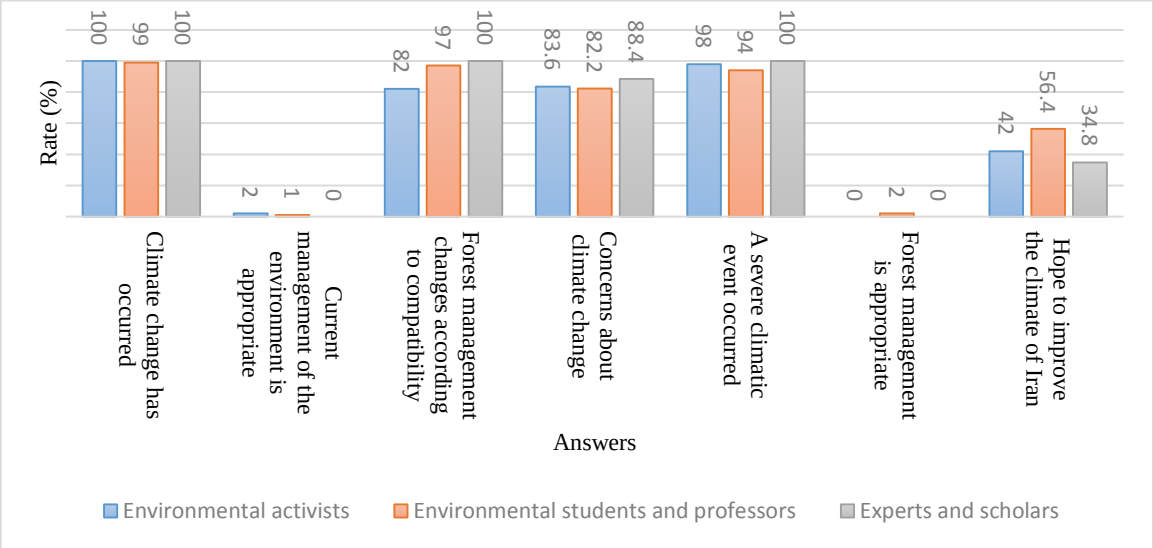

Fig. 1. Responses rate (%) to the questionnaire from different groups

According to Fig. 1, 100% of the activists, 99% of the students and teachers, and 100% of the experts believed in the occurrence of climate change in Iran. Besides, 82% of the activists, 97% of the students and teachers, and 100% of the experts suggested the need for the adaptation of forest management practices in Iran. Only, 2% of the activists and 1% of the academicians assessed the present environment management practices to be suitable in Iran. Among the participants, 83.6% of the activists, 82.2% of the academicians, and 88.4% of the experts stated a degree of concern about climate change in Iran. In addition, 98% of the activists, 94% of the academicians, and 100% of the experts acknowledged that they had witnessed severe climatic changes around them in recent years. Only 2% of the academicians found forest management to be carried out appropriate in Iran whereas none of the activists or the experts supported this viewpoint. Finally, hope for the improvement in climatic conditions of Iran was 56.4% among the environment students and teachers, 42% among the environmental activists, and 34.8% among the experts. Then, we divided all forests of Iran into five groups including the Northern, Zagros, Persian Gulf, Arasbaran, and Central forests, then scrutinized the degree to which these forests had been influenced by climate change. The results are illustrated in Fig. 2. According to Fig. 2.53% of the participants believed that the Zagros forests were most severely destroyed by climate change, whereas 31.7%, 8.6%, 4.5% and 2.2% were of the opinion that climate change was the most detrimental to the Northern, Persian Gulf, Arasbaran, and Central forests, respectively.

Table 1 presents the results of the Kruskal-Wallis test, exhibiting that the different groups of participants did not have significantly different opinions about the occurrence of climate change, appropriate management of natural resources, concern about climate change, vulnerability of different regions, severe events, and forest management. However, their opinions about the need for management change and hope for improvement differed significantly. The occurrence of climate change with an error coefficient of 0.78 revealed that all studied groups agreed with it. All the three groups were also of the similar opinions about the natural resources management, since this parameter had a coefficient of 0.17. But, as the coefficient of 0.00 in association with the need for a change in

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environment and natural resources management exhibits, there was no consensus on this parameter, such that the three groups differed from each other significantly.

The coefficients of 0.06 and 0.14 for concern on climate change and vulnerability of different regions revealed insignificant differences among the reference groups of the research. Furthermore, the coefficients of 0.163 and 0.36 confirm this parameter for severe events and forest management. Finally, there was no difference in hope for the improvement in environmental conditions of Iran with a coefficient of 0.00.

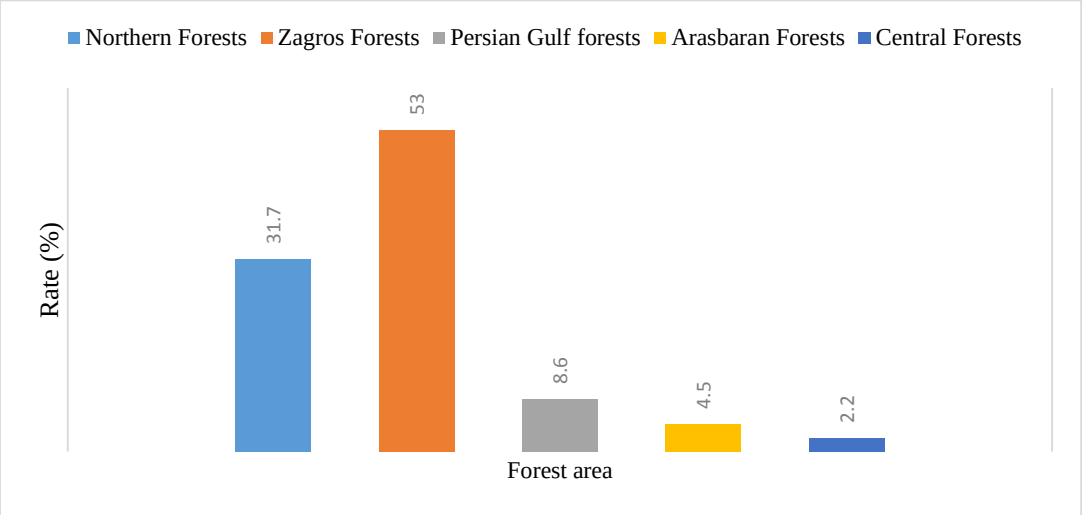

Fig. 2. Vulnerability of Iran's forests

Table 1. The results of Kruskal-Wallis test in the studied groups.

	Occurrence of climate change	Proper management of natural resources	Need for management change	Concern on climate change	Vulnerability of different regions	Severe events	Forest management	Hope for improvement
χ^2	0.5	3.52	24.57	5.51	3.92	3.62	2.01	47.33
df	2	2	2	2	2	2	2	2
Asymp.Sig.	0.78	0.17	0.00	0.06	0.14	0.163	0.36	0.00

Climate change of Iran in seven regions

The seven regions were considered to be center, northeast, northwest, southeast, southwest, north and south of Iran. The responses supplied by the participants are analyzed below for these seven regions. According to Fig. 3, all respondents had the highest rate of agreement with the occurrence of climate change, adaptive change in forest management, the occurrence of severe climatic events, concerns about climate change, as well as hope for improvement in climatic conditions. They expressed the lowest rate of agreement with the suitability of present environment management style and appropriate forest management practices. Table 2 presents the results of the Kruskal-Wallis test for this section. It can be observed that the responses about the seven regions were not significantly different in terms of the occurrence of climate change, appropriate natural resources management practices, and forest management but they significantly differed in terms of the need for management change, concerns about climate change, vulnerability of different regions, the occurrence of severe events, and hope for improvement. The occurrence of climate change with an error coefficient of 42% exhibited that different regional groups accepted this phenomenon and this could not be denied. The opinions of the three groups were similar about natural resources management with a coefficient of 67%. The error coefficient of 0.00 relating to the need for a change in environment and natural resources management, concerns about climate change, vulnerability of different regions, severe events, and hope for improvement indicate that there was no consensus and people from different regions of the country had significantly different opinions. There was also a consensus about forest management with an error coefficient of 0.36.

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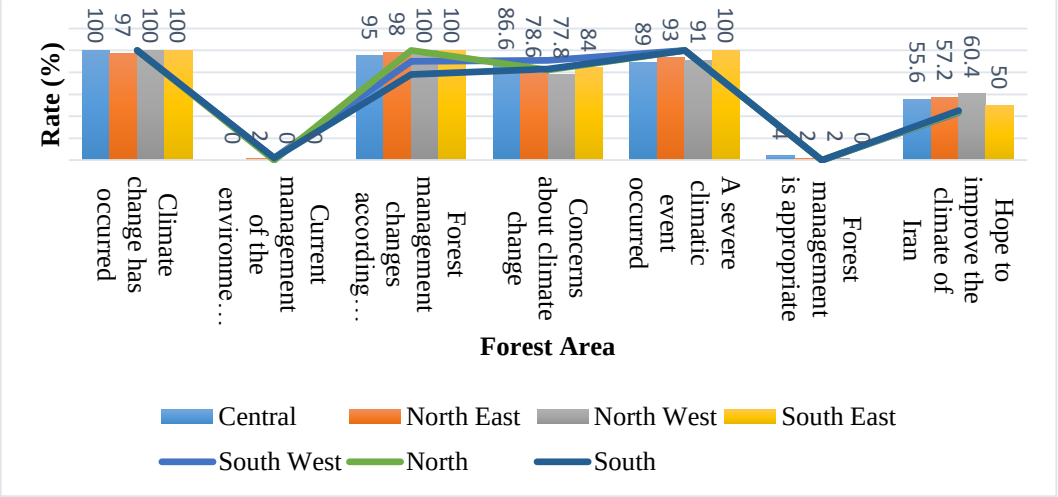

Fig. 3. Rateof responses (%) to the questionnaire in different regions

Table 2. The results of Kruskal-Wallis test for different regions in this study

	Occurrence of climate change	Proper management of natural resources	Need for management change	Concern on climate change	Vulnerability of different regions	Severe events	Forest management	Hope for improvement
χ^2	6	4.02	34.58	28.39	53.82	17.58	6.52	27.96
Df	6	6	6	6	6	6	6	6
Asymp.Sig.	0.42	0.67	0.00	0.00	0.00	0.007	0.36	0.00

Coefficients of correlation

This section reviews the correlation of the research variables. According to Table 3, the belief in the occurrence of climate change was negatively related to acknowledging appropriate natural resources management, vulnerability of different regions, and forest management, while positively and significantly to the need for management change, concerns about climate change and severe events. Besides, the belief in appropriate management of natural resource had a significant negative relationship with the need for management change, concerns about climate change and acknowledging the occurrence of severe climatic events, while a significant positive relationship with forest management and hope for improvement. Concerns about climate change was positively related to severe events, whereas negatively to the hope for improvement. Finally, a negative relationship was observed between severe climatic events and forest management while a significant positive relationship between forest management and hope for improvement.

CONCLUSION AND RECOMMENDATIONS

The present study evaluated the awareness and belief of environmental activists, environmental students and teachers, and environmental experts of Iran about the occurrence of climate change, its natural resource damages, and the efficiency and adaptively of the present environment and forest management practices. So that, a survey was performed among participants from these groups using a questionnaire and the collected data were analyzed using the Kruskal-Wallis and Spearman tests. According to the results, almost all respondents believed in the occurrence of climate change with an error coefficient of 0.78. Besides, over 80% of the participants expressed their concern about climate change. In addition, the participants believed that the present forest and environment management practices were not efficient enough to accommodate themselves with adaptive approaches. All three studied groups had similar opinions about natural resources management with a coefficient of 0.17. However, the three groups differed significantly in their opinions about the change in environment and natural resources management change and hope for improvement in environmental conditions. On the other hand, after the forests were divided into five different groups, it was concluded that the extent to which the forests of different regions of Iran were influenced by climate change was different. The highest susceptibility was related to the Zagros forests (53%) followed by the Northern forests (31.7%).

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Table 3. Results of Spearman's correlation test.

	Occurrence of climate change	Proper management of natural resources	Need for management change	Concern on climate change	Vulnerability of different regions	Severe events	Forest management	Hope for improvement
Occurrence of climate change	1	-0.576* (0.00)	0.236* (0.00)	0.106** (0.05)	-0.018 (0.75)	0.284* (0.00)	-0.498* (0.00)	-0.97 (0.08)
Proper management of natural resources	-0.576* (0.00)	1	-0.266* (0.00)	-0.124* (0.02)	0.07 (0.21)	-0.15* (0.00)	0.281* (0.00)	0.151* (0.00)
Need for management change	0.236* (0.00)	-0.266* (0.00)	1	-0.019 (0.73)	-0.037 (0.51)	0.026 (0.64)	-0.098 (0.08)	-0.036 (0.52)
Concern on climate change	0.106** (0.05)	-0.124* (0.02)	-0.019 (0.73)	1	-0.028 (0.61)	0.174* (0.00)	-0.082 (0.14)	-1.22* (0.00)
Vulnerability of different regions	-0.18 (0.75)	0.07 (0.21)	-0.037 (0.51)	-0.028 (0.61)	1	-0.006 (0.91)	-0.01 (0.85)	-0.015 (0.78)
Severe events	0.284* (0.00)	-0151* (0.00)	0.026 (0.64)	0.174 (0.00)	0.006 (0.91)	1	-0.274* (0.00)	-0.098 (0.08)
Forest management	-0.498 (0.00)	0.281* (0.00)	-0.098 (0.08)	-0.082 (0.14)	-0.01 (0.85)	-0.274* (0.00)	1	0.122* (0.00)
Hope for improvement	-0.097 (0.08)	0.095 (0.09)	-0.036 (0.52)	1.22* (0.03)	-0.015 (0.75)	0.098 (0.08)	0.122** (0.03)	1

* and ** indicate significance level at 1% and 5%, respectively.

The results for climate change in seven-fold regions of Iran (central, northeastern, northwestern, southeastern, southwestern, northern, and southern) revealed that in these regions, all respondents expressed most agreed with the occurrence of climate change, the change in forest management towards adaptation, the occurrence of severe climatic events, concern about climate change, and hope for improvement in climatic conditions, while least agreed with the suitability of the present environmental management style and suitable management of forests. According to the results of the Kruskal-Wallis test for these seven regions, the respondents had consensus on the issues related to the occurrence of climate change, natural resources management, and forest management. However, they had different opinions about the change in environment and natural resources management, concern about climate change, susceptibility of different regions, severe events, and hope for improvement of environmental conditions. Overall, the results of Spearman's coefficient of correlation revealed a negative relationship of the belief in the occurrence of climate change with acknowledging suitable natural resources management, vulnerability of different regions, and forest management, while its positive relationship with the need for management change, concern for climate change, and severe events. A significant positive relationship was also found between the belief in suitable natural resources management and forest management as well as hope for improvement. We observed that the phenomenon of climate change is happening in Iran and the current management practices of environmental resources and forests of Iran are not efficient enough to adapt with this phenomenon. So, it is recommended to make a more precise assessment of forest conditions and to identify the causes of susceptibility in locations that are more exposed to risk, such as the Zagros and Northern forests. Furthermore, it is necessary for researchers, managers, policymakers, and planners of environment and forestry fields to adopt strategies that are adaptive in the short term in order to reduce the adverse effects of climate change in these regions. The results of this study are in agreement with the results of the studies of Johnston & Hesseln (2012), Mori *et al.* (2013), Klapwijk *et al.* (2018) and Muller *et al.* (2019). In fact, there are limited studies on Iran climate change.

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چالش‌های مدیریت و سازگاری با تغییرات اقلیم در جنگل‌های ایران

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چکیده

امروزه تغییرات اقلیمی به عنوان یکی از مهم‌ترین موضوعات جهانی مطرح است. با توجه به وقوع تغییرات اقلیمی در نقاط مختلف جهان در طی سال‌های اخیر، عمده نگرانی فعالان و مدیران محیط زیست و جنگلداری، بررسی تأثیرات مستقیم و غیرمستقیم این پدیده در جنبه‌های مختلف بوم سازگان جنگلی و جوامع محلی است. هدف مطالعه حاضر بررسی اثر تغییرات شدید اقلیمی بر جنگل‌های ایران و ارزیابی عملکرد منابع طبیعی و شیوه‌های مدیریت جنگل است. از این رو در این مطالعه ۳۱۵ پرسشنامه در میان فعالان محیط زیستی، دانشجویان، اساتید و کارشناسان محیط زیست در ایران و در سال ۲۰۱۹ توزیع شده است. نتایج تجزیه و تحلیل داده‌ها نشان داد که بیش از ۹۰٪ از مصاحبه شوندگان به وقوع تغییرات شدید اقلیمی در سال‌های اخیر اذعان داشته و تقریباً هیچ یک از آن‌ها شیوه مدیریت جنگل موجود را مناسب ارزیابی نکردند. از سوی دیگر، مصاحبه شوندگان اظهار داشتند که جنگل‌های زاگرس و شمالی ایران به ترتیب در حدود ۵۳ ٪ و ۳۱/۷ ٪ از تغییرات جوی به شدت آسیب دیده‌اند. بنابراین برای کاهش تأثیرات مخرب تغییراقلیم و گرم شدن کره زمین بر روی جامعه انسانی و محلی، توصیه می‌شود اولویت استراتژی‌های مدیریت انطباقی با تغییرات آب و هوایی در این مناطق باشد.

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