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BIOCLIMATIC MODELING OF THE SPECIES JURINEA SCHACHIMORDANICA (ASTERACEAE)

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Abstract
For more than 60 years, herbarium specimens of this species have not been recollected and targeted field studies have not been conducted. In 2023-2024, bioclimatic modeling was carried out on the basis of targeted field research in Shahimardan and the Kyrgyz Republic (Batkent; Okhna) region of the Fergana Valley.
According to the RCP 2.6 (2061-2080) climate scenario, an increase in temperature of 0.4-1.6 °C will create many potentially suitable areas in the form of the regions of Kazakhstan and Tajikistan. It is directly related to precipitation (Bio19) and elevation (Elv.) in the coldest quarter. Under the RCP8.5_2070s climate scenario, an increase in temperature of 1.4-2.6 °C has replaced scattered high-level suitable areas with medium-level suitable areas. Under both climate scenarios, temperature increases of 0.4–1.6 °C and 1.4–2.6 °C did not adversely affect the species' main hotspots.

Keywords Climate change, MaxEnt model, hot spots, Jurinea schachimordanica, potential geographical distribution.

INTRODUCTION

Central Asia is a particularly vulnerable region due to its physical geography with temperate deserts and semi-deserts (Lioubimtseva and Henebry 2009). The environment is very sensitive to global climate change, and it is particularly vulnerable to changing weather patterns (Brooke 2014). Especially, water resources in this area are the main factors for the sustainable development of biodiversity. There is a low concentration of water vapor over this area and the distribution of water resources in Central Asia is very uneven. Meteorological data have shown that air temperatures are increasing across Central Asia, and regional climate change scenarios show that temperatures will rise by 1°C–3°C in the next 20–40 years. If global greenhouse gas emissions are not reduced, temperatures are projected to rise by 3°C to 6°C above today's levels by the end of the century (Novikov et al., 2012).

In recent years, the growing demand for natural medicinal plant and climate change has led to a reduction in plant stocks. For this reason, much attention is paid in the world to determine the species composition of medicinal plants, study their biological properties, identify natural resources and bioclimatic modeling, scientifically substantiating changes in populations as a result of external.

For the first time, bioclimatic modeling of the future potential distribution areas of this plant species is being done using Maxent and ArcGIS programs. The obtained results allow to sobtain enough biomass for the creation and production of plantations of the species in the areas of potential distribution.

In recent years, the number of studies on bioclimatic modeling has been increasing (Gulomov, 2023; Abdullayev, 2024; Nuridinov, 2023; Najmiddinov, 2023).

The following tasks were defined as the research objective: (1) identify the hot spots of J. schachimordanica plant in Pamir-Alay under past climatic conditions. (2) Explore the relationship between the distribution of hot spots and environmental factors, and explore the important environmental factors that limit the distribution of hot spots. (3) The hot spots of J. schachimordanica plant in Pamir-Alay were predicted according to the global climate change scenarios of the future (2070s).

METHODS

In total 11 species presence records of J. schachimordanica were incorporated in this investigation. By searching the Global Biodiversity Information Facility (GBIF; https://www.gbif.org/), National Herbarium of Uzbekistan (TASH), Kyrgyz National Herbarium (FRU) and the results of field research conducted in the Pamir-Alay regions in 2023-2024 were used. The point's record from each herbarium specimens was transformed into GPS geographical coordinates using Google Earth Pro 7.1 and ArcGIS (version 10.6.1) software.

The current climate data used in this study (1970-2000) come from the WorldClim database (http://www.worldclim.org/). The model contains four emission scenarios proposed by the sixth International Coupled Models Comparison Program (CMIP6). This scenarios are developed on the basis of the typical concentration path (RCPs) scenario, with a spatial resolution of 2.5 arc minutes (~4.64 km2 at the equator). The data contain 19 bioclimatic variables, which are obvious biologically significant and are usually used in species distribution and related ecological modeling. The topographic data contain elevation variables.

We used MaxEnt software (version 3.4.4) to model the habitat suitability of J. schachimordanica plant in Pamir-Alay. This software is considered to build some of the best performing models for forecasting species distribution with a limited number of records. Initially, 11 coordinates in *CSV format were stored and 19 bioclimatic variables and altitude values obtained from the WorldClim database were imported into the MaxEnt model. From the MaxEnt model, the output map values range from 0 to 1 (0 least and 1 most suitable species probability pixels) (Phillips et al., 2006; Min-Su Park, 2024; Gulomov and Batoshov, 2022; Gulomov, 2022). In our models, 75% of the occurrence records were used for training whereas 25% of the records were used for testing the model. The background points and the number of iterations were set at no more than 10,000 and 1000, respectively.

When receiving research results the scenarios RCP2.6_2070s (SSP1-2.6 (ssp126) minimum greenhouse gases) and RCP8.5_2070s (SSP5-8.5 (ssp585) maximum greenhouse gases) based on IPCC proposed greenhouse gas concentrations (RCP) were used. According to the IPCC (2019) sixth report (AR5), the annual average temperature is 0.4-1.6 °C under the RCP 2.6 (2061-2080) scenario, and 1.4-2.6 °C under the RCP 8.5 (2061–2080) scenario.

The default output of Maxent is in the logistic form, indicating the environmental suitability for J. schachimordanica in Pamir-Alay with values ranging from 0 to 1. For further analyses, the results of MaxEnt were imported into ArcGIS program potential habitats were reclassified as follows: In this appendix, the high range of the species is described in "Red", the areas with low distribution are described in "Orange", the areas with low probability of distribution and almost no chance of occurrence are described in "Green and

White”. The resulting model was validated on the basis of the area under the curve (AUC) calculated from the receptor operating characteristic and whose growth factor is set from 0 to 1. AUC values > 09 indicate high accuracy, values of 07–08 indicate good accuracy, < 07 indicate poor accuracy, and <05 indicate poor accuracy (Guo et al., 2017). The contribution of variable environmental factors is evaluated according to the results of the Jackknife test.

RESULTS

For more than 60 years, herbarium specimens of this species have not been re-collected and targeted field research has not been conducted. In 2023-2024, as a result of targeted field research conducted in Shakhimardan region of Fergana Valley, it was possible to redefine the population of J. schachimordanica, and samples of its leaves were taken for the purpose of herbarium and DNA barcoding (Gulomov et al., 2023).

By applying the MaxEnt model, the model predicted the potential distribution of J. schachimordanica plant in Pamir-Alay, with a training AUC value of 0.991 and a test AUC value of 0.985, (under both climate scenarios) which indicates its high level of predictive performance (Fig.1).

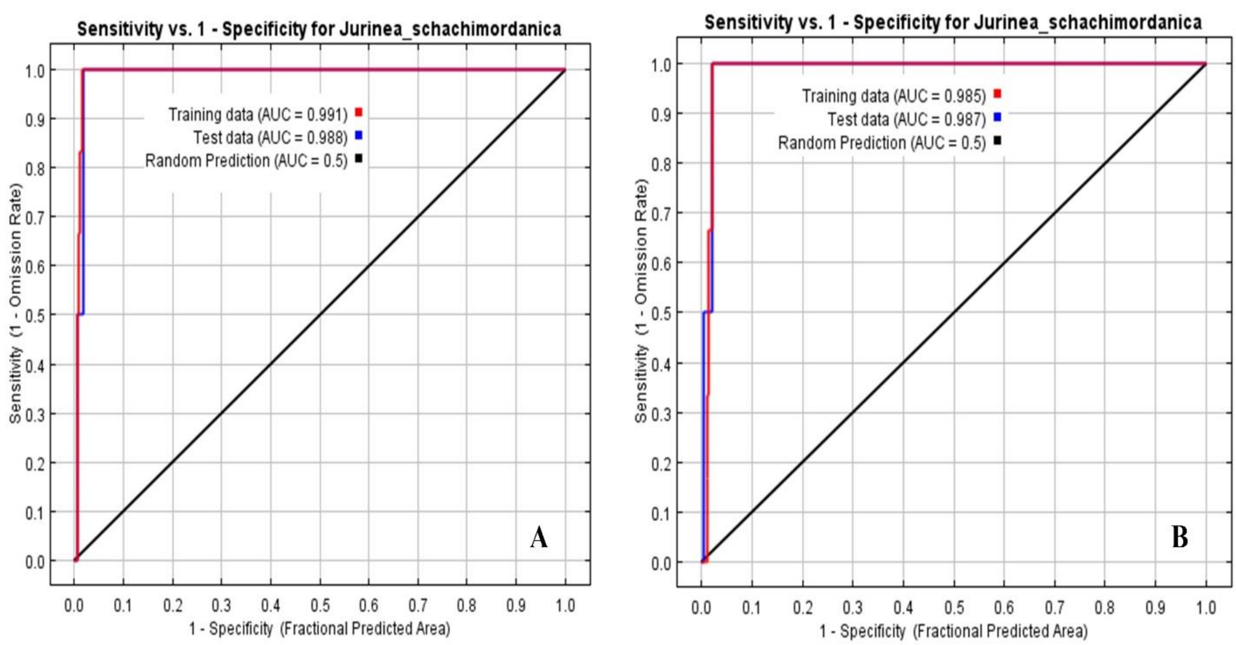

Figure 1. Receiver operating characteristic curve; A) RCP2.6_2070s; B) RCP8.5_2070s

It is endemic to the Fergana Valley. In the period of Industry development (1970–2000), despite the limiting effect of late anthropogenic climate change on the range of the species, the ecological niche of the species showed that it can be distributed in the Badakhshan regions of the Central Asia, Pamir-Alay, southwestern Tiyonshan, Tukmaniston. However, the distribution of the species in these areas has not been recorded (Fig.1).

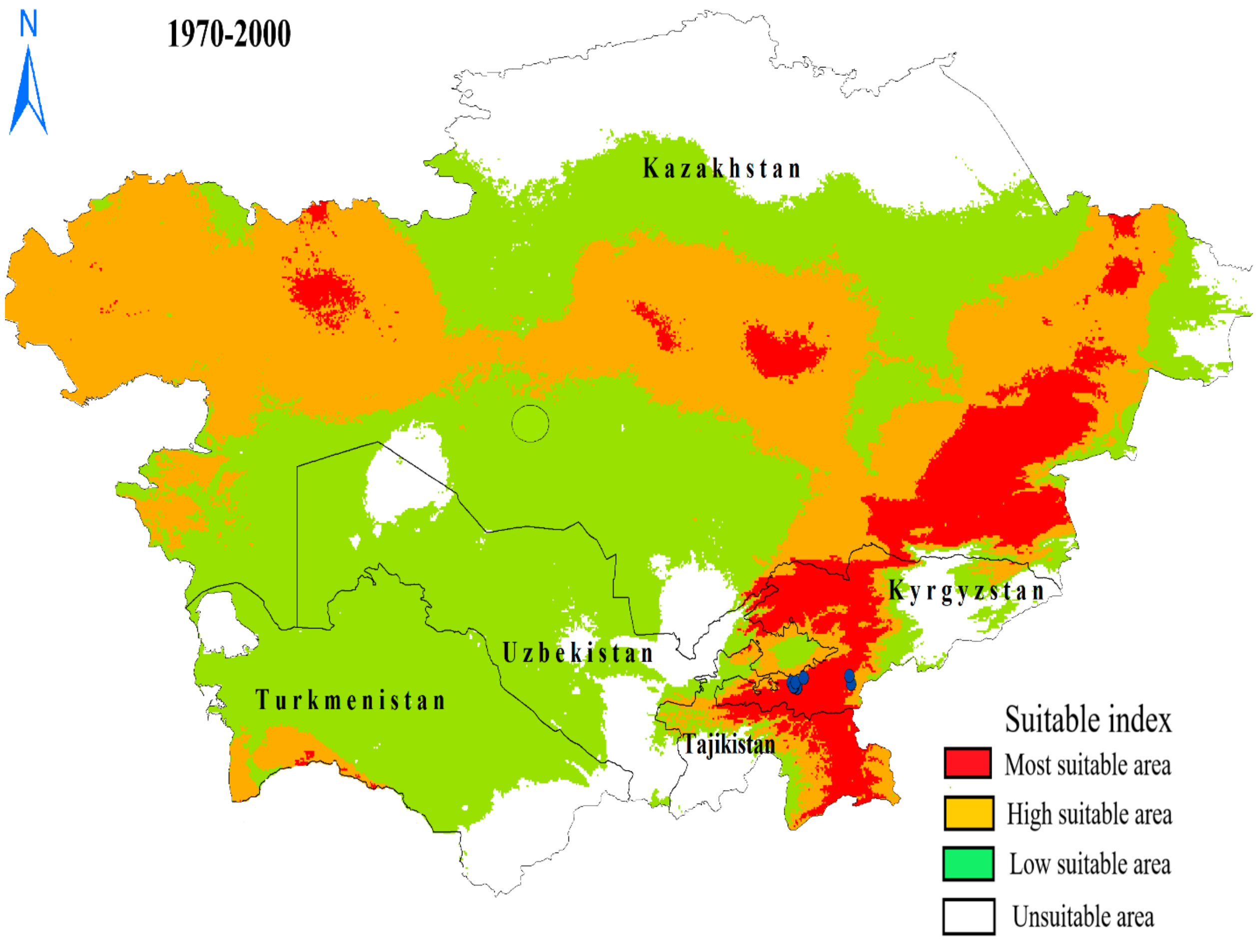

Figure 2. Hot spots of species under past climate change scenarios.

The RCP 2.6 2070 climate scenario associated with an increase in minimum greenhouse gas concentrations showed that the species' high and medium suitable habitat will expand in the future. In particular, during the period of industrial development, the areas with a low brightness index and unsuitable for the growth of the species will become highly suitable areas under the RCP 2.6 2070 climate scenario. According to the RCP 2.6 (2061-2080) climate scenario, an increase in temperature of 0.4-1.6 °C will create many potentially suitable areas in the form of fragments in the regions of Kazakhstan and Tajikistan. It is directly related to precipitation (Bio19) and elevation (Elv.) in the coldest quarter. Under the RCP8.5_2070s climate scenario, an increase in temperature of 1.4-2.6 °C has replaced scattered high-level suitable areas with medium-level suitable areas. Under both climate scenarios, temperature increases of 0.4–1.6 °C and 1.4–2.6 °C did not adversely affect the species main hotspots (Fig.3).

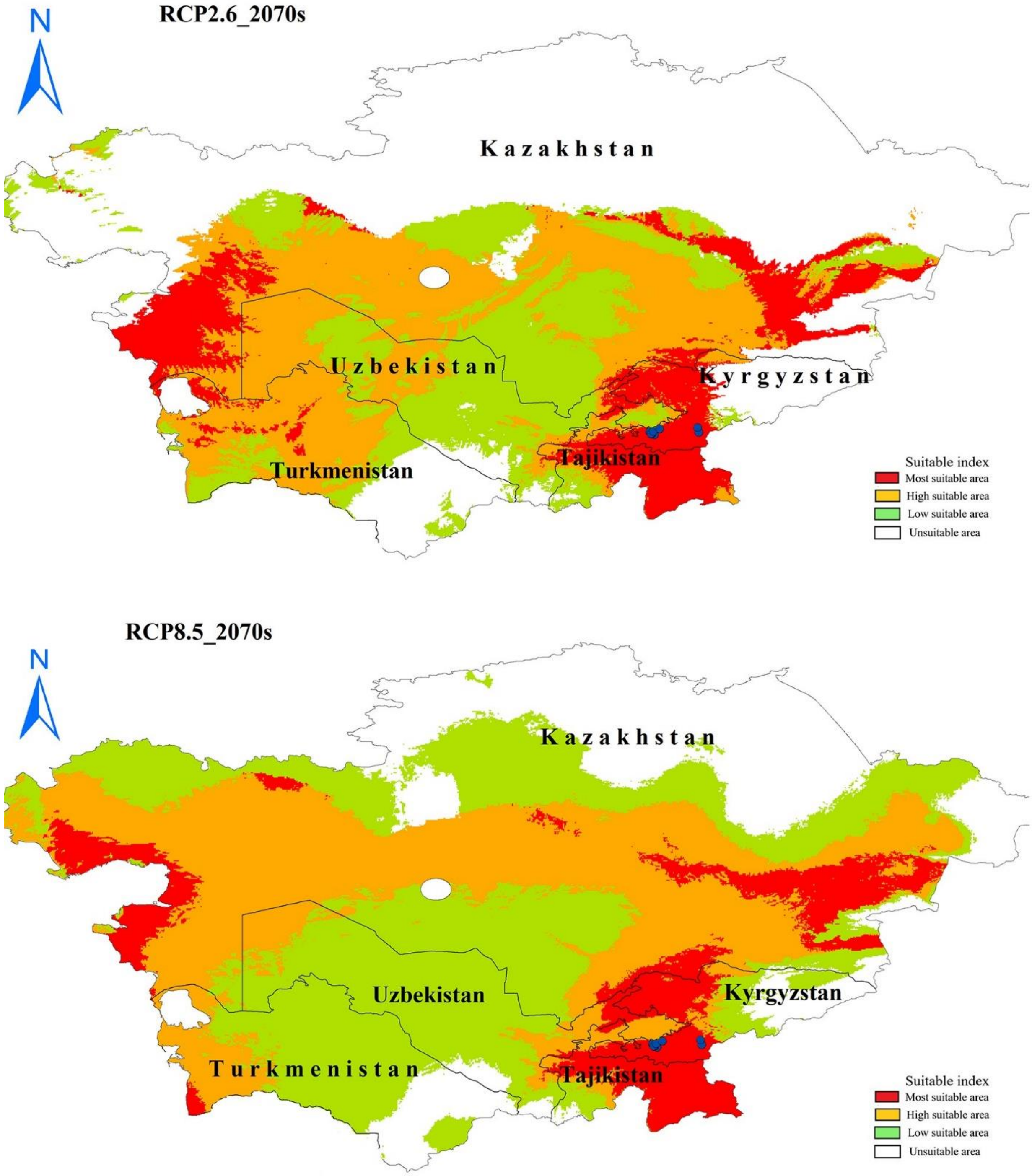

Figure 3. Hot spots of species under future climate change scenarios.

Based on the predictions of the MaxEnt model, our study showed that the species high habitats were gradually differentiated but not drastically reduced. Further research on its biological and ecological adaptation should be done in the future depending on different habitats and the response of the plant to climate change. This makes it possible to determine the ecological optimality of the species and its successful introduction in the near future.

CONCLUSION

According to the RCP 2.6 (2061-2080) climate scenario, an increase in temperature of 0.4-1.6 °C will create many potentially suitable areas in the form of the regions of Kazakhstan and Tajikistan. It is directly related to precipitation (Bio19) and elevation (Elv.) in the coldest quarter. Under the RCP8.5_2070s climate scenario, an increase in temperature of 1.4-2.6 °C has replaced scattered high-level suitable areas with medium-level suitable areas. Under both climate scenarios, temperature increases of 0.4–1.6 °C and 1.4–2.6 °C did not adversely affect the species' main hotspots.

REFERENCES

1. Brooke J. (2014). Climate change and the course of global history: A rough journey. Cambridge: University Press.
2. Gulomov, R., Rakhimova, K., Batoshov, A., Komilov, D. (2023). Bioclimatic modeling of the species Phlomoides canescens (Lamiaceae). The Scientifi Temper, 14(4):1060-1065. Doi: https://10.58414/SCIENTIFICTEMPER.2023.14.4.01
3. Abdullaev Sh., Akbarov F., Abdupatteva Sh., Asatulloev T., Dekhkonov D., Tojibaev K., Khoshimov Kh., Gulomov R. Species Distribution Modelling of Poa Bactriana Roshev under Different Climate Change Scenarios. International Journal of Virology and Molecular Biology 2024, 13(1): 15-21. Doi: https://10.5923/j.ijvmb.20241301.03
4. Dilshod Nuridinov, Rustam Gulomov, Bakhrom Toxtasinov (2023). Bioclimatic Modeling of Phlomoides Kirghisorum (Lamiaceae) Species Distributed in Fergana Valley. International Journal of Current Science Research and Review, 6(4), 2568-2575. Doi: https://10.47191/ijcsrr/V6-i4-39
5. Min-Su Park, Nu-Ree Na, Chang-Gee Jang, Rustam Gulomov and Komiljon Tojibaev 2024. The complete chloroplast genome sequence of Phlomoides kirghisorum Adylov, Kamelin & Makhmedov 1987 (Lamiaceae), an endemic species of Fergana Valley. Mitochondrial DNA B Resour. 9(1):104–108. https://doi.org/10.1080/23802359.2023.2292159
6. Gulomov, R.K. (2022). Fluorosenotypes of phlomoides moench species distributed in the Fergana valley: Central Asia. International Journal of Life Sciences & Earth Sciences, 5(1), 1-9. https://doi.org/10.21744/ijle.v5n1.1816
7. Gulomov R.K., Batoshov A.R. Morphological Phylogeny of the Species Phlomoides Moench (Lamiaceae) Distributed in the Fergana Valley. International Journal of Virology and Molecular Biology 2022, 11(1): 9-15. https://doi.org/10.5923/j.ijvmb.20221101.03
8. Najmiddinov A., Gulomov, R., Batoshov, A., Hoshimov, H., Rakhmatov, A., & Mullajonova, S. (2023). The conservation status of euphorbia L. in the Fergana valley of central Asia. International Journal of Life Sciences & Earth Sciences, 6(1), 19-29. https://doi.org/10.21744/ijle.v6n1.2091
9. Guo, J., Liu, X., Zhang, Q., Zhang, D., Xie, C., & Liu, X. (2017). Prediction for the potential distribution area of Codonopsis pilosula at global scale based on Maxent model. Chinese Journal of Applied Ecology, 28. – p. 992–1000.
10. Global Biodiversity Information Facility. https://www.gbif.org/ru/ species/3885744.
11. Lioubimtseva E, Henebry G. (2009). Climate and environmental change in arid Central Asia: Impacts, vulnerability, and adaptations. Journal of Arid Environments 73: 963-977.
12. Novikov V. et al. (2012). Biodiversity in Central Asia in maps and diagrams. Ecological network “Zoï” - p. 84.
13. Phillips, S.J., Anderson, R.P. and Schapire, R.E. (2006). Maximum Entropy Modeling of Species Geographic Distributions. Ecological Modeling, – p. 231–259.
14. WorldClim. https://www.worldclim.org/data/index.html.
15. Rustam Gulomov, Shahnoza Alisherova, Azamat Ismatov, Doniyor Komilov.

Conservation status of the species Jurinea schachimordanica (Asteraceae) Scientifi Bulletin. Series: Biological Research. 2023. 8(76). 14-22.