

Cold waves and Environmental Degradation: A Case Study of Tree Mortality in Sharbazher District of Sulaymaniyah Province

Pshtiwan Gharib Ghafur¹, Hero Nasraddin Mohammed Amin²

¹ Department of Social Science, College of Basic Education, University of Sulaimani, Kirkuk Road, Sulaimani, Kurdistan Region, Iraq, ²Department of Geography, College of Humanities, University of Sulaimani, Kirkuk Road, Sulaimani, Kurdistan Region, Iraq

DOI: <https://doi.org/10.31918/twejer.2694GSCP.04>

Published:3/5/2026

Abstract

This study investigated the impact of cold wave on tree die-off in Sharbazher District in Sulaimani Province in the Kurdistan Region of Iraq. For this purpose, climatic data and MODIS Vegetation Indices images have been used from February 18 to June 10, 2022. The results indicate that the cold wave lasted from March 4 to March 29 and trees died after the cold wave. A decrease in temperature was brought on by an earlier-than-normal warming event (false spring), which accelerated tree leaf emergence. Spring frosts later destroyed the exposed trees, causing the decline to occur. Trees that are vulnerable were walnut, almond, pomegranate, fig, and grape trees as well as aspen, willow, and neem (margosa) trees. In the future, should those species of trees be planted that are able to defend against cold weather or could recover quickly after frost damage in terms of mitigation and adaptation.

Keyword: Cold wave, tree mortality, and Sharbazher District

1. Introduction

The rise in climatic variability, which causes more frequent temperature extremes, is a significant factor in the current climate change. As a result of global warming, there will be more frequent, intense, and long-lasting heat waves as well as cold wave, in spite of a tendency towards fewer cold days. Differently from regular climatic variability, these climate extremes will have an impact on the growth, productivity, and composition of the forest (Camarero et al, 2023:1). Cold waves have a negative impact on the global economy, food security, and ecosystems, including an increase in atmospheric CO₂ levels as a result of decreased photosynthesis and damage to young leaves (Chamberlain et al, 2019:2210; Pflieger et al, 2019:516; Zohner et al, 2020:12192). Late-spring frosts, or late-spring temperatures below freezing, are among the most hazardous extreme phenomena in temperate and boreal regions. Tissue damage caused by below-freezing temperatures has a substantial impact on plant development, competitiveness, and distribution boundaries. Because immature leaves of plants are particularly vulnerable to frost (Zohner et al, 2020:12192). The data indicate that 35, 26, and 10% of Europe's, Asia's, and North America's forests are increasingly threatened by frost damage (Zohner et al, 2020:12192).

A cold wave could be defined as a sudden drop in temperature within 24 hours to a level demanding considerably increased protection for agriculture, industry, commerce, and social activities. The boundary between a cold wave and a normal temperature drop can be differentiated and classified into two categories depending on the normal temperature of the area. First, when the minimum typical temperature is 10°C or more, cold wave 5 to 6°C is lower than usual, and a severe cold wave is present when temperatures 7°C or more drop from the normal temperature. Second, when the normal minimum temperature is less than 10°C, the cold wave departure from normal is 4°C to 5°C, and the severe cold wave departure from normal is 6°C or more. This criterion does not apply to stations where the average low temperature is below 0°C (Himachal Pradesh State Disaster Management Authority, 2021:2).

Temperature typically plays a key role in the intricate set of elements and interactions that govern phenology, especially in temperate and boreal environments (Olano et al, 2021:1). A cold wave's potential to cause phenological changes, such as late hardening, early dehardening, or premature bud break, could raise the risk of forest damage. These changes weaken the frost hardiness of tree tissues, making them more susceptible to low temperatures

(Camarero et al, 2015:1). There are three categories of limits for cold temperatures and general plant damage: Tender plants are killed by light frost or freeze between -1.7°C and -0.1°C with little harm to other vegetation; moderate frost or freeze between -3.9°C and -2.2°C causes widespread destruction of most vegetation with severe harm to fruit blossoms and tender and semi-hardy plants; and severe frost or freeze between -4.4°C and lower causes serious harm to most plants. The depth to which the ground freezes solid depends on the length and intensity of the freeze, the soil's moisture content, and the type of soil (National Disaster Management Authority, 2021:7-8).

As temperature decrease to 0°C living cells transform large starch particles into smaller, and they also increase the amount of dissolved components in cell protoplasm. Increasing solutes works as a temporary anti-freeze and is effective between -1 and -5 degrees Celsius. Water from cells is drawn out onto the surface of ice crystals when solute concentration rises and ice crystals start to develop outside of cells. If there is not enough apoplast volume to allow ice crystal expansion, the crystals will pierce and crush the membranes of live cells. Cold is more likely to harm active tissues than inactive or dormant tissues (Coder, 2017:5).

Global warming led to changes in atmospheric and oceanic currents, intensified cold waves in the Mid latitude, and a rise in wintertime temperatures (López-Bueno et al, 2021:1; Menezes-Silva, 2019:11986). In the Mediterranean climate, more frequent freeze-thaw cycles in the winter can cause frost damage and tree mortality (Camarero et al, 2015:918). In response to recent climatic changes, large-scale changes in land use and forest management have occurred across the Mediterranean basin, including the abandonment of agricultural lands and conventional management methods (Hartmann, 2022:685).

In the study area, trees, particularly horticultural trees, have a significant impact on farmers' income, food security, and ecosystem services. Despite this, cold waves harm trees and lessen their value as a resource. There is no comprehensive scientific study to evaluate the impact of cold waves on the forests in the studied area. Therefore, the purpose of this study was to ascertain how the cold wave affected tree mortality and show how different types of common trees responded to the cold wave.

2. Materials and Methods

2.1. Study Area

The Sharbazher district is located east of the Kurdistan region in the northeast of Iraq. It is in a location bounded by latitudes $35^{\circ} 31' 40''$ to $35^{\circ} 59' 55''$ N and longitudes $45^{\circ} 15' 20''$ to $45^{\circ} 50' 20''$ E (Figure 1). The study area has a Mediterranean climate, which is wet and cold in winter and dry and hot in summer (Ghafur, 2013:2). It is a mountainous area with elevations ranging from 787 to 2337 meters above sea level. The major types of vegetation are grass and forest, which are mostly oak trees. The Sharbazher district, which has a total area of 1243.3 km², consists of five sub-districts, including Chwarta (district center), Siwail, Zalan, Sitak, and Gapilon. Based on temperature, the study area was divided into two parts: Chwarta and Basne.

2.2 Data Sources and Methods

The NDVI data used in this study was acquired at the Terra Moderate Resolution Imaging Spectroradiometer (MODIS) Vegetation Indices (MOD13Q1) Version 6. The data are generated every 16 days at a spatial resolution of 250 metres as a Level 3 product from February 18 to June 10, 2022. The MOD13Q1 product provides the Normalised Difference Vegetation Index (NDVI), which is referred to as the continuity index to the existing National Oceanic and Atmospheric Administration-Advanced Very High-Resolution Radiometer (NOAA-AVHRR)-derived NDVI. Out of all the acquisitions during the 16-day period, the algorithm selects the best pixel value that is currently possible. Low view angles, low clouds, and the highest NDVI value are the determining factors (Didan, 2015). The climate data including hourly, daily and monthly maximum, minimum, mean temperature, and earth skin temperature, were obtained from Power Data Access at NASA during the study period for Chwarta and Basne sub-districts. Furthermore, a DEM file with 30m spatial resolution of the study area was obtained from Glovis USGS and used as secondary data to produce terrain factors (elevation, slope, aspect, and Shaded relief), which were resampled to 250m and used as a supplementary factor in NDVI correlation determination. Finally, images of sensitive trees were taken throughout the study area, and the severity of cold wave dangers to trees was assessed.

The images were processed to NDVI using ArcGIS Spatial Analyst (Version 10.8.1). A linear regression model for mean NDVI and temperature was estimated. The correlation

coefficients between NDVI and daily maximum, minimum, mean temperature, and earth skin temperature were determined for Chwarta and Basne sub-districts using the Statistical Package for the Social Sciences (SPSS) version 20 (IBM Inc., USA).

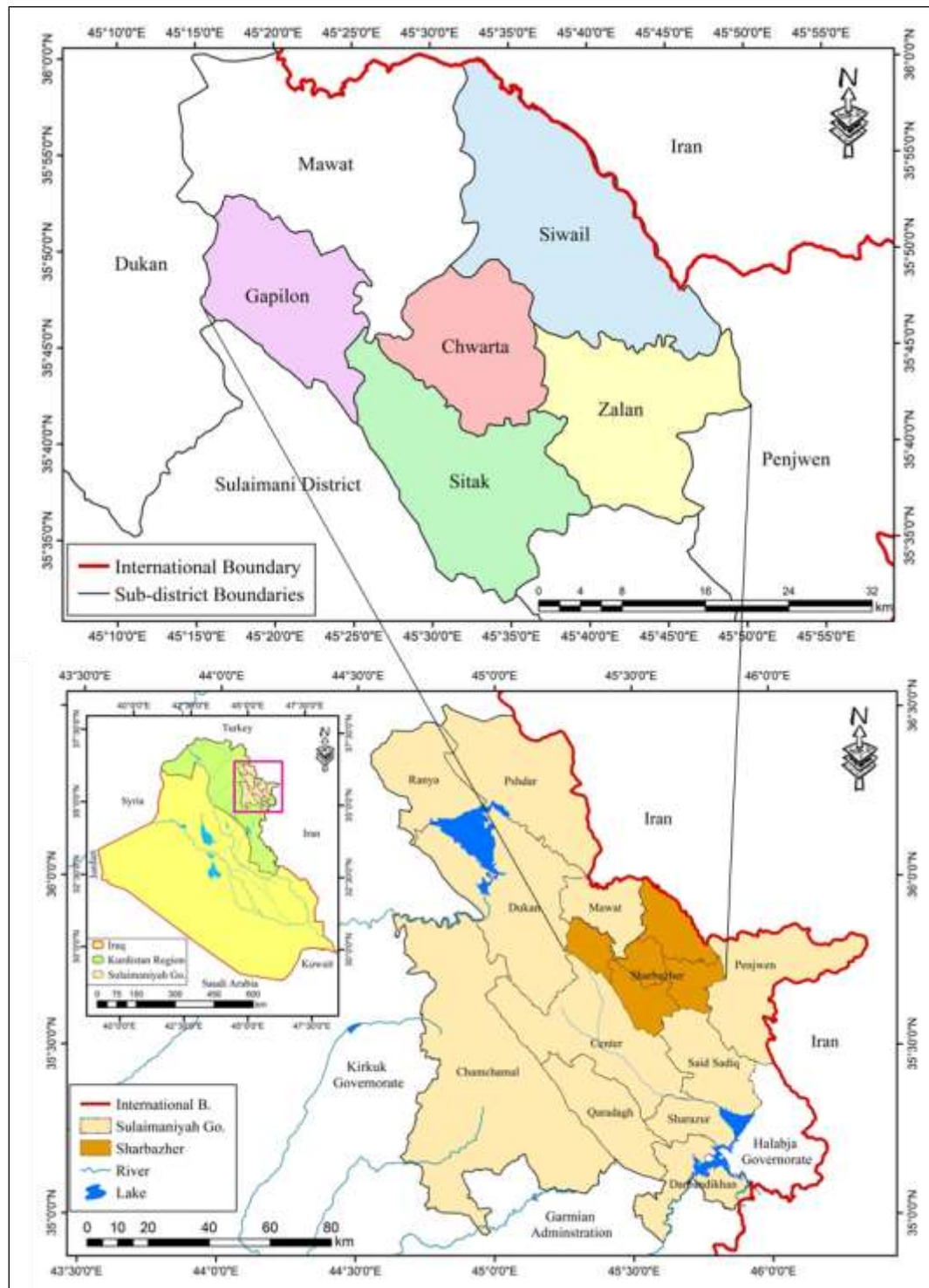


Figure 1. Location map of the Study area.

3. Results and Discussion

3.1. Cold wave and NDVI

In early March 2022, air temperatures reached below zero in the Sharbazher district. The cold wave, which lasted from March 4 to March 29, was characterized by a rapid drop in lowest temperatures (Figure 2C and 2D). This results in significant short-term temperature variability, which regularly alternates between warm and freezing conditions, increasing the risk of tree mortality. Abnormally warm period in February, followed by a cold wave in March that largely affected the south and southeast of the study area (Chwarta part).

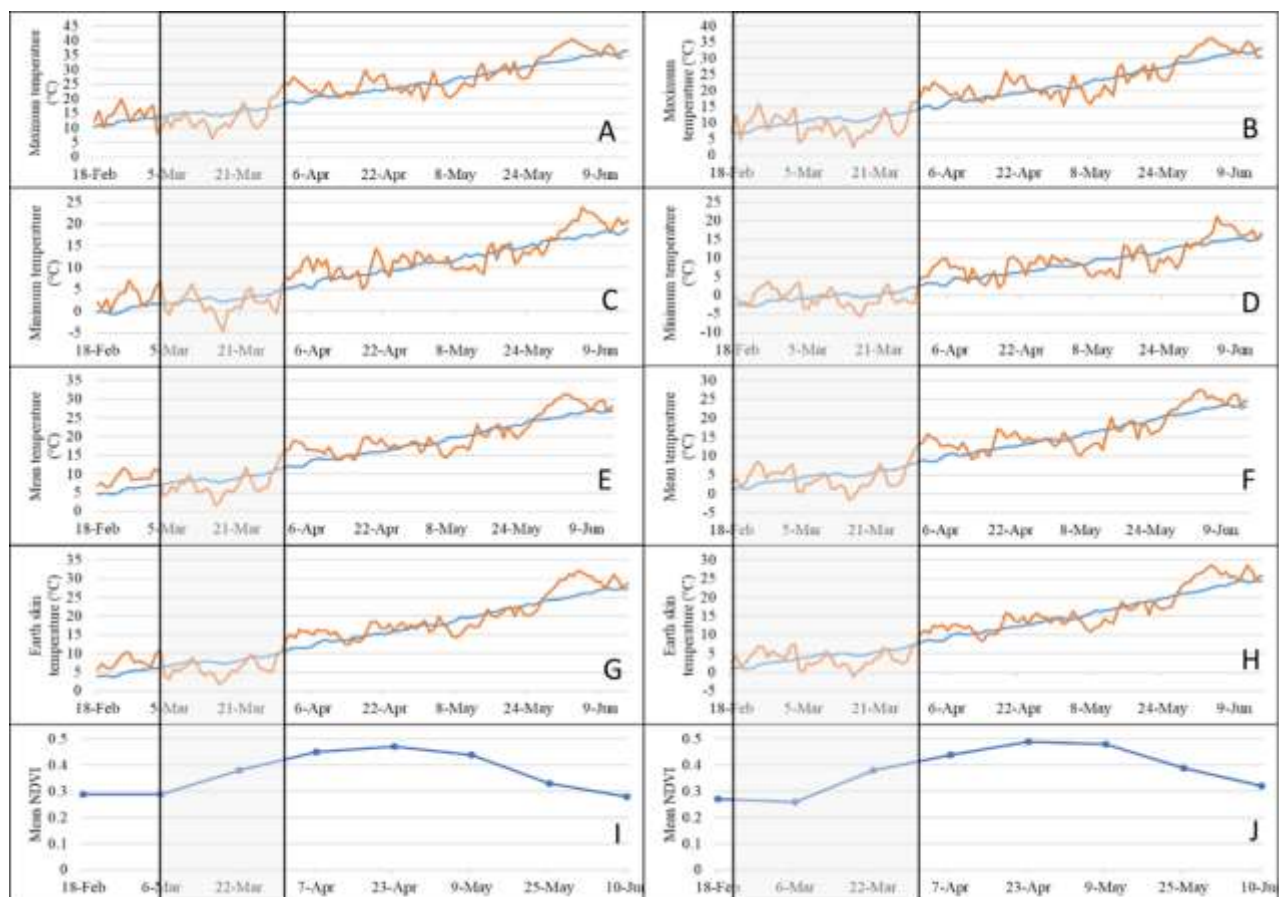


Figure 2. Minimum, Maximum, Mean, Earth Skin Temperature and NDVI for Chwarta (left) and Basne (right) are shown in the graphs. The orange lines show the temperature range from

February 18 to June 15, 2022, while the light blue lines show the mean temperature range from February 18 to June 15, 1985–2021.

In Chwarta, the effects of cold temperatures on trees were evident. The Basne region, however, was least hit (figure 3). In comparison to their means from 1985 to 2021, the air temperature (figure 2A–H) and earth skin temperature (figures 2I–J) fluctuated more dramatically from February to June of 2022. Overall, temperatures and NDVI had strong positive correlation coefficient and r^2 of multivariate linear model results ranged from 0.62 to 0.7 in both Chwarta and Basne parts (table 1). The correlation between temperature and NDVI was statistically significant (p values < 0.05) in Basne, but non-significant in Chwarta except for maximum temperature.

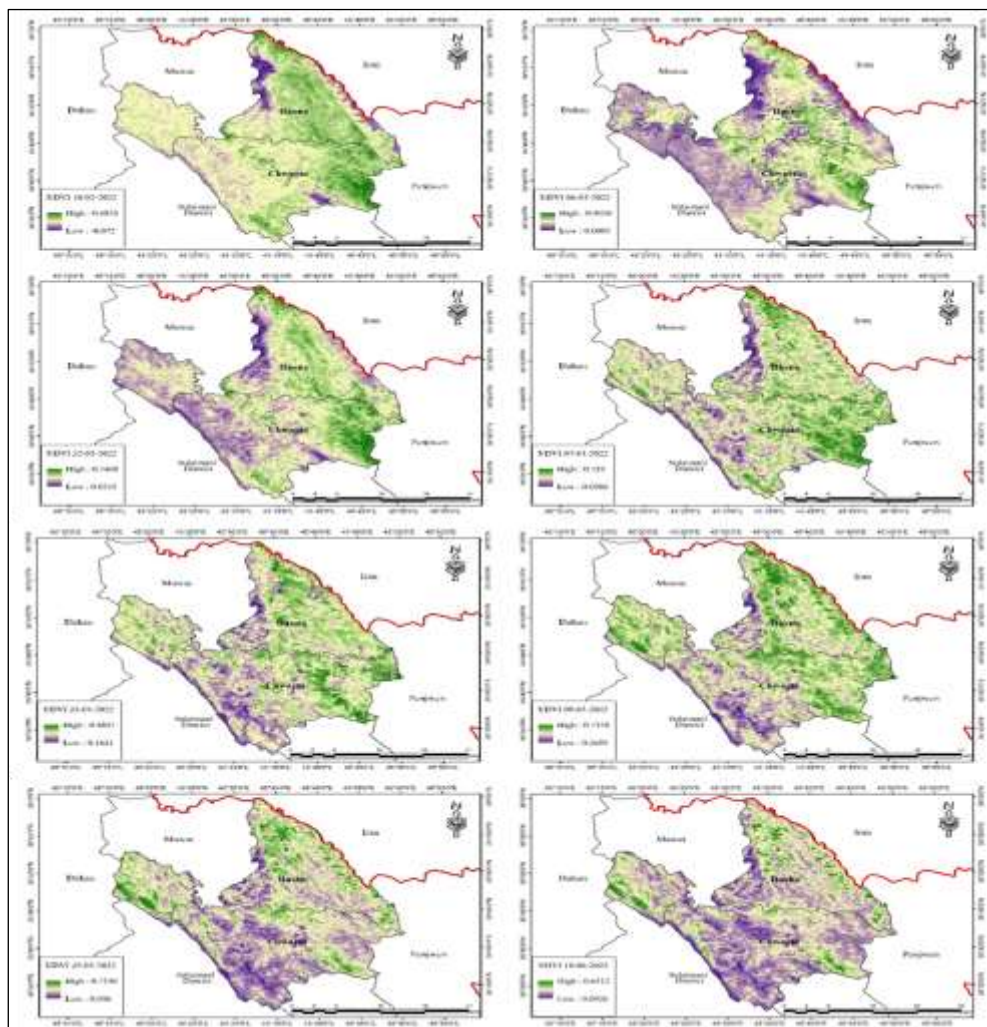


Figure 3. NDVI values of the study area from February 18 to June 10, 2022.

Table 1. Regression results of temperature and NDVI

Temperature (°C)	r		r ²		p. value	
	Chwarta	Basne	Chwarta	Basne	Chwarta	Basne
Maximum temperature	0.83	0.83	0.70	0.68	0.039	0.043
Minimum temperature	0.78	0.83	0.62	0.68	0.065	0.042
Mean temperature	0.80	0.83	0.64	0.70	0.057	0.039
Earth skin temperature	0.80	0.84	0.64	0.70	0.056	0.036

In Chwarta compared to Basne, trees blossom earlier due to geographic factors. This earlier blossom brought on by terrain variables such as elevation, slope, aspect, and shaded relief. Terrain factors and NDVI had weak correlation coefficients and the maximum r^2 of the multivariate linear model result was 7% for elevation in Basne. The P values were > 0.05 except for shaded relief in Chwarta and elevation in Basne, which were significant. (table 2). Prior to the cold wave, Chwarta's NDVI was 2.5% higher than Basne's; however, following the cold wave, Basne's NDVI was 3% higher than Chwarta's. The early blossoming of trees caused this alteration, which primarily affected young trees.

Table 2. Regression results of terrain factor and NDVI

Terrain factor	r		r ²		p. value	
	Chwarta	Basne	Chwarta	Basne	Chwarta	Basne
Elevation	0.08	-0.27	0.007	0.07	0.065	0
Slope	0.04	-0.03	0.001	0.001	0.4	0.6
Aspect	-	-	0.003	0.001	0.25	0.67
Shaded relief	0.13	0.08	0.016	0.007	0.005	0.17

3.2. Vulnerable trees to cold waves

Plants in extratropical environments have a dormant period during which they strengthen their ability to withstand cold temperatures by removing water from the extracellular

space, concentrating sugar inside the cells, and generating proteins that shield enzymes and the cellular membrane from freezing and dehydration. In order to prevent damage from early frost events, these processes start at the end of the summer and gradually fade in the spring as the chance of frost decreases. Consequently, there is no threshold for distinguishing a frost episode from one that causes tree damage. When a frost occurrence exceeds the capacity of plant tissues to withstand freezing temperatures, damage is to be expected. This is most likely to occur in the spring and autumn, when trees are less resilient to freezing temperatures. Frost damage can seriously impede plant development once it has occurred. For instance, trees' ability to photosynthesize less effectively and grow more slowly when newly created leaves are damaged by cold. Trees harmed by frost may lose the competition for space to frost-unaffected trees or shrub species if the apical meristem is destroyed, which exacerbates the problem of growth stagnation (Marquis et al, 2022:1; Menezes-Silva et al, 2019:11986).

In the study area, the following trees were particularly susceptible to a cold wave:

3.2.1. Walnut

Walnut trees are highly affected by the cold wave, especially young trees in the study area. In some places, 50% of young trees die back (Figure 4A). This result is consistent with previous studies that stated that Walnuts prefer a temperate climate and are susceptible to frosts in the winter and late spring. Cold winters can cause serious structural damage to young trees, while spring frosts can harm blooms and young nuts. Older trees, on the other hand, can resist winter temperatures as low as -30°C (de Rigo et al, 2016:1; USDA, 2015:1).

3.2.2. Almond

The cold wave caused the death of some almond trees in the study area (figure 4B). The almond trees are among the most cold-hardy fruit species during the winter vegetative halt phase, being able to withstand temperatures below -15°C (Cultifort, 2023). However, young almond trees can be killed at temperatures below -0.5°C (Haifa, 2021). The trees that survived and were flowering earlier may have risked their flowering and turned black.

3.2.3. Pomegranate

Pomegranate plants can withstand moderate frost and temperatures of up to roughly -10°C (Özgüven and Yılmaz, 2000:41); however, in some parts of the study area, the cold wave caused 100% of the pomegranate trees to perish (Figure 4C).

3.2.4. Fig

Despite the fact that figs are a subtropical species, mature fig trees are fully cold-hardy to -6.7°C (Himelrick, 2019:5), but many fig trees on a large scale died due to the cold wave in the study area (Figure 4D).

3.2.5. Grape

During their early growing phases, grapevines can withstand temperatures as low as $15-20^{\circ}\text{C}$ below zero. However, throughout the spring, it is particularly susceptible to frost damage (Cardell et al, 2019:2300). Despite having a high temperature tolerance for frost, the cold wave killed approximately 40% of grape trees, particularly in Chwarta (figure 4E).

3.2.6. Aspen

When warm spring days are followed by a strong freeze when frost dangers begin to develop at temperatures below 5°C , aspen suffers freezing damage. Most likely, such pattern occurs in nighttime cold-air sinks at relatively low altitudes. Maybe mature leaves are more resistant to freezing than young or immature leaves (Schreiber et al, 2013:495; Jones et al, 1985:75). The majority of the aspen trees died back as a result of the cold wave in Tagaran Valley, which is located in the Sitak sub-district (figure 4F).

3.2.7. Willow

Despite their remarkable resistance to frosts that reached -50°C (Pitcher and McKnight, 2022), willow as well as aspen trees in the Tagaran Valley were impacted by the cold wave (figure 4G).

3.2.8. Neem (margosa)

Neem trees were highly affected by the cold wave in the study area and were planted in parks and road verges by municipalities in cities (figure 4H). Neem can withstand high summer temperatures of up to 50°C , but it cannot withstand frost or temperatures below 4°C since it will drop its leaves and perhaps perish (Csurhes, 2016:7).

In the study area, oak trees account for around 90% of the overall forest cover. *Q. aegilops* is the most common species of oak, followed by *Q. libani*, *Q. infectoria*, and *Q. macranthera*. The other species, with the exception of *Q. macranthera*, are regarded as local natives. Only *Q. aegilops* makes up about 70% of the oak woodlands (Khwarahm, 2020:2).

Despite the high cover of oak trees, it survived the cold wave due to its high tolerance for frost that reached -40°C (Matt, 2022).

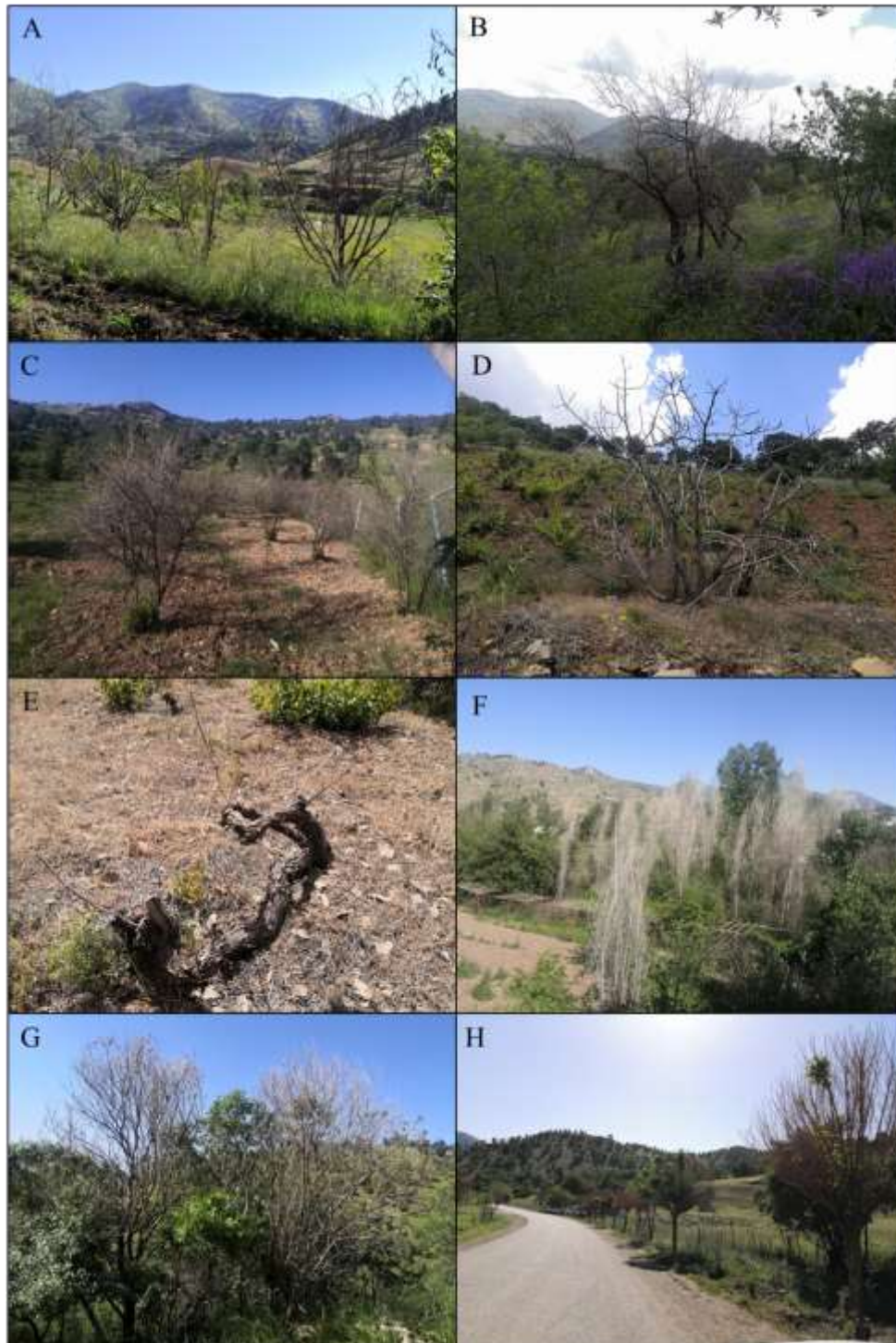


Figure 4. susceptible trees for cold waves in the study area in 2022 (a. walnut, b. almond, c. pomegranate, d. fig, e. grape, f. aspen, g. willow, h. neem).

4. Conclusion

a. The cold wave lasted 26 days, from March 4 to March 29, in the Sharbazher district. Abnormally warm period in February (false spring), followed by a cold wave in March that largely affected the Chwarta part compared to the Basne part. Trees blossom earlier due to geographic factors, which primarily affect young trees.

b. Maximum, minimum, mean and earth skin temperatures and NDVI had strong positive correlation coefficients and high r^2 of multivariate linear model results.

c. Trees that were vulnerable are walnut, almond, pomegranate, fig, and grape trees, as well as aspen, willow, and neem trees. In the future, should those species of trees be planted that are able to defend against cold weather or could recover quickly after frost damage and flower later in terms of mitigation and adaptation.

References

1. Camarero, J. J., Gazol, A., Sancho-Benages, S. and Sangüesa-Barreda, G., 2015. Know your limits? Climate extremes impact the range of Scots pine in unexpected places. *Annals of Botany*, 116(6), pp.917-927.
2. Camarero, J.J., Colangelo, M., Valeriano, C. and Pizarro, M., 2023. Reversible Impacts of a Cold Spell on Forest Cover, Tree Growth and Carbohydrates in Mediterranean Pine and Oak Forests. *Forests*, 14(4), p.678.
3. Cardell, M.F., Amengual, A. and Romero, R., 2019. Future effects of climate change on the suitability of wine grape production across Europe. *Regional Environmental Change*, 19, pp.2299-2310.
4. Chamberlain, C.J., Cook, B.I., García de Cortázar-Atauri, I. and Wolkovich, E.M., 2019. Rethinking false spring risk. *Global Change Biology*, 25(7), pp.2209-2220.
5. Coder, K.D., 2017. Trees & Cold Temperatures. Warnell School of Forestry & Natural Resources, University of Georgia, Athens, Georgia, USA.
6. Csurhes, S., 2016. Invasive plant risk assessment: Neem tree *Azadirachta indica*. Department of Agriculture and Fisheries Biosecurity Queensland. State of Queensland.

7. Cultifort, 2023. Almond cultivation: crop demands, plant material and nutrition. Cultifort · Pol. Ind. Sector 2 · C/ Benigànim, 17. <https://www.cultifort.com/en/almond-cultivation-crop-plant-nutrition/>
8. de Rigo, D., Enescu, C. M., Houston Durrant, T., Tinner, W., Caudullo, G., 2016. Juglans regia in Europe: distribution, habitat, usage and threats. In: San-Miguel-Ayanz, J., de Rigo, D., Caudullo, G., Houston Durrant, T., Mauri, A. (Eds.), European Atlas of Forest Tree Species. Publ. Off. EU, Luxembourg, pp. e01977c+.
9. Didan, K.. *MOD13Q1 MODIS/Terra Vegetation Indices 16-Day L3 Global 250m SIN Grid V006*. 2015, distributed by NASA EOSDIS Land Processes Distributed Active Archive Center, <https://doi.org/10.5067/MODIS/MOD13Q1.006>. Accessed 2023-05-14.
10. Ghafur, P, G., 2013. *Assessment of Spatial and Temporal Variability of Groundwater Recharge in Sulaimani Province, Iraqi Kurdistan* (MSc thesis, Department of Geography, University of Leicester).
11. Haifa, 2021. Recommendations for Almond fertilization. <https://www.haifa-group.com/recommendations-almond-fertilization>
12. Hartmann, H., Bastos, A., Das, A.J., Esquivel-Muelbert, A., Hammond, W.M., Martínez-Vilalta, J., McDowell, N.G., Powers, J.S., Pugh, T.A., Ruthrof, K.X. and Allen, C.D., 2022. Climate change risks to global forest health: emergence of unexpected events of elevated tree mortality worldwide. *Annual Review of Plant Biology*, 73, pp.673-702.
13. Himachal Pradesh State Disaster Management Authority. Cold Wave Action Plan. 2021. Disaster Management Cell, Department of Revenue, HP Secretariat, Shimla-2.
14. Himelrick. D. G., 2019. Fig Production Guide. The Alabama Cooperative Extension System (Alabama A&M University and Auburn University). ANR-1145.
15. Jones, John R.; Kaufmann, Merrill R.; Richardson, E. Arlo 1985. Effects of water and temperature. In: DeByle, Norbert V.; Winokur, Robert P., editors. Aspen: Ecology and management in the western United States. USDA Forest Service General Technical Report RM-119. Rocky Mountain Forest and Range Experiment Station, Fort Collins, Colo. p. 71-76
16. Khwarahm, N.R., 2020. Mapping current and potential future distributions of the oak tree (*Quercus aegilops*) in the Kurdistan Region, Iraq. *Ecological Processes*, 9(1), pp.1-16.
17. López-Bueno, J.A., Navas-Martín, M.Á., Díaz, J., Mirón, I.J., Luna, M.Y., Sánchez-Martínez, G., Culqui, D. and Linares, C., 2021. The effect of cold waves on mortality in urban and rural areas of Madrid. *Environmental Sciences Europe*, 33(1), pp.1-14.

18. Marquis, B., Bergeron, Y., Houle, D., Leduc, M. and Rossi, S., 2022. Variability in frost occurrence under climate change and consequent risk of damage to trees of western Quebec, Canada. *Scientific reports*, 12(1), p.7220.
19. Matt., 2022. The Temperature Tolerance of Oak Trees. Mast Producing Trees. <https://mast-producing-trees.org/the-temperature-tolerance-of-oak-trees/>
20. Menezes-Silva, P.E., Loram-Lourenço, L., Alves, R.D.F.B., Sousa, L.F., Almeida, S.E.D.S. and Farnese, F.S., 2019. Different ways to die in a changing world: Consequences of climate change for tree species performance and survival through an ecophysiological perspective. *Ecology and evolution*, 9(20), pp.11979-11999.
21. Menezes-Silva, P.E., Loram-Lourenço, L., Alves, R.D.F.B., Sousa, L.F., Almeida, S.E.D.S. and Farnese, F.S., 2019. Different ways to die in a changing world: Consequences of climate change for tree species performance and survival through an ecophysiological perspective. *Ecology and evolution*, 9(20), pp.11979-11999.
22. National Disaster Management Authority, (2021). National Guidelines for Preparation of Action Plan—Prevention and Management of Cold Wave and Frost, Government of India, New Delhi.
23. Olano, J.M., García-Cervigón, A.I., Sangüesa-Barreda, G., Rozas, V., Muñoz-Garachana, D., García-Hidalgo, M. and García-Pedrero, Á., 2021. Satellite data and machine learning reveal the incidence of late frost defoliations on Iberian beech forests. *Ecological Applications*, 31(3), p.e02288.
24. Özgüven, A.I. and Yilmaz, C., 2000. Pomegranate growing in Turkey. *Options Mediterraneennes, Serie A: Seminaires Mediterraneennes*, 42, pp.41-48.
25. Pfleiderer, P., Menke, I. and Schleussner, C.F., 2019. Increasing risks of apple tree frost damage under climate change. *Climatic Change*, 157(3-4), pp.515-525.
26. Pitcher, J. A. and McKnight, J. S. 2022. Black Willow. *Salix nigra* Marsh - Southern Research Station – USDA.
27. Power Data Access from NASA. <https://power.larc.nasa.gov/data-access-viewer/>
28. Schreiber, S.G., Ding, C., Hamann, A., Hacke, U.G., Thomas, B.R. and Brouard, J.S., 2013. Frost hardiness vs. growth performance in trembling aspen: an experimental test of assisted migration. *Journal of Applied Ecology*, 50(4), pp.939-949.
29. USDA-United States Department of Agriculture. 2015. Walnuts *Juglans regia* (Juglandaceae). Southwest Regional Climate Hub and California Subsidiary Hub Assessment

of Climate Change Vulnerability and Adaptation and Mitigation Strategies. Crop Fact Sheet series.

30. USGS. Digital Elevation Model (DEM-30-meter) from Glovis USGS. 2017.

31. Zohner, C.M., Mo, L., Renner, S.S., Svenning, J.C., Vitasse, Y., Benito, B.M., Ordonez, A., Baumgarten, F., Bastin, J.F., Sebal, V. and Reich, P.B., Liangk, J., Nabuursl G. J., de-Miguel, S., Alberti, G., Antón-Fernández, C., Balazy, R., Brändli, U. B., Chen, H. Y. H., Chisholm, C., Cienciala, E., Dayanandan, S., Fayle, T. M., Frizzera, L., Gianelle, D., Jagodzinski, A. M., Jaroszewicz, B., Jucker, T., Kepfer-Rojas, S., Khan, M. L., Kim, H. S., Korjus, H., Johannsen, V. K., Laarmann, D., Lang, M., Zawila-Niedzwiecki, T., Niklaus, P. A., Paquette, A., Hans Pretzsch, Saikia, P., Schall, Peter., Sebe, V., Svoboda, M., Tikhonova, E., Viana, H., Zhang, C., Zhao, X., and Crowther., T. W. 2020. Late-spring frost risk between 1959 and 2017 decreased in North America but increased in Europe and Asia. *Proceedings of the National Academy of Sciences*, 117(22), pp.12192-12200.

شەپۆلی سەرما و تیکچوونی ژینگە: لەناوچوونی دارەکانی قەزای شارباژێر لە پارێزگای سلیمانی وەک نمونە

د. پشٹیوان غفور (پروفیسۆری یاریدەدەر)^{۱*}، د. ھێرۆ نصرالدین محمد امین (مامۆستا)^۲
^۱ بەشی زانستە کۆمەڵایەتیەکان، کۆلیجی پەرۆردەیی بنەرەتی، زانکۆی سلیمانی، شەقامی کەرکوک، سلیمانی، ھەریمی کوردستان، عێراق.
^۲ بەشی جوگرافیا، کۆلیجی زانستە مەرفایەتیەکان، زانکۆی سلیمانی، شەقامی کەرکوک، سلیمانی، ھەریمی کوردستان، عێراق.

E-mail:pshtiwan.ghafur@univsul.edu.iq*,
E-mail:hero.mohammedamin@univsul.edu.iq

پوختە

ئەم توێژینەمیە لێکۆڵینەمیەکە دەربارەی کاریگەری شەپۆلی سەرما لەسەر لەناوچوونی (مردنی) دارەکانی قەزای شارباژێر لە پارێزگای سلیمانی لە ھەریمی کوردستان. بەیپی ئامانجی توێژینەمیەکە، داتای کەشوەھا و وێنەکانی پێوانەکانی ڕوومکی مۆدیس لە ۱۸ی شوبات تا ۱۰ی حوزەیرانی ۲۰۲۲ بەکار ھێنراون. ئەنجامەکان نامازە بەو دەکەن، کە شەپۆلی سەرما لە ۴ی ئازار تا ۲۹ی ئازار بەردەوام بوو و، دارەکان دواي شەپۆلی سەرماکە لەناوچوون. دابەزینی پلەیی گەرمی دواي بەرزای پلەیی گەرمی پێشومختە بەبەرئورد بە پلەیی گەرمی ئاسایی (بەھاری ساختە) ھاتۆتە ئارو، کە چڕۆکردنی دارەکانی خێراتر کردووە. دواتر بەستن (شەختە)ی بەھارە دارە ژیاوەکانی لەناوبردوو و ھۆکار بوو بۆ کەمبوونەوی ژمارەی دارەکان. ئەو دارانەی بە شەپۆلی سەرماکە کاریگەریبوون بریتیبوون لە دارەکانی گۆیز، بادەم،

هه‌نار، هه‌نجیر و ترێ، هه‌روه‌ها داره‌کانی چنار، بی و نیم (مارگوزا). دهمکریت له‌داهاتوو‌دا له‌چار‌چینه‌ی که‌مکر‌دنه‌وه‌ی کار‌یگه‌ری شه‌پۆلی سه‌رما‌یان خۆ‌گون‌جان‌دن له‌گه‌ڵی، ئه‌و چۆره‌دارانه‌ب‌ج‌ین‌رین، که‌توان‌ای به‌ر‌گر‌ی‌کر‌دن‌یان بۆ که‌شو‌ه‌ه‌و‌ای سارد زیاتره‌، یان ده‌توانن به‌زوویی دوا‌ی زیانه‌کانی به‌ست‌ن گه‌شه‌به‌که‌نه‌وه‌.

کلیله‌وشه‌: شه‌پۆلی سه‌رما، له‌ناو‌چوونی دار و قه‌زای شار‌باژێر

موجة البرد والتدهور البيئي: موت الأشجار في قضاء شهربازار بمحافظة السلیمانیة كحالة دراسة

د. یشتیوان غریب غفور (أستاذ مساعد)^{1*}، د. هیرو نصرالدین محمد أمين (مدرس)²

¹ قسم العلوم الاجتماعية، كلية التربية الأساسية، جامعة السليمانية، طريق كركوك، السليمانية، إقليم كردستان، العراق.

² قسم الجغرافيا، كلية العلوم الإنسانية، جامعة السليمانية، طريق كركوك، السليمانية، إقليم كردستان، العراق.

E-mail:pshtiwan.ghafur@univsul.edu.iq*,

E-mail:hero.mohammedamin@univsul.edu.iq

الملخص

اهتم هذه الدراسة بتأثير موجة البرد على موت الأشجار في منطقة شهربازار في محافظة السليمانية في إقليم كردستان العراق. ولهذا الغرض، تم استخدام البيانات المناخية و مؤشرات في الفترة من 18 فبراير إلى 10 يونيو ٢٠٢٢. توصلت MODIS الغطاء النباتي بواسطة صور الدراسة إلى أن موجة البرد استمر بين 4 مارس الى 29 مارس و الذي ادى إلى تدهور الاشجار. جاء هذا الانخفاض في درجة الحرارة بعد ارتفاع درجات الحرارة في وقت أبكر من المعتاد (الربيع الكاذب) الذي أدى إلى تسريع ظهور أوراق الأشجار. في وقت لاحق، دمر صقيع الربيع الأشجار المزدهرة، مما تسبب في حدوث الانخفاض. وتشمل الأشجار المعرضة للخطر أشجار الجوز، اللوز، الرمان، التين والعنب بالإضافة إلى أشجار الحور الرجراج والصفصاف والنيم (المارجوسا). في المستقبل يجب زراعة أنواع الأشجار القادرة على الدفاع ضد الطقس البارد أو التي يمكن أن تتعافى بسرعة بعد أضرار الصقيع من حيث التخفيف والتكيف.

الكلمات المفتاحية: موجة البرد، موت الأشجار، منطقة شهربازار