ISSN: 2754-4982

Journal of Civil Engineering Research & Technology

SCIENTIFIC Research and Community

Review Article

Open Access

Regional Climate Change Symptoms Indication

Moshe Gophen

Migal, Galilee Scientific Research Institute Tel Hai-Kiryat Shmone University under construction POB 831 Kiryat Shmone, (11016) Israel

ABSTRACT

Several long-term durations (61,85 and 38 years) of climatological records are comparatively evaluated, aimed at indicating regional climate change symptoms. Meteorological parameters such as air temperature, rainfall capacity, wind velocity, gust wind, event frequency, relative humidity and radiation are included. The conclusion indicates the differences between larger and smaller regions, including Jerusalem, the Kinneret drainage basin, and the Hula Valley. Sixty-one years of daily record (1908-1969) of daily rainfall capacity in Jerusalem do not confirm climate change, whilst several climatological parameters recorded in the Hula valley suggest regional climate change.

***Corresponding author**

Moshe Gophen, Migal, Galilee Scientific Research Institute Tel Hai-Kiryat Shmone University under construction POB 831 Kiryat Shmone, (11016) Israel.

Received: January 19, 2026; **Accepted:** January 22, 2026; **Published:** January 31, 2026

Keywords: Climate Change, Climatological Parameters, Hula Valley, Jerusalem Rainfall

Introduction

Symptoms of climate change conditions were indicated in the Kinneret watershed ecosystem. Air and water temperatures increase, accompanied by a decline in rainfall and reduced river discharges, resulting in a decrease in epilimnetic lake nitrogen levels. Three major headwaters, flowing southward from the Hermon mountain rocky block, the Dan, Hermon (Banyas) and Snir (Hazbany) rivers, join to form the Jordan River, flowing southward into Lake Kinneret [1]. Until 1957 the Hula Valley was covered by the old Lake Hula and swampy wetlands. The Hula Valley was drained and land use was converted into agricultural development.

Inappropriate agricultural management resulted in peat soil damageable development. Consequently, a reclamation project, namely "the Hula Project," was implemented. Analysis of a long-term (1946-2008) record of daily mean air temperature in the Hula Valley confirmed a trend of decline since the drainage of the Hula Valley (1957). In contrast, from the mid-1980s, a temperature elevation was documented. Those regional climate changes were probably induced by modifications of the Albedo level [2]. Climate change caused a decline in rainfall, followed by a reduction of headwaters and consequently Jordan discharges, accompanied by a decline in the Kinneret water level and a reduction of water allocation for irrigation [1-5]. Why is climate change critical for water quality in Lake Kinneret? The temperature of surface water increased and the water level declined, were accompanied by a reduction in nitrogen and a slight increase in phosphorus in the lake Epilimnion [6]. The outcome was epilimnetic nitrogen deficiency and phosphorus sufficiency, which enhanced the modification of phytoplankton assemblages composition. The impacts of precipitation and headwaters discharge were accompanied by a decline in TP (total phosphorus) migration through erosive action and consequently, epilimnetic enhanced TP was supported from internal sources. Warmer temperatures and reduced rainfall induce phosphorus dynamics changes in Lake Kinneret, leading to shifts in nutrient cycling, potentially boosting phosphorus in upper layers and fostering Cyanobacteria over desirable algae like Peridinium [7,8].

Climate change is not an issue of denial or confirmation; it is an existence or non-existence. Thought, professional scientific conflicts of agreement or disagreement can be settled by data bridging [1]. It is not a disputed state analysis issue because the data are beyond dispute and bridging disagreement through data is the only solution to settle a dispute. The objective of this paper is to raise awareness of environmental precaution, forwarding critical precaution of early symptom spotting as well as avoidance of climate change disturbances. The background is focused on two test case studies: long-term daily rain capacity records in Jerusalem (1908-1969) and climatological records in the Hula Valley (1946-2025).

Materials and Methods

Data Source

The Israel Meteorological Service; Migal Hula Project Database: Migal, National Water Authority, Governmental Agricultural and Food Safety Office, and Jewish National Fund (Keren Kayemet LeIsrael, KKL); Mekorot-National Water Supply Company; Kinneret Limnological Laboratory, IOLR River discharge unit is: mcm: 10^6 m^3/year.

Statistical Evaluation

Statistical evaluation was conducted using the software: STATA 17.0-Standard Edition, Statistics and Data Science, Copyright

1985-2021 StataCorp LLC, StataCorp, 4905 Lakeway Drive, 4905 Lakeway Drive, 800-STATA-PC, Stata license: Single-user perpetual, Serial number: 401706315938, Licensed to: Moshe Gophen, Migal. Two statistical methods were utilized: Linear (LR) and Fractional Polynomial (FP) (w/95% Confidence interval) Regression (Prediction).

Results

Rainfall Capacities Fluctuations in Jerusalem (1908-1969): Test Case Results of Monthly-averaged daily means (mm/d) and annual [mm/m; (%)] of rainfall capacity in Jerusalem during 1908-1969 are shown in Figure 1, Table 1. Results given in Figure 1 indicated a temporal annual mean (10.0 mm/d: SD=13.6; SE=0.014) of daily capacity decline of app 4 mm/d but on the red line limit of insignificance. Conclusively, a distinct climate change as reflected from 61 years record can`t be confirmed.

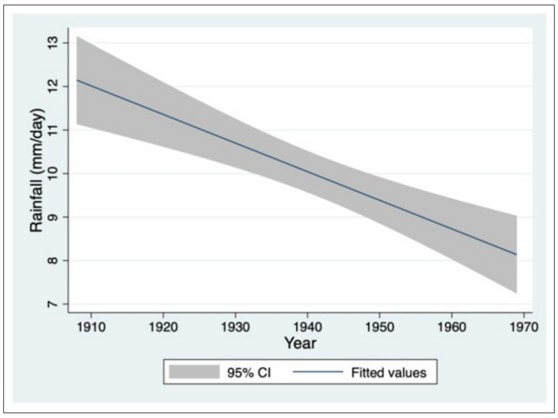

Figure1: Daily rainfall capacity (mm/d) in Jerusalem 1908-1969; Temporal decline (LR) : r^2=0.0072; p<0.0001; Mean=10.0; SD=13.6; SE= 0.014; Coefficient=-0.066; Min.- Max range: 0.1-121. A year is consider as "Hydrological" from October (rarely November) = through April (rarely May).

Table 1: Monthly (1-12) Averaged Daily Means (mm/d) and annual [mm/m; (%)] of Rainfall Capacity in Jerusalem During 1908-1969

Month	mm/d	mm/y	(%)
9	2.3	0.3	(0.1)
10	5.1	10.4	(2.1)
11	9.1	51.1	(10.2)
12	10.4	94.3	(18.7)
1	12	135.8	(27)
2	11.4	111.4	(22.1)
3	9.8	76.3	(15.2)
4	6	20.3	(3.9)
5	3.1	3.4	(0.7)
6	0.8	0	(0)
7	0	0	(0)
8	0	0	(0)
Total		503.3	(100)

Results given in Table 1 indicate that 100% of annual rainfall falls during October through April.

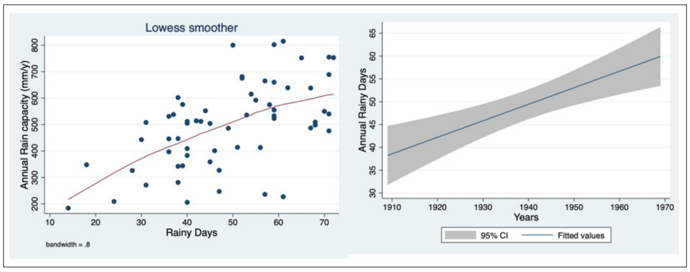

Figure 2: The correlation between Annual rainfall capacity and the number of rainy days: Left: Lowess Smoother plot. Right; LR: r2=0.2057; p=0.0002; Coefficient= 0.36; Mean No. of annual Rainy Days=49; SD=14; SE=0.09; n=61; Min-Max renge=14-72; Trivial temporal increase of No. of Rainy days resulting total annual rain capacity enhancement is confirmed

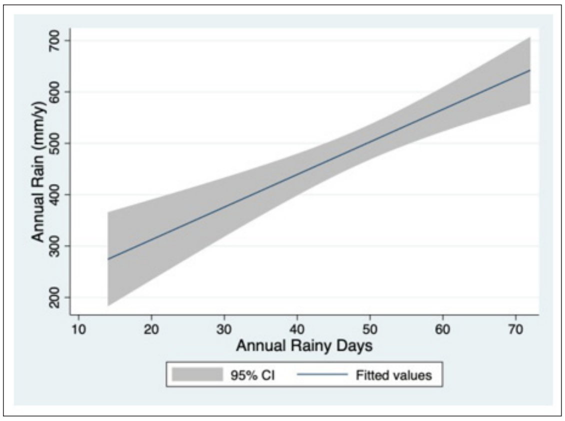

Figure 3: LR: r^2=0.3178; p<0.0001; Coefficient=6.35; n=61; Mean of mm/y=497; SD=159; SE=1.21. Trivial predicted increase of No. of Rainy days resulting annual rain capacity enhancement is confirmed.

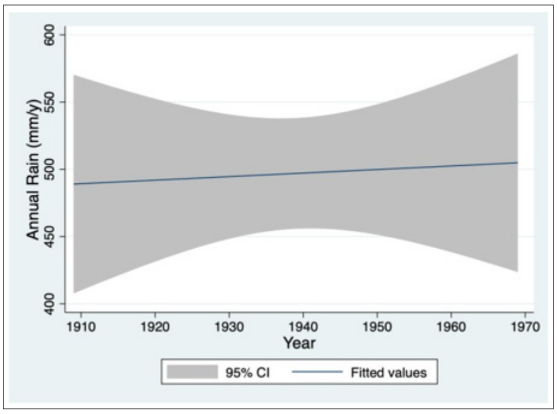

Figure 4: Temporal (1908-1969) change (LR) of annual Rainfall capacity in Jerusalem is insignificant. Results given in Figure 4 clearly indicate unchanged annual rainfall capacity during 61 years (1908-1969)

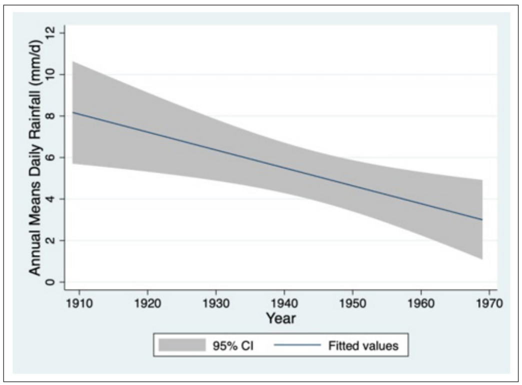

Figure 5: Temporal changes of October Daily rainfall capacity: A low level of significance of temporal Linear Regression (LR) decline throughout 1908-1969 was indicated: r^2=0.0599; p=0.0061; Coefficient=-0.09; Mean=5.2; SD=6.8;SE=0.03;n=124;

The evaluation of temporal dynamics of daily rainfall (>1mm/d) throughout 1908- 1969 (Linear regression, w/95% CI) (Table 2; Figure 4) confirmed unchanged climate conditions. Although statistically at a very low level of significance (r^2=0.0599; p=0.0061), daily annual rainfall confirmed a continuous slight decline. Moreover, linear regressions for particular rainy months, February, April and October have indicated similar results with slightly higher levels of significance.

Table 2: Results of Statistical Parameters of Linear Regression Between Daily Rainfall Capacity During 1908-1969, February, April and October (Table 2) are Presented. the Significance Level of Other Months is Lower

Parameter	February	April	October
r^2	0.0105	0.0306	0.0599
p	0.0122	0.0119	0.0061
Coefficient	-0.084	-0.073	-0.09
Mean	11.4	6	5.1
SD	14.1	7.8	6.8
SE	0.039	0.03	0.03
n	597	205	123

Results given in Table 2 indicate fairly stable climate conditions (rainfall capacity) throughout 1908-1969 in Jerusalem, excluded short duration extreme rainy or drought events.

Climatological Conditions and Headwater Discharge Fluctuations in the Hula Valley (1940-2024): Test Case

Long term (1940-2025) rainfall record (daily, monthly and annual, October-May) recorded in northern Hula valley (Dafna station, altitude 135 MASL) and statistical evaluation was carried out. In 22 years (26%), the rainy season (>1mm/day) was terminated exceptionally in May, in 13 (15%) years started earlier in November, and 14 (16%) years started earlier in September. Most commonly rainy season duration is from October to the next April; therefore, exceptional cases of start and termination, which are temporally disordered and distributed, do not indicate a trend of climatic change. An 85-year rainfall record from Dafna, in the northern Hula Valley, shows no sustained trend of significant climate change. While there is a clear correlation between daily and annual rainfall totals, the data reveals a shift in patterns: a decrease in the number of rainy days has been offset by an increase in daily intensity. Consequently, total annual capacity remains stable, and the record does not confirm a broader climatic shift.

Nevertheless, at the Gadash station in the Hula valley, located 2 kilometers south of Dafna, a record (1987-2024) of Chill Hours a trend of regional (Hula Valley) variability of climate conditions was confirmed.

Temporal (1940-2025) annual monthly (October-May) rainfall capacity (>1mm/month) was evaluated in search of its timing (year) correlation. Throughout the entire period (1940-2025), the rainy season (annual >1mm/y) strictly limited between October and May was confirmed. Moreover, a seasonal shifting to later or earlier than the Oct.-May monthly range was not confirmed despite an insignificant temporal very slight decline. The normal rainfall seasonal distribution was strictly maintained during the entire period, as given in Table 3:

Table 3: Monthly Means (1940-2025) of Rainfall Capacity (mm/m). Mean Annual (n=86) total – 603.7; SD=156.5; SE= 0.68; and Min.-Max. range 272-1057 mm;

Month	mm/m	%
9	1.6	0.3
10	20.2	3.3
11	69.5	11.5
12	122.6	20.3
1	152.7	25.3
2	11.4	18.6
3	78.5	13.1
4	35.7	5.9
5	9.2	1.5
6-8	1.3	0.2
Total	603.7	100

Results given in Table 3 indicate that 95% of annual rainfall is received during November through April.

The scientific definition of climate change is unambiguous, flexible and has not yet strictly defined despite the unlimited available environmental data. In the present study, air temperature, rainfall, river discharge, wind velocity, and relative humidity that were recorded in the Hula valley during 1987-2025 were selected. Despite anthropogenic involvement, the regional water balance is primarily controlled by rainfall regime and capacity and river discharges as well. Hydrological record and climate change analysis are given in the next 9 Figures (6-14).

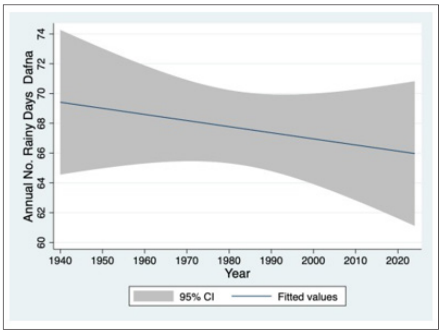

Figure 6: Temporal Fluctuations of the Annual Number of Rainy Days in DAFNA, 1940-2025. A Slight and Insignificant Trend of Temporal Decline: LR: r2-0.008; p=0.4168; Coefficient= -0.04; n=85; Annual number of Rainy days: Mean=68; SD=11; SE=0.05;

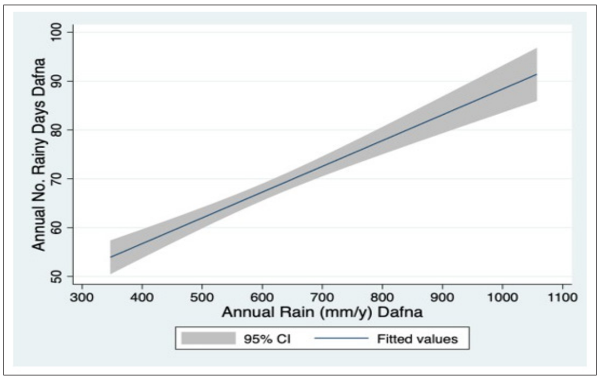

Figure 7: Linear Correlation Between the Annual Number of Rainy Days and the Annual Rainfall Capacity in Dafna, 1940-2025. Expected Significant Correlation is Indicated:
LR: r2-0.5043; p<0.0001; Coefficient=0.053;
n=85; Annual No. of Rainy Days: 68; SD=11; SE=0.006.

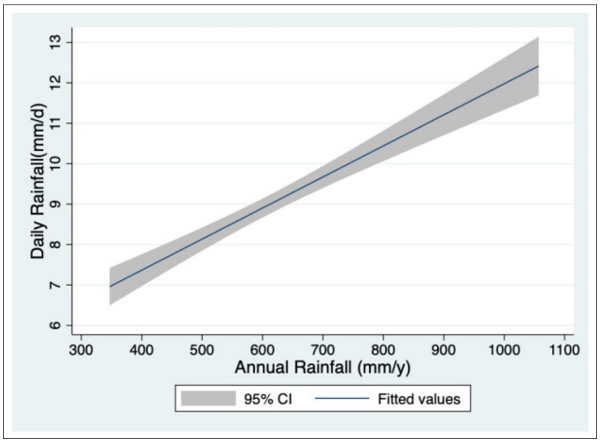

Figure 8: Linear Correlation Between Annual Rainfall Capacity (mm/y) in Dafna (1940-2025) and Mean Daily Rainfall Capacity (mm/d). Expected Significant Correlation is Indicated: LR:: r2-0.5473; ; p<0.0001; Coefficient=0.008; n=85;
Daily capacity: Mean=9; SD=1.6; SE=0.0008

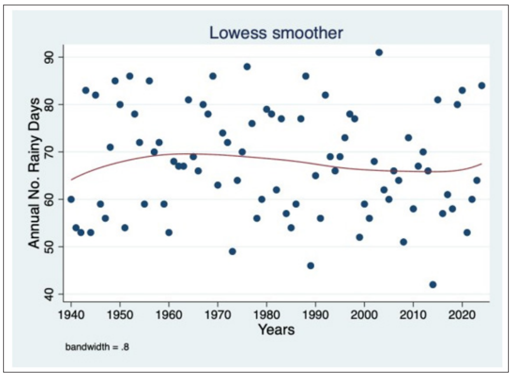

Figure 9: Lowess Smoother Plot of Temporal (1940-2024) Fluctuations of the Annual Number of Rainy Days (Dafna).

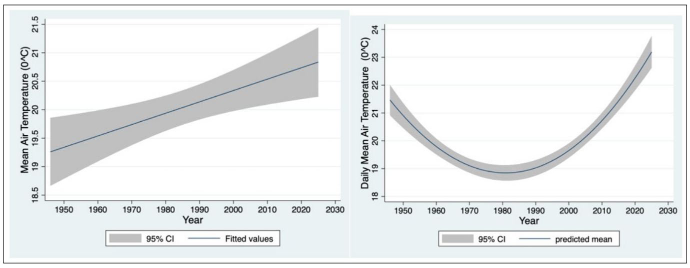

Figure 10: Temporal (Dafna 1946-2015) Distribution Changes of Mean Air Temperature (0^C): Left-Linear Regression (LR): r2=0.1054; p=0.0035 (Significant); Coefficients=0.02; Mean=29.04; SD 1.42; SE= 0.007;n=79; Min- Max range: 17.6-24.3. Right: Fractional Polynomial Prediction (FP).

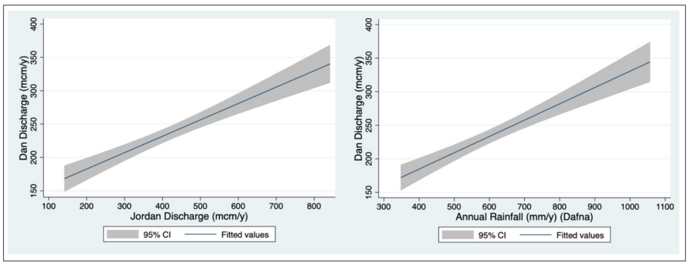

Figure 11: Linear Regressions (LR) Between Headwater Discharges (mcm/y) and Rainfall Capacity (mm/y): Left: Dan (mcm/y) vs. Jordan (mcm/y): r2=0.5937; p<0.0001; coefficient: 0.25; mean=234.8; SD=53.6; SE=0.03;
n=46; min-max range: 125-311. Right: Dan (mcm/y) vs. rainfall (mm/y): r2=0.5885; p<0.0001; coefficient: 0.22; mean=234.8; SD=53.6; SE=0.05;
n=46; min-max range: 125-311.

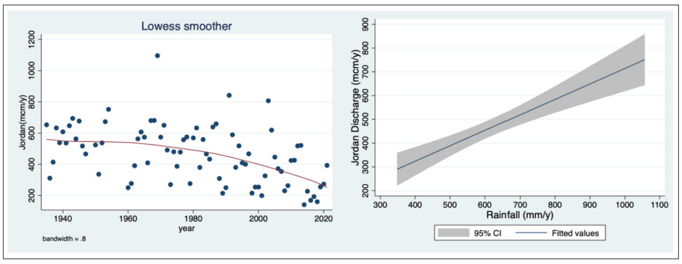

Figure 12: Left: Lowess Smoother Plot of Annual Temporal (1908-1969) Jordan Discharge (mcm/y): Continuous Decline Throughout the Entire Period is Indicated. Right: Linear Regression (LR) Between annual Jordan Discharge (mcm/y) and Annual Rainfall (Dafna) (mm/y) Throughout 1935-2020: r2=0.3079; p<0.0001SE= 0.11; Coefficient=0.65; Mwan=463.8; SD=182.4; n=84

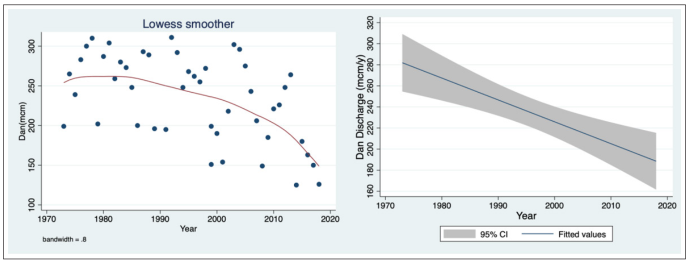

Figure 13: Temporal (1973-2018) Changes of Dan River Discharge. Left: Lowess Smoother Plot. Results Indicate a Continuous Decline from the Early 1980s. Right: Linear Regression (LR) Between Dan Discharge and Yers: r2=0.2700; P=0.0002; Coefficient=-0.08; SE=0.51; Mean=234; SD=.53.6; Min-Max=125-311; n=46.

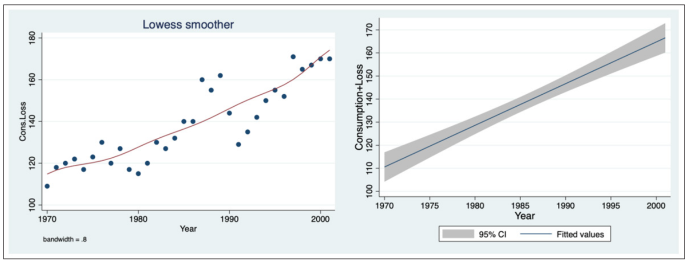

Figure 14: Temporal (1970-2001) Changes of Water Consumption and Loss in part of Huri Station on the Jordan River. Left: Lowess Smoother plot; Right: Linear Regression (LR) of Temporal Changes of Water Consumption and Loss in Correlation with year: r2= 0.8752; p<0.0001; Coefficient=1.84; Mean=138.6; SD=19.1; SE=0.17; n=32; Min-Max range=109-171.The increase during the 2000s is due to the implementation of the Peat Convention and a sharp decline (90-110 mcm/y) existed during the drought of 2014-2017.

Regional Climate Change Variability

The area of the geographically entitled Hula valley is about 200 km2 (20x10^3 ha) of which 5900 ha (app 30%) are included within the "Hula Project" (HP) territory. HP has been under intensive agricultural development since 1957, when the Hula wetlands were drained. Nevertheless, as a result of inappropriate irrigation and cultivation procedures, the peat soil features were deteriorated and a reclamation project was implemented in 1993. Since then, the regional climate conditions monitoring program has been implemented. Automatic and manual technologies were operated and data of several climatological parameters were monitored at intervals, varying between minutes, hours and days were collected. A partial summary (1987-2021) of annual means of rainfall capacities, air temperature, daily mean and maximal exceptional windy gust event velocities collected in the central location of the HP territory entitled "Gadash Station". A statistical analysis of these data was conducted, aimed at indicating the existence of temporal regional trend fluctuations and is shown in Table 4.

Table 4: Temporal (1987-2021) Linear Regression (LR) between climatological parameters and years (Correlation Coefficient - r^2, Probability – p, the Slope and Direction (Positive or Negative) of the Best-Fit Line Coefficient are given). Evaluated parameters are: Annual Means of Air Temperature (°C), Percentage (%) of Relative Humidity (Hygrometer: wet-bulb/dry-bulb, thermometers), mean wind velocity (m/s) (Anemometer, rotating cups), gust event wind velocity (max m/s), rain capacity (mm/year), radiation units: MJ/m^2/day (10^6 Joules/m^2/day, 239 kcal/m^2/day), n=35. S=significance; Trend=increase (positive) or decline (negative).

Parameters	r^2	p	coefficient	S, Trend
^{0}C	0.3654	0.0001	0.039	S Increase
%	0.0938	0.0743	-0.103	NS; decline
max-m/s	0.6041	<0.0001	0.076	S Increase
m/s	0.5063	<0.0001	-0.017	S decline
mm/y	0.2376	0.0040	11.366	S Increase
MJ/day	0.1624	0.0201	0.045	S Increase

A comparative analysis was conducted between annual precipitation in northern Hula valley (Dafna station: Dafna- mm/y) and the Jordan river's annual discharge (mcm/y:10^6 m^3/y). The results showed an insignificant correlation between these parameters and respective values in the HP record. As shown in temporal, significant correlations were identified across all environmental factors, except gust-wind velocity and relative humidity. These findings confirm a regional trend of climate change in the HP area, notably driven by an increase in wind gust events.

Discussion

International Considerations

A recent literature survey confirms the importance given by the scientific community to the climate change issue [9-20]. Moreover, the maintenance of efficient agricultural management in the Hula Valley and water quality in Lake Kinneret and along the River Jordan are of national and international concerns [6-23]. Global and regional climate change, especially warming, is presently a crucial issue for human society. Scientists, political leaders, economists and water managers are worried about the predicted significant future impact of risky climate changes. The prediction of extreme events of droughts and floods, starvation, health difficulties, economic disturbances, food safety and others was thoroughly discussed within the scientific and non-scientific communities. The objective of the present study is to assess the ability of spotting initial symptoms of climate change and avoid incorrect assessment.

A review of physical and other lake features response to climate change and discussion of recent and expected lake responses and future prediction of research opportunities in lake monitoring and modelling management were documented [11]. The world encountered 315 cases of natural disasters during 2018, shedding light on optional climate disasters. A reviewed perspective summary of surface and atmosphere climate change indicators was documented [14,15]. Regional climate change modelling over a worldwide geographical zones of which northern and southern river Jordan ecosystems were intensively explored, was documented [17,19,20,23].

Regional climate change modelling over a worldwide geographical zones of which northern and southern river Jordan ecosystems were intensively explored, and documented [17-23]. Seasonal distribution of rain capacity records in Jerusalem represents the typical sub-tropical pattern of short (November through April) wet winter, which was not modified during 61 years (Table 1). The positive (and trivial) significant correlation between annual rainfall capacity and rainy days density (Figures 2,3) indicates no impact of the negligible temporal daily decline. It is supportive evidence for climate stability during 1908-1969 in Jerusalem (Figure 4). The insignificant daily rainfall decline (Figure 5) is compensated by additional rainy days (Figure 2), resulting in stable annual capacities (Figure 4), confirming the stability of climate conditions. A comprehensive evaluation of the data given in figures 1-5 and tables 1,2, confirm climate stability.

Hula Valley

Monthly means (1940-2025) of rainfall capacities data, recorded in northern Hula valley (Dafna) (Table 3), are complements to similar data monitored in Jerusalem (1908-1969). Consistent similarity of seasonal rainfall distribution in the Hula Valley and in Jerusalem despite timing overlap dissimilarity. Though both are included within the sub-tropical climatological-geographic zone definition, 95% of annual precipitation falls during November through next April. Nevertheless, it is suggested that climatological-geographical trait consistency does not necessarily experience similar weather and climate change. Altitude and other regional feature dissimilarity enhance weather dissimilarity, whilst globally scaled climate change zones create wider uniformity [20-23].

Temporal record of annual capacities, as documented in the northern part of the Hula valley (Dafna), actually indicates stability (Figure 6). The trivial and obvious relation between annual capacity (mm/y) and rainy days density and daily capacities (mm/d) is confirmed (Figures 7, 8). Moreover, no fluctuations in temporal (1987-2024) dynamics of rainy day density (No/y) were indicated (Figure 9). The long term record of precipitation in the northern part of the Hula Valley (Dafna) (Figures 6-9) supports the confirmation of climate stability. Despite the suggested northern Hula valley climate stability as reflected from rainfall records, the evaluation of the involvement of other climate parameter records and location (Gadash) in the central valley, from Dafna, reached different conclusions. Air temperature recorded at the Gadash station in the central part of the Hula valley (HP, Hula Project Territory) (Figure 10) indicates a significant temperature increase during 1987-2024. Whereas, Fractional Polynomial (FP) analysis indicate decline during 1949-1980 and an increase later (1980-2024). Consequently, timing fractionating is required for a precise conclusion of the climatological trend of change. Considering the fluctuating long-term record of air temperature in the Hula valley, it was the result of anthropogenic involvement, such as Hula drainage and the implementation of the HP reclamation project. These anthropogenic modifications altered land, water and vegetation cover, which probably affected the Albedo level. Man-Made ecosystem structure (1957) modified land cover from wetlands to field crops and later (1994) the implementation of the Hula reclamation project (HP) intensified and continued the plant-land cover. It is suggested that those changes modified the albedo level and consequently air temperature, confounding other potential natural climate changes.

Rainfall-River Discharge Relation

The drainage basins of the three major Jordan-Kinneret headwaters stretched far beyond the Hula valley boundaries that are considered in this paper. Despite incomplete surface area overlap, the outcome of rainfall dynamics, the discharge, is crucial for the investigation of climate change in the Hula valley (Figures 11,12). As the primary headwater, the Dan River's temporal dynamics and long-term decline correlate significantly with discharge fluctuations in the Jordan River (Figure 11). Dan River discharge is clearly dependent on precipitation volume (Figure 11, Right); although only the Dafna station record is presented here, the correlation between the Dan and Jordan discharges and the Dafna rainfall data remains statistically significant (Figures 11, 12). Furthermore, a downward trend in both Dan and Jordan discharges has been evident since the mid-1980s (Figure 13), driven by a combination of reduced rainfall and increased water consumption (Figure 14). Water consumption withdrawal from Jordan and Dan River sources located north of the Huri station (Figure 14), as well as natural loss, which might have an impact on the decline in Jordan discharge (Figure 13). Water consumption in the north of Huri station was significantly enhanced during 1970- 2000 and varied between 140-160 mcm/y (10^6 m^3 /y), whilst during the drought period in mid 2010s, water allocation for agricultural irrigation was drastically cut off to <100 mcm/y. Conclusively, it is not impossible that a 4-year drought period during the late 2010s is a symptom of climate change. The distinct temporal decline configuration of headwater discharges justify indication of regional (northern Israel, Hula Valley) and probably other parts of the Kinneret drainage basin climate change conditions. The data given in Table 4 support this conclusion. The data shown in Table 4 were evaluated from long-term records of climatological parameters in the Hula Reclamation Project (HP) during 1987-2021, at the meteorological station Gadash. Linear Regression between the meteorological parameters and time (years) resulted in the following: Air temperature, Wind gust events, Rainfall and Radiation, significant increase; Wind averaged velocity-decline; insignificant decline of Relative Humidity. These results support the conclusion of regional climate change in the Hula Valley.

Conclusion

Based on two test case studies, Jerusalem (1908-1969) and Dafna in Northern Hula Valley (1946-2024), of temporal distributional fluctuations pattern of annual rainfall capacities, a periodical trend of climate change cannot be confirmed. Nevertheless, a continuous slight (10 mm/y) decline in rainfall capacity was indicated in Jerusalem over 61 years. Consequently, the long-term (1908-1969) rainfall record in Jerusalem, which confirms continuity of climate minor changes, worthwhile entitled of "Quasi climate change". Fairly stable climate conditions are reflected in the 84-year record of rainfall capacity documented in the northern Hula Valley (Dafna). Nevertheless, Kinneret headwater discharge records and climatological conditions recorded in central Hula Valley (Gadash) indicate a change in climate conditions since the early 1980s. The higher the data precision is, and the longer the record, the better the climate change definition is qualified and reliable.

Acknowledgement

The authorities of Israel Meteorological Service, Migal Hula Project Data Base, Migal, National Water Authority, Governmental Agricultural and Food Safety Office, and Jewish National Fund (Keren Kayemet Le`Israel, KKL), Mekorot- National Water Supply Company and Kinneret Limnological Laboratory, IOLR, are acknowledged for providing data.

Data Availability

There is no restriction on the availability of data from the author on request.

Contributions

The author is responsible for the scientific structuring, computerized evaluations, design and writing of the paper.

Conflicts of Interest

The author has no conflict of interest that may affect this article.

References

1. Tal A., Paz S (2026) The political psychology of climate denial. Nat. Clim. Chang. 16: 2-4.
2. Gophen M (2014) Land-use, Albedo and air temperature changes in the Hula valley (israel) during 1946-2008. open journal of modern hydrology 4: 101-111
3. Gophen M (2020) Climate and water balance changes in the Kinneret watershed: a review. open journal of modern hydrlogy 10: 21-29.
4. Gophen M (2023) chapter: Land use - land cover and climate change in the Hula valley in: M. Gophen, agriculture,

recreation, water quality and nature protection in the Hula valley, Israel, springer geography pp 89-111.
5. Gophen M, Meron M, Levin-Orlov V, Tsipris Y, Peres M (2020) Climate change, regional water balance and land use policy, in the watershed of lake Kinneret (israel). Open journal of ecology 10: 200-224.
6. Gophen M (2019) The ecological outcome of climate change in lake Kinneret – thermal pollution; open journal of modern hydrology 9: 89-102.
7. Gophen M (2021) a Climate change – enhanced Cyanobacteria domination in lake Kinneret: a retrospective overview/ water, in: special issue "Cyanobacteria threat on freshwater safety, water mdpi, (prof. Moshe Gophen, guest editor) mdpi 183: 1-19.
8. Gophen M (2021b) Short commentary phosphorus outsourcing to lake Kinneret (israel) is significantly affected by climate conditions (short commentary) geol earth mar sci 3: 1-2.
9. Malhi Y, Franklin J, Seddon N, Solan M., Turner MG, et al. (2020) Climate change and ecosystems: threats, opportunities and solutions. Phil. Trans. R. Soc. B 375: 20190104.
10. Choi D, Gao z, Jiang W (2020) Attention to global warming available for purchase the review of financial studies 33: 1112-1145.
11. Woolway RL, Kraemer BM., Lenters JD, Merchant CJO, 'Reilly CM., et al. (2020) Global lake responses to climate change Nature Reviews Earth & Environment 1: 388-403
12. Fawzy S, Osman AI. John Doran J, Rooney DW (2020) Strategies for mitigation of climate change: a review, Environmental Chemistry Letters 18: 2069-2094.
13. Jansson JK., Hofmockel KS (2020) Soil microbiomes and climate change nature reviews microbiology volume 18, pages 35-46.
14. Smith, Walsh, Lamb, Lamboll, Forster, et al. (2023) Indicators of Global Climate Change 2023: annual update of large-scale indicators of the state of the climate system and human influence 15: 2295-2327.
15. Yila, KM, Gboku MLS, Lebbie MS, Kamara LI (2023) Changes in Rainfall and Temperature and Its Impact on Crop Production in Moyamba District, Southern Sierra Leone. Atmospheric and Climate Sciences 13: 19-43.
16. Alnaser NW, Flanagan R, Kazmerski L, Sayigh AA, Nayfeh MH, et al. (2022) Worrying about Climate Change. Atmospheric and Climate Sciences 12: 441-461.
17. Parry ML, Canziani OF, Palutikof JP, Van der linden PJ, Hanson CE (2007) Climate change 2007: Impacts, adaptation and vulnerability. cambridge university press 976.
18. Vicuna S, Dracup JA (2007) The evolution of climate change impact studies on hydrology and water resources in california. Climatic change 82: 327-350.
19. Viney NR, Sivapalan M (1996) the hydrological response of catchments to simulated changes in climate. ecol. modell 86: 189-193.
20. Pal JS Giorgi F, BI X, Elguindi N, Solmon F, Gao X, et al. (2007) Regional climate modeling for the developing world: the ictp regcm3 and regcnet. bull. amer. meteor. soc 88: 1395-1409.
21. Samuels R, Rimmer A, Hartmann A, Krichak,S, Alpert P (2010) climate change impacts on Jordan river flow: downscaling application from a regional climate model, journal of hydrometeorology 11: 860-879.
22. Kunstmann H, Suppan P, Heckl A, Rimmer A (2007) Regional climate change in the middle east and impact on hydrology in the upper Jordan catchment. quantification and reduction of predictive uncertainty for sustainable water resources management, e. Boegh et al., eds., Iahs publ 313: 141-149.
23. Rimer A (2007) Systems hydrology models for the upper catchments of the Jordan river and lake Kinneret, Israel, Israel journal of earth sciences 56: 1-17.