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Analysis of Meteorological Factors and Atmospheric Index NAO and ONI in the Year 2020 for, Managua, Nicaragua

Victor Rogelio Tirado Picado

Faculty of Engineering and Architecture, American University UAM, Managua, Nicaragua
Email: victornica2001@yahoo.com

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Abstract

The purpose of this paper is to synthesize the analysis of the relationship between the occurrence of disasters, the level of development, and the need for a style of sustainable development as a framework strategy for comprehensive risk management. On this occasion, the atmospheric parameters of the ONI and the NAO, which are the atmospheric indices that affect hydrometeorological factors, were analyzed. In order to forecast future events, in possible scenarios of changes in temperature, precipitation, relative humidity and evapotranspiration, the research work is motivated to mitigate the possible negative natural effects on the daily life of the Nicaraguan population.

Keywords

Climate Change, Risk Management, Relative Humidity, Hurricanes, Earthquakes

1. Introduction

The countries of the Central American region are one of the regions most threatened by natural and social phenomena, and at the same time, it is one in which development models have created the most marked social and environmental imbalances in the world, generating conditions of vulnerability that exacerbate the occurrence of various disasters.

Nicaragua, due to its geographical position and its physical, social, economic and environmental, economic and social vulnerabilities, is one of these countries that presents a high risk, and these have not been adequately managed.

These disasters have also generated serious problems that affect production, causing direct and indirect economic losses, greater poverty, unemployment and migration of families who have to travel to other places in search of how to survive.

All these events are also disasters, which cause damage in human and material losses and, as can be seen, not all of them are caused by natural phenomena.

Disasters are considered as "external aggression", a product of the "fury of nature" against human beings, who have no other protection mechanism to face or respond to.

Over time it has been reflected and evolved so that today there are sectors of society that understand that the problem is not "disasters" in themselves but rather the effect of the existing risk conditions in our countries and, of our capacity and judgment to act on the factors that determine them, depending on whether or not they materialize in disasters.

Our perception begins to expand and we have a new vision of the problem: our locations as Risk Scenarios built through historical accumulation, in the same scenario of threats and vulnerabilities.

It can be affirmed that, in the 15 years in Nicaragua, Disaster Risk Management (DRM) has evolved, becoming a priority for authorities at all territorial levels and its population, framed in the national development plan with its investments. Oriented towards a process of sustainable development. Human development.

In this context, the motivation of the analysis lies from the motivation and review of a bibliography that works in the area of meteorology and its implication in the life of the population; in the case of Nicaragua, some of the bibliographies are as follows:

Kante, I., Diouf, I., Millimono, T. y Kourouma, J. (2021) Enfermedad por coronavirus 2019 (COVID-19) en Conakry, República de Guinea: análisis y relación con factores meteorológicos. Ciencias Atmosféricas y Climáticas, 11, 302-323. doi: 10.4236/acs.2021.112018.

Elemo, E.O., Ogobor, E.A., Ayantunji, B.G., Mangete, O.E., Alagbe, G.A., Abdulkareem, M.L., Obarolo, A.E. y Onuh, B.O. (2021) Relación entre la humedad relativa y la temperatura del punto de rocío en Abuja, Nigeria. Diario de la biblioteca de acceso abierto, 8, 1-13. doi: 10.4236/oalib.1108086.

2. Objectives

Study the most relevant climatic factors related to Disaster Risk Reduction (DRR) and Climate Change (CC).

Analyze the scenic aspects associated with Disaster Risk Reduction (DRR) and Climate Change (CC).

Assess the importance of studying climatic factors in the scenarios of Disaster Risk Reduction and Climate Change.

3. Methodological Design

Kind of Investigation

The research design is qualitative since the hydrometeorological behavior of elements such as evapotranspiration, relative humidity, precipitation and temperature was analyzed using the historical database.

Execution Time

The development of the research to meet the proposed objectives, was carried out in one month of work, one week for data collection, one week for data analysis and two weeks to present results in the June 2020 period.

Data Collection Techniques and Methods

Primary Sources

Primary Web

https://origin.cpc.ncep.noaa.gov/products/analysis_monitoring/ensostuff/ONI_v5.php

https://www.ncei.noaa.gov/access/monitoring/nao/

Secondary Sources

Nicaraguan Institute of Territorial Studies (INETER).

Universe

All hydrometeorological factors of ONI, NAO, TNA, SOI, OA.

Sample

ONI and NAO hydrometeorological factors: evapotranspiration, relative humidity, precipitation, temperature. Historical data up to 2020.

Inclusion Criteria

Climatological factors, evapotranspiration, relative humidity, precipitation and temperature from ONI and NAO.

Exclusion Criteria

Climatological factors, evapotranspiration, relative humidity, precipitation and temperature that do not belong to the ONI and NAO database.

Theoretical Aspects

Threats

[1] Possibility of occurrence of a phenomenon of natural, socio-natural, or anthropic origin, potentially harmful, that can become dangerous for people, their goods and their environment, installed in a region or community exposed to it. Frequent examples: strong winds, torrential rains, earthquakes, volcanic eruptions, tsunamis, nearby presence of dangerous material, among others (**Table 1**).

Hurricanes

[2] In this sense, a hurricane can also be considered a tropical cyclone or typhoon, circulating around a center of low pressure and generating strong winds and rains. It is known as the eye of the hurricane to the area of air that circulates downstream in the interior and that is usually free of clouds. With respect to the hurricane's energy, it comes from the condensation of humid air. It should be noted that the violence of the wind means that hurricanes can have destructive effects and destroy entire cities.

[3] Based on the experiences acquired in recent times, the concept of a Hurricane has been synthesized as a wind of extraordinary force that forms a

Table 1. Synthesis of the types of threats: Natural, socio-natural and anthropogenic.

Natural	Socionatural	Anthropogenic
Geological	Landslides	Minning tailings
Earthquakes, earthquakes	Erosion	Excess use of agrochemicals
Tsunami or Tsunami	Landslides	Contamination with plastic and garbage
Volcanic eruptions	Droughts	Oil spills
Erosion	Floods	Drains that Flow and household appliances, cell pones, batteries, etc.
Landslides	Fires	Wars and terrorism
	Desiccation of wetlands	Criminal gangs
Hidrometeorological		Narcoactivity and organized crime
Hurricanes		Social crises
Tropical storms		
El Niño and Niña Phenomena		
Droughts		
Whirlwinds		
Topological		
Floods		
Landslides		

Source: Author (2018).

whirlwind and that spins in large circles. And easy training in the tropics and from its birth, this begins to expand its diameter.

Climatic Threats

[4] It is necessary to clarify that the different climatic results are supported by data from the airport station precipitation and the atmospheric indices: Oceanic Index of the Child (ONI) and the North Atlantic Oscillation (NAO), for Managua. However, this analysis can be done with any main or ordinary station in the country. See Figure 1.

Oceanic Index of the Child

The Oceanic Index of El Niño (ONI in English), whose behavior is as shown in Figure 1, is in fact the standard that NOAA uses to identify warm (El Niño) and cold (La Niña) events in the tropical Pacific Ocean. It is calculated as the three-month moving average of anomalies in sea surface temperature for the El Niño 3.4 region (that is, the range between 5˚N - 5˚S and 120˚ - 170˚W).

North Atlantic Oscillation

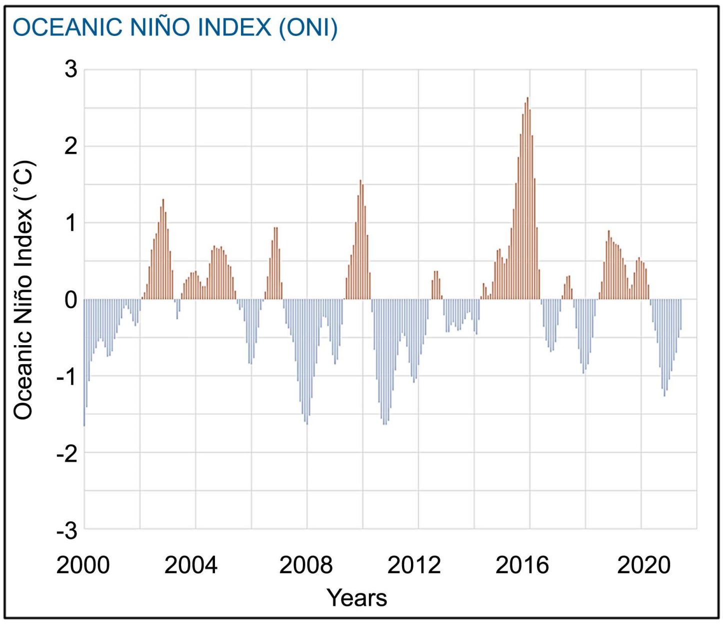


Figure 1. Child Ocean Index (ONI). Source: (Climate.gov, 2020).

The North Atlantic Oscillation (NAO) is a large-scale variation of the atmospheric mass located between the subtropical high-pressure zone of the Azores (38˚ Latitude) and the polar low in the North Atlantic basin (60˚ Latitude). However, thanks to the so-called Teleconnections, its influence extends to virtually the entire planet. This phenomenon was first described by Gilbert Thomas Walker in 1923. This phenomenon can manifest itself in two phases, usually expressed during the winter.

The positive phase in which the Azores anticyclone has a center of pressure higher than usual and deeper polar depression. This causes a greater amount of winter storms and greater intensity that cross the Atlantic Ocean. The eastern areas of the US will have mild and humid winters. In Canada and Greenland, the winters will be colder and drier. In Northern Europe, the winters are warmer and rainier, while in Southern Europe, dry winters are experienced. The negative phase occurs when the high-pressure center of the Azores weakens and the polar depression softens. As the pressure gradient decreases, fewer winter storms and weaker storms cross the North Atlantic, the eastern coast of the US experiences winter conditions with more outbreaks of cold and therefore more temporary snow. In Greenland, winter temperatures soften. On the other hand, the Atlantic storms bring humid air to the Mediterranean and cold air to Northern Europe.

Although it is true that the apparently intense effects of the NAO are far from the Iberian Peninsula, the influence exerted by the Azores anticyclone in our latitudes makes clear the importance of this phenomenon, which, to increase its complexity, is usually maintained for 3 years - 5 years in the same phase. In addition, the Peninsula presents great orographic difficulty and great variability in the rainfall regime, divided into a purely Mediterranean and temperate oceanic climate, which makes the Iberian Peninsula a case of study apart from the rest of

Europe. In a study carried out by the University Institute of Geography, it is concluded that, during the months of October to March, the center and southwest of the peninsula is strongly affected by the situation of the NAO.

In this way, it can be concluded that in carrying out a Water Resources Assessment, the phenomena that affect the study area must be taken into account in order to be able to carry it out as rigorously as possible and to be able to carry out later sustainable management of the resource (Figure 2).

Precipitation

[5] Analyzing the precipitation data, the great spatial variation of the precipitation can be observed, where there are records that go from 5297 mm in Guatuso (Costa Rica) to 891 mm in Panayola (Nicaragua). It should be noted that the maximum values occur towards the mouth of the San Juan River in the Caribbean Sea where they reach 6000 mm.

The variability of annual precipitation is also notable. The mean annual hyetograms show that some stations have a very marked dry season that in some cases covers from November to April, as in Juigalpa. This marked drought notably affects agricultural activities. In the months of December to April, it only rains an average of 36 mm in that season, that is, 3.1% of the annual total. Another phenomenon that is also observed in the Rivas station is the presence of two rain peaks, in the months of June and September. It is interesting to note that the months of July and August, when there is a drop in rainfall in Rivas and Juigalpa, are when the greatest rainfall occurs in El Castillo. In general, the rainy periods extend from May to October or November and the dry periods from November to December or April. The greater precipitations in the lower basin of the San Juan River and in the basins of the rivers on the right bank attenuate this phenomenon.

Temperature

[5] It is a very constant meteorological parameter for the region. The amplitude of the mean values is less than 6˚C. The daily variation is more important, which according to the zone can be 9˚C between the maximum and the

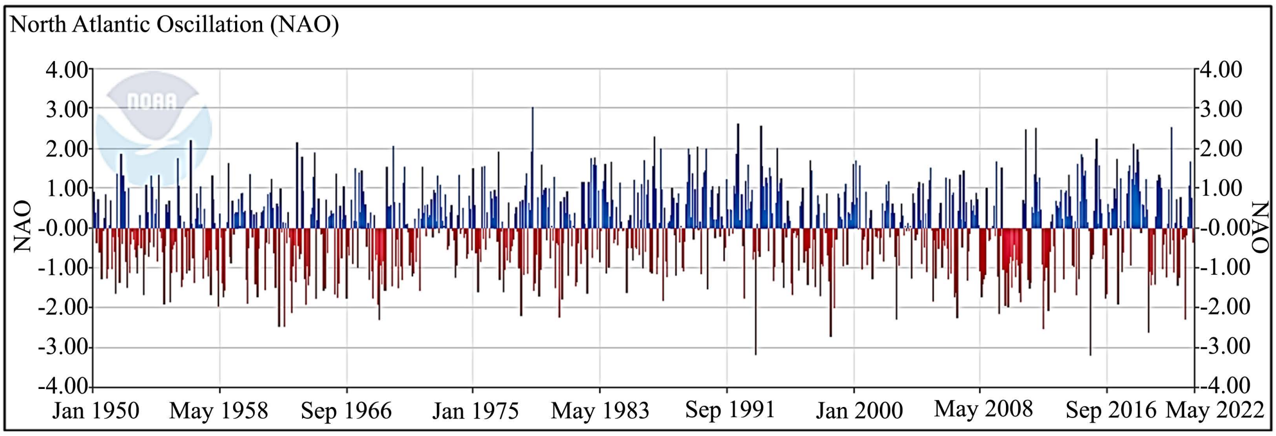


Figure 2. Map representation of tele-connections worldwide. Source: https://www.cpc.ncep.noaa.gov/products/precip/CWlink/pna/norm.nao.monthly.b5001.current.ascii.table

minimum in the rainy season and 14˚C in the dry season. The difference in temperature between a clear day and a cloudy day is also notable, as in the case of the El Sauce station, where it varies from 36.5˚C to 19.5˚C, respectively.

RH

[5] The relative humidity is a parameter highly correlated with precipitation, temperature and the proximity of large bodies of water. Throughout the area, values of the order of 90% are maintained in the rainiest regions and decrease towards the driest regions in the northwest of the Basin.

Evaporation

[5] This parameter is correlated with relative humidity, temperature and winds. Therefore, it is to be expected that in the driest areas, where the relative humidity is lower and the temperature is higher, the evaporation values are also higher. This occurs in the northern and western regions of the Basin, where evaporation reaches 2500 to 3000 mm per year, while in the rainiest areas of the middle and lower portion of the San Juan River, values decrease from 1200 to 1500 mm.

4. Results

Behavior and projection of evapotranspiration

Graph 1 shows the historical behavior of evapotranspiration, and it is observed that the data are:

Behavior and projection of precipitation

See Graphs 2-4.

Behavior and projection of relative humidity

Methods of means between intervals to generate a trend graph. Graph 3 shows the trend of the HR for the next 30 years. (Graph 5 and Graph 6)

Behavior and projection of relative humidity

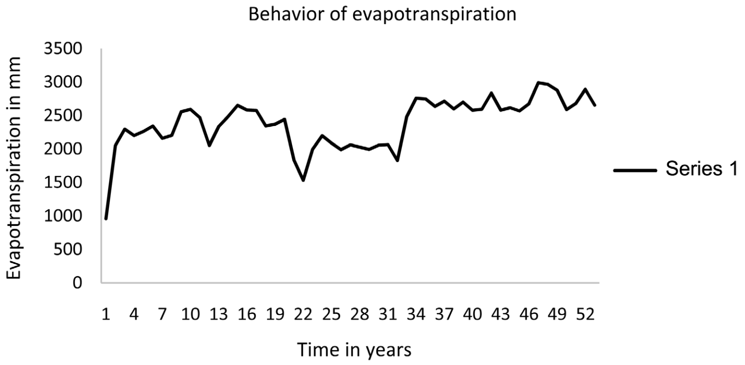
See Graph 7 and Graph 8.

Comparison of data adjusted and normalized over time

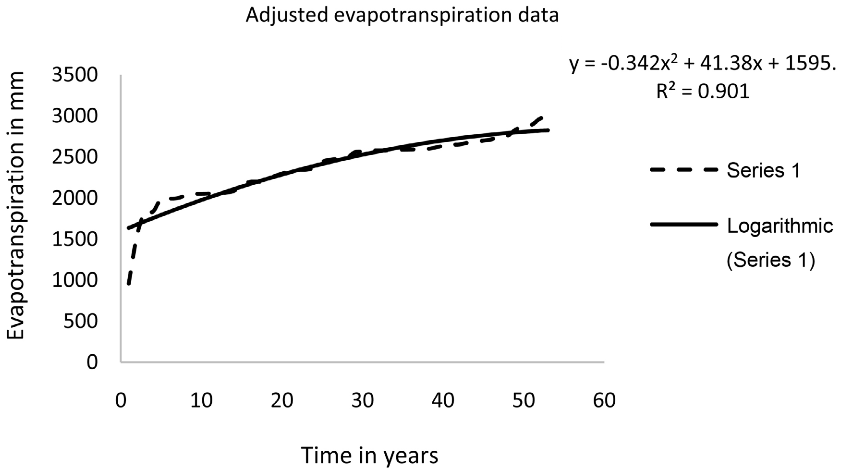
See Graph 9.

Comparison of data adjusted and normalized over time

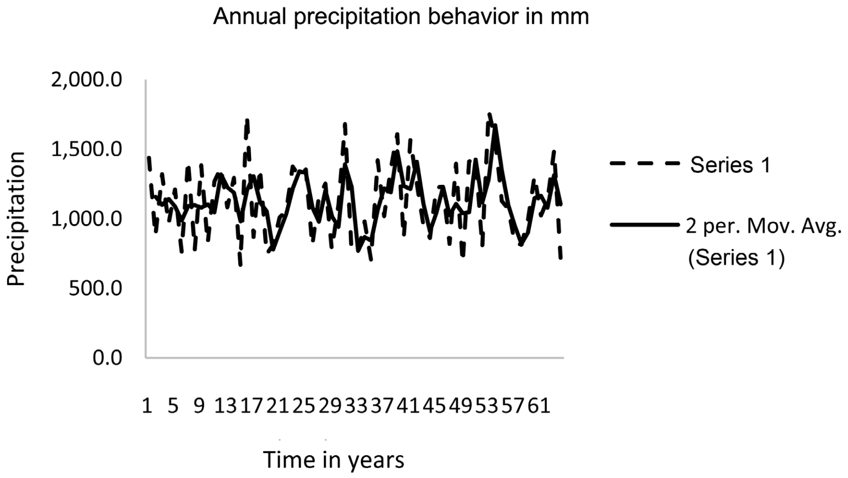
See Graph 10.



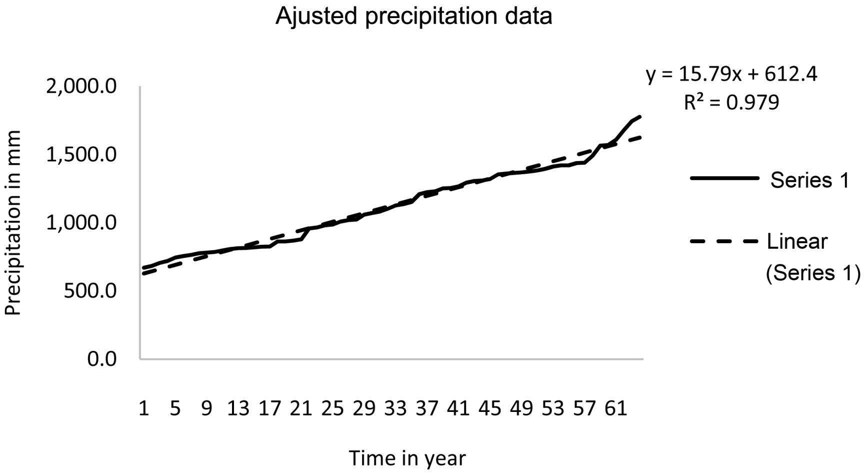
Graph 1. Behavior of evapotranspiration, with data from the airport station, Managua. Source: Author (2020).



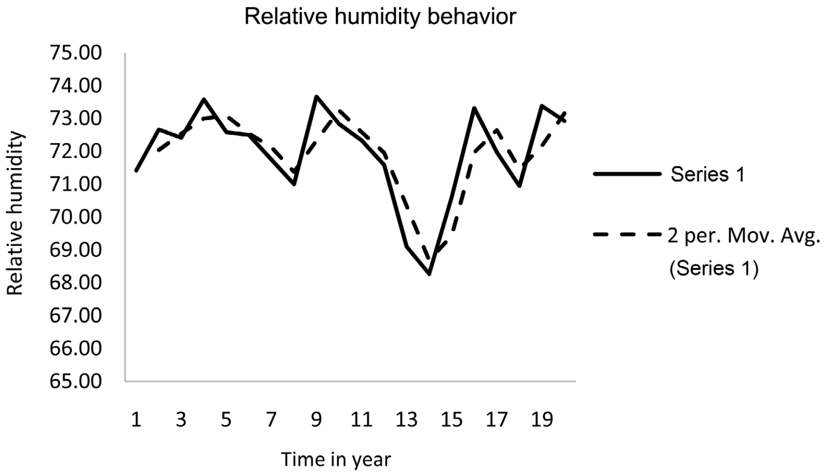
Graph 2. Behavior of evapotranspiration, with data from the airport station, Managua. Source: Author (2020).



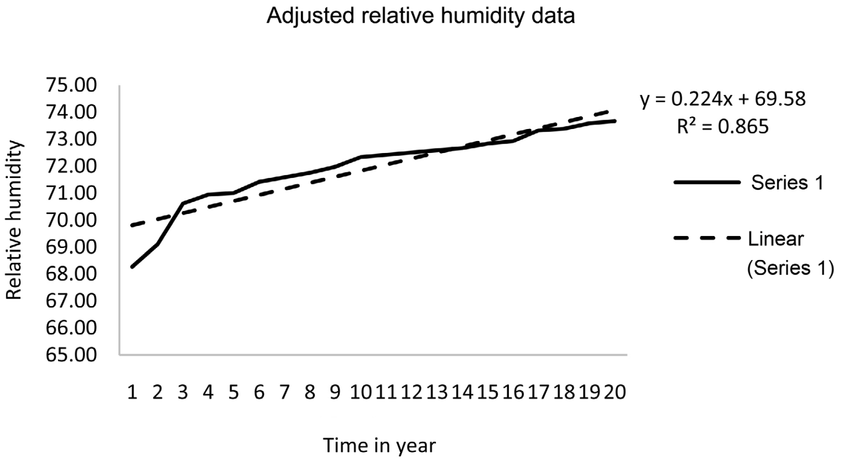
Graph 3. Historical behavior of precipitation in mm, with data from the airport station, Managua. Source: Author (2020).



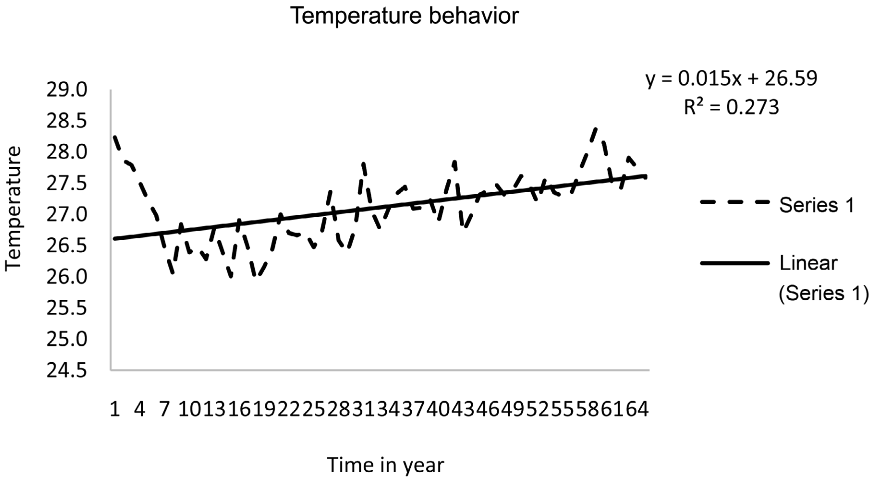
Graph 4. Adjustment of precipitation data from the airport station, Managua. Source: Self-made (2020).



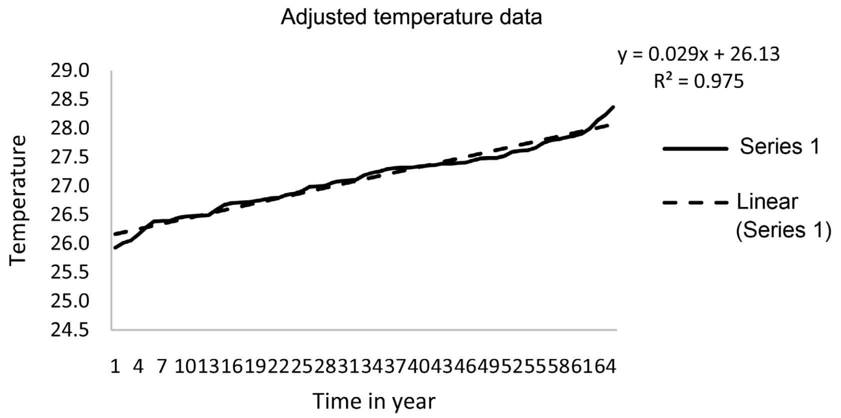
Graph 5. Behavior of the HR, with data from the airport station, Managua. Source: Author (2020).



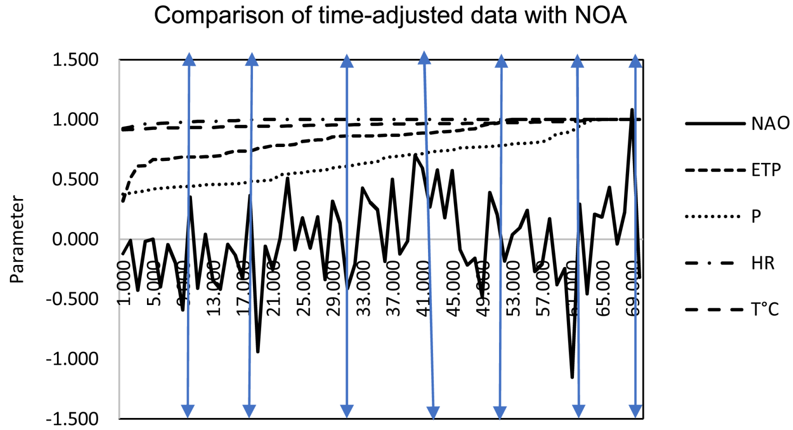
Graph 6. Adjustment of the HR data of the airport station, Managua. Source: Author (2020).



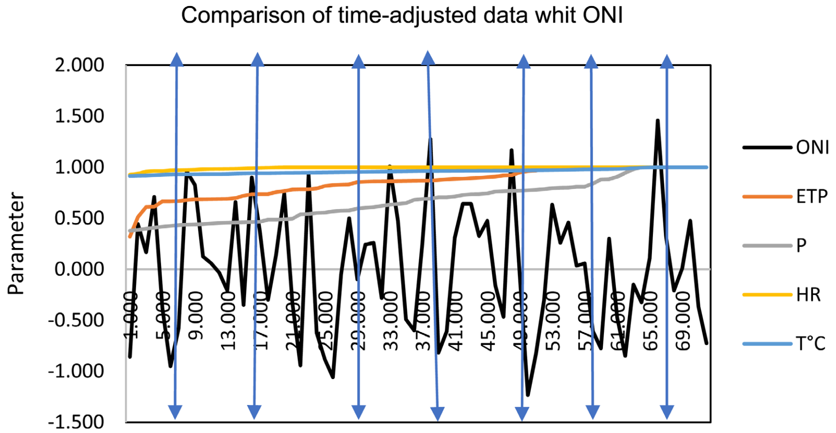
Graph 7. Temperature behavior with data from the airport station, Managua. Source: Author (2020).



Graph 8. Temperature trend graph with adjusted data from the airport station, Managua. Source: Author (2020).



Graph 9. Comparison of adjusted and time-normalized meteorological data with the North Atlantic Oscillation (NOA). Source: Author (2020).



Graph 10. Comparison of the data adjusted and normalized over time with the Oceanic Index of Child (ONI). Source: Author (2020).

5. Analysis of the Results

See **Tables 2-7**.

Table 2. Summary table of the results of the evapotranspiration trend.

R^2 correlation	0.5658
Effective correlation R	0.7521
ETP mm mínimum	2000
ETP mm máximum	2500
Δmm	500
Δ% Increase in evapotranspiration in the last 40 years	20

Source: Author (2020).

Table 3. Summary table of the results of the precipitation.

Precipitation in mm	1300
Last precipitation in mm	1210
Δmm	90
Δ% decrease in rainfall and behavioral tren for the next 40 years	6.92

Source: Author (2020).

Table 4. Summary table of the results of the HR trend.

R^2 correlation	0.6537
Effective correlation R	0.801
HR% mínimum	71.5
HR% máximum	80.5
Δ	−9
Δ% Relative humidity decrease in the last 40 years	−11.18

Source: Author (2020).

Table 5. Summary table of temperature data.

R^2 correlation	0.5561
Effective correlation R	0.7457
Temperature mínimum	26.2
Temperature máximum	27.4
Δ˚C	1.2
Δ% decrease in rainfall and behavioral tren the next 40 years	4.3

Source: Author (2020).

Table 6. Results of the behavior of meteorological factors, under the influence of the NOA.

North Atlantic Oscillation (NOA)		
Time	**Atmospheric index**	**Interpretation**
1950-1960, 10 years	ETP (mm)>	Increases
	HR%>	Increases
	P (mm)>	Increases
	<T˚C	Decreases
1960-1990, 30 years	ETP (mm)>	Increases
	<HR%	Decreases
	<P (mm)	Decreases
	T˚C>	Increases
1990-2020, 30 years	ETP (mm)>	Increases
	<HR%	Decreases
	<P (mm)	Decreases
	T˚C>	Increases

Source: Author (2020).

Table 7. Results of the behavior of meteorological factors, under the influence of ONI.

Oceanic Child Index (ONI)		
Time	**Atmospheric index**	**Interpretation**
1950-1960, 10 years	ETP (mm)>	Increases
	HR%>	Increases
	P (mm)>	Increases
	<T˚C	Decreases
1960-1990, 30 years	ETP (mm)>	Increases
	<HR%	Decreases
	<P (mm)	Decreases
	T˚C>	Increases
1990-2020, 30 years	ETP (mm)>	Increases
	<HR%	Decreases
	<P (mm)	Decreases
	T˚C>	Increases

Source: Author (2020).

6. Conclusions

Analyzing the climatological variables recorded for 60 years at the national level, and the reported effects of disasters, some links can be established between certain development conditions and processes and disaster risk. This focuses on tropical cyclones and floods.

Regarding the findings found, there is a strong correlation between the hydrometeorological factors with NOA and ONI, since climatic variability differs over 60 years analyzed in periods of 1950-1960, 1960-1990, 1990-2020, occurring an increase in evapotranspiration and temperature; and a decrease in relative humidity and precipitation.

With this analysis, risk scenarios can be generated for decision-making that mitigates climate change.

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First of all, to God, our father, who has given me a hand to continue on the right path as a person.

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Conflicts of Interest

The author declares no conflicts of interest regarding the publication of this paper.

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