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Climate and Climate Change in Hidalgo, Mexico

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Abstract: Climate change is a global phenomenon that affects different regions, so it is important to study and know the climate and climate change at different scales in order to know the possible future impacts. Hidalgo is one of the 32 states that make up the Mexican Republic, its territory of 20.8 million square kilometers is part of two natural provinces Sierra Madre Oriental and Nejeolocánico, which contribute to biological diversity and climate. According to climate map 39 percent corresponds to temperate climates being the one of greater presence, 28 percent of the territory has hidalguense climates of type semi-warm, 18 percent dry climates and 15 percent warm climates. Through documentary research and in the field it was found that some regions of the state of Hidalgo have been damaged by climate change especially by the increase of the temperatures and the decrease of the precipitations, the stories like Sierra Madre Oriental or the Valley of the Mezquital (which includes a Tula de Allende and Meztitlán).

Keywords: climate change, climate, regional economics, adaptation, environmental problems.

1. Introduction

What is climate change?Climate Change means: "a change of climate attributed directly or indirectly to human activities that alters the composition of the global atmosphere and which adds to the natural variability of the climate observed over comparable periods of time" definition developed in the United Nations Framework Convention on Climate Change [1].

Climates are a representation and description of average values obtained from weather conditions (temperature, humidity, pressure, winds and precipitation) measured in periods of time generally greater than 30 years or more [2]. However, due to the alterations and changes that are increasingly recurrent in the weather, measurements must be made more and more frequently to know Climate Change [3].

The United Nations Framework Convention on Climate Change (UNFCCC) definition emphasizes the impact of human actions and activities on a daily basis, being understood as those we carry out to satisfy our needs under a model of capitalist production and consumption [4].

Climate change is a natural phenomenon that has always taken place, accompanying the planet's geological and atmospheric changes. These are interactions between the different cycles of water, carbon, nitrogen, etc., as well as interactions with ecosystems and natural landscapes, as well as the evolution of the planet and even the sun itself [5].

The first man to investigate the different climates in the world according to his regime of temperatures and precipitation was Köppen in 1923 with his published work Die Klimate der Erde (Climate of the Earth). It is the first systematic work of climatology known in the world, employs a system of lower case and upper case letters separating the values in terms of average annual temperatures to describe the warm climates (letter A) of temperate (letter C) and these of the Cold (letter D) and polar (letter E) [6].

Thus we can see different types of climates associated with various forms of vegetation, and in turn with certain height and precipitation levels, as well as their longitudinal location.
Summarizing the climatic classification of Köppen can be indicated the following types of climate:
A - Macropérmico Climates (Warm, from the intertropical zone).
B - Dry climates (located in the subtropical zones and in the interior of the continents of the intertropical zone or the temperate zones). It is divided into two types: Desert (BW) and semidesert or steppe (BS).
C - Mesothermal or temperate climates.
D - Cold climates (located in high latitudes, close to polar circles and where the influence of the sea is very scarce).
E - Polar climates. They are located in the polar zones, limited towards the equator by the Polar Circles.
H - Undifferentiated high mountain climates.
To determine the subgroups or subtypes are added lowercase letters:
f - Rainfall all year round (in the intertropical zone): Af = jungle climate.
w - High sunshine (thermal summer), also in the intertropical zone: Aw = Climate of savanna

m - Monsoon showers. Similar to the Aw, but with more intense rains originated by the accentuated difference of the atmospheric pressures between the ocean and the continents. Only occurs in the south and southeast of the Asian continent.

s - Rains in winter. It corresponds to the dry subtropical climate or Mediterranean climate (according to Köppen), located in the subtropical latitudes of the western coasts of the continents.

On the other hand, EnriquetaGarcía elaborated an important modification to the system of Köppen to adapt it better to the conditions of Mexico[7]. The modified system developed by García in 1964 arises because none of the classification systems, including that of Köppen, was sufficiently detailed to be able to express, in a cartographic way, the enormous variety of climates present in Mexico, where the physiographic characteristics Of these change in relatively short distances as a consequence of the great orographic accidents that act on the climatic elements, as the barrier effects, that modify both the temperature and the distribution of the rain. For its part, the Köppen System was conceived to explain climates in wide geographical areas extended essentially in latitude, but not in altitude; The same author includes a very significant sentence in this regard: "So far we (referring to the Köppen working group) have not taken into account the differences between the climates of the plains of the upper latitudes and those of the mountains of the low latitudes. Consequently, there is no correspondence at regional level with the particular conditions of their rainfall regimes and their temperature conditions. "

2. Economy and climate change

In 2006 Nicholas Stern published The Economics of Climate Change, or better known as the Stern Report. This report shows the results of research using different models to measure the correlation between the world economy based on current patterns of consumption and production, global warming and climate change. It also performs different scenarios to measure risk and consequences On climate change, and even the economic, natural and social costs that would be derived depending on the level of commitment and responsibility of countries with higher GHG emissions, the factor that is most altering climate change.

The forecasts are overwhelming; According to Stern, climate change is categorized as a serious global threat against which we must all unite to fight it. "Climate change will affect the basic elements of life for people around the world - access to water, food production, health, and the environment. Hundreds of millions of people could suffer from hunger, water shortages and coastal flooding as the planet warms" [8].

Scientific evidence indicates that there is a serious risk that if we continue to maintain a level of economic growth as at present (BAU, with its respective GHG emissions), it can have serious and irreversible consequences for mankind.

Any decision taken on climate change has an impact, either not acting or continuing with the same policies, the same customs of consumption, production, among others, will result in reaching a level of GHG emission by 2050 550 parts per million, an increase the global temperature by two degrees Celsius more and a decrease of the Gross Domestic Product (GDP) of at least 5 percent.

The current level of GHG concentration in the atmosphere is 440 parts per million of CO2 according to the World Meteorological Organization and NASA, which has caused a global warming of 1.1 degree centigrade more in just 15 years. The bad news is that according to the projections made by Stern not only have we not stopped or lowered our level of emissions, but on the contrary, we have increased it, so we will most likely reach the scenario set for 2050 well before expected.

Some of the consequences that will result from this warming are the following:

• Changes in precipitation levels and average temperatures.
• The number and intensity of meteorological events such as hurricanes, storms, floods and even desertification processes could also be intensified.
• Changes in the water supply, in some areas will be considerably reduced and in others will be too abundant.
• Alterations in agricultural cycles due to changes in precipitation patterns and temperatures.
• Changes in species and ecosystems, increase of pests, extinction of species, disappearance of complete ecosystems.
• The total number of deaths due to thermal stress will increase.
• Between 15 and 40 percent of species will be exposed to extinction.
• Increased risk and poverty in areas of high marginality due to natural disasters and climatological changes.
• Decrease in GDP according to each country and region according to the level of mitigation and adaptation to Global Climate Change.

For its part, the Paris Agreement signed in 2016 has urged Annex I countries to accelerate their GHG reduction processes and limit the increase to 1.5 ° C. However, countries such as the United States far from cooperating have become an important barrier to achieving these achievements and promoting fossil energies, including coal.

3. Economic and natural system

The Environmental Economic Accounts System (SEEA) measures the economic costs of degradation and exploitation of natural resources and the use of the environment. A large number of advanced countries now count on this system, including Mexico, to measure the effects of the economy on the environment and on renewable and non-renewable natural resources, seen as a natural capital.

The idea of conceptualizing nature and natural resources, such as water, clean air, aquifers, ecosystems, biodiversity, the atmosphere, etc., as a capital comes from the approaches to environmental economics and Ecological economics, and even global discussions at the various conferences of the United Nations Organization on the Environment [9].

This idea tries to indicate that the economic cycle and the reproduction of capital do not begin with the extraction of the resources nor end in the landfills, but it is a broader cycle that includes the nature like main supplier and recycler-degrading maximum of the elements[10].

Recognizing that nature is not only a resource provider, but also part of the economic process has cost economic science a great deal of effort, because if this happened it would be necessary to increase economic costs due to environmental effects [11].

Figure 1 shows the extended economic cycle showing how the economic cycle starts from the existence of a natural capital, termed as lands, aquifers, atmosphere, climate, mines, among others. Which we extract the materials and make use of environmental services to even breathe, then find the agricultural activities as part of the production of food and other resources provided by nature but with the help of human labor to be able to reproduce.

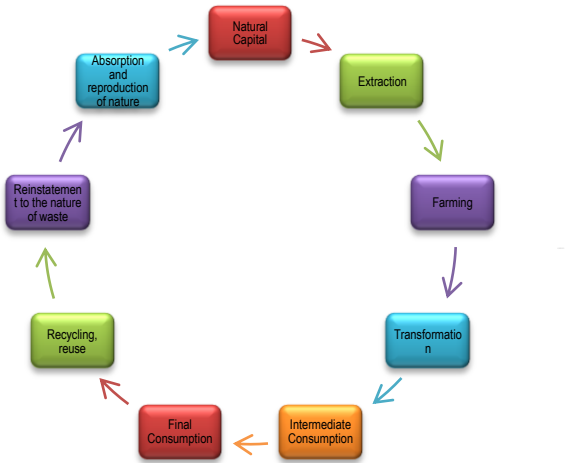

Figure 1: Extended Economic Cycle.

Once extraction and harvests are available, thesecondary sector (transformation of theraw material into new products), which has severalsubsectors of industries, such as metalworking, agroindustry, leather, etc., appears. . Withinthissame sector, theproducts can be usedforother industries orfor final householdconsumption, thisiscalledintermediateconsumption and final consumptionrespectively.

Traditionallytheeconomiccycleendedhere in the final consumption of products in households, sinceitwasnotnecessarytoconsiderthecosts of pollution and environmentaldegradation [12]. Forexample, a largenumber of industries puttheirproductsonthemarketwithoutworryingabouttheenvironmentalcoststhey cause, frombatteries, oils, plastics, and so on.

Differentcountries are adopting and incorporatinglawsto stop pollution, imposing fines, raisingtaxes, promotingchanges in consumption and productionpatternstowardsenvironmental-friendlytechniques. In thisway, thetechnologicalimprovementisencouraged and, in turn, theeconomyisinsertedintotheenvironment, in returnfortheenvironmentalcostsderivedfromeconomicactivity.

Othercountries, ontheotherhand, decide tosacrificetheirenvironmentalquality at the expense of economicgrowthortoattractforeign capital, however, environmentalcosts can not be avoided and couldeventuallyresult in lower-than-expectedeconomicgrowth.

Recycling, reuse and reduction (3R) activities are part of theprocessesbeforereturningwastetotheenvironmentfordisintegration and re-incorporationintothe natural system[13]. Thesethreeactivitiesserveto reduce wasteconsiderably, butagainitdependsonthelegislation and thepoliticalwill of each country orstate, reduce wastebyencouragingtherecyclingindustry, reuse and reduction of pollutants.

Finally, theincorporation of theresiduesintonature and theirabsorptiononthepart of thelatterdependsgreatlyonthecompoundsused in production, forexample, aneconomywithlessfossilenergy use will be muchlesspolluting, Theproduction of productswitheasily degradable materials, less use of pesticides, hazardousmaterials, heavy metals, etc. willcontributeto a more sustainableeconomywithlowerenvironmentalcosts.

4. Climate of Hidalgo

Hidalgo is one of the 32 states that Mexico has, located in the center of the country, its territory represents 1.06% and where about 2.8 million people live. Industry is one of the main activities of the economy, although agriculture and services are also an important part. Only 52 per cent of people live in urban areas and 48 per cent live in rural areas.

Hidalgo presents a great variety of climates as we see in Figure 2, the conformation of each of them has to do with its location in the central zone of the country, in addition to the rock formations and altitudinal that can change in short distances. Note that going to the northwest climates become warm humid and semi-warm due to the proximity to the Gulf, while to the west and the middle part prevail dry and semi-dry climates, in a mixture with humid and subhumid temperate climates according to the level Altitudinal, so we can find some areas with contrasts between temperate forests and xerophyticforests.

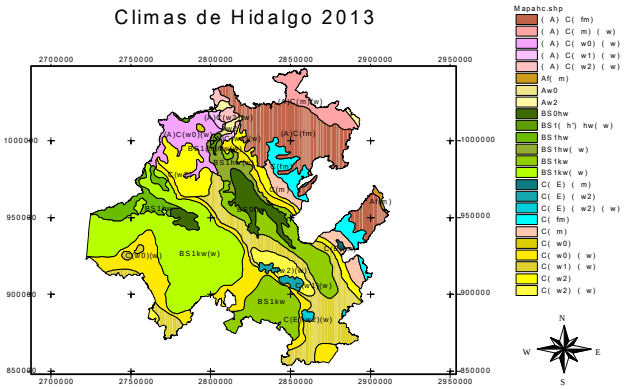

Figure 2:Climate map

Grouping in four large groups the types of climates, we observe that 39 percent corresponds to temperate climates being the one of greater presence, 28 percent of the territory has hidalguense climates of type semi-warm, 18 percent dry climates and 15 percent warm climates (see Figure 3).

Description of the climates present in Hidalgo

1. (A)C(fm), (A)C, Semicálido, (fm), húmedo, N/A, N/A, f, todo el año, N/A, < 18, > 40, > 18
2. (A)C(m)(w), (A)C, Semicálido, (m), húmedo, N/A, N/A, m, abundante de verano, (w), < 5, < 40, > 18
3. (A)C(w0)(w), (A)C, Semicálido, (w), subhúmedo, 0, menos húmedo, w, de verano, (w), < 5, < 40, > 18
4. (A)C(w1)(w), (A)C, Semicálido, (w), subhúmedo, 1, humedad media, w, de verano, (w), < 5, < 40, > 18
5. (A)C(w2)(w), (A)C, Semicálido, (w), subhúmedo, 2, más húmedo, w, de verano, (w), < 5, < 40, > 18
6. Af(m), A, Cálido, f(m), húmedo, N/A, N/A; f, todo el año, (m), < 18, > 60, > 22
7. Aw0, A, Cálido, N/A, subhúmedo, 0, menos húmedo, w, de verano, N/A, entre 5 y 10.2, < 60, > 22
8. Aw2, A, Cálido, N/A, subhúmedo, 2, más húmedo, w, de verano, N/A, entre 5 y 10.2, < 60, > 22
9. BS0hw, BS, estepario, 0, seco, h, semicálido, w, de verano, N/A, entre 5 y 10.2, entre 18 y 22, < 18, N/A, invierno fresco
10. BS1 (h')hw(w), BS, estepario, 1, semiseco, (h')h, cálido, w, de verano, (w), < 5, > 22, < 18, N/A, N/A
11. BS1 hw, BS, estepario, 1, semiseco, h, semicálido, w, de verano, N/A, entre 5 y 10.2, entre 18 y 22,< 18, N/A, invierno fresco
12. BS1 hw(w), BS, estepario, 1, semiseco, h, semicálido, w, de verano, (w), < 5, entre 18 y 22, < 18, N/A, invierno fresco
13. BS1 kw, BS, estepario, 1, semiseco, k, templado, w, de verano, N/A, entre 5 y 10.2, entre 12 y 18, entre 3 y 18, > 18, verano cálido
14. BS1 kw(w), BS, estepario, 1, semiseco, k, templado, w, de verano, (w), < 5, entre 12 y 18, entre - 3 y 18, > 18, verano cálido
15. C(E)(m), C(E), Semifrío, (m), húmedo, N/A, N/A, m, abundante de verano, > 5, < 40, entre 5 y 12
16. C(E)(w2), C(E), Semifrío, (w), subhúmedo, 2, más húmedo, w, de verano, entre 5 y 10.2, < 40, entre 5 y12
17. C(E)(w2)(w), C(E), Semifrío, (w)(w), subhúmedo, 2, más húmedo, w, de verano, < 5, < 40, entre 5 y 12
18. C(fm), C, Templado, (fm), húmedo, N/A, N/A, f, todo el año, N/A, < 18, > 40, entre 12 y 18

19. C(m), C, Templado, (m), húmedo, N/A, N/A, m, abundante de verano, N/A, > 5, < 40, entre 12 y 18
20. C(w0), C, Templado, (w), subhúmedo, 0, menos húmedo, w, de verano, N/A, entre 5 y 10.2, < 40, entre 12 y 18
21. C(w0)(w), C, Templado, (w)(w), subhúmedo, 0, menos húmedo, w, de verano, (w), < 5, < 40, entre 12 y 18
22. C(w1)(w), C, Templado, (w)(w), subhúmedo, 1, humedad media, w, de verano, (w), < 5, < 40, entre 12 y 18
23. C(w2), C, Templado, (w), subhúmedo, 2, más húmedo, w, de verano, N/A, entre 5 y 10.2, < 40, entre 12 y 18
24. C(w2)(w), C, Templado, (w)(w), subhúmedo, 2, más húmedo, w, de verano, (w), < 5, < 40, entre 12 y 18

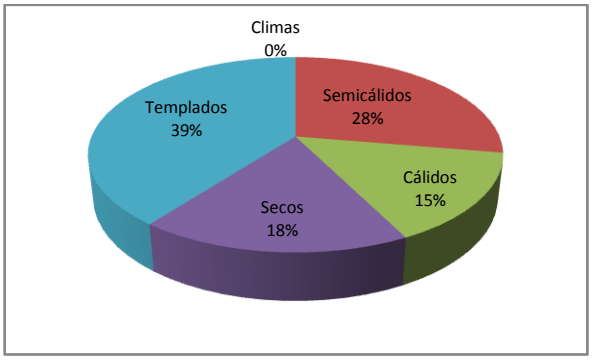

Figure 3: Types of climates in Hidalgo 2013

5. Climate Change in Hidalgo

Pompilio and Mezaconducted a research on climate change in the state of Hidalgo, based on data obtained from the 79 meteorological stations that are distributed throughout the state and with information in a period of time from the late nineteenth century to 2006 [14]. Thus, they were able to assess whether Köppen's climate classification modified by EnriquetaGarcía has been maintained despite local and global climate changes in the state. The result of this investigation shows that the climate has effectively changed, we can state in a strict sense that there is a climatic change in Hidalgo, which presents variations in temperature and decrease in precipitation especially.

The research also points out that the most vulnerable sites to climate change are particularly humid regions, emphasizing the areas that cover the Sierra de Hidalgo state, where there is a mesophyll mountain forest vegetation - one of the most threatened ecosystems and Is in danger of extinction -, present in the Otomí-Tepehua mountain range, so that municipalities such as: Tlanchinol, Agua Blanca and San BartoloTutotepec have had important modifications, are becoming increasingly warm by climate change.

Likewise, in the Mezquital Valley there are trends towards a decrease in the frequency of rainfall, so that this region is becoming increasingly arid. On the other hand, although extreme alterations are not yet observed, the change in the climates of the regions of Hidalgo will be gradual, but it is expected that the alterations in the climate will increase considerably.

On the other hand, in June 2013 tours and visits were made to other regions of the state, such as the Endho Dam in Tula, where we observed a very low level of water given the dam's capacity, partly because of the dry season; However, the high evaporation rate given the increase in average temperatures is also noticeable.

Figure 4: Endhó Tula Hidalgo Dam

In the same way we visited the lake of Meztitlán, where we observed the same phenomenon of evaporation of water, but more alarming: it was observed that about two kilometers or more of the lagoon is in the open, due to the lack Of rainfall in more than a year, ie the rainy season could be prolonging more than normal.

Metztitlán is limited to the south with the transverse volcanic axis; To the north with mountains that originate the fluvial of the rivers Moctezuma-Pánuco and the Lerma Santiago: to the east by the Sierra Madre Oriental and to the west by the Sierra Madre Oriental, forming a small valley, that frames the birth of the HuastecaHidalguense.

La Vega de Meztitlán, as it is known, has a privileged geography as it is surrounded by two mountain ranges that form the lagoon, where the runoff occurs during the rainy season. This gives way to a microclimate and to natural conditions of agricultural production very good, although the climate change is affecting those conditions.

Figure 5: Metztitlánlagoon

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6. Conclusions

Climate Change is a global phenomenon that specifically affects each locality. Some regions of the state of Hidalgo have been damaged by rising temperatures and declining rainfall, such as the Sierra Madre Oriental or the Mezquital Valley (which includes Tula de Allende and Meztitlán); However, it is necessary to carry out constant monitoring in other areas where there may be serious damage to crops and recharge of aquifers.

The state of Hidalgo is in the phase of carrying out a State Program of Action for Climate Change by specialists and consultants, with which measurements of GHG emissions can be made in the state by sector, the energy balance , Scenario of emissions, recommendations for mitigation, adaptation strategies, among others, also mentions that in two of its scenarios the average temperature in the state could rise between 1.7 and 2.85 ° C, as well as a decrease in the average precipitation between The 800 and 900mm annually by the year 2080.

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