













Uncontrolled urbanization south of Zapopan, Jalisco, Mexico: Adaptation measures to infringe the effects of climate change





Urbanización descontrolada sur de Zapopan, Jalisco, México: Medidas de adaptación para vulnerar los efectos del cambio climático

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Abstract

The La Primavera Forest System and El Bajío Zone have suffered uncontrolled urban growth, which causes a decrease in permeable soil for river waters. This has caused flooding in surrounding neighborhoods for more than five years, and affected the properties and furniture of the inhabitants of those neighborhoods. Currently this system is characterized as a territory contributing to climate change. This contribution is related to the economic sector, since the negative anthropogenic externalities generated by uncontrolled urban growth are due to the existence of limited urban-environmental legislation, and also because these are not applied completely and sufficiently. For this reason, the following work is proposed, the objective of which is to “Propose adaptation measures for the La Primavera Forest System and the Bajío Zone, through the analysis of the floods that neighboring colonies have suffered, which will allow improving the quality of life of the inhabitants and the conditions of the territory.”

Resumen

El Sistema Bosque la Primavera y Zona El Bajío ha sufrido un crecimiento urbano descontrolado, lo cual ocasiona disminución de suelo permeable para las aguas fluviales. Esto ha causado durante más de cinco años inundaciones en colonias aledañas, y afectado inmuebles y mobiliario de los habitantes de esas colonias. Actualmente este sistema se caracteriza como un territorio contribuyente al cambio climático. Esta contribución se relaciona con el sector económico, ya que las externalidades antropogénicas negativas que genera el crecimiento urbano descontrolado se deben a la existencia de legislación urbanoambiental limitada, además, porque estas no se aplican de manera total y suficiente. Por tal motivo, se propone el siguiente trabajo cuyo objetivo es “Plantear medidas de adaptación para el Sistema Bosque la Primavera y Zona El Bajío, a través del análisis de las inundaciones que han sufrido colonias aledañas a este, que permita mejorar la calidad de vida de los habitantes y las condiciones del territorio”.

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Objective	Methodology	Contribution
To propose adaptation measures for the Bosque la Primavera System and the El Bajío Zone, through the analysis of political, urban and environmental controversies, which allows the surrounding neighborhoods to adapt to the system, in turn, improve the quality of life of the inhabitants and the conditions of the territory.	The research is qualitative, with respect to the research strategy, the study is situated from the interpretive perspective, through the case study strategy. As for the type of case study, this corresponds to the intrinsic one, remember that it is one that is not sought by the researcher.	Answer why the neighborhoods surrounding the La Primavera Forest System and the El Bajío Zone are flooded.

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Objetivo	Metodología	Contribución
Plantear medidas de adaptación para el Sistema Bosque la Primavera y Zona El Bajío, a través del análisis de las controversias políticas, urbanas y ambientales, que permita adaptar las colonias aledañas al sistema, a su vez, mejorar la calidad de vida de los habitantes y las condiciones del territorio.	La investigación es de tipo cualitativa, respecto a la estrategia de investigación, el estudio se sitúa desde la perspectiva interpretativa, a través de la estrategia de estudio de caso. En cuanto al tipo de estudio de caso, este corresponde al intrínseco, recordemos que es aquel que no es buscado por el investigador.	Responder por qué se inundan las colonias aledañas al Sistema Bosque la Primavera y Zona El Bajío.

Uncontrolled urbanization, climate change and adaptation

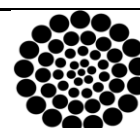
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Introduction

The La Primavera Forest System and El Bajío Zone have suffered uncontrolled urban growth, which causes a decrease in permeable soil for river waters. This has caused flooding in surrounding neighborhoods for more than five years, and affected the properties and furniture of the inhabitants of those neighborhoods. Currently this system is characterized as a territory contributing to climate change. This contribution is related to the economic sector, since the negative anthropogenic externalities that generate uncontrolled urban growth are due to the existence of limited urban-environmental legislation, and also because these are not applied in a complete and sufficient manner. For this reason, the following work is proposed, the objective of which is to "Propose adaptation for the La Primavera Forest System and the El Bajío Zone, through the analysis of measurements of the floods that neighboring colonies have suffered, which allow improving the quality of life. of the inhabitants and the conditions of the territory."

This proposal will make it possible to improve the vitality of the inhabitants, in turn, increase the quality of life; Together, contribute to the eradication of poverty and the sustainability of life, by increasing psychological, health, labor stability, sense of belonging and social cohesion, which together make governance possible. The research is qualitative, with respect to the research strategy, the study is situated from the interpretive perspective, through the case study strategy. As for the type of case study, this corresponds to the intrinsic one, remember that it is one that is not sought by the researcher.

Statement of the problem

Problem Urban growth in the lower area of the Bosque la Primavera and El Bajío area, identified in this work as the Bosque la Primavera System and the El Bajío Area, generates flooding. In 2021 Milenio published "This year, for the third time the El Seco stream overflowed in Zapopan after the storm that occurred on Saturday afternoon, affecting the neighborhoods Lomas de la Primavera, Miramar, Villas de la Primavera, Arenales Tapatíos, Colinas de la Primavera, El Briseño and Jardines Tapatíos" (Ruiz, 09/05/2021).

In 2022 Telediario reported "The residents of the Miramar neighborhood in Zapopan describe what they are experiencing as a nightmare, because after the rains that have been recorded in recent days and which have caused the El Seco stream to overflow, it has made it difficult for them their daily life" (Álvarez, 07/11/2022). For its part, the Jalisco State Human Rights Commission announced in its document "Environmental problems in Jalisco August 29, 2022" "In the metropolitan area of Guadalajara, the rains damaged 50 houses in Tlajomulco de Zúñiga; in addition to the west of Guadalajara and the center and south of Zapopan" In short, for two consecutive years the south-eastern area of Zapopan has been flooded, this can be considered an environmental problem.

Research question

The question that guides this work is: Why are the colonies surrounding the Bosque la Primavera System and Zona El Bajío flooded?

Hypothesis

To answer the research question, the following hypothesis is proposed, which has emerged from the preliminary analysis of the territory and the political, urban and environmental controversies. The neighborhoods surrounding the Bosque la Primavera System and Zona El Bajío are flooded due to the uncontrolled urban growth that their territory has suffered, which begins with the deforestation of the forests and concludes with the increase in concrete and a decrease in permeable surface for river waters. . Added to this situation is the insufficiency of current environmental legislation, in turn, the lack of application of the existing one.

General and specific objective

The general objective through which the research question will be answered is to "Propose adaptation measures for the La Primavera Forest System and the El Bajío Zone, through the analysis of political, urban and environmental controversies, which allow the adaptation of the surrounding colonies. to the system, in turn, improve the quality of life of the inhabitants and the conditions of the territory." To achieve the general objective, the specific objectives are set:

Article

1. Analysis of the floods that occurred in the Bosque la Primavera System and the El Bajío Zone.
2. Establish the political, urban and environmental controversies that are related to the climate impact that occurs in the La Primavera Forest System and the El Bajío Zone.
3. Establish the relationship between quality of life and conditions of the territory.

Theoretical fundament

Climate change

Climate change is a worldwide phenomenon that brings with it global variation in climate, whose persistence is for long periods of time. This modification is due to the direct action of man who alters the composition of the global atmosphere, due to the excessive emission of greenhouse gases, which are produced through the use of electrical energy, excessive consumption of fossil fuels, pollution of urban areas, etc. Its effect is observed in the increase in temperature, heat waves, a greater number of hurricanes and tropical storms, the drying of rivers, etc.

Box 1



Figure 1
Overall Effect: Global warming

Source: Google:2023

Box 1



Figure 2
Local Effect: Air pollution: Western area of the Guadalajara Metropolitan Area

Box 1

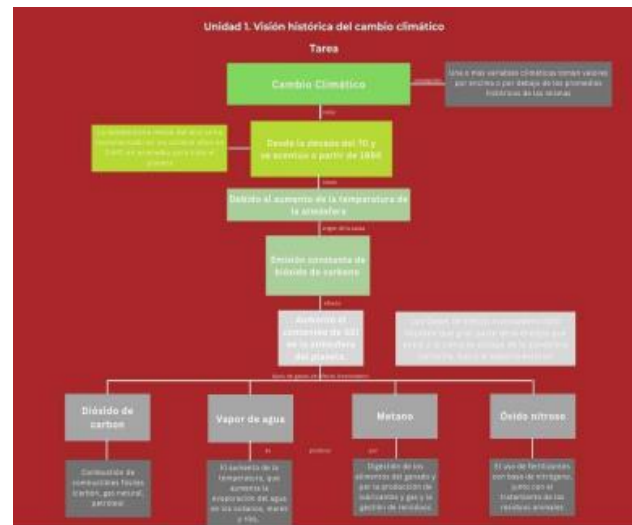


Figure 3
Historical view of climate change

Source: Own construction

Methodology

Develop give the meaning of the variables in linear writing and important is the comparison of the used criteria.

Climate change is a phenomenon caused by several factors, in which the complexity of their interrelationships stands out. Likewise, its effects are systemic in nature. In this sense, the starting point of my interpretation of climate change is built from difference and not identity.

Therefore, we start from the condition before climate change and contrast it with the current situation. From there we establish what current situation climate change communicates to us?

I will focus my interpretation on the local, I clarify, it is not reality, since everyone builds their own, mine is an interpretation. So what does climate change tell us locally? We look at only a part of the environment and there we observe that urbanization in the last 7 decades has contributed to the increase in the emission of carbon dioxide, which has increased in the last 40 years, through a diffuse and expansive urbanization that generates greater travel distances, consequently, an increase in gasoline or diesel means of transportation, both public and private, with the complacency of the corresponding authorities.

The developers do not agree with this, they continue to exploit an architectural “model” of designing buildings for residential and commercial use that lacks sustainability, which only causes greater consumption of non-renewable energy (at least in our country) such as electricity, to quell the high temperatures that are reached inside houses and residential and office apartments, lacking conditions that violate the quality of life, such as lighting, ventilation, etc. Regarding the effects on health, family coexistence, learning at home, etc., we better not even interpret it.

The research is qualitative; this type, following [Katayama \(2014\)](#), allows knowledge of complex phenomena, focuses on typically human phenomena, and allows the study of the fields where deceptive behaviors occur. Therefore, considering that it is a social investigation, the present study is framed in the conceptual-inductive model or system. The research process in this model is focused, according to [Katayama \(2014\)](#), on the following dimensions:

1. Beginning of the observation of social facts
2. Obtaining and classifying data until saturation is achieved
3. Formulation of concepts and hypotheses
4. Systematization and structuring of concepts and hypotheses for the construction of theories.

In this type of research, the phenomena are observed in situ, through two moments: i) exploration, inspection and description and explanation; ii) words, non-numerical data, objects of exploration; and numerical data are words, texts and images. And from these, categories and concepts are established. [Katayama \(2014\)](#).

Regarding the research strategy, the study is situated from the interpretive perspective, through the case study strategy. The nature of this strategy is the study of a particular phenomenon. This is understood as a specific theoretical construction pre-established by a scientific community.

As for the type of case study, this corresponds to the intrinsic one, remember that it is one that is not sought by the researcher.

The case is not studied because it represents other cases, or because it illustrates some feature, but because the case is interesting in itself.

Political-environmental controversies

Crossroads between environmental policy and political environment

The Mexican government finds itself in a dilemma between sustainability and a higher rate of acceptance by the population. In the last three decades, Mexico has signed international agreements to contribute to the fight against climate change. If we draw a timeline from 1992, the United Nations Framework Convention on Climate Change, COP3 held in Kyoto in 1997, COP13 in Bali in 2007, COP15 in Copenhagen in 2009, COP16 in Cancún in 2010, COP11 in Durban in 2011, COP18 in Doha in 2012, COP19 in Warsaw in 2013, COP20 in Lima in 2014, COP21 in Paris in 2015, COP22 in Marrakech in 2016, the COP23 in Bonn in 2017, COP24 in Katowice in 2018, COP25 in Chile in Madrid and COP26 in Glasgow in 2021 and COP27 in Egypt in 2022. On the other hand, in the national political and economic sphere, the beginning of the construction of the Texcoco Airport in 2015, the beginning of the implementation of the Mayan Train in December 2018 and the inauguration of the construction of the Dos Bocas refinery, in Tabasco, in August 2019. In the timeline, two representations can be seen, the first, 26 years of international consensus on policies and economies against climate change, in the second, eight years of national dissent caused by economic politicking.

The United Nations Conference on Environment and Development in Rio de Janeiro in 1992 is recognized as the formal start on climate change. The United Nations Conference on Environment and Development, held in Rio de Janeiro in 1992, reflected the international consensus when addressing the problem of climate change. During its celebration, the United Nations Framework Convention on Climate Change (UNFCCC) was created, which was initially signed by 166 countries and finally came into force on March 21, 1994. Currently, it has been ratified by 197 countries. ([Iberdrola, 2023](#)).

During the 16 COPs, 5 agreements stand out ([Iberdrola, 2023](#)):

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1. Limit the increase in global temperature to below 2° C compared to the level of the pre-industrial 404 era.
2. National climate contributions that contribute to the defined long-term objective.
3. Financing from developed countries to developing countries for investment in sustainable and socially responsible assets such as renewable energies.
4. Technology transfer to developing countries to achieve the 2°C objective.
5. Adaptation and mitigation to climate change through planning and implementation of measures.

In conclusion, the agreements established from the United Nations Framework Convention on Climate Change give shape to a pact to build a global strategy to combat climate change.

Participation of Mexico in cooperation agreements

Mexico, two faces with different makeup in the face of climate change: towards the outside, a makeup of commitment; towards the interior, a makeup of oblivion. The Mexican government presents two different faces regarding Climate Change.

Towards the outside world, it declares its commitment to combating Climate Change, “The Government of the Republic is committed to respecting the environment and promoting the generation of clean energy” (Government of Mexico, 2016). Inside “At the beginning of the six-year term, López Obrador set out to increase oil production and “rescue” Pemex —the parastatal's emissions have doubled since then—” (Cullell, 2022). In summary “Mexico has surprised the COP 27. After building a huge refinery and paralyzing private investment in renewable energy, the Mexican Government wanted to show the world that it takes the environment seriously” — (Cullell, 2022).

The Government of Mexico, a lot of written commitment. In 1992, Mexico signs the United Nations Framework Convention on Climate Change (UNFCCC). The Convention was ratified before the UN in 1993 and entered into force on March 21, 1994.

It established a framework for action whose ultimate objective is to “Achieve the stabilization of greenhouse gas concentrations in the atmosphere at a level that prevents dangerous anthropogenic interference in the climate system (Government of Mexico, 2018). As part of the UNFCCC agreements, it was established to hold the Conference of the Parties (COP) annually, a meeting in which negotiations are carried out to advance towards compliance with the objectives of the UNFCCC. The first COP was held in 1995 in Berlin, Germany (Government of Mexico, 2018). In short, it seems that Mexico actively and regularly participates in the international context regarding Climate Change policies.

Mexico active and regular participation in meeting the objectives of the United Nations Framework Convention on Climate Change (UNFCCC)? As part of the UNFCCC agreements, it was established to hold the Conference of the Parties (COP) annually.

The first COP was held in 1995 in Berlin, Germany and since then Mexico has participated. On June 9, 1998, Mexico signed the Kyoto Protocol. Although it was approved in December 1997, it came into force until February 16, 2005 (Government of Mexico, 2018). This legally binding instrument commits industrialized countries to reduce emissions of greenhouse gases: carbon dioxide (CO₂), methane gas (CH₄) and nitrous oxide (N₂O), in addition to three fluorinated industrial gases: Hydrofluorocarbons (HFC's), Perfluorocarbons (PFC) and Sulfur Hexafluoride (SF₆), on average, by 5.2% in its first commitment period (2008-2012).

Finally, in 2015 COP 21 was held in Paris, France, where 195 nations made commitments against climate change and in favor of the environment and sustainable development.

The main agreements are about the reduction of greenhouse gas (GHG) emissions. In it the nations, both developed and developing, to work together in an ambitious, progressively equitable and transparent manner to keep the global temperature below 1.5 °C. At the end of the day, no one would doubt the efforts resulting in the Paris Agreement, however, it would be appropriate to ask ourselves: What has happened in Mexico?

Environmental controversies

The then president Enrique Peña Nieto relaunched the Airport project in Texcoco in 2014; In December 2018, the cancellation of the construction of the New International Airport of Mexico City (NAICM) was decided. After the results of the citizen consultation were published in which 70% of just over a million voters chose to cancel the airport in Texcoco and instead recondition the AICM and the Santa Lucía air base” (Van Bedolla, 25 /02/2021) the Government of Mexico decided to cancel the construction. On April 26, 2019, the Ministry of Communications and Transportation published “The Airport in Texcoco should never have been approved, much less started. It was a very serious error, the cancellation of which prevented a major ecological disaster, a severe demographic explosion in the Eastern Zone of the Valley of Mexico...” (Government of Mexico, 04/26/2019).

In this regard, Greenpeace considered at the time that the project in Texcoco "will bring consequences for the environment such as: poor air quality, deterioration of the area, impact on the habitat of migratory and shorebirds, as well as damage to surrounding towns." (El Financiero, 10/25/2018).

Today, more than 4 years after the cancellation, the site where the NAICM was going to be built is abandoned, and the works that were left unfinished appear flooded by the rains “far from having a policy in favor of nature, the López Obrador government “It has given a great boost to other megaprojects that are devastating to the environment” (Villanueva, 08/25/2020).

Mayan Train, a devastating project for the environment, at the same time, the way in which the decision was made is controversial. The Mayan Train is a work that, “before starting his mandate in 2018, AMLO proposed as one of the main infrastructures works to be built during his government” (Blanco, 07/28/2022). The main controversy with the construction of the Mayan Train, following (Medellín, as cited in Blanco, 2022) is related to the environmental impact; For example, issues related to the destruction of the jungle, the impact of cenotes or the modification of ecosystems due to changes in the project route.

“The Greenpeace organization is now joining the protests, asking the president to avoid an irreparable environmental impact. López Obrador defends that the work will bring benefits, and affirms that they have the support of indigenous communities in the area” (Cano, 04/01/2022).

It is important to highlight that voices of protest have been raised regarding the fact that they have never seen an executive plan that specifically indicates what the implications of the project will be.

The Dos Bocas refinery in the state of Tabasco is a refinery that is being built in an era focused on renewable energy. “Pemex is building the Dos Bocas refinery in an area it promised to protect. Between 2006 and 2007, the oil company promised not to touch a mangrove forest in exchange for the right to drill nearby” (De Haldevang, 07/28/2021).

However, “public documents reveal that Dos Bocas, one of President Andrés Manuel López Obrador's favorite projects for his native Tabasco, is being built in an area that the state oil company had promised to protect” (De Haldevang, 07/28/2021).

A 2008 study conducted by the state-run Mexican Petroleum Institute for PEMEX revealed that “Dos Bocas was the worst of seven potential sites considered for a new refinery due to environmental and social reasons, including the presence of mangroves and the risk of flooding” (From Haldevang, 07/28/2021).

It is noteworthy that the hydrocarbon sector is detrimental worldwide, however, renewable energies are emerging with great potential.

The current Government of the Republic has emerged from the dilemma it found itself in in 2018, when it came to power. At that time, Mexico had a track record in recent years of meeting climate change goals, however, it moved away in search of a higher popularity index among the population.

He turned his economic policy to the Stabilizing Development model, which was based mainly on a division of labor between the government and businessmen.

In this model, contradictions and polarization are observed with international agreements to contribute to the fight against climate change, among others:

1. Insufficiency of adaptation and mitigation measures to face the effects of changes in land use and nature, caused by the works promoted by the current Government. These works generate greater emissions of greenhouse gases, destruction of protected natural areas, attacks on established cultures and socioeconomic uncertainty, among other negative externalities.
2. Indetermination of anthropogenic impacts to the environment, which were not considered in the production costs due to environmental damage
3. Promotion of the Stabilizing Development economic model, which puts its interest before the growth of production, reductions in inflation rates and stability in exchange rates.

Failing that, climate change policies must be closely related to economic policies for climate change. Therefore, it is necessary to think about a sustainable economy that harmonizes international commitments regarding climate action policies, among others, the 2030 Agenda, the Paris Agreement. Certainly, to think about a harmonious economic model today is to think about a model based on the Degrowth Theory. Without a doubt, this requires the participation of civil society, academia, and the private sector, through an exercise of governance and not imperial politicking.

Political-environmental disagreement

Disagreement between international policies for the use of renewable energies and the actions of the Government of Mexico. As if it were a baseball match between developed and developing countries where the result is anticipated, this is what happens in the field of international policies for the use of renewable energies where the “action” of our country We imagine before they happen.

On the one hand, the UN seeks to transform access and transition to clean energy or renewable energy, remember that “these are replaced faster than they can be consumed, an example of these sources are sunlight and wind.” (ONU, s/f), on the other hand, the Government of Mexico expands the Dos Bocas refinery and purchases the Deer Park refinery, the latter “since 1992 was managed in co-ownership by the Dutch company Shell and the state company *Petróleos Mexicanos*” (Brooks, 12/27/2021). Without a doubt, the Government of Mexico bet on the Development Economy at a time when the world moves towards replacing oil with other renewable energies.

High-level dialogue results in a global roadmap for universal energy access and transition. “On September 24, 2021, more than 130 world leaders, including heads of state and government, ministers, executive heads of UN entities and international organizations, joined the High-Level Energy Dialogue and announced ambitious goals, actions of transformation and bold investments to achieve universal access to energy and net zero emissions” (09/24/2021), in the year 2050, among those present was the Mexican Foreign Minister Marcelo Ebrard. Let us remember that net zero emissions “indicate cutting greenhouse gas emissions until they are as close as possible to zero emissions, with some residual emissions that are reabsorbed from the atmosphere through, for example, the ocean and forests” (UN, s /F). “The commitments made aim to provide hundreds of millions of people with access to clean energy and accelerate the energy transition while creating green jobs to leave no one behind.” (09/24/2021).

In this sense, the United Nations (s/f) points out “Current national plans have fallen short.” Therefore, a 45% reduction in greenhouse gas emissions is necessary by 2030, compared to 2010 levels, so that global warming does not exceed 1.5°C” (UN, s/f). It is important to note that the combustion of the 340 thousand barrels per day that the Dos Bocas refinery will produce will emit around 6% more carbon dioxide.

The dialogue of the deaf results in a technically and financially unviable refinery. “On March 18, 2019, the federal government launched a tender restricted to four companies with experience, but also with questions in the field of refining” (Reforma, 10/14/2021).

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Two months later, “the Ministry of Energy (Sener) announced that the tender was declared void, since none of the companies met the requirements of completing construction in three years (...) Pemex and Sener took the reins of the project, with the promise of respecting the budget and having it ready by May 2022, as the President offered” (Reforma, 10/14/2021). Among several inconveniences due to its construction, the Mexican Petroleum Institute (IMP) “warned about the possibilities of flooding at the Dos Bocas refinery, Tabasco, both in an analysis carried out in 2008 and in the Environmental Impact Statement (MIA) of these oil facilities presented in 2019” (Badillo, 10/21/2023). And the premonition came true “The municipal president of Paraíso, Anita Castellanos stated that the Olmeca Refinery located in the Port of Dos Bocas is flooded due to heavy rains. The mayor indicated that 80% of the municipality faces flooding problems since the Seco River overflowed at midday and they are also affected by the construction of the Refinery. Consequently, “Achieving autonomy in oil refining at any cost may be a task based on a nationalist narrative that leaves rational decision aside” (Deloya, 01/26/2022).

In conclusion, the historical disagreement between international policies for the use of renewable energies versus national policies, held in Tabasco, and despite the hypothesis that developed countries defeat developing countries, the dialogue between the deaf He dispatched the game without a hit, or runs to those in high-level dialogue. Well, despite the Paris Agreements, the Degrowth Economy, the Sustainable Economy, the obsession with the highest possible number of Gross Domestic Product emerged victorious. Here and now, we need to harmonize the Mexican economy with international commitments, build a climate action policy from Governance.

Urban-environmental controversies

Current urbanization in Mexico drives Climate Change. Graizbord, (2010) points out “The size, growth rate and distribution of the population in the national territory are the relevant data to understand the demographic pressure on resources and environmental services; but other dimensions must be added.”

For example, experts from the UNAM warn “The climate of Mexico City and the Metropolitan Area has increased, mainly due to the change in land use and the disorderly growth of the territory and number of residents, which leads to registration increase in temperature, among other phenomena” (Castro and Luyando, 2021).

The Guadalajara Metropolitan Area is not immune to this situation. In Zapopan, some of the spaces that interact mostly with risks associated with climate change paradoxically coincide with the zoning of strategic spaces that has delimited the so-called “Municipal Strategy for Urban Prosperity 2030”, these are El Colli and Las Mesas. In the latter, in 2018, 39 damaged homes were reported, of which three collapsed (Gran, 2019).

In conclusion, we point out that Mexico has signed several agreements on Climate Change. It is noteworthy that these contain instruments to formulate, implement and evaluate the results of these agreements within the country. However, it seems that these instruments and actions in the national territory have been somewhat forgotten. In this case, it is urgent to develop policies, projects, regulatory and evaluation instruments on climate change under state and municipal jurisdiction, which are disaggregated from the commitments acquired at the international level. Although we are behind, the Mexican population and its territory cannot wait any longer. Urbanization in the Guadalajara Metropolitan Area The urbanization model of the Guadalajara Metropolitan Area (AMG) is based on chaos, which in turn contributes to climate change.

The Secretariat of Agrarian, Territorial and Urban Development (SEDATU) points out that “during the second half of the 20th century, urban areas grew in a disorderly and uncontrolled manner” (Herrera, 2014). For her part, Patricia Martínez, Director of the Metropolitan Planning Institute (IMEPLAN), pointed out that, “as a consequence of urban growth, between 2018 and 2022, 1,568 hectares of natural areas were lost, with environmental protection zones representing 77 percent of the loss (Milenio, 01/26/2023). The urbanization of the AMG in the last 70 years generated population concentration and territorial distribution of different intensity.

The conurbated municipalities of the AMG have had heterogeneous urban growth. During the first three periods of 1940-1950, 1950-1960 and 1960-1970 Zapopan, Guadalajara and San Pedro Tlaquepaque had the highest growth rates in the Guadalajara Metropolitan Zone (ZMG). With average rates around 4.5 for the first; 6.50 for the second; and 7.60 for the third. During the periods of 1970-1980 and 1980-1990 Zapopan, Tlquepaque and Tonalá reached an average rate of 7.60. In the period 2000-2010 Tlajomulco de Zúñiga reached a rate of 12.48 and Ixtlahuacán de los Membrillos 9.42 ([Institute of Territorial Information of the state of Jalisco, 2013](#)). In short, until the end of the last century, urbanization extended horizontally to the municipalities surrounding the city of Guadalajara; On the other hand, so far this year, urbanization has grown uncontrollably towards the remaining municipalities of the AMG, through a chaotic expansion.

The expansive and dispersed urban structure of the AMG favors greater carbon dioxide emissions through the combustion of fossil fuels. The urban growth of the AMG formed an urban structure that was both expansive and dispersed, mainly towards the corridors of López Mateos and Adolf Horn avenues in the municipality of Tlajomulco de Zúñiga, and towards the town of Tesistán, in Zapopan ([Barajas, 2023](#)). This growth “in terms of number of inhabitants, surface area and physical extension, produces congestion and increases the distance to travel when traveling to work” ([López and Gómez, 2022](#)).

According to ([Levine et al., 2019](#), cited by [López and Gómez 2022](#)), urban accessibility is the result of the interaction between three elements: mobility, proximity and connectivity. Regarding the urban accessibility of these corridors, it is observed that public transportation, which should reach the destinations considering investment and time, does not achieve the goal; proximity, which refers to the distribution in the territory of origins and destinations, is not relevant; Connectivity, whose consideration is access to goods or services in people's place of residence, is not achieved. In short, the search to achieve mobility, proximity and connectivity has increased the use of public and private vehicles, in turn, the impact on the environment due to gas emissions caused by the burning of fossil fuels.

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Given this reality, the need arises to identify the scope that the legal and normative has had in the chaotic conformation of the current urban structure.

On the one hand, the municipalities neighboring Guadalajara were characterized until 1992 by having a significant percentage of ejidal land in their jurisdiction. In this sense, the 1992 Agrarian Reform Law was approved, with the main purpose of regularizing the land market in agrarian centers, giving certainty to land tenure; On the other hand, in 1993 the Urban Development Law of the State of Jalisco was approved, whose objective was to dictate the necessary measures to organize human settlements in the state of Jalisco.

In conclusion, three decades after the approval of the Agrarian Reform Law and the Urban Development Law of the State of Jalisco, and the programs that derive from it, the Municipal Urban Development Program and the Partial Urban Development Plans of the municipalities that make up the AMG, today there are corridors of subdivisions around the main highway exits of the Metropolitan Area of Guadalajara, Colima, Nogales, México, Chapala and Zacatecas and an important urban dispersion, where some areas reach an extreme construction density and , others, an opposite behavior.

In addition, a notable increase in vehicles has been observed, reaching 220% in the last two decades, a situation that triggers the consumption of gasoline and diesel. Given this reality, it is urgent to review and/or apply the Environmental Law of Mexico, the State Law of Ecological Balance and Environmental Protection of Jalisco, the Urban Code for the state of Jalisco, in addition, the Real Estate Law of Jalisco, among other legislations.

Results

Colonies in the southeast of the municipality of Zapopan, Jalisco, present insufficient mitigation and adaptation measures to face floods. “The measures aimed at reducing the vulnerability of natural and human systems to the real or expected effects of climate change are known as adaptation” ([National Institute of Ecology and Climate Change, 05/18/2018](#)).

In this context, the guiding instruments of the national policy on climate change are the General Climate Change Law (LGCC), the National Climate Change Strategy and the Special Climate Change Program. The LGCC establishes the objective of “reducing the vulnerability of society and ecosystems to the effects of climate change, and strengthening the resilience and resistance of natural and human systems” (National Institute of Ecology and Climate Change, 05/18/2018). Despite legislation, strategies and programs to address the vulnerability of society and ecosystems, the southeast of Zapopan remains forgotten and its territory growing uncontrollably.

Floods in the southeastern neighborhood of Zapopan, resulting from the overflowing of two streams, are frequent incidents. The severe floods that hit the southeast of Zapopan in 2021 and 2022 were caused by the overflowing of the “Arroyo Seco” and the “Garabato”. In this area surrounding the Bosque de la Primavera and El Bajío, more than a dozen neighborhoods were affected, including “Miramar, Tizate, Mariano Otero, Villas de la Primavera, Jardines Tapatíos, 12 de Diciembre, Carlos Rivera, Colinas de la Primavera, Lomas de la Primavera and Arenales Tapatíos” (López, 02/28/2023). It is important to recognize that the affected neighbors point out “...every year their streets flood (...) it had been at least five years since the “Arroyo Seco” had overflowed, but this time the storm took them by surprise” (Niño, 07/25/2021), for this reason, these events are not isolated, they are incidents that occur every rainy season.

Deforestation and construction of subdivisions caused the overflowing of the two streams. The collapse of the “El Seco” and “Garabato” streams according to Alejandro Banda (Ortega, 10/17/2022), a resident of the area, mentions that the floods “were caused because part of what is The Bajío area where all the water flowed, there was a detour through the subdivisions that they built, a detour towards the bed of the Garabato and Arroyo Seco rivers, which filled the gabions” (sic). About the floods, Mr. Luis Valdivia Ornelas, researcher at the University Center of Social Sciences and Humanities (CUCSH), pointed out, “another variable is that urban growth transforms the channels, they can disappear, become segmented or lose their conduction capacity due to invasions or changes in the geometry” (Serrano, 05/19/2022).

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Therefore, based on these statements and specialized literature we can establish that the transformation of natural and permeable surfaces to concrete slabs has caused floodable surfaces to increase and flooding to be more severe.

From forest to concrete, a transformation resulting from human activity that contributes to climate change. According to the World Bank's statement regarding forests, these “are the main carbon stores on our planet. However, when trees are cut down for agricultural reasons or to build infrastructure, large amounts of carbon dioxide and other greenhouse gases are emitted into the atmosphere, contributing to climate change.” At the same time, standing forests help decisively address the impacts of climate change not only by absorbing greenhouse gases, but also by creating landscapes with greater resilience” (World Bank, 03/18/2018). In summary, forests regulate the flow of water, improve and maintain the soil to protect the population; on the contrary, concrete slabs violate sustainability and put society at risk.

International, national, state and municipal agreements and the deaf ears of the authorities. After the Paris Agreement, several countries have shown a strong commitment to their climate action plans on adaptation measures. The Government of Mexico, through the General Congress of the United Mexican States, issued the new General Law on Climate Change, which states that the principles, among others, of:

- I. Sustainability in the exploitation or use of ecosystems and the natural 696 elements that make them up.
- II. Caution, where there is a threat of serious or irreversible damage, the lack of full scientific certainty should not be used as a reason to postpone mitigation and adaptation measures to address the adverse effects of climate change.

Adaptation actions will be considered, as indicated in Article 29, among others:

- I. The determination of the natural vocation of the soil.
- II. The establishment of population centers or human settlements, as well as their development, improvement and conservation actions.

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Article

- III. The construction and maintenance of infrastructure.
- IV. The protection of flood zones and arid zones

To this end, the agencies and entities of the centralized federal and parastatal public administration, the federal entities and the municipalities, within the scope of their powers, will implement actions for adaptation. However, the reality is different, Guadalupe, a neighbor of the Miramar neighborhood, points out “Unfortunately they did not listen to us about the retaining wall. We fight a lot for a retaining wall here in Puerto Tehuantepec, because the bridge is very small and does not supply all the water that comes down from above. Here are the consequences” (Ortega, 10/17/2022).

This type of accusation confirms that the neighbors displace the co-responsible authorities and they are the ones who suggest adaptation measures. The neighbors' perception is of abandonment by the authorities.

The authorities of the three levels of government fail to comply with their obligations, therefore, they should be held accountable. “The Paris Agreement is a legally binding international climate change treaty. It was adopted by 196 Parties at COP21 in Paris, on December 12, 2015 and entered into force on November 4, 2016” (United Nations, s/f).

However, what happened in the southeast of Zapopan is an event that is reproduced at the municipal, state and national level. Faced with this reality, society as a whole must begin a local and global crusade to publicize the dismantling of the mitigation and adaptation measures that exist in our country, due to the complacency or omission of the authorities, and the state of vulnerability in that places the population and ecosystems, and legally bind whoever is responsible. If we are not able to sustain our dignity, we will not be able to sustain our country.

El Arroyo Seco and Arroyo El Garabato are located south of the municipality of Zapopan, Jalisco. According to the Mural newspaper (06/12/2023) “Between 2019 and 2021 alone, the Arroyo Seco has overflowed and caused flooding on 17 occasions in Zapopan.”

It should be noted that due to the flooding suffered by the colonies El Tizate, Colinas de la Primavera, Arenales Tapatios, Miramar, Lomas de la Primavera, La Floresta del Colli, Carlos Rivera Aceves, El Briseño, El Fortín, Mariano Otero, Brisas de la Primavera, Cantaluna, Campestre Los Pinos, El Mante, Miramar Poniente, Paraísos del Colli, El Rehilete, Residencia San Nicolás, Valle de San Nicolás, Villas de la Primavera and those located in the vicinity of Arroyo El Grande and Teisquinque, in the municipality of Zapopan, Jalisco, the Zapopan City Council, issued a Declaration of Emergency for the municipality of Zapopan.

Regarding the problem that has caused these floods, the State Commission on Human Rights, in a special report that it prepared on the La Primavera Forest, points out that this stream “has its origin in said ecosystem that is impacted by fires, filling of channels, garbage and invasions of human settlements,...” (CEDHJ, 2023). For his part, Luis Valdivia Ornelas, CUCSH researcher, indicates that “...the variables that are involved in the genesis of these because not only rain is involved, but the transformations in natural conditions due to urban growth; that is the determining factor...” (Aréchiga, 05/17/2023). The Master Luis Valdivia Ornelas, researcher at the University Center of Social Sciences and Humanities (CUCSH), pointed out, “another variable is that urban growth transforms the channels, they can disappear, become segmented or lose their conduction capacity due to invasions or changes in the geometry” (Serrano, 05/19/2022).

In the case of the affected neighbors, they point out that “although their streets flood every year, the water never exceeds the level of the sidewalks and it has been at least five years since the Arroyo Seco overflowed, but this time the storm It took them by surprise. They say that in the area it did not rain that hard and, however, the current came with great force” (Niño, 07/25/2022). According to Alejandro Banda (Ortega, 10/17/2022), a resident of the area, he mentions that the floods “were caused because the part of the Bajío area where all the water flowed was diverted, there was a diversion Because of the subdivisions they built, a detour towards the bed of the Garabato and Arroyo Seco rivers, which filled the gabions” (sic).

Axis 2. Territory

As mentioned previously, the floods that this work refers to are located in the lower part of the La Primavera Forest, however, as the researcher from the Department of Geography and Territorial Planning of the CUCSH Luis Valdivia Ornelas points out, the consequences of the floods of previous years They are a product of the poor urbanization that takes place in the upper parts of the city.

For example, industrial areas, shopping centers, parking lots are being built in the higher parts, so the increase in damage is exponential and that is causing a greater increase in damages and for example it is being observed in Garabato where before it did not overflow, in addition, the The developments that are taking place in the upper part of Mariano Otero are increasing the overflow problem in the lower areas of Arroyo del Garabato and in Santa Anita, not to mention El Palomar or El Cielo where commercial infrastructure is being built in the upper part. In this sense, although the problem is observed in the colonies mentioned above, the effects are broader, therefore, it must be considered that the territorial impact goes far beyond the colonies mentioned.

Axis 3. Intervention or attention

In consideration of the problem, the problem and its territorial impact, the proposal is oriented towards Prevention, with the application of the corresponding laws; Adaptation, through measures that consider the change of residence of inhabitants who are in vulnerable areas due to river waters and the havoc they cause, in the population and in the territory; and, Mitigation, through infrastructure works that channel river water volumes.

Conclusions

The south of Zapopan is flooded by the urban growth that the lower area of Bosque La Primavera and the El Bajío area, Zapopan, have had. To a question asked to Mr. Luis Valdivia Ornelas about Why is Guadalajara flooding? He responded “Another variable is that urban growth transforms the causes, they can disappear, become segmented or lose their conduction capacity due to invasions or changes in geometry.”

The Master Luis Valdivia continues with his statements, "An example of this situation is what happens in the area of Juan Palomar and Arias avenues, in Zapopan, where said road completely cut off the runoff coming from Bajío and San Juan de Ocotán, which gives origin to the Atemajac River" (Serrano, 2022). In short, an environmental problem is a negative alteration in the environment that affects natural elements.

El Bajío area, just a look at the toponymy was enough to have made sustainable urban decisions. El Bajío is an area of Zapopan that is located at the coordinates: latitude 20°41'38N and longitude 103°26'58W. On September 3, 2019, the “Decree of the Governor of the State of Jalisco was approved, establishing “El Bajío” as an environmental recovery zone, with an area of 980.89 hectares, located in the municipality of Zapopan, Jalisco, as well as the El Bajío Environmental Recovery Program and its annexes” (Government of the State of Jalisco, 2019). The Secretariat of Environment and Territorial Development (SEMADET), stated “The El Bajío area represents one of the most relevant areas for the recharge of aquifers within the Guadalajara Metropolitan Area (AMG). The water that infiltrates emerges in lower parts of the basin and is used for human use. The Atemajac River is born from the water infiltrated in this area. The area is composed of Quercus Pinus mixed forest, induced shrubland and induced grassland. In short, it seems that the environmental policies in the state of Jalisco and the municipality of Zapopan are corresponding with Mexican environmental policies and with the international agreements to counteract climate change that Mexico has signed, however? Real estate speculation in El Bajío is above the interest of citizens and sustainability. “A citizen obtained a ruling from a federal judge against the decree of the governor of Jalisco establishing El Bajío, in Zapopan, as an environmental recovery zone.” This, therefore, was interpreted that "the decree of the governor of Jalisco affects the right to property and possession of the complainant, since it limits him from the free disposal of the property he owns for the use he wants to give it" (Observatory of Socio-Environmental Conflicts , 02/12/2022).

Let us remember that the protected polygon covers hectares, of which 315 are already urbanized, part of it with the Akron stadium, the Pan American Villages, etc.

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In conclusion, we mention that the El Bajío area in Zapopan is a strategic place for collecting river water, which supplies the metropolitan area and properties of Colomos and the Atemajac Valley.

However, this natural benefit that nature gave us is at risk of being lost due to the urbanization process that currently exists and the construction of the Akron stadium, the Pan American Villages, Judicial City and others. Consequently, the greater the urbanization, the greater the flooding, as we remember that housing, commercial and industrial developments in the area have modified the natural vegetation cover of the soil with concrete slabs, consequently, a change in runoff. What awaits us? If we wait there will be droughts, floods, greater environmental pollution; If we stand up, socio-environmental justice, resilience, regularization and a better quality of life and a contribution to the planet.

Conflict of interest

The authors declare no interest conflict. They have no known competing financial interests or personal relationships that could have appeared to influence the article reported in this article.

Author contribution

Salas-Tafoya, José Manuel: Research coordinator, Research approach, Research approach, Development of the research

Valenzuela-González, Elizabeth: General contribution to the research development

Porrás-Zárate, Iván: Documentary and statistical analysis of information

Hernández-Valenzuela, José de Jesús Nicolás: Documentary analysis of the information

The adaptation actions correspond to resiliency the territory affected by the overflows of the two streams, for this the following is required:

1. Reorganize the cause of the two streams and give it the appropriate surface (volumetry) to conduct the waters. A hydrological study must be carried out, which considers the most catastrophic scenarios, based on the history of the two streams and the floods.

2. The inhabitants who live in the vicinity of the two streams must change their residence, based on scientific studies and relevant legislation.
3. Civil engineering elements must be built to ensure that the cause of the two streams does not invade the estimated surface area.
4. Environmental impact and cost-effectiveness studies must be carried out to reconcile federal, state and municipal expenditures and benefits and effectiveness.
5. The benefits will be a better quality of life for the inhabitants of the area, this contributes to the eradication of poverty. In addition, psychological, health, work stability, sense of belonging and social cohesion, highlighting governance.

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