*Elfide Mariela Rivas Gómez
**Carlos E. Aparicio M.

Disaster Risk and Clean Technology Transfer facing Climate Change: a theoretical approach towards sustainability and safety in middle-size Latin-America cities

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Abstract Disasters are not natural, they are problems unsolved by global development. Associated to disasters, vulnerability is characterized by factors like physical exposure, social fragility and lack of resilience. As part of an on-going research, our work shows a theoretical approach for analyzing the Disaster Risk and Clean Technology Transfer, looking for sustainable and safe middle-size cities in Latin America, facing the Climate Change. We expose that middle urban centers develop services functions, as well as big metropolis, nevertheless, its size allows to establish complementary management networks in case of natural disasters. If Climate change (CC) is a global threat, we look for its relationship with risk and disaster notions, as well as its effects in the cities of the mentioned region of the world. For the Disaster Risk Transfer (DRT), we review the evolution of retention and transfer as one of the four policies of the Integrated Risk Management (IRM), understood as a prevention phase. Risk cannot be transferred if it is not identified and reduced beforehand, because there is a link between an event's occurrence before (*ex-ante*) and after (*ex-post*). With Clean Technology Transfer (CTT), we explore this concept and the sustainable energy production in the above mentioned countries. We are looking for a definition of sustainable and safe Latin-America middle-size cities. We finish our document with some methodological guidelines for learning about the choice of a case study: the Mexican city Victoria de Durango.

* Universidad Autónoma de Nuevo León, Facultad de Arquitectura, San Nicolás de los Garza, Mexico, rgjunior69@gmail.com

** Universidad Autónoma de Nuevo León, Facultad de Arquitectura, San Nicolás de los Garza, Mexico, caparicio55@yahoo.com

1 | INTRODUCTION

Latin America is a cultural region exposed to events like earthquakes, floods, droughts and fires, among others. Examples like the 1999 torrential mudslides and the 2010 extraordinary rains occurred at the Caracas Metropolitan Region, in Venezuela (Córdova, 2003; SELA, 2010), as well as the 1985 and 2017 earthquakes at Mexico City (SEGOB & Banco Mundial, 2012: 14; Patiño, 2017), have shown the importance of developing disaster risk management programs. Based on documents from Mexico and Venezuela (Comisión Nacional para la Reconstrucción, 1986; República Bolivariana de Venezuela, 2009; Cámara de Diputados del H. Congreso de la Unión, 2012), we can classify the events depending on the type of threat. According with its origin, the threats or hazards can be natural, socio-natural or anthropic. Hazards of a purely natural cause are from geologic sources, as earthquakes or volcanism. Socio-natural threats are those of natural origin, but increased by the human action, like hydro-meteorological. This group includes tropical cyclones, floods, droughts, hailstorms and snow. This category includes climate change, too.

Anthropic hazards are divided in technological, health and socio-organizational. Inside the technological threats, chemicals issues, like fires and explosions are considered. Environmental pollution and epidemics are health menaces. The socio-organizational origin includes transportation accidents, interruption or malfunction of operational services and vital systems, as well as the massive concentrations of population.

In the framework of the Sustainable Development and Climate Change, are there technological tools for managing the hydro-meteorological hazards in Latin-America cities? Looking for parameters to define sustainable and safe cities in this region of the world, in this paper we present a theoretical approach for analyzing both, Disaster Risk and Clean Technology Transfer. We propose to work with middle-size urban settlements. The sections of this document are related to a theoretical structure, the criteria for defining the sustainable and safe Latin-America middle-size cities, the methodological guidelines for choosing a case study in Mexico, as well as the conclusion.

To start the theoretical structure, we discuss about Climate Change (CC), Disaster Risk Transfer (DRT), Integrated Risk Management (IRM), and Clean Technology Transfer (CTT). In all these concepts we try to highlight their importance in Latin-America. Secondly, for defining the characteristics of sustainable and safe Latin-America middle-size cities, we mention that the scale of middle urban centers allows people and authorities to establish harmonic management networks in case of natural disasters. These cities are more attractive to investments and migrations, because of its physical and social positions related to major conurbations. These centers have competitive advantages due to their lower rates of insecurity, road congestion and pollution. The experiences on disaster risk management in this kind of cities could serve for developing better strategies in bigger metropolis.

Afterwards, we mention the methodological guidelines for justifying the selection of the city of Victoria de Durango, in Northern Mexico as our case study. Among the criteria for this selection we considered that this middle-size city is susceptible to the CC effects. Moreover, there are documents for describing the potential risks at this urban center and we found many logistic facilities for making this research.

Between the conclusions of this work, we can mention that this theoretical approach led us to identify the most susceptible flood risk areas in Durango or in other middle-size cities. It is essential to highlight the importance of prevention for reducing the disaster impacts. This paper could be

considered as the first stage of an on-going research, because we are focused on the theoretical framework and the methodological criteria adopted for choosing a case study. In a future second document, we will concentrates on the fieldwork description and the final results of this research.

2 | THEORETICAL STRUCTURE

Focusing in Latin-America, the theoretical elements of this work are Climate Change, Disaster Risk Transfer, Policies evolution on Disaster Risk Transfer, and Clean Technology Transfer. First of all, we discuss about the concept of CC and its analysis as a global threat. Moreover, we treat the risk and disaster conceptualization, the intersection between the CC adaptations and IRM. To support the debate about the DRT concept, we talk about the financial disaster risk prevention, and the DRT policies evolution. Considering that IRM has four stages, these stages are the risk identification, the risk reduction, the financial protection, and the disasters management. To finish this section, we link the CTT with the sustainable production, the clean development mechanism experiences, and the clean technology knowledge management.

2.1 Climate Change (CC)

The concept of CC is related to the present and the future scenarios where the emissions of CO_2 cause a greater warming in the components of the Earth climatic system. Rusticucci (2013) mentions that anthropogenic factors have facilitated the increasing average of global temperature between 1951 and 2010. The human action has carried consequences like the warming of the atmosphere and the oceans, changes in the global hydrological cycle, the snow and ice reduction, the global sea level average increase, and extreme weather changes.

Beck (2002: 232) has ranked CC as a *global threat*, adding that "the risks are hybrids created by man". In this sense, the ecosystems and the populated territories around the globe have suffered or they are being affected by some event linked to the CC, like frozen temperatures, waves of heat, flooding, and soils desertification. The industrial and technological development is part of a way of life strongly influenced by consumption. Martelo (2004: 2) sights that effectively in the 1980 s many politicians took conscience about the consequences of CC, because these concerns could be extended "over several centuries, compromising sustainable development throughout the world". At the end of the same decade, the United Nations (UN) assumed the CC problematic as a central subject on the development agenda. In order to monitor the technical, scientific and socio-economic information about the CC at the planetary level, the Intergovernmental Panel on Climate Change (IPCC, 2013) was founded by two specialized agencies from the UN, the World Meteorological Organization (WMO) and the United Nations Environment Program (UNEP).

Risk and disaster are associated to CC. On the one hand, Olcina (2008: 19) mentions that risk is a natural condition for human being since the beginning of its history. The author adds that we are a "society of risk" who makes "territories of risk". The risk is an effect of the human being's imprudence at the moment to carry out actions on the territory. On the other hand, disasters are the evidence of a vulnerability composed by the social fragility and lack of resilience of communities who are not able to face the vulnerable agent (Cardona 2001: 106). Lavell (2001: 32) discusses about the differentiation among "disaster as product" and "disaster as a process". Disaster as a product is seen with connotations of inevitability; it is a consummate and measurable fact who privileges the analysis of impacts and immediate response, as well as the rehabilitation and reconstruction practices. Disaster as a process introduces the subject of social risk and the notion of the risk cycle. From this point of view, the population and some stakeholders, like

governmental and academic institutions, must take the responsibility for the conception and management on disaster and risk policies.

According with Romero & Maskrey. (1993) disasters are not natural, and they are an unsolved problem by worldwide development. The effects of certain natural phenomena are not necessarily disastrous. A disaster occurs only when a natural phenomenon affects the life conditions of a community. At the same time, the risk is inevitable, but it can be reduced. Therefore, Cardona (2012: 13) mentions that there is a fundamental theoretical consideration referred to the relation or intersection between the Adaptation to the CC and the IRM. In this sense, for UN (2015: 2) *Adaptation* is "a process of adjustment to actual or expected climate and its effects. In human systems, adaptation seeks to moderate harm or exploit beneficial opportunities. In natural systems, human intervention may facilitate adjustment to expected climate and its effects".

Lavell (2011: 3) indicates that IRM is more than a reactive response in front of risks. IRM involves technical aspects for reduction and mitigation of vulnerability. Cardona (2001: 106) mentions that the characteristic factors or vulnerability are physical exposition, social fragility and lack of resilience. The physical exposition could be understood as a physical fragility facing disturbing events, meanwhile the social fragility is linked to disadvantages and relative weakness due to socio-economic factors. In front of a disaster, the lack of resilience is defined by the incapacity for responding and the deficiency to absorb the impacts of the disaster.

In Latin America and the Caribbean there are many experiences about the generation of financial and institutional mechanisms to deal with the CC effects (SELA, 2010). For example, in Peru, *El Niño* phenomenon forced the national institutions to create financial protection instruments for fronting the disaster's risks effects, especially in CC matters. Between 1993 and 2003, the national authorities created along with some insurance companies a feasibility study for developing an agricultural insurance. During its first years, this program was not successful because there was not a culture about insurances in that country. In 2003, the Peruvian Government created the National Commission for Development of the Agricultural Insurance. This initiative, in 2005, promoted the creation of the Catastrophic Agricultural Insurance (SAC) and the Indexed Insurance against *El Niño* Extreme Phenomenon (GIZ, 2013). Moreover, the Caribbean Islands and some Central American countries created the Caribbean Catastrophe Risk Insurance Facility (CCRIF-SPC), a regional response for facing disasters (Banco Mundial, 2015).

On the road to Sustainable Development (SD), Rockström *et al.* (2009) mentions that four of the nine critical limits of the planet have been transgressed. One of them is the CC (Figure 1), in spite of some detractors like Durkin (2006) in his documentary *The Great Global Warming Swindle* indicates otherwise.

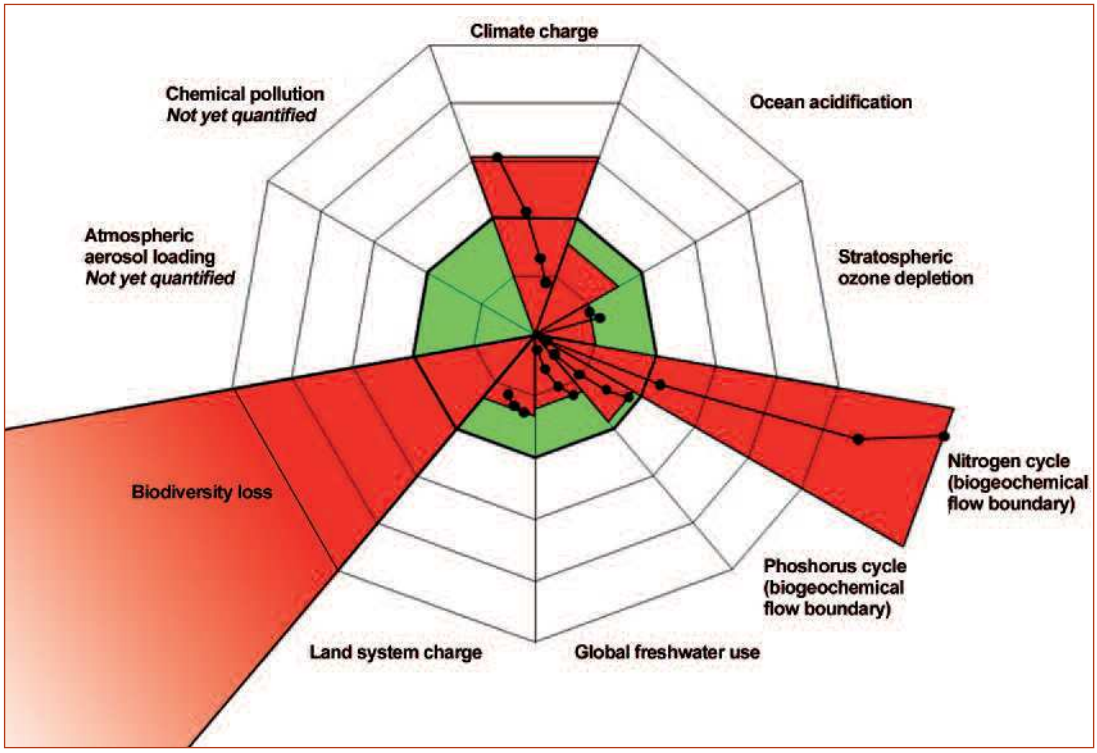

Figure 1 Estimate of quantitative evolution of control variables for seven planetary boundaries from preindustrial levels to the present - *Source – Rockström et al. (2009)*

2.2 Disaster Risk Transfer (DRT)

The DRT concept is commonly referred to the payment of an insurance premium to a physical or legal person, public or private, through a financial institution. Davila (2008: 77) defines risk transfer referred to disasters as "the application of financial mechanisms for the management of the residual risk (not reduced) in specific scenarios, which are mainly defined according to the exposed capital". The author indicates that the Governments must respond in disaster cases, like in public buildings, infrastructure or housing, among others. Financial protection includes retention and risk transfer mechanisms, both provide Governments a way of insurability and the availability of financial resources to deal with emergencies, as well as for the rehabilitation and reconstruction post-disaster (Yamin *et al*., 2013: 5). When Beck (2002) refers to global threats, like the CC, he states that risk could be estimated using accident rate stats, generalized compensation formulas, and the exchange of money for damages.

Referring to the risk's concept, Luhmann (1992) states that communication is moralized only when victims are found after a disaster. For this author, the *financial disaster risk prevention* must be understood as an awareness for future damages, because people are more willing to participate in a process whose outcome is uncertain when they have the legal protection of an insurance. The DRT has to consider two stages for managing the risk: *ex-ante* and *ex-post* disaster (SELA, 2010).

For Arias (2013: 2) the *ex-ante* strategies are mitigation, prevention and adaptation; in addition, the *ex-post* schemes involve response mechanisms, social protection, as well as public financing plans. Financing actions include fiscal resources, credits, catastrophe bonds, and insurances, among others. Rangel (2011) adds that the strategies for financial protection against disasters should be considered as preventive measures, thus the transfer of risk becomes a necessity. The German Agency for International Cooperation (GIZ, 2013: 24) exposes that three elements should be taken into account for transferring risk. Firstly, a solid statistical database as a tool for making decisions upon the measures to prevent, reduce or transfer risk. Secondly, a prospective management besides a corrective risk management for reducing the risks and the associated costs to the disturbing phenomena. Thirdly, the satisfactory DRT instruments.

The disaster management could be considered inside the human being history. As part of this history, the DRT policies have evolved. For example, Revet (2011: 541) mentions that after the earthquakes happened in Lisbon, 1755, and in Caracas, 1812, the international assistance was there. Both countries, Portugal and Venezuela, received assistance through ships loaded with food and even with money. Between both world wars, The International Relief Union of 1932 was signed by 19 countries of the League of Nations. Later, in 1971, after the catastrophe caused by a cyclone and its floods in Pakistan, the United Nations Disasters Relief Organization (UNDRO) was created. In 1998 this organization become the Office for the Coordination of Humanitarian Affairs (OCHA), having a close relationship with the assistance of the Inter-Agency Standing Committee (IASC) an organization who includes the UN, the International Red Cross, and other humanitarian associations. In 1996, the OCHA created the Disaster Preparedness ECHO Program (DIPECHO).

At the end of the 20th century and the first two decades of the 21st, many experiences on DRT could be found around the world. For example, we can mention the Yokohama Strategy and Plan of Action for a Safer World 1994: guidelines for natural disaster prevention, preparedness and mitigation; the International Strategy for Disaster Reduction (ISDR-2001); the Hyogo Framework for Action 2005-2015: Building the Resilience of Nations and Communities to Disasters (HFA); the Sendai Framework for Disaster Risk Reduction 2015-2030; the United Nations Summits on Sustainable Development (1992; 2002 and 2012); and the 2030 Agenda for Sustainable Development

For Latin-America, Cardona (2007) refers examples where national funds were managed with operational capacity and efficiency, like the creation of the National Calamity Fund (FNC) existing in Colombia since 1984, also the Operational Technical Unit for Support and Strengthening (UTOAF), started in Bolivia in 1998, after the El Niño phenomenon damages. In legal terms, since 2009, Venezuela put in place the Socio-natural and Technology Hazards Management Law. In 2011, Peru began with its Risk Management Law, and in 2012, with the Insurance Contract Law. Mexico, in 2011, advanced with the Civil Protection Law, additionally in 2012 with the Climate Change General Law. Graizbord & Monteiro (2011: 23) mention that, beyond reducing *post-event* effects, if the insurance policies are properly structured, they not only protect buildings and infrastructure, they also serve to foster the risks reduction.

2.3 Policies evolution on Disaster Risk Transfer (DRT)

The evolution of retention and transfer policies as part of the IRM study involves a multidisciplinary participation. Ferrero & Gargantini (2003: 75) mention that, historically, disasters were seen from the naturalist perspective. From a multidisciplinary point of view, the authors comment that disasters are not only natural, they are socio-natural. Garza & Rodríguez (2001) declare that since the 1990 decade the studies on disasters have integrated the natural sciences, the exact sciences and the social scientific knowledge.

Considering that damages are disasters only when there is a degree of uncontrolled exposure, in August 1992, an organization for studying the concept of disasters was born. This group is named *La Red de Estudios Sociales en Prevención de Desastres en América Latina* (The Social Studies Network for Disaster Prevention in Latin America), commonly known as *LaRED*. It was created as a response to the need for stimulating and strengthening the social study of the risk problems, as well as for defining new forms of intervention and management for prevention and mitigation of risk. Vulnerability conditions presented in a population have been created by the human being (Romero & Maskrey, 1993: 9). Talking about CC, disasters are evident when there is a vulnerability composed by the physical exposure to the risk element, plus a social fragility and the lack of resilience of communities (Cardona, 2001: 106).

Cardona *et al.* (2005: 20) considers the risk identification, the risk reduction, the financial protection, and the disaster management as the IRM stages. According with the Latin America and Caribbean Economic System (SELA, 2010: 9), the three first stages are related to the *ex-ante* disaster actions and the fourth is linked to the *ex-post* adversity moment. Firstly, the risk identification involves the objective evaluation of the risk, individual perceptions and social representations. Moreover, the risk reduction includes the prevention and mitigation of the physical and social vulnerability. Also, from the economic and public investment points of view, the financial protection is related with the DRT and the retention of the risk. Finally, the disaster management corresponds to the preparation, alert, response, rehabilitation and reconstruction after the disaster occurrence.

In Latin America, Mexico has a recognized leadership in IRM terms due to its Natural Disasters Fund, called FONDEN (SEGOB & Banco Mundial, 2012). After the devastating earthquakes at Mexico City, in September 1985, at least 6,000 people died, the economic losses were nearby 8 billion dollars. Moreover, about 250,000 houses disappeared, 30% of the hospital capacity was completely destroyed, and 1,700 schools suffered structural damages. Subsequently, this country made a shift for developing disaster risk management policies. During the same year, the National Commission for Reconstruction was created and established in 1986, the Civil Protection National System (SINAPROC). In 1988, as the technical area focused on risk reduction, the National Center for Disasters Prevention (CENAPRED) was created. Later, in 1996, was officially created the FONDEN, as a fund within the national budget. In 2003, the FONDEN was complemented by a Natural Disasters Prevention Fund (FOPREDEN). This economic reserve allows the promotion of risk evaluation and mitigation tasks.

It is necessary to underline that there is an increasing tendency for having economic losses caused by disasters in Mexico, because about 40% of its territory and more than 25% of its population are exposed to storms, hurricanes and floods. In June 2011, the FONDEN acquired a catastrophic coverage to protect public properties and low income population housing, through an insurance contract in the amount of $ 400,000,000 USD. Later, in August 2017, the FONDEN acquired a new coverage to protect people against catastrophic natural events such as hurricanes in the Pacific and

Atlantic Oceans, as well as earthquakes inside the national territory, in the quantity of $ 360,000,000 USD (SHCP, 2017). This coverage was almost immediately activated for the reconstruction of communities of the states of Oaxaca and Chiapas affected by an 8.2° magnitude earthquake, in September 2017 (Ramos, 2017).

In the beginning of the 21st Century, the efforts toward financial protection were displayed in Latin America geography. Many nations went from speech to action, placing the DRT as a national policy (Cardona et al., 2005), without detriment to the *post*-event humanitarian aid for reconstruction, depending on the capacity of each country to attend their own recovery and resilience.

2.4 Clean Technology Transfer (CTT)

Clean technology is also known as Clean Development Mechanism (CDM). Also, the Kyoto Protocol, in its article 12, recognizes this mechanism as a convergence instrument of the existing interests between the industrialized and the developing countries for mitigating the CC effects (UN, 1998: 11). For contributing to the mitigation and adaptation to CC, the mentioned document talks about the industry restructuration toward the use of alternative energies and the certified reductions on Greenhouse Gas Emissions (GGE). The CDM is seen as an instrument for global sustainability. On the economic pillar, there is a consideration of fees for obtaining rights on CO_2 emissions. On the environmental side, the countries are required to obtain clean energy and to preserve their natural resources. On the social support, because CDM started on developing countries, there are contributions on investment, technology transfer and jobs creation. According to Graizbord (2011: 40), the technology transfers could be, firstly, from industrialized countries to developing nations through funding, scientific exchange or cooperation alliances. Also, this transfer could serve for creating laboratories, for the development of prototypes, and for the construction of research networks. Thirdly, the technology knowledge management could be transferable to many societies around the world.

The United Nations Framework Convention on Climate Change (UNFCCC, 2015), as result of the Paris Agreement, shows in its article 10 the importance of technology transfer to improve communities' resilience facing the CC and for reducing the GGE. In this context, the signatory nations could take advantage of the CTT development as an effective way to reduce the effects of the CC, plus as a new economic opportunity for developed and developing countries, according to Sustainable Development Goals (SDGs), defined by leaders from 193 countries in 2015 and projected for 2030 (UNDP, 2015).

CTT is part of the sustainable energy production. The SDGs number 7 and 12 mention the compromise for ensuring the access to a modern, sustainable, safe, and affordable energy for everybody. Clean technology will help to reduce vulnerability to risk disaster and to improve the adaptation to CC. According to Gutman & López (2017: 21), Sustainable Production, or *Green Production*, looks for a greater human well-being and social equity, at the same time, this production looks for a significant reduction on the environmental risks and the ecological scarcity. In the case of CTT, it should be done under strict environmental standards and social responsibility practices. Besides, it implies a business transformation in terms of procedures, processes, and products, looking for contributing to a better environmental performance. The respect to the environment includes the use of renewable energy and clean fuels, as well as achieving the transportation and buildings infrastructures making an efficient use of energy and water, reducing the production of GGE adding an integrated management of solid, hazardous and special waste.

In Latin America there is an evident oil dependence. On the one hand, Central America and the Caribbean islands countries have an unsustainable energy model because they use the oil for generating electric energy. On the other hand, the continental oil countries, like Venezuela and Mexico, are also tied up to the hydrocarbons international prices, besides their contribution to GGE. In this context, the CTT opens possibilities for investing in clean, renewable, and green energy, for reducing the oil consumption and for facing the CC challenges.

Miller & Visicdi (2016) remark the leadership of Brazil, Mexico and Chile in innovation for clean energy production in Latin America. For example, Brazil is a country at the top in the use of biofuels, some institutions have generated energy through hydropower, adding to the use of solar, wind and ocean energy resources. Brazilian institutions have supplied a considerable level of intellectual property, in particular in bioenergy, as biogas and biomass. The Alberto Luiz Coimbra Institute Graduate School and Research in Engineering, from the Federal University of Rio de Janeiro (FURJ), has created a company as an experimental business called *Seahorse Energy*. This enterprise holds four patents for using the sea waves and currents energy. Their researchers have also focused on batteries and fuel cells, capture and sequestration of carbon, optimization of energy transmission and energy efficiency (COPPE UFRJ, 2012).

The majority of countries in this region of the world have promoted standards, plans, programs and/or strategies for fostering the Sustainable development, associated to the concept of an efficient, low-carbon and socially inclusive economy. One of the strategies to combine the access to alternative energy and the sustainable production practices is related to the *Green Economy*. According to UN (2012: 6), this kind of economy includes the reconciliation of the growth of economic and commercial activity with sustainable resources management and stronger environmental protection. It is important to invest in agricultural technologies and having more sustainable policies in the use of soil and natural resources management. Green Economy considers the reduction of carbon emissions too by promoting, disseminating and investing in renewable energies. An environmentally sustainable waste management, an adequate management of chemical products, besides the promotion of sustainable consumption and production patterns, with developed countries taking the leadership for implementing measures, are part of an economic clean process that includes the sustainable social habitat promotion by using clean technologies in construction, adding the creation of industrial employment opportunities.

3 | DEFINING THE SUSTAINABLE AND SAFE LATIN-AMERICA MIDDLE-SIZE CITIES

On the one hand, it is clear that sustainable development is not only a limited problem to ecological adaptations of a social process; it is a multiple model strategy for societies, involving the economic viability and ecological feasibility (Carabias & Provencio, 1992: 11). In this sense, a sustainable city can be defined as an ecological system, where inhabits aspire to a circular metabolism, where consumption is reduced improving performance and increasing the reuse of resources. This system involves recycling materials, conservation of non-renewable energy and care renewables resources, but without neglecting the social justice. Therefore, the environmentally sustainable cities tend to be more productive, competitive, innovative and prosperous. These cities are able to maintain a healthy balance between economic growth and the environment, facilitating integrated development and resilience (ONU & Habitat, 2016: 101). Facing the intense processes of urbanization around the world, the researches at COPPE UFRJ (2012: 16) are looking for solutions to make cities more human. They are working on technologies to improve urban mobility and for the intelligent use of waste, as strategies for contributing to the wellbeing of people.

On the other hand, authors like Ray Jeffery (1971) have linked the term *safe city* to the crime prevention through environmental design (CPTED). In this sense, the author mentions that physical environments can inhibit or motivate criminal conducts. In other words, public spaces can promote coexistence, social integration and vitality to the city, making it safer facing urban violence. Nevertheless, in this work, the *safe city* concept is related to the CC problematic. Thus, the security in the urban space is related to the adaptive capacity and resilience developed by communities against the hydrometeorological disasters risk. From this point of view, the United Nations (UN) have established the *Global Campaign 2010-2015 for Making Cities Resilient* (UNISDR, 2012). Through a *Handbook for Local Government Leaders*, this intergovernmental organization outlines the significance of local rules for including on their political and sustainable development agendas about prevention and resilience to risks. A safe city includes the protection of the communities and disaster risk reduction, while socio-economic and environmental conditions are improved.

We remark that in urban studies there is a trend for learning about large agglomerations, metropolis and big cities. However, Bellet & Llop (2004:1) mention that the numerous and extensive urban presence in the world is related to the intermediate cities. The authors consider, for defining these kind of spaces, their relation with rural surrounding areas and other urban zones, more than their demographic size or territorial dimension. Carrión (2013: 30) states three types of intermediate cities. Firstly, the rural cities or those who articulate the urban network with rurality. Then, the middle cities or those who integrate the urban system within a country. Thirdly, the border, regional or metropolitan cities articulate the global cities. Rodríguez & Villa (1998: 56) mention that many institutions in Latin-America countries have tried to define their middle-size cities. As a common criteria (Bellet & Llop, 2004; Carrión, 1994; Rodríguez & Villa, 1998), this kind of human settlements have a population size between 50,000 and 1,000,000 inhabitants. It's true that there are different dynamics between the urban centers considered inside this range of population. In Mexico, according with the official institutions (SEDESOL & CONAPO, 2012), the Main Urban System (*Sistema Urbano Principal –SUN-*) is integrated by the set of cities with more than 15,000 inhabitants, which are functionally related. Inside this classification, the Mexican intermediate cities are considered those which its population varies between 500,000 and 999,999 people.

If we want to define sustainable and safe Latin-America middle-size cities, we need to consider a place with urban an environmental quality of life. In the case of intermediate cities they are more attractive, because they have a strategic position relative to big cities (Carrión, 2013). These human settlements are easier to manage in terms of insecurity, road congestion and pollution. Also, these cities are more attractive in economic and social terms, because its size stimulates investments. At the same time, the funds invite to create employment, and these jobs consolidate the existing inhabitants and attract new migrants. We could mention that the scale of middle urban centers allows people and authorities to establish harmonic management networks in case of natural disasters. The experiences on disaster risk management in this kind of cities could serve for developing better strategies in bigger metropolis.

4 | METHODOLOGICAL GUIDELINES FOR CHOOSING A CASE STUDY: VICTORIA DE DURANGO, MEXICO

To select a middle-size Latin-America city, we looked for a place with a strategic location for attracting people and economic activities. Moreover, we tried to find a vulnerable urban center in front of the CC, but at the same time, a place where some actions to deal with had been developed.

Commonly known as Durango City, Victoria de Durango is the capital of the State of Durango. Strategically located in the Northern Mexico, this city is in the intersection between the national highways 40 and 45. The Highway 40 is the main Mexican axis east-west. At the east coast and bordering with the United States of America (USA), it starts in the city of Matamoros and it ends in the Pacific Coast, in Mazatlán, touching important urban centers as Reynosa, Monterrey, Saltillo and Torreon. Also, the Highway 45 connects the capital of the country, Mexico City, with the USA border at El Paso-Ciudad Juarez, passing by Chihuahua, Zacatecas, Aguascalientes, Guanajuato and Queretaro (Figure 2).

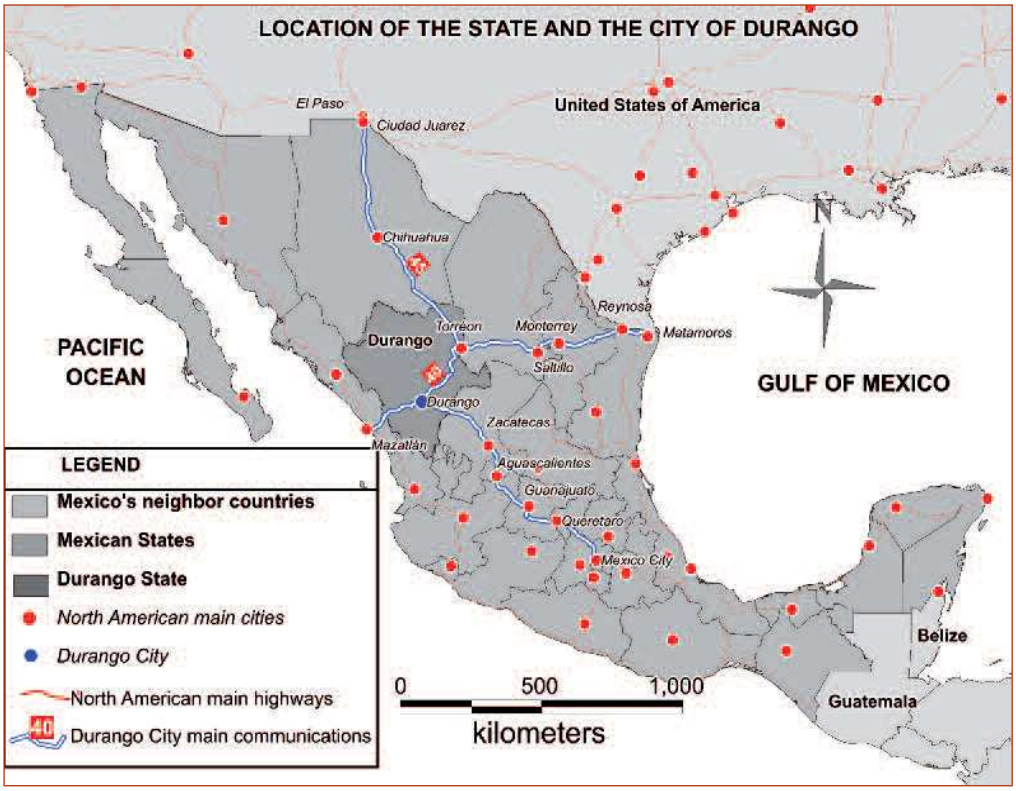

Figure 2 Location of the State and the City of Durango - *Source: elaborated by the authors*

Victoria de Durango is an intermediate urban center with 586,904 inhabitants in 2017; for 2030, this city will have 656,180, as an estimated population (CONAPO, 2018). This city is located inside the Municipality of Durango, which total area is 9,306 km^2. The urban surface is 98.556 km^2, representing only 1.06% of the municipality area. In addition, Durango City plays a role as a service center at a regional level, integrating five Micro-regions of the State (Ayuntamiento de Durango 2016: 13) (Figure 3).

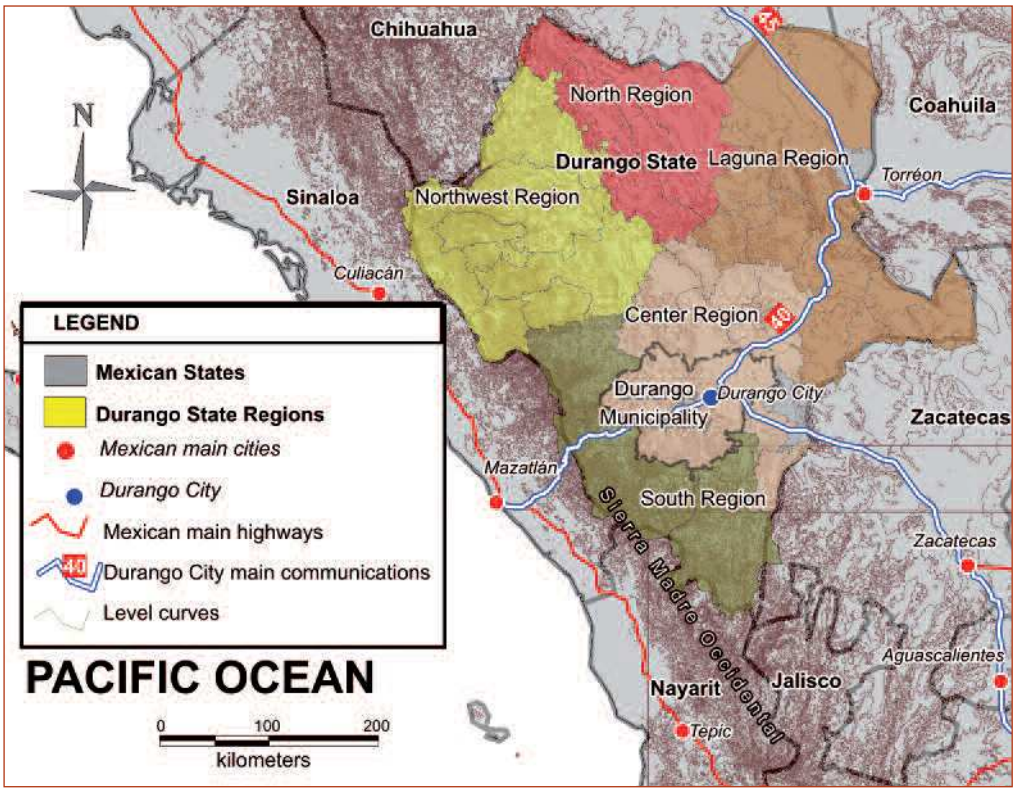

Figure 3 Durango State Micro-regions.
Source: Ayuntamiento de Durango, 2016. Elaborated by the authors

Physically, this urban center is located in the plain of the physiographic province of the mountain ranges called *Sierra Madre Occidental,* which serves as a barrier to the air masses coming from the Pacific Ocean. These elevations are located at the west of the city, and during the rains many streams reach this place. The main water source is the Guadiana River, called inside the urban area *Acequia Grande* (Big Ditch) (Arrieta, 2013). Along its history, Durango City has suffered serious floods, as well as droughts and frosts. The 3D model presented on Figure 4 can give us an idea of this context.

Continuing with this research, we selected this urban center, defined by many criteria as an intermediate city. On the one hand, Victoria de Durango can not diagnose the quantity and quality of its water. In terms of quantity, its population is vulnerable to climate variations, sometimes the water is scarce and other times they get flooded. In terms of quality, water is not suitable for human consumption, due to certain levels of fluoride and arsenic. On the other hand, the State and the Municipality of Durango have passed legislations on CC and disaster risk management. For example,

people who pay their property taxes are covered by a home insurance against theft, fire, flood or any other damages (Maldonado, 2017).

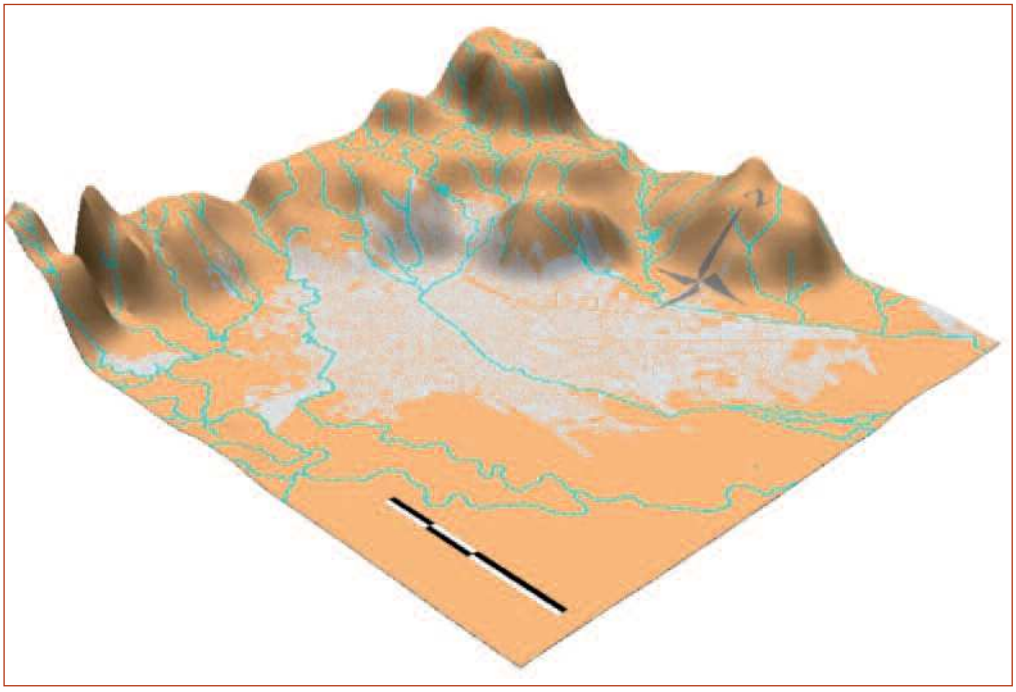

Figura 4 Urban surface and streams in a 3D Model of Durango City. The graphic scale represents 5 kilometers.
Source: elaborated by the authors

Moreover, there are documents related to historical hydro-meteorological events, especially floods and droughts, like a Natural Risk Atlas (Gobierno Municipal de Durango & SEDESOL, 2012). We think that Durango's territory bears the probability to face the CC negative consequences in early stages. Added to the legislative issues, the first steps to the insurability culture are given. Similarly, Durango has active research centers working on sustainability projects like the management of renewable energy, recycling, and CTT. In this sense, the Advanced Materials Research Center (*Centro de Investigación en Materiales Avanzados* CIMAV-Durango) has developed some research and graduate teaching programs on energy and environment, like solar thermal systems design, efficient use of energy in buildings, water, integrated waste management, forest resources and climate variability (CIMAV-Durango, 2018).

5 | CONCLUSION

This theoretical approach for analyzing DRT and CTT looks for defining Latin-America sustainable and safe intermediate cities, facing the CC. A middle urban center with service functions and complementary management networks is Victoria de Durango, in Mexico. Inside the Sustainable Development framework, our work proposes to link DRT and CTT in the cities with the capacity to be adapted to the CC challenges. The strategies for facing climate variations, must include being prepared for the inevitable, but conceiving the IRM. Also, through the CTT, it is essential to slow down the processes that trigger the hydro-meteorological disasters. According to Alguacil (2009: 66) the top needs for the right to a sustainable city, like protection and subsistence, could not be optimized without the participation of citizens, both in the resources management and in the decision making capacity.

We argue that a city with urban-environmental quality of life should be a sustainable and prosperous city. A particular interest of this research is medium-sized cities, because they could become more attractive for having more competitive advantages in relation to the big metropolis. For example, these urban centers have lower insecurity rates, less traffic congestion and a smaller amount of pollutants. With better environmental conditions, these kind of cities can obtain investments, create jobs and provide the conditions to receive qualified population. In these urban areas, public policies can be developed more efficiently.

The Natural Risks Atlas of Durango's municipality (Gobierno Municipal de Durango & SEDESOL, 2012: 167) emphasizes that floods are the most common threat in this city. Often, these floods occur slowly, but those with sudden origin cause more damages, even if they don't last long. Flash flood waters have great force and they carry within debris along its route, increasing its destructive capacity. In September 2016, three hydro-meteorological phenomena occurred at the same time over Durango City: the tropical storm "Roslyn" in the Pacific Ocean, a rainy system coming from the Gulf of Mexico, and a cold front in the middle of the country. Together they caused atmospheric instability, called by the National Meteorological Service "The Perfect Storm" (Maldonado, 2016). This event is part of phenomena linked to a periodical rain system dated since 1906 (Arrieta, 2013; Nevárez, 2015). However, the referred Atlas mentions that the Guadiana Valley and the Durango capital city are located in an arid zone. There are records stating these places have suffered droughts in 1923, 2011 and 2012. The same document exposes future meteorological drought scenarios.

Even Victoria de Durango is susceptible to be affected by floods and droughts, this city has designed an advance insurance system for Disaster Risk Transfer and Integrated Risk Management. In order to become a policy, this initiative must be followed by stakeholders. Moreover, research work in Clean Technology Transfer is being done in academic institutions like CIMAV (Figure 5). The strategic placing of this Latin-America middle-size urban center allows stakeholders to create management networks in case of natural disasters at different territorial scales. People in this kind of cities have established social mutual aid links. The experiences on disaster risk management, like floods and droughts, could serve as examples for developing better strategies in other cities.

FigurE 5CIMAV Researchers on energy savings by solar reflectance.
Source: CIMAV-Durango (2016)

According to our theoretical contribution, between the multiple policies on SD at Latin America cities, in this work we outlined two: DRT and CTT. We consider that both have to be treated with an urgent attention on a common agenda. On the one hand, society must assume DRT and CTT as its own, and its application owe to be a requirement. On the other hand, both policies have to be an inescapable part of the public agenda at all government levels in the construction of safe cities facing the CC.

It is significant to mention that this paper could be considered as the first stage of an on-going research, because we are focused on the theoretical framework. We emphasize the importance of prevention and mitigation of disaster impacts. However, it is imperative to align the theoretical and practical agendas from the scientific communities who work on CC and IMR. In a future second document, we will concentrate on the fieldwork description and the final results of this research.

In the first stage of the doctoral research, our theoretical approach, as well as the methodological guidelines exposed for choosing a case study, will lead us to identify, as continuation of this work, the most susceptible flood risk areas in Durango. We will work on the selection of some quartiers affected by periodical floods as a cartographic instrument and a public policies tool.

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