INTERNATIONAL EXPERIENCES ON THE IMPLEMENTATION OF PUBLIC POLICIES FOR URBAN PLANNING TO FACE CLIMATE CHANGE

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Abstract
The objective is to analyze successful international experiences on how to implement urban development plans and programs to face the problems that climate change and their application in Mexico. Through the sciencedirect® database search, focused on implementation strategies, particularly on the roles of direct managers (governments) as well as on methods and models for the implementation of programs and projects for optimal regional urban development. As a result, multiple cases are presented worldwide applicable to the Mexican context, on the success in the implementation of public policies aimed at solving the problems that are being generated in population centers. It is concluded that the results could be very useful to contribute to the decision making by the governments in charge of urban development, including support for the public policy makers in this regard.
Keywords: Implementation procedures; Climate change; Urban planning; Predictive models; Public policies.

1. INTRODUCTION

One of the main problems on urban development that has recently been identified around the world is the implementation phase of the programs oriented to adequately order population centers in the face of climate change (Hernández-Moreno et al., 2017: 30). Reaching the global goals and challenges of the UN Habitat Agenda 2030, not only involves the design and strategic planning of programs and commissions to meet certain initiatives and goals in the planning phase, but also in the next phase, which is the implementation phase, in which the greatest obstacles have been found (Robin and Acuto, 2018: 76, Parnell, 2016, United Nations, 2016), obstacles that are mainly reflected in the incipient use of technologies and models to support procedures, in this case, of implementation of public policy programs in the face of climate change in population centers.

Therefore, the challenges of creating cities in the face of climate change and its effects on population centers have been the subject of studies worldwide, which are fully identified in Table 1 (Cities Alliance, 2015; IPCC, 2013: 867-952, UN, 2016, Mario Molina Center, 2014, CONEVAL, 2014, National Institute

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of Statistics and Geography, 2014, UN-Habitat, 2014, Hernández-Moreno, 2016); but, the basic question on how to successfully and adequately implement public policies on urban and regional planning in the face of climate change? It has not been fully resolved in a practical way, existing a wide variety of international, federal, state and local programs to adapt cities and other population centers to climate change, which is already imminent.

TABLE 1 - MAIN EFFECTS OF CLIMATE CHANGE IDENTIFIED IN CITIES AND POPULATION CENTERS BOTH IN MEXICO AND IN THE WORLD

Climate variability	**Effect in urban areas and population centers of the case study** (metropolitan and regional scale)	**Effects on households** (urban-architectural scale)
Warm periods and heat waves: Higher frequency in most land areas	Heat islands with temperatures up to 7˚ C higher in some parts of the world Greater air pollution, among other effects on the environment	Increased risk of diseases (vector-borne) and heat-related deaths and effects on those who perform tiring tasks Increased incidence of respiratory diseases Shortage of food due to effects on agriculture
Heavy rainfall: Greater frequency in most areas Higher intensity of tropical cyclonic activity (including hurricanes and typhoons)	Increased risk of floods and landslides Disruption in access to livelihoods and in the economies of cities Damage to homes, goods, businesses, transportation and infrastructure in general Loss of income and assets Often, population displacements and consequently risk to assets and social networks	Deaths Wounds Increased incidence of diseases related to food and water Increased malaria due to stagnant water Less mobility and its consequences on livelihoods Food shortage Displacement and related risks for mental health
Greater area affected by the drought	Lack of water Migration of affected people Limitations for hydroelectric generation Lower rural demand for goods and services Higher food prices	Greater shortage of food and water Increased incidence of malnutrition and diseases transmitted by water and food Increased risk of forest fires and related respiratory problems

Sources: Cities Alliance, 2015; IPCC, 2013: 867-952; UN, 2016; Mario Molina Center, 2014; National Council for the Evaluation of Social Development Policy, 2014; National Agricultural Survey, 2014; UN-Habitat, 2014

The main objective of this work is to analyze successful international experiences on how to implement the urban and territorial development plans and programs, in order to face the problems that climate change entails in the Mexican context, and as a complement, review the scientific literature of technological tools and methods, mainly on predictive and simulation models that have served as a technical support in other countries, both in urban and territorial planning phases and in implementation and control phases.

In Mexico, for example, the State Programs for Action on Climate Change (PEACC) derived from the National Climate Change Strategy are structurally well-designed proposals, but at the time of wanting to implement them in a practical way to urban and regional development they encounter various technical obstacles and deficiencies of various kinds, mainly of implementation procedures.

Regarding the problem described above and the central question of this investigation, it is observed that the procedures for the implementation of public policies in Mexico have not been sufficiently operative enough to make them work. If you really want to organize the space and the territory in order to carry out a real transformation that helps to confront the identified environmental problems (table 1), it is therefore necessary to improve the implementation procedures of the best available public policies.

Because -planning cities- is a multidimensional activity with diverse purposes such as developing projects, programs, master plans and other planning strategies (Oliveira and Hersperger, 2018: 623), therefore, the implementation phase is also; In addition, it should be noted that the central object of planning, ie the city, being a complex system, must be resolved as a complex problem (Cooke and Thomas, 2017: 1176; Batty, 2013) which is also multifactorial; so the solutions must be systemic. Systemic in the sense of regulating and planning each of the systems that have to do with the infrastructure and equipment of cities, such as transport, mobility, housing, commerce, industry, electricity lines, drinking water, eviction of both solid waste as liquids, security, etc., which have to do directly with strategies of land uses and selection and application of new environmental technologies, both to implement them and to monitor and operate them.

2. METHODOLOGY

The review and analysis of scientific literature on successful international procedures on the implementation of urban planning plans and programs in the face of climate change was carried out through the *sciencedirect*® database, which is one of the databases of scientific knowledge most powerful and complete technology in the world. The review focused on the search for implementation strategies, particularly the roles and functions of those directly responsible, as well as successful

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methods and models for the implementation of programs and projects for optimal regional urban development in the face of climate change. The total universe was around 130,712 results of documents on the subject matter (implementation in urban and regional planning); having a sub-universe of around 12,578 results only for cases of open access documents; later, the universe was further reduced by limiting the 2011-2018 search years to date, although 95% of the documents reviewed in the sample were from 2015 to 2018, since, in fact, documents from the year 2011 were only included 1 in the final sample. The universe of study was also limited to the type of document, with 85% of scientific and review articles; 9% of papers in extensive and 6% of scientific books. The final sample was in 35 documents reviewed and analyzed in detail divided into 12 categories of analysis corresponding only to the best success stories that could be taken as reference for the Mexican context.

On the other hand, and as a complement to the above, the main predictive models and simulators of growth and land use planning were reviewed (with a sample of 23 successful models) which could be of great help for those who carry out and design public policies, and also, for decision makers on urban planning in the face of climate change. It should be noted that this review of scientific literature was made from a technical urbanism approach aimed at answering the central research question: How to adequately implement public policies on urban planning in the face of climate change?

3. RESULTS AND LIMITATIONS

Review of scientific literature on successful procedures at the international level on the implementation of urban planning plans and programs in the face of climate change.

Table 2 shows the results of the review and analysis of scientific literature on successful international procedures on the implementation of urban planning plans and programs in the face of climate change, mainly highlighting data and strategic and management information on public policies to be implemented, particularly of successful programs, projects and methods that have been successfully tested for such purposes, and that could be relatively easily adapted to the Mexican context.

Table 2 also shows 12 categories of analysis that the search showed in the scientific database used. Of these 12 categories, the highest number of results obtained was transport with 11 documents, so we can observe the shows, that the issue of transport and mobility is the one that currently concerns the scientific community, for several reasons, but mainly because the transport sector is the one that produces the most CO2e emissions into the atmosphere (Hernández-Moreno et al., 2018: 8). It is followed by energy and negotiation categories with 5 documents of the main sample each, where the relationship of energy with transport is perfectly understood due to the issue of CO2 emissions and

attempts to reduce energy consumption in cities; The category of negotiation is a very important issue for the issue of the implementation of urban development plans, since it is the part where the actions to be taken into account among the different actors involved are agreed upon. Regarding the category of water, the results yielded only 3 results, but this does not mean that it is a minor issue, but that in terms of water implementation (according to the results of the output) there have been more advances than in transportation or in the energy, and the same for the topics of the categories that continue as land uses, security, nature and urban metabolism that are issues of great importance for urban and regional development but that according to the results thrown by the database used and under the criteria used in this research present a lesser sign of alarm compared to transport and energy, which are central issues that define and influence all public policies regarding environmental issues in cities and population centers with greater weight.

TABLE 2 - HIGHLIGHTS OF THE LITERATURE REVIEW ON SUCCESSFUL PROCEDURES AT THE INTERNATIONAL LEVEL ON THE IMPLEMENTATION OF URBAN PLANNING PLANS AND PROGRAMS FOR CLIMATE CHANGE APPLICABLE TO THE MEXICAN CONTEXT

Review of scientific literature on successful procedures at the international level on the implementation of urban planning plans and programs in the face of climate change				
N °	**No. Refs.**	**Categories of Analysis**	**Source**	**Outstanding observations**
1	1	**Water**	Omar et al., 2017	The Study mentions the importance of the cultural influence that exists in the implementation of plans and programs on urban water and its relation with risk management derived in the expansion of pilot studies.
2	2	**Water**	Shamsuzzoha et al., 2018	The study recommends tha, in order to adequately implement drinking water plans, it must be accompanied by quantitative studies on natural disasters, mainly on the vulnerability of the water supply network, which is where most is contaminated.
3	3	**Water**	Bahri et al., 2016	It is mentioned that for the implementation to be successful, governments must work with programs and projects where the professional and technical capacities of the executors are first developed.
4	1	**Air**	Castro et al., 2017	The study confirms that it is important to carry out evaluations that provide feedback to the application of subsequent programs, in this case of air quality, after any implementation mainly to measure its success.
5	1	**Energy**	Wu et al., 2017	The study proposes that the planning and implementation of top-down public policies generally hinder actions at the local urban level, suggesting that greater freedom be given to local governments to act.
6	2	**Energy**	Huang et al., 2015	The document deals with how the energy sector in cities can be more effective working at community scales both in the production and distribution of energy and in its commercialization, in order to make the rest of the energy programs to be implemented more efficient.
7	3	**Energy**	Trotter et Al., 2017	They mention that the transition from fossil-based technologies to green technologies will be key to more efficiently implement the electrification programs in the world.

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8	4	**Energy**	Jagger and Das, 2018	Regarding the issue of implementation of programs and projects to improve the quality of life of the inhabitants and for the environment, this work teaches us that local governments should work together with private sector companies to be able to implement efficiently and together programs, which in this case, are about sustainable energies.
9	5	**Energy**	Volpe, 2015	The study recommends the evaluation of the dynamic evolution of energy flows, a flexible mathematical procedure capable of characterizing the energy profile of an urban environment through the implementation of the theory of complex networks.
10	1	**Logistics**	Colomer-Font et Al., 2016	Proposal for the implementation of clusters at the regional level, which can address many different types of issues related to urban logistics, a complex process that requires many steps and different negotiations.
11	1	**Manufacture**	Ghaffar et al., 2018	In the construction sector, ecological and innovative solutions are required, so the authors propose disruptive solutions to the problem of building in the world, optimizing the design, construction and maintenance processes.
12	1	**Metabolism**	Elliot et al., 2018	The integration of system dynamics to calculations of urban metabolism and analysis by life cycle can help evaluate the potential of urban projects, plans and their implementation.
13	2	**Metabolism**	Lehmann, 2018	Proposal for the use of development of integrated approaches to infrastructure planning and implementation as a tool to increase resource efficiency (example: "living laboratories").
14	1	**Naturation**	Raymond et al., 2017	Design implementation processes based on evaluating the value of collateral benefits of natural solutions in the urbanization processes, as well as orienting the information in an intersectoral manner.
15	2	**Naturation**	Turan et al., 2016	It is recommended the design of green areas that must be designed implemented a participatory process using criteria of accessibility, user profile, several activities, comfort and image (security and maintenance).
16	1	**Negotiation**	Cirolia and Berrisford, 2017	They propose the concept of "negotiated planning" as a useful conceptual tool for: the deviation of normative assumptions about good or adequate planning: "unpacking" the traditional nature of the implementation.
17	2	**Negotiation**	Oliveira and Hersperger, 2018	To implement, we must start with an institutional strategy, creating financing mechanisms and governance agreements. The study shows in some cases that private interest groups have substantial bargaining power, for example, the development of a new housing settlement or a specific installation, while other groups struggle to safeguard natural and human resources.
18	3	**Negotiation**	Guan and Rowe, 2016	This research applies a scenario based on cellular automata models for a case study that produces useful data and projections based on predictive scenarios using quantitative methods for the correct allocation of resources in a certain urban area.
19	4	**Negotiation**	Kalmykova et al., 2018	It discusses the circular economy (EC) approach that aims to reduce both the entry of materials and the production of virgin waste, closing the "loops" or economic and ecological flows of resources.
20	5	**Negotiation**	Campagna et Al., 2014	Solutions are presented implementing workflows of the spatial planning process thanks to the development of original spatial data and processing of service connectors with the help of business management processes.
21	1	**Pedestrianization**	Sdoukopoulos et al., 2017	Within the planning and proposals for pedestrianization of cities, the contribution of Pedestrianization audits as a tool for monitoring, evaluation and improvement of walking conditions in an urban area.

22	2	**Pedestrianization**	Zhao et al., 2012	The pedestrian infrastructure must be evaluated in order to be restructured or modified for the good of the pedestrian and the mobility of the cities.
23	1	**Security**	Lai et al., 2011	They propose a structured technique to deal with complex decisions together with the use of Geographic Information Systems to deal in this case with the implementation of infrastructure in the face of the risk of fires in the cities, with the solutions being the ones that best suit the needs.
24	1	**Land use**	Kalkuhl et al., 2018	They mention that non-linear fiscal schemes could avoid adverse effects on poverty, first by leveling the distribution of income and reducing the gap between rich and poor.
25	1	**Transport**	Di Pasquale et al., 2016	They present some recent innovative solutions implemented in urban public transport that are mainly based on the technology implemented within the public transport infrastructure, which in each region or country changes the perception and the focus.
26	2	**Transport**	Iwan, 2014	To achieve the success of the implementation in transport technologies, it is based on transferring only the proven solutions based on an adaptive approach.
27	3	**Transport**	Schmitz et al., 2018	To reduce motorized traffic, for example, it is necessary that governments first provide their inhabitants with all the information necessary to understand the problem and the community solution.
28	4	**Transport**	Moro et al., 2018	Bicycle exchange systems still present major obstacles to their implementation, one of the main ones is resistance to change by society in general, and ignorance of technical aspects on the subject by local governments.
29	5	**Transport**	Hardinghaus et Al., 2016	To implement electric-type freight transport infrastructure networks, through modeling of traffic, with management models and implementation based on roles and work assignment, particularly in the operational part of the project development.
30	6	**Transport**	Issa and Abu-Eisheh, 2017	The execution of operation and maintenance manuals in the cities are an essential part for the successful implementation of urban and territorial development plans. In this case, 95% of the maintenance works were executed through external contracts.
31	7	**Transport**	Crúz and Montenon, 2016	One of the ways in which air quality can be improved in urban areas is by introducing low emission zones where the schemes come from either local or national governments.
32	8	**Transport**	Drličiak and Čelko, 2016	Detailed data is needed on the current travel pattern and traffic volumes to develop urban transport forecasting / prediction models and for the implementation of the development plans involved.
33	9	**Transport**	Oskarbski and Kaszubowski, 2016	The article presents how the weighing system in motion can be used to manage Gdynia's cargo traffic. The implementation occurred in two ways, the first with simulation of different scenarios, and the second through a pilot case.
34	10	**Transport**	Kühnel et Al., 2018	Implementing an adaptive traffic signal control algorithm in a transport simulation through the simulation of comparative scenarios, validating the performance for the case of transport and intelligent mobility.
35	11	**Transport**	Cré et al., 2012	Implementation scenarios are proposed directly with local and regional authorities for the integration of one or more innovative concepts in existing urban transport policies where the transfer of knowledge and technology is crucial for the success of the implementation.

Source: Indicated in the fourth column of this table

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On the other hand, focusing on the -relevant observations- of the documents in Table 2, mention other subcategories that derive, for example, on cultural issues and environmental education by the general population, as well as technical issues such as for example: previous realization of quantitative studies applied to projects, feedback of information in subsequent programs, implementation of the theory of complex networks, propose disruptive solutions to the problem of building in the world, integration of system dynamics to metabolism calculations Urban and life cycle analysis can help evaluate the potential of urban projects and even the technical preparation of direct implementers of technologies and infrastructure so that the implementation phase is successful. Also pay more attention to management strategies for successful implementation such as: give greater freedom to local governments to act; work at community scales, transition from technologies of fossil origin to green technologies, that local governments work jointly with private sector companies, creation of financing mechanisms appropriate to the circumstances, design and use appropriate audit schemes, use of non-linear fiscal schemes as an alternative, adequate transfer of technology according to local budgets and the execution of operation and maintenance manuals in the cities are an essential part for the successful implementation of urban and territorial development plans.

3.1. Review of scientific literature of the main predictive models and simulators of planning and implementation and monitoring of urban-territorial plans

Table 3 shows a synthesis of the results obtained from the review of scientific literature corresponding to the main technological tools such as predictive models and simulators of urban environmental growth and ordering used to predict different scenarios in the creation of cities and other population centers in all over the world, which could be of great help (in addition to traditional tools of Computer Aided Design, Geographic Information Systems, etc.) for the decision making of those responsible for urban development in Mexico, including policy makers public on the subject, and of course to urban planners, architects, real estate developers and in general to all those involved in the creation, planning, project, maintenance, durability (Hernández-Moreno, 2015: 24) and operability of cities and other centers of population.

TABLE 3 - SYNTHESIS ON THE REVIEW OF SCIENTIFIC LITERATURE OF TOOLS AND PREDICTIVE MODELS ON URBAN ENVIRONMENTAL DEVELOPMENT OF THE SELECTED SAMPLE

N°	Tool or model	Specific type of tool or technique	Main applications in urbanization	Source
1	*Adaptation Planning Support Toolbox AST®*	Simulation model using specialized databases	Evaluates and predicts impacts of climate change on urban planning and adaptation of cities	van de Ven et al., 2016

N°	Tool or model	Specific type of tool or technique	Main applications in urbanization	Source
2	*Erdas imagine® and ArcGIS® Software*	Remote sensing data system	Analysis of urban growth	Garouani et al., 2017
3	*SLEUTH® model in simulating the urban growth*	Geospatial techniques and cellular automata	Modeling and monitoring urban growth in an urban strip	Kumar-Jat et al., 2017
4	*VISUM®*	Simulation model	Comprehensive modeling of urban transport systems	Solecka and Żak, 2014
5	Models of data-based approaches	Statistical and probabilistic model	Prediction of energy consumption of buildings at urban level	Tardioli et al., 2015
6	*Data-driven Urban Energy Simulation (DUE-S®)*	Simulation model	Data-driven urban energy simulation	Nutkiewicz et Al., 2018
7	Delphi® method	Predictive model based on the systematic use of an intuitive judgment issued by a group of experts	Exploration of indicators of subjective well-being for sustainable urban planning	Musa et al., 2018
8	Fuzzy logic model	Predictive model	Predictions on the urban development index	Eraqi, 2016
9	*PRACT Project® (Predicting Road ACcidents - a Transferable methodology across Europe)*	Predictive model	Security and vehicular traffic	La Torre et al., 2016
10	Social networks over the Internet	Predictive model	Transport, mobility and security	Comito, 2018
11	Hybrid models of artificial neural networks (using sensor devices)	Predictive model by neural networks	Effective prediction and mitigation of NO2 pollution in urban roads	Cabaneros et al., 2017
12	Artificial neural networks and the ARIMAX® model	Predictive models by neural networks	Planning, implementation and monitoring of urban transport systems	Catalano et al., 2016
13	*Urban growth model*	Dynamic simulation model	Non-stationary modeling of urban growth	McGarigal et al., 2018
14	Dynamics of complexity models	Dynamic simulation model	Modeling the dynamics of the complexity of land use and urban transport	Noviandi et al., 2017
15	Markov® cellular automaton model	Predictive models of dynamic type	Monitoring and control of rapid urbanization and its environmental impacts	Bharath et al., 2017
16	Model based on mathematical predictions of urban climate	Simulation model	Modeling radiation-based thermal stress indicators for urban areas	Leroyer et al., 2018
17	Deterministic model based on mesh mapping and vector use	Predictive model of the cube	Prediction of urban growth	Brunner, 2016

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N°	Tool or model	Specific type of tool or technique	Main applications in urbanization	Source
18	Analysis model of Bayesian networks	Predictive-probabilistic model using Bayesian networks	Prediction of urban road congestion	Liu et al., 2014
19	Cell automata based on urban scenarios	Predictive model of iterative type and mathematical modeling for dynamic systems	Modeling and simulation of the growth of cities and application of public policies	Guan and Rowe, 2016
20	Models of artificial neural networks and methods of grouping urban space	Predictive model based on artificial intelligence	Forecast of transport zones with high risk of crime in urban areas	Kouziokas, 2017
21	Markov® cellular automaton model and Logistic regression	Predictive model based on cellular automata	Planning, implementation and control of urban growth dynamics	Siddiqui et al., 2017
22	*Urban Growth Model (UGM)®*	Predictive model based on artificial intelligence of cellular automata	Predicting urban growth using an artificial neural network	Aarthi and Gnanappazham, 2018
23	*City-planning gaming software*	Simulation model based on gaming technology	Simulation in urban production	Juraschek et al., 2017

Sources: (indicated in the fifth column of this table)

4. CONCLUSIONS

It is concluded that there is sufficient scientific literature in the part referring to the planning phase of urban and territorial development of programs and projects to deal with climate change problems in cities, but not enough in the implementation and follow-up phase, such programs and projects, which is where most of the time the biggest obstacles identified are presented. Obstacles that are summarized in 3 types: those of cultural and educational nature; those of technical questions and of procedures and those of strategic questions and of management of public policies.

The author of this work considers that it is necessary to strengthen and solve the three types, placing greater emphasis on technical issues and implementation procedures, since this is where the greatest deficiencies were observed by those directly responsible (government) of the planning and execution of urban development at all levels of government (federal, state and municipal) at the time of trying to carry them out. As discussed above in the results section, the category or theme of transport is the most attended by the scientific community as it is closely linked to issues of polluting emissions and therefore energy consumption which is where most of the negotiations between government, industrialists,

businessmen and transporters are given in many ways and approaches, and although in this work this topic does not enter as a research objective, it is important to mention it.

In addition to the above and as it has been observed that it is necessary to strengthen the technical part and procedures of implementation of programs and projects for urban developments adaptable to climate change. The results of the review and analysis of scientific literature of tools and predictive models on environmental urban development of the selected sample, could be very useful for decision makers and in the same way for the directors of the corresponding public policies.

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