Volume 5, Issue 8 – January – June - 2019

ECORFAN

Journal- Republic of Nicaragua

ISSN-On line 2414-8830

10th ANNIVERSARY ECORFAN Special Edition

ECORFAN Journal-Republic of Nicaragua, Volume 5, Issue 8, January-June 2019, is a journal edited semestral by ECORFAN. First Avenue Southwest, San Sebastian area, León, Republic of Nicaragua. P. C. 21000. WEB: www.ecorfan.org/republicofnicaragua/, journal@ecorfan.org. Editor in Chief: ZAPATA-MONTES, Nery Javier, PhD. ISSN On line: 2414-8830. Responsible for the latest update of this number ECORFAN Computer Unit. ESCAMILLA-BOUCHÁN, Imelda, LUNA-SOTO, Vladimir. Last updated June 30, 2019.

ECORFAN Journal Republic of Nicaragua

Definition of Journal

Scientific Objectives

Support the international scientific community in its written production Science, Technology and Innovation in the Field of Biotechnology and Agricultural Sciences, in Subdisciplines of agriculture-forest, pathology-sustainable, forest, management, horticulture, engineering and integrated water use.

ECORFAN-Mexico SC is a Scientific and Technological Company in contribution to the Human Resource training focused on the continuity in the critical analysis of International Research and is attached to CONACYT-RENIECYT number 1702902, its commitment is to disseminate research and contributions of the International Scientific Community, academic institutions, agencies and entities of the public and private sectors and contribute to the linking of researchers who carry out scientific activities, technological developments and training of specialized human resources with governments, companies and social organizations.

Encourage the interlocution of the International Scientific Community with other Study Centers in Mexico abroad and promote a wide incorporation of academics, specialists and researchers to the publication in Science Structures of Autonomous Universities - State Public Universities - Federal IES - Polytechnic Universities - Technological Universities - Federal Technological Institutes - Normal Schools - Decentralized Technological Institutes - Intercultural Universities - S & T Councils - CONACYT Research Centers.

Scope, Coverage and Audience

ECORFAN Journal Republic of Nicaragua is a Journal edited by ECORFAN-Mexico S.C in its Holding with repository in Republic of Nicaragua, is a scientific publication arbitrated and indexed with semester periods. It supports a wide range of contents that are evaluated by academic peers by the Double-Blind method, around subjects related to the theory and practice of agriculture-forest, pathology-sustainable, forest, management, horticulture, engineering and integrated water use with diverse approaches and perspectives , That contribute to the diffusion of the development of Science Technology and Innovation that allow the arguments related to the decision making and influence in the formulation of international policies in the Field of Biotechnology and Agricultural Sciences. The editorial horizon of ECORFAN-Mexico® extends beyond the academy and integrates other segments of research and analysis outside the scope, as long as they meet the requirements of rigorous argumentative and scientific, as well as addressing issues of general and current interest of the International Scientific Society.

Editorial Board

Arbitration Committee

Assignment of Rights

The sending of an Article to ECORFAN Journal Republic of Nicaragua emanates the commitment of the author not to submit it simultaneously to the consideration of other series publications for it must complement the Originality Format for its Article.

The authors sign the Authorization Format for their Article to be disseminated by means that ECORFAN-Mexico, S.C. In its Holding Republic of Nicaragua considers pertinent for disclosure and diffusion of its Article its Rights of Work.

Declaration of Authorship

Indicate the Name of Author and Coauthors at most in the participation of the Article and indicate in extensive the Institutional Affiliation indicating the Department.

Identify the Name of Author and Coauthors at most with the CVU Scholarship Number-PNPC or SNI-CONACYT- Indicating the Researcher Level and their Google Scholar Profile to verify their Citation Level and H index.

Identify the Name of Author and Coauthors at most in the Science and Technology Profiles widely accepted by the International Scientific Community ORC ID - Researcher ID Thomson - arXiv Author ID - PubMed Author ID - Open ID respectively.

Indicate the contact for correspondence to the Author (Mail and Telephone) and indicate the Researcher who contributes as the first Author of the Article.

Plagiarism Detection

All Articles will be tested by plagiarism software PLAGSCAN if a plagiarism level is detected Positive will not be sent to arbitration and will be rescinded of the reception of the Article notifying the Authors responsible, claiming that academic plagiarism is criminalized in the Penal Code.

Arbitration Process

All Articles will be evaluated by academic peers by the Double Blind method, the Arbitration Approval is a requirement for the Editorial Board to make a final decision that will be final in all cases. MARVID® is a derivative brand of ECORFAN® specialized in providing the expert evaluators all of them with Doctorate degree and distinction of International Researchers in the respective Councils of Science and Technology the counterpart of CONACYT for the chapters of America-Europe-Asia- Africa and Oceania. The identification of the authorship should only appear on a first removable page, in order to ensure that the Arbitration process is anonymous and covers the following stages: Identification of the Journal with its author occupation rate - Identification of Authors and Coauthors - Detection of plagiarism PLAGSCAN - Review of Formats of Authorization and Originality-Allocation to the Editorial Board-Allocation of the pair of Expert Arbitrators-Notification of Arbitration -Declaration of observations to the Author-Verification of Article Modified for Editing-Publication.

Instructions for Scientific, Technological and Innovation Publication

Knowledge Area

The works must be unpublished and refer to topics of agriculture-forest, pathology-sustainable, forest, management, horticulture, engineering and integrated water useand other topics related to Biotechnology and Agricultural Sciences.

Presentation of the Content

In the first chapter we present, *Pilot Underground Greenhouse as an alternative against frequent and intense frosts that occur in the Hidalguense Highlands* by AHUMADA-MEDINA, Albino, CHIO-AUSTRIA, Rosa María and AHUMADA-GÓMEZ, Jorge with adscription in the Universidad Politécnica de Pachuca and Instituto Tecnológico Latinoamericano, as a second article we present *Air Quality Index for Ciudad Juárez based on a Community Collaboration Scheme*by by RODRÍGUEZ-GARCÍA, Nabile Edith, VÁZQUEZ-GÁLVEZ, Felipe Adrián, ESTRADA-SALDAÑA, Fernando and HERNÁNDEZ-HERNÁNDEZ, Israel with adscription in the Universidad Autónoma de Ciudad Juárez, as the following article we present *GHG emissions in KG-CO2 / M2 generated by a House Type INFONAVIT* by ACEVES-GUTIERREZ, Humberto, LÓPEZ-CHÁVEZ, Oscar, MERCADO-IBARRA, Santa Magdalena and CONTRERAS-QUINTANAR, Cesar Alejandro with affiliation at the Instituto Tecnológico de Sonora as Next article we present *Remediation methods for the removal of pesticides in wastewater* by GODINEZ-GARCÍA, Andres, HERNÁNDEZ-MORALES María Guadalupe, GUIJOSA-GUADARRAMA, Santiago and DÍAZ-TECANHUEY, Pedro Jesús with affiliation at the Universidad Autónoma Metropolitana - Azcapotzalco

Content

Pilot Underground Greenhouse as an alternative against frequent and intense frosts that occur in the Hidalguense Highlands

Invernadero Subterráneo Piloto como alternativa contra las heladas frecuentes e intensas que ocurren en el Altiplano Hidalguense

AHUMADA-MEDINA, Albino*†, CHIO-AUSTRIA, Rosa María and AHUMADA-GÓMEZ, Jorge

Universidad Politécnica de Pachuca. Pachuca-Cd. Sahagún, Km 20.Rancho Luna. Former Hacienda of Santa Barbara. Zempoala, Hidalgo. México. C. P. 43830
Instituto Tecnológico Latinoamericano. Pachuca, Hidalgo. Pachuca-Cd. Sahagun, Km. 11. Pachuca, Hidalgo. México. C. P. 42083

ID 1st Author: *Albino, Ahumada-Medina* / **ORC ID:** 0000-0003-3429-1144, **Researcher ID Thomson**: V-5798-2018

ID 1st Coauthor: *Rosa María, Chio-Austria* / **ORC ID:** 0000-0003-2354-073

ID 2nd Coauthor: *Jorge, Ahumada-Gómez* / **ORC ID:** 0000-0002-1376-0346

DOI: 10.35429/EJRN.2019.8.5.1.5 Received January 28, 2019; Accepted March 30, 2019

Abstract

The prevailing weather conditions in the Valles Altos of the Mexican state of Hidalgo enhance high frequency of frosts that usually last from September to April, causing serious damage and constraints on agricultural cycles, both open sky and protected agriculture. In this paper, the results of observations of the behavior of temperatures during night and early morning hours of an underground greenhouse built on the campus of the Polytechnic University of Pachuca are reported. These data allow for an innovative approach to the production of horticultural, ornamental and medicinal plants during the period of frost. After four years of continuous experimentation, there have been cultivated horticultural, ornamental and medicinal plants, during all months of the year, even when they came to present -10 degrees Celsius or lower coolings. As observed, one can conclude that the results have been satisfactory to the experimental design and, therefore, may try to build greenhouses of 2000 square meters with trade capacity throughout the year with some adaptations derived from a larger area.

Agricultural damage due to frost, Mexican high plateau frost, Underground greenhouse

Resumen

Las condiciones climatológicas prevalecientes en los Valles Altos del estado mexicano de Hidalgo favorecen una alta frecuencia de heladas que suelen prolongarse de septiembre a abril, lo que ocasiona serios daños y limitaciones en los ciclos agrícolas, tanto a cielo abierto como en la agricultura protegida. En el presente trabajo, se reportan los resultados de observaciones del comportamiento de temperaturas durante noches y primeras horas del día de un invernadero subterráneo construido en el campus de la Universidad Politécnica de Pachuca. Estos datos permiten hacer una propuesta innovadora para la producción de plantas de interés hortícola, ornamental y medicinal durante la etapa de heladas. Tras cuatro años de experimentación continua, se han logrado cultivos de plantas hortícolas, ornamentales y medicinales durante todos los meses del año, aun cuando se llegaron a presentar enfriamientos inferiores a 10 grados centígrados bajo cero. Por lo observado, es posible concluir que los resultados han sido satisfactorios para el diseño experimental, y es posible, por tanto, intentar la construcción de invernaderos de 2000 metros cuadrados con capacidad comercial todo el año con algunas adaptaciones derivadas de una mayor superficie.

Daños agrícolas por heladas, Heladas altiplano mexicano, Invernadero subterráneo

Citation: AHUMADA-MEDINA, Albino., CHIO-AUSTRIA, Rosa María and AHUMADA-GÓMEZ, Jorge. Pilot Underground Greenhouse as an alternative against frequent and intense frosts that occur in the Altiplano Hidalguense. ECORFAN Journal-Republic of Nicaragua. 2019. 5-8: 1-5

* Correspondence to Author (email: ahumadamedina@upp.edu.mx)
† Researcher contributing first author.

June 2019 Vol.5 No.8 1-5

Introduction

In its greater proportion the Mexican territory, particularly its coasts, are favourably influenced for the cultivation of vegetables by their tropical latitude, particularly in winter, when in the latitudes of the mainland the lack of light and heat become limiting factors; however, as the territory increases its height above sea level, especially regions directly exposed to the influence of cold fronts, they are exposed to the effect of frost by advection and irradiation that prevent the production of the field during the last and first part of the year. These phenomena combined with water scarcity have favoured in recent decades the development of a growing activity in agricultural production through the use of greenhouses and hydroponics in the central states of the highlands of the republic with dry-dry climates; It is also important to note that in these entities there are the best commercial opportunities facilitated by proximity and good communications with the largest national consumption centres.

In the highlands of the state of Hidalgo, the installation of greenhouses has increased in the last fifteen years, probably exceeding 40 hectares, however this data should be taken with caution, because an undetermined proportion are not in production when abandoned by various reasons among which the following stand out:

- Production limited to frost-free months (May-August).
- Design of greenhouses with characteristics not appropriate to the climate.
- Establishment of farms with limited area.
- Low level of competitiveness compared to other regions of the country with better conditions to produce vegetables throughout the year.
- Lack of preparation and technical information of the producers.

For the understanding of this work, we will analyse the geographical-climatological aspects that limit agricultural production to the season that goes from May to August with 130 days free of frost, even if occasionally there are temperatures below zero in the months of May and June, without that reports of having seriously affected the economy of the producers are known.

In principle, the territory of the high plateau of Hidalgo is crossed by tropical latitudes that are around 20 ° north but, in counterpart, in its greater proportion it maintains a height greater than 2,000 meters above sea level; It also suffers a low rainfall resulting from the mountain shadow caused by the Sierra Madre Oriental and above all it is affected from September to May by the incidence of cold fronts from the north of the continent. Together, these factors are combined to facilitate various variants of frost with potential agricultural hazard for eight, and occasionally, nine months in the year. Records obtained in the municipality of Zempoala, Hidalgo, through the Network of Meteorological Stations of the National Institute of Forest Research (NNMS) [1] and the Internal Network of Meteorological Stations of the UPP (INMSUPP) [2] between 2008 and 2014 they indicate the incidence of such events between 47 (2014) and past one hundred (2008 and 2011) table 1

	E	F	M	A	M	J	J	A	S	O	N	D	Total
2007	7	10	7	2					3	6	10	17	63
2008	26	8	9						2	10	18	27	100
2009	22	18	9	1	1				2	1	4	9	67
2010	9	7	6	1						17	17	28	82
2011	26	15	14						3	12	8	24	102
2012	21	1	4	5	3					8	11	22	65
2013	10	18	10	1						1	3	8	51
2014	16	13			4					4	5	5	47

Tabla 1 Number of Monthly Frosts and Total Annuals Registered During the years 2007 to 2011

It is important to note that the severity of the damage caused by frost in agriculture is accentuated by the dates on which they occur, since the early September to October cause their damage in the final phase of the harvests and the late ones in March, April and May cause losses in the phases of crop preparation either open field or protected crops.

ISSN-On line 2414-8830

Date	T. Minimum	T Maximum	T Media
23/09/2007	-0.4	11.42	11.4
29/09/2008	-1	21.6	10.2
01/10/2009	-4.5	20.6	8.7
29/09/2010	-3.5	22.7	9.5
08/09/2011	-2.6	19.3	8.0
03/10/2012	-1.9	20.1	10
30/11/2013	-3.7	21	8.1
26/10/2014	-1.4	22.1	10

Tabla 2 Minimum, Maximum and Average Temperatures of Days with First Frosts in the years 2007 to 2013

Table 2 shows that the first frosts can occur from the first days of September as happened on the morning of the eighth day of the mentioned month in 2011, causing innumerable losses not only in the municipality of Zempoala, Hidalgo, but its effects were felt in most of the centre of the Mexican Republic. On the other hand, the “table 3”, indicates that the presence of late frosts affects during the months of April and occasionally those of May, causing significant losses those that occurred during the months of March and April where low temperatures can be interspersed with warmer days of the waste in the region, time in which the plants are more active by the stimulation of the lengthening and warmth of the days.

According to the data reported in Table 3, in the High Valleys there were strong losses due to early frosts in September 2009 and 2006, which although there was not a markedly low decrease in temperature, if they affected the crops of field and greenhouse at harvest times; also, what happened in April 2012 and March 2013, caused losses of consideration in the vegetative material that was prepared for the following agricultural cycle.

Radiation frosts are those that are observed in the highest proportion in the highlands of Hidalgo due to the low daytime and night-time cloudiness that are frequently observed from late summer, winter and early spring, favouring the gradual cooling of the soil by losing its heat from the late hours of the afternoon, all night and early hours of dawn; However, occasionally there are advection frosts arising from the invasion of cold air masses from polar regions. These conditions may occur unexpectedly for one or several days with slightly higher or lower temperatures 0°C.

It is important to note that the greatest losses caused by frosts in agriculture in the highlands of Hidalgo are derived from the conjugation of advection and radiation phenomena [3,4]. These are observed for one or several days, when a stream of air originating in Arctic latitudes, acts cooling during the day, until approximately 22: 00-24: 00 hours, reaching temperatures close to 0 ° C or lower, leaving then of running the wind for more than eight hours with the consequent loss of heat by irradiation, to present in the early hours of dawn extreme minimum temperatures for the region "table 4", as happened during the autumn-winter 2010-2011, "table 3". These extreme conditions not only tend to seriously damage outdoor or protected crops, but also affect endogenous flora of cacti and agavaceae due to the freezing of water inside plant cells.

The models of greenhouses [5,6] that have been tried in the highlands of Hidalgo, can be considered that their handling to dislodge heat during the day is efficient due to their height and ventilation systems, but they are inoperative for heat conservation and quickly they lose every night.

The proposal to build an underground greenhouse derived from the concern of taking advantage of low productivity land but well connected with large centres of consumption but adapting technologies of protected agriculture to a climate in which the types of greenhouses tested so far in Mexico do not offer satisfactory results.

Material and method

On land located at the Polytechnic University of Pachuca in the latitude of 19 ° 58 '49.41” and longitude 98 ° 41' 07.43” and a height above sea level of 2377 meters, an excavation was carried out on clay soil of 2 meters of depth, forming a rectangle 16 meters long and 12 meters wide. Bales of barley and sacks containing clay were placed on the side walls facing northeast, with a height of 1.5 meters on the side walls, bales and sacks were also placed but gradually decreasing until reaching the level of the two meters on the southwest wall. All the walls were covered in their lower portion with earth to give greater protection against lateral winds.

The excavation was covered with polyethylene fabric with a shadow capacity of 30% and a 50% half shade mesh was placed on it. On these two permanent covers, a third plastic cloth was placed that unwinds only when frosty nights are expected, to form an air mattress that does not allow heat to escape.

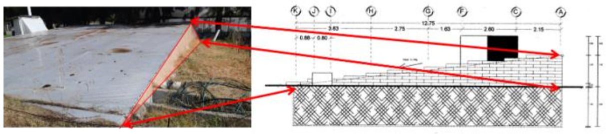


Figure 1 Side view of underground greenhouse

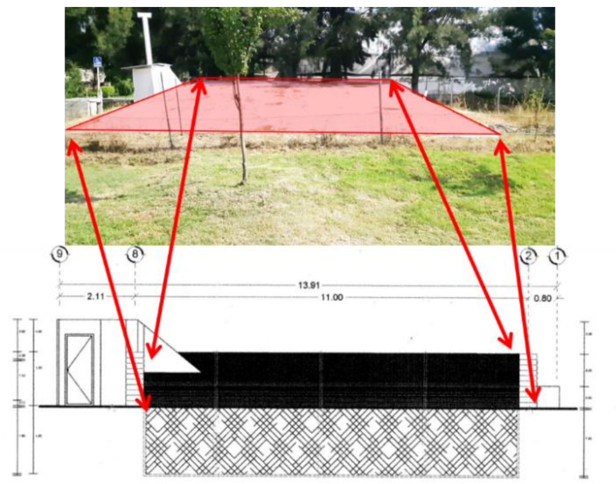


Figure 2 Front view of underground greenhouse

Temperature monitoring is done every 30 minutes by comparing three different weather stations (WSUPP):

- Station 1. It is located outdoors and indicates the general weather conditions. Davis Vantage Pro 2 Plus 06162.

- Station 2. It is located in a tunnel greenhouse of 5m high, with an area of 180 square meters, indicating the temperature and humidity. Wireless Temperature / Humidity 06382. Davis.

- Station 3. It is located in the underground experimental greenhouse, indicating the temperature and humidity. Wireless Temperature / Humidity 06382. Davis.

The information of the three stations is concentrated in the console that is part of the Vantage Pro 2 Plus station and through the intercom that allows the Weather Link 06510SER software. Davis, the information has been concentrated for interpretation on a PC.

Results

The Polytechnic University of Pachuca has several types of greenhouses, so it is possible to make comparative measurements in real time in them with respect to the time in the open field.

In these observations it has been established that although during the day the greenhouses with polyethylene walls fulfil their function of capturing and accumulating the infrared energy, during the last hours of the day, they lose it quickly and throughout the night, until dawn internal and external temperatures are maintained with little difference, in the case that the low temperatures are prolonged longer in the first hours after dawn, inside the installation due to the ice formed on the internal walls it defrosts more slowly than in the Exterior.

In table 5, the evolution of an irradiation frost can be observed that although it starts at 6:00 am, the difference between the outside and inside temperatures of the greenhouse with polyethylene walls, while the underground greenhouse starts the weather phenomenon with a positive difference of 7.5 degrees Celsius and maintains this trend throughout the event throughout the event.

Regarding the behaviour of temperatures during the rigor of an advection cooling linked to a table 6 irradiation, the underground greenhouse showed an appropriate behaviour, which although it reached temperatures below 0 °, these can be considered manageable at a minimum cost, either with passive preventive methods or through the use of heaters since the earth walls do not lose heat quickly and the ceiling being low can be managed so that it does not dissipate heat. In the reported case, no precautions of any kind were taken.

For the damping of temperatures during the day, it has been experimented with various types of heat extractors, being the installation of side curtains in the upper part of the greenhouse the best means achieved to keep the excess temperature controlled during the hours of greatest solar incidence.

ISSN-On line 2414-8830

Conclusions

As for crops, the underground greenhouse has been worked as of January 2012 with various types of vegetables that have generally been adapted, mainly tomatoes and other medicinal plants useful in experiments that are developed by professors and students of the Bachelor of Physical Therapy, that if it were not for the protection of the greenhouse, they would not have resisted the effect of the frost observed during the last three years.

The integral operation of the greenhouse in its pilot stage allows us to conclude that its scaling to protected areas of 2000 square meters is possible, so that its operation is programmable and commercially attractive to produce according to the market's own demands and make better use to lands that are currently used for the production of barley and oats, although they show resistance to the eventualities of the climate and short cycles for their cultivation, the value of their crops in the market is unsatisfactory and they can also be affected by droughts and early frost.

Acknowledgments

Universidad Politécnica de Pachuca
Dr. Marco Antonio Flores González
Dr. Francisco Rafael Trejo Macotela
Dr. Alejandro Téllez Jurado

References

[1]. http://clima.inifap.gob.mx/redinifap/est.aspx?est=27783. 2009-2014

[2]. RIEMUPP. 2012-2016. Tecnologías Intermedias. Universidad Politécnica de Pachuca.

[3,4]. Olcina Cantos J. Riesgos Climáticos en La Península Ibérica. Libros Penthalon. Madrid, 1994. 440 pp.

Snyder L. R. Protección contra las heladas: fundamentos,práctica y economía. FAO. Serie Sobre el Medio Ambiente y la Gestión de Recursos. Vol. 1. Roma 2010.

[5]. Urrestarazu Gavilán. Ediciones Mundi Prensa.Madrid-Barcelona México

[6]. Castañeda-Miranda R. Análisis y simulación del Modelo Físico de un Invernadero Bajo Condiciones Climáticas de la Región Central de México. Agrociencia 41: 317-335. 2007.

Air Quality Index for Ciudad Juárez based on a Community Collaboration Scheme

Índice de Calidad de Aire para Ciudad Juárez basado en un Esquema de Colaboración Comunitaria

RODRÍGUEZ-GARCÍA, Nabile Edith †, VÁZQUEZ-GÁLVEZ, Felipe Adrián, ESTRADA-SALDAÑA, Fernando and HERNÁNDEZ-HERNÁNDEZ, Israel*

Universidad Autónoma de Ciudad Juárez

ID 1st Author: *Nabile Edith, Rodríguez-García* / **ORC ID:** 0000-0003-4535-3275, **CVU CONACYT ID**: 862063

ID 1st Coauthor: *Felipe Adrián Vázquez-Gálvez* / **ORC ID:** 0000-0003-0282-8023, **Researcher ID Thomson**: G-7554-2019, **CVU CONACYT ID**: 64472

ID 2nd Coauthor: *Fernando, Estrada-Saldaña* / **ORC ID**: 0000-0002-8236-0725, **CVU CONACYT ID**: 373553

ID 3rd Coauthor: *Israel, Hernández-Hernández* / **ORC ID**: 0000-0003-3807-565X, **CVU CONACYT ID**: 35286

DOI: 10.35429/EJRN.2019.8.5.6.14 Received April 02, 2019; Accepted May 30, 2019

Abstract

There is a global concern for the increase in health costs in a poor air quality relationship especially in urban environments. In Ciudad Juárez, Chihuahua, although it has a discontinuous monitoring of air quality, there is no air quality program that includes thresholds and contingencies for poor quality. This article proposes an environmental quality index based on the algorithms of other entities and climatic variables typical of the characteristics of the city of Ciudad Juárez and El Paso. The system is in the way of integrating the measurements of gases such as Ozone, CO and PM2.5 as well as the meteorological variables of humidity, wind speed and temperature. To obtain the above, it is necessary to strategically install sensors in different areas of the city, extract their information, store them in databases, analyze the data and create a citizen warning mechanism when the value of the index can harm the health of people. Citizen participation is a fundamental element in the development of the project. This article shows the development of the environmental quality index for Ciudad Juárez and the results of the project.

Community-based monitoring, Air quality index, Climatology

Resumen

Existe una preocupación global por el incremento en los costos de salud en relación a una mala calidad del aire sobre todo en los entornos urbanos. En Ciudad Juárez, Chihuahua si bien se tiene un monitoreo discontinuo de la calidad del aire, no se cuenta con un programa de calidad de aire que contemple umbrales y contingencias por mala calidad. Este artículo propone un índice de calidad ambiental a partir de algoritmos desarrollados en otras entidades y variables climáticas propias de las características de la región de Ciudad Juárez y El Paso. El sistema atiende de manera integrada las mediciones de concentraciones de gases criterio como el Ozono, CO y $PM_{2.5}$ así como las variables meteorológicas de humedad, velocidad de viento y temperatura. Para lograr lo anterior es necesario instalar estratégicamente sensores en diferentes áreas de la Ciudad, extraer su información, almacenarlos en bases de datos, analizar los datos y crear un mecanismo de alerta ciudadana cuando el valor del índice puede perjudicar la salud de las personas. La participación ciudadana es un elemento primordial en el desarrollo del proyecto. Este artículo muestra el desarrollo del índice de calidad ambiental para Ciudad Juárez y los resultados obtenidos del proyecto.

Índice de calidad de aire, Climatología, Monitoreo comunitario

Citation: RODRÍGUEZ-GARCÍA, Nabile Edith, VÁZQUEZ-GÁLVEZ, Felipe Adrián, ESTRADA-SALDAÑA, Fernando and HERNÁNDEZ-HERNÁNDEZ, Israel. Air Quality Index for Ciudad Juárez based on a Community Collaboration Scheme. ECORFAN Journal-Republic of Nicaragua. 2019 5-8: 6-14

* Correspondence to Author (email: israel.hernandez@uacj.mx)

† Researcher contributing as first author.

Introduction

Advances in computing technologies have given rise to the development of general circulation climate models that allow studying the behavior of climatic variables in time horizons of more than 20 years, such as solar radiation, temperature, precipitation, among others. (Romero Placeres, Diego Olite, & Álvarez Toste, 2006). From these results, scenarios are created on the vulnerability of populations and environmental systems with a direct effect on economic activities like agriculture, ecosystems, energy, industry, consumption, production, tourism, disasters, fishing, human well-being, construction and livestock (Fuka et al., 2014). However, the results of these models are produced on scales of hundreds of kilometers, which makes them impractical for everyday and short-term products on a city scale.

To create products of a useful scale, it is necessary to integrate to satellite products and models of medium scale surface and height networks that allow it. Therefore, climate is a set of conditions, obtained by data, collected by weather stations. That is, the information we see allows us to establish climatic models with variations depending on where we are on the surface, in addition to studying the climatic changes that have occurred from the past and predicting the future (Guevara Sanginés, 2005). Environmental quality is understood as an arduous set of human and environmental factors that have a favorable or unfavorable impact on society's life (Nichol & Wong, 2005).

Within the public health area, the emission of greenhouse gases and radiactive forcing agents contribute to the increase of toxic aerosol loads in urban environments. While the former have a global effect, the latter affect the exposed people locally. Global climate change coupled with poor environmental conditions has a synergistic effect which keeps those responsible for public health programs on constant alert ("Climate Change and Health," 2017) (Querol, 2008).

This project addresses the need of having a practical and easy-to-interpret indicator that allows the community to be informed and alert. Most of the air quality indices are based on monitoring station readings with geospatial coverage of 5 km or more, so it does not necessarily reflect the environmental conditions that affect most people.

The idea is to "down-scaling" environmental conditions at geospatial scales of less than 1 km. In the case of Ciudad Juárez, there is no information system and, at the moment, there is only one reference station located north of the city. Therefore, there are areas of the city that may be exposed to dangerous concentrations and that are not registered by the reference stations. The next challenge is to disseminate information relevant to the community and decision makers, which includes not only weather information such as humidity, wind and temperature, but also relevant pollutants that, in the case of Ciudad Juárez, are ozone (in summer), suspended particles (all year) and carbon monoxide (especially in winter) (Correa García, 2011). Ideally, a practical indicator yields numerical values on a standardized scale for all gases and total suspended particles in a range between 1-100. The foregoing would serve as a basis for the identification and feasibility analysis applicable to the study and development of the environmental quality index.

This project presents a practical proposal of the index, which is associated with health hazard of the standardized levels from a palette of colors that distinguish the appropriate level. (MATUS C., PATRICIA, & LUCERO CH., 2002).

In the sections presented below, the elements that make up the environmental quality index are explained in detail, as well as the methodology used, and, finally, the results and conclusions obtained at the end of the project.

Air quality: elements and challenges

One of the challenges was to identify the elements that would comprise the air quality index and the methods for obtaining, storage, process and disseminate the information.

First, the variables used were: carbon monoxide (CO), ozone (O3) and fine particles with aerodynamic diameter less than 2.5 micrometers (PM2.5). The criteria used considered the toxicology of the pollutants and the damage they cause to health, as well as the diseases that result from exposure, the optimal frequency of measurement and average concentration values and their relevance in terms of presence in the atmosphere (Rosales-castillo et al., 2001) (Rojas Bracho & Garibay Bravo, 2003).

To estimate the toxicology, the thresholds of protection and concentration criteria established in the Mexican Official Standards (Federation, 2012) were considered to evaluate air quality with respect to ozone (O3), sulfur dioxide (SO2), nitrogen dioxide (NO2), carbon monoxide (CO), total suspended particles (TSP) and particles smaller than 10 micrometers (PM10).

Contaminante	Valores límite			Normas Oficiales Mexicanas
	Exposición aguda		Exposición crónica	
	Concentración y tiempo promedio	Frecuencia máxima aceptable	(Para protección de la salud de la población susceptible)	
Ozono (O3)	0.11 ppm (1 hora) (216 µg/m3)	Ninguna vez al año		Modificación a la NOM-020-SSA1-1993*
	0.08 ppm (8 horas)	Quinto máximo en un año		
Monóxido de carbono (CO)	11 ppm (8 horas) (12595 µg/m3)	1 vez al año		NOM-021-SSA1-1993**
Partículas con diámetro aerodinámico equivalente igual o menor a 10 micrómetros (PM10); Partículas menores a 2.5 micrómetros (PM2.5)	120 µg/m3 promedio de 24 horas. 65 µg/m3 promedio de 24 horas.	1 vez al año	50 µg/m3 (media aritmética anual) 15 µg/m3 (promedio aritmético anual)	Modificación a la NOM-025-SSA1-1993**
	* Diario Oficial de la Federación del 30 de octubre de 2002.			
	** Diario Oficial de la Federación del 26 de septiembre de 2005.			

Table 1 Official Mexican Standards
Source: SEMARNAT

An environmental indicator (Perevochtchikova, 2013) must therefore meet a series of fundamental requirements: (Quiroga, 2001) (Escobar, 2006)

– Be scientifically valid.
– Be representative.
– Be sensitive to changes that occur in the environment or in human activities related to it.
– Be based on reliable and good quality data.
– Offer relevant information to the user.

Methodology

One of the main foundations used for the development of this project was the IMECA, defined as a tool created to report pollution levels in an easy and timely manner, using the standard metric of the NADF-009-AIR-2006 standard which, through identifiers (1-100), informs the level of environmental quality every 1.8 or 24 hours depending on the values to be measured.

However, the method used in this project defines as a basis the equations and cut-off points established in the Official Mexican Standard for the variables used and adapts the readings with a minimum amount of time, making possible to monitor every 5 minutes or even reduce it up to half the time. The established variables are recorded, considering that their selection has been to satisfy the need to create devices for the Autonomous University of Ciudad Juárez.

Once available in the website, the processes of the collected data were established.

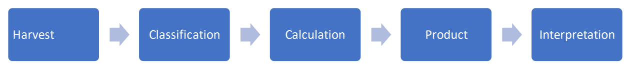


Figure 1 Processes for a quality index
Source: Own Elaboration

Collection

The collection, as the first process, is carried out through a web service, where it contains the readings with the actual values of the air quality station instrument and is updated every five minutes.

The values are stored in the SQL database, as well as MongoDB. However, only those that correspond to the variables mentioned above and which are used to define the environmental quality index are selected. Also, if necessary, the extraction of others such as: coarse suspended particles (PM10), sulfur dioxide (SO2) and nitrogen oxides (NOx) can be included.

Classification

The classification is established according to the collection, and is carried out individually in terms of the value of the data. Likewise, the range of Air Quality Index is determined based on a color palette used in Mexico City's air quality program, presented in Table 2, which is identified by means of a color assigned to the interval of the variable. The color ranges from green, which indicates good quality, to other colors, reaching a violet shade, which indicates that the quality is extremely bad. It is also necessary to detail that the air quality intervals have a difference of 50 points between each of them.

Assigned color	Quality Interval
(green)	0 – 50
(yellow)	51 – 100
(orange)	101 – 150
(red)	151 – 200
(purple)	Greater than 201

Table 2 Environmental indicator
Source: Own Elaboration.

The following table indicates, according to the color, the corresponding recommendations.

The air quality is:	
Good	Suitable for outdoor activities
Regular	You can carry out outdoor activities
Bad	Avoid outdoor activities, watch for air quality information
Very Bad	Avoid leaving home and keep windows closed, be aware of air quality information
Extremely Bad	Protect your health, do not use the car and avoid leaving home, be aware of air quality information

Table 3 Air quality indicator
Source: SEMARNAT

However, the cut-off points are different between each other. They were assigned a color where the reading value must have resided in one of them. Each interval depends on the concentration, defining different cut-off points, independent of each other. In addition, the intervals will not be unified, since they are in different units, that is, the CO interval in parts per million (PPM), the O3 interval in parts per billion (PPB) and the PM2.5 interval in micrograms/cubic meter (µg/m^3).

The concentration range (C) represents the value on the scale corresponding to each variable and will serve to perform the equation which will result in a number within the color range. The cut-off points for carbon dioxide (CO) in Table 4 are found in parts per million (PPM), but there is the possibility of converting to another unit if required.

Quality Interval	CO Interval
(green)	0.00 – 5.50
(yellow)	5.51 – 11.00
(orange)	11.01 – 16.50
(red)	16.51 – 22.00
(purple)	> 22.00

Table 4 Carbon monoxide intervals
Source: Prepared by the authors

The cut-off points for ozone (O3) in Table 5 are in parts per billion (PPB). This interval was modified to adapt from PPM to PPB, and it was verified that the same result was obtained without any variation due to the change of units.

Quality Interval	Interval O_3
(green)	0 – 55
(yellow)	56 – 110
(orange)	111 – 165
(red)	166 – 220
(purple)	> 220

Table 5 Ozone interval
Source: Own Elaboration

The cut-off points for suspended particles 2.5 in Table 6 are in microgram/cubic meter (µg/m^3). The interval between each one is different from the previous ones since it follows the United States quality index.

Quality Interval	Interval $PM_{2.5}$
(green)	0.00 – 15.40
(yellow)	15.50 – 40.40
(orange)	40.50 – 65.40
(red)	65.50 – 150.40
(purple)	> 150.40

Table 6 Interval of suspended particles *2.5*
Source: Own Elaboration

Calculation

The calculation of the environmental quality index is based on the process of air quality classification, since it depends on the interval that will correspond to the value recorded.

Air quality algorithms were used as the basis to determine a significant value of some color, in order to establish a correlation to a color. These equations are linked to the concentration range and air quality index. The above refers to the fact that the equation is equal to the concentration of the variable, where the intervals are involved, taking into account the cut-off points to replace the values depending on the case of each of them. More than 3 variables related to air quality can be considered or, if necessary, increase them.

The transformation equation varies according to the established cut-off points of the concentration ranges, but it can be generalized. The interval (I) is the result of the equation assigned according to the corresponding cut-off point.

ISSN 2414-8830

CO intervals can be calculated with the general equation. They cover the average limit of eight hours:

I = C *100/11

The intervals of O3 can be calculated with the general equation and they cover the average permissible limit of one hour, taking into account that it was exclusively modified to be interpreted in PPB:

I = C *100/110

The transformation equation in Table 7 for CO is established according to the cut-off points, both of the quality range and the corresponding concentration range.

	C	I
CO	0.09	0.81
O3	32.36	29.41
PM2.5	19.45	58.77

Tabla 7 Carbon monoxide transformation equations
Source: Own Elaboration.

The transformation equation in Table 8 for O3 is established according to the cut-off points, both of the quality range and the corresponding concentration range.

Intervalo O_3	Equation O_3
0 – 55	I = C * 50/55
56 - 110	I = C * 50/55
111 - 165	I = C * 50/55
166 - 220	I = C * 50/55
> 220	I = C * 200/222

Tabla 8 Ozone transformation equations
Source: Own Elaboration

The transformation equation in Table 9 for PM2.5 is established according to the cut-off points, both of the quality range and the corresponding concentration range, which is part of the concentration range, considered necessary for the final result.

Interval PM2.5	Equation PM2.5
0 - 15.40	I = C * 50/15.4
15.50 – 40.40	I = 20.50+C * 49/24.9
40.50 – 65.40	I = 21.30+C * 49/24.9
65.50 - 150.40	I = 113.20+C * 49/84.9
> 150.40	I = C * 201/150.5

Table 9 Transformation equations of suspended particles 2.5
Source: Own Elaboration

Product

The product is the relation between the quality interval and the result of the transformation equation. First, the value obtained from the previous process must be assigned to a color that indicates the air quality.

For example, the collection process has a value of 0.09 PPM for carbon monoxide, a value of 32.36 PPB for ozone and a value of 19.45 $\mu g/m^3$ for suspended particles. Applying the cut-off intervals according to the previous concentrations in Table 9 and the quality range is obtained in Table 10.

	C	Intervalo	Ecuación
CO	0.09	0.00 - 5.50	I = C * 50/5.5
O3	32.36	0 – 55	I = C * 50/55
PM2.5	19.45	15.50– 40.40	I = 20.50+C * 49/24.9

Tabla 10 Calculation Example
Source: Own Elaboration

Interval CO	Equation CO
0.00 - 5.50	I = C * 50/5.5
5.51 - 11.00	I = C * 50/5.5
11.01 - 16.50	I = C * 50/5.5
16.52 - 22.00	I = C * 50/5.5
> 22.00	I = C * 200/22

Tabla 11 Example calculation result
Source: Own Elaboration.

The product that resulted from applying first the classification process and then the calculation process provides the interval individually, independent of one another.

Interpretation

The interpretation is the final phase of the process, which involves the previous steps, the product being related to the quality interval. It is also present when selecting which variable has the greatest importance in relation to the quality range. The foregoing was defined at the request of experts, since we did not consider with arithmetic any value obtained, as it would mean leaving the possibility prone to error. That is, not taking the average of the values resulting from the previous process, but selecting the one with a higher value.

For example, in Table 11 the color of the quality range in carbon monoxide and ozone is green, and in suspended particles 2.5 is yellow.

	I	Quality Interval
CO	0.81	
O3	29.41	
PM2.5	58.77	

Tabla 12 Interpretación de ejemplo
Source: Own Elaboration.

Using the average with the intervals in the previous table, it results in a value of 29.66 with a green color, indicating that it does not even approach the actual value of PM2.5.

Results

The results correspond to data generated by the IIT-01 reference station located on the campus of the Institute of Engineering and Technology of the Autonomous University of Ciudad Juárez (31 ° 44.28 'N, 106 ° 25.57' W).

This station samples every minute averages of the criteria gases (carbon monoxide, sulfur dioxide, tropospheric ozone, nitrogen oxides) and fine and coarse particles (PM2.5 and PM10). Four samples were taken on a random day within the first four months of 2019.

On February 6, maximum and minimum temperatures were reported respectively 18 °C/10 °C. 24 hours are shown in Graph 1 of the ozone air quality index.

It can be seen that during the day it was green, that is, the measured value did not exceed the range of 50. The above assures that the air quality was good for ozone.

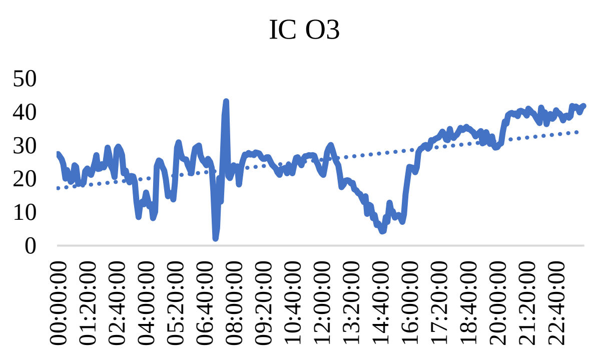


Gráfico 1 Índice de calidad para ozono 6 de febrero
Source: Own Elaboration.

Graph 2 shows 24 hours and, as with ozone, also resulted in green, so it could be said that there was good quality for carbon monoxide.

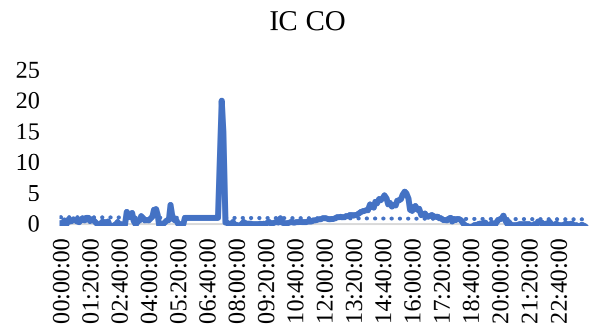


Gráfico 2 Quality index for carbon monoxide February 6
Source: Own Elaboration

In Graph 3, a noticeable change can be seen around 8:00 p.m. It should be noted that, according to the records of that day, the wind speed increased near the same time and particles began to increase, so that the air quality was regular.

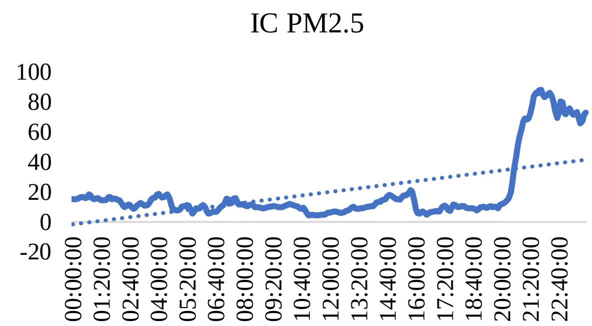


Gráfico 3 Índice de calidad para partículas suspendidas 2.5 6 de febrero
Source: Own Elaboration

In general, the air quality was good, except after 20:00 hours when it changed to moderate.

On March 7, maximum and minimum temperatures were reported as 27 °C/11 °C, respectively. In Graph 4 regarding ozone, it can be seen that the air quality in general was good, except for a few minutes, when it increased between two readings of 5 minutes each.

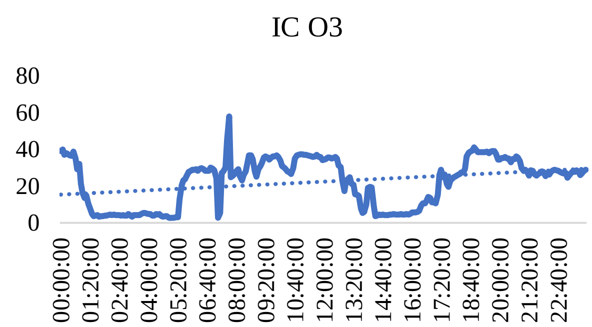


Gráfico 4 Índice de calidad para ozono 7 de marzo
Source: Own Elaboration.

In Graph 5 we can visualize that it is good, without having any drastic changes or any effect that could make it vary.

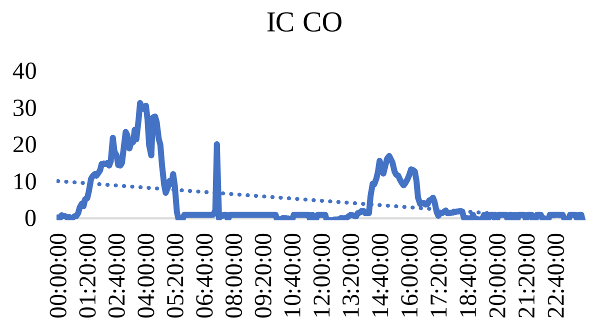


Gráfico 5 Quality index for carbon monoxide March 7
Source: Own Elaboration

In Graph 6, corresponding to suspended particles 2.5, the air quality was variable throughout the day, showing a considerable concentration in the time intervals. In general, the wind speed near 21:00 hours influenced the rise in air quality.

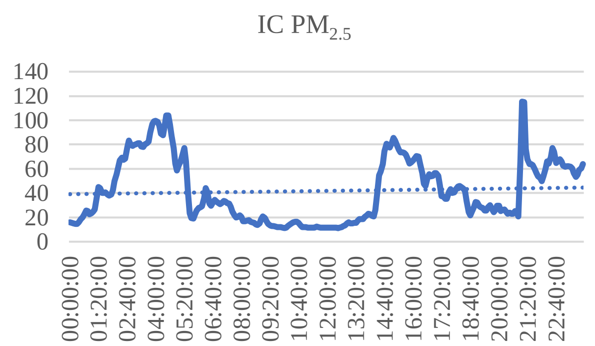


Gráfico 6 Quality index for suspended particles March 7
Source: Own Elaboration

On April 2, maximum and minimum temperatures were reported 26 °C/8 °C, respectively. Graph 7 shows the values of the air quality index for the assigned day. It can be seen that, at the beginning of the day, the quality was regular, as was the day before from 7:40 p.m.

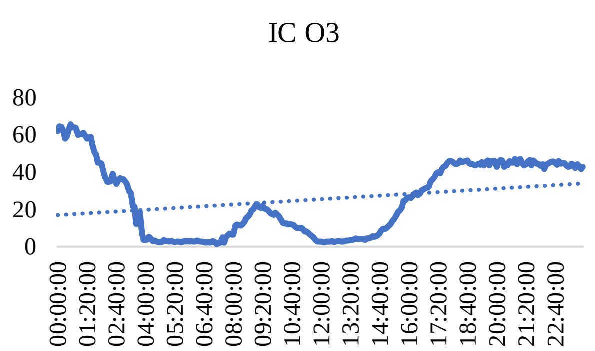


Gráfico 7 Ozone Quality Index April 2
Source: Own Elaboration

Graph 8 shows the results of the quality index for carbon monoxide, indicating that it was good during the entire day.

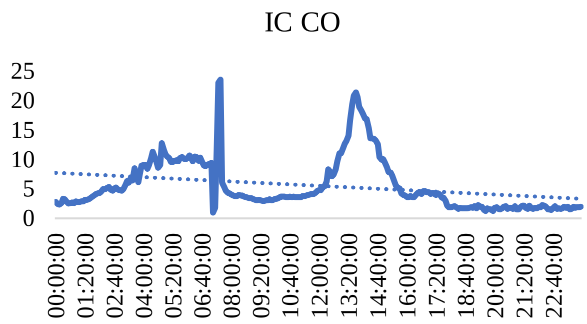


Gráfico 8 Quality index for carbon monoxide April 2
Source: Own Elaboration

The quality assigned to suspended particles 2.5 can be visualized in Graph 9, in which there are three different parameters: good, regular and bad. It is incorrect to answer why the levels were so high at a certain time, since the wind did not influence, for the established schedules do not match.

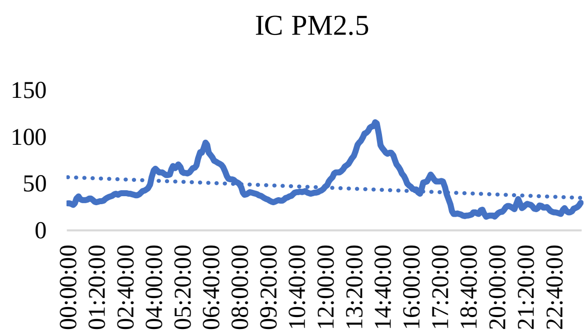


Gráfico 9 Quality index for suspended particles April 2
Source: Own Elaboration

On May 20, maximum and minimum temperatures were reported 27 °C/11 °C. In summary, Graph 10 shows that the level of air quality underwent variation.

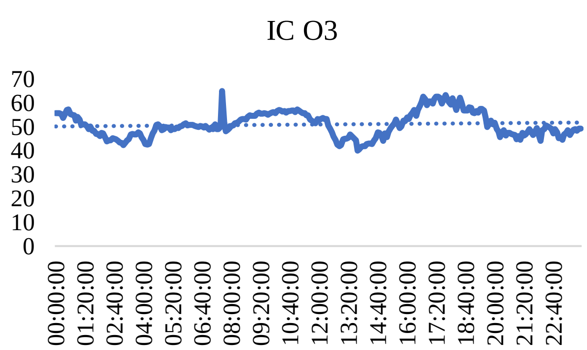


Gráfico 10 Ozone Quality Index May 20
Source: Own Elaboration

ISSN 2414-8830

Graph 11 shows that the quality index for carbon monoxide was good, without high levels varying between hours.

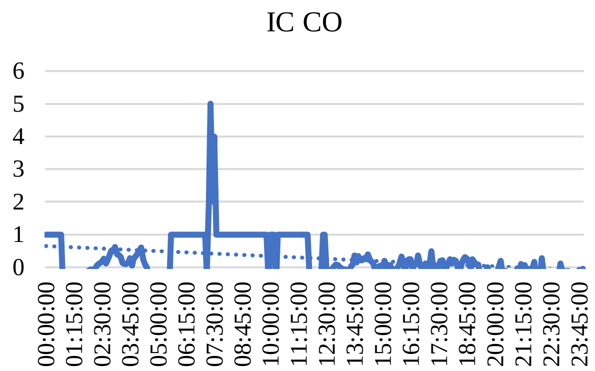


Gráfico 11 Quality index for carbon monoxide May 20
Source: Own Elaboration.

It is worth mentioning that the readings of the day described above recorded gusts of wind with high speed, which could indicate the reason for the increase in 2.5 particles, showed in Graph 12. The levels reached indicated that people should remain at home, since they were extremely bad.

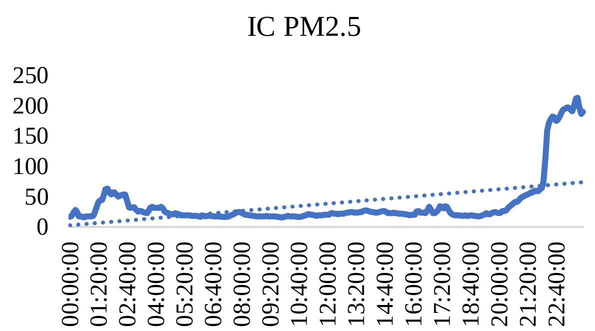


Gráfico 12 Quality index for suspended particles 2.5 May 20
Source: Own Elaboration

Additionally, it is intended to install air quality stations in strategic public places, so that the community of Ciudad Juárez can access the results of the index calculations through a mobile device and take their respective precautions. Each station will have its own QR on the deck and once a person reads it with their mobile device, the current weather conditions (last calculation of the air quality index) of the place where the station is located will be displayed. In this way, people will have the ability to make decisions related to their health.

The service offered at the reference station IIT-01 is shown in Figure 2. It has the option of adapting to both a web page and the screen of any device.

Figura 2 Servicio web disponible
Source: Own Elaboration.

It also has the reference to show the values of the variables used at the time of displaying the indicator, as can be seen below. Figure 3 shows the current conditions for ozone, carbon monoxide and 2.5 suspended particles, as well as the current temperature, time and day of consultation (necessary characteristics can be added).

Figura 3 Condiciones actuales 13/07/19
Source: Own Elaboration.

The values represent data not submitted by the processing.

Conclusions

An air quality index for Ciudad Juarez is necessary, since society is only used to be informed, for example, about temperature. However, by including various factors, some formulas and visualizing the results, information becomes even more extensive.

Each variable used for the air quality index is what our planet reflects. Being able to transform it into reality and, above all, unraveling its interior is, without a doubt, the expected result. Finally, the need to find novel solutions has been the great advantage of this project.

References

Cambio Climático y Salud. (2017).

Correa García, A. (2011). Los Índices de Calidad del Aire : Alcances y Limitaciones.

Escobar, L. (2006). Indicadores sintéticos de calidad ambiental: un modelo general para grandes zonas urbanas, XXXII, 73–98.

Federación, D. O. de la. (2012). Dof: 07/16/2012, 1–14.

Fuka, D. R., Walter, M. T., Macalister, C., Degaetano, A. T., Steenhuis, T. S., & Easton, Z. M. (2014). Using the Climate Forecast System Reanalysis as weather input data for watershed models. Hydrological Processes, 28(22), 5613–5623. https://doi.org/10.1002/hyp.10073

Guevara Sanginés, A. (2005). POLÍTICA AMBIENTAL EN MÉXICO: GÉNESIS, DESARROLLO Y PERSPECTIVAS, 163–176. MATUS C., PATRICIA, & LUCERO CH., R. (2002). Norma Primaria de calidad del aire. Revista Chilena de Enfermedades Respiratorias, 18, 112–122.

Perevochtchikova, M. (2013). La evaluación del impacto ambiental y la importancia de los indicadores ambientales, XXII, 283–312.

Querol, X. (2008). Calidad del aire, partículas en suspensión y metales, 447–453.

Quiroga, R. (2001). Indicadores de sostenibilidad ambiental y desarrollo sostenible: estado del arte y perspectivas.

Rojas Bracho, L., & Garibay Bravo, V. (2003). Las partículas suspendidas , aeropartículas o aerosoles : ¿ hacen daño a la salud ?; ¿ podemos hacer algo ? Gaceta Ecológica.

Romero Placeres, M., Diego Olite, F., & Álvarez Toste, M. (2006). La contaminación del aire: su repercusión como problema de salud, 44(2), 1–14.

Rosales-Castillo, J. A., C, M., Torres-meza, V. M., C, M., Olaiz-fernández, G., Borja-aburto, V. H., & Ph, D. (2001). Los efectos agudos de la contaminación del aire en la salud de la población : evidencias de estudios epidemiológicos, 43(6)

ISSN 2414-8830

Article **ECORFAN Journal-Republic of Nicaragua**
June, 2019 Vol.5 No.8 15-28

GHG emissions in KG-CO_2 / M2 generated by a House Type INFONAVIT

Emisiones de GEI en KG-CO_2 /M2 generados por una Vivienda Tipo INFONAVIT

ACEVES-GUTIERREZ, Humberto †*, LÓPEZ-CHÁVEZ, Oscar, MERCADO-IBARRA, Santa Magdalena and CONTRERAS-QUINTANAR, Cesar Alejandro

Instituto Tecnológico de Sonora

ID 1st Author: *Humberto, Aceves-Gutierrez* / **ORC ID**: 0000-0001-9916-3114, **Researcher ID Thomson**, F-8970-2018, **CVU CONACYT ID:** 2811581

ID 1 st Coauthor: *Oscar López-Chávez* / **ORC ID**: 0000-0002-0568-2763

ID 2 nd Coauthor: *Santa Magdalena, Mercado-Ibarra* / **ORC ID**: 0000-0002-4417-0736, **Researcher ID Thomson**, H-3386-2018, **CVU CONACYT ID:** 258533

ID 3 st Coauthor: *Cesar Alejandro, Contreras-Quintanar* / **ORC ID**: 0000-0002-0553-7515, **arXiv Author ID**: cesarcq, **CVU CONACYT ID:** 972613

DOI: 10.35429/EJRN.2019.8.5.15.28 Received April 08, 2019; Accepted May 30, 2019

Abstract

Climate change is one of the main current problems, it concerns the entire human population since its effects are worldwide, especially now we have seen its consequences, according to Menghi (2007), the average global temperatures grew by more than 0.5 ° C in the last century, and the glaciers are disappearing from the earth. The greenhouse effect generated mainly by the gases of the same name (GHG), is the fundamental factor of climate change. Construction is one of the ways in which the human being contaminates in a constant way this due to urban growth and the demand for infrastructure that this generates. This research has the purpose of determining the KG-CO_2 / M2 generated by a 44 m2 house of interest type INFONAVIT using the Life Cycle methodology (ACV) of the products or materials, established in ISO 14040, employee an inventory of KG-CO_2 emissions from building materials, obtained from various bibliographic sources and databases and using the work volumes required to build the house. The results obtained of 161.57 Kg-CO_2 / M2.

House, GHG, KG-CO_2/M2

Resumen

El cambio climático es uno de los principales problemas actuales, concierne a toda la población humana ya que sus efectos son de alcance mundial, especialmente en la actualidad hemos visto sus consecuencias, según Menghi (2007), las temperaturas promedio mundiales crecieron en más de 0.5 °C en el último siglo y los glaciares están desapareciendo de la tierra. El efecto invernadero generado principalmente por los gases del mismo nombre (GEI), es el factor fundamental del cambio climático. La construcción es una de las formas a través de las que el ser humano contamina de una manera constante esto debido al crecimiento urbano y la demanda de infraestructura que ello genera. Esta investigación tiene como propósito la determinación de los KG-CO_2/M2 que genera una vivienda de 44 M2 de construcción interés tipo INFONAVIT empleando la metodología de Ciclo de Vida (ACV) de los productos o materiales, establecida en la norma ISO 14040, empleado un inventario de emisiones de KG-CO_2 de materiales de construcción, obtenidos de diversa Sources bibliográficas y bases de datos y empleando los volúmenes de obra requeridos para construir la vivienda. Los resultados obtenidos de 161.57 Kg-CO_2/M2.

Vivienda, GEI, KG-CO_2/M2

Citation: ACEVES-GUTIERREZ, Humberto, LÓPEZ-CHÁVEZ, Oscar, MERCADO-IBARRA, Santa Magdalena and CONTRERAS-QUINTANAR, Cesar Alejandro. GHG emissions in KG-CO2 / M2 generated by a House Type INFONAVIT. ECORFAN Journal-Republic of Nicaragua. 2019 5-8: 15-28

* Correspondence to Author (email: haceves_itson@hotmail.com)
† Researcher contributing as first author.

Introduction

Global warming is the effect caused by the high amount of greenhouse gases (GHG) that accumulate in the atmosphere, preventing the solar rays that enter the earth bounce and escape into the atmosphere, to the contrary, bounce back to the earth's surface thus achieving heat to gather in the earth's crust and the biggest affected are the living beings that live in it, in this work we will focus specifically on the effects on human beings.

The environmental impact that industries have on the environment and natural resources has been considerable, not only as a result of production growth but also because this growth was concentrated in sectors with high environmental impact. (SEMARNAT, 2010).
It is important to be aware of the consequences that this may have on our health.

Recent studies have described a significant number of adverse effects of ozone, the most important ones related to the respiratory system, such as decreased lung function, worsening asthma, increased risk of emergency visits, hospital admissions and, probably, an increase of risk of dying. On the other hand, there is some evidence that individuals, especially younger ones, with hyperreactivity of airways, such as asthmatics, constitute a group more sensitive to the effects of ozone (Ballester, 2005).

The ozone concentration has increased in the atmosphere to almost eight times the natural atmospheric concentration, causing in the people respiratory system alterations, headache, burning eyes and skin infections (Montaño & Sandoval, 2007).

The study conducted by Pope and colleagues as part of the II Study for the Prevention of Cancer, which was published in March 2002, concluded that fine particles (PM2.5) and sulfur oxides showed an association with mortality for all the causes, for diseases of the circulatory system and for lung cancer. Each 10 µg / M3 increase in atmospheric levels of fine particles was associated approximately with an increase of 4%, 6%, and 8%, respectively, of the risk of dying from all causes, from the circulatory system and from lung cancer (Ballester, 2005).

Mexico annually emits 188 million tons of carbon (C), that is, about 2% of global greenhouse gas emissions and ranks as the ninth country in this area worldwide. Directly CO2 causes heart failure, suffocation and even death to exposed people. This occurs because CO2 replaces the oxygen in the red blood cells and reduces the amount that should reach the cells of the body to keep it alive, so it affects all people, but even more so with those with diseases cardiovascular, cerebral and respiratory. Indirectly, CO2 favors the increase in temperature to a degree Celsius (°C) which can cause the presence of mosquitoes in regions where the cold prevented them from surviving and reproducing; many of them are vectors of diseases such as: malaria transmitted by the Anopheles mosquito, encephalitis transmitted by the Culex mosquito and dengue virus and Nile fever transmitted by the Ades aegypti mosquito.

Also, an increase in temperature could allow the appearance of microorganisms that generate new diseases. The increase in temperature also affects agricultural systems, where severe droughts and the emergence of pests can reduce the quantity and quality of food (Montaño & Sandoval, 2007).

The World Health Organization (WHO) has estimated a number of deaths attributable to climate change of 160,000 per year. Heat waves will be more frequent and extreme in some areas of Europe and North America for the second half of the 21st century (Gonzales, Fernández & Gutiérrez, 2013).

For this reason it is considered very important to look for ways to reduce greenhouse gases (GHG), especially CO2, which is the most abundant after water vapor. Carbon dioxide (CO2) is the second most important GHG since it is added to the atmosphere both naturally and anthropogenicly (global warming).

Throughout the history of the Earth, volcanoes have naturally added it, and it has been recycled through multiple natural pathways that carbon follows in nature. Without the presence of CO2, the temperature on the Earth's surface would be about 33 ° C lower than the current one, which would be hostile to life. But CO2 is also added unnaturally, as a result of common human activities, mainly due to the burning of fossil fuels and the destruction (nowadays) of the rainforest.

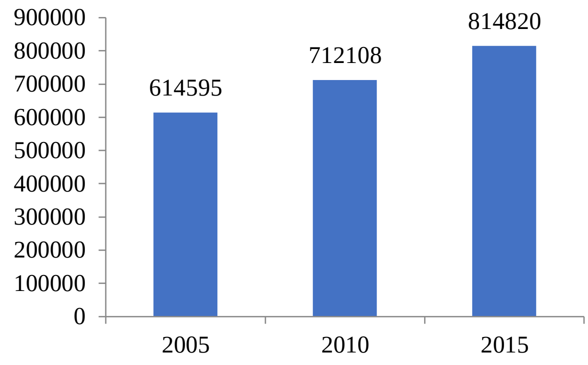
Being the main contributor to global warming with 55% (Echeverri, 2006), it has been decided by different organizations and countries worldwide to focus efforts towards global emissions of CO_2.

According to the Classification of Individual Consumption According to Purpose (COICOP), more than 80% of the total emissions associated with the private consumption of Spanish households is due to the expenditure incurred in: "transport and communications", "food, beverages and tobacco "," leisure, culture and hospitality "," electricity, gas and other fuels "and" articles of clothing and footwear ". The remaining 20% corresponds to the expenditure on "housing and water", "other goods and services", "furniture, equipment and conservation of housing" and "health and education (private)" (Serrano, 2019).

On the other hand Shen. et al. (2005) argues that construction is the main source of environmental pollution compared to other industries. In the European Union the construction sector generates 36% of CO2 emissions, it is the one that consumes the most energy and the one that generates the most waste, and also uses 60% of the materials that are extracted in the continent (Bravo, 2011).

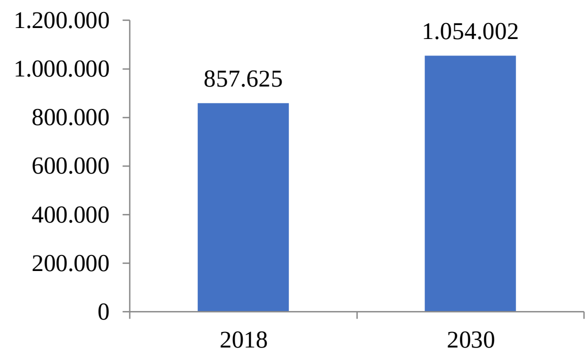
60% of the materials that are extracted from the lithosphere, are destined for construction. 50% of the CO2 emissions emitted into the atmosphere have their origin in the construction and use of buildings. 40% of the primary energy consumed on the planet and 75% of the electricity allocated is aimed at buildings. 20% of fresh water is consumed in the use of buildings. 60% of solid waste is produced in the construction and destruction of buildings (Casanovas, 2009).

That is why special attention should be paid to the construction sector, in order to predict how many CO2 emissions could be emitted. Analyzing the Population and Housing Census 2010 and the 2015 Intercensal Survey of INEGI (2015), it can be seen how in those 5 years the number of homes grew by 14.42% in Sonora; the number of dwellings, translated into figures, would be 102,712 new dwellings in a period of 5 years, and if we compare with the II Population and Housing Count 2005 of the INEGI (2005) the same trends are observed, from 2005-2010 the number of housing increase 15.86% or 97.513 housing is the same.



Graphic 1 Private homes inhabited in Sonora in the period 2005, 2010 and 2015
Source: INEGI. II Conteo de Población y Vivienda 2005, INEGI. Censo de Población y Vivienda 2010, INEGI(2010). Encuesta Intercensal 2015

In (CONAPO, 2018) "Demographic indicators of Mexico from 1950 to 2050 and of the federal entities from 1970 to 2050" tells us that Sonora has a total annual growth rate of 37,397.5 inhabitants in 2019 and in 2030 that rate will remain positive having a number of 30,267.5 inhabitants. In the "Household Projections" database of the National Housing Commission (CONAVI), the national and state data of the homes estimated until 2030 were obtained.



Graphic 2 *Number of estimated Homes in Sonora in the period 2018 and 2030*
Source: Prepared by CONAVI with information on CONAPO projections

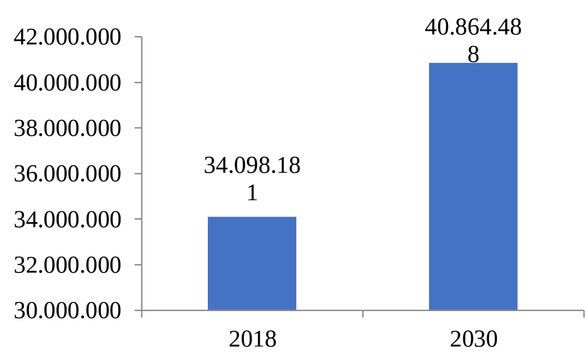


Gráfico 3 *Number of estimated homes in Mexico in the period 2018 and 2030*
Source: Prepared by CONAVI with information on CONAPO projections

By 2030 there will be an increase in the number of homes nationwide of 6,766,307, and at the state level speaking of Sonora it will be 196,377, compared to 2018 that gives us a great basis to determine the amount of GHG that will be thrown at the atmosphere in the next 12 years.

Several research projects have taken on the task of investigating the environmental impact of the materials consumed in the construction of a house, as is the case of (Mercader, 2012) "Model for quantification of CO2 emissions produced in buildings derived from resources materials consumed in its execution "where the CO2 emissions produced in the execution of the usual construction model defined as the residential block destined for official housing are quantified, derived from the manufacturing process of the material resources used in its execution. Others have focused on an economic point of view as in (Estrada, 2014) "implement carbon footprint reduction and compensation measures in their construction projects" where they analyze it with the objective of finding how feasible it is, from the point of technical and economic view, implement carbon footprint reduction and compensation measures in its construction projects.

Within the above-mentioned investigations, different ways of determining GHGs are presented, in the first case the steps proposed by the GHG Protocol are followed, which is a model that establishes comprehensive and comprehensive frameworks to measure and manage GHG emissions from operations of the private and public sector, value chains and mitigation actions (World Resources Institute and the World Business Council for Sustainable Development, 2019), when measuring emissions, the protocol indicates that we must add the amount of a specific material and then multiply it by its emission factor. The protocol does not offer emission factors, but mentions that if there are no local, regional or country-specific sources available, predetermined factors of the Intergovernmental Panel on Climate Change should be used. (IPCC).

In the second investigation, the form used to calculate the carbon footprint proposes a series of steps within which they begin with the selection of the calculation methodology, if you have a business approach you should use GHG Protocol, If you focus on a product, you must resort to the PAS 2050 standard.

Then you define the limits for accounting for GHG emissions, according to the selected methodology. Next, any field or record data that allows quantifying the processes and operations defined in the previous step should be collected. And finally, the carbon footprint must be calculated by multiplying the data obtained in the previous step by an appropriate emission factor (Estrada, 2014). It can be observed in both cases the similarity between them in the aspect of quantifying emissions, it is essentially the same even as it is observed both cases are used or considered the GREENHOUSE GAS (GHG) Protocol, which is based primarily on quantifying the total of each material and then multiply by its emission factor.

In an effort to have a better perspective on the amount of emissions produced by the construction industry, it was decided to investigate the amount of emissions that are had in the construction of a house located in Ciudad Obregón, Sonora, in a social interest subdivision with an area of 43.87 M2, built with block walls, foundation slab and polystyrene slab and vault slab system, based on the background obtained, we chose to record the emissions by adding the product quantities and multiplying them by their emission factor, considering the materials that are used in quantities of significant enough size in the work. The life cycle analysis (LCA) is considered as an environmental tool that can provide a better understanding of the dimensions of the environmental profile of products, processes and services. It is a suitable tool to compare potential environmental impacts of various product alternatives. Combined with economic and social considerations, life cycle analysis can be used to analyze product sustainability (Anonymous, 2004).

Depending on the processes contemplated by the LCA, it may have different scopes:

– "From the cradle to the grave": Includes the extraction of raw materials and the processing of the necessary materials for component manufacturing, the use of the product and finally its recycling and/or final management. Transport, storage, distribution and other intermediate activities between the life cycle phases are also included when they are of sufficient relevance (Badilla, Elizondo, Fernández, Mora, Méndez & Quesada, 2015).

- "From the cradle to the door": The scope of the system is limited from when raw materials are obtained until the product is placed on the market, at the exit of the manufacturing plant (Badilla, Elizondo, Fernández, Mora, Méndez & Quesada, 2015).
- "From door to door": Only manufacturing processes are taken into account (Badilla, Elizondo, Fernández, Mora, Méndez & Quesada, 2015).

The dwelling studied was taken as a product, to which the LCA was applied, in order to better measure its environmental impact. To achieve a correct methodology with the life cycle, the first thing that was done was to define a calculation method, which depending on the approach can be selected from one of the existing ones. A common dwelling was analyzed and selected in the national context, from which the explosion of inputs (materials, labor, machinery and equipment) required for the construction of the dwelling was obtained, as a result of the quantification of each of them. Finally, the scope of the study (cradle at the door) was selected and the corresponding emission factors were searched and selected.
With the results obtained, the damages to which the atmosphere will be exposed can be predicted and in this way actions can be initiated with the purpose of improving the conditions of the atmosphere today. The results can also be applied to the national territory in works of similar characteristics and will be usable information to determine in a practical way the GHG emissions generated in the housing construction stage.

Methodology

To carry out this project, the participation of a student and civil engineering research professors from the Technological Institute of Sonora was carried out, making the pertinent calculations to obtain results, the materials and equipment used were, the Excel electronic sheet for the visualization of the explosion of inputs and to capture the data created to quantify the CO2 emissions generated by the construction, interpretation of results. The sources of information were previous works related to the project such as thesis, articles, scientific journals, database of the Mexican government, electronic bibliography in general.

Procedure:

1. It began by choosing a project of a very common INFONAVIT housing in the national context, in order to have a representative figure in the entire national context, from this the explosion of inputs related to the materials used in its construction and the construction Plan of the work.

2. A calculation methodology was defined, as it focused on the use of emission factors, the GHG PROTOCOL and the LIFE CYCLE ASSESMENT ISO 14040 were used as a basis, making the appropriate adjustments to the context of the study.

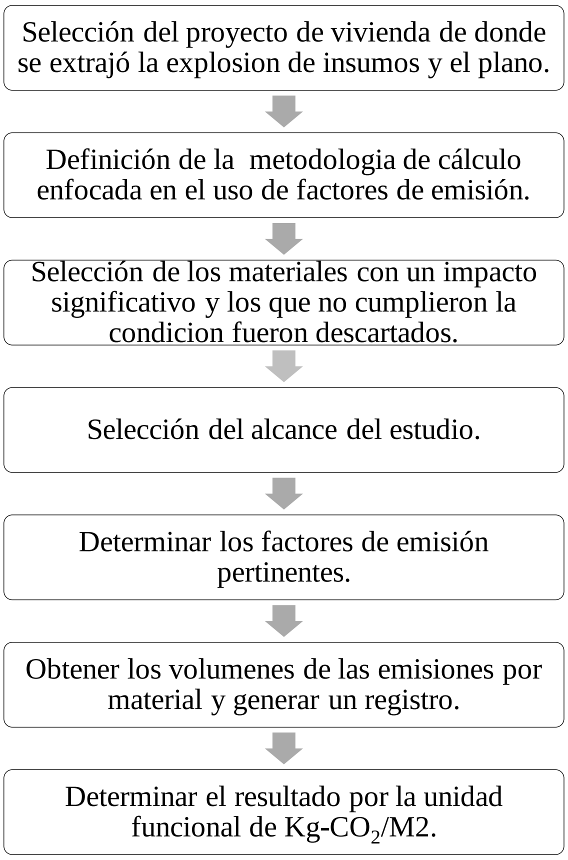
3. The explosion of inputs of the materials used in a study dwelling was used, then began to discard materials that are used in small quantities and that are not repeated. The remaining materials were ordered and in cases where there are composite materials they were separated into their components and each material was calculated as individual and then assembled into a single concept.

4. The scope of the LCA was selected as "Cradle at the door" since the period of use of the house and the final disposal of waste at the end of its useful life was not contemplated.

5. The emission factors to be used for the calculation of the emission inventory in the established project were determined.

6. The materials relevant to the input explosion were multiplied by their emission factor and recorded in the Excel electronic sheet.

7. The results of Kg-CO2 / M2 from the housing input explosion were obtained and the information was therefore interpreted.



Graphic 4 Diagrama de flujo de la metodología
Source: Own elaboration

Emission factors

It is explained in a concise manner how the emission factors of each material were chosen, which factors influenced their choice and if they have any conditions in their use.

It was investigated in (Rodríguez, 2010) "Emission factors of construction materials" where the main factors of gray construction materials were obtained from the carbon calculator developed by the author. At the same time in (Argüello, 2008) "Analysis of the environmental impact associated with the construction materials used in the low-cost housing of the 10 x 10 Techo-Chiapas program of the CYTED", for example, the emission factor used for the steel, where (Mercader, 2012) "Quantification model of CO2 emissions produced in buildings derived from the material resources consumed in its execution" determines different additional emission factors to obtain a more reliable database. Additionally also in (Suárez, 2014) "Environmental viability of gypsum recycling" the cast factor was specifically sought. Finally, in "Emission factors for the different types of fossil fuels and alternative that is common in Mexico" developed by the Mexican Petroleum Institute in 2014, the wood emission factor was obtained.

Another source that was taken into account was the (SEMARNAT, 2019) National Emissions Registry (RENE) which shows the official steps to register the emissions of the company or organization with the Mexican government, with an updated emissions calculator and with National data provided by the Ministry of Environment and Natural Resources (SEMARNAT) shows indicative results, some emission factors were obtained from it.

An international data source was the (Circular Ecology, 2019) Inventory of Carbon and Energy (ICE) Version 2.0 of the University of Bath, where various emission factors of different materials were found.

Through research in the sources cited and others, the emission factors for each material were reached.

Composite materials

As mentioned in the methodology, there are some materials that by their nature are composed of various materials such as, the case of concrete that require cement, gravel, sand and water for their preparation or the case of cement-sand mixtures, mortar-sand, lime-sand that also require combining various materials for its preparation and final presentation, in the specific case of this work are the joists from which it was better to separate the different emission factors that are used in the different materials and in the end just show the value of emissions generated.

The joist is composed of a concrete base and a triangular structure of steel rods, so in that case it was counted for the concrete how many M3 would be used and the quantities of material needed to create the concrete were calculated.

Concreto f´c =250 Kg/cm2 para cada M3			
Tamaño máximo 20 mm (3/4")			
Material	Cant.	N° de M3/vigueta	Total
Cemento (kg)	390[1]	0.01704	6.65
Grava (kg)	1000[1]	0.01704	17.04
Arena n°4 (kg)	790[1]	0.01704	13.46
Agua (lt)	205[1]	0.01704	3.49

Table 1 Cantidad de material para el concreto de la vigueta V-284 armada con 2 Ø 3/16" y refuerzo adicional 1 Ø 3/16"
Source: [1]CEMEX Concretos, Manual del Constructor.

With the results obtained, their respective emission factor was applied, then multiplied by the number of pieces and concrete emissions were counted.

Concreto f´c =250Kg/cm2 para cada M3			
Tamaño máximo 20 mm (3/4")			
Total	F. Emisión	N° Piezas	Total CO_2
6.65*	0.513[1]	14	47.729
17.04**	0.03[2]	14	7.157
13.46***	0.03[2]	14	5.654
3.49****	0.00003[2]	14	0.001

*Cemento, **Grava, ***Arena, ****Agua

Table 2 *Total, de emisión del concreto de la vigueta V-284 armada con 2 Ø 3/16" y refuerzo adicional 1 Ø 3/16"*
Source: [1]SEMARNAT. RENE, [2]Mercader. Modelo de cuantificación de las emisiones de CO_2 producidas en edificación derivadas de los recursos materiales consumidos en su ejecución

But the steel also makes up the joist, for the steel it was quantified how much steel is needed to meet the specifications of the rods that are needed and the emission factor was applied and the partial emissions of the steel were obtained.

Material	kg/ML	N° de M	F. Emisión	Total CO_2
Acero	0.14[1]	8.52	2.8[2]	3.34

Table 3 Cantidad de material de acero para la vigueta V-284 armada con 2 Ø 3/16" y refuerzo adicional 1 Ø 3/16
Source: [1]Salazar. Costo y tiempo en edificación, [2]Mercader. Modelo de cuantificación de las emisiones de CO_2 producidas en edificación derivadas de los recursos materiales consumidos en su ejecución.

Then it was multiplied by the number of pieces and the total CO_2 emissions were achieved.

Material	Total CO_2	N° Piezas	Total CO_2
Acero	3.34	14	46.76

Table 4 Total, de emisión del acero de la vigueta V-284 armada con 2 Ø 3/16" y refuerzo adicional 1 Ø 3/16"
Source: Own elaboration

With both calculated emissions, they were added and thus it was possible to have a total emission value for the joist of 107.30 kg-CO2, which is not applicable for the other joists, unless they have the same specifications.

Following this methodology with all composite materials, the relevant emissions are obtained. (annexes)

Results

Next, the data obtained in the study are presented in tables.

Material	Unidad	Factor de emisión
Azulejo cerámico	M2	23.22[1]
Poliestireno	kg	3.43[2]
PVC y CPVC	kg	3.1[3]
Pintura	kg	2.91[3]
Acero	kg	2.8[1]
Madera	kg	2.314[4]
Block 12x20x40 cm	Pieza	0.604[5]
Cal	kg	0.59[6]
Cemento	kg	0.513[6]
Block 12x20x20 cm	Pieza	0.302[5]
Block 12x10x40 cm	Pieza	0.302[5]
Mortero	kg	0.2268[1]
Yeso	kg	0.072525[7]
Grava	kg	0.03[1]
Arena	kg	0.03[1]
Agua	M3	0.03[1]

Table 5 Factores de emisiones en kg-CO_2/ Unidad de material
Source: [1]Mercader. Modelo de cuantificación de las emisiones de CO_2 producidas en edificación derivadas de los recursos materiales consumidos en su ejecución, [2]Pedreño. Desarrollo de una aplicación para el cálculo de la huella de carbono en proyectos de construcción, [3]Hammond & Jones. ICE, [4]SEMARNAT, Factores de emisión para los diferentes tipos de combustibles fósiles y alternativos que se consumen en México, [5]Rodríguez. Calculadora de carbono para materiales básicos de construcción de obra gris en Costa Rica, [6]SEMARNAT. RENE, [7]Suárez. Viabilidad ambiental del reciclaje del yeso

Material	Peso	CO_2/ Ud.	Pzas.	Total CO_2
Block Entero 12x20x40 (kg)	1	0.604[1]	834.9	504.28
Block Dala 12x20x40	1	0.604[1]	145	87.58
Block Esquina 12x20x40	1	0.604[1]	138.99	83.95
Block Ajuste 12x20x32	1	0.604[1]	108.99	65.83
Block Mitad 12x20x20	1	0.302[1]	91.99	27.78
Block Piña 12x10x40	1	0.302[1]	58.96	17.81
Block Dala 12x20x40	1	0.604[1]	16	9.66
Block Dala Mitad 12x20x20	1	0.302[1]	10	3.02
Vigueta V-284 armada con 2 Ø 3/16" y refuerzo adicional 1 Ø 3/16"				107.30[2]
Vigueta V-274 armada con 2 Ø 3/16" y refuerzo adicional 1 Ø 3/16"				29.58[2]
Vigueta V-234 armada con 2 Ø 3/16" y refuerzo adicional 1 Ø 3/16"				18.94[2]
Vigueta V-095 armada con 2 Ø 3/16" sin refuerzo adicional				2.19

Table 6 Explosión de insumos de los blocks y las viguetas con la multiplicación de factores de emisión
Source: [1]Rodríguez. Calculadora de carbono para materiales básicos de construcción de obra gris en Costa Rica, [2]ver anexos

In (Rodríguez, 2010) "Emission factors for construction materials" the block of measures 12x19x39 cm is mentioned, with an emission factor of 0.604 kg-CO2 / unit and having great similarity with the housing block obtained from the explosion of inputs that factor was selected, considering that it is practically the same factor for a 12x20x40 cm block.

For the blocks with measures 12x20x20 cm and 12x10x40 cm having half the volume compared to the block 12x20x40 cm, half of the emission factor was taken for these cases, as can be seen in table 6.

Material	Peso	CO_2/ Ud.	Pzas.	Total CO_2
Varilla Corrugada de 1/2"	172.23	2.8[1]	1	482.24
Varilla corrugada de 3/8"	160.79	2.8[1]	1	450.21
Malla Electrosoldada 6-6 / 6-6	1.97	2.8[1]	76.1	419.77
Regla Tubular 1 1/2"x4" (6.1 M)	50.7032	2.8[1]	1.17	166.1
Malla electrosoldada 6x6-10/10	0.97	2.8[1]	58.55	159.02
Armex 12x12-4	6	2.8[1]	8.2	137.76
Alambre recocido	29.98	2.8[1]	1	83.94
Armex 12-20-4 (tramo 6m)	6.4	2.8[1]	2.57	46.05
Tubo galvanizado de 3/4"	1.6875	2.8[1]	6.16	29.11
Perfil Monten 4MT14	18.29	2.8[1]	0.28	14.34
Regla tubular de 1" x 2" (6.1 M)	25.1259	2.8[1]	0.2	14.07
Solera de 1 1/4" x 1/4" (6.1 M)	9.48	2.8[1]	0.47	12.48
Alambrón de 1/4"	3.85	2.8[1]	1	10.78
Varilla corrugada 3/8"	3.42	2.8[1]	0.14	1.34

Table 7 Explosión de insumos de elementos constituidos de puro acero con la multiplicación de factores de emisión
Source: [1]Mercader. Modelo de cuantificación de las emisiones de CO_2 producidas en edificación derivadas de los recursos materiales consumidos en su ejecución.

Table 7 shows how in the case of steel only the weight of each piece of the material was considered, and its resistance was ignored because it does not affect the emission factor.

For the solera and the tubular ruler, the sections were taken with the commercial measures of 6.10 M. For the tubular ruler, the caliber No. 8 was selected for analysis.

Material	Peso	CO_2/ Ud.	Pzas.	Total de CO_2
Cemento Gris	1000	0.513[1]	1.55	795.15
Cemento Gris	1000	0.513[1]	0.25	128.25
Yeso Mocuzari	40	0.07252528[2]	6.1	17.70
Cemento Blanco	50	0.513[1]	0.62	15.90
Calhidra Pimacal	25	0.59[1]	0.06	0.885
Concreto premezclado Autocurable F'c=200 Kg/cm² T.M.A. 1 1/2", REV. 10 cm. +/- 2.5 cm. con Tiro Directo.				1001.18[3]
Concreto premezclado F'c = 200 Kg/cm² T.M.A. 3/4" REV. 10 cm +/- 3.5 cm Incluye servicio de banda olla				719.32[3]
Concreto premezclado Autocurable F'c = 150 Kg/cm² T.M.A. 3/4" Rev. 10 cm +/-2.5 cm.				322.25[3]

Table 8 Explosión de insumos de la calhidra, cemento, concreto y yeso con la multiplicación de factores de emisión
Source: [1]SEMARNAT. RENE, [2]Suárez. Viabilidad ambiental del reciclaje del yeso, [3]ver anexos

The cement emission factor observed in table 8 was obtained in the RENE database, the national emission data for each ton of Clinker was determined; considering the ordinary portland cement that is used for the concrete of the beams with a percentage of 95% of Clinker, the emission factor is obtained. Any difference between the emission factors of white cement, gray compared to ordinary portland, was neglected, since they have the same characteristics.

According to (SEMARNAT & INECC, 2002) "National Inventory of Emissions of Greenhouse Gases 1990-2002" published in 2002, hydrated lime, hydraulic lime and hydrated aerial lime are reported in the same way, so no distinction was made between them and the same factor was used in table 8.

Material	Peso	CO_2/ Ud.	Pzas.	Total CO_2
Casetón 1.22x0.61x0.125	1.1163	3.43[2]	56	214.42
Azulejo Filadelfia 20x30 cm. Marca PORCELANITE	1	23.22[1]	5.52	128.17
Azulejo Antiderrapante Venecia/Cabos de 20 cm. x 20 cm Marca PORCELANITE	1	23.22[1]	1.14	26.47
Malla de Refuerzo (Rollo de 100 m2) KOVER sencilla	3	4.45[3]	0.55	7.34
Placa de poliestireno (Fajilla 1" x 4" x 1.22 m)	0.0377	3.43[2]	48	6.21
Mortero especial para pegue (MORTAR, Línea Cement King) Saco de 25 kg.	25	0.22268[1]	0.62	3.45

Table 9 Explosión de insumos del mortero, azulejo, casetón, placa de poliestireno y malla de refuerzo con la multiplicación de factores de emisión

ISSN 2414-8830

Material	Peso	CO_2/ Ud.	Pzas.	Total CO_2
Pintura Vinílica Rekolor color blanco o pastel Marca Berel.	27.55	2.91[1]	2.52	202.03
Pintura Elastomerica Berel, color blanco o pastel. (Garantía 3 años)	27.55	2.91[1]	2.46	197.22
Pintura para molduras	5.49	2.91[1]	1.23	19.65
Pintura de esmalte anticorrosivo marca Berel línea Qualik	21.85	2.91[1]	0.04	2.54
Pintura Esmalte color	1.45	2.91[1]	0.33	1.39

Table 10 Explosión de insumos de la pintura con la multiplicación de factores de emisión
Source: [1]Hammond & Jones. ICE

Material	Peso	CO_2/ Ud.	Pzas.	Total CO_2
Arena	1560	0.03[1]	3.49	163.33
Barrote 2" x 4" x 12'	1.175	2.314[2]	4.34	11.80
Tablón de 2" x 8" x 10'	1.1775	2.314[2]	1.53	4.17
Fajilla de 1" x 4" x 10'	0.9	2.314[2]	1.52	3.17
Tablón de 2" x 4" x 10"	1.17	2.314[2]	1.1	2.98
Fajilla de 1" x 4" x 8'	2.5	2.314[2]	0.39	2.26
Grava	1560	0.03[1]	0.04	1.87
Pipa de Agua (7.0 M^3)	7	0.03[1]	1.4	0.29

Tabla 11 Explosión de insumos del agua, los áridos y la madera con la multiplicación de factores de emisión
Source: [1]Mercader. Modelo de cuantificación de las emisiones de CO_2 producidas en edificación derivadas de los recursos materiales consumidos en su ejecución, [2]SEMARNAT, Factores de emisión para los diferentes tipos de combustibles fósiles y alternativos que se consumen en México

Material	Peso	CO_2/ Ud.	Pzas.	Total CO_2
Tubo de P.V.C. Sanitario 4" (tramo 6.0 M)	6.925	3.1[1]	3.17	68.05
Tubo de P.V.C. de 2" (tramo de 6.0 M)	2.275	3.1[1]	1.85	13.05
Tubo de CPVC de 1/2" (tramo 3.05)	0.38	3.1[1]	7.87	9.27
Tubo de CPVC. de 3/4" (tramo 6.0 M)	1.24	3.1[1]	0.91	3.50
Tubo de P.V.C. Sanitario 1 1/2" (tramo 6.0 M)	1.92	3.1[1]	0.45	2.68
Yee de P.V.C. de 4" a 2"	0.214	3.1[1]	2	1.33
Tee lisa CPVC 1/2"	0.031	3.1[1]	12	1.15
Tapón CPVC 1/2"	0.012005	3.1[1]	24	0.89
Codo de P.V.C. de 2" x 45°	0.135	3.1[1]	2	0.84
Codo CPVC 1/2" x 90°	0.01	3.1[1]	25	0.78
Codo de P.V.C. de 2" x 90°	0.05	3.1[1]	5	0.78
Cople o Adaptador macho CPVC 1/2"	0.011	3.1[1]	15	0.51
Tee de P.V.C. de 2"	0.07	3.1[1]	2	0.43
Cople liso CPVC de 1/2"	0.007	3.1[1]	7	0.15

Table 12 Explosión de insumos del PVC y CPVC con la multiplicación de factores de emisión
Source:[1]Hammond & Jones. ICE

Se consideró el mismo factor de emisión para el PVC y el CPVC en la tabla 12.

Emisiones totales en la vivienda		
Total en Kg-CO_2	7087.95	Kg-CO_2
Emisión por área	161.57	Kg-CO_2/M2

Tabla 13 Emisiones totales generadas en la vivienda
Source: Own elaboration

Table 13 shows the total Kg-CO2 emissions of all the work studied and also shows the result of dividing the previous result in the work area and thus obtaining the emissions in Kg-CO2 / M2.

To carry out this investigation, an area of 43.87 M2 of total construction was used, which allowed us to obtain the result of 161.57 Kg-CO2 / M2.

Annexes

Annexe 1

Material	Peso	CO_2/ Ud.	Pzas.	Total CO_2
Malla de Refuerzo (Rollo de 100 M2) KOVER sencilla	3	4.45[1]	0.55	7.34

Tabla 14. Factor de emisión de la Malla de Refuerzo.
Source: [1]Pedreño. Desarrollo de una aplicación para el cálculo de la huella de carbono en proyectos de construcción

Anexo 2

Material	Peso Volumétrico (kg/M3)
Arena grava, seca, suelta	1440-1680[1]*

**Se promedio el valor de los rangos inferior y superior.*

Table 15 *Peso volumétrico de la arena y la grava*
Source: [1]Fundidora Monterrey (México). Manual para Constructores

Anexo 3

Material	Cantidad	N° M3	Total
Cemento (kg)	310[1]	1.5	465.00
Grava (kg)	1000[1]	1.5	1500.00
Arena (kg)	860[1]	1.5	1290.00
Agua (lt)	205[1]	1.5	307.50

Table 16 Cantidad total de material para el Concreto premezclado Autocurable F'c = 150 Kg/CM2 T.M.A. 3/4" Rev. 10 CM +/-2.5 CM
Source: [1]CEMEX Concretos, Manual del Constructor

Anexo 4

Total	Factor de Emisión	kg de CO_2
465.00*	0.513[1]	238.55
1500.00**	0.03[2]	45.00
1290.00***	0.03[2]	38.70
307.50****	0.00003[2]	0.01
	Total	322.254

*Cemento, **Grava, ***Arena, ****Agua

Table 17 Total, de emisiones para el Concreto premezclado Autocurable F'c = 150 Kg/CM2 T.M.A. 3/4" Rev. 10 CM +/-2.5 CM.
Source: [1]SEMARNAT. RENE, [2]Mercader. Modelo de cuantificación de las emisiones de CO_2 producidas en edificación derivadas de los recursos materiales consumidos en su ejecución.

Anexo 5

Material	Cantidad	N° M3	Total
Cemento (kg)	305[1]	4.69	1430.45
Grava (kg)	1000[1]	4.69	4690.00
Arena (kg)	900[1]	4.69	4221.00
Agua (lt)	190[1]	4.69	891.10

Table 18 Cantidad total de material para el Concreto premezclado Autocurable F'c=200 Kg/CM2 T.M.A. 1 1/2", REV. 10 CM. +/- 2.5 CM. con Tiro Directo
Source: [1]CEMEX Concretos, Manual del Constructor.

Anexo 6

Total	Factor de Emisión	kg de CO_2
1430.45*	0.513[1]	733.82
4690.00**	0.03[2]	140.70
4221.00***	0.03[2]	126.63
891.10****	0.00003[2]	0.03
	Total	1001.178

*Cemento, **Grava, ***Arena, ****Agua

Table 19 Total, de emisiones para el Concreto premezclado Autocurable F'c=200 Kg/CM2 T.M.A. 1 1/2", REV. 10 CM. +/- 2.5 CM. con Tiro Directo
Source: [1]SEMARNAT. RENE, [2]Mercader. Modelo de cuantificación de las emisiones de CO_2 producidas en edificación derivadas de los recursos materiales consumidos en su ejecución.

Anexo 7

Material	Cantidad	N° M3	Total
Cemento (kg)	350[1]	3.07	1074.50
Grava (kg)	1000[1]	3.07	3070.00
Arena (kg)	825[1]	3.07	2532.75
Agua (lt)	205[1]	3.07	629.35

Table 20 Cantidad total de material para el Concreto premezclado F'c = 200 Kg/ CM2 T.M.A. 3/4" REV. 10 CM +/- 3.5 CM Incluye servicio de banda olla
Source: [1]CEMEX Concretos, Manual del Constructor

Anexo 8

Total	Factor de Emisión	kg de CO_2
1074.50*	0.513[1]	551.219
3070.00**	0.03[2]	92.100
2532.75***	0.03[2]	75.983
629.35****	0.00003[2]	0.019
	Total	719.320

*Cemento, **Grava, ***Arena, ****Agua

Table 21 Total, de emisiones para el Concreto premezclado F'c = 200 Kg/ CM2 T.M.A. 3/4" REV. 10 CM +/- 3.5 CM Incluye servicio de banda olla
Source: [1]SEMARNAT. RENE, [2]Mercader. Modelo de cuantificación de las emisiones de CO_2 producidas en edificación derivadas de los recursos materiales consumidos en su ejecución.

Anexo 9

Concreto F´c =250 Kg/cm2 para cada M3, tamaño máximo 20 mm (3/4")			
Material	Cant.	N° de M3/vigueta	Total
Cemento (kg)	390[1]	0.01644	6.41
Grava (kg)	1000[1]	0.01644	16.44
Arena n°4 (kg)	790[1]	0.01644	12.99
Agua (lt)	205[1]	0.01644	3.37

Table 22 Cantidad de material para el concreto de la vigueta V-274 armada con 2 Ø 3/16" y refuerzo adicional 1 Ø 3/16"
Source: [1]CEMEX Concretos, Manual del Constructor

Anexo 10

Concreto F´c =250Kg/cm2 para cada M3, tamaño máximo 20 mm (3/4")		
Total	F. Emisión	Kg de CO_2
6.41*	0.513[1]	3.289
16.44**	0.03[2]	0.493
12.99***	0.03[2]	0.390
3.37****	0.00003[2]	0.000

*Cemento, **Grava, ***Arena, ****Agua

Table 23 Total, de emisión del concreto de la vigueta V-274 armada con 2 Ø 3/16" y refuerzo adicional 1 Ø 3/16"
Source: [1]SEMARNAT. RENE, [2]Mercader. Modelo de cuantificación de las emisiones de CO_2 producidas en edificación derivadas de los recursos materiales consumidos en su ejecución

Anexo 11

Material	kg/ML	N° de M	F. Emisión	Kg de CO_2
Acero	0.14[1]	8.22	2.8[2]	3.22

Table 24 Cantidad de material de acero para la vigueta V-274 armada con 2 Ø 3/16" y refuerzo adicional 1 Ø 3/16
Source: [1]Salazar. Costo y tiempo en edificación, [2]Mercader. Modelo de cuantificación de las emisiones de CO_2 producidas en edificación derivadas de los recursos materiales consumidos en su ejecución

Anexo 12

Kg de CO_2	N° Piezas	Total de CO_2
7.39	4	29.58

Table 25 Total, de emisiones de las viguetas V-274 armada con 2 Ø 3/16" y refuerzo adicional 1 Ø 3/16"
Source: Own Elaboration

Anexo 13

Concreto F'c =250Kg/cm2 para cada M3, tamaño máximo 20 mm (3/4")			
Material	Cant.	N° de M3/vigueta	Total
Cemento (kg)	390[1]	0.0057	2.22
Grava (kg)	1000[1]	0.0057	5.70
Arena n°4 (kg)	790[1]	0.0057	4.50
Agua (lt)	205[1]	0.0057	1.17

Table 26 Cantidad de material para el concreto de la vigueta V-095 armada con 2 Ø 3/16" sin refuerzo adicional
Source: [1]CEMEX Concretos, Manual del Constructor

Anexo 14

Concreto F´c =250Kg/cm2 para cada M3, tamaño máximo 20 mm (3/4")		
Total	F. Emisión	Kg de CO_2
2.22*	0.513[1]	1.14
5.70**	0.03[2]	0.17
4.50***	0.03[2]	0.14
1.17****	0.00003[2]	0.00

*Cemento, **Grava, ***Arena, ****Agua

Table 27 Total, de emisión del concreto de la vigueta V-095 armada con 2 Ø 3/16" sin refuerzo adicional
Source: [1]SEMARNAT. RENE, [2]Mercader. Modelo de cuantificación de las emisiones de CO_2 producidas en edificación derivadas de los recursos materiales consumidos en su ejecución.

Anexo 15

Material	kg/ML	N° de M	F. Emisión	Kg de CO_2
Acero	0.14[1]	1.9	2.8[2]	0.74

Table 28 Cantidad de material de acero para la vigueta V-095 armada con 2 Ø 3/16" sin refuerzo adicional
Source: [1]Salazar. Costo y tiempo en edificación, [2]Mercader. Modelo de cuantificación de las emisiones de CO_2 producidas en edificación derivadas de los recursos materiales consumidos en su ejecución.

Anexo 16

Kg de CO_2	N° Piezas	Total de CO_2
2.19	1	2.19

Table 29 Total de emisiones de la vigueta V-095 armada con 2 Ø 3/16" sin refuerzo adicional
Source: Own Elaboration

Anexo 17

Material	kg/ML	N° de M	F. Emisión	Kg de CO_2
Acero	0.14[1]	7.02	2.8[2]	2.75

Table 30 Cantidad de material para el concreto de la vigueta V-234 armada con 2 Ø 3/16" y refuerzo adicional 1 Ø 3/16"
Source: [1]CEMEX Concretos, Manual del Constructor

Anexo 18

Concreto F´c =250Kg/cm2 para cada M3, tamaño máximo 20 mm (3/4")		
Total	F. Emisión	Kg de CO_2
5.48*	0.513[1]	2.809
14.04**	0.03[2]	0.421
11.09***	0.03[2]	0.333
2.88****	0.00003[2]	0.000

*Cemento, **Grava, ***Arena, ****Agua

Table 31 Total de emisión del concreto de la vigueta V-234 armada con 2 Ø 3/16" y refuerzo adicional 1 Ø 3/16"
Source: [1]SEMARNAT. RENE, [2]Mercader. Modelo de cuantificación de las emisiones de CO_2 producidas en edificación derivadas de los recursos materiales consumidos en su ejecución

Anexo 19

Concreto F'c =250Kg/cm2 para cada M3, tamaño máximo 20 mm (3/4")			
Material	Cant.	N° de M3/vigueta	Total
Cemento (kg)	390[1]	0.01404	5.48
Grava (kg)	1000[1]	0.01404	14.04
Arena n°4 (kg)	790[1]	0.01404	11.09
Agua (lt)	205[1]	0.01404	2.88

Table 32 Cantidad de material de acero para la vigueta V-234 armada con 2 Ø 3/16" y refuerzo adicional 1 Ø 3/16"

Anexo 20

Kg de CO_2	N° Piezas	Total de CO_2
6.31	3	18.94

Table 33 Total de emisiones de la vigueta V-234 armada con 2 Ø 3/16" y refuerzo adicional 1 Ø 3/16"
Source: Own elaboration

Conclusions

Based on our results, it was observed that the large emission factors do not influence as much as one would think, but the main factor that manages to increase the total emissions is the volume and quantity of material, since the elements with the greatest amount of weight and / or pieces are those that have a greater number of emissions.

An example was that of sand that even with the lowest emission factor was found well above the average, due to its large volume used.

Material	Peso	CO_2/Ud.	Pzas.	Total CO_2
Arena	1560	0.03[1]	3.49	163.332

Table 34 Emisiones totales de la arena
Source: [1]Mercader. Modelo de cuantificación de las emisiones de CO_2 producidas en edificación derivadas de los recursos materiales consumidos en su ejecución

Even so, the materials with the highest emission factor are above the median of the number of emissions. But, taking the above that the amount is more important, we can see the example of the PVC parts used that were still the third largest emission factor are those that least contributed to the total emissions.

Material	Peso	CO_2/ Ud.	Pzas.	Total CO_2
Cople o Adaptador macho CPVC 1/2"	0.011	3.1[1]	15	0.5115
Tee de P.V.C. de 2"	0.07	3.1[1]	2	0.434
Cople liso CPVC de 1/2"	0.007	3.1[1]	7	0.1519

Table 35 Emisiones parciales de las piezas de PVC y CPVC
Source:[1]Hammond & Jones. ICE

What tells us that it is not enough to have a low emission factor, we must also be responsible for the amount of material that we will use and the opposite case is that elements with high emission factors can be used, if they are used in very small quantities, although it would be best to look for an alternative with a lower emission factor and thus emissions in that case could be almost nil.

In particular, it is likely that the impact of 7087.95 Kg-CO2 / housing or 161.57 Kg-CO2 / M2 are not as representative individually, however, by performing the analysis presented below, we can measure the magnitude of future impacts.

With the results obtained of 7087.95 Kg-CO2 / per house related to the estimated number of new homes that will be in 2030 compared to 2018 in Sonora, that is, 196,377; The number of new homes in 12 years will generate 1,391,910,357.15 Kg-CO2 that extrapolated nationally generated emissions pass to critical levels.

So you should start asking and reflecting on what to do to minimize the damage that will cause all these emissions to the atmosphere and the inhabitants of our planet.

Carbon footprint reduction and compensation measures must be implemented in construction projects.

Carbon neutrality is the condition in which the GHG emissions that are reduced and compensated are equal to the GHG emissions generated. Consequently, net GHG emissions are equal to zero.

Another option is to offset their emissions through financial support for some emission reduction project, such as forest conservation and restoration projects, wind farm projects or solar park projects (Estrada, 2014).

It is essential to become aware immediately as global warming can become irreversible, as mentioned in the UN News portal (2019), “The special report of the Intergovernmental Panel on Climate Change revealed in 2018 that it is necessary to limit the global warming at 1.5 ° C to avoid irreversible changes in the life of the planet ”; which is an urgent call to take the data provided by that study and begin to design clear strategies, with very well defined objectives, which allow quantifying, reducing and counteracting the emissions that are caused in the construction of houses.

References

Anónimo. “Comparative life cycle assessment study. 3 cleaning products for kitchen surfaces. French study”. PROCTER & GAMBLE. Brussels innovation Center, Central Product Safety. Noviembre 2004

Argüello Méndez, T. D. R., & Cuchí Burgos, A. (2008). Análisis del impacto ambiental asociado a los materiales de construcción empleados en las viviendas de bajo coste del programa 10x10 con Techo-Chiapas del CYTED. *Informes de la Construcción*, *60*(509), 25-34.

Badilla Arroyo, P., Elizondo Santiago, J. A., Fernández Martínez, T., Mora Solano, F., Méndez Trejos, J., & Quesada Yamasaki, M. (2015). CO2e: cálculo de huella de carbono para materiales de construcción en Costa Rica.

Ballester, F. (2005). Contaminación atmosférica, cambio climático y salud. *Revista Española de Salud Pública*, *79*, 159-175.

Bravo, R. (2011). *El sector de la construcción genera el 36% de las emisiones de CO2 en la Unión Europea*. mayo 01, 2019, de dicyt Sitio web: http://www.dicyt.com/noticias/el-sector-de-la-construccion-genera-el-36-de-las-emisiones-de-co2-en-la-union-europea

Casanovas, X. (2009). La construcción sostenible: una mirada estratégica. *Extraído el*, *13*.

CEMEX Concretos. (2003). *Manual del constructor*. México: CEMEX.

Circular Ecology (2019)- *Embodied energy and carbon - The ICE database*. Recuperado el 6 de junio 2019 de http://www.circularecology.com/embodied-energy-and-carbon-footprint-database.html#.XPndNdJKi1t

CONAPO (2018). *Indicadores Demográficos de México de 1950-2050.*Recuperado de http://www.conapo.gob.mx/work/models/CONAPO/Mapa_Ind_Dem18/index_2.html

Echeverri Londoño, C. A. (2006). Estimación de la emisión de gases de efecto invernadero en el municipio de Montería (Córdoba, Colombia). *Revista Ingenierías Universidad de Medellín*, *5*(9), 85-96.

Estrada Garita, L. C. (2014). Implementación de medidas de reducción y compensación de huella de carbono en proyectos constructivos de la empresa constructora EDIFICAR SA.

Fundidora Monterrey (México). (1977). *Manual para constructores*. México: Fundidora Monterrey.

González Sánchez, Y., Fernández Díaz, Y., & Gutiérrez Soto, T. (2013). El cambio climático y sus efectos en la salud. *Revista Cubana de Higiene y Epidemiología*, *51*(3), 331-337.

Hammond, G. P., & Jones, C. I. (2008). Embodied energy and carbon in construction materials. *Proceedings of the Institution of Civil Engineers-Energy*, *161*(2), 87-98.

INEGI. (2005). *II Conteo de Población y Vivienda 2005*. junio 16, 2019, de INEGI Sitio web: https://www.inegi.org.mx/programas/ccpv/2005/

INEGI. (2010). *Censo de Población y Vivienda 2010*. junio 16, 2019, de INEGI Sitio web: https://www.inegi.org.mx/programas/ccpv/2010

INEGI. (2015). *Encuesta Intercensal 2015*. junio 16, 2019, de INEGI Sitio web: https://www.inegi.org.mx/programas/intercensal/2015/

Menghi, C. I. (2007). Calentamiento global: el riesgo oculto para la salud. *Revista argentina de microbiología*, *39*(3), 131-132.

Mercader, M. P., de Arellano, A. R., & Olivares, M. (2012). Modelo de cuantificación de las emisiones de CO_2 producidas en edificación derivadas de los recursos materiales consumidos en su ejecución. *Informes de la Construcción*, *64*(527), 401-414.

Montaño Arias, N. M., & Sandoval Pérez, A. L. (2007). Contaminación atmosférica y salud.

Noticias ONU. (2019). *Todos los dirigentes de la ONU piden planes urgentes contra el cambio climático*. mayo 23, 2019, de Noticias ONU Sitio web: https://news.un.org/es/story/2019/05/1455732

Pedreño Manresa, A. (2015). Desarrollo de una aplicación para el cálculo de la huella de carbono en proyectos de construcción.

Rodríguez Durón, C. (2010). Calculadora de carbono para materiales básicos de construcción de obra gris en Costa Rica. Proyecto de Graduación – Licenciatura en Ingeniería en Construcción, Instituto Tecnológico de Costa Rica, Cartago, Costa Rica.

Salazar, C. S., & Suarez, C. (1978). *Costo y tiempo en edificación*. Editorial Limusa.

SEMARNAT & INECC. (2002). *Inventario Nacional de Emisiones de Gases de Efecto Invernadero 1990-2002*. 10 de Junio de 2019, de SEMARNAT & INECC Sitio web: http://www2.inecc.gob.mx/descargas/cclimatico/mexico_nghgi_2002.pdf

SEMARNAT, , 2010, con base en: Instituto Nacional de Ecología, S**istema** Integrado de Regulación Directa y Gestión Ambiental de la Industria, Segunda edición, SEMARNAP / INE, México, 1997. SEMARNAP, Gestión ambiental hacia la Industria, 1ª edición, SEMARNAP, México, 2000.

SEMARNAT, Integración y actualización del Inventario Nacional de Generación de Residuos Peligrosos, 1ª edición, SEMARNAT, México, 2010.http://dgeiawf.semarnat.gob.mx:8080/ibi_apps/WFServlet?IBIF_ex=D2_R_INDUSTRIA01_01&IBIC_user=dgeia_mce&IBIC_pass=dgeia_mce
SEMARNAT. (2019). *Registro Nacional de Emisiones (RENE)*. Recuperado el 6 de junio 2019
de https://www.gob.mx/semarnat/acciones-y-programas/registro-nacional-de-emisiones-rene

Serrano, M. S. G. (2019). Consumo privado de los hogares y emisiones de gases de efecto invernadero en España. *Índice. Revista de Estadística y Sociedad*, 2019, vol. 72, p. 25-27.

Shen, L. Y., Lu, W. S., Yao, H., & Wu, D. H. (2005). A computer-based scoring method for measuring the environmental performance of construction activities. *Automation in Construction*, *14*(3), 297-309.

World Resources Institute and the World Business Council for Sustainable Development. (2019). *About us*. junio 16, 2019, de GREENHOUSE GAS PROTOCOL Sitio web: https://ghgprotocol.org/about-us

Remediation methods for the removal of pesticides in wastewater

Métodos de remediación para la remoción de pesticidas en aguas residuales

GODINEZ-GARCÍA, Andres†*, HERNÁNDEZ-MORALES María Guadalupe, GUIJOSA-GUADARRAMA, Santiago and DÍAZ-TECANHUEY, Pedro Jesús

Universidad Autónoma Metropolitana - Azcapotzalco. Departamento de Ciencias Básicas

ID 1st Autor: *Andres, Godinez-García /* **ORC ID**: 0000-0002-0732-5591, **CVU CONACYT ID**: 168578, **SNI-CONACYT ID**: 60484

ID 1st Coautor: *María Guadalupe, Hernández-Morales/* **ORC ID**: 0000-0002-6793-273X, **CVU CONACYT ID:** 74002

ID 2nd Coautor: *Santiago, Guijosa-Guadarrama/* **ORC ID**: 0000-0002-8064-3684

ID 3st Coautor: *Pedro Jesús, Díaz Tecanhuey/* **ORC ID**: 0000-0003-0391-6332

DOI: 10.35429/EJRN.2019.8.5.29.35 Received March 28, 2019; Accepted May 22, 2019

Abstract

This work is part of one of the priorities of sustainable development that is the conservation of soil and the care of aquifers. Water is a vital liquid for human and all kind of living beings, the presence of pesticides in drinking water is a health problem that requires solution. In this paper, a review of the different methods used for the removal of pesticides in wastewater is made, such as biological remediation methods, using plants and microorganisms, remediation by physical methods by adsorption of contaminants with activated carbon, zeolites, polymers and clays and finally chemical remediation, through advanced oxidation with the production of hydroxyl radicals. A review of the most commonly used pesticides in the different agricultural areas is carried out, as well as their impact on the health of the inhabitants in these regions. Finally, a comparison of the advantages and disadvantages of these methods is made both for its effectiveness as well as for their cost.

Remediation methods, Removal of pesticides, Wastewater

Resumen

El presente trabajo se inscribe dentro de una de las prioridades del desarrollo sostenible que es la conservación del suelo y el cuidado de los mantos acuíferos. El agua es un líquido vital para el ser humano y todos los demás seres vivos, la presencia de pesticidas en el agua potable es un problema de salud que requiere solución. En este trabajo se hace una revisión de los diferentes métodos utilizados para la remoción de pesticidas en aguas residuales, tales como métodos de remediación biológicos, utilizando plantas y microorganismos, remediación por métodos físicos por adsorción de los contaminantes con carbón activado, zeolitas, polímeros y arcillas y finalmente remediación química, mediante oxidación avanzada con la producción de radicales hidroxilo. También, se hace una revisión de los pesticidas de mayor uso en las diferentes zonas agrícolas, así como su impacto en la salud de los habitantes en dichas regiones. Finalmente, se hace una comparación de las ventajas y desventajas de estos métodos tanto por su eficacia, así como por su costo

Métodos de remediación, Aguas residuales, Remoción de pesticidas

Citation: GODINEZ-GARCÍA, Andres, HERNÁNDEZ-MORALES María Guadalupe, GUIJOSA-GUADARRAMA, Santiago and DÍAZ-TECANHUEY, Pedro Jesús. Remediation methods for the removal of pesticides in wastewater. ECORFAN Journal-Republic of Nicaragua. 2019 5-8: 29-35

* Correspondence to Author (email: israel.hernandez@uacj.mx)

† Researcher contributing as first author.

Article ECORFAN Journal-Republic of Nicaragua
June, 2019 Vol.5 No.8 29-35

Introduction

Population growth has led to an increase in food production. And this in turn leads to an increase in the use of pesticides, with the aim of increasing the production and quality of crops. Pesticides are also used in industry, in gardening, in domestic use, livestock use and urban use, that is, they are practically present in every activity of our daily lives. However, the use of pesticides has caused health problems in animals and humans since many of them are highly toxic and also contaminate soil, water and air.

A pesticide or pesticide is a substance whose objective is to destroy, repel, attract or prevent any type of pest, be it of animal or plant origin. According to their biological activity, pesticides are classified as herbicides, insecticides, fungicides, bactericides and rodenticides (Bejarano-González edit. 2017). 7 types of pesticides, chemical, biochemical, microbial, botanical, microbial and miscellaneous are distinguished (Bejarano-González edit. 2017). In particular, chemical pesticides have had considerable development since 1940, the year in which the insecticidal properties of DDt were discovered and since then the development of new pesticides has intensified; Some of the most important groups are organophosphates, organochlorines, carbamates and pyrethroids. (Table 1).

Group	Level of toxicity	Rapid degradation in the environment	Some commercial pesticides	Health damage
Organophosphates (inectidal herbicide, fungicide and acaricide)	Very toxic (I)	Very fast and easy to degrade	glyfosfato, dimetoato malation, paration	It damages lungs, liver, kidneys, bone marrow and nervous system irreversibly .
Organochlorines (insecticide, acaricide, herbicide and fungicide)	Very toxic (I)	Very slow	DDt,atrazin, lindano, endrin,heptacloro, endosulfan,metoxiclor,hexaclorobenceno	Cancer, central and peripheral nervous system, liver and kidney. They accumulate in fatty tissues
Carbamates (insecticide, fungicide, herbicides)	Moderately toxic (II)	Very fast	carbaryl, aldicarb baygon, carbofuran	Nervous and respiratory system
Pyrethroids (insecticide)	Moderately toxic (II)	Very fast	permetrina, cipermetrina,	Nervous system, brain

Table 1 Some of the most important chemical pesticides and their effects on health

Data from the 2014 National Agricultural Survey indicate that of the total hectares of production in the country only 16.7% use biological control of pests, in the remaining 83.3% chemical pesticides are used.

This tells us about the high consumption of agrochemicals in the country. One of the problems in its control is that there is no detailed information on the active ingredients used. Information from the Mexican Social Security Institute (IMSS) indicates that from 2001 to 2016 there have been 31,257 cases of acute pesticide poisoning nationwide (Guzmán-Plazola et al.2016). According to FAO data, the consumption of pesticides in Mexico, during 2014 was 98,814 t, of which 40% correspond to fungicides and bactericides, 32% to insecticides and the remaining 27% to herbicides (Bejarano-González edit. 2017) as shown in Fig. 1.

The objective of this article is to present an overview of the use and risks that pesticides present in Mexico, as well as the existing remediation methods and the options to replace chemical pesticides with biological options. For this purpose, a review of the main pesticides used in several states with a higher food production was made, which are presented in section 2.

In section 3 different methods used for the degradation of pesticides in water are presented, while that in section 4 some of the remediation processes used in Mexico are listed. Finally, section 5 corresponds to our conclusions and we discuss the scope and limitations of our work. It is important to mention that while the different hydrocarbon remediation processes are known, in the case of pesticides there is very little information about.

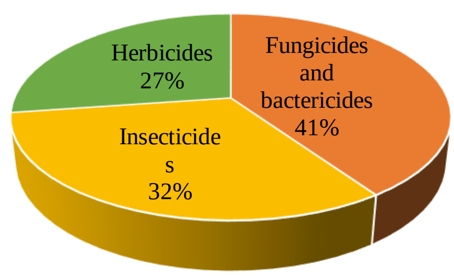


Figure 1 Pesticide consumption in Mexico, during 2014, according to FAO data

Pesticide use in Mexico

Mexico produces large amounts of food, both for internal consumption and for export, as well as being one of the leading producers of flowers worldwide.

The states where pesticides are most used are: Campeche, Chiapas, Chihuahua, State of Mexico, Morelos, Michoacán, Nayarit, Oaxaca, Puebla, Sinaloa, Sonora, Tabasco, Tamaulipas, Veracruz and Yucatan according to a statement from the Secretariat of Health of 2012. These states are key in the production of food for their levels of production intended for both national consumption and export (Arellano y Rendón 2016).

Sinaloa is one of the largest food producers in the country, with an area of 1,153,311.78 hectares, where corn, sorghum, tomato, green chili, potato, watermelon, forage sorghum, sugar cane, alfalfa and magician are produced. Between November 2011 and October 2012, 246 tons of pesticides were used. The most used were fungicides, herbicides and insecticides of the families of organochlorines, organophosphates, carbamates and pyrethroids (García Hernández et al. 2018). In studies conducted by Green Peace (2016) and Silvera-Gramont et al. (2018), considerable contamination was found, in soil, water and biota, due to pesticide discharges. In Sinaloa, 80 new cases of childhood cancer are presented each year and this is probably due to contamination by agricultural pesticides (Ministry of Health of the State of Sinaloa (SS, 2013)) and, on the other hand, Chaín-Castro et al. (1998) reported that 20% of Culiacán farmers, mainly those in charge of agrochemical mixtures, have presented intoxication at least once, due to contact with pesticides.

In Sonora, the Rural Development District (DDR) 144 Hermosillo has a cultivated irrigated area of 72,499 ha (SIAP 2015). The main crops are alfalfa, pumpkin, chickpea, orange, walnut, watermelon, sorghum, wheat and vine. Between 2009 and 2010, 270 t of pesticides were used, of which the most commonly used were fungicides followed by insecticides and herbicides belonging to the organophosphorus groups, dithiocarbamates, synthetic pyrethroids and organochlorines (García-Hernández et al. 2018). Regarding the use of biological pesticides, 25% was used in chickpea, while in the rest of the crops 5% was used (SENASICA 2011).

In the basin, in Valle de Santiago and Salvatierra the area of cultivated hectares is 760,921 (SIAP, 2015). The main crops are corn, sorghum, wheat, barley and vegetables.

It is estimated that in the spring-summer cycle, 9.515.3 t of pesticides were used, corresponding to approximately 10% of the national total reported by SENER (2017). Of these pesticides, 82.1% correspond to highly dangerous pesticides (PAP), among which edonsulfan, methamidophos and carbofuran, which are banned in different countries.

The municipalities of Coatepec Harina, Ixtapan de la Sal, Tenancingo, Tonatico, Villa Guerrero, Malinalco and Zumpahuacán, in the state of Mexico, are dedicated to the cultivation of vegetables and fruits, although their main activity is flowers, whose production corresponds to 50.4 % of national production and 80% of exports to the United States, Canada and Europe. In the floricultural production, organochlorine pesticides, pyrethroids, benzimidazole and triazole are mainly used (Martinez et al. 2014. When conducting studies to the farmers of Villa Guerrero, it was found that of 52 cases studied, 50% presented one or more pesticides in their waste According to statistics from the Institute of Health of the State of Mexico (ISEM), during 2006 140 cases of poisoning were recorded. (Ferrusquía-García et al. 2008).

In the area of Los Altos de Chiapas, in the municipalities of Chamula, Zinacat and Amatenango del Valle, the population is engaged in horticultural, floricultural and maize production. Producers of flowers and vegetables most frequently use highly toxic pesticides belonging to organophosphates and carbamates such as methyl parathion, methamidophos, paraquat and glyphosate among others (Díaz-Coutiño, et al. 1998; Cantoral, 2001). Due to their ignorance in the handling of pesticides and the damage they cause to the environment and their health, they are contaminating water, when disposing of, pesticide containers in areas that are recharged by aquifers. On the other hand, very high amounts of DDT (37.5 μg / L) have been found in the blood of children in locations where this pesticide was used until 2000 (Herrera-Portugal et al. (2008)).

As in other states, in Yucatan and Campeche, the consumption of agrochemicals has increased, due to the industrial planting of GM soy, corn and vegetables. According to Greenpeace studies between 1990 and 2005 there was an increase of 606 to 4800 tons of pesticides in the state of Yucatán.

The main pesticides used are glyphosate, endosulfan, paraquat, 2,4-D, carbofuran, emamectin benzoate, methamidophos, emamectin benzoate and cypermethrin. Several of these pesticides are classified as highly dangerous (PAN, 2016) and some are banned in other countries, (PAN 2017) (Rendón von Osten 2004). In fact, Campeche from 1998 to 2010, presented at national level one of the highest rates of pesticide poisoning according to the report of the Epidemiological Bulletin of the Ministry of Health (Gutiérrez, 2013)

Methods of degradation of pesticides in water

The process of contamination by pesticides in waters is due, on the one hand, to their use in agriculture and on the other, due to their poor management, as waste and pesticide containers are dumped in rivers, lakes, lagoons or near some freatic level. Once pesticides are released into the environment, they suffer alterations in their composition due to environmental conditions such as temperature, intensity and duration of solar radiation, pH and water composition. There are different methods for the degradation of pesticides in water, the selection of the method depends on the pesticides to be treated, their concentration and the environment. In principle, what is expected is that the degradation leads to the mineralization of the pesticides obtaining CO2, H2O, etc. But sometimes what is achieved is its degradation into compounds that may be more toxic and persistent than the initial products. Below are the main methods used in the degradation of pesticides in water.

Remediation by biological processes or bioremediation

The purpose of these processes is to transform dangerous organic compounds into less harmful compounds such as CO2 and H2O through the use of microorganisms, algae, worms, fungi and plants, present in the system or outside the environment. The advantage of these processes is that they are environmentally friendly and inexpensive (Nwankwegu and Onwosi 2017; Rajiv et al. 2009). Among the factors to be considered for its effectiveness are temperature, pH, pesticide concentration, chemical and physical characteristics of the substrate, nutrients, etc. that affect the development of microorganisms responsible for the mineralization of pesticides.

Remediation by Physical processes

These processes allow the elimination of pesticides without changing their chemical structure, through physical methods such as clays, activated carbon, zeolites and polymeric materials among others (Tan 2009).

In general, these methods work by adsorption, in which the contaminants are adhered to the surface of the materials used.

Clays

Mineral clays are hydrophilic and have a negative charge so they can be used to retain cationic pesticides. They can also be mixed with Fe or Ti to improve their adsorption. The important factors in the adsorption of pesticides by clays are temperature, solution pH, pesticide concentration, contact time, adsorbent mass and ionic strength.

Activated carbon

It is a material that adsorbs pesticides and drugs very efficiently in water. Its efficiency depends on the pH of the solution, the temperature and other compounds dissolved in the solution. There are different varieties of activated carbon such as granules and powders.

The most commonly used is dust due to its lower cost and ease of handling. There is also a carbon-rich material called biochar, which is obtained from biomass by pyrolysis (burning at very high temperatures plant material).

A disadvantage of this material is that regeneration of activated carbon is very expensive. Patricia Torres and collaborators used activated carbon in combination with a coagulation method to decrease the concentration of pentachlorophenol in the Cauca River below 1.56 μg/L (Reyes Serrano y López Alejo 2016, p.36).

Zeolites

These materials have been used to remove pesticides and heavy metals from water. Even though De Schmedt (2015) showed that adsorption depends on the polarity and mobility of the pesticide.

Polymeric materials

The advantage of these materials compared to activated carbon is that they do not require so much energy to regenerate the adsorption capacity and this represents a cost advantage. The disadvantage of some organic pesticides is their low water solubility, some polymeric materials are currently being used to improve their solubility.

Among the most commonly used polymers are cyclodextrins, dendrimers and hyper-cross polymers. The dendrimers have been used with great success in the removal of pesticides in drinking water, which were not removed by nanofiltration membranes due to their low molecular weight. However, the main disadvantage of dendrimers and hypercrossed is its high cost of synthesis.

Chemical Remediation

Advanced Oxidation Processes

This methodology consists of a family of processes that use hydroxyl radical generation, oxidation reactions on pesticides to degrade them in inorganic salts, H2O and CO2. These processes can be catalytic or non-catalytic and with the contribution or not of external energy.

The difference between the different processes is the way in which the hydroxyl radical is generated. In general, these processes require the aggregation of hydrogen peroxide and ozone, reagents that are expensive and limit their use in the treatment of large quantities of water (Rodríguez et al. 2010). Table 2 shows the family of advanced oxidation processes. (Rodríguez et al. 2010).

Advanced oxidation processes				
Heterogeneous Processes	**Homogeneous Processes**			
	Without energy input	**With energy input**		
		Electric	**Ultrasound**	**Radiation Ultraviolet**
Ozonation Catalytic Catalytic photo Heterogeneous Heterogeneous photocatalysis Fenton Heterogeneous Photofenton	O_3 in alkaline medium O_3/O_3H_3 Fe^{+2}/H_2O_2	Oxidation electrochemistry Anodic oxidation Electro-fenton	O_3/US H_2O_2/US	O_3/UV H_2O_2/UV O_3/H_2O_2/UV Fe^{+2}/H2O2/UV

Table *2* Advanced oxidation processes. Adapted from Rodriguez et al.2010

Dissolved oxygen processes

This methodology uses dissolved oxygen as an oxidant for pollutants and there are two methods, wet oxidation and supercritical oxidation (Rodríguez and Santos 2010). In wet oxidation, dissolved contaminants are oxidized using oxygen or air in a temperature range of (125-300 °C) and pressures of (5-200 bar) (Zimmermann et al. 1960, Himmelblau et al. 1960). The process can be carried out with or without catalysts. The advantage of using catalysts is that it improves the conversion of pollutants, decreases temperature and pressure conditions. The catalysts used are salts of Fe + 2, Cu + 2, noble metals such as (Ru, Pd, Pt) and metal oxides.

Remediation processes used in Mexico

Knowing the problems that come with the intensive use of pesticides, various studies have been carried out to explore less harmful methods for health and the environment in the fight against pests and for the remediation of water and soil contaminated with pesticides.

In this sense, Thompson et al 2000, and Infante-Rodríguez et al. 2011, proved that the effectiveness of the spinosal naturally occurring larvicide is similar to that of the organophosphorus pesticide temefos in the fight against black fly, vector of onchocerciasis, (Infante-Rodríguez et al. 2011) and against the pest of the fly White in cotton.

On the other hand, in the state of Mexico the degradation of methyl parathion in aqueous solution was studied using heterogeneous photolysis, in the presence of titanium dioxide (TiO2) and hydrogen peroxide. In this study they obtained a removal percentage of 58% at 60 min (Ferrusquía-García et al. 2008).

While by means of a photochemical process in the presence of folic acid they obtained the degradation of methyl paration, in p-phenol and other products at a PH 2 (Manzanilla-Cano et al. 2008). In Yucatan, biological beds have been used, consisting of a mixture of soil and a component such as straw, charcoal, corn husks, etc. where pesticides are retained and degraded, Góngora-Echeverría et al. 2018 have obtained the removal of up to 99% of 2.4 dichlorophenoxyacetic acid (2,4-D), atrazine, carbofuran, diazinon and glyphosate after 40 days.

ISSN 2414-8830

Conclusions

In the literature there are several publications that refer to the pesticides most commonly used in the Mexican countryside, both for the production of food and flowers. As well as the damages that originate to the health of human beings, animals and the environment, contaminating soil and water. Likewise, there are publications in which they expose the main methods of chemical pesticide remediation in wastewater, but these are mainly at the laboratory or pilot plant level. However, while the different hydrocarbon remediation processes are known, in the case of pesticides we made an extensive review and found very little information about it, when it comes to its application in the field.

As for the remediation processes known in the treatment of wastewater, although the chemical remediation processes are successful in the oxidation of various pesticides, they are expensive and in many cases more toxic and persistent metabolites than the initial compound are generated, coupled with the fact that so far its use is at the laboratory or pilot plant level. As for the physical processes by membranes or activated carbon, they have the disadvantage of being expensive both in the activation of the carbon and in the cleaning and operating conditions of the membranes since high pressures are required for their operation, the advantage of these methods Remediation is that they do not add any chemical agent to the medium.

On the other hand, bioremediation processes are friendly to the environment, they are economical, it is not necessary to implement them every time an agrochemical is applied, unlike the chemical and physical processes that must be implemented every time the pesticide is applied. This means savings in energy and economic resources. In this way the most efficient and economical way to eliminate pesticides in wastewater is to make a combination of biological methods with chemical and / or physical methods.

References

Arellano Aguilar, O., Rendón von Osten J.(2016). La huella de los plaguicidas en México |Greenpeace México. https://www.greenpeace.org/mexico/es/y/La-huella-de-los-plaguicidas-en-Mexico/

Bejarano Gonzáles, F. (Coordinador y editor). *Los Plaguicidas Altamente Peligrosos en México* (2017). (1era Ed.) https://rap-al.org/tag/libro-plaguicidas-altamente-peligrosos-mexico/.

Cantoral M.S.G. (2001) La comercialización de la producción florícola de Zinacantán en el mercado Nacional y su perspectiva ante el TLC de 199-1999. (Tesis de Licenciatura). Universidad Autónoma de Chiapas. San Cristóbal de Las Casas, Chiapas, México

Chain-Castro, T.J, Barrón-Aragón, R, Haro-García, L.(1998). Pesticide poisoning in Mexican seasonal farm workers. International Journal of Occupational and Environmental Health, 4(3):202-203.

Díaz Coutiño, J. M., Ordóñez Morales, C. E., González Ponciano, J. R., (1998), Parra Vázquez, M. R.,La microrregión florícola de Zinacantán y las perspectivas de desarrollo rural regional. Revista de Geografía Agrícola: Estudios de la Agricultura Mexicana. No. 26 , p. 347-372. ISSN: 0186-4394

Ferrusquía-García, G., Roa-Morales, M. M., García-Fabila, A., Amaya-Chávez y T. B. Pavón-Silva (2008). Evaluación de la degradación de metil paratión en solución usando fotocatálisis heterogénea. Revista Latinoamericana de Recursos Naturales, 4 (2): 285-290.

García Hernández, J., Leyva Morales, J. B, Martínez Rodríguez, I. E., Hernández Ochoa, M.I., Aldana Madrid, M. L., Rojas García,A. E., Betancourt Lozano,M., Perez Herrera, N. E. y Perera Rios, J. H. (2018). Estado actual de la investigación sobre plaguicidas en México. Rev. Int. Contam. Ambie. 34 (Especial sobre Contaminación y Toxicología por Plaguicidas (CTP) 29-60.

Gutiérrez J.J. (2013) Panorama histórico de morbilidad y mortalidad por Intoxicación por plaguicidas en México 1995-2012 (Segunda de tres partes). Boletín Epidemiológico 30(34), pp.1-5.

Guzmán-Plazola, P., Guevara-Gutiérrez, R. D., Olguín-López J.L., Oscar Raúl Mancilla-Villa, O.R. (2016). Perspectiva campesina, intoxicaciones por plaguicidas y uso de agroquímicos. IDESIA (Arica), 34(3), 67-78.

Herrera-Portugal,C., Franco-Sánchez, G., Zelada- Castillo, V., Schlottfeldt-Trujillo, Y., Rodríguez-Feliciano, M.A. y Barrientos-Becerra, H.(2008), Niveles de plaguicidas organoclorados (DDT y DDE) en niños de comunidades endémicas de paludismo en Chiapas, México. Revista Latinoamericana de Recursos Naturales, 4 (3): 349-356.

Himmelblau, D., (1960), Solubilities of inert gases in water, 0 o C near the critical point of water. J Chem. Eng. Data 5(1):10-15.

Infante-Rodríguez, D.A., Novelo-Gutiérrez, R., Mercado, G., Williams, T.,(2011), Spinosad toxicity to Simulium spp. larvae and associated aquatic biota in a coffee-growing region of Veracruz State, Mexico. J Med Entomol. 2011 May;48(3):570-6.

Manzanilla-Cano, J. A., Barcelo-Quintal, M.H., and Coral-Martinez, T.I., (2008), Photochemical degradation of methylparathion in the presence of humic acid. Journal of Environmental Science and Health Part B 43, 546–552.

Martínez-Luna, G., Mejia-Sanchez, F., Serment-Guerrero, J. H., Castillo-Cadena, J. (2014). “Quality spermatic alterations in floriculturists exposed to pesticides in Villa Guerrero, State of Mexico”. American Journal of Agriculture and Forestry. 2 (6) 284-288.

Nwankwegu AS, Onwosi CO (2017) Bioremediation of gasoline contaminated agricultural soil by bioaugmentation. Environ Technol Innov 7:1–11. https://doi.org/10.1016/j.eti.2016.11.003.

PAN (2016) PAN International List of Highly Hazardous Pesticides. December 2016. Pesticide Action Network International (PAN International), Hamburg, Germany. 35 pp.

PAN (2017) Consolidated list of banned pesticides 3rd. Edition, April 2017. Pesticide Action Network International (PAN International) Disponible en: http://pan-international.org/pan-international-consolidated-list-of-banned-pesticides/

Rajiv K, SinhaDV, Shanu S, Shweta S, Sunil H (2009) Bioremediation of contaminated sites: allow cost nature’s biotechnology for environmental cleanup by versatile microbes, plants & earthworms. Solid Waste Management and Environmental Remediation. Nova Science Publishers, Incoparate, Hauppauge, pp 1–69

Rendón-von Osten J. Tinoco-Ojanguren R, Soares AMVM, Guilhermino L. (2004) Effect of pesticide exposure on acetylcholinesterase activity in subsistence farmers from Campeche Mexico. Archives of Environmental Health 59 (8), pp. 428-435.

Reyes Serrano, A. y López Alejo, J.E. (2016). Biosorción de plaguicidas organoclorados en aguas contaminadas a través de celulosa de maíz. Tesis de Licenciatura del IPN.

Rodríguez, J.J., Casas, J.A., Mohedano, A.F., Zazo, J.A., Pliego, G y Blasco, S. (2010).Tecnologías de tratamiento de aguas para su reutilización. Capítulo 1. Aplicación del proceso fenton a la depuración de efluentes industriales y contaminantes emergentes. Programa Consolider Tragua. www.consolider-tragua.com.

Rodríguez, S. y Santos, A. (2010), Tecnologías de tratamiento de aguas para su reutilización. Capítulo 5. Oxidación húmeda, Programa Consolider Tragua. www.consolider-tragua.com.

Silveira-Gramont, M.I., Aldana-Madrid, M.L. Piri-Santana,J.,Valenzuela-Quintanar, A.I.

Jasa-Silveira, G. y Rodríguez-Olibarria,G.(2018),Plaguicidas agricolas: un marco de referencia para evaluar riesgos a la salud en comunidades rurales en el estado de Sonora, México. Rev. Int. Contam. Ambie. 34 (1) 7-21.

Tan KH (2009) Environmental soil science. CRC Press, Boca Raton.Chapter 11: soil and pollutions, p 380.

Thompson, D.G., Harris, B.J., Buscarini, T.M-and Chartrand, D.T., (2002). Fate of spinosad in litter and soils of a white spruce plantation in central Ontario. Pest Manag Sci 58:397–404.

Zimmermann, F.J, Diddams, D.G., (1960), The Zimmermann process and its application in the pulp and paper industry. TAPPI., 43(8):710-5.

[Title in Times New Roman and Bold No. 14 in English and Spanish]

Surname (IN UPPERCASE), Name 1st Author†*, Surname (IN UPPERCASE), Name 1st Coauthor, Surname (IN UPPERCASE), Name 2nd Coauthor and Surname (IN UPPERCASE), Name 3rd Coauthor

Institutional Affiliation of Author including Dependency (No.10 Times New Roman and Italic)

<u>*International Identification of Science - Technology and Innovation*</u>

ID 1st Author: (ORC ID - Researcher ID Thomson, arXiv Author ID - PubMed Author ID - Open ID) and CVU 1st author: (Scholar-PNPC or SNI-CONACYT) (No.10 Times New Roman)

ID 1st Coauthor: (ORC ID - Researcher ID Thomson, arXiv Author ID - PubMed Author ID - Open ID) and CVU 1st coauthor: (Scholar or SNI) (No.10 Times New Roman)

ID 2nd Coauthor: (ORC ID - Researcher ID Thomson, arXiv Author ID - PubMed Author ID - Open ID) and CVU 2nd coauthor: (Scholar or SNI) (No.10 Times New Roman)

ID 3rd Coauthor: (ORC ID - Researcher ID Thomson, arXiv Author ID - PubMed Author ID - Open ID) and CVU 3rd coauthor: (Scholar or SNI) (No.10 Times New Roman)

(Report Submission Date: Month, Day, and Year); Accepted (Insert date of Acceptance: Use Only ECORFAN)

Abstract (In English, 150-200 words)

Objectives
Methodology
Contribution

Keywords (In English)

Indicate 3 keywords in Times New Roman and Bold No. 10

Abstract (In Spanish, 150-200 words)

Objectives
Methodology
Contribution

Keywords (In Spanish)

Indicate 3 keywords in Times New Roman and Bold No. 10

Citation: Surname (IN UPPERCASE), Name 1st Author, Surname (IN UPPERCASE), Name 1st Coauthor, Surname (IN UPPERCASE), Name 2nd Coauthor and Surname (IN UPPERCASE), Name 3rd Coauthor. Paper Title. ECORFAN Journal-Republic of Nicaragua. Year 1-1: 1-11 [Times New Roman No.10]

* Correspondence to Author (example@example.org)
† Researcher contributing as first author.

Introduction

Text in Times New Roman No.12, single space.

General explanation of the subject and explain why it is important.

What is your added value with respect to other techniques?

Clearly focus each of its features

Clearly explain the problem to be solved and the central hypothesis.

Explanation of sections Article.

Development of headings and subheadings of the article with subsequent numbers

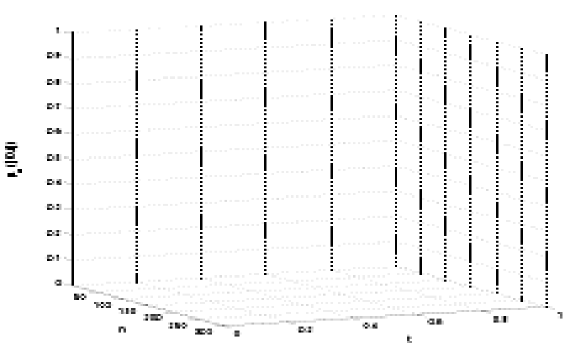
[Title No.12 in Times New Roman, single spaced and bold]

Products in development No.12 Times New Roman, single spaced.

Including graphs, figures and tables-Editable

In the article content any graphic, table and figure should be editable formats that can change size, type and number of letter, for the purposes of edition, these must be high quality, not pixelated and should be noticeable even reducing image scale.

[Indicating the title at the bottom with No.10 and Times New Roman Bold]



Graphic 1 Title and *Source (in italics)*

Should not be images-everything must be editable.

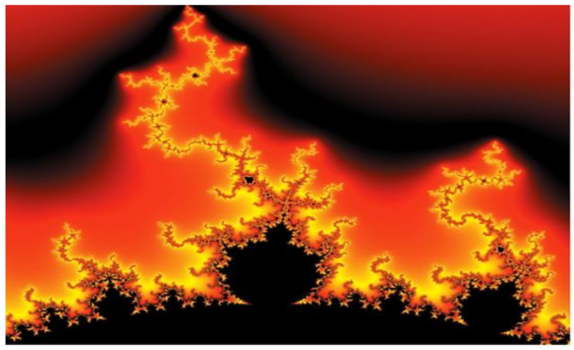


Figure 1 Title and *Source (in italics)*

Should not be images-everything must be editable.

Table 1 Title and *Source (in italics)*

Should not be images-everything must be editable.

Each article shall present separately in **3 folders**: a) Figures, b) Charts and c) Tables in .JPG format, indicating the number and sequential Bold Title.

For the use of equations, noted as follows:

$$Y_{ij} = \alpha + \sum_{h=1}^{r} \beta_h X_{hij} + u_j + e_{ij} \qquad (1)$$

Must be editable and number aligned on the right side.

Methodology

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

Results

The results shall be by section of the article.

Annexes

Tables and adequate sources

Thanks

Indicate if they were financed by any institution, University or company.

Conclusions

Explain clearly the results and possibilities of improvement.

ISSN 2414-8830

References

Use APA system. Should not be numbered, nor with bullets, however if necessary numbering will be because reference or mention is made somewhere in the Article.

Use Roman Alphabet, all references you have used must be in the Roman Alphabet, even if you have quoted an Article, book in any of the official languages of the United Nations (English, French, German, Chinese, Russian, Portuguese, Italian, Spanish, Arabic), you must write the reference in Roman script and not in any of the official languages.

Technical Specifications

Each article must submit your dates into a Word document (.docx):

Journal Name
Article title
Abstract
Keywords
Article sections, for example:

1. Introduction
2. Description of the method
3. Analysis from the regression demand curve
4. Results
5. Thanks
6. Conclusions
7. References

Author Name (s)
Email Correspondence to Author
References

Intellectual Property Requirements for editing:

-Authentic Signature in Color of Originality Format Author and Coauthors

-Authentic Signature in Color of the Acceptance Format of Author and Coauthors

Reservation to Editorial Policy

ECORFAN Journal Republic of Nicaragua reserves the right to make editorial changes required to adapt the Articles to the Editorial Policy of the Journal. Once the Article is accepted in its final version, the Journal will send the author the proofs for review. ECORFAN® will only accept the correction of errata and errors or omissions arising from the editing process of the Journal, reserving in full the copyrights and content dissemination. No deletions, substitutions or additions that alter the formation of the Article will be accepted.

Code of Ethics - Good Practices and Declaration of Solution to Editorial Conflicts

Declaration of Originality and unpublished character of the Article, of Authors, on the obtaining of data and interpretation of results, Acknowledgments, Conflict of interests, Assignment of rights and Distribution

The ECORFAN-Mexico, S.C Management claims to Authors of Articles that its content must be original, unpublished and of Scientific, Technological and Innovation content to be submitted for evaluation.

The Authors signing the Article must be the same that have contributed to its conception, realization and development, as well as obtaining the data, interpreting the results, drafting and reviewing it. The Corresponding Author of the proposed Article will request the form that follows.

Article title:

– The sending of an Article to ECORFAN Journal Republic of Nicaragua emanates the commitment of the author not to submit it simultaneously to the consideration of other series publications for it must complement the Format of Originality for its Article, unless it is rejected by the Arbitration Committee, it may be withdrawn.

– None of the data presented in this article has been plagiarized or invented. The original data are clearly distinguished from those already published. And it is known of the test in PLAGSCAN if a level of plagiarism is detected Positive will not proceed to arbitrate.

– References are cited on which the information contained in the Article is based, as well as theories and data from other previously published Articles.

– The authors sign the Format of Authorization for their Article to be disseminated by means that ECORFAN-Mexico, S.C. In its Holding Republic of Nicaragua considers pertinent for disclosure and diffusion of its Article its Rights of Work.

– Consent has been obtained from those who have contributed unpublished data obtained through verbal or written communication, and such communication and Authorship are adequately identified.

– The Author and Co-Authors who sign this work have participated in its planning, design and execution, as well as in the interpretation of the results. They also critically reviewed the paper, approved its final version and agreed with its publication.

– No signature responsible for the work has been omitted and the criteria of Scientific Authorization are satisfied.

– The results of this Article have been interpreted objectively. Any results contrary to the point of view of those who sign are exposed and discussed in the Article.

Copyright and Access

The publication of this Article supposes the transfer of the copyright to ECORFAN-Mexico, SC in its Holding Republic of Nicaragua for its ECORFAN Journal Republic of Nicaragua, which reserves the right to distribute on the Web the published version of the Article and the making available of the Article in This format supposes for its Authors the fulfilment of what is established in the Law of Science and Technology of the United Mexican States, regarding the obligation to allow access to the results of Scientific Research.

Article Title:

Name and Surnames of the Contact Author and the Coauthors	Signature
1.	
2.	
3.	
4.	

Principles of Ethics and Declaration of Solution to Editorial Conflicts

Editor Responsibilities

The Publisher undertakes to guarantee the confidentiality of the evaluation process, it may not disclose to the Arbitrators the identity of the Authors, nor may it reveal the identity of the Arbitrators at any time.

The Editor assumes the responsibility to properly inform the Author of the stage of the editorial process in which the text is sent, as well as the resolutions of Double-Blind Review.

The Editor should evaluate manuscripts and their intellectual content without distinction of race, gender, sexual orientation, religious beliefs, ethnicity, nationality, or the political philosophy of the Authors.

The Editor and his editing team of ECORFAN® Holdings will not disclose any information about Articles submitted to anyone other than the corresponding Author.

The Editor should make fair and impartial decisions and ensure a fair Double-Blind Review.

Responsibilities of the Editorial Board

The description of the peer review processes is made known by the Editorial Board in order that the Authors know what the evaluation criteria are and will always be willing to justify any controversy in the evaluation process. In case of Plagiarism Detection to the Article the Committee notifies the Authors for Violation to the Right of Scientific, Technological and Innovation Authorization.

Responsibilities of the Arbitration Committee

The Arbitrators undertake to notify about any unethical conduct by the Authors and to indicate all the information that may be reason to reject the publication of the Articles. In addition, they must undertake to keep confidential information related to the Articles they evaluate.

Any manuscript received for your arbitration must be treated as confidential, should not be displayed or discussed with other experts, except with the permission of the Editor.

The Arbitrators must be conducted objectively, any personal criticism of the Author is inappropriate.

The Arbitrators must express their points of view with clarity and with valid arguments that contribute to the Scientific, Technological and Innovation of the Author.

The Arbitrators should not evaluate manuscripts in which they have conflicts of interest and have been notified to the Editor before submitting the Article for Double-Blind Review.

Responsibilities of the Authors

Authors must guarantee that their articles are the product of their original work and that the data has been obtained ethically.

Authors must ensure that they have not been previously published or that they are not considered in another serial publication.

Authors must strictly follow the rules for the publication of Defined Articles by the Editorial Board.

The authors have requested that the text in all its forms be an unethical editorial behavior and is unacceptable, consequently, any manuscript that incurs in plagiarism is eliminated and not considered for publication.

Authors should cite publications that have been influential in the nature of the Article submitted to arbitration.

Information services

Indexation - Bases and Repositories

RESEARCH GATE (Germany)
GOOGLE SCHOLAR (Citation indices-Google)
REDIB (Ibero-American Network of Innovation and Scientific Knowledge- CSIC)
MENDELEY (Bibliographic References Manager)

Publishing Services

Citation and Index Identification H
Management of Originality Format and Authorization
Testing Article with PLAGSCAN
Article Evaluation
Certificate of Double-Blind Review
Article Edition
Web layout
Indexing and Repository
ArticleTranslation
Article Publication
Certificate of Article
Service Billing

Editorial Policy and Management

Southwest Avenue, San Sebastian – León-Nicaragua. Phones: +52 1 55 6159 2296, +52 1 55 1260 0355, +52 1 55 6034 9181; Email: contact@ecorfan.org www.ecorfan.org

ECORFAN Journal-Nicaragua

"Pilot Underground Greenhouse as an alternative against frequent and intense frosts that occur in the Hidalguense Highlands"
AHUMADA-MEDINA, Albino, CHIO-AUSTRIA, Rosa María and AHUMADA-GÓMEZ, Jorge
Universidad Politécnica de Pachuca
Instituto Tecnológico Latinoamericano

"Air Quality Index for Ciudad Juárez based on a Community Collaboration Scheme"
RODRÍGUEZ-GARCÍA, Nabile Edith, VÁZQUEZ-GÁLVEZ, Felipe Adrián, ESTRADA-SALDAÑA, Fernando and HERNÁNDEZ-HERNÁNDEZ, Israel
Universidad Autónoma de Ciudad Juárez

"GHG emissions in KG-CO2 / M2 generated by a House Type INFONAVIT"
ACEVES-GUTIERREZ, Humberto, LÓPEZ-CHÁVEZ, Oscar, MERCADO-IBARRA, Santa Magdalena and CONTRERAS-QUINTANAR, Cesar Alejandro
Instituto Tecnológico de Sonora

"Remediation methods for the removal of pesticides in wastewater"
GODINEZ-GARCÍA, Andres, HERNÁNDEZ-MORALES María Guadalupe, GUIJOSA-GUADARRAMA, Santiago and DÍAZ-TECANHUEY, Pedro Jesús
Universidad Autónoma Metropolitana - Azcapotzalco

2414 8830
ISSN 2414-8830
www.ecorfan.org