

Name of the University
Name of the Faculty
Name of the Programme

RESEARCH PROJECT PROPOSAL

Name of Candidate: _____ Applicant Full Name _____

Date of Admission to this programme: _____ March 3, 2022 _____

Full time mode

Abstract

Brief summary of the proposal and its sections.

1. Project Title

Communicate the key problem of the research in a brief sentence.

2. Introduction

This study focus on the impact that the air quality have in the population welfare primarily in the Monterrey Metropolitan Area between 2018 and 2019 because we have a database containing air quality data obtained from the Comprehensive Environmental Monitoring System (abbreviated SIMA in Spanish from Sistema Integral de Monitoreo Ambiental) [32]. Also, it have been incorporated a database containing the hospital discharge records for Mexico over the same span of time from the open repository of the Department of Health of Mexico [12].

As the atmosphere is result of the combination of 78% of N₂, 21% of O₂ and 1% of combined helium, water vapor, oxides, methane, noble gases, sulfides, ozone, ammonia, formaldehyde, and hydroxyl radical, can be defined that the air is *polluted* when these concentrations are altered by human activities resulting in harmful environments to biological ecosystems [13].

The human activities that cause pollution have been increasing over the years. Air quality became an urban problem since 1930 when a fog in Belgium was associated with the death of 63 people and then in London during 1952 [10] when another fog caused 4,000 deaths [28] being pneumonia the principal illness diagnosed in both cases. Its negative impact on health and general welfare concerned authorities that design regulations in order to minimize those undesirable effects. In 1981 it became an international problem when the CO concentrations were seen from space for the first time [1]. Such images show that the pollution was not only generated from expected sources, but from other unforeseen activities, and that the pollution generated in one place affected distant populations over time.

Air pollution can be caused by events that impacts the atmosphere, like forest fires, increased volcanic activity, animal and vegetable decomposition, climate change [21], etc. The main difference from natural and human pollutants is that the natural ones tend to occur far from large human populations and are less often than human sources of pollution, which are generally located in or near large human populations, and their emissions are more frequent. The main human sources of air pollution are associated with transportation, fuel combustion, and industrial processes [8].

The International Classification of Diseases (ICD)¹ is a code associated to diseases by their trends and statistical values, established by the [35]. It consists, generally, in a letter and three

¹The name of the diseases corresponding to the ICD code is obtained from <https://icd.who.int/browse10/2019/en>

numbers between 0 and 9. For example, the code for pneumonia due to staphylococcus is J152. This system comprehends from the values A00.0 to Z99.9, leaving the U letter for yet unknown sources. This classification was proposed by Farr at the end of the XIX century [34], and its purpose is to understand the causes of morbidity and mortality in order to improve the quality of life of the human population [34].

3. Hypothesis

Write the hypothesis that will be tested in one sentence. This should guide the project objectives and research questions.

4. Project objectives and/or Research questions

- The two or three most important goals.
- Can be pointed in a list or a concise paragraph.

5. Background and related literature

The first correspondence to discuss relationship between air quality and human health was registered during December 1930 in Belgium, when a three-day fog was declared to be the cause of death of 63 people — during the fog, disease and death were observed to increase, whereas after its dissipation, the figures normalized again [10]. Similarly, in December 1952, a four-day fog in London was associated with four thousand deaths [28]. The majority of the fog-related deaths were related to respiratory diseases.

In 1959 Lawther used a method to quantify the severity of respiratory illness based on their condition (negative numbers indicated they were recovered and positive numbers that they were getting worse). Then, he plotted a time series superposed with concentrations of two pollutants — SO_2 and smoke — and two weather variables — temperature and humidity; he discovered that the pollutants bore a similarity to the severity whereas the climate ones did not.

During the 1970s, short-term exposure to different pollutants was studied [7, 15, 16, 27] with experiments that implied some ethical and legal considerations, focusing on physiological analysis of the subjects. A compilation was published in by Ferris who documented that the pollutants, in regulated concentrations, had a negative impact on health, primarily on respiratory diseases. A set of methodologies are used to measure the relationships that are the focus of this study. They are multiple regression analysis [17, 18, 20, 25] with variations in the distributions such as logistic regressions [22], multivariate analysis [14, 23], auto regressive models [19], causality models [30] and case-crossover approximations [4, 29].

6. Methodology

The study will focus in the **Monterrey Metropolitan Area (MMA) between 2018 and 2019**. The air quality samples in the are taken each hour from 13 sensors over the MMA that measure concentrations of **CO, NO, NO₂, O₃, SO₂, PM₁₀, PM_{2.5}, and atmospheric pressure, rainfall, relative humidity, solar radiation, temperature, wind velocity and direction**. This data is provided by the *Sistema Integral de Monitoreo Ambiental de Nuevo León* (SIMA) [32]. The Mexican diseases data was obtained from the Mexican *Department of Health* [31] and contains information from all states and municipalities in Mexico such as **date of admission, egress date, age at the admission, gender, weight, height, ICD code upon arrived, ICD code upon diagnosed, reason of egress**.

The air quality data needs to be interpolated because it contains imputed records. Different temporal interpolation techniques are used and compared [11]. Also, an spatio-temporal interpolation is performed to obtain the missing data values [26]. Both data sets are processed and converted to georeferenced time series [33] that are stationary [20] in order to establish

their relationship by cross correlation [6], multiple regression analysis [3], vector autorregressive approaches, causality models [30] and geographic interactions [5]. The results are ranked by metrics like R^2 , the Akaike (AIC), and the Bayesian (BIC) information criteria [2]. Finally, it will be produced a web application that allow general and specialized population to interact with the data and obtain forecasts, interactions and visualizations of the models described.

7. Significance

While the Introduction mention the relevance of the research, here it need to be highlighted and demonstrated. Focus specially in the contributions that the results could bring to the state of the art and/or the solutions that can provide to the problems involved.

8. External Collaboration

If any, include authors, published papers, works in research programs or conferences where the research have been involved.

9. Project schedule

Add a schedule that includes the steps of the process, from investigation, possible publications and participation in conferences, to final products like thesis, libraries...A Gantt diagram is recommended.

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